N00129.AR.001359
NSB NEW LONDON
5090.3a

# FEASIBILITY STUDY REPORT FOR OPERABLE UNIT 4 (OU 4) VOLUME 4 OF 4 APPENDICES B.5 THROUGH E NSB NEW LONDON CT

12/01/2010

TETRA TECH NUS

# Feasibility Study
# for
# Operable Unit 4, Lower Subase

## Volume IV of IV - Appendices B.5 through E

# Naval Submarine Base
# New London

Groton, Connecticut

## Naval Facilities Engineering Command
## Mid-Atlantic

**Contract Numbers N62467-04-D-0055 and**

**N62470-08-D-1001**

**Contract Task Orders 424, WE24, and WE57**

December 2010

100706/P

# FEASIBILITY STUDY FOR OPERABLE UNIT 4, LOWER SUBASE

## VOLUME IV - APPENDICES B.5 THROUGH E

## NAVAL SUBMARINE BASE - NEW LONDON GROTON, CONNECTICUT

## COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

**Submitted to:**
**Naval Facilities Engineering Command Mid-Atlantic**
**9742 Maryland Avenue**
**Norfolk, Virginia 23511-3095**

**Submitted by:**
**Tetra Tech NUS, Inc.**
**234 Mall Boulevard, Suite 260**
**King of Prussia, Pennsylvania 19406**

**CONTRACT NOs. N62467-04-D-0055 AND N62470-08-D-1001**
**CONTRACT TASK ORDERS 424, WE24, AND WE57**

**DECEMBER 2010**


**PREPARED UNDER THE DIRECTION OF:**

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# APPENDIX B.5

# SEDIMENT ERM-Qs CALCULATIONS

# B.5.1 - 2008 SEDIMENT INVESTIGATION - FIELD FORMS AND DATA VALIDATION REPORTS

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TR24-SD-00183-[illegible]
Sample Location:
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/6/08<br>Time: 1015<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 0'-1' | BLACK | WET, SILTY, SANDY, CLAY W/ SHELLS, SOME ORGANIC MATTER. SAND IS FINE GRAINED. |

**COMPOSITE SAMPLE DATA:**

| | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| Date: | | | | |
| Method: | | | | |
| Monitor Readings (Range in ppm): | | | | |

**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| PAHs, ETPH | 1 x 8-OZ | X | |
| Metals by ICP, Hg by FIA, TOC | 1 x 8-OZ | X | |
| Pesticides, PCBs | 1 x 4-oz | X | |

**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|

Signature(s):

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TR24-SD-0001-0002
Sample Location: TR24-SD-001
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/6/08<br>Time: 1000<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 0'-2' | BLACK | WET, SILTY, SANDY CLAY, W/ SHELLS & SOME ORGANIC MATTER. SAND IS F-M GRAINED. |

**COMPOSITE SAMPLE DATA:**

| | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| Date: | | | | |
| Method: | | | | |
| Monitor Readings (Range in ppm): | | | | |

**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| TCLP-Metals, Moisture, pH, Salinity | 1 x 8-oz | X | |
| grain size | 1 x 8-oz | X | |
| bulk density | 1x 8-oz | X | |
| PCBs (Aroclors) | 1x 8-oz | X | |

**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|

Signature(s):

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TR24-SD-001A-0201
Sample Location: TR24-SD-001
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/6/08<br>Time: 1005<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 2'-4' | BLACK | WET SILTY CLAY & SAND. SHELLS & SOME FINE GRAVEL. SOME ORGANIC MATTER. SAND IS F-C GRAINED. |

**COMPOSITE SAMPLE DATA:**

| | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| Date: | | | | |
| Method: | | | | |
| Monitor Readings (Range in ppm): | | | | |

**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| PAH, ETPH, PCB (Aroclors) | 1 x 8-oz | X | |
| grain size | 1 x 8-oz | X | |
| bulk density | 1x 8-oz | X | |
| Metals ICP, Hg FIA, TCLP-Metals, TOC, pH, Salinity, Moisture Content | 1x 8-oz | X | |
| Pesticides, PCB (congeners) | 1x 4-oz | X | |

**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

MS/MSD
105

Duplicate ID No.:

Signature(s):

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TRZ4-SD-001A-0406
Sample Location: TRZ4-SD-001
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/6/08<br>Time: 1010<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 4'-6' | BLACK | WET SILTY, SANDY, CLAY, SOME SHELLS AND ORGANIC MATTER. SAND IS F-M |

**COMPOSITE SAMPLE DATA:**

| | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| Date: | | | | |
| Method: | | | | |
| Monitor Readings (Range in ppm): | | | | |

**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| PAH, ETPH, PCB (Aroclors) | 1 x 8-oz | X | |
| grain size | 1 x 8-oz | X | |
| bulk density | 1x 8-oz | X | |
| Metals ICP, Hg FIA, TCLP-Metals, TOC, pH, Salinity, Moisture Content | 1x 8-oz | X | |
| Pesticides, PCB (congeners) | 1x 4-oz | X | |

**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

MS/MSD

Duplicate ID No.:

Signature(s):

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TR24-SD-0023-0001
Sample Location: TR24-SD-002
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/6/08<br>Time: 1100<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 0'-1' | BLACK/DK BROWN | SILTY, SANDY, CLAY, WITH SHELLS, SOME ORGANIC MATTER. WET. SAND IS F GRAINED. |

**COMPOSITE SAMPLE DATA:**

| | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| Date: | | | | |
| Method: | | | | |
| Monitor Readings (Range in ppm): | | | | |

**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| PAHs, ETPH | 1 x 8-OZ | X | |
| Metals by ICP, Hg by FIA, TOC | 1 x 8-OZ | X | |
| Pesticides, PCBs | 1 x 4-oz | X | |

**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|

Signature(s):

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TR24-SD-002A-0002
Sample Location: TR24-SD-002
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/6/06<br>Time: 1105<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 0'-2' | BLACK | SILTY CLAY, SOME FINE SAND, SHELLS, & ORGANIC MATTER. WET. |

**COMPOSITE SAMPLE DATA:**

| | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| Date: | | | | |
| Method: | | | | |
| Monitor Readings (Range in ppm): | | | | |

**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| TCLP-Metals ~~[illegible]~~, Moisture, pH, Salinity | 1 x 8-oz | X | |
| grain size | 1 x 8-oz | X | |
| bulk density | 1x 8-oz | X | |
| PCBs (Aroclors) | 1x 8-oz | X | |

**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|

**Signature(s):**

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TR24-SD-002A-0204
Sample Location: TR24-SD-002
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/6/08<br>Time: 1110<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 2'-4' | BLACK | SILTY, SANDY, CLAY, SOME SHELLS, & ORGANIC MATTER. WET. SAND IS F-M GRAINED. |

**COMPOSITE SAMPLE DATA:**

| | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| Date: | | | | |
| Method: | | | | |
| Monitor Readings (Range in ppm): | | | | |

**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| PAH, ETPH, PCB (Aroclors) | 1 x 8-oz | X | |
| grain size | 1 x 8-oz | X | |
| bulk density | 1x 8-oz | X | |
| Metals ICP, Hg FIA, TCLP-Metals, TOC, pH, Salinity, Moisture Content | 1x 8-oz | X | |
| Pesticides, PCB (congeners) | 1x 4-oz | X | |

**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|

Signature(s):

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TRZ4-SD-002A-0406
Sample Location: TRZ4-SD-002
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/6/08<br>Time: 1115<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 4'-6' | BLACK | SILTY, SANDY, CLAY, SOME SHELLS & ORGANIC MATTER, WET SAND IS F-M GRAINED |

**COMPOSITE SAMPLE DATA:**

| | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| Date: | | | | |
| Method: | | | | |
| Monitor Readings (Range in ppm): | | | | |

**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| PAH, ETPH, PCB (Aroclors) | 1 x 8-oz | X | |
| grain size | 1 x 8-oz | X | |
| bulk density | 1x 8-oz | X | |
| Metals ICP, Hg FIA, TCLP-Metals, TOC, pH, Salinity, Moisture Content | 1x 8-oz | X | |
| Pesticides, PCB (congeners) | 1x 4-oz | X | |

**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|

**Signature(s):**

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TR24-SD-0033-0001
Sample Location: TR24-SD-003
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/6/08<br>Time: 1350<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 0'-1' | BLACK | WET, SILTY, SANDY, CLAY. SOME SHELLS & ORGANIC MATTER SAND IS FINE GRAINED |

**COMPOSITE SAMPLE DATA:**

| | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| Date: | | | | |
| Method: | | | | |
| Monitor Readings (Range in ppm): | | | | |

**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| PAHs, ETPH | 1 x 8-OZ | X | |
| Metals by ICP, Hg by FIA, TOC | 1 x 8-OZ | X | |
| Pesticides, PCBs | 1 x 4-oz | X | |

**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|

Signature(s):

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TR24-SD-003A-0002
Sample Location: TR24-SD-003
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/6/08<br>Time: 1355<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 0'-2' | BLACK | WET, SILTY, SANDY CLAY, SOME SHELLS & ORGANIC MATTER. SAND IS FINE GRAINED. |

**COMPOSITE SAMPLE DATA:**

| Date: | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| | | | | |
| Method: | | | | |
| | | | | |
| Monitor Readings (Range in ppm): | | | | |
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**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| TCLP-Metals [redacted], Moisture, pH, Salinity | 1 x 8-oz | X | |
| grain size | 1 x 8-oz | X | |
| bulk density | 1x 8-oz | X | |
| PCBs (Aroclors) | 1x 8-oz | X | |
| | | | |
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| | | | |

**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|

Signature(s):

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TR24-SD-003A-0204
Sample Location: TR24-SD-003
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/6/08<br>Time: 1400<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 2'-4' | DK GRAY | WET SILTY, SANDY, CLAY, SOME SHELLS & ORGANIC MATTER. >2" DIA ROCK @ 4'<br>SAND IS F-M. |

**COMPOSITE SAMPLE DATA:**

| | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| Date: | | | | |
| Method: | | | | |
| Monitor Readings (Range in ppm): | | | | |

**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| PAH, ETPH, PCB (Aroclors) | 1 x 8-oz | X | |
| grain size | 1 x 8-oz | X | |
| bulk density | 1x 8-oz | X | |
| Metals ICP, Hg FIA, TCLP-Metals, TOC, pH, Salinity, Moisture Content | 1x 8-oz | X | |
| Pesticides, PCB (congeners) | 1x 4-oz | X | |

**OBSERVATIONS / NOTES:**

>2" DIA ROCK @ 4'.

**MAP:**

**Circle if Applicable:**

MS/MSD YES

Duplicate ID No.:

Signature(s):

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TR24-SD-003A-0406
Sample Location: TR24-SD-003
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/6/08<br>Time: 1405<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 4'-6' | DK GRAY/BROWN | 4'-5' WET SILTY, SANDY CLAY, SOME SHELLS. ORGANIC MATTER, SAND IS F.<br>5'-6' WET F-C BROWN SAND. |

**COMPOSITE SAMPLE DATA:**

| Date: | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| | | | | |
| Method: | | | | |
| | | | | |
| Monitor Readings (Range in ppm): | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| PAH, ETPH, PCB (Aroclors) | 1 x 8-oz | X | |
| grain size | 1 x 8-oz | X | |
| bulk density | 1x 8-oz | X | |
| Metals ICP, Hg FIA, TCLP-Metals, TOC, pH, Salinity, Moisture Content | 1x 8-oz | X | |
| Pesticides, PCB (congeners) | 1x 4-oz | X | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|

**Signature(s):**

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TR24-SD-004B-001
Sample Location: TR24-SD-004
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/7<br>Time: 0945<br>Method: 3" S.S. Vibracore<br>Monitor Reading (ppm): NA | 0'-1' | BLACK/GRAY | 0-0.5 BLACK, WET, SILTY CLAY WITH SAND (F-C), SHELLS, & ORANIC<br>0.5-1.0 - GRAY F-C WET SAND |

**COMPOSITE SAMPLE DATA:**

| Date: | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| | | | | |
| Method: | | | | |
| | | | | |
| Monitor Readings (Range in ppm): | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| PAH, ETPH | 1 x 8-oz | X | |
| TOC, Metals by ICP, Hg by FIA | 1 x 8-oz | X | |
| Pesticides, PCBs | 1 x 4-oz | X | |
| | | | |
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| | | | |
| | | | |

**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|

**Signature(s):**

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TR24-SD-0014-0002
Sample Location: TR24-SD-0014
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/7<br>Time: 0950<br>Method: 3" S.S. Vibracore<br>Monitor Reading (ppm): NA | 0'-2' | BLACK/GRAY | 0-0.5 BLACK, WET, SILTY CLAY WITH F-C SAND, SHELLS & ORGANICS<br>0.5-2.0 GRAY F-C WET SAND, SOME SILT. |

**COMPOSITE SAMPLE DATA:**

| | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| Date: | | | | |
| Method: | | | | |
| Monitor Readings (Range in ppm): | | | | |

**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | | Collected | Other |
|---|---|---|---|---|
| TCLP-Metals, Moisture Content, pH, Salinity | 1 x 8-oz | | X | |
| grain size | 1 x 8-oz | | X | |
| bulk density | 1 x 8-oz | | X | |
| PCBs (congeners) | 1 x 8-oz | | X | |

**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|

Signature(s):

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TR24-SD-004A-0204
Sample Location: TR24-SD-004
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/7/08 | | BLACK/GRAY | 2'-3' WET GRAY F-C SAND WITH SILT |
| Time: 0955 | | | 3'-4' WET BLACK SILTY, SANDY CLAY. SOME SHELLS, ORGANIC MATTER |
| Method: 3" s.s. Vibracore | 2-4 | | |
| Monitor Reading (ppm): NA | | | |

**COMPOSITE SAMPLE DATA:**

| | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| Date: | | | | |
| Method: | | | | |
| Monitor Readings (Range in ppm): | | | | |

**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| PAH, ETPH, PCB (Aroclors) | 1 x 8-oz | X | |
| grain size | 1 x 8-oz | X | |
| bulk density | 1x 8-oz | X | |
| Metals ICP, Hg FIA, TCLP-Metals, TOC, pH, Salinity, Moisture Content | 1x 8-oz | X | |
| Pesticides, PCB (congeners) | 1x 4-oz | X | |

**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|

Signature(s):

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TR24-SD-0014A-0406
Sample Location: TR24-SD-0014
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/7/08<br>Time: 1000<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 4'-6' | Black | WET SILTY, SANDY, CLAY. SOME SHELLS & ORGANIC MATTER. SAND IS F-M. |

**COMPOSITE SAMPLE DATA:**

| | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| Date: | | | | |
| Method: | | | | |
| Monitor Readings (Range in ppm): | | | | |

**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| PAH, ETPH, PCB (Aroclors) | 1 x 8-oz | X | |
| grain size | 1 x 8-oz | X | |
| bulk density | 1x 8-oz | X | |
| Metals ICP, Hg FIA, TCLP-Metals, TOC, pH, Salinity, Moisture Content | 1x 8-oz | X | |
| Pesticides, PCB (congeners) | 1x 4-oz | X | |

**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

MS/MSD YES

Duplicate ID No.:

Signature(s):

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TR24-SD-005B-0001
Sample Location: TR24-SD-005
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/6/08<br>Time: 1140<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 0'-1' | BLACK | WET, SILTY CLAY, SOME F-M SAND, SOME SHELLS & ORGANIC MATTER. # FIBERS (HAIR?) (FUR?) |

**COMPOSITE SAMPLE DATA:**

| | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| Date: | | | | |
| Method: | | | | |
| Monitor Readings (Range in ppm): | | | | |

**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| PAHs, ETPH | 1 x 8-OZ | X | |
| Metals by ICP, Hg by FIA, TOC | 1 x 8-OZ | X | |
| Pesticides, PCBs | 1 x 4-oz | X | |

**OBSERVATIONS / NOTES:**

SOME SORT OF HAIR/FUR/FIBERS THROUGHOUT SAMPLE.

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|

Signature(s):

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TR24SD-005A-0002
Sample Location: TR24-SD-005
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/6/08<br>Time: 1145<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 0'-2' | BLACK | WET SILTY, CLAY, SOME F SAND, SHELLS, AND ORGANIC MATTER. |

**COMPOSITE SAMPLE DATA:**

| | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| Date: | | | | |
| Method: | | | | |
| Monitor Readings (Range in ppm): | | | | |

**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| TCLP-Metals ~~[illegible]~~, Moisture, pH, Salinity | 1 x 8-oz | X | |
| grain size | 1 x 8-oz | X | |
| bulk density | 1x 8-oz | X | |
| PCBs (Aroclors) | 1x 8-oz | X | |

**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|

Signature(s):

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TR24-SD-005A-0204
Sample Location: TR24-SD-005
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/6/08<br>Time: 1150<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 2'-4' | BLACK | WET SILTY CLAY, SOME F SAND, ABUNDANT SHELLS. |

**COMPOSITE SAMPLE DATA:**

| | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| Date: | | | | |
| Method: | | | | |
| Monitor Readings (Range in ppm): | | | | |

**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| PAH, ETPH, PCB (Aroclors) | 1 x 8-oz | X | |
| grain size | 1 x 8-oz | X | |
| bulk density | 1x 8-oz | X | |
| Metals ICP, Hg FIA, TCLP-Metals, TOC, pH, Salinity, Moisture Content | 1x 8-oz | X | |
| Pesticides, PCB (congeners) | 1x 4-oz | X | |

**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|

Signature(s):

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TR24-SD-005A-0206
Sample Location: TR24-SD-005
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/6/08<br>Time: 1155<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 4'-6' | BLACK/DK BROWN | WET SILTY CLAY, SOME FINE SAND, SHELLS, & ORGANIC MATTER. |

**COMPOSITE SAMPLE DATA:**

| | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| Date: | | | | |
| Method: | | | | |
| Monitor Readings (Range in ppm): | | | | |

**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| PAH, ETPH, PCB (Aroclors) | 1 x 8-oz | X | |
| grain size | 1 x 8-oz | X | |
| bulk density | 1x 8-oz | X | |
| Metals ICP, Hg FIA, TCLP-Metals, TOC, pH, Salinity, Moisture Content | 1x 8-oz | X | |
| Pesticides, PCB (congeners) | 1x 4-oz | X | |

**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|

Signature(s):

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

Sample ID No.: TR24-SD-00-6B-0001
Sample Location: TR24-SD-006
Sampled By: CW
C.O.C. No.:

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/6/08<br>Time: 1300<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 0'-1' | BLACK | SILTY, SANDY, CLAY, ABUNDANT SHELL FRAGS & ORGANIC MATTER WET. SAND IS FINE GRAINED. |

**COMPOSITE SAMPLE DATA:**

| | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| Date: | | | | |
| Method: | | | | |
| Monitor Readings (Range in ppm): | | | | |

**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| PAHs, ETPH | 1 x 8-OZ | X | |
| Metals by ICP, Hg by FIA, TOC | 1 x 8-OZ | X | |
| Pesticides, PCBs | 1 x 4-oz | X | |

**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

MS/MSD

Duplicate ID No.:

Signature(s):

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TR24-SD-0016A0002
Sample Location: TR24-SD-0016
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/6/08<br>Time: 1305<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 0'-2' | DK BROWN | SANDY, SILTY, CLAY, SOME SHELLS & ORGANIC MATTER. WET. SAND IS FINE-MED GRAINED. |

**COMPOSITE SAMPLE DATA:**

| | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| Date: | | | | |
| Method: | | | | |
| Monitor Readings (Range in ppm): | | | | |

**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| TCLP-Metals [redacted], Moisture, pH, Salinity | 1 x 8-oz | X | |
| grain size | 1 x 8-oz | X | |
| bulk density | 1x 8-oz | X | |
| PCBs (Aroclors) | 1x 8-oz | X | |

**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|

**Signature(s):**

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TR24-SD-006A-0204
Sample Location: TR24-SD-006
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/6/08<br>Time: 1310<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 2'-4' | DK BROWN | SANDY, SILTY CLAY. SOME SHELLS & ORGANIC MATTER. WET SAND IS F-M |

**COMPOSITE SAMPLE DATA:**

| | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| Date: | | | | |
| Method: | | | | |
| Monitor Readings (Range in ppm): | | | | |

**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| PAH, ETPH, PCB (Aroclors) | 1 x 8-oz | X | |
| grain size | 1 x 8-oz | X | |
| bulk density | 1x 8-oz | X | |
| Metals ICP, Hg FIA, TCLP-Metals, TOC, pH, Salinity, Moisture Content | 1x 8-oz | X | |
| Pesticides, PCB (congeners) | 1x 4-oz | X | |

**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|

Signature(s):

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TR24-SD-006A-0406
Sample Location: TR24-SD-006
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/6/08<br>Time: 1315<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 4'-6' | DK BROWN | 4'-5' F SANDY, SILTY CLAY, SOME SHELLS & ORGANIC MATTER! WET. F-M SAND<br>5'-6' - F-C SAND, BROWN, WET SOME SILT. |

**COMPOSITE SAMPLE DATA:**

| Date: | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| | | | | |
| Method: | | | | |
| | | | | |
| Monitor Readings (Range in ppm): | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| PAH, ETPH, PCB (Aroclors) | 1 x 8-oz | X | |
| grain size | 1 x 8-oz | X | |
| bulk density | 1x 8-oz | X | |
| Metals ICP, Hg FIA, TCLP-Metals, TOC, pH, Salinity, Moisture Content | 1x 8-oz | X | |
| Pesticides, PCB (congeners) | 1x 4-oz | X | |
| | | | |
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**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|

Signature(s):

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TR24-SD-007B-0001
Sample Location: TR24-SD-007
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/6/08<br>Time: 1215<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 0'-1' | BLACK | WET SILTY, CLAY. SOME SAND & SHELLS. SAND IS FINE GRAINED. |

**COMPOSITE SAMPLE DATA:**

| | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| Date: | | | | |
| Method: | | | | |
| Monitor Readings (Range in ppm): | | | | |

**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| PAHs, ETPH | 1 x 8-OZ | X | |
| Metals by ICP, Hg by FIA, TOC | 1 x 8-OZ | X | |
| Pesticides, PCBs | 1 x 4-oz | X | |

**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|

Signature(s):

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TR24-SD-0004-0002
Sample Location: TR24-SD-007
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/6<br>Time: 1220<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 0'-2' | DK BROWN | SILTY, SANDY, CLAY, SOME SHELLS WET. SAND IS FINE GRAINED |

**COMPOSITE SAMPLE DATA:**

| | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| Date: | | | | |
| Method: | | | | |
| Monitor Readings (Range in ppm): | | | | |

**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| TCLP-Metals, Moisture, pH, Salinity | 1 x 8-oz | X | |
| grain size | 1 x 8-oz | X | |
| bulk density | 1x 8-oz | X | |
| PCBs (Aroclors) | 1x 8-oz | X | |

**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

MS/MSD

Duplicate ID No.:

Signature(s):

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TR24-SD-007A-0406
Sample Location: TR24-SD-007
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/6/08<br>Time: 1230<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 4'-6' | DK BROWN | WET SILTY, SANDY, CLAY. A FEW SHELLS. SAND IS F-M. |

**COMPOSITE SAMPLE DATA:**

| | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| Date: | | | | |
| Method: | | | | |
| Monitor Readings (Range in ppm): | | | | |

**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| PAH, ETPH, PCB (Aroclors) | 1 x 8-oz | X | |
| grain size | 1 x 8-oz | X | |
| bulk density | 1x 8-oz | X | |
| Metals ICP, Hg FIA, TCLP-Metals, TOC, pH, Salinity, Moisture Content | 1x 8-oz | X | |
| Pesticides, PCB (congeners) | 1x 4-oz | X | |

**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

MS/MSD

Duplicate ID No.:

Signature(s):

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TR24-SD-008B-0001
Sample Location: TR24-SD-008
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/6/08<br>Time: 1450<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 0'-1' | BLACK | WET, SILTY, SANDY CLAY, SOME SHELLS & ORGANIC MATTER. SAND IS FINE GRAINED. |

**COMPOSITE SAMPLE DATA:**

| Date: | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| | | | | |
| Method: | | | | |
| | | | | |
| Monitor Readings (Range in ppm): | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| PAHs, ETPH | 1 x 8-OZ | X | |
| Metals by ICP, Hg by FIA, TOC | 1 x 8-OZ | X | |
| Pesticides, PCBs | 1 x 4-OZ | X | |
| | | | |
| | | | |
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| | | | |
| | | | |

**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|
| | |

Signature(s):

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TR24-SD-008A-0002
Sample Location: TR24-SD-008
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/6/08<br>Time: 1435<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 0'-2' | BLACK | WET SILTY SANDY CLAY. SOME ORGANIC MATTER SAND IS FINE GRAINED |

**COMPOSITE SAMPLE DATA:**

| Date: | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| | | | | |
| Method: | | | | |
| | | | | |
| Monitor Readings (Range in ppm): | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| TCLP-Metals [redacted], Moisture, pH, Salinity | 1 x 8-oz | X | |
| grain size | 1 x 8-oz | X | |
| bulk density | 1x 8-oz | X | |
| PCBs (Aroclors) | 1x 8-oz | X | |
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**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|

Signature(s):

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TR24-SD-008A-0204
Sample Location: TR24-SD-008
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/6/08<br>Time: 1440<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 2'-4' | BLACK | WET SILTY SANDY CLAY. SOME ORGANIC MATTER SAND IS F-M GRAINED |

**COMPOSITE SAMPLE DATA:**

| Date: | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| Method: | | | | |
| Monitor Readings (Range in ppm): | | | | |

**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| PAH, ETPH, PCB (Aroclors) | 1 x 8-oz | X | |
| grain size | 1 x 8-oz | X | |
| bulk density | 1x 8-oz | X | |
| Metals ICP, Hg FIA, TCLP-Metals, TOC, pH, Salinity, Moisture Content | 1x 8-oz | X | |
| Pesticides, PCB (congeners) | 1x 4-oz | X | |

**OBSERVATIONS / NOTES:**

**MAP:**

**Duplicate ID No.:**

**Signature(s):**

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TR24-SD-008A-0406
Sample Location: TR24-SD-008
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/6/08<br>Time: 1445<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 4'-6' | BLACK | SILTY CLAY WITH MINOR SAND. SOME ORGANIC MATTER SAND IS F-M. |

**COMPOSITE SAMPLE DATA:**

| Date: | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| | | | | |
| Method: | | | | |
| | | | | |
| Monitor Readings (Range in ppm): | | | | |
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**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| PAH, ETPH, PCB (Aroclors) | 1 x 8-oz | X | |
| grain size | 1 x 8-oz | X | |
| bulk density | 1x 8-oz | X | |
| Metals ICP, Hg FIA, TCLP-Metals, TOC, pH, | | X | |
| Salinity, Moisture Content | 1x 8-oz | X | |
| Pesticides, PCB (congeners) | 1x 4-oz | X | |
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**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|

Signature(s):

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TRPI-SD-0018-0001
Sample Location: TRPI-SD-001
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/6<br>Time: 1530<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 0'-1' | BLACK | WET, SILTY CLAY W/F SAND, ABUNDANT SHELLS, SOME ORGANIC MATTER |

**COMPOSITE SAMPLE DATA:**

| | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| Date: | | | | |
| Method: | | | | |
| Monitor Readings (Range in ppm): | | | | |

**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| PAHs, ETPH | 1 x 8-OZ | X | |
| Metals by ICP, Hg by FIA, TOC | 1 x 8-OZ | X | |
| Pesticides, PCBs | 1 x 4-oz | X | |

**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|

**Signature(s):**

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TRPI-SD-001A-0002
Sample Location: TRPI-SD-001
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/6/08<br>Time: 1535<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 0'-2' | BLACK | WET SILTY, SANDY, CLAY, SOME SHELLS & ORGANIC MATTER SAND IS FINE GRAINED. |

**COMPOSITE SAMPLE DATA:**

| Date: | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| | | | | |
| Method: | | | | |
| | | | | |
| Monitor Readings (Range in ppm): | | | | |
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**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| TCLP-Metals-[redacted], Moisture, pH, Salinity | 1 x 8-oz | X | |
| grain size | 1 x 8-oz | X | |
| bulk density | 1x 8-oz | X | |
| PCBs (Aroclors) | 1x 8-oz | X | |
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**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|

**Signature(s):**

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TRP1-SD-001A-0204
Sample Location: TRP1-SD-001
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/6/08<br>Time: 1540<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 2'-4' | BLACK | WET, SILTY, SANDY, CLAY, SOME SHELLS & ORGANIC MATTER SAND IS F-M. |

**COMPOSITE SAMPLE DATA:**

| | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| Date: | | | | |
| Method: | | | | |
| Monitor Readings (Range in ppm): | | | | |

**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| PAH, ETPH, PCB (Aroclors) | 1 x 8-oz | X | |
| grain size | 1 x 8-oz | X | |
| bulk density | 1x 8-oz | X | |
| Metals ICP, Hg FIA, TCLP-Metals, TOC, pH, Salinity, Moisture Content | 1x 8-oz | X | |
| Pesticides, PCB (congeners) | 1x 4-oz | X | |

**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|

**Signature(s):**

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TRP1-SD-C01A-0406
Sample Location: TRP1-SD-061
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/6/08<br>Time: 1545<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 4'-6' | BLACK | WET SILTY, SANDY, CLAY, SOME SHELLS & ORGANIC MATTER. SAND IS F-M GRAINED. |

**COMPOSITE SAMPLE DATA:**

| Date: | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| Method: | | | | |
| Monitor Readings (Range in ppm): | | | | |

**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| PAH, ETPH, PCB (Aroclors) | 1 x 8-oz | X | |
| grain size | 1 x 8-oz | X | |
| bulk density | 1x 8-oz | X | |
| Metals ICP, Hg FIA, TCLP-Metals, TOC, pH, Salinity, Moisture Content | 1x 8-oz | X | |
| Pesticides, PCB (congeners) | 1x 4-oz | X | |

**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|

Signature(s):

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TRP1-SD-002B-0001
Sample Location: TRP1-SD-002
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/7/08<br>Time: 1030<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 0'-1' | BLACK | WET, SILTY CLAY, SOME SAND, SHELLS, & ORGANIC MATTER. SAND IS FINE |

**COMPOSITE SAMPLE DATA:**

| | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| Date: | | | | |
| Method: | | | | |
| Monitor Readings (Range in ppm): | | | | |

**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| PAHs, ETPH | 1 x 8-OZ | X | |
| Metals by ICP, Hg by FIA, TOC | 1 x 8-OZ | X | |
| Pesticides, PCBs | 1 x 4-ox | X | |

**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|

Signature(s):

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TRPI-SD-002A-0002
Sample Location: TRPI-SD-002
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/7/08<br>Time: 1035<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 0'-2' | BLACK | WET SILTY SANDY CLAY, FEW SHELLS & ORGANIC MATTER. SAND IS FINE GRAINED |

**COMPOSITE SAMPLE DATA:**

| Date: | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| | | | | |
| Method: | | | | |
| | | | | |
| Monitor Readings (Range in ppm): | | | | |
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**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| TCLP-Metals by [redacted], Moisture, pH, Salinity | 1 x 8-oz | X | |
| grain size | 1 x 8-oz | X | |
| bulk density | 1x 8-oz | X | |
| PCBs (Aroclors) | 1x 8-oz | X | |
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**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|

**Signature(s):**

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TRP1-SD-002A-0204
Sample Location: TRP1-SD-002
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/7/08<br>Time: 1040<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 2'-4' | BLACK | 2'-3' WET SILTY, SANDY, CLAY, SOME SHELLS & ORGANIC MATTER. SAND IS F-M<br>3'-4' WET F-C SILTY SAND, SOME SHELLS |

**COMPOSITE SAMPLE DATA:**

| Date: | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| | | | | |
| Method: | | | | |
| | | | | |
| Monitor Readings (Range in ppm): | | | | |
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**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| PAH, ETPH, PCB (Aroclors) | 1 x 8-oz | X | |
| grain size | 1 x 8-oz | X | |
| bulk density | 1x 8-oz | X | |
| Metals ICP, Hg FIA, TCLP-Metals, TOC, pH, Salinity, Moisture Content | 1x 8-oz | X | |
| Pesticides, PCB (congeners) | 1x 4-oz | X | |
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**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|
| | |

**Signature(s):**

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TRPI-SD-002A-0406
Sample Location: TRPI-SD-002
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/7/08<br>Time: 1045<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 4'-6' | BLACK | WET, SILTY, SANDY, CLAY. SOME SHELLS & ORGANIC MATTER SAND IS F-M. |

**COMPOSITE SAMPLE DATA:**

| Date: | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| | | | | |
| Method: | | | | |
| | | | | |
| Monitor Readings (Range in ppm): | | | | |
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**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| PAH, ETPH, PCB (Aroclors) | 1 x 8-oz | X | |
| grain size | 1 x 8-oz | X | |
| bulk density | 1x 8-oz | X | |
| Metals ICP, Hg FIA, TCLP-Metals, TOC, pH, Salinity, Moisture Content | 1x 8-oz | X | |
| Pesticides, PCB (congeners) | 1x 4-oz | X | |
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**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|
| | |

Signature(s):

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TRPI-SD-003B-0001
Sample Location: TRPI-SD-003
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| Date: 11/7/08 | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Time: 1130<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 0'-1' | BLACK | WET, SILTY CLAY, SOME SAND (F to C) GRAINED, SOME ORGANIC MATTER |

**COMPOSITE SAMPLE DATA:**

| Date: | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| | | | | |
| Method: | | | | |
| | | | | |
| Monitor Readings (Range in ppm): | | | | |
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**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| PAHs, ETPH | 1 x 8-OZ | X | |
| Metals by ICP, Hg by FIA, TOC | 1 x 8-OZ | X | |
| Pesticides, PCBs | 1 x 4-oz | X | |
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**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|
| | |

**Signature(s):**

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TRP1-SD-003A-0002
Sample Location: TRP1-SD-003
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/7/08<br>Time: 1135<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 0'-2' | BLACK/BROWN | WET SILTY, SANDY CLAY. SOME ORGANIC MATTER. SAND IS FINE GRAINED. |

**COMPOSITE SAMPLE DATA:**

| Date: | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| | | | | |
| Method: | | | | |
| | | | | |
| Monitor Readings (Range in ppm): | | | | |
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**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| TCLP-Metals, Moisture, pH, Salinity | 1 x 8-oz | X | |
| grain size | 1 x 8-oz | X | |
| bulk density | 1x 8-oz | X | |
| PCBs (Aroclors) | 1x 8-oz | X | |
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**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|

**Signature(s):**

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TRPI-SD-003A-0204
Sample Location: TRPI-SD-003
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/7/08<br>Time: 1140<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 2-4' | BLACK | WET, SILTY, SANDY CLAY, ABUNDANT SHELL FRAGMENTS, SOME ORGANIC MATTER. SAND IS F-M. |

**COMPOSITE SAMPLE DATA:**

| Date: | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| | | | | |
| Method: | | | | |
| | | | | |
| Monitor Readings (Range in ppm): | | | | |
| | | | | |
| | | | | |
| | | | | |
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**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| PAH, ETPH, PCB (Aroclors) | 1 x 8-oz | X | |
| grain size | 1 x 8-oz | X | |
| bulk density | 1x 8-oz | X | |
| Metals ICP, Hg FIA, TCLP-Metals, TOC, pH, | | X | |
| Salinity, Moisture Content | 1x 8-oz | | |
| Pesticides, PCB (congeners) | 1x 4-oz | X | |
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**OBSERVATIONS / NOTES:**

DEBRIS / HARD MATERIAL CAUSING REFUSAL @ 4'.
SEVERAL ATTEMPTS MET WITH REFUSAL @ 4'.

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|
| | |

Signature(s):

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TRPI-SD-0041B-0001
Sample Location: TRPI-SD-0041
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 10/7/08<br>Time: 1230<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 0'-1' | BLACK | WET, SILTY CLAY, SOME F-M SAND, SHELL FRAGS, & ORGANIC MATTER |

**COMPOSITE SAMPLE DATA:**

| Date: | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| | | | | |
| Method: | | | | |
| | | | | |
| Monitor Readings (Range in ppm): | | | | |
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**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| PAHs, ETPH | 1 x 8-OZ | X | |
| Metals by ICP, Hg by FIA, TOC | 1 x 8-OZ | X | |
| Pesticides, PCBs | 1 x 4-oz | X | |
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**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|

Signature(s):

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TRPI-SD-004A-0002
Sample Location: TRPI-SD-004
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/7/08<br>Time: 1235<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 0'-2' | BLACK | WET, SILTY, SANDY CLAY. SOME SHELLS & ORGANIC MATTER<br>SAND IS F-M GRAINED |

**COMPOSITE SAMPLE DATA:**

| | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| Date: | | | | |
| Method: | | | | |
| Monitor Readings (Range in ppm): | | | | |

**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| TCLP-Metals by ICP, Moisture, pH, Salinity | 1 x 8-oz | X | |
| grain size | 1 x 8-oz | X | |
| bulk density | 1x 8-oz | X | |
| PCBs (Aroclors) | 1x 8-oz | X | |

**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|

**Signature(s):**

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TRPI-SD-004A-020Y
Sample Location: TRPI-SD-004Y
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/7/08<br>Time: 1240<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 2'-4' | BLACK | WET SILTY, SANDY, CLAY. SOME SHELLS & ORGANIC MATTER. SAND IS F-M |

**COMPOSITE SAMPLE DATA:**

| Date: | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| | | | | |
| Method: | | | | |
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| Monitor Readings (Range in ppm): | | | | |
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**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| PAH, ETPH, PCB (Aroclors) | 1 x 8-oz | X | |
| grain size | 1 x 8-oz | X | |
| bulk density | 1x 8-oz | X | |
| Metals ICP, Hg FIA, TCLP-Metals, TOC, pH, Salinity, Moisture Content | 1x 8-oz | X | |
| Pesticides, PCB (congeners) | 1x 4-oz | X | |
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**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

MS/MSD YES

**Duplicate ID No.:**

**Signature(s):**

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TRP1-SD-004A-040L
Sample Location: TRP1-SD-004
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/7/08<br>Time: 1245<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 4'-6' | BLACK/DK BROWN | WET, SILTY, SANDY CLAY, ABUNDANT SHELLS & SOME ORGANIC MATTER SAND IS F-M. |

**COMPOSITE SAMPLE DATA:**

| | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| Date: | | | | |
| Method: | | | | |
| Monitor Readings (Range in ppm): | | | | |

**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| PAH, ETPH, PCB (Aroclors) | 1 x 8-oz | X | |
| grain size | 1 x 8-oz | X | |
| bulk density | 1x 8-oz | X | |
| Metals ICP, Hg FIA, TCLP-Metals, TOC, pH, Salinity, Moisture Content | 1x 8-oz | X | |
| Pesticides, PCB (congeners) | 1x 4-oz | X | |

**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|

Signature(s):

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TRPI-SD-0008-0001
Sample Location: TRPI-SD-005
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/7/08<br>Time: 1330<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 0'-1' | BLACK | BLACK, WET, SILTY, SANDY, CLAY, ABUNDANT SHELLS, SOME ORGANIC MATTER. SAND IS F-M. |

**COMPOSITE SAMPLE DATA:**

| Date: | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
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| Method: | | | | |
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| Monitor Readings (Range in ppm): | | | | |
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**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| PAHs, ETPH | 1 x 8-OZ | X | |
| Metals by ICP, Hg by FIA, TOC | 1 x 8-OZ | X | |
| Pesticides, PCBs | 1 x 4-oz | X | |
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**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|
| | |

**Signature(s):**

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TRPI-SD-005A-0002
Sample Location: TRPI-SD-005
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/7/08<br>Time: 1335<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 0'-2' | BLACK | WET SILTY, SANDY, CLAY. ABUNDANT SHELLS, SOME ORGANIC MATTER SAND IS F-M. |

**COMPOSITE SAMPLE DATA:**

| Date: | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| | | | | |
| Method: | | | | |
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| Monitor Readings (Range in ppm): | | | | |
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**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| TCLP-Metals by ICP, Moisture, pH, Salinity | 1 x 8-oz | X | |
| grain size | 1 x 8-oz | X | |
| bulk density | 1x 8-oz | X | |
| PCBs (Aroclors) | 1x 8-oz | X | |
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**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|

**Signature(s):**

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TRP1-SD-005A-0204
Sample Location: TRP1-SD-005
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/7/08<br>Time: 1340<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 2'-4' | BLACK | WET SILTY, SANDY CLAY, ABUNDANT SHELLS, SOME ORGANIC MATTER SAND IS F-M. |

**COMPOSITE SAMPLE DATA:**

| Date: | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| | | | | |
| Method: | | | | |
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| Monitor Readings (Range in ppm): | | | | |
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**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| PAH, ETPH, PCB (Aroclors) | 1 x 8-oz | X | |
| grain size | 1 x 8-oz | X | |
| bulk density | 1x 8-oz | X | |
| Metals ICP, Hg FIA, TCLP-Metals, TOC, pH, | | X | |
| Salinity, Moisture Content | 1x 8-oz | | |
| Pesticides, PCB (congeners) | 1x 4-oz | X | |
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**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|

Signature(s):

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TRPI-SD-005A-0406
Sample Location: TRPI-SD-005
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/7/08<br>Time: 1345<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 4'-6' | BLACK/DK BROWN | WET SILTY, SANDY, CLAY, ABUNDANT SHELLS, SOME ORGANIC MATERIAL SAND ↑ WITH DEPTH, F-M GRAIN |

**COMPOSITE SAMPLE DATA:**

| Date: | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| | | | | |
| Method: | | | | |
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| Monitor Readings (Range in ppm): | | | | |
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**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| PAH, ETPH, PCB (Aroclors) | 1 x 8-oz | X | |
| grain size | 1 x 8-oz | X | |
| bulk density | 1x 8-oz | X | |
| Metals ICP, Hg FIA, TCLP-Metals, TOC, pH, | | X | |
| Salinity, Moisture Content | 1x 8-oz | | |
| Pesticides, PCB (congeners) | 1x 4-oz | X | |
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**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|

Signature(s):

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TRP1-SD-006B-0001
Sample Location: TRP1-SD-006
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/7/08<br>Time: 0830<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 0'-1' | BLACK | WET SILTY CLAY. SOME SAND (F-C) ABUNDANT SHELLS. SOME ORGANIC MATTER. |

**COMPOSITE SAMPLE DATA:**

| | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| Date: | | | | |
| Method: | | | | |
| Monitor Readings (Range in ppm): | | | | |

**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| PAHs, ETPH | 1 x 8-OZ | X | |
| Metals by ICP, Hg by FIA, TOC | 1 x 8-OZ | X | |
| Pesticides, PCBs | 1 x 4-oz | X | |

**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|

**Signature(s):**

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TRP1-SD-006A-0002
Sample Location: TRP1-SD-006
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/7/08<br>Time: 0835<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 0'-2' | BLACK | WET SILTY CLAY. SOME SAND. F-C, ABUNDANT SHELLS. SOME ORGANIC MATTER |

**COMPOSITE SAMPLE DATA:**

| Date: | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| | | | | |
| Method: | | | | |
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| Monitor Readings (Range in ppm): | | | | |
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**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| TCLP-Metals by ICP, Moisture, pH, Salinity | 1 x 8-oz | X | |
| grain size | 1 x 8-oz | X | |
| bulk density | 1x 8-oz | X | |
| PCBs (Aroclors) | 1x 8-oz | X | |
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**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|

**Signature(s):**

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TRP1-SD-006A-0203
Sample Location: TRP1-SD-006
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/7/08<br>Time: 0840<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 2' - 3'<br>~~2'~~<br>DEBRIS @ 3' BGS | BLACK | WET, SILTY, SANDY CLAY, SAND IS F-C, ABUNDANT SHELLS, SOME ORGANIC MATTER. |

**COMPOSITE SAMPLE DATA:**

| Date: | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| | | | | |
| Method: | | | | |
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| Monitor Readings (Range in ppm): | | | | |
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**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| PAH, ETPH, PCB (Aroclors) | 1 x 8-oz | X | |
| grain size | 1 x 8-oz | X | |
| bulk density | 1x 8-oz | X | |
| Metals ICP, Hg FIA, TCLP-Metals, TOC, pH, Salinity, Moisture Content | 1x 8-oz | X | |
| Pesticides, PCB (congeners) | 1x 4-oz | X | |
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**OBSERVATIONS / NOTES:**

DEBRIS AROUND END OF PIER 1
COULD NOT CORE PAST 3' IN DEPTH.

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|
| | |

**Signature(s):**

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TRP1-SD-007B-0001
Sample Location: TRP1-SD-007
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/6/08<br>Time: 0915<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 0'-1' | BLACK | WET, SILTY, SANDY CLAY, SOME F GRAVEL, SHELLS, & ORGANIC MATTER * METAL PIECES, SAND IS F-C |

**COMPOSITE SAMPLE DATA:**

| | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| Date: | | | | |
| Method: | | | | |
| Monitor Readings (Range in ppm): | | | | |

**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| PAHs, ETPH | 1 x 8-OZ | X | |
| Metals by ICP, Hg by FIA, TOC | 1 x 8-OZ | X | |
| Pesticides, PCBs | 1 x 4-oz | X | |

**OBSERVATIONS / NOTES:**

* METAL SHAVINGS IN CORE

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|

Signature(s):

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TRP1-SD-0004-0002
Sample Location: TRP1-SD-0002
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/6/08<br>Time: 0920<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 0'-2' | BLACK | WET, SILTY, SANDY CLAY W/ ABUNDANT SHELLS, SOME F GRAVEL & ORGANIC MATTER. SAND IS F-C GRAINED. |

**COMPOSITE SAMPLE DATA:**

| Date: | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| | | | | |
| Method: | | | | |
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| Monitor Readings (Range in ppm): | | | | |
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**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| TCLP-Metals [redacted], Moisture, pH, Salinity | 1 x 8-oz | X | |
| grain size | 1 x 8-oz | X | |
| bulk density | 1x 8-oz | X | |
| PCBs (Aroclors) | 1x 8-oz | X | |
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**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|

Signature(s):

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TRP1-SD-007A-0204
Sample Location: TRP1-SD-007
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/6/08<br>Time: 0925<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 2'-4' | BLACK | WET SILTY CLAY, ABUNDANT F-C SAND, F GRAVEL, SOME SHELLS & ORGANIC MATTER |

**COMPOSITE SAMPLE DATA:**

| | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| Date: | | | | |
| Method: | | | | |
| Monitor Readings (Range in ppm): | | | | |

**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| PAH, ETPH, PCB (Aroclors) | 1 x 8-oz | X | |
| grain size | 1 x 8-oz | X | |
| bulk density | 1x 8-oz | X | |
| Metals ICP, Hg FIA, TCLP-Metals, TOC, pH, Salinity, Moisture Content | 1x 8-oz | X | |
| Pesticides, PCB (congeners) | 1x 4-oz | X | |

**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|

Signature(s):

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TRP1-SD-007A-0406
Sample Location: TRP1-SD-007
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/6/08<br>Time: 0930<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 4'-6' | BLACK | WET, SILTY, SANDY CLAY. SOME SHELLS & ORGANIC MATTER SAND IS F-M GRAINED |

**COMPOSITE SAMPLE DATA:**

| | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| Date: | | | | |
| Method: | | | | |
| Monitor Readings (Range in ppm): | | | | |

**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| PAH, ETPH, PCB (Aroclors) | 1 x 8-oz | X | |
| grain size | 1 x 8-oz | X | |
| bulk density | 1x 8-oz | X | |
| Metals ICP, Hg FIA, TCLP-Metals, TOC, pH, Salinity, Moisture Content | 1x 8-oz | X | |
| Pesticides, PCB (congeners) | 1x 4-oz | X | |

**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|
| | |

Signature(s):

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TRP1-SD-0008-0001
Sample Location: TRP1-SD-0008
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/5/08<br>Time: 1430<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 0'-1' | BLACK | WET, SILTY, SANDY CLAY. SOME SHELLS & ORGANIC MATTER. SAND IS F-M |

**COMPOSITE SAMPLE DATA:**

| | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| Date: ~~11/5/08~~ | | | | |
| Method: | | | | |
| Monitor Readings (Range in ppm): | | | | |

**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| PAHs, ETPH | 1 x 8-OZ | X | |
| Metals by ICP, Hg by FIA, TOC | 1 x 8-OZ | X | |
| Pesticides, PCBs | 1 x 4-oz | X | |

**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|

Signature(s):

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TRPI-SD-008A-0002
Sample Location: TRPI-SD-008
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/5/08<br>Time: 1435<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 0'-2' | BLACK | WET, SILTY SANDY CLAY, SOME SHELLS, VF-GRAVEL, & ORGANIC MATTER SAND IS F-C |

**COMPOSITE SAMPLE DATA:**

| | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| Date: | | | | |
| Method: | | | | |
| Monitor Readings (Range in ppm): | | | | |

**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| TCLP-Metals [redacted], Moisture, pH, Salinity | 1 x 8-oz | X | |
| grain size | 1 x 8-oz | X | |
| bulk density | 1x 8-oz | X | |
| PCBs (Aroclors) | 1x 8-oz | X | |

**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|

Signature(s):

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TRPI-SD-0084-0201
Sample Location: TRPI-SD-008
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/5/08<br>Time: 1440<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 2'-4' | BLACK | WET SILTY, SANDY, CLAY, SOME SHELLS, & ORGANIC MATTER. SAND IS F-M |

**COMPOSITE SAMPLE DATA:**

| | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| Date: | | | | |
| Method: | | | | |
| Monitor Readings (Range in ppm): | | | | |

**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| PAH, ETPH, PCB (Aroclors) | 1 x 8-oz | X | |
| grain size | 1 x 8-oz | X | |
| bulk density | 1x 8-oz | X | |
| Metals ICP, Hg FIA, TCLP-Metals, TOC, pH, Salinity, Moisture Content | 1x 8-oz | X | |
| Pesticides, PCB (congeners) | 1x 4-oz | X | |

**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|

Signature(s):

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TRPI-SD-0024-0406
Sample Location: TRPI-SD-008
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/5/08<br>Time: 1445<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 4'-6' | BLACK | WET, SILTY, SANDY, CLAY, SOME SHELLS, & ORGANIC MATTER SAND IS F-M GRAINED |

**COMPOSITE SAMPLE DATA:**

| | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| Date: | | | | |
| Method: | | | | |
| Monitor Readings (Range in ppm): | | | | |

**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| PAH, ETPH, PCB (Aroclors) | 1 x 8-oz | X | |
| grain size | 1 x 8-oz | X | |
| bulk density | 1x 8-oz | X | |
| Metals ICP, Hg FIA, TCLP-Metals, TOC, pH, Salinity, Moisture Content | 1x 8-oz | X | |
| Pesticides, PCB (congeners) | 1x 4-oz | X | |

**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|

**Signature(s):**

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TRP1-SD-009B-000
Sample Location: TRP1-SD-009
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/5/08<br>Time: 1500<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 0'-1' | BLACK | WET, SILTY CLAY, SOME F-C SAND, F GRAVEL, SHELLS, ORGANIC MATTER. |

**COMPOSITE SAMPLE DATA:**

| | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| Date: | | | | |
| Method: | | | | |
| Monitor Readings (Range in ppm): | | | | |

**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| PAHs, ETPH | 1 x 8-OZ | X | |
| Metals by ICP, Hg by FIA, TOC | 1 x 8-OZ | X | |
| Pesticides, PCBs CON | 1 x 4-oz | X | |

**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|

Signature(s):

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TRP1-SD-009A-0002
Sample Location: TRP1-SD-009
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/5/08<br>Time: 1505<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 0'-2' | | WET, SILTY, SANDY (VF-M) CLAY, SOME SHELLS, & ORGANIC MATTER |

**COMPOSITE SAMPLE DATA:**

| Date: | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| | | | | |
| Method: | | | | |
| | | | | |
| Monitor Readings (Range in ppm): | | | | |
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**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| TCLP-Metals ~~by ICP~~, Moisture, pH, Salinity | 1 x 8-oz | X | |
| grain size | 1 x 8-oz | X | |
| bulk density | 1x 8-oz | X | |
| PCBs (Aroclors) | 1x 8-oz | X | |
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**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|

**Signature(s):**

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TRP1-SD-009A-0204
Sample Location: TRP1-SD-009
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/05/08<br>Time: 1500<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 2'-4' | BLACK | SILTY, SANDY, CLAY WITH F GRAVEL & SHELLS. WET. SAND IS F-C |

**COMPOSITE SAMPLE DATA:**

| Date: | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| | | | | |
| Method: | | | | |
| | | | | |
| Monitor Readings (Range in ppm): | | | | |
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**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| PAH, ETPH, PCB (Aroclors) | 1 x 8-oz | X | |
| grain size | 1 x 8-oz | X | |
| bulk density | 1x 8-oz | X | |
| Metals ICP, Hg FIA, TCLP-Metals, TOC, pH, | | X | |
| Salinity, Moisture Content | 1x 8-oz | | |
| Pesticides, PCB (congeners) | 1x 4-oz | X | |
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**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|
| | |

**Signature(s):**

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TRP1-SD-0009A-0406
Sample Location: TRP1-SD-0009
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/5/08<br>Time: 1518<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 4'-6' | BLACK | SILTY, SANDY, CLAY, SOME F GRAVEL & SHELLS. WET, SAND IS F-C |

**COMPOSITE SAMPLE DATA:**

| Date: | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| | | | | |
| Method: | | | | |
| | | | | |
| Monitor Readings (Range in ppm): | | | | |
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**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| PAH, ETPH, PCB (Aroclors) | 1 x 8-oz | X | |
| grain size | 1 x 8-oz | X | |
| bulk density | 1x 8-oz | X | |
| Metals ICP, Hg FIA, TCLP-Metals, TOC, pH, | | X | |
| Salinity, Moisture Content | 1x 8-oz | | |
| Pesticides, PCB (congeners) | 1x 4-oz | X | |
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**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|
| | |

**Signature(s):**

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TRP1-SD-0103-0001
Sample Location: TRP1-SD-010
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/5/08<br>Time: 1330<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 0'-1' | BLACK | WET, CLAY WITH SILT & F-C SAND, SOME F GRAVEL AND SHELLS. SOME ORGANIC MATTER. |

**COMPOSITE SAMPLE DATA:**

| | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| Date: | | | | |
| Method: | | | | |
| Monitor Readings (Range in ppm): | | | | |

**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| PAHs, ETPH | 1 x 8-OZ | X | |
| Metals by ICP, Hg by FIA, TOC | 1 x 8-OZ | X | |
| Pesticides, PCBs | 1 x 4-oz | X | |

**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|

**Signature(s):**

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TRP1-SD-010A-0002
Sample Location: TRP1-SD-010
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/5/08<br>Time: 1315<br>Method: 3" s.s. Vibracore<br>Monitor Reading (ppm): NA | 0'-2' | BULK | SILTY, SANDY CLAY, FINE GRAVEL WET, SOME SHELLS & ORGANIC MATTER. SAND IS F-C |

**COMPOSITE SAMPLE DATA:**

| Date: | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| | | | | |
| Method: | | | | |
| | | | | |
| Monitor Readings (Range in ppm): | | | | |
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**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| TCLP-Metals ~~by SW~~, Moisture, pH, Salinity | 1 x 8-oz | X | |
| grain size | 1 x 8-oz | X | |
| bulk density | 1x 8-oz | X | |
| PCBs (Aroclors) | 1x 8-oz | X | |
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**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|
| | |

Signature(s):

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TRP1-SD-01GA-0102
Sample Location: TRP1-SD-01D
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/5/08<br>Time: 1325<br>Method: 3" S.S. Vibracore<br>Monitor Reading (ppm): NA | 2'-4' | DK GRAY | WET, SILTY, CLAYEY, SAND (F-C), SOME F-M GRAVEL & SHELLS. |

**COMPOSITE SAMPLE DATA:**

| Date: | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| | | | | |
| Method: | | | | |
| | | | | |
| Monitor Readings (Range in ppm): | | | | |
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**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| PAH, ETPH, PCB (Aroclors) | 1 x 8-oz | X | |
| grain size | 1 x 8-oz | X | |
| bulk density | 1 x 8-oz | X | |
| Metals by ICP, HG by FIA, TCLP-Metals, TOC, pH, | | X | |
| Salinity, Moisture Content | 1 x 8-oz | | |
| Pesticides, PCB (congeners) | 1 x 4-oz | X | |
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**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|

**Signature(s):**

Tetra Tech NUS, Inc.

# SOIL & SEDIMENT SAMPLE LOG SHEET



Project Site Name: NSB NLON
Project No.: 112G00811

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: TRP1-SD-010A-0204
Sample Location: TRP1-SD-010
Sampled By: CW
C.O.C. No.:

Type of Sample:
[] Low Concentration
[] High Concentration

**GRAB SAMPLE DATA:**

| | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|
| Date: 11/5/08<br>Time: 1320<br>Method: 3" S.S. Vibracore<br>Monitor Reading (ppm): NA | 4'-6' | BLACK | SILTY, SAND, F-M GRAVEL, WET, SOME CLAY & SHELLS. SAND IS F-C GRAINED |

**COMPOSITE SAMPLE DATA:**

| Date: | Time | Depth Interval | Color | Description (Sand, Silt, Clay, Moisture, etc.) |
|---|---|---|---|---|
| | | | | |
| Method: | | | | |
| | | | | |
| Monitor Readings (Range in ppm): | | | | |
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| | | | | |
| | | | | |
| | | | | |

**SAMPLE COLLECTION INFORMATION:**

| Analysis | Container Requirements | Collected | Other |
|---|---|---|---|
| PAH, ETPH, PCB (Aroclors) | 1 x 8-oz | X | |
| grain size | 1 x 8-oz | X | |
| bulk density | 1 x 8-oz | X | |
| Metals by ICP, HG by FIA, TCLP-Metals, TOC, pH, | | X | |
| Salinity, Moisture Content | 1 x 8-oz | | |
| Pesticides, PCB (congeners) | 1 x 4-oz | X | |
| | | | |
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**OBSERVATIONS / NOTES:**

**MAP:**

**Circle if Applicable:**

| MS/MSD | Duplicate ID No.: |
|---|---|

**Signature(s):**

**TETRA TECH NUS, INC.** | **CHAIN OF CUSTODY** | **NUMBER** 0597 | **PAGE** 1 **OF** 2

| PROJECT NO: | FACILITY: | PROJECT MANAGER | PHONE NUMBER | LABORATORY NAME AND CONTACT: |
|---|---|---|---|---|
| 112G0081 | NSB NLON | Corey Kice | 412-921-7190 | [illegible] |
| **SAMPLERS (SIGNATURE)** | | **FIELD OPERATIONS LEADER** | **PHONE NUMBER** | **ADDRESS** |
| [signature] | | Charlie Workman | 421-208-6047 | 175 Metro Center Blvd Warwick, RI 02886 |
| | | **CARRIER/WAYBILL NUMBER** | | **CITY, STATE** |
| | | Courier | | |

STANDARD TAT ☐
RUSH TAT ☒
☐ 24 hr. ☐ 48 hr. ☐ 72 hr. ☐ 7 day ☐ 14 day

CONTAINER TYPE PLASTIC (P) or GLASS (G)

PRESERVATIVE USED

TYPE OF ANALYSIS

| DATE YEAR 2008 | TIME | SAMPLE ID | LOCATION ID | TOP DEPTH (FT) | BOTTOM DEPTH (FT) | MATRIX (GW, SO, SW, SD, QC, ETC.) | COLLECTION METHOD GRAB (G) COMP (C) | No. OF CONTAINERS | PAH | ETBE | PCB Aroclors | Carbon Black | MAP Pesticides | Aroclors | [illegible] | [illegible] | VOC | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11/5 | 1500 | TR11-SD-0003-0001 | TR11-SD-009 | 0 | 1 | SO | G | 3 | X | X | | | X | X | | X | | | X | X | | | |
| 11/5 | 1505 | TR11-SD-0008A-0002 | TR11-SD-008 | 0 | 2 | SO | G | 4 | | | X | X | X | | X | | X | X | X | | | | |
| 11/5 | 1510 | TR11-SD-0008A-0240 | TR11-SD-008 | 2 | 4 | SO | G | 5 | X | X | X | X | X | X | X | X | X | X | X | X | | | |
| 11/5 | 1515 | TR11-SD-0008A-0406 | TR11-SD-008 | 4 | 6 | SO | G | 5 | X | X | X | X | X | X | X | X | X | X | X | X | | | |
| 11/5 | 1330 | TR11-SD-0108-0001 | TR11-SD-010 | 0 | 1 | SO | G | 3 | X | X | | | | X | X | | X | | | X | X | | |
| 11/5 | 1315 | TR11-SD-0108A-0002 | TR11-SD-010 | 0 | 2 | SO | G | 4 | | | X | X | X | | | X | | X | X | X | | | |
| 11/5 | 1320 | TR11-SD-0108A-0240 | TR11-SD-010 | 2 | 4 | SO | G | 5 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | |
| 11/5 | 1325 | TR11-SD-0108A-0406 | TR11-SD-010 | 4 | 6 | SO | G | 5 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | |
| 11/5 | 1430 | TR11-SD-0098-0001 | TR11-SD-009 | 0 | 1 | SO | G | 3 | X | X | | | | X | X | | X | | | X | X | | |
| 11/5 | 1435 | TR11-SD-0098A-0002 | TR11-SD-009 | 0 | 2 | SO | G | 4 | | | X | X | X | | | X | | X | X | X | | | |
| 11/5 | 1440 | TR11-SD-0098A-0240 | TR11-SD-009 | 2 | 4 | SO | G | 5 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | |
| 11/5 | 1445 | TR11-SD-0098A-0406 | TR11-SD-009 | 4 | 6 | SO | G | 5 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | |
| | | | | | | | | | | | | | | | | | | | | | | | |

| | DATE | TIME | | DATE | TIME |
|---|---|---|---|---|---|
| 1. RELINQUISHED BY [signature] | 11/6/08 | 1245 | 1. RECEIVED BY [signature] | 11/6/08 | 1245 |
| 2. RELINQUISHED BY | DATE | TIME | 2. RECEIVED BY | DATE | TIME |
| 3. RELINQUISHED BY | DATE | TIME | 3. RECEIVED BY | DATE | TIME |

COMMENTS

DISTRIBUTION: WHITE (ACCOMPANIES SAMPLE) YELLOW (FIELD COPY) PINK (FILE COPY)

4/02R
FORM NO. TtNUS-001

TETRA TECH NUS, INC. — CHAIN OF CUSTODY — NUMBER 0598 — PAGE 2 OF 2

| | | | |
|---|---|---|---|
| PROJECT NO: 112G00811 | FACILITY: NSB NLON | PROJECT MANAGER: COREY RICH | PHONE NUMBER: 412-921-7090 |
| SAMPLERS (SIGNATURE): [signature] | | FIELD OPERATIONS LEADER: CHARLIE WARING | PHONE NUMBER: 724-288-6047 |
| | | CARRIER/WAYBILL NUMBER: COURIER | |

LABORATORY NAME AND CONTACT: ED LAWLER / MITKEM

ADDRESS: 175 METRO CENTER BLVD

CITY, STATE: WARWICK, RI 02886

STANDARD TAT ☐
RUSH TAT ☐ ☐ 24 hr. ☐ 48 hr. ☐ 72 hr. ☐ 7 day ☐ 14 day

CONTAINER TYPE PLASTIC (P) or GLASS (G): [illegible]

PRESERVATIVE USED: [illegible]

TYPE OF ANALYSIS: [illegible]

| DATE YEAR 2008 | TIME | SAMPLE ID | LOCATION ID | TOP DEPTH (FT) | BOTTOM DEPTH (FT) | MATRIX (GW, SO, SW, SD, QC, ETC.) | COLLECTION METHOD GRAB (G) COMP (C) | No. OF CONTAINERS | Analysis 1 | Analysis 2 | Analysis 3 | Analysis 4 | Analysis 5 | Analysis 6 | Analysis 7 | | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11/6 | 0915 | TRP1-SD-007B-0001 | TRP1-SD 007 | 0 | 1 | SD | G | 3 | X X | | X | ✓ | X | | X ✓ | | |
| 11/6 | 0920 | TRP1-SD-007A-0002 | TRP1-SD 007 | 0 | 2 | SD | G | 4 | | ✓ X | ✓ | X | ✓ | X X | | | |
| 11/6 | 0925 | TRP1-SD-007A-0204 | TRP1-SD 007 | 2 | 4 | SD | G | 5 | X X | ✓ ✓ | ✓ ✓ | X X | X X | X X | X X | | |
| 11/6 | 0930 | TRP1-SD-007A-0406 | TRP1-SD 007 | 4 | 6 | SD | G | 5 | X X | X ✓ | X X | X X | X ✓ | X X | X X | | |
| 11/6 | 1015 | TRP4-SD-001B-0001 | TRP4-SD 001 | 0 | 1 | SD | G | 3 | X X | | X | X | X | | X X | | |
| 11/6 | 1000 | TRP4-SD-001A-0002 | TRP4-SD 001 | 0 | 2 | SD | G | 4 | | X X | ✓ | X | ✓ | X ✓ | | | |
| 11/6 | 1005 | TRP4-SD-001A-0204 | TRP4-SD 001 | 2 | 4 | SD | G | 5 | X X | X ✓ | ✓ ✓ | ✓ ✓ | ✓ ✓ | ✓ ✓ | X X | | *MS/MSD* |
| 11/6 | 1010 | TRP4-SD-001A-0406 | TRP4-SD 001 | 4 | 6 | SD | G | 5 | ✓ X | X ✓ | ✓ ✓ | ✓ ✓ | ✓ ✓ | ✓ ✓ | ✓ ✓ | | |
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|---|---|---|---|---|---|
| 1. RELINQUISHED BY [signature] | DATE 11/6/08 | TIME 1245 | 1. RECEIVED BY [signature] | DATE 11/6/08 | TIME 12:45 |
| 2. RELINQUISHED BY | DATE | TIME | 2. RECEIVED BY | DATE | TIME |
| 3. RELINQUISHED BY | DATE | TIME | 3. RECEIVED BY | DATE | TIME |

COMMENTS

DISTRIBUTION: WHITE (ACCOMPANIES SAMPLE) YELLOW (FIELD COPY) PINK (FILE COPY)

4/02R
FORM NO. TtNUS-001

**TETRA TECH NUS, INC.** | **CHAIN OF CUSTODY** | **NUMBER** 0586 | **PAGE** 1 **OF** 2

| PROJECT NO: | FACILITY: | PROJECT MANAGER | PHONE NUMBER | LABORATORY NAME AND CONTACT: |
|---|---|---|---|---|
| 112G0811 | NSB NLON | Corey Pick | 412-921-7090 | Mitkem / Ed Lawler |
| **SAMPLERS (SIGNATURE)** | | **FIELD OPERATIONS LEADER** | **PHONE NUMBER** | **ADDRESS** |
| [signature] | | Charlie Owens | 724-288-6047 | 175 Metro Center Blvd |
| | | **CARRIER/WAYBILL NUMBER** | | **CITY, STATE** |
| | | Courier | | Warwick, RI 02886 |

STANDARD TAT ☐
RUSH TAT ☒
☐ 24 hr. ☐ 48 hr. ☐ 72 hr. ☐ 7 day ☐ 14 day

CONTAINER TYPE PLASTIC (P) or GLASS (G): G G G G G G G G G G G G

PRESERVATIVE USED: - - - - - - - - - - - - -

TYPE OF ANALYSIS

| DATE YEAR 2008 | TIME | SAMPLE ID | LOCATION ID | TOP DEPTH (FT) | BOTTOM DEPTH (FT) | MATRIX (GW, SO, SW, SD, QC, ETC.) | COLLECTION METHOD GRAB (G) COMP (C) | No. OF CONTAINERS | TAL Metals | TAL Metals | VOC Aromatics | Cyanide | Sulfide | Metals | TPH | TPH | PCB | PCB | Reactivity | Reactivity | Percent Solids | Percent Solids | | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11/6 | 1100 | TE24-SD-002B-0001 | TE24-SD-002 | 0 | 1 | SO | G | 3 | X | X | | | | X | X | | X | | | | X | X | | |
| 11/6 | 1105 | TE24-SD-002A-0002 | TE24-SD-002 | 0 | 2 | SO | G | 4 | | | X | X | X | X | | X | | X | X | X | | | | |
| 11/6 | 1110 | TE24-SD-002A-0204 | TE24-SD-002 | 2 | 4 | SO | G | 5 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | |
| 11/6 | 1115 | TE24-SD-002A-0406 | TE24-SD-002 | 4 | 6 | SO | G | 5 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | |
| 11/6 | 1140 | TE24-SD-005B-0001 | TE24-SD-005 | 0 | 1 | SO | G | 3 | X | X | | | | X | X | | X | | | | X | X | | |
| 11/6 | 1145 | TE24-SD-005A-0002 | TE24-SD-005 | 0 | 2 | SO | G | 4 | | | X | X | X | | | X | | X | X | X | | | | |
| 11/6 | 1150 | TE24-SD-005A-0204 | TE24-SD-005 | 2 | 4 | SO | G | 5 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | |
| 11/6 | 1155 | TE24-SD-005A-0406 | TE24-SD-005 | 4 | 6 | SO | G | 5 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | |
| 11/6 | 1215 | TE24-SD-007B-0001 | TE24-SD-007 | 0 | 1 | SO | G | 3 | X | X | | | | X | X | | X | | | | X | X | | |
| 11/6 | 1220 | TE24-SD-007A-0002 | TE24-SD-007 | 0 | 2 | SO | G | 4 | | | X | X | X | | | X | | X | X | X | | | | |
| 11/6 | 1225 | TE24-SD-007A-0204 | TE24-SD-007 | 2 | 4 | SO | G | 5 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | |
| 11/6 | 1230 | TE24-SD-007A-0406 | TE24-SD-007 | 4 | 6 | SO | G | 5 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | |
| | | | | | | | | | | | | | | | | | | | | | | | | |

| 1. RELINQUISHED BY | DATE | TIME | 1. RECEIVED BY | DATE | TIME |
|---|---|---|---|---|---|
| [signature] | 11/7/08 | 1230 | [signature] | 11/7/08 | [illegible] |
| 2. RELINQUISHED BY | DATE | TIME | 2. RECEIVED BY | DATE | TIME |
| | | | | | |
| 3. RELINQUISHED BY | DATE | TIME | 3. RECEIVED BY | DATE | TIME |
| | | | | | |

COMMENTS

DISTRIBUTION: WHITE (ACCOMPANIES SAMPLE) YELLOW (FIELD COPY) PINK (FILE COPY)

4/02R
FORM NO. TtNUS-001

**TETRA TECH NUS, INC.** | **CHAIN OF CUSTODY** | **NUMBER** 0600 | **PAGE** 2 **OF** 3

| PROJECT NO: | FACILITY: | PROJECT MANAGER | PHONE NUMBER | LABORATORY NAME AND CONTACT: |
|---|---|---|---|---|
| 1122-0081 | NAS Niagara | Carey Rich | 412-411-7040 | Mitkem / [illegible] |

| SAMPLERS (SIGNATURE) | FIELD OPERATIONS LEADER | PHONE NUMBER | ADDRESS |
|---|---|---|---|
| [signature] | Charlie Garand | 724-722-6047 | 175 Metro Center Blvd |
| | **CARRIER/WAYBILL NUMBER** | | **CITY, STATE** |
| | Hand Del | | Warwick, RI 02886 |

STANDARD TAT ☐
RUSH TAT ☒
☐ 24 hr. ☐ 48 hr. ☐ 72 hr. ☐ 7 day ☐ 14 day

CONTAINER TYPE PLASTIC (P) or GLASS (G)

PRESERVATIVE USED

TYPE OF ANALYSIS

| DATE YEAR 2003 | TIME | SAMPLE ID | LOCATION ID | TOP DEPTH (FT) | BOTTOM DEPTH (FT) | MATRIX (GW, SO, SW, SD, QC, ETC.) | COLLECTION METHOD GRAB (G) COMP (C) | No. OF CONTAINERS | TCL VOC | TCL SVOC | PCB Aroclors | Pesticides | Select Metals | Hg | Cyanide | Sulfide | Sulfate | Nitrate | Nitrite | Ortho-Phosphate | Total Phosphorus | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11/6 | 1300 | TRZH-SD-006B-0001 | TRZH-006 | 0 | 1 | SO | G | 3 | X | X | | | X | X | X | X | | X | X | | | [illegible] |
| 11/6 | 1305 | TRZH-SD-006A-0002 | TRZH-006 | 0 | 2 | SO | G | 4 | | | X | X | X | | | X | | X | X | X | | |
| 11/6 | 1310 | TRZH-SD-006A-0204 | TRZH-006 | 2 | 4 | SO | G | 5 | X | X | X | X | X | X | X | X | X | X | X | X | X | |
| 11/6 | 1315 | TRZH-SD-006A-0406 | TRZH-006 | 4 | 6 | SO | G | 5 | X | X | X | X | X | X | X | X | X | X | X | X | X | |
| 11/6 | 1350 | TRZH-SD-003B-0001 | TRZH-003 | 0 | 1 | SO | G | 3 | X | X | | | X | X | | X | | | | X | X | |
| 11/6 | 1355 | TRZH-SD-003A-0002 | TRZH-003 | 0 | 2 | SO | G | 4 | | | X | X | X | | | X | | X | X | X | | |
| 11/6 | 1400 | TRZH-SD-003A-0204 | TRZH-003 | 2 | 4 | SO | G | 10 | X | X | X | X | X | X | X | X | X | X | X | X | X | * MS/MSD * |
| 11/6 | 1405 | TRZH-SD-003A-0406 | TRZH-003 | 4 | 6 | SO | G | 5 | X | X | X | X | X | X | X | X | X | X | X | X | X | |
| 11/6 | 1430 | TRZH-SD-005B-0001 | TRZH-005 | 0 | 1 | SO | G | 3 | X | X | | | X | X | | X | | | | X | X | |
| 11/6 | 1435 | TRZH-SD-005A-0002 | TRZH-005 | 0 | 2 | SO | G | 4 | | | X | X | X | | | X | | X | X | X | | |
| 11/6 | 1440 | TRZH-SD-005A-0204 | TRZH-005 | 2 | 4 | SO | G | 5 | X | X | X | X | X | X | X | X | X | X | X | X | X | |
| 11/6 | 1445 | TRZH-SD-005A-0406 | TRZH-005 | 4 | 6 | SO | G | 5 | X | X | X | X | X | X | X | X | X | X | X | X | X | |
| | | | | | | | | | | | | | | | | | | | | | | |

| 1. RELINQUISHED BY | DATE | TIME | 1. RECEIVED BY | DATE | TIME |
|---|---|---|---|---|---|
| [signature] | 11/6/03 | 1330 | [signature] | 11/6/03 | 1330 |
| 2. RELINQUISHED BY | DATE | TIME | 2. RECEIVED BY | DATE | TIME |
| | | | | | |
| 3. RELINQUISHED BY | DATE | TIME | 3. RECEIVED BY | DATE | TIME |
| | | | | | |

COMMENTS

DISTRIBUTION: WHITE (ACCOMPANIES SAMPLE) YELLOW (FIELD COPY) PINK (FILE COPY)

4/02R
FORM NO. TtNUS-001

TETRA TECH NUS, INC. | CHAIN OF CUSTODY | NUMBER 0599 | PAGE 3 OF 3

| PROJECT NO: | FACILITY: | PROJECT MANAGER | PHONE NUMBER | LABORATORY NAME AND CONTACT: |
|---|---|---|---|---|
| 112G00811 | NSB NLON | COREY RICH | 412-921-7090 | MITKEM / ED LAWLER |

| SAMPLERS (SIGNATURE) | FIELD OPERATIONS LEADER | PHONE NUMBER | ADDRESS |
|---|---|---|---|
| [signature] | CHARLIE WARING | 724-788-6047 | 175 METRO CENTER BLVD |

| CARRIER/WAYBILL NUMBER | CITY, STATE |
|---|---|
| COURIER | WARWICK, RI 02886 |

STANDARD TAT ☐
RUSH TAT ☒
☐ 24 hr. ☐ 48 hr. ☐ 72 hr. ☐ 7 day ☐ 14 day

CONTAINER TYPE PLASTIC (P) or GLASS (G): G G G G G G G G G G G G G G
PRESERVATIVE USED: - - - - - - - - - - - - - -

TYPE OF ANALYSIS

| DATE YEAR 2008 | TIME | SAMPLE ID | LOCATION ID | TOP DEPTH (FT) | BOTTOM DEPTH (FT) | MATRIX (GW, SO, SW, SD, QC, ETC.) | COLLECTION METHOD GRAB (G) COMP (C) | No. OF CONTAINERS | RAD | ETPH | [illegible] | GRAIN SIZE | BULK DENSITY | [illegible] | Hg BY FIA | [illegible] | TAL METALS | pH | [illegible] | [illegible] | [illegible] | PCB [illegible] | | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11/6 | 1530 | TRP1-SD-001B-0001 | TRP1-SD 001 | 0 | 1 | SO | G | 3 | X | X | | | | X | X | | X | | | | X | X | | |
| 11/6 | 1535 | TRP1-SD-001A-0002 | TRP1-SD 001 | 0 | 2 | SO | G | 4 | | | X | X | X | | | X | | X | X | X | | | | |
| 11/6 | 1540 | TRP1-SD-001A-0204 | TRP1-SD 001 | 2 | 4 | SO | G | 5 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | |
| 11/6 | 1545 | TRP1-SD-001A-0406 | TRP1-SD 001 | 4 | 6 | SO | G | 5 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | |
| 11/7 | 0830 | TRP1-SD-006B-0001 | TRP1-SD 006 | 0 | 1 | SO | G | 3 | X | X | | | | X | X | | X | | | | X | X | | |
| 11/7 | 0835 | TRP1-SD-006A-0002 | TRP1-SD 006 | 0 | 2 | SO | G | 4 | | | X | X | X | | | X | | X | X | X | | | | |
| 11/7 | 0840 | TRP1-SD-006A-0203 | TRP1-SD 006 | 2 | 3 | SO | G | 5 | X | X | ✓ | ✓ | X | X | X | X | X | X | X | X | X | X | | |
| 11/7 | 0945 | TR24-SD-004B-0001 | TR24-SD 004 | 0 | 1 | SO | G | 3 | X | X | | | | X | X | | X | | | | X | X | | |
| 11/7 | 0950 | TR24-SD-004A-0002 | TR24-SD 004 | 0 | 2 | SO | G | 4 | | | X | X | X | | | X | | X | X | X | | | | |
| 11/7 | 0955 | TR24-SD-004A-0204 | TR24-SD 004 | 2 | 4 | SO | G | 5 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | |
| 11/7 | 1000 | TR24-SD-004A-0406 | TR24-SD 004 | 4 | 6 | SO | G | 10 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | *MS/MSD* |

| 1. RELINQUISHED BY [signature] | DATE 11/7/08 | TIME 1230 | 1. RECEIVED BY [signature] | DATE 11/7/08 | TIME 1230 |
|---|---|---|---|---|---|
| 2. RELINQUISHED BY | DATE | TIME | 2. RECEIVED BY | DATE | TIME |
| 3. RELINQUISHED BY | DATE | TIME | 3. RECEIVED BY | DATE | TIME |

COMMENTS

DISTRIBUTION: WHITE (ACCOMPANIES SAMPLE) YELLOW (FIELD COPY) PINK (FILE COPY)

4/02R
FORM NO. TtNUS-001

**TETRA TECH NUS, INC.** | **CHAIN OF CUSTODY** | **NUMBER** 4934 | **PAGE** 1 **OF** 2

| PROJECT NO: | FACILITY: | PROJECT MANAGER | PHONE NUMBER | LABORATORY NAME AND CONTACT: |
|---|---|---|---|---|
| 112G60411 | NSB NLON | CORLY [illegible] | 412-921-7090 | MITKEM / ED [illegible] |
| **SAMPLERS (SIGNATURE)** | | **FIELD OPERATIONS LEADER** | **PHONE NUMBER** | **ADDRESS** |
| [signature] | | [illegible] | 732 [illegible] | 175 [illegible] CENTER BLVD |
| | | **CARRIER/WAYBILL NUMBER** | | **CITY, STATE** |
| | | COURIER | | WARWICK, RI 02886 |

STANDARD TAT ☐
RUSH TAT ☒
☐ 24 hr. ☐ 48 hr. ☐ 72 hr. ☐ 7 day ☐ 14 day

CONTAINER TYPE PLASTIC (P) or GLASS (G): P/G P/G P/G P/G P/G P/G P/G P/G

PRESERVATIVE USED: - - - - - - - - - - - - - - - -

TYPE OF ANALYSIS: PAH; METALS; PCBs; PESTICIDES; CORROSIVITY, etc.; BULK DENSITY; ANIONS; MOISTURE; TOC; TOTAL ALKALINITY; MERCURY; PH; CYANIDE; REACTIVITY; IGNITABILITY; TOTAL SOLIDS; TOTAL ORGANIC CARBON

| DATE YEAR 2008 | TIME | SAMPLE ID | LOCATION ID | TOP DEPTH (FT) | BOTTOM DEPTH (FT) | MATRIX (GW, SO, SW, SD, QC, ETC.) | COLLECTION METHOD GRAB (G) COMP (C) | No. OF CONTAINERS | PAH | METALS | PCBs | PESTICIDES | CORROSIVITY, etc. | BULK DENSITY | ANIONS | MOISTURE | TOC | MERCURY | PH | TOTAL ALKALINITY | CYANIDE | REACTIVITY | IGNITABILITY | TOTAL SOLIDS | TOTAL ORGANIC CARBON | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11/7 | 1030 | TRPI-SD-002B-0001 | TRPI-SD 002 | 0 | 1 | SO | G | 3 | X | X | | | | X | X | | X | | | | | | X | X | | |
| 11/7 | 1035 | TRPI-SD-002A-0002 | TRPI-SD 002 | 0 | 2 | SO | G | 4 | | | X | X | X | | | X | | X | X | X | | | | | | |
| 11/7 | 1040 | TRPI-SD-002A-0204 | TRPI-SD 002 | 2 | 4 | SO | G | 5 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | |
| 11/7 | 1045 | TRPI-SD-002A-0406 | TRPI-SD 002 | 4 | 6 | SO | G | 5 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | |
| 11/7 | 1130 | TRPI-SD-003B-0001 | TRPI-SD 003 | 0 | 1 | SO | G | 3 | X | X | | | | X | X | | X | | | | | | X | X | | |
| 11/7 | 1135 | TRPI-SD-003A-0002 | ↓ | 0 | 2 | SO | G | 4 | | | X | X | X | | | X | | X | X | X | | | | | | |
| 11/7 | 1140 | TRPI-SD-003A-0204 | ↓ | 2 | 4 | SO | G | 5 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | |
| 11/7 | 1230 | TRPI-SD-004B-0001 | TRPI-SD 004 | 0 | 1 | SO | G | 3 | X | X | | | | X | X | | X | | | | | | X | X | | |
| 11/7 | 1235 | TRPI-SD-004A-0002 | ↓ | 0 | 2 | SO | G | 4 | | | X | X | X | | | X | | X | X | X | | | | | | |
| 11/7 | 1240 | TRPI-SD-004A-0204 | ↓ | 2 | 4 | SO | G | 10 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | * MS / MSD * |
| 11/7 | 1245 | TRPI-SD-004A-0406 | ↓ | 4 | 6 | SO | G | 5 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | |
| 11/7 | 1330 | TRPI-SD-005B-0001 | TRPI-SD 005 | 0 | 1 | SO | G | 3 | X | X | | | | X | X | | X | | | | | | X | X | | |
| 11/7 | 1335 | TRPI-SD-005A-0002 | ↓ | 0 | 2 | SO | G | 4 | | | X | X | X | | | X | | X | X | X | | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| 1. RELINQUISHED BY [signature] | DATE 11-7-08 | TIME 1710 | 1. RECEIVED BY [signature] | DATE 11/7/08 | TIME 17:15 |
| 2. RELINQUISHED BY | DATE | TIME | 2. RECEIVED BY | DATE | TIME |
| 3. RELINQUISHED BY | DATE | TIME | 3. RECEIVED BY | DATE | TIME |

COMMENTS

DISTRIBUTION: WHITE (ACCOMPANIES SAMPLE) YELLOW (FIELD COPY) PINK (FILE COPY)

4/02R
FORM NO. TtNUS-001

TETRA TECH NUS, INC. | CHAIN OF CUSTODY | NUMBER 4935 | PAGE 2 OF 2

| PROJECT NO: | FACILITY: | PROJECT MANAGER | PHONE NUMBER | LABORATORY NAME AND CONTACT: |
|---|---|---|---|---|
| 112600811 | NAS - NLON | [illegible] | [illegible] | [illegible] |
| **SAMPLERS (SIGNATURE)** | | **FIELD OPERATIONS LEADER** | **PHONE NUMBER** | **ADDRESS** |
| [signature] | | CHARLIE WARNER | 734-748-6017 | 175 METROCENTER BLVD |
| | | **CARRIER/WAYBILL NUMBER** | | **CITY, STATE** |
| | | COURIER | | WARWICK, RI 02886 |

STANDARD TAT ☐
RUSH TAT ☑
☐ 24 hr. ☐ 48 hr. ☐ 72 hr. ☐ 7 day ☐ 14 day

CONTAINER TYPE PLASTIC (P) or GLASS (G): G G G G G G G G G G G G G G

PRESERVATIVE USED: - - - - - - - - - - - - - -

TYPE OF ANALYSIS: TAL METALS; TAL CYANIDE; TCL ACIDS/BASE/NEUTRALS; TCL PESTICIDES/PCBS; TCL VOLATILES; TAL MERCURY BY CVAA; TAL MERCURY BY ICP; TOC; TPH; ALKALINITY; AMMONIA; CHLORIDES; SULFATE; SULFIDE

| DATE YEAR 2008 | TIME | SAMPLE ID | LOCATION ID | TOP DEPTH (FT) | BOTTOM DEPTH (FT) | MATRIX (GW, SO, SW, SD, QC, ETC.) | COLLECTION METHOD GRAB (G) COMP (C) | No. OF CONTAINERS | TAL METALS | TAL CYANIDE | TCL ACIDS/BASE/NEUTRALS | TCL PESTICIDES/PCBS | TCL VOLATILES | TAL MERCURY BY CVAA | TAL MERCURY BY ICP | TOC | TPH | ALKALINITY | AMMONIA | CHLORIDES | SULFATE | SULFIDE | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11/7 | 1340 | TRPI-SD-00SA-0204 | TRPI-SD-005 | 2 | 4 | SO | G | 5 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | |
| 11/7 | 1345 | TRPI-SD-00SA-0406 | ↓ | 4 | 6 | SO | G | 5 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | |

| | | | | | |
|---|---|---|---|---|---|
| 1. RELINQUISHED BY [signature] | DATE 11/7/08 | TIME 1700 | 1. RECEIVED BY [signature] | DATE 11/7/08 | TIME 1900 |
| 2. RELINQUISHED BY | DATE | TIME | 2. RECEIVED BY | DATE | TIME |
| 3. RELINQUISHED BY | DATE | TIME | 3. RECEIVED BY | DATE | TIME |

COMMENTS

DISTRIBUTION: WHITE (ACCOMPANIES SAMPLE) YELLOW (FIELD COPY) PINK (FILE COPY)

4/02R
FORM NO. TtNUS-001

11/5/08 WED

Work continued from Page 50's CLOUDY CHARLIE WARNO, COREY RICH

0730 ONSITE @ PASS & ID OFFICE, WAITING TO MEET DICK CONANT & TG & B TO GAIN LOWER BASE ACCESS.

0750 DICK CONANT ONSITE, STEWARDING CW & CR THROUGH PASS PROCEDURE

0830 TG & B ONSITE, OBTAINING PASSES.

0900 RADIOLOGICAL CONTROL TRAINING IN DICK'S OFFICE. MOBILIZING TO PIER 2 TO VIEW PROJECT AREA AND SPEAK WITH PORT OPS.

1000 REVIEWED RAD HAZARD WITH MM, TAYLOR. SUB AT PIER 26 IS NOT ACTIVE TODAY, IT WOULD BE BEST TO COLLECT SAMPLE CLOSEST TO PIER 26 TODAY.

1045 DICK CONANT & COREY RICH OFFSITE, TG & B MOBILIZING EQUIPMENT, PREPPING BOAT FOR LAUNCH / SETTING UP SAMPLING EQ

1230 SETTING BOAT @ TRPI-SD010 TO COLLECT FIRST SAMPLE.
SEE SAMPLE SHEETS FOR DETAILS
- HAVE TO COLLECT 2 6' CORES TO OBTAIN CORRECT SAMPLE VOLUME

1615 COLLECTED SAMPLES 0001, 0002, 0204, & 0406 FOR LOCATIONS TRPI-008 TRPI-009 & TRPI-010.

1630 TG & B OFF SITE TO PURCHASE NEW RADIO

1700 CW FINISHED PACKING SAMPLES, OFFSITE.

END

CW

Work continued to Page

SCIENTIFIC BINDERY PRODUCTIONS CHICAGO 60605 MADE IN USA

SIGNATURE DATE 11/5/08

DISCLOSED TO AND UNDERSTOOD BY DATE WITNESS DATE

11/6/08 THURS.

Work continued from Page 60° RAIN CW, TG&B (DOUG & MARK)

0700 ONSITE, DEPLOYING SAMPLING STATION, AWAITING ARRIVAL OF TG&B PERSONNEL

0730 TG&B ONSITE, CALLING MMI TAYLOR FOR RADLON BRIEFING

0800 CLEARED TO BEGIN SAMPLING. TG&B DEPLOYING BOAT TO BEGIN SAMPLING - SEE SAMPLE SHEETS -

12:30 CW PACKING COOLERS FOR COURIER

1300 CW MET COURIER AND TRANSFERED SAMPLES FROM LOCATIONS TRP1-007 THROUGH TRP1-010 AND TRZ4-001 C.O.C #'S 0597 & 0598

1315 CW RETURNING TO CONTINUE PROCESSING SAMPLES

1600 TG&B FINISHED FOR THE DAY. TOTAL OF 9 SAMPLE LOCATIONS COLLECTED TODAY. TRP1-007, 001, TRZ4-001, 002, 003, 005, 006, 007, & 008

CW FINISHING PROCESSING SAMPLES

1730 CW FINISHED PROCESSING, KEEPING SAMPLES FROM TRZ4-003, 008 & TRP1-001 IN BAGS ON ICE, WILL BOTTLE @ HOTEL. LOSING LIGHT, TOO DARK.

OFFSITE

END

CW

SCIENTIFIC BINDERY PRODUCTIONS CHICAGO 60605 MADE IN USA

Work continued to Page

SIGNATURE DATE 11/6/08

DISCLOSED TO AND UNDERSTOOD BY DATE WITNESS DATE

11/7/08 FRIDAY

Work continued from Page 60° CLOUDY CW, TG&B (MARK & DOUG)

0700 ONSITE, CW SETTING UP SAMPLE PROCESSING STATION.

0720 TG&B ONSITE, CALLING MM1 TAYLOR FOR RADCON BRIEFING. HE INFORMED US THAT THERE IS NO ACTIVITY TODAY, BRIEFING NOT NECESSARY. TG&B RELOADING VIBRACORE EQUIPMENT, SETTING OUT TO BEGIN SAMPLING.

0830 THERE SEEMS TO BE A LOT OF DEBRIS AROUND THE END OF PIER 1. TG&B HAVING TROUBLE MANEUVERING CORE THROUGH DEBRIS. ONLY ABLE TO REACH 3' IN DEPTH FOR LOCATION TRPI-SD-006.

1130 TG&B RENCHING REFUSAL @ 4' AT LOCATION TRPI-SD-003. ATTEMPTING SEVERAL ADJACENT LOCATIONS, UNABLE TO GET PAST 4'.

1345 TG&B FINISHED SAMPLING. CW HAS FINAL FOUR LOCATIONS TO PROCESS. TG&B LOADING UP.

CW MET COURIER TO DROP OF SAMPLES FROM LOCATIONS TRZU-SD-002, 005, 007, 006, 003, 008, 004, TRPI-SD-001, & 006.
C.O.C. #'s 0586, 0599, & 0600

1430 TG&B OFFSITE

1600 CW FINISHED PROCESSING & PACKING SAMPLES. LEAVING FOR MITKEM TO DELIVER SAMPLES. - TRPI-SD-002, 003, 004, & 005.

1710 ARRIVE @ MITKEM → C.O.C #'s 4934, 4955

END

CW



SIGNATURE [signature] DATE 11/7/08

DISCLOSED TO AND UNDERSTOOD BY DATE WITNESS DATE

**Tetra Tech NUS** **INTERNAL CORRESPONDENCE**

| | | | |
|---|---|---|---|
| **TO:** | **C. RICH** | **DATE:** | **DECEMBER 10, 2008** |
| **FROM:** | **LEIGH A. CIOFANI** | **COPIES:** | **DV FILE** |

**SUBJECT:** **ORGANIC DATA VALIDATION- PAH / PCB / ETPH / HEXACHLOROBENZENE**
**CTO 424, NSB NEW LONDON**
**SAMPLE DELIVERY GROUP (SDG) G2056**

**SAMPLES:** 5 / Solid / SVOC / PAH / ETPH / Hexachlorobenzene

| | | |
|---|---|---|
| TRP1-SD-004A-0204 | TRP1-SD-004A-0406 | TRP1-SD-005A-0204 |
| TRP1-SD-005A-0406 | TRP1-SD-005B-0001 | |

5 / Solid / PCB

| | | |
|---|---|---|
| TRP1-SD-004A-0204 | TRP1-SD-004A-0406 | TRP1-SD-005A-0002 |
| TRP1-SD-005A-0204 | TRP1-SD-005A-0406 | |

OVERVIEW

The sample set for CTO 424, NSB New London, SDG G2056, consists of six (6) solid environmental samples. There are no field duplicate pairs associated with this SDG.

Samples were analyzed for polycyclic aromatic hydrocarbons (PAH), polychlorinated biphenyls (PCB), and extractable total petroleum hydrocarbons (ETPH).

The samples were collected by Tetra Tech NUS on November 7, 2008 and analyzed by Mitkem Corporation. All analyses were conducted in accordance with SW-846 Method 8270D/selected ion monitoring (SIM) 8270D and 8082, and the Connecticut ETPH method analysis and reporting protocols. It is important to note that PAH compounds were analyzed with both the 8270D and 8270D SIM. More information regarding this is discussed in the sections below and in the laboratory narrative. A Tier 3 data validation was performed on the referenced samples. The data contained in this SDG were validated with regard to the following parameters:

| | |
|---|---|
| * | • Data Completeness |
| * | • Holding Times |
| * | • GC/MS Tuning |
| * | • Initial/Continuing Calibrations |
| * | • Laboratory Method/Field Blank Results |
| | • Surrogate Recoveries |
| * | • Laboratory Control Spike/Laboratory Control Spike Duplicate Results |
| * | • Matrix Spike/Matrix Spike Duplicate Results |
| * | • Internal Standards |
| * | • Field Duplicate Precision |
| * | • Compound Quantitation |
| * | • Compound Identification |
| | • Detection Limits |

The asterisk (*) indicates that all quality control criteria were met for this parameter. Qualified (if applicable) analytical results are summarized in Appendix A. Results as reported by the laboratory are presented in Appendix B. Appendix C contains Region I worksheets, and Appendix D contains the documentation to support

the findings as discussed in this data validation report. The attached Table summarizes the validation qualifications which are based on the following information:

## CALIBRATIONS

The following table summarized solid calibration noncompliance and corresponding actions for PAH by 8270D:

| Analyte | CCV 11/19/08 (10:32) |
|---|---|
| 2-methylnaphthalene | X |

Associated Samples: All

Calibration Actions:
X - No action was warranted, as no results for this analyte were retained from the full scan 8270D analysis.

## SURROGATE RECOVERIES

The PCB samples TRP1-SD-004A-0204, TRP1-SD-005A-0204, and TRP1-SD-005A-0406 had recoveries for decachlorobiphenyl (DCB) on the primary column that were less than laboratory quality control criteria. No action was necessary because the DCB recoveries for these samples were within limits on the secondary column.

The ETPH surrogate recovery was less than the laboratory quality control acceptance criteria for 5a-androstane in sample TRP1-SD-005A-0204. The positive ETPH result in this sample was qualified as estimated (J) due to surrogate recovery noncompliance.

## MATRIX SPIKE/MATRIX SPIKE DUPLICATE RESULTS

The PAH by 8270D matrix spike/matrix spike duplicate (MS/MSD) performed on sample TRP1-SD-004A-0204 had an MSD percent recovery greater than the laboratory acceptance limit for fluoranthene, benzo(a)anthracene, and chrysene. Additionally, the MSD percent recoveries and relative percent difference (RPD) results were greater than the laboratory quality control criteria for pyrene and benzo(b)fluoranthene. No action was taken because the MS and laboratory control sample (LCS) percent recoveries for these analytes were within limits.

## INTERNAL STANDARDS

All PAH parameters analyzed by SIM 8270D had internal standard areas that were greater than the laboratory quality acceptance limits. No action was taken because the exceedances were due to using full scan (8270D) internal standard spikes in the SIM analysis. See additional comments and laboratory narrative for further details.

## DETECTION LIMITS

Non-detected results for hexachlorobenzene exceeded the quantitation limit (QL) of 1 ug/kg (based on 100% solids) presented in the QAPP as follows:

| Sample | Concentration | | % Solids | Adjusted QL |
|---|---|---|---|---|
| TRP1-SD-004A-0406 | 5.9 U | UG/KG | 56 | 1.8 |
| TRP1-SD-005A-0204 | 7 U | UG/KG | 47 | 2.1 |
| TRP1-SD-005A-0406 | 6.8 U | UG/KG | 48 | 2.1 |
| TRP1-SD-005B-0001 | 8.2 U | UG/KG | 40 | 2.5 |
| TRP1-SD-004A-0204 | 6.9 U | UG/KG | 48 | 2.1 |

## ADDITIONAL COMMENTS

PAH compounds were analyzed by SIM 8270D. Many PAH results exceeded the instrument calibration range,

and no sample dilutions were performed using this method. However, analytes that exceeded the instrument calibration range in the SIM method were within limits in the samples and dilutions analyzed by full scan 8270D. PAH results from the SIM method were used for validation except for analytes in exceedance of the calibration range; results for these analytes were taken from the full scan 8270D results. The laboratory did not conduct a separate surrogate recovery, LCS, or MS/MSD analysis for PAH by the SIM method. Instead, the laboratory notes that the surrogate recovery, LCS, and MS/MSD from the 8270D analysis apply to the SIM data. Additionally, the internal standard areas for the SIM analysis were all greater than laboratory quality control limits because the internal standard spikes used were from the full scan analysis. No qualifications were made to PAH results due to internal standard areas. These issues are documented in the laboratory SDG narrative report.

According to the laboratory narrative, results for pesticides and PCB congeners for these samples are reported in a separate SDG. No action was taken on this basis.

Positive results detected between the quantitation limit and the method detection limit (MDL) were qualified as estimated (J) due to uncertainty near the detection limit.

The PAH by 8270D analysis had results for fluoranthene in sample TRP1-SD-005A-0204 and fluoranthene and pyrene in TRP1-SD-005A-0406 that exceeded the instrument calibration range. Results for these analytes were taken from dilutions performed at a dilution factor (DF) of 2 for sample TRP1-SD-005A-0204 and a DF of 4 for sample TRP1-SD-005A-0406.

## EXECUTIVE SUMMARY

**Laboratory Performance Issues:** One ETPH result was qualified as estimated due to surrogate recovery noncompliance. Required quantitation limits were exceeded for hexachlorobenzene.

**Other Factors Affecting Data Quality:** Several results were qualified as estimated due to uncertainty near the detection limit.

The data for these analyses were reviewed with reference to the Region I EPA "Data Validation Functional Guidelines - Part II" (12/96), and the Department of Defense (DoD) document entitled "Quality Systems Manual (QSM) for Environmental Laboratories" (January 2006). The text of this report has been formulated to address only those problem areas affecting data quality.

"I attest that the data referenced herein were validated according to the agreed upon validation criteria as specified in the DoD QSM."

Leigh A. Ciofani
TetraTech NUS

Leigh A. Ciofani
Data Validator/Environmental Scientist I

Edward Siedlecki for
TetraTech NUS

Joseph A. Samchuck
Data Validation Quality Assurance Officer

Attachments:

Appendix A – Qualified Analytical Results
Appendix B – Results as Reported by the Laboratory
Appendix C – Support Documentation

# APPENDIX A

## QUALIFIED ANALYTICAL RESULTS

**Data Validation Qualifier Codes:**

A = Lab Blank Contamination
B = Field Blank Contamination
C = Calibration Noncompliance (e.g. % RSDs, %Ds, ICVs, CCVs, RRFs, etc.)
C01 = GC/MS Tuning Noncompliance
D = MS/MSD Recovery Noncompliance
E = LCS/LCSD Recovery Noncompliance
F = Lab Duplicate Imprecision
G = Field Duplicate Imprecision
H = Holding Time Exceedance
I = ICP Serial Dilution Noncompliance
J = GFAA PDS - GFAA MSA's $r < 0.995$
K = ICP Interference - includes ICS % R Noncompliance
L = Instrument Calibration Range Exceedance
M = Sample Preservation Noncompliance
N = Internal Standard Noncompliance
N01 = Internal Standard Recovery Noncompliance Dioxins
N02 = Recovery Standard Noncompliance Dioxins
N03 = Clean-up Standard Noncompliance Dioxins
O = Poor Instrument Performance (e.g. base-line drifting)
P = Uncertainty near detection limit (< 2 x IDL for inorganics and <CRQL for organics)
Q = Other problems (can be any number of issues; e.g. poor chromatography,interferences, etc.)
R = Surrogates Recovery Noncompliance
S = Pesticide/PCB Resolution
T = % Breakdown Noncompliance for DDT and Endrin
U = % Difference between columns/detectors >25% for positive results determined via GC/HPLC
V = Non-linear calibrations; correlation coefficient $r < 0.995$
W = EMPC result
X = Signal to noise response drop
Y = Percent solids <30%
Z = Uncertainty at 2 sigma deviation is greater than sample activity

# PROJ_NO: 00811

SDG: G2056 MEDIA: SOIL DATA FRACTION: OS

| | |
|---|---|
| nsample | TRP1-SD-004A-0204 |
| samp_date | 11/7/2008 |
| lab_id | G2056-01A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 48.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ACENAPHTHENE | 790 | | |
| BENZO(A)ANTHRACENE | 1100 | | |
| BENZO(B)FLUORANTHENE | 1100 | | |
| CHRYSENE | 1200 | | |
| FLUORANTHENE | 3400 | | |
| PHENANTHRENE | 1700 | | |
| PYRENE | 3200 | | |

| | |
|---|---|
| nsample | TRP1-SD-004A-0406 |
| samp_date | 11/7/2008 |
| lab_id | G2056-02A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 56.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ANTHRACENE | 620 | | |
| BENZO(A)ANTHRACENE | 1100 | | |
| BENZO(A)PYRENE | 720 | | |
| BENZO(B)FLUORANTHENE | 1100 | | |
| CHRYSENE | 1200 | | |
| FLUORANTHENE | 4100 | | |
| FLUORENE | 520 | J | P |
| PHENANTHRENE | 2000 | | |
| PYRENE | 2800 | | |

| | |
|---|---|
| nsample | TRP1-SD-005A-0204 |
| samp_date | 11/7/2008 |
| lab_id | G2056-05A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 47.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ANTHRACENE | 1300 | | |
| BENZO(A)ANTHRACENE | 4700 | | |
| BENZO(A)PYRENE | 2300 | | |
| BENZO(B)FLUORANTHENE | 4100 | | |
| BENZO(G,H,I)PERYLENE | 970 | | |
| BENZO(K)FLUORANTHENE | 1400 | | |
| CHRYSENE | 4400 | | |
| INDENO(1,2,3-CD)PYRENE | 1000 | | |
| PHENANTHRENE | 1400 | | |
| PYRENE | 11000 | | |

# PROJ_NO: 00811

SDG: G2056 MEDIA: SOIL DATA FRACTION: OS

| | |
|---|---|
| nsample | TRP1-SD-005A-0204DL |
| samp_date | 11/7/2008 |
| lab_id | G2056-05ADL |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 47.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| FLUORANTHENE | 16000 | | |

| | |
|---|---|
| nsample | TRP1-SD-005A-0406 |
| samp_date | 11/7/2008 |
| lab_id | G2056-06A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 48.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ANTHRACENE | 3000 | | |
| BENZO(A)ANTHRACENE | 8700 | | |
| BENZO(A)PYRENE | 4400 | | |
| BENZO(B)FLUORANTHENE | 6200 | | |
| BENZO(G,H,I)PERYLENE | 1800 | | |
| BENZO(K)FLUORANTHENE | 3300 | | |
| CHRYSENE | 8300 | | |
| INDENO(1,2,3-CD)PYRENE | 1800 | | |
| NAPHTHALENE | 2700 | | |
| PHENANTHRENE | 2200 | | |

| | |
|---|---|
| nsample | TRP1-SD-005A-0406DL |
| samp_date | 11/7/2008 |
| lab_id | G2056-06ADL |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 48.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| FLUORANTHENE | 23000 | | |
| PYRENE | 19000 | | |

# PROJ_NO: 00811

SDG: G2056 MEDIA: SOIL DATA FRACTION: OS

| | |
|---|---|
| nsample | TRP1-SD-005B-0001 |
| samp_date | 11/7/2008 |
| lab_id | G2056-03A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 40.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| BENZO(A)ANTHRACENE | 1700 | | |
| BENZO(A)PYRENE | 1200 | | |
| BENZO(B)FLUORANTHENE | 1700 | | |
| CHRYSENE | 1900 | | |
| FLUORANTHENE | 4100 | | |
| PYRENE | 3000 | | |

# PROJ_NO: 00811

SDG: G2056 MEDIA: SOIL DATA FRACTION: PAH

| | |
|---|---|
| nsample | TRP1-SD-004A-0204 |
| samp_date | 11/7/2008 |
| lab_id | G2056-01A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 48.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 1-METHYLNAPHTHALENE | 85 | | |
| 2-METHYLNAPHTHALENE | 53 | | |
| ACENAPHTHYLENE | 150 | | |
| ANTHRACENE | 480 | | |
| BENZO(A)PYRENE | 620 | | |
| BENZO(G,H,I)PERYLENE | 350 | | |
| BENZO(K)FLUORANTHENE | 370 | | |
| DIBENZO(A,H)ANTHRACENE | 110 | | |
| FLUORENE | 690 | | |
| HEXACHLOROBENZENE | 6.9 | U | |
| INDENO(1,2,3-CD)PYRENE | 310 | | |
| NAPHTHALENE | 55 | | |

| | |
|---|---|
| nsample | TRP1-SD-004A-0406 |
| samp_date | 11/7/2008 |
| lab_id | G2056-02A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 56.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 1-METHYLNAPHTHALENE | 100 | | |
| 2-METHYLNAPHTHALENE | 65 | | |
| ACENAPHTHENE | 450 | | |
| ACENAPHTHYLENE | 140 | | |
| BENZO(G,H,I)PERYLENE | 310 | | |
| BENZO(K)FLUORANTHENE | 490 | | |
| DIBENZO(A,H)ANTHRACENE | 97 | | |
| HEXACHLOROBENZENE | 5.9 | U | |
| INDENO(1,2,3-CD)PYRENE | 280 | | |
| NAPHTHALENE | 74 | | |

| | |
|---|---|
| nsample | TRP1-SD-005A-0204 |
| samp_date | 11/7/2008 |
| lab_id | G2056-05A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 47.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 1-METHYLNAPHTHALENE | 26 | | |
| 2-METHYLNAPHTHALENE | 45 | | |
| ACENAPHTHENE | 140 | | |
| ACENAPHTHYLENE | 340 | | |
| DIBENZO(A,H)ANTHRACENE | 280 | | |
| FLUORENE | 300 | | |
| HEXACHLOROBENZENE | 7 | U | |
| NAPHTHALENE | 320 | | |

# PROJ_NO: 00811

SDG: G2056 MEDIA: SOIL DATA FRACTION: PAH

| | |
|---|---|
| nsample | TRP1-SD-005A-0406 |
| samp_date | 11/7/2008 |
| lab_id | G2056-06A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 48.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 1-METHYLNAPHTHALENE | 200 | | |
| 2-METHYLNAPHTHALENE | 270 | | |
| ACENAPHTHENE | 620 | | |
| ACENAPHTHYLENE | 560 | | |
| DIBENZO(A,H)ANTHRACENE | 450 | | |
| FLUORENE | 450 | | |
| HEXACHLOROBENZENE | 6.8 | U | |

| | |
|---|---|
| nsample | TRP1-SD-005B-0001 |
| samp_date | 11/7/2008 |
| lab_id | G2056-03A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 40.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 1-METHYLNAPHTHALENE | 11 | | |
| 2-METHYLNAPHTHALENE | 19 | | |
| ACENAPHTHENE | 110 | | |
| ACENAPHTHYLENE | 170 | | |
| ANTHRACENE | 620 | | |
| BENZO(G,H,I)PERYLENE | 460 | | |
| BENZO(K)FLUORANTHENE | 570 | | |
| DIBENZO(A,H)ANTHRACENE | 150 | | |
| FLUORENE | 140 | | |
| HEXACHLOROBENZENE | 8.2 | U | |
| INDENO(1,2,3-CD)PYRENE | 450 | | |
| NAPHTHALENE | 21 | | |
| PHENANTHRENE | 630 | | |

# PROJ_NO: 00811

SDG: G2056 MEDIA: SOIL DATA FRACTION: PEST/PCB

| | |
|---|---|
| nsample | TRP1-SD-004A-0204 |
| samp_date | 11/7/2008 |
| lab_id | G2056-01A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 48.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| AROCLOR-1016 | 69 | U | |
| AROCLOR-1221 | 69 | U | |
| AROCLOR-1232 | 69 | U | |
| AROCLOR-1242 | 69 | U | |
| AROCLOR-1248 | 69 | U | |
| AROCLOR-1254 | 140 | | |
| AROCLOR-1260 | 69 | U | |

| | |
|---|---|
| nsample | TRP1-SD-004A-0406 |
| samp_date | 11/7/2008 |
| lab_id | G2056-02A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 56.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| AROCLOR-1016 | 59 | U | |
| AROCLOR-1221 | 59 | U | |
| AROCLOR-1232 | 59 | U | |
| AROCLOR-1242 | 59 | U | |
| AROCLOR-1248 | 59 | U | |
| AROCLOR-1254 | 59 | U | |
| AROCLOR-1260 | 59 | U | |

| | |
|---|---|
| nsample | TRP1-SD-005A-0002 |
| samp_date | 11/7/2008 |
| lab_id | G2056-04A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 49.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| AROCLOR-1016 | 67 | U | |
| AROCLOR-1221 | 67 | U | |
| AROCLOR-1232 | 67 | U | |
| AROCLOR-1242 | 67 | U | |
| AROCLOR-1248 | 67 | U | |
| AROCLOR-1254 | 67 | U | |
| AROCLOR-1260 | 67 | U | |

# PROJ_NO: 00811

SDG: G2056 MEDIA: SOIL DATA FRACTION: PEST/PCB

| | | | |
|---|---|---|---|
| nsample | TRP1-SD-005A-0204 | nsample | TRP1-SD-005A-0406 |
| samp_date | 11/7/2008 | samp_date | 11/7/2008 |
| lab_id | G2056-05A | lab_id | G2056-06A |
| qc_type | NM | qc_type | NM |
| units | UG/KG | units | UG/KG |
| Pct_Solids | 47.0 | Pct_Solids | 48.0 |
| DUP_OF: | | DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| AROCLOR-1016 | 70 | U | |
| AROCLOR-1221 | 70 | U | |
| AROCLOR-1232 | 70 | U | |
| AROCLOR-1242 | 70 | U | |
| AROCLOR-1248 | 70 | U | |
| AROCLOR-1254 | 72 | | |
| AROCLOR-1260 | 70 | U | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| AROCLOR-1016 | 68 | U | |
| AROCLOR-1221 | 68 | U | |
| AROCLOR-1232 | 68 | U | |
| AROCLOR-1242 | 68 | U | |
| AROCLOR-1248 | 68 | U | |
| AROCLOR-1254 | 530 | | |
| AROCLOR-1260 | 68 | U | |

# PROJ_NO: 00811

SDG: G2056 MEDIA: SOIL DATA FRACTION: PET

| | |
|---|---|
| nsample | TRP1-SD-004A-0204 |
| samp_date | 11/7/2008 |
| lab_id | G2056-01A |
| qc_type | NM |
| units | MG/KG |
| Pct_Solids | 48.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| EXTRACTABLE PETROLEUM HYDROCARB | 1100 | | |

| | |
|---|---|
| nsample | TRP1-SD-004A-0406 |
| samp_date | 11/7/2008 |
| lab_id | G2056-02A |
| qc_type | NM |
| units | MG/KG |
| Pct_Solids | 56.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| EXTRACTABLE PETROLEUM HYDROCARB | 7300 | | |

| | |
|---|---|
| nsample | TRP1-SD-005A-0204 |
| samp_date | 11/7/2008 |
| lab_id | G2056-05A |
| qc_type | NM |
| units | MG/KG |
| Pct_Solids | 47.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| EXTRACTABLE PETROLEUM HYDROCARB | 240 | J | R |

# PROJ_NO: 00811

SDG: G2056 MEDIA: SOIL DATA FRACTION: PET

| | |
|---|---|
| nsample | TRP1-SD-005A-0406 |
| samp_date | 11/7/2008 |
| lab_id | G2056-06A |
| qc_type | NM |
| units | MG/KG |
| Pct_Solids | 48.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| EXTRACTABLE PETROLEUM HYDROCARB | 1000 | | |

| | |
|---|---|
| nsample | TRP1-SD-005B-0001 |
| samp_date | 11/7/2008 |
| lab_id | G2056-03A |
| qc_type | NM |
| units | MG/KG |
| Pct_Solids | 40.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| EXTRACTABLE PETROLEUM HYDROCARB | 280 | | |

**Tetra Tech NUS** **INTERNAL CORRESPONDENCE**

| | | | |
|---|---|---|---|
| **TO:** | **C. RICH** | **DATE:** | **DECEMBER 12, 2008** |
| **FROM:** | **LEIGH A. CIOFANI** | **COPIES:** | **DV FILE** |

**SUBJECT:** **ORGANIC DATA VALIDATION- PAH / PCB / ETPH / HEXACHLOROBENZENE**
**CTO 424, NSB NEW LONDON**
**SAMPLE DELIVERY GROUP (SDG) G2038**

**SAMPLES:** 15 / Solid / PAH / ETPH / Hexachlorobenzene

| | | |
|---|---|---|
| TRP1-SD-007A-0204 | TRP1-SD-007A-0406 | TRP1-SD-007B-001 |
| TRP1-SD-008A-0204 | TRP1-SD-008A-0406 | TRP1-SD-008B-0001 |
| TRP1-SD-009A-0204 | TRP1-SD-009A-0406 | TRP1-SD-009B-0001 |
| TRP1-SD-010A-0204 | TRP1-SD-010A-0406 | TRP1-SD-010B-0001 |
| TRZ4-SD-001A-0204 | TRZ4-SD-001B-0001 | TRZ4-SD-001A-0406 |

15 / Solid / PCB

| | | |
|---|---|---|
| TRP1-SD-007A-0002 | TRP1-SD-007A-0204 | TRP1-SD-007A-0406 |
| TRP1-SD-008A-0002 | TRP1-SD-008A-0204 | TRP1-SD-008A-0406 |
| TRP1-SD-009A-0002 | TRP1-SD-009A-0204 | TRP1-SD-009A-0406 |
| TRP1-SD-010A-0002 | TRP1-SD-010A-0204 | TRP1-SD-010A-0406 |
| TRZ4-SD-001A-0002 | TRZ4-SD-001A-0204 | TRZ4-SD-001A-0406 |

OVERVIEW

The sample set for CTO 424, NSB New London, SDG G2038, consists of twenty (20) solid environmental samples. There are no field duplicate pairs associated with this SDG.

Samples were analyzed for polycyclic aromatic hydrocarbons (PAH), polychlorinated biphenyls (PCB), and extractable total petroleum hydrocarbons (ETPH).

The samples were collected by Tetra Tech NUS on November 5 and 6, 2008 and analyzed by Mitkem Corporation. All analyses were conducted in accordance with SW-846 selected ion monitoring (SIM) 8270D and 8082, and the Connecticut ETPH method analysis and reporting protocols. A Tier 3 data validation was performed on the referenced samples. The data contained in this SDG were validated with regard to the following parameters:

* • Data Completeness
* • Holding Times
* • GC/MS Tuning
* • Initial/Continuing Calibrations
* • Laboratory Method/Field Blank Results
* • Surrogate Recoveries
* • Laboratory Control Spike/Laboratory Control Spike Duplicate Results
* • Matrix Spike/Matrix Spike Duplicate Results
* • Internal Standards
* • Field Duplicate Precision
* • Compound Quantitation

- Compound Identification
- Detection Limits

The asterisk (*) indicates that all quality control criteria were met for this parameter. Qualified (if applicable) analytical results are summarized in Appendix A. Results as reported by the laboratory are presented in Appendix B. Appendix C contains Region I worksheets, and Appendix D contains the documentation to support the findings as discussed in this data validation report. The attached Table summarizes the validation qualifications which are based on the following information:

## CALIBRATIONS

The following table summarizes calibration noncompliance and corresponding actions for PCBs:

| Analyte | CCV, Col. CLPPest 11/13/08 (17:01/17:59) | CCV, Col. CLPPest 11/13/08 (21:42-22:30) | CCV, Col. CLPPest 11/14/08 (01:09-01:57) |
|---|---|---|---|
| Aroclor-1016 | X | X | X |
| Aroclor-1260 | X | X | X |
| Aroclor-1242 | | X | X |
| Aroclor-1254 | X | X | X |
| Assoc. Samples: | TRP1-SD-009A-0002<br>TRP1-SD-009A-0204<br>TRP1-SD-009A-0406<br>TRP1-SD-010A-0002<br>TRP1-SD-010A-0204<br>TRP1-SD-010A-0406<br>TRP1-SD-008A-0002<br>TRP1-SD-008A-0204<br>TRP1-SD-008A-0406<br>TRP1-SD-007A-0002 | All | TRP1-SD-007A-0204<br>TRP1-SD-007A-0406<br>TRZ4-SD-001A-0002<br>TRZ4-SD-001A-0204<br>TRZ4-SD-001A-0406 |

Calibration Actions:
X – Percent difference results were outside the ±15% acceptance range. Positive results were not qualified because all positive results were reported from Column CLPPestII, which was compliant. Non-detected results were not qualified because Column CLPPestII was compliant.

## SURROGATE RECOVERIES

The PAH surrogate recoveries were reported to be diluted out with zero percent recoveries reported for dilutions of the following samples: TRZ4-SD-001A-0406, TRP1-SD-008A-0406, TRP1-SD-010A-0406, TRP1-SD-007B-001, TRZ4-SD-001A-0204, TRP1-SD-008A-0204, and TRP1-SD-007A-0406. No action was taken on this basis.

The PCB surrogate recovery for decachlorobiphenyl (DCB) on the secondary column was less than the laboratory acceptance minimum for sample TRP1-SD-009A-0002. No action was necessary because the DCB recovery was within limits on the primary column.

## LABORATORY CONTROL SAMPLE

Hexachlorobenzene was not included in the PAH spike mix for the laboratory control sample (LCS). No action was taken on this basis.

## MATRIX SPIKE/MATRIX SPIKE DUPLICATE RESULTS

Hexachlorobenzene was not included in the PAH spike mix for the matrix spike/matrix spike duplicate (MS/MSD). No action was taken on this basis.

In the MS/MSD performed on sample TRZ4-SD-001A-0204, many PAH analytes had MS/MSD percent recoveries and/or relative percent difference (RPD) results that were outside of laboratory quality control criteria. All sample concentrations were taken from the original undiluted sample TRZ4-SD-001A-0204. However, no action was taken because the sample concentration was greater than 2X the spike amount used for all analytes outside quality control limits:

| Analyte | Details |
|---|---|
| Naphthalene | high RPD |
| 2-methylnaphthalene | high MSD % recovery |
| Acenaphthylene | low MS % recovery, high RPD |
| Acenaphthene | high MSD % recovery, high RPD |
| Fluorene | low MS % recovery, high MSD % recovery, high RPD |
| Phenanthrene | low MS % recovery, high MSD % recovery |
| Anthracene | low MS/MSD % recovery |
| Fluoranthene | low MS/MSD % recovery |
| Pyrene | low MS % recovery, high MSD % recovery, high RPD |
| Benzo(a)anthracene | low MS/MSD % recovery |
| Chrysene | low MS % recovery, high MSD % recovery, high RPD |
| Benzo(b)fluoranthene | low MS/MSD % recovery |
| Benzo(k)fluoranthene | low MS/MSD % recovery |
| Benzo(a)pyrene | low MS/MSD % recovery |
| Indeno(1,2,3-cd)pyrene | low MS/MSD % recovery |
| Dibenzo(a,h)anthracene | low MS % recovery, high RPD |
| Benzo(g,h,i)perylene | low MS/MSD % recovery |

The PCB MS/MSD performed on sample TRZ4-SD-001A-0204 had MSD percent recoveries and RPDs that were greater than the laboratory quality control criteria on both columns for Aroclor-1260. No action was taken because the MS and LCS percent recoveries were within limits and Aroclor-1260 is non-detected in all samples.

The MS/MSD performed on sample TRZ4-SD-001A-0204 had both MS and MSD percent recoveries and an RPD that were greater than the laboratory quality control limits for ETPH. No action was taken because the sample concentration was greater than 2X the spike amount used.

## INTERNAL STANDARDS

Several PAH samples had internal standard area counts greater than the laboratory quality control maximum for the internal standard perylene-d12. Internal standard area counts were within limits for the dilutions of all samples. Therefore, positive results for analytes quantitated with this internal standard were taken from the associated diluted samples as follows:

| Sample | Analytes taken from Dilution |
|---|---|
| TRP1-SD-009B-0001 | benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene, dibenzo(a,h)anthracene, benzo(g,h,i)perylene |
| TRP1-SD-009A-0406 | benzo(k)fluoranthene, indeno(1,2,3-cd)perylene, dibenzo(a,h)anthracene, benzo(g,h,i)perylene |

| | |
|---|---|
| TRP1-SD-010A-0406 | benzo(k)fluoranthene, dibenzo(a,h)anthracene |
| TRP1-SD-008B-0001 | indeno(1,2,3-cd)pyrene, dibenzo(a,h)anthracene, benzo(g,h,i)perylene |

Results for dibenzo(a,h)anthracene were positive in the original samples but non-detected in the dilutions of samples TRP1-SD-008A-0204, TRP1-SD-007B-001, and TRZ4-SD-001A-0204. These samples also had internal standard area counts greater than the quality control limit. Therefore, the positive results for dibenzo(a,h)anthracene in the original undiluted samples were used for validation and qualified as estimated (J) for internal standard noncompliance.

## COMPOUND IDENTIFICATION

The following PCB samples had percent difference between columns results that were greater than the 25% acceptance limit. Positive results were qualified as estimated (J) if the percent difference was greater than 25% but less than or equal to 100% and unusable (R) if the percent difference exceeded 100%.

| Sample | Analyte | % Difference | Qualifier |
|---|---|---|---|
| TRP1-SD-010A-0406 | Aroclor-1254 | 100.6% | R |
| TRP1-SD-001A-0204 | Aroclor-1242 | 36.6% | J |

## DETECTION LIMITS

Non-detected results for hexachlorobenzene exceeded the quantitation limit (QL) of 1 ug/kg (based on 100% solids) presented in the QAPP as follows:

| Sample | Concentration | | % Solids | Adjusted QL |
|---|---|---|---|---|
| TRP1-SD-007A-0204 | 7.2 U | UG/KG | 46 | 2.2 |
| TRP1-SD-007A-0406 | 6.4 U | UG/KG | 51 | 2.0 |
| TRP1-SD-007B-001 | 9.2 U | UG/KG | 36 | 2.8 |
| TRP1-SD-008A-0204 | 8.7 U | UG/KG | 38 | 2.6 |
| TRP-SD-008A-0406 | 7.6 U | UG/KG | 43 | 2.3 |
| TRP1-SD-008B-0001 | 11 U | UG/KG | 31 | 3.2 |
| TRP1-SD-009A-0204 | 9.4 U | UG/KG | 35 | 2.9 |
| TRP1-SD-009A-0406 | 8.0 U | UG/KG | 41 | 2.4 |
| TRP1-SD-009B-0001 | 7.5 U | UG/KG | 44 | 2.3 |
| TRP1-SD-010A-0204 | 5.4 U | UG/KG | 61 | 1.6 |
| TRP1-SD-010A-0406 | 6.0 U | UG/KG | 54 | 1.9 |
| TRP1-SD-010B-0001 | 6.9 U | UG/KG | 48 | 2.1 |
| TRZ4-SD-001A-0204 | 8.7 U | UG/KG | 38 | 2.6 |
| TRZ4-SD-001B-0001 | 8.9 U | UG/KG | 37 | 2.7 |
| TRZ4-SD-001A-0406 | 8.2 U | UG/KG | 40 | 2.5 |

## ADDITIONAL COMMENTS

According to the laboratory narrative, results for pesticides and PCB congeners for these samples are reported in a separate SDG. No action was taken on this basis.

Sample TRP1-SD-009A-0204 was originally reported as TRP1-SD-009A-0240 on the Chain-of-Custody, in the

database, and on the laboratory Form I reports. This sample name was changed to TRP1-SD-009A-0204 in the database and on the Form I reports to reflect the sample collection depth.

Sample TRZ4-SD-001A-0406 was originally reported as TRZ4-SD-01A-0406 on the Form I reports and in the database. This sample ID was changed to TRZ4-SD-001A-0406 in the database and on the Form Is to match the Chain-of-Custody.

Several PAH results in each sample exceeded the instrument calibration range. Therefore, all samples were reanalyzed at dilution factors greater than 1. Undiluted PAH results were used for validation except for analytes that exceeded the calibration range. For analytes exceeding the calibration range, results from the dilutions were used for validation. The samples were diluted as follows:

| Sample | Dilution Factor |
|---|---|
| TRP1-SD-009B-0001 | 5 |
| TRP1-SD-010B-0001 | 5 |
| TRZ4-SD-001B-0001 | 5 |
| TRP1-SD-007A-0204 | 5 |
| TRP1-SD-008A-0406 | 10 |
| TRP1-SD-008B-0001 | 10 |
| TRP1-SD-009A-0204 | 10 |
| TRP1-SD-009A-0406 | 10 |
| TRP1-SD-010A-0204 | 10 |
| TRP1-SD-010A-0406 | 20 |
| TRP1-SD-007A-0406 | 40 |
| TRP1-SD-008A-0204 | 40 |
| TRZ4-SD-001A-0406 | 40 |
| TRP1-SD-007B-001 | 80 |
| TRZ4-SD-001A-0204 | 80 |

The ETPH sample TRZ4-SD-001A-0204 (lab ID: G2083-19A) initially had a second result reported in the electronic data deliverable (EDD) for a reanalysis run at a dilution factor of 4 on 11/24/08. However, no forms for this reanalysis were included in the laboratory data package. The laboratory was contacted and provided information regarding this reanalysis, which was used for laboratory quality control purposes (see email statement) and was not intended to be included in the EDD. Therefore, the result of the original analysis was used for validation.

## EXECUTIVE SUMMARY

**Laboratory Performance Issues:** Two PCB results were qualified as due to percent difference between columns. Required quantitation limits were exceeded for hexachlorobenzene.

**Other Factors Affecting Data Quality:** None.

The data for these analyses were reviewed with reference to the Region I EPA "Data Validation Functional Guidelines - Part II" (12/96), and the Department of Defense (DoD) document entitled "Quality Systems Manual (QSM) for Environmental Laboratories" (January 2006). The text of this report has been formulated to address only those problem areas affecting data quality.

"I attest that the data referenced herein were validated according to the agreed upon validation criteria as specified in the DoD QSM."

Leigh A. Ciofani
Tetra Tech NUS

Leigh A. Ciofani
Data Validator/Environmental Scientist I

Edward Lechner /for
TetraTech NUS

Joseph A. Samchuck
Data Validation Quality Assurance Officer

Attachments:

Appendix A – Qualified Analytical Results
Appendix B – Results as Reported by the Laboratory
Appendix C – Regional Worksheets
Appendix D – Support Documentation

# APPENDIX A

## QUALIFIED ANALYTICAL RESULTS

**Data Validation Qualifier Codes:**

A = Lab Blank Contamination
B = Field Blank Contamination
C = Calibration Noncompliance (e.g. % RSDs, %Ds, ICVs, CCVs, RRFs, etc.)
C01 = GC/MS Tuning Noncompliance
D = MS/MSD Recovery Noncompliance
E = LCS/LCSD Recovery Noncompliance
F = Lab Duplicate Imprecision
G = Field Duplicate Imprecision
H = Holding Time Exceedance
I = ICP Serial Dilution Noncompliance
J = GFAA PDS - GFAA MSA's $r < 0.995$
K = ICP Interference - includes ICS % R Noncompliance
L = Instrument Calibration Range Exceedance
M = Sample Preservation Noncompliance
N = Internal Standard Noncompliance
N01 = Internal Standard Recovery Noncompliance Dioxins
N02 = Recovery Standard Noncompliance Dioxins
N03 = Clean-up Standard Noncompliance Dioxins
O = Poor Instrument Performance (e.g. base-line drifting)
P = Uncertainty near detection limit (< 2 x IDL for inorganics and <CRQL for organics)
Q = Other problems (can be any number of issues; e.g. poor chromatography,interferences, etc.)
R = Surrogates Recovery Noncompliance
S = Pesticide/PCB Resolution
T = % Breakdown Noncompliance for DDT and Endrin
U = % Difference between columns/detectors >25% for positive results determined via GC/HPLC
V = Non-linear calibrations; correlation coefficient $r < 0.995$
W = EMPC result
X = Signal to noise response drop
Y = Percent solids <30%
Z = Uncertainty at 2 sigma deviation is greater than sample activity

# PROJ_NO: 00811

SDG: G2038 MEDIA: SOIL DATA FRACTION: PAH

| | |
|---|---|
| nsample | TRP1-SD-007A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2038-15A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 46.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 1-METHYLNAPHTHALENE | 7.2 | U | |
| 2-METHYLNAPHTHALENE | 20 | | |
| ACENAPHTHENE | 30 | | |
| ACENAPHTHYLENE | 170 | | |
| ANTHRACENE | 330 | | |
| BENZO(G,H,I)PERYLENE | 480 | | |
| BENZO(K)FLUORANTHENE | 650 | | |
| DIBENZO(A,H)ANTHRACENE | 170 | | |
| FLUORENE | 59 | | |
| HEXACHLOROBENZENE | 7.2 | U | |
| INDENO(1,2,3-CD)PYRENE | 470 | | |
| NAPHTHALENE | 22 | | |
| PHENANTHRENE | 430 | | |

| | |
|---|---|
| nsample | TRP1-SD-007A-0204DL |
| samp_date | 11/6/2008 |
| lab_id | G2038-15ADL |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 46.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| BENZO(A)ANTHRACENE | 960 | | |
| BENZO(A)PYRENE | 980 | | |
| BENZO(B)FLUORANTHENE | 1400 | | |
| CHRYSENE | 1200 | | |
| FLUORANTHENE | 1500 | | |
| PYRENE | 2800 | | |

| | |
|---|---|
| nsample | TRP1-SD-007A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2038-16A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 51.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 1-METHYLNAPHTHALENE | 110 | | |
| 2-METHYLNAPHTHALENE | 51 | | |
| ACENAPHTHYLENE | 230 | | |
| DIBENZO(A,H)ANTHRACENE | 640 | | |
| HEXACHLOROBENZENE | 6.4 | U | |
| NAPHTHALENE | 59 | | |

# PROJ_NO: 00811

SDG: G2038 MEDIA: SOIL DATA FRACTION: PAH

| | |
|---|---|
| nsample | TRP1-SD-007A-0406DL |
| samp_date | 11/6/2008 |
| lab_id | G2038-16ADL |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 51.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ACENAPHTHENE | 2100 | | |
| ANTHRACENE | 2300 | | |
| BENZO(A)ANTHRACENE | 3800 | | |
| BENZO(A)PYRENE | 2700 | | |
| BENZO(B)FLUORANTHENE | 3700 | | |
| BENZO(G,H,I)PERYLENE | 1400 | | |
| BENZO(K)FLUORANTHENE | 2200 | | |
| CHRYSENE | 4700 | | |
| FLUORANTHENE | 14000 | | |
| FLUORENE | 1500 | | |
| INDENO(1,2,3-CD)PYRENE | 1300 | | |
| PHENANTHRENE | 6800 | | |
| PYRENE | 12000 | | |

| | |
|---|---|
| nsample | TRP1-SD-007B-001 |
| samp_date | 11/6/2008 |
| lab_id | G2038-13A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 36.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 1-METHYLNAPHTHALENE | 22 | | |
| 2-METHYLNAPHTHALENE | 60 | | |
| ACENAPHTHENE | 490 | | |
| DIBENZO(A,H)ANTHRACENE | 710 | J | N |
| FLUORENE | 800 | | |
| HEXACHLOROBENZENE | 9.2 | U | |
| NAPHTHALENE | 51 | | |

| | |
|---|---|
| nsample | TRP1-SD-007B-001DL |
| samp_date | 11/6/2008 |
| lab_id | G2038-13ADL |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 36.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ACENAPHTHYLENE | 760 | | |
| ANTHRACENE | 3100 | | |
| BENZO(A)ANTHRACENE | 12000 | | |
| BENZO(A)PYRENE | 5300 | | |
| BENZO(B)FLUORANTHENE | 7800 | | |
| BENZO(G,H,I)PERYLENE | 1900 | | |
| BENZO(K)FLUORANTHENE | 4100 | | |
| CHRYSENE | 13000 | | |
| FLUORANTHENE | 52000 | | |
| INDENO(1,2,3-CD)PYRENE | 2000 | | |
| PHENANTHRENE | 2400 | | |
| PYRENE | 36000 | | |

# PROJ_NO: 00811

SDG: G2038 MEDIA: SOIL DATA FRACTION: PAH

| | |
|---|---|
| nsample | TRP1-SD-008A-0204 |
| samp_date | 11/5/2008 |
| lab_id | G2038-11A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 38.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 1-METHYLNAPHTHALENE | 220 | | |
| 2-METHYLNAPHTHALENE | 78 | | |
| ACENAPHTHYLENE | 490 | | |
| DIBENZO(A,H)ANTHRACENE | 450 | J | N |
| HEXACHLOROBENZENE | 8.7 | U | |
| NAPHTHALENE | 120 | | |

| | |
|---|---|
| nsample | TRP1-SD-008A-0204DL |
| samp_date | 11/5/2008 |
| lab_id | G2038-11ADL |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 38.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ACENAPHTHENE | 4900 | | |
| ANTHRACENE | 2700 | | |
| BENZO(A)ANTHRACENE | 5100 | | |
| BENZO(A)PYRENE | 2700 | | |
| BENZO(B)FLUORANTHENE | 3900 | | |
| BENZO(G,H,I)PERYLENE | 1100 | | |
| BENZO(K)FLUORANTHENE | 2100 | | |
| CHRYSENE | 6100 | | |
| FLUORANTHENE | 21000 | | |
| FLUORENE | 2300 | | |
| INDENO(1,2,3-CD)PYRENE | 1100 | | |
| PHENANTHRENE | 4600 | | |
| PYRENE | 16000 | | |

| | |
|---|---|
| nsample | TRP1-SD-008A-0406 |
| samp_date | 11/5/2008 |
| lab_id | G2038-12A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 43.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 1-METHYLNAPHTHALENE | 31 | | |
| 2-METHYLNAPHTHALENE | 35 | | |
| ACENAPHTHENE | 250 | | |
| ACENAPHTHYLENE | 260 | | |
| ANTHRACENE | 620 | | |
| BENZO(G,H,I)PERYLENE | 690 | | |
| BENZO(K)FLUORANTHENE | 560 | | |
| DIBENZO(A,H)ANTHRACENE | 280 | | |
| FLUORENE | 200 | | |
| HEXACHLOROBENZENE | 7.6 | U | |
| INDENO(1,2,3-CD)PYRENE | 680 | | |
| NAPHTHALENE | 94 | | |

# PROJ_NO: 00811

SDG: G2038 MEDIA: SOIL DATA FRACTION: PAH

| | |
|---|---|
| nsample | TRP1-SD-008A-0406DL |
| samp_date | 11/5/2008 |
| lab_id | G2038-12ADL |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 43.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| BENZO(A)ANTHRACENE | 2000 | | |
| BENZO(A)PYRENE | 1700 | | |
| BENZO(B)FLUORANTHENE | 2300 | | |
| CHRYSENE | 2400 | | |
| FLUORANTHENE | 4500 | | |
| PHENANTHRENE | 1100 | | |
| PYRENE | 4700 | | |

| | |
|---|---|
| nsample | TRP1-SD-008B-0001 |
| samp_date | 11/5/2008 |
| lab_id | G2038-09A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 31.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 1-METHYLNAPHTHALENE | 11 | U | |
| 2-METHYLNAPHTHALENE | 31 | | |
| ACENAPHTHENE | 150 | | |
| ACENAPHTHYLENE | 440 | | |
| FLUORENE | 240 | | |
| HEXACHLOROBENZENE | 11 | U | |
| NAPHTHALENE | 34 | | |

| | |
|---|---|
| nsample | TRP1-SD-008B-0001DL |
| samp_date | 11/5/2008 |
| lab_id | G2038-09ADL |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 31.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ANTHRACENE | 1200 | | |
| BENZO(A)ANTHRACENE | 3300 | | |
| BENZO(A)PYRENE | 2400 | | |
| BENZO(B)FLUORANTHENE | 3400 | | |
| BENZO(G,H,I)PERYLENE | 1100 | | |
| BENZO(K)FLUORANTHENE | 1700 | | |
| CHRYSENE | 4100 | | |
| DIBENZO(A,H)ANTHRACENE | 370 | | |
| FLUORANTHENE | 7800 | | |
| INDENO(1,2,3-CD)PYRENE | 1000 | | |
| PHENANTHRENE | 1200 | | |
| PYRENE | 6100 | | |

# PROJ_NO: 00811

SDG: G2038 MEDIA: SOIL DATA FRACTION: PAH

| | |
|---|---|
| nsample | TRP1-SD-009A-0204 |
| samp_date | 11/5/2008 |
| lab_id | G2038-03A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 35.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 1-METHYLNAPHTHALENE | 12 | | |
| 2-METHYLNAPHTHALENE | 21 | | |
| ACENAPHTHENE | 600 | | |
| ACENAPHTHYLENE | 150 | | |
| ANTHRACENE | 660 | | |
| BENZO(G,H,I)PERYLENE | 380 | | |
| BENZO(K)FLUORANTHENE | 600 | | |
| DIBENZO(A,H)ANTHRACENE | 150 | | |
| FLUORENE | 280 | | |
| HEXACHLOROBENZENE | 9.4 | U | |
| INDENO(1,2,3-CD)PYRENE | 390 | | |
| NAPHTHALENE | 24 | | |
| PHENANTHRENE | 650 | | |

| | |
|---|---|
| nsample | TRP1-SD-009A-0204DL |
| samp_date | 11/5/2008 |
| lab_id | G2038-03ADL |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 35.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| BENZO(A)ANTHRACENE | 2100 | | |
| BENZO(A)PYRENE | 1100 | | |
| BENZO(B)FLUORANTHENE | 1600 | | |
| CHRYSENE | 2100 | | |
| FLUORANTHENE | 6400 | | |
| PYRENE | 4200 | | |

| | |
|---|---|
| nsample | TRP1-SD-009A-0406 |
| samp_date | 11/5/2008 |
| lab_id | G2038-04A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 41.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 1-METHYLNAPHTHALENE | 19 | | |
| 2-METHYLNAPHTHALENE | 32 | | |
| ACENAPHTHENE | 290 | | |
| ACENAPHTHYLENE | 180 | | |
| ANTHRACENE | 750 | | |
| FLUORENE | 340 | | |
| HEXACHLOROBENZENE | 8 | U | |
| NAPHTHALENE | 41 | | |

# PROJ_NO: 00811

SDG: G2038 MEDIA: SOIL DATA FRACTION: PAH

| | |
|---|---|
| nsample | TRP1-SD-009A-0406DL |
| samp_date | 11/5/2008 |
| lab_id | G2038-04ADL |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 41.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| BENZO(A)ANTHRACENE | 1700 | | |
| BENZO(A)PYRENE | 1200 | | |
| BENZO(B)FLUORANTHENE | 1700 | | |
| BENZO(G,H,I)PERYLENE | 630 | | |
| BENZO(K)FLUORANTHENE | 810 | | |
| CHRYSENE | 2000 | | |
| DIBENZO(A,H)ANTHRACENE | 180 | | |
| FLUORANTHENE | 4900 | | |
| INDENO(1,2,3-CD)PYRENE | 560 | | |
| PHENANTHRENE | 2200 | | |
| PYRENE | 3900 | | |

| | |
|---|---|
| nsample | TRP1-SD-009B-0001 |
| samp_date | 11/5/2008 |
| lab_id | G2038-01A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 44.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 1-METHYLNAPHTHALENE | 7.5 | U | |
| 2-METHYLNAPHTHALENE | 16 | | |
| ACENAPHTHENE | 32 | | |
| ACENAPHTHYLENE | 150 | | |
| ANTHRACENE | 480 | | |
| FLUORENE | 77 | | |
| HEXACHLOROBENZENE | 7.5 | U | |
| NAPHTHALENE | 21 | | |
| PHENANTHRENE | 520 | | |

| | |
|---|---|
| nsample | TRP1-SD-009B-0001DL |
| samp_date | 11/5/2008 |
| lab_id | G2038-01ADL |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 44.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| BENZO(A)ANTHRACENE | 1600 | | |
| BENZO(A)PYRENE | 1100 | | |
| BENZO(B)FLUORANTHENE | 1700 | | |
| BENZO(G,H,I)PERYLENE | 480 | | |
| BENZO(K)FLUORANTHENE | 880 | | |
| CHRYSENE | 1800 | | |
| DIBENZO(A,H)ANTHRACENE | 160 | | |
| FLUORANTHENE | 1800 | | |
| INDENO(1,2,3-CD)PYRENE | 480 | | |
| PYRENE | 3200 | | |

# PROJ_NO: 00811

SDG: G2038 MEDIA: SOIL DATA FRACTION: PAH

| | |
|---|---|
| nsample | TRP1-SD-010A-0204 |
| samp_date | 11/5/2008 |
| lab_id | G2038-07A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 61.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 1-METHYLNAPHTHALENE | 7.7 | | |
| 2-METHYLNAPHTHALENE | 19 | | |
| ACENAPHTHENE | 82 | | |
| ACENAPHTHYLENE | 140 | | |
| BENZO(G,H,I)PERYLENE | 540 | | |
| DIBENZO(A,H)ANTHRACENE | 190 | | |
| FLUORENE | 170 | | |
| HEXACHLOROBENZENE | 5.4 | U | |
| INDENO(1,2,3-CD)PYRENE | 530 | | |
| NAPHTHALENE | 19 | | |

| | |
|---|---|
| nsample | TRP1-SD-010A-0204DL |
| samp_date | 11/5/2008 |
| lab_id | G2038-07ADL |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 61.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ANTHRACENE | 840 | | |
| BENZO(A)ANTHRACENE | 1600 | | |
| BENZO(A)PYRENE | 1200 | | |
| BENZO(B)FLUORANTHENE | 1600 | | |
| BENZO(K)FLUORANTHENE | 860 | | |
| CHRYSENE | 1700 | | |
| FLUORANTHENE | 5300 | | |
| PHENANTHRENE | 2800 | | |
| PYRENE | 4700 | | |

| | |
|---|---|
| nsample | TRP1-SD-010A-0406 |
| samp_date | 11/5/2008 |
| lab_id | G2038-08A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 54.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 1-METHYLNAPHTHALENE | 40 | | |
| 2-METHYLNAPHTHALENE | 49 | | |
| ACENAPHTHENE | 220 | | |
| ACENAPHTHYLENE | 120 | | |
| FLUORENE | 320 | | |
| HEXACHLOROBENZENE | 6 | U | |
| NAPHTHALENE | 130 | | |

# PROJ_NO: 00811

SDG: G2038 MEDIA: SOIL DATA FRACTION: PAH

| | |
|---|---|
| nsample | TRP1-SD-010A-0406DL |
| samp_date | 11/5/2008 |
| lab_id | G2038-08ADL |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 54.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ANTHRACENE | 770 | | |
| BENZO(A)ANTHRACENE | 2100 | | |
| BENZO(A)PYRENE | 1600 | | |
| BENZO(B)FLUORANTHENE | 2200 | | |
| BENZO(G,H,I)PERYLENE | 800 | | |
| BENZO(K)FLUORANTHENE | 1100 | | |
| CHRYSENE | 2400 | | |
| DIBENZO(A,H)ANTHRACENE | 240 | | |
| FLUORANTHENE | 7000 | | |
| INDENO(1,2,3-CD)PYRENE | 730 | | |
| PHENANTHRENE | 2300 | | |
| PYRENE | 5900 | | |

| | |
|---|---|
| nsample | TRP1-SD-010B-0001 |
| samp_date | 11/5/2008 |
| lab_id | G2038-05A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 48.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 1-METHYLNAPHTHALENE | 6.9 | U | |
| 2-METHYLNAPHTHALENE | 21 | | |
| ACENAPHTHENE | 31 | | |
| ACENAPHTHYLENE | 180 | | |
| ANTHRACENE | 410 | | |
| BENZO(G,H,I)PERYLENE | 500 | | |
| BENZO(K)FLUORANTHENE | 490 | | |
| DIBENZO(A,H)ANTHRACENE | 180 | | |
| FLUORENE | 71 | | |
| HEXACHLOROBENZENE | 6.9 | U | |
| INDENO(1,2,3-CD)PYRENE | 480 | | |
| NAPHTHALENE | 16 | | |
| PHENANTHRENE | 670 | | |

| | |
|---|---|
| nsample | TRP1-SD-010B-0001DL |
| samp_date | 11/5/2008 |
| lab_id | G2038-05ADL |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 48.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| BENZO(A)ANTHRACENE | 950 | | |
| BENZO(A)PYRENE | 930 | | |
| BENZO(B)FLUORANTHENE | 1400 | | |
| CHRYSENE | 1300 | | |
| FLUORANTHENE | 1800 | | |
| PYRENE | 3200 | | |

# PROJ_NO: 00811

SDG: G2038 MEDIA: SOIL DATA FRACTION: PAH

| | |
|---|---|
| nsample | TRZ4-SD-001A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2038-19A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 38.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 1-METHYLNAPHTHALENE | 66 | | |
| 2-METHYLNAPHTHALENE | 150 | | |
| ACENAPHTHYLENE | 790 | | |
| DIBENZO(A,H)ANTHRACENE | 680 | J | N |
| HEXACHLOROBENZENE | 8.7 | U | |
| NAPHTHALENE | 580 | | |

| | |
|---|---|
| nsample | TRZ4-SD-001A-0204DL |
| samp_date | 11/6/2008 |
| lab_id | G2038-19ADL |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 38.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ACENAPHTHENE | 1800 | | |
| ANTHRACENE | 3900 | | |
| BENZO(A)ANTHRACENE | 8700 | | |
| BENZO(A)PYRENE | 4500 | | |
| BENZO(B)FLUORANTHENE | 6600 | | |
| BENZO(G,H,I)PERYLENE | 1700 | | |
| BENZO(K)FLUORANTHENE | 3300 | | |
| CHRYSENE | 9800 | | |
| FLUORANTHENE | 36000 | | |
| FLUORENE | 1300 | | |
| INDENO(1,2,3-CD)PYRENE | 1700 | | |
| PHENANTHRENE | 5800 | | |
| PYRENE | 24000 | | |

| | |
|---|---|
| nsample | TRZ4-SD-001A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2038-20A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 40.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 1-METHYLNAPHTHALENE | 180 | | |
| 2-METHYLNAPHTHALENE | 280 | | |
| ACENAPHTHYLENE | 430 | | |
| BENZO(G,H,I)PERYLENE | 800 | | |
| DIBENZO(A,H)ANTHRACENE | 340 | | |
| HEXACHLOROBENZENE | 8.2 | U | |

# PROJ_NO: 00811

SDG: G2038 MEDIA: SOIL DATA FRACTION: PAH

| | |
|---|---|
| nsample | TRZ4-SD-001A-0406DL |
| samp_date | 11/6/2008 |
| lab_id | G2038-20ADL |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 40.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ACENAPHTHENE | 6400 | | |
| ANTHRACENE | 3800 | | |
| BENZO(A)ANTHRACENE | 4600 | | |
| BENZO(A)PYRENE | 2200 | | |
| BENZO(B)FLUORANTHENE | 3500 | | |
| BENZO(K)FLUORANTHENE | 1700 | | |
| CHRYSENE | 5200 | | |
| FLUORANTHENE | 26000 | | |
| FLUORENE | 1800 | | |
| INDENO(1,2,3-CD)PYRENE | 930 | | |
| NAPHTHALENE | 930 | | |
| PHENANTHRENE | 6400 | | |
| PYRENE | 17000 | | |

| | |
|---|---|
| nsample | TRZ4-SD-001B-0001 |
| samp_date | 11/6/2008 |
| lab_id | G2038-17A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 37.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 1-METHYLNAPHTHALENE | 19 | | |
| 2-METHYLNAPHTHALENE | 40 | | |
| ACENAPHTHENE | 80 | | |
| ACENAPHTHYLENE | 230 | | |
| ANTHRACENE | 470 | | |
| BENZO(G,H,I)PERYLENE | 450 | | |
| BENZO(K)FLUORANTHENE | 460 | | |
| DIBENZO(A,H)ANTHRACENE | 170 | | |
| FLUORENE | 120 | | |
| HEXACHLOROBENZENE | 8.9 | U | |
| INDENO(1,2,3-CD)PYRENE | 450 | | |
| NAPHTHALENE | 98 | | |
| PHENANTHRENE | 800 | | |

| | |
|---|---|
| nsample | TRZ4-SD-001B-0001DL |
| samp_date | 11/6/2008 |
| lab_id | G2038-17ADL |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 37.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| BENZO(A)ANTHRACENE | 1200 | | |
| BENZO(A)PYRENE | 1100 | | |
| BENZO(B)FLUORANTHENE | 1500 | | |
| CHRYSENE | 1800 | | |
| FLUORANTHENE | 3100 | | |
| PYRENE | 3700 | | |

| PROJ_NO: 00811<br>SDG: G2038<br>FRACTION: PEST/PCB<br>MEDIA: SOIL | NSAMPLE | TRP1-SD-007A-0002 | | | TRP1-SD-007A-0204 | | | TRP1-SD-007A-0406 | | | TRP1-SD-008A-0002 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LAB_ID | G2038-14A | | | G2038-15A | | | G2038-16A | | | G2038-10A | | |
| | SAMP_DATE | 11/6/2008 | | | 11/6/2008 | | | 11/6/2008 | | | 11/5/2008 | | |
| | QC_TYPE | NM | | | NM | | | NM | | | NM | | |
| | UNITS | UG/KG | | | UG/KG | | | UG/KG | | | UG/KG | | |
| | PCT_SOLIDS | 42.0 | | | 46.0 | | | 51.0 | | | 46.0 | | |
| | DUP_OF | | | | | | | | | | | | |
| PARAMETER | | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD |
| AROCLOR-1016 | | 79 | U | | 71 | U | | 64 | U | | 71 | U | |
| AROCLOR-1221 | | 79 | U | | 71 | U | | 64 | U | | 71 | U | |
| AROCLOR-1232 | | 79 | U | | 71 | U | | 64 | U | | 71 | U | |
| AROCLOR-1242 | | 79 | U | | 71 | U | | 64 | U | | 71 | U | |
| AROCLOR-1248 | | 79 | U | | 71 | U | | 64 | U | | 71 | U | |
| AROCLOR-1254 | | 100 | | | 420 | | | 370 | | | 420 | | |
| AROCLOR-1260 | | 79 | U | | 71 | U | | 64 | U | | 71 | U | |

| PROJ_NO: 00811<br>SDG: G2038<br>FRACTION: PEST/PCB<br>MEDIA: SOIL | NSAMPLE | TRP1-SD-008A-0204 | | | TRP1-SD-008A-0406 | | | TRP1-SD-009A-0002 | | | TRP1-SD-009A-0204 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LAB_ID | G2038-11A | | | G2038-12A | | | G2038-02A | | | G2038-03A | | |
| | SAMP_DATE | 11/5/2008 | | | 11/5/2008 | | | 11/5/2008 | | | 11/5/2008 | | |
| | QC_TYPE | NM | | | NM | | | NM | | | NM | | |
| | UNITS | UG/KG | | | UG/KG | | | UG/KG | | | UG/KG | | |
| | PCT_SOLIDS | 38.0 | | | 43.0 | | | 35.0 | | | 35.0 | | |
| | DUP_OF | | | | | | | | | | | | |
| PARAMETER | | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD |
| AROCLOR-1016 | | 86 | U | | 76 | U | | 94 | U | | 94 | U | |
| AROCLOR-1221 | | 86 | U | | 76 | U | | 94 | U | | 94 | U | |
| AROCLOR-1232 | | 86 | U | | 76 | U | | 94 | U | | 94 | U | |
| AROCLOR-1242 | | 86 | U | | 76 | U | | 94 | U | | 94 | U | |
| AROCLOR-1248 | | 86 | U | | 76 | U | | 94 | U | | 94 | U | |
| AROCLOR-1254 | | 260 | | | 890 | | | 210 | | | 94 | U | |
| AROCLOR-1260 | | 86 | U | | 76 | U | | 94 | U | | 94 | U | |

| PROJ_NO: 00811<br>SDG: G2038<br>FRACTION: PEST/PCB<br>MEDIA: SOIL | NSAMPLE | TRP1-SD-009A-0406 | | | TRP1-SD-010A-0002 | | | TRP1-SD-010A-0204 | | | TRP1-SD-010A-0406 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LAB_ID | G2038-04A | | | G2038-06A | | | G2038-07A | | | G2038-08A | | |
| | SAMP_DATE | 11/5/2008 | | | 11/5/2008 | | | 11/5/2008 | | | 11/5/2008 | | |
| | QC_TYPE | NM | | | NM | | | NM | | | NM | | |
| | UNITS | UG/KG | | | UG/KG | | | UG/KG | | | UG/KG | | |
| | PCT_SOLIDS | 41.0 | | | 46.0 | | | 61.0 | | | 54.0 | | |
| | DUP_OF | | | | | | | | | | | | |
| PARAMETER | | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD |
| AROCLOR-1016 | | 80 | U | | 72 | U | | 54 | U | | 61 | U | |
| AROCLOR-1221 | | 80 | U | | 72 | U | | 54 | U | | 61 | U | |
| AROCLOR-1232 | | 80 | U | | 72 | U | | 54 | U | | 61 | U | |
| AROCLOR-1242 | | 80 | U | | 72 | U | | 54 | U | | 61 | U | |
| AROCLOR-1248 | | 80 | U | | 72 | U | | 54 | U | | 61 | U | |
| AROCLOR-1254 | | 91 | | | 190 | | | 300 | | | 390 | R | U |
| AROCLOR-1260 | | 80 | U | | 72 | U | | 54 | U | | 61 | U | |

| PROJ_NO: 00811<br>SDG: G2038<br>FRACTION: PEST/PCB<br>MEDIA: SOIL | NSAMPLE | TRZ4-SD-001A-0002 | | | TRZ4-SD-001A-0204 | | | TRZ4-SD-001A-0406 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | LAB_ID | G2038-18A | | | G2038-19A | | | G2038-20A | | |
| | SAMP_DATE | 11/6/2008 | | | 11/6/2008 | | | 11/6/2008 | | |
| | QC_TYPE | NM | | | NM | | | NM | | |
| | UNITS | UG/KG | | | UG/KG | | | UG/KG | | |
| | PCT_SOLIDS | 36.0 | | | 38.0 | | | 40.0 | | |
| | DUP_OF | | | | | | | | | |
| PARAMETER | | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD |
| AROCLOR-1016 | | 91 | U | | 86 | U | | 82 | U | |
| AROCLOR-1221 | | 91 | U | | 86 | U | | 82 | U | |
| AROCLOR-1232 | | 91 | U | | 86 | U | | 82 | U | |
| AROCLOR-1242 | | 91 | U | | 120 | J | U | 190 | | |
| AROCLOR-1248 | | 91 | U | | 86 | U | | 82 | U | |
| AROCLOR-1254 | | 91 | U | | 86 | U | | 110 | | |
| AROCLOR-1260 | | 91 | U | | 86 | U | | 82 | U | |

| PROJ_NO: 00811 | NSAMPLE | TRP1-SD-007A-0204 | | | TRP1-SD-007A-0406 | | | TRP1-SD-007B-001 | | | TRP1-SD-008A-0204 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SDG: G2038 | LAB_ID | G2038-15A | | | G2038-16A | | | G2038-13A | | | G2038-11A | | |
| FRACTION: PET | SAMP_DATE | 11/6/2008 | | | 11/6/2008 | | | 11/6/2008 | | | 11/5/2008 | | |
| MEDIA: SOIL | QC_TYPE | NM | | | NM | | | NM | | | NM | | |
| | UNITS | MG/KG | | | MG/KG | | | MG/KG | | | MG/KG | | |
| | PCT_SOLIDS | 46.0 | | | 51.0 | | | 36.0 | | | 38.0 | | |
| | DUP_OF | | | | | | | | | | | | |
| PARAMETER | | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD |
| EXTRACTABLE PETROLEUM HYDROCARBONS | | 270 | | | 2300 | | | 760 | | | 520 | | |

| PROJ_NO: 00811<br>SDG: G2038<br>FRACTION: PET<br>MEDIA: SOIL | NSAMPLE | TRP1-SD-008A-0406 | | | TRP1-SD-008B-0001 | | | TRP1-SD-009A-0204 | | | TRP1-SD-009A-0406 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LAB_ID | G2038-12A | | | G2038-09A | | | G2038-03A | | | G2038-04A | | |
| | SAMP_DATE | 11/5/2008 | | | 11/5/2008 | | | 11/5/2008 | | | 11/5/2008 | | |
| | QC_TYPE | NM | | | NM | | | NM | | | NM | | |
| | UNITS | MG/KG | | | MG/KG | | | MG/KG | | | MG/KG | | |
| | PCT_SOLIDS | 43.0 | | | 31.0 | | | 35.0 | | | 41.0 | | |
| | DUP_OF | | | | | | | | | | | | |
| PARAMETER | | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD |
| EXTRACTABLE PETROLEUM HYDROCARBONS | | 460 | | | 280 | | | 220 | | | 480 | | |

| PROJ_NO: 00811<br>SDG: G2038<br>FRACTION: PET<br>MEDIA: SOIL | NSAMPLE | TRP1-SD-009B-0001 | | | TRP1-SD-010A-0204 | | | TRP1-SD-010A-0406 | | | TRP1-SD-010B-0001 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LAB_ID | G2038-01A | | | G2038-07A | | | G2038-08A | | | G2038-05A | | |
| | SAMP_DATE | 11/5/2008 | | | 11/5/2008 | | | 11/5/2008 | | | 11/5/2008 | | |
| | QC_TYPE | NM | | | NM | | | NM | | | NM | | |
| | UNITS | MG/KG | | | MG/KG | | | MG/KG | | | MG/KG | | |
| | PCT_SOLIDS | 44.0 | | | 61.0 | | | 54.0 | | | 48.0 | | |
| | DUP_OF | | | | | | | | | | | | |
| PARAMETER | | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD |
| EXTRACTABLE PETROLEUM HYDROCARBONS | | 250 | | | 400 | | | 1100 | | | 160 | | |

| PROJ_NO: 00811<br>SDG: G2038<br>FRACTION: PET<br>MEDIA: SOIL | NSAMPLE | TRZ4-SD-001A-0204 | | | TRZ4-SD-001A-0406 | | | TRZ4-SD-001B-0001 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | LAB_ID | G2038-19A | | | G2038-20A | | | G2038-17A | | |
| | SAMP_DATE | 11/6/2008 | | | 11/6/2008 | | | 11/6/2008 | | |
| | QC_TYPE | NM | | | NM | | | NM | | |
| | UNITS | MG/KG | | | MG/KG | | | MG/KG | | |
| | PCT_SOLIDS | 38.0 | | | 40.0 | | | 37.0 | | |
| | DUP_OF | | | | | | | | | |
| PARAMETER | | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD |
| EXTRACTABLE PETROLEUM HYDROCARBONS | | 1200 | | | 970 | | | 390 | | |

**Tetra Tech NUS** **INTERNAL CORRESPONDENCE**

**TO:** **COREY RICH** **DATE: DECEMBER 30, 2008**

**FROM:** **JOSEPH KALINYAK** **COPIES: DV FILE**

**SUBJECT:** **ORGANIC DATA VALIDATION: PAH/PCB/ETPH/HEXACHLOROBENZENE**
**CTO 424, NSB NEW LONDON**
**SDG G2049**

**SAMPLES:** 18/Soil/PAH/PET/HEXACHLOROBENZENE

| | | |
|---|---|---|
| TRZ4-SD-002A-0204 | TRZ4-SD-002A-0406 | TRZ4-SD-002B-0001 |
| TRZ4-SD-003A-0204 | TRZ4-SD-003A-0406 | TRZ4-SD-003B-0001 |
| TRZ4-SD-005A-0204 | TRZ4-SD-005A-0406 | TRZ4-SD-005B-0001 |
| TRZ4-SD-006A-0204 | TRZ4-SD-006A-0406 | TRZ4-SD-006B-0001 |
| TRZ4-SD-007A-0204 | TRZ4-SD-007A-0406 | TRZ4-SD-007B-0001 |
| TRZ4-SD-008A-0204 | TRZ4-SD-008A-0406 | TRZ4-SD-008B-0001 |

18/Soil/PCB

| | | |
|---|---|---|
| TRZ4-SD-002A-0002 | TRZ4-SD-002A-0204 | TRZ4-SD-002A-0406 |
| TRZ4-SD-003A-0002 | TRZ4-SD-003A-0204 | TRZ4-SD-003A-0406 |
| TRZ4-SD-005A-0002 | TRZ4-SD-005A-0204 | TRZ4-SD-005A-0406 |
| TRZ4-SD-006A-0002 | TRZ4-SD-006A-0204 | TRZ4-SD-006A-0406 |
| TRZ4-SD-007A-0002 | TRZ4-SD-007A-0204 | TRZ4-SD-007A-0406 |
| TRZ4-SD-008A-0002 | TRZ4-SD-008A-0204 | TRZ4-SD-008A-0406 |

Overview

The sample set for CTO 424 SDG G2049 NSB New London, consists of eighteen (18) environmental soil samples. There were no field duplicates associated with this SDG. All samples were analyzed as indicated above.

The samples were collected by Tetra Tech NUS, Inc. on November 6, 2008 and analyzed by Mitkem Laboratories. All analyses were conducted in accordance with Naval Facilities Engineering Service Center (NFESC) Quality Assurance/Quality Control (QA/QC) criteria using USEPA SW-846 Methods 8082, 8270D SIM, and Method CT ETPH analytical and reporting protocol. A USEPA Region I Tier 3 data validation was performed on the referenced samples. The data contained in this SDG were validated with regard to the following parameters:

- * Data Completeness
- * Holding Times
- * GC/MS Tuning
- Initial and Continuing Calibration
- * Laboratory Method and/or Field Quality Control Blanks
- Surrogate Spike Recoveries
- * Laboratory Control Spike / Laboratory Control Spike Duplicate Recoveries
- Internal Standards Performance

- Matrix Spike/Matrix Spike Duplicate Results
- * Detection Limits
- * Sample Quantitation

The asterisk (*) indicates that all quality control criteria were met for this parameter. Qualified (if applicable) analytical results are summarized in Appendix A. Results as reported by the laboratory are presented in Appendix B. Appendix C contains Region I worksheets, and Appendix D contains the documentation to support the findings as discussed in this data validation report. The attached Table summarizes the validation qualifications which are based on the following information:

## CALIBRATIONS

The PCB calibration verification average %D exceeded the 15% quality control limit for Aroclor-1260 on the primary and secondary GC column on 11/15/08 @ 05:01. The PCB calibration verification %D exceeded the 15% quality control limit for Aroclor-1260 on the primary and secondary GC column on 11/15/08 @ 08:46. Additionally, the surrogate DCB exceeded the 15% quality control limit on the primary and secondary GC column on 11/15/08 @ 05:01 and also on 11/15/08 @ 08:46. The affected samples TRZ4-SD-005A-0002, TRZ4-SD-007A-0002, TRZ4-SD-007A-0204, TRZ4-SD-007A-0406, TRZ4-SD-006A-0002, TRZ4-SD-003A-0002, TRZ4-SD-008A-0002, TRZ4-SD-008A-0204, and TRZ4-SD-008A-0406 all had non-detected results for Aroclor-1260 which were qualified as estimated, (UJ). No action was necessary for the non-detected results for the associated samples due to the DCB quality control limit exceedances.

The PCB calibration average %D exceeded the quality control limit for Aroclor-1254 on the primary and secondary GC column on 11/15/08 @ 22:04. The affected samples TRZ4-SD-002A-0002, TRZ4-SD-002A-0204, TRZ4-SD-002A-0406, TRZ4-SD-005A-0204, and TRZ4-SD-005A-0406 positive and non-detected results for the aforementioned samples were qualified as estimated, (J) and (UJ), respectively.

The PCB calibration average %D exceeded the quality control limit for Aroclor-1254 on the secondary GC column on 11/17/08 @ 18:42. No action was necessary as all results were reported from the primary GC column.

## BLANKS

No issues.

## SURROGATE SPIKE RECOVERIES

The PCB % recovery was less than the quality control limit for the surrogate DCB for sample TRZ4-SD-002A-0002 on the primary GC column. No action was necessary as the secondary GC column recovery for DCB was within the quality control limits and all associated sample results were non-detected.

## MATRIX SPIKE / MATRIX SPIKE DUPLICATE (MS / MSD)

The PAH matrix spike % recoveries were greater than the quality control limit for acenaphthene, fluorene, phenanthrene, anthracene, benzo(a)anthracene, chrysene, benzo(a)pyrene, and indeno(1,2,3-cd)pyrene. The MS % recoveries were less than the quality control limit for pyrene and benzo(k)fluoranthene. The MSD % recoveries were less than the quality control limit for acenaphthylene, anthracene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, and benzo(k)fluoranthene. The RPDs exceeded the QC limit for naphthalene, acenaphthene, fluorene, phenanthrene, anthracene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene benzo(a)pyrene, indeno(1,2,3-cd), benzo(g,h,i)perylene. The sample used for the MS/MSD had high levels for most of these PAH compounds. Due to this matrix effect, the positives and

Hexachlorobenzene results do not meet the reporting limit of 1.0 µg/kg.

The %RPD between the primary and secondary GC columns was manually calculated for the positive PCB detections. The laboratory presented %D between GC columns instead of %RPD.

There were dilutions performed for a number of samples in the PAH analysis due to compounds which exceeded the calibration range. Results for the undiluted and diluted samples were combined in this report. The following lists the samples which were diluted, the dilution performed, and the compounds whose results were taken from the diluted analysis.

| Sample | Dilution Factor | Compounds |
|---|---|---|
| TRZ4-SD-002A-0204 | 20X | Anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, fluoranthene, indeno(1,2,3-cd)pyrene, phenanthrene, pyrene |
| TRZ4-SD-002A-0406 | 5X | Fluoranthene, phenanthrene, pyrene |
| TRZ4-SD-002B-0001 | 10X | Anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, fluoranthene, phenanthrene, pyrene |
| TRZ4-SD-003A-0204 | 10X | Benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, fluoranthene, pyrene |
| TRZ4-SD-003A-0406 | 20X | Acenaphthene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, fluoranthene, phenanthrene, pyrene |
| TRZ4-SD-003B-0001 | 10X | Benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, fluoranthene, pyrene |
| TRZ4-SD-005A-0204 | 10X | Anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, fluoranthene, phenanthrene, pyrene |
| TRZ4-SD-005A-0406 | 40X | 1-methylnaphthalene, 2-methylnaphthalene, acenaphthene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, fluoranthene, fluorene, naphthalene, phenanthrene, pyrene |
| TRZ4-SD-005B-0001 | 5X | Benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, fluoranthene, pyrene |
| TRZ4-SD-006A-0204 | 4X | Fluoranthene, pyrene |
| TRZ4-SD-006A-0406 | 5X | Benzo(a)anthracene, benzo(b)fluoranthene, chrysene, fluoranthene, pyrene |
| TRZ4-SD-006B-0001 | 5X | Benzo(a)anthracene, benzo(b)fluoranthene, chrysene, fluoranthene, pyrene |
| TRZ4-SD-007B-0001 | 10X | Benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, fluoranthene, pyrene |
| TRZ4-SD-008A-0204 | 5X | Fluoranthene, pyrene |
| TRZ4-SD-008A-0406 | 5X | Benzo(a)anthracene, benzo(b)fluoranthene, fluoranthene, pyrene |
| TRZ4-SD-008B-0001 | 4X | Fluoranthene, pyrene |

Sample TRZ4-SD-002A-0406 was diluted 6X for the PCB analysis which resulted in higher detection and reporting limits as all results were reported from the dilution analysis.

The lower PCB result, when choosing between the primary and secondary GC column PCB results, was reported by the laboratory with following exceptions. In the case where the QC for the secondary GC column exceeded QC limits (Aroclor-1254) the results from the QC compliant primary column were used by the laboratory (for Aroclor-1254). Additionally, for all samples analyzed on 11/17/08 the results were taken from the primary GC column for Aroclor-1254 even if they were higher than those from the secondary GC column.

## EXECUTIVE SUMMARY

**Laboratory Performance:** There were PCB continuing calibration %Ds greater than the quality control limits. There were PCB MS/MSD % recoveries with QC limit exceedances for several compounds. The PAH internal standard naphthalene-d8 recoveries were less than the quality control limits for several samples. There were %RPD differences greater than 25% between GC column results for PCBs.

**Other Factors Affecting Data Quality:** None.

The data for these analyses were reviewed with reference to the Region I EPA "Data Validation Functional Guidelines - Part II" (12/96), National Functional Guidelines for Low Concentration Organic Data Review, and the DoD Quality Systems (QSM) (January 2006).

"I attest that the data referenced herein were validated according to the agreed upon validation criteria as specified in the NFESC Guidelines and the DoD QSM."

TetraTech NUS
Joseph Kalinyak
Chemist/Data Validator

Edward Sedlmyer /for
TetraTech NUS
Joseph A. Samchuck
Data Validation Quality Assurance Officer

Attachments:
1. Appendix A - Qualified Analytical Results
2. Appendix B - Results as Reported by the Laboratory
3. Appendix C - Regional Worksheets
4. Appendix D - Support Documentation

# APPENDIX A

## QUALIFIED LABORATORY RESULTS

**Data Validation Qualifier Codes:**

A = Lab Blank Contamination
B = Field Blank Contamination
C = Calibration Noncompliance (e.g. % RSDs, %Ds, ICVs, CCVs, RRFs, etc.)
C01 = GC/MS Tuning Noncompliance
D = MS/MSD Recovery Noncompliance
E = LCS/LCSD Recovery Noncompliance
F = Lab Duplicate Imprecision
G = Field Duplicate Imprecision
H = Holding Time Exceedance
I = ICP Serial Dilution Noncompliance
J = GFAA PDS - GFAA MSA's $r < 0.995$ / ICP PDS Recovery Noncompliance
K = ICP Interference - includes ICS % R Noncompliance
L = Instrument Calibration Range Exceedance
M = Sample Preservation Noncompliance
N = Internal Standard Noncompliance
N01 = Internal Standard Recovery Noncompliance Dioxins
N02 = Recovery Standard Noncompliance Dioxins
N03 = Clean-up Standard Noncompliance Dioxins
O = Poor Instrument Performance (e.g. base-line drifting)
P = Uncertainty near detection limit (< 2 x IDL for inorganics and <CRQL for organics)
Q = Other problems (can encompass a number of issues; e.g. chromatography,interferences, etc.)
R = Surrogates Recovery Noncompliance
S = Pesticide/PCB Resolution
T = % Breakdown Noncompliance for DDT and Endrin
U = % Difference between columns/detectors >25% for positive results determined via GC/HPLC
V = Non-linear calibrations; correlation coefficient $r < 0.995$
W = EMPC result
X = Signal to noise response drop
Y = Percent solids <30%
Z = Uncertainty at 2 sigma deviation is greater than sample activity

# PROJ_NO: 00811

SDG: G2049 MEDIA: SOIL DATA FRACTION: PAH

| | |
|---|---|
| nsample | TRZ4-SD-002A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2049-03A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 48.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 1-METHYLNAPHTHALENE | 55 | | |
| 2-METHYLNAPHTHALENE | 68 | | |
| ACENAPHTHENE | 220 | | |
| ACENAPHTHYLENE | 170 | | |
| DIBENZO(A,H)ANTHRACENE | 510 | | |
| FLUORENE | 380 | | |
| HEXACHLOROBENZENE | 6.9 | U | |
| NAPHTHALENE | 66 | | |

| | |
|---|---|
| nsample | TRZ4-SD-002A-0204DL |
| samp_date | 11/6/2008 |
| lab_id | G2049-03ADL |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 48.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ANTHRACENE | 1700 | | |
| BENZO(A)ANTHRACENE | 4600 | | |
| BENZO(A)PYRENE | 3800 | | |
| BENZO(B)FLUORANTHENE | 4800 | | |
| BENZO(G,H,I)PERYLENE | 1600 | | |
| BENZO(K)FLUORANTHENE | 2500 | | |
| CHRYSENE | 5300 | | |
| FLUORANTHENE | 12000 | | |
| INDENO(1,2,3-CD)PYRENE | 1500 | | |
| PHENANTHRENE | 4300 | | |
| PYRENE | 11000 | | |

| | |
|---|---|
| nsample | TRZ4-SD-002A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2049-04A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 46.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual. | Qual Code |
|---|---|---|---|
| 1-METHYLNAPHTHALENE | 130 | J | N |
| 2-METHYLNAPHTHALENE | 170 | J | N |
| ACENAPHTHENE | 520 | | |
| ACENAPHTHYLENE | 120 | J | N |
| ANTHRACENE | 430 | | |
| BENZO(A)ANTHRACENE | 470 | | |
| BENZO(A)PYRENE | 360 | | |
| BENZO(B)FLUORANTHENE | 500 | | |
| BENZO(G,H,I)PERYLENE | 200 | | |
| BENZO(K)FLUORANTHENE | 230 | | |
| CHRYSENE | 500 | | |
| DIBENZO(A,H)ANTHRACENE | 69 | | |
| FLUORENE | 400 | | |
| HEXACHLOROBENZENE | 7.2 | U | |
| INDENO(1,2,3-CD)PYRENE | 180 | | |
| NAPHTHALENE | 320 | J | N |

# PROJ_NO: 00811

SDG: G2049 MEDIA: SOIL DATA FRACTION: PAH

| | |
|---|---|
| nsample | TRZ4-SD-002A-0406DL |
| samp_date | 11/6/2008 |
| lab_id | G2049-04ADL |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 46.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| FLUORANTHENE | 2100 | | |
| PHENANTHRENE | 1000 | | |
| PYRENE | 1600 | | |

| | |
|---|---|
| nsample | TRZ4-SD-002B-0001 |
| samp_date | 11/6/2008 |
| lab_id | G2049-01A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 49.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 1-METHYLNAPHTHALENE | 18 | | |
| 2-METHYLNAPHTHALENE | 35 | | |
| ACENAPHTHENE | 350 | | |
| ACENAPHTHYLENE | 270 | | |
| BENZO(G,H,I)PERYLENE | 590 | | |
| BENZO(K)FLUORANTHENE | 650 | | |
| DIBENZO(A,H)ANTHRACENE | 230 | | |
| FLUORENE | 200 | | |
| HEXACHLOROBENZENE | 6.7 | U | |
| INDENO(1,2,3-CD)PYRENE | 600 | | |
| NAPHTHALENE | 92 | | |

| | |
|---|---|
| nsample | TRZ4-SD-002B-0001DL |
| samp_date | 11/6/2008 |
| lab_id | G2049-01ADL |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 49.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ANTHRACENE | 680 | | |
| BENZO(A)ANTHRACENE | 2200 | | |
| BENZO(A)PYRENE | 1600 | | |
| BENZO(B)FLUORANTHENE | 2400 | | |
| CHRYSENE | 3100 | | |
| FLUORANTHENE | 6500 | | |
| PHENANTHRENE | 1400 | | |
| PYRENE | 6600 | | |

# PROJ_NO: 00811

SDG: G2049 MEDIA: SOIL DATA FRACTION: PAH

| | |
|---|---|
| nsample | TRZ4-SD-003A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2049-19A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 38.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 1-METHYLNAPHTHALENE | 19 | | |
| 2-METHYLNAPHTHALENE | 43 | | |
| ACENAPHTHENE | 300 | | |
| ACENAPHTHYLENE | 260 | | |
| ANTHRACENE | 720 | | |
| BENZO(G,H,I)PERYLENE | 530 | | |
| DIBENZO(A,H)ANTHRACENE | 200 | | |
| FLUORENE | 190 | | |
| HEXACHLOROBENZENE | 8.6 | U | |
| INDENO(1,2,3-CD)PYRENE | 510 | | |
| NAPHTHALENE | 61 | J | D |
| PHENANTHRENE | 810 | | |

| | |
|---|---|
| nsample | TRZ4-SD-003A-0204DL |
| samp_date | 11/6/2008 |
| lab_id | G2049-19ADL |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 38.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| BENZO(A)ANTHRACENE | 2600 | | |
| BENZO(A)PYRENE | 1500 | | |
| BENZO(B)FLUORANTHENE | 2100 | | |
| BENZO(K)FLUORANTHENE | 1100 | | |
| CHRYSENE | 2400 | | |
| FLUORANTHENE | 8200 | | |
| PYRENE | 6000 | | |

| | |
|---|---|
| nsample | TRZ4-SD-003A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2049-20A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 58.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 1-METHYLNAPHTHALENE | 28 | | |
| 2-METHYLNAPHTHALENE | 65 | | |
| ACENAPHTHYLENE | 180 | | |
| BENZO(G,H,I)PERYLENE | 380 | | |
| BENZO(K)FLUORANTHENE | 480 | | |
| DIBENZO(A,H)ANTHRACENE | 130 | | |
| FLUORENE | 310 | | |
| HEXACHLOROBENZENE | 5.7 | U | |
| INDENO(1,2,3-CD)PYRENE | 370 | | |
| NAPHTHALENE | 160 | | |

# PROJ_NO: 00811

SDG: G2049 MEDIA: SOIL DATA FRACTION: PAH

| | |
|---|---|
| nsample | TRZ4-SD-003A-0406DL |
| samp_date | 11/6/2008 |
| lab_id | G2049-20ADL |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 58.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ACENAPHTHENE | 800 | | |
| ANTHRACENE | 1100 | | |
| BENZO(A)ANTHRACENE | 1900 | | |
| BENZO(A)PYRENE | 1300 | | |
| BENZO(B)FLUORANTHENE | 1900 | | |
| CHRYSENE | 1900 | | |
| FLUORANTHENE | 7700 | | |
| PHENANTHRENE | 1700 | | |
| PYRENE | 5700 | | |

| | |
|---|---|
| nsample | TRZ4-SD-003B-0001 |
| samp_date | 11/6/2008 |
| lab_id | G2049-17A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 44.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 1-METHYLNAPHTHALENE | 14 | | |
| 2-METHYLNAPHTHALENE | 26 | | |
| ACENAPHTHENE | 140 | | |
| ACENAPHTHYLENE | 160 | | |
| ANTHRACENE | 440 | | |
| BENZO(G,H,I)PERYLENE | 390 | | |
| BENZO(K)FLUORANTHENE | 580 | | |
| DIBENZO(A,H)ANTHRACENE | 150 | | |
| FLUORENE | 95 | | |
| HEXACHLOROBENZENE | 7.5 | U | |
| INDENO(1,2,3-CD)PYRENE | 390 | | |
| NAPHTHALENE | 33 | | |
| PHENANTHRENE | 520 | | |

| | |
|---|---|
| nsample | TRZ4-SD-003B-0001DL |
| samp_date | 11/6/2008 |
| lab_id | G2049-17ADL |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 44.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| BENZO(A)ANTHRACENE | 1800 | | |
| BENZO(A)PYRENE | 1200 | | |
| BENZO(B)FLUORANTHENE | 1600 | | |
| CHRYSENE | 1600 | | |
| FLUORANTHENE | 5200 | | |
| PYRENE | 4100 | | |

# PROJ_NO: 00811

SDG: G2049 MEDIA: SOIL DATA FRACTION: PAH

| | |
|---|---|
| nsample | TRZ4-SD-005A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2049-07A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 42.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 1-METHYLNAPHTHALENE | 21 | | |
| 2-METHYLNAPHTHALENE | 67 | | |
| ACENAPHTHENE | 540 | | |
| ACENAPHTHYLENE | 230 | | |
| BENZO(G,H,I)PERYLENE | 370 | | |
| BENZO(K)FLUORANTHENE | 630 | | |
| DIBENZO(A,H)ANTHRACENE | 150 | | |
| FLUORENE | 500 | | |
| HEXACHLOROBENZENE | 7.8 | U | |
| INDENO(1,2,3-CD)PYRENE | 380 | | |
| NAPHTHALENE | 100 | | |

| | |
|---|---|
| nsample | TRZ4-SD-005A-0204DL |
| samp_date | 11/6/2008 |
| lab_id | G2049-07ADL |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 42.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ANTHRACENE | 1700 | | |
| BENZO(A)ANTHRACENE | 1700 | | |
| BENZO(A)PYRENE | 1000 | | |
| BENZO(B)FLUORANTHENE | 1400 | | |
| CHRYSENE | 2300 | | |
| FLUORANTHENE | 4500 | | |
| PHENANTHRENE | 1100 | | |
| PYRENE | 4500 | | |

| | |
|---|---|
| nsample | TRZ4-SD-005A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2049-08A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 43.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ACENAPHTHYLENE | 390 | J | N |
| BENZO(G,H,I)PERYLENE | 580 | | |
| BENZO(K)FLUORANTHENE | 730 | | |
| DIBENZO(A,H)ANTHRACENE | 110 | | |
| HEXACHLOROBENZENE | 7.7 | U | |
| INDENO(1,2,3-CD)PYRENE | 590 | | |

# PROJ_NO: 00811

SDG: G2049 MEDIA: SOIL DATA FRACTION: PAH

| | |
|---|---|
| nsample | TRZ4-SD-005A-0406DL |
| samp_date | 11/6/2008 |
| lab_id | G2049-08ADL |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 43.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 1-METHYLNAPHTHALENE | 1500 | | |
| 2-METHYLNAPHTHALENE | 1400 | | |
| ACENAPHTHENE | 9900 | | |
| ANTHRACENE | 2600 | | |
| BENZO(A)ANTHRACENE | 3200 | | |
| BENZO(A)PYRENE | 1700 | | |
| BENZO(B)FLUORANTHENE | 2300 | | |
| CHRYSENE | 3700 | | |
| FLUORANTHENE | 19000 | | |
| FLUORENE | 6800 | | |
| NAPHTHALENE | 3400 | | |
| PHENANTHRENE | 17000 | | |
| PYRENE | 12000 | | |

| | |
|---|---|
| nsample | TRZ4-SD-005B-0001 |
| samp_date | 11/6/2008 |
| lab_id | G2049-05A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 38.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 1-METHYLNAPHTHALENE | 8.7 | U | |
| 2-METHYLNAPHTHALENE | 15 | | |
| ACENAPHTHENE | 25 | | |
| ACENAPHTHYLENE | 160 | | |
| ANTHRACENE | 320 | | |
| BENZO(G,H,I)PERYLENE | 340 | | |
| BENZO(K)FLUORANTHENE | 420 | | |
| DIBENZO(A,H)ANTHRACENE | 130 | | |
| FLUORENE | 65 | | |
| HEXACHLOROBENZENE | 8.7 | U | |
| INDENO(1,2,3-CD)PYRENE | 340 | | |
| NAPHTHALENE | 33 | | |
| PHENANTHRENE | 320 | | |

| | |
|---|---|
| nsample | TRZ4-SD-005B-0001DL |
| samp_date | 11/6/2008 |
| lab_id | G2049-05ADL |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 38.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| BENZO(A)ANTHRACENE | 1200 | | |
| BENZO(A)PYRENE | 920 | | |
| BENZO(B)FLUORANTHENE | 1300 | | |
| CHRYSENE | 1300 | | |
| FLUORANTHENE | 2300 | | |
| PYRENE | 2900 | | |

# PROJ_NO: 00811

SDG: G2049 MEDIA: SOIL DATA FRACTION: PAH

| | |
|---|---|
| nsample | TRZ4-SD-006A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2049-15A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 36.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 1-METHYLNAPHTHALENE | 11 | | |
| 2-METHYLNAPHTHALENE | 24 | | |
| ACENAPHTHENE | 200 | | |
| ACENAPHTHYLENE | 110 | | |
| ANTHRACENE | 270 | | |
| BENZO(A)ANTHRACENE | 570 | | |
| BENZO(A)PYRENE | 470 | | |
| BENZO(B)FLUORANTHENE | 670 | | |
| BENZO(G,H,I)PERYLENE | 240 | | |
| BENZO(K)FLUORANTHENE | 200 | | |
| CHRYSENE | 590 | | |
| DIBENZO(A,H)ANTHRACENE | 75 | | |
| FLUORENE | 95 | | |
| HEXACHLOROBENZENE | 9.1 | U | |
| INDENO(1,2,3-CD)PYRENE | 220 | | |
| NAPHTHALENE | 42 | | |
| PHENANTHRENE | 510 | | |

| | |
|---|---|
| nsample | TRZ4-SD-006A-0204DL |
| samp_date | 11/6/2008 |
| lab_id | G2049-15ADL |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 36.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| FLUORANTHENE | 2500 | | |
| PYRENE | 2000 | | |

| | |
|---|---|
| nsample | TRZ4-SD-006A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2049-16A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 61.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 1-METHYLNAPHTHALENE | 19 | | |
| 2-METHYLNAPHTHALENE | 34 | | |
| ACENAPHTHENE | 68 | | |
| ACENAPHTHYLENE | 77 | | |
| ANTHRACENE | 310 | | |
| BENZO(A)PYRENE | 430 | | |
| BENZO(G,H,I)PERYLENE | 200 | | |
| BENZO(K)FLUORANTHENE | 280 | | |
| DIBENZO(A,H)ANTHRACENE | 76 | | |
| FLUORENE | 66 | | |
| HEXACHLOROBENZENE | 5.4 | U | |
| INDENO(1,2,3-CD)PYRENE | 200 | | |
| NAPHTHALENE | 130 | | |
| PHENANTHRENE | 270 | | |

# PROJ_NO: 00811

SDG: G2049 MEDIA: SOIL DATA FRACTION: PAH

| | |
|---|---|
| nsample | TRZ4-SD-006A-0406DL |
| samp_date | 11/6/2008 |
| lab_id | G2049-16ADL |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 61.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| BENZO(A)ANTHRACENE | 800 | | |
| BENZO(B)FLUORANTHENE | 820 | | |
| CHRYSENE | 780 | | |
| FLUORANTHENE | 2700 | | |
| PYRENE | 2300 | | |

| | |
|---|---|
| nsample | TRZ4-SD-006B-0001 |
| samp_date | 11/6/2008 |
| lab_id | G2049-13A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 33.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 1-METHYLNAPHTHALENE | 13 | | |
| 2-METHYLNAPHTHALENE | 25 | | |
| ACENAPHTHENE | 59 | | |
| ACENAPHTHYLENE | 140 | | |
| ANTHRACENE | 400 | | |
| BENZO(A)PYRENE | 940 | | |
| BENZO(G,H,I)PERYLENE | 410 | | |
| BENZO(K)FLUORANTHENE | 500 | | |
| DIBENZO(A,H)ANTHRACENE | 140 | | |
| FLUORENE | 99 | | |
| HEXACHLOROBENZENE | 10 | U | |
| INDENO(1,2,3-CD)PYRENE | 400 | | |
| NAPHTHALENE | 63 | | |
| PHENANTHRENE | 630 | | |

| | |
|---|---|
| nsample | TRZ4-SD-006B-0001DL |
| samp_date | 11/6/2008 |
| lab_id | G2049-13ADL |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 33.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| BENZO(A)ANTHRACENE | 1400 | | |
| BENZO(B)FLUORANTHENE | 1700 | | |
| CHRYSENE | 1500 | | |
| FLUORANTHENE | 3300 | | |
| PYRENE | 4300 | | |

# PROJ_NO: 00811

SDG: G2049 MEDIA: SOIL DATA FRACTION: PAH

| | |
|---|---|
| nsample | TRZ4-SD-007A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2049-11A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 48.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 1-METHYLNAPHTHALENE | 6.9 | U | |
| 2-METHYLNAPHTHALENE | 6.9 | U | |
| ACENAPHTHENE | 6.9 | U | |
| ACENAPHTHYLENE | 14 | | |
| ANTHRACENE | 27 | | |
| BENZO(A)ANTHRACENE | 74 | | |
| BENZO(A)PYRENE | 83 | | |
| BENZO(B)FLUORANTHENE | 120 | | |
| BENZO(G,H,I)PERYLENE | 40 | | |
| BENZO(K)FLUORANTHENE | 47 | | |
| CHRYSENE | 99 | | |
| DIBENZO(A,H)ANTHRACENE | 15 | | |
| FLUORANTHENE | 160 | | |
| FLUORENE | 7.2 | | |
| HEXACHLOROBENZENE | 6.9 | U | |
| INDENO(1,2,3-CD)PYRENE | 37 | | |
| NAPHTHALENE | 8.8 | | |
| PHENANTHRENE | 27 | | |
| PYRENE | 240 | | |

| | |
|---|---|
| nsample | TRZ4-SD-007A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2049-12A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 49.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 1-METHYLNAPHTHALENE | 6.7 | U | |
| 2-METHYLNAPHTHALENE | 6.7 | U | |
| ACENAPHTHENE | 6.7 | U | |
| ACENAPHTHYLENE | 6.7 | U | |
| ANTHRACENE | 6.7 | U | |
| BENZO(A)ANTHRACENE | 6.7 | U | |
| BENZO(A)PYRENE | 6.7 | U | |
| BENZO(B)FLUORANTHENE | 6.7 | U | |
| BENZO(G,H,I)PERYLENE | 6.7 | U | |
| BENZO(K)FLUORANTHENE | 6.7 | U | |
| CHRYSENE | 6.7 | U | |
| DIBENZO(A,H)ANTHRACENE | 6.7 | U | |
| FLUORANTHENE | 10 | | |
| FLUORENE | 6.7 | U | |
| HEXACHLOROBENZENE | 6.7 | U | |
| INDENO(1,2,3-CD)PYRENE | 6.7 | U | |
| NAPHTHALENE | 6.7 | U | |
| PHENANTHRENE | 6.7 | U | |
| PYRENE | 12 | | |

| | |
|---|---|
| nsample | TRZ4-SD-007B-0001 |
| samp_date | 11/6/2008 |
| lab_id | G2049-09A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 35.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 1-METHYLNAPHTHALENE | 23 | J | N |
| 2-METHYLNAPHTHALENE | 39 | J | N |
| ACENAPHTHENE | 85 | | |
| ACENAPHTHYLENE | 240 | J | N |
| ANTHRACENE | 540 | | |
| BENZO(G,H,I)PERYLENE | 420 | | |
| BENZO(K)FLUORANTHENE | 670 | | |
| DIBENZO(A,H)ANTHRACENE | 180 | | |
| FLUORENE | 130 | | |
| HEXACHLOROBENZENE | 9.4 | U | |
| INDENO(1,2,3-CD)PYRENE | 430 | | |
| NAPHTHALENE | 190 | J | N |
| PHENANTHRENE | 500 | | |

# PROJ_NO: 00811

SDG: G2049 MEDIA: SOIL DATA FRACTION: PAH

| | |
|---|---|
| nsample | TRZ4-SD-007B-0001DL |
| samp_date | 11/6/2008 |
| lab_id | G2049-09ADL |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 35.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| BENZO(A)ANTHRACENE | 1800 | | |
| BENZO(A)PYRENE | 1200 | | |
| BENZO(B)FLUORANTHENE | 1800 | | |
| CHRYSENE | 2100 | | |
| FLUORANTHENE | 3100 | | |
| PYRENE | 5400 | | |

| | |
|---|---|
| nsample | TRZ4-SD-008A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2049-23A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 37.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 1-METHYLNAPHTHALENE | 9.1 | | |
| 2-METHYLNAPHTHALENE | 22 | | |
| ACENAPHTHENE | 49 | | |
| ACENAPHTHYLENE | 130 | | |
| ANTHRACENE | 300 | | |
| BENZO(A)ANTHRACENE | 740 | | |
| BENZO(A)PYRENE | 510 | | |
| BENZO(B)FLUORANTHENE | 770 | | |
| BENZO(G,H,I)PERYLENE | 260 | | |
| BENZO(K)FLUORANTHENE | 260 | | |
| CHRYSENE | 740 | | |
| DIBENZO(A,H)ANTHRACENE | 88 | | |
| FLUORENE | 68 | | |
| HEXACHLOROBENZENE | 8.9 | U | |
| INDENO(1,2,3-CD)PYRENE | 260 | | |
| NAPHTHALENE | 28 | | |
| PHENANTHRENE | 380 | | |

| | |
|---|---|
| nsample | TRZ4-SD-008A-0204DL |
| samp_date | 11/6/2008 |
| lab_id | G2049-23ADL |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 37.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| FLUORANTHENE | 3300 | | |
| PYRENE | 2500 | | |

# PROJ_NO: 00811

SDG: G2049 MEDIA: SOIL DATA FRACTION: PAH

| | |
|---|---|
| nsample | TRZ4-SD-008A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2049-24A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 37.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 1-METHYLNAPHTHALENE | 22 | | |
| 2-METHYLNAPHTHALENE | 43 | | |
| ACENAPHTHENE | 300 | | |
| ACENAPHTHYLENE | 200 | | |
| ANTHRACENE | 400 | | |
| BENZO(A)PYRENE | 640 | | |
| BENZO(G,H,I)PERYLENE | 370 | | |
| BENZO(K)FLUORANTHENE | 260 | | |
| CHRYSENE | 730 | | |
| DIBENZO(A,H)ANTHRACENE | 110 | | |
| FLUORENE | 190 | | |
| HEXACHLOROBENZENE | 8.9 | U | |
| INDENO(1,2,3-CD)PYRENE | 340 | | |
| NAPHTHALENE | 57 | | |
| PHENANTHRENE | 680 | | |

| | |
|---|---|
| nsample | TRZ4-SD-008A-0406DL |
| samp_date | 11/6/2008 |
| lab_id | G2049-24ADL |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 37.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| BENZO(A)ANTHRACENE | 1100 | | |
| BENZO(B)FLUORANTHENE | 1000 | | |
| FLUORANTHENE | 4000 | | |
| PYRENE | 3100 | | |

| | |
|---|---|
| nsample | TRZ4-SD-008B-0001 |
| samp_date | 11/6/2008 |
| lab_id | G2049-21A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 34.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 1-METHYLNAPHTHALENE | 12 | | |
| 2-METHYLNAPHTHALENE | 29 | | |
| ACENAPHTHENE | 33 | | |
| ACENAPHTHYLENE | 140 | | |
| ANTHRACENE | 260 | | |
| BENZO(A)ANTHRACENE | 700 | | |
| BENZO(A)PYRENE | 640 | | |
| BENZO(B)FLUORANTHENE | 920 | | |
| BENZO(G,H,I)PERYLENE | 300 | | |
| BENZO(K)FLUORANTHENE | 330 | | |
| CHRYSENE | 730 | | |
| DIBENZO(A,H)ANTHRACENE | 110 | | |
| FLUORENE | 60 | | |
| HEXACHLOROBENZENE | 9.6 | U | |
| INDENO(1,2,3-CD)PYRENE | 290 | | |
| NAPHTHALENE | 67 | | |
| PHENANTHRENE | 310 | | |

# PROJ_NO: 00811

SDG: G2049 MEDIA: SOIL DATA FRACTION: PAH

| | |
|---|---|
| nsample | TRZ4-SD-008B-0001DL |
| samp_date | 11/6/2008 |
| lab_id | G2049-21ADL |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 34.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| FLUORANTHENE | 1300 | | |
| PYRENE | 2400 | | |

# PROJ_NO: 00811

SDG: G2049 MEDIA: SOIL DATA FRACTION: PEST/PCB

| | |
|---|---|
| nsample | TRZ4-SD-002A-0002 |
| samp_date | 11/6/2008 |
| lab_id | G2049-02A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 45.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| AROCLOR-1016 | 73 | U | |
| AROCLOR-1221 | 73 | U | |
| AROCLOR-1232 | 73 | U | |
| AROCLOR-1242 | 230 | | |
| AROCLOR-1248 | 73 | U | |
| AROCLOR-1254 | 260 | J | C |
| AROCLOR-1260 | 73 | U | |

| | |
|---|---|
| nsample | TRZ4-SD-002A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2049-03A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 48.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| AROCLOR-1016 | 69 | U | |
| AROCLOR-1221 | 69 | U | |
| AROCLOR-1232 | 69 | U | |
| AROCLOR-1242 | 190 | J | U |
| AROCLOR-1248 | 69 | U | |
| AROCLOR-1254 | 250 | J | C |
| AROCLOR-1260 | 69 | U | |

| | |
|---|---|
| nsample | TRZ4-SD-002A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2049-04A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 46.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| AROCLOR-1016 | 430 | U | |
| AROCLOR-1221 | 430 | U | |
| AROCLOR-1232 | 430 | U | |
| AROCLOR-1242 | 1400 | | |
| AROCLOR-1248 | 430 | U | |
| AROCLOR-1254 | 430 | UJ | C |
| AROCLOR-1260 | 550 | J | PU |

# PROJ_NO: 00811

SDG: G2049 MEDIA: SOIL DATA FRACTION: PEST/PCB

| | |
|---|---|
| nsample | TRZ4-SD-003A-0002 |
| samp_date | 11/6/2008 |
| lab_id | G2049-18A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 38.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| AROCLOR-1016 | 87 | U | |
| AROCLOR-1221 | 87 | U | |
| AROCLOR-1232 | 87 | U | |
| AROCLOR-1242 | 87 | U | |
| AROCLOR-1248 | 87 | U | |
| AROCLOR-1254 | 87 | U | |
| AROCLOR-1260 | 87 | UJ | C |

| | |
|---|---|
| nsample | TRZ4-SD-003A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2049-19A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 38.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| AROCLOR-1016 | 86 | U | |
| AROCLOR-1221 | 86 | U | |
| AROCLOR-1232 | 86 | U | |
| AROCLOR-1242 | 190 | | |
| AROCLOR-1248 | 86 | U | |
| AROCLOR-1254 | 150 | J | U |
| AROCLOR-1260 | 86 | U | |

| | |
|---|---|
| nsample | TRZ4-SD-003A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2049-20A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 58.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| AROCLOR-1016 | 57 | U | |
| AROCLOR-1221 | 57 | U | |
| AROCLOR-1232 | 57 | U | |
| AROCLOR-1242 | 120 | | |
| AROCLOR-1248 | 57 | U | |
| AROCLOR-1254 | 120 | J | U |
| AROCLOR-1260 | 57 | U | |

# PROJ_NO: 00811

SDG: G2049 MEDIA: SOIL DATA FRACTION: PEST/PCB

| | |
|---|---|
| nsample | TRZ4-SD-005A-0002 |
| samp_date | 11/6/2008 |
| lab_id | G2049-06A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 40.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| AROCLOR-1016 | 82 | U | |
| AROCLOR-1221 | 82 | U | |
| AROCLOR-1232 | 82 | U | |
| AROCLOR-1242 | 82 | U | |
| AROCLOR-1248 | 82 | U | |
| AROCLOR-1254 | 82 | U | |
| AROCLOR-1260 | 82 | UJ | C |

| | |
|---|---|
| nsample | TRZ4-SD-005A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2049-07A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 42.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| AROCLOR-1016 | 78 | U | |
| AROCLOR-1221 | 78 | U | |
| AROCLOR-1232 | 78 | U | |
| AROCLOR-1242 | 230 | | |
| AROCLOR-1248 | 78 | U | |
| AROCLOR-1254 | 150 | J | CU |
| AROCLOR-1260 | 78 | U | |

| | |
|---|---|
| nsample | TRZ4-SD-005A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2049-08A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 43.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| AROCLOR-1016 | 76 | U | |
| AROCLOR-1221 | 76 | U | |
| AROCLOR-1232 | 76 | U | |
| AROCLOR-1242 | 290 | J | U |
| AROCLOR-1248 | 76 | U | |
| AROCLOR-1254 | 210 | J | CU |
| AROCLOR-1260 | 76 | U | |

# PROJ_NO: 00811

SDG: G2049 MEDIA: SOIL DATA FRACTION: PEST/PCB

| | |
|---|---|
| nsample | TRZ4-SD-006A-0002 |
| samp_date | 11/6/2008 |
| lab_id | G2049-14A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 36.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| AROCLOR-1016 | 91 | U | |
| AROCLOR-1221 | 91 | U | |
| AROCLOR-1232 | 91 | U | |
| AROCLOR-1242 | 91 | U | |
| AROCLOR-1248 | 91 | U | |
| AROCLOR-1254 | 91 | U | |
| AROCLOR-1260 | 91 | UJ | C |

| | |
|---|---|
| nsample | TRZ4-SD-006A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2049-15A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 36.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| AROCLOR-1016 | 91 | U | |
| AROCLOR-1221 | 91 | U | |
| AROCLOR-1232 | 91 | U | |
| AROCLOR-1242 | 110 | | |
| AROCLOR-1248 | 91 | U | |
| AROCLOR-1254 | 110 | J | U |
| AROCLOR-1260 | 91 | U | |

| | |
|---|---|
| nsample | TRZ4-SD-006A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2049-16A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 61.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| AROCLOR-1016 | 54 | U | |
| AROCLOR-1221 | 54 | U | |
| AROCLOR-1232 | 54 | U | |
| AROCLOR-1242 | 330 | | |
| AROCLOR-1248 | 54 | U | |
| AROCLOR-1254 | 91 | J | U |
| AROCLOR-1260 | 54 | U | |

# PROJ_NO: 00811

SDG: G2049 MEDIA: SOIL DATA FRACTION: PEST/PCB

| | |
|---|---|
| nsample | TRZ4-SD-007A-0002 |
| samp_date | 11/6/2008 |
| lab_id | G2049-10A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 36.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| AROCLOR-1016 | 91 | U | |
| AROCLOR-1221 | 91 | U | |
| AROCLOR-1232 | 91 | U | |
| AROCLOR-1242 | 91 | U | |
| AROCLOR-1248 | 91 | U | |
| AROCLOR-1254 | 91 | U | |
| AROCLOR-1260 | 91 | UJ | C |

| | |
|---|---|
| nsample | TRZ4-SD-007A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2049-11A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 48.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| AROCLOR-1016 | 69 | U | |
| AROCLOR-1221 | 69 | U | |
| AROCLOR-1232 | 69 | U | |
| AROCLOR-1242 | 69 | U | |
| AROCLOR-1248 | 69 | U | |
| AROCLOR-1254 | 69 | U | |
| AROCLOR-1260 | 69 | UJ | C |

| | |
|---|---|
| nsample | TRZ4-SD-007A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2049-12A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 49.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| AROCLOR-1016 | 67 | U | |
| AROCLOR-1221 | 67 | U | |
| AROCLOR-1232 | 67 | U | |
| AROCLOR-1242 | 67 | U | |
| AROCLOR-1248 | 67 | U | |
| AROCLOR-1254 | 67 | U | |
| AROCLOR-1260 | 67 | UJ | C |

# PROJ_NO: 00811

SDG: G2049 MEDIA: SOIL DATA FRACTION: PEST/PCB

| | |
|---|---|
| nsample | TRZ4-SD-008A-0002 |
| samp_date | 11/6/2008 |
| lab_id | G2049-22A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 34.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| AROCLOR-1016 | 96 | U | |
| AROCLOR-1221 | 96 | U | |
| AROCLOR-1232 | 96 | U | |
| AROCLOR-1242 | 96 | U | |
| AROCLOR-1248 | 96 | U | |
| AROCLOR-1254 | 96 | U | |
| AROCLOR-1260 | 96 | UJ | C |

| | |
|---|---|
| nsample | TRZ4-SD-008A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2049-23A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 37.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| AROCLOR-1016 | 89 | U | |
| AROCLOR-1221 | 89 | U | |
| AROCLOR-1232 | 89 | U | |
| AROCLOR-1242 | 89 | U | |
| AROCLOR-1248 | 89 | U | |
| AROCLOR-1254 | 89 | U | |
| AROCLOR-1260 | 89 | UJ | C |

| | |
|---|---|
| nsample | TRZ4-SD-008A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2049-24A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 37.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| AROCLOR-1016 | 89 | U | |
| AROCLOR-1221 | 89 | U | |
| AROCLOR-1232 | 89 | U | |
| AROCLOR-1242 | 89 | U | |
| AROCLOR-1248 | 89 | U | |
| AROCLOR-1254 | 89 | U | |
| AROCLOR-1260 | 89 | UJ | C |

# PROJ_NO: 00811

SDG: G2049 MEDIA: SOIL DATA FRACTION: PET

| | |
|---|---|
| nsample | TRZ4-SD-002A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2049-03A |
| qc_type | NM |
| units | MG/KG |
| Pct_Solids | 48.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| EXTRACTABLE PETROLEUM HYDROCARB | 570 | | |

| | |
|---|---|
| nsample | TRZ4-SD-002A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2049-04A |
| qc_type | NM |
| units | MG/KG |
| Pct_Solids | 46.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| EXTRACTABLE PETROLEUM HYDROCARB | 670 | | |

| | |
|---|---|
| nsample | TRZ4-SD-002B-0001 |
| samp_date | 11/6/2008 |
| lab_id | G2049-01A |
| qc_type | NM |
| units | MG/KG |
| Pct_Solids | 49.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| EXTRACTABLE PETROLEUM HYDROCARB | 360 | | |

# PROJ_NO: 00811

SDG: G2049 MEDIA: SOIL DATA FRACTION: PET

| | |
|---|---|
| nsample | TRZ4-SD-003A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2049-19A |
| qc_type | NM |
| units | MG/KG |
| Pct_Solids | 38.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| EXTRACTABLE PETROLEUM HYDROCARB | 610 | | |

| | |
|---|---|
| nsample | TRZ4-SD-003A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2049-20A |
| qc_type | NM |
| units | MG/KG |
| Pct_Solids | 58.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| EXTRACTABLE PETROLEUM HYDROCARB | 370 | | |

| | |
|---|---|
| nsample | TRZ4-SD-003B-0001 |
| samp_date | 11/6/2008 |
| lab_id | G2049-17A |
| qc_type | NM |
| units | MG/KG |
| Pct_Solids | 44.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| EXTRACTABLE PETROLEUM HYDROCARB | 380 | | |

# PROJ_NO: 00811

SDG: G2049 MEDIA: SOIL DATA FRACTION: PET

| | |
|---|---|
| nsample | TRZ4-SD-005A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2049-07A |
| qc_type | NM |
| units | MG/KG |
| Pct_Solids | 42.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| EXTRACTABLE PETROLEUM HYDROCARB | 890 | | |

| | |
|---|---|
| nsample | TRZ4-SD-005A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2049-08A |
| qc_type | NM |
| units | MG/KG |
| Pct_Solids | 43.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| EXTRACTABLE PETROLEUM HYDROCARB | 1300 | | |

| | |
|---|---|
| nsample | TRZ4-SD-005B-0001 |
| samp_date | 11/6/2008 |
| lab_id | G2049-05A |
| qc_type | NM |
| units | MG/KG |
| Pct_Solids | 38.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| EXTRACTABLE PETROLEUM HYDROCARB | 260 | | |

# PROJ_NO: 00811

SDG: G2049 MEDIA: SOIL DATA FRACTION: PET

| | |
|---|---|
| nsample | TRZ4-SD-006A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2049-15A |
| qc_type | NM |
| units | MG/KG |
| Pct_Solids | 36.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| EXTRACTABLE PETROLEUM HYDROCARB | 320 | | |

| | |
|---|---|
| nsample | TRZ4-SD-006A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2049-16A |
| qc_type | NM |
| units | MG/KG |
| Pct_Solids | 61.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| EXTRACTABLE PETROLEUM HYDROCARB | 470 | | |

| | |
|---|---|
| nsample | TRZ4-SD-006B-0001 |
| samp_date | 11/6/2008 |
| lab_id | G2049-13A |
| qc_type | NM |
| units | MG/KG |
| Pct_Solids | 33.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| EXTRACTABLE PETROLEUM HYDROCARB | 220 | | |

# PROJ_NO: 00811

SDG: G2049 MEDIA: SOIL DATA FRACTION: PET

| | |
|---|---|
| nsample | TRZ4-SD-007A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2049-11A |
| qc_type | NM |
| units | MG/KG |
| Pct_Solids | 48.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| EXTRACTABLE PETROLEUM HYDROCARB | 25 | U | |

| | |
|---|---|
| nsample | TRZ4-SD-007A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2049-12A |
| qc_type | NM |
| units | MG/KG |
| Pct_Solids | 49.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| EXTRACTABLE PETROLEUM HYDROCARB | 24 | U | |

| | |
|---|---|
| nsample | TRZ4-SD-007B-0001 |
| samp_date | 11/6/2008 |
| lab_id | G2049-09A |
| qc_type | NM |
| units | MG/KG |
| Pct_Solids | 35.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| EXTRACTABLE PETROLEUM HYDROCARB | 190 | | |

# PROJ_NO: 00811

SDG: G2049 MEDIA: SOIL DATA FRACTION: PET

| | |
|---|---|
| nsample | TRZ4-SD-008A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2049-23A |
| qc_type | NM |
| units | MG/KG |
| Pct_Solids | 37.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| EXTRACTABLE PETROLEUM HYDROCARB | 260 | | |

| | |
|---|---|
| nsample | TRZ4-SD-008A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2049-24A |
| qc_type | NM |
| units | MG/KG |
| Pct_Solids | 37.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| EXTRACTABLE PETROLEUM HYDROCARB | 610 | | |

| | |
|---|---|
| nsample | TRZ4-SD-008B-0001 |
| samp_date | 11/6/2008 |
| lab_id | G2049-21A |
| qc_type | NM |
| units | MG/KG |
| Pct_Solids | 34.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| EXTRACTABLE PETROLEUM HYDROCARB | 220 | | |

**Tetra Tech NUS** **INTERNAL CORRESPONDENCE**

**TO:** **COREY RICH** **DATE: DECEMBER 31, 2008**

**FROM:** **JOSEPH KALINYAK** **COPIES: DV FILE**

**SUBJECT:** **ORGANIC DATA VALIDATION: PAH/PCB/ETPH/HEXACHLOROBENZENE**
**CTO 424, NSB NEW LONDON**
**SDG G2054**

**SAMPLES:** 14/Soil/PAH/PET/Hexachlorobenzene

| | | |
|---|---|---|
| TRP1-SD-001A-0204 | TRP1-SD-001A-0406 | TRP1-SD-001B-0001 |
| TRP1-SD-002A-0204 | TRP1-SD-002A-0406 | TRP1-SD-002B-0001 |
| TRP1-SD-003A-0204 | TRP1-SD-003B-0001 | TRP1-SD-004B-0001 |
| TRP1-SD-006A-0203 | TRP1-SD-006B-0001 | TRZ4-SD-004A-0204 |
| TRZ4-SD-004A-0406 | TRZ4-SD-004B-0001 | |

14/Soil/PCB

| | | |
|---|---|---|
| TRP1-SD-001A-0002 | TRP1-SD-001A-0204 | TRP1-SD-001A-0406 |
| TRP1-SD-002A-0002 | TRP1-SD-002A-0204 | TRP1-SD-002A-0406 |
| TRP1-SD-003A-0002 | TRP1-SD-003A-0204 | TRP1-SD-004A-0002 |
| TRP1-SD-006A-0002 | TRP1-SD-006A-0203 | TRZ4-SD-004A-0002 |
| TRZ4-SD-004A-0204 | TRZ4-SD-004A-0406 | |

Overview

The sample set for CTO 424 SDG G2054 NSB New London, consists of twenty (20) environmental soil samples. There were no field duplicates associated with this SDG. All samples were analyzed as indicated above.

The samples were collected by Tetra Tech NUS, Inc. on November 6 and 7, 2008 and analyzed by Mitkem Laboratories. All analyses were conducted in accordance with Naval Facilities Engineering Service Center (NFESC) Quality Assurance/Quality Control (QA/QC) criteria using USEPA SW-846 Methods 8082, 8270D Full Scan, 8270D SIM, and Method CT ETPH analytical and reporting protocol. A USEPA Region I Tier 3 data validation was performed on the referenced samples. The data contained in this SDG were validated with regard to the following parameters:

- * Data Completeness
- * Holding Times
- * GC/MS Tuning
- Initial and Continuing Calibration
- * Laboratory Method and/or Field Quality Control Blanks
- Surrogate Spike Recoveries
- * Laboratory Control Spike / Laboratory Control Spike Duplicate Recoveries
- Internal Standards Performance
- Matrix Spike/Matrix Spike Duplicate Results
- * Detection Limits

* • Sample Quantitation

The asterisk (*) indicates that all quality control criteria were met for this parameter. Qualified (if applicable) analytical results are summarized in Appendix A. Results as reported by the laboratory are presented in Appendix B. Appendix C contains Region I worksheets, and Appendix D contains the documentation to support the findings as discussed in this data validation report. The attached Table summarizes the validation qualifications which are based on the following information:

## CALIBRATIONS

The PAH 8270 Full Scan %D was greater than the 25% quality control limit for 2-methylnaphthalene on instrument S3 on 11/19/08 @ 10:32 affecting samples TRP1-SD-001B-0001, TRP1-SD-001A-0204, TRP1-SD-001A-0406, TRP1-SD-006B-0001, TRP1-SD-006A-0203, TRZ4-SD-004B-0001, TRZ4-SD-004A-0204, and TRZ4-SD-004A-0406. The PAH Full Scan %D was greater than the 25% quality control limit for 2-methylnaphthalene on instrument S3 on 11/20/08 @ 08:44 affecting samples TRZ4-SD-004A-0406(diluted), TRP1-SD-006A-0203(diluted), TRP1-SD-002B-0001, TRP1-SD-002A-0204, TRP1-SD-002A-0406, TRP1-SD-003B-0001, TRP1-SD-003A-0204, and TRP1-SD-004B-0001. All 2-methylnaphthalene sample results were reported from the PAH 8270 SIM analysis and not from the PAH 8270 Full Scan analysis so no 2-methylnaphthalene sample results were qualified.

The PCB calibration average %D exceeded the quality control limit for Aroclor-1016 on the secondary GC column on 11/19/08 @ 20:38 affecting samples TRP1-SD-006A-0002, TRZ4-SD-004A-0406, and TRP1-SD-002A-0406. The non-detected Aroclor results for the aforementioned samples were not qualified as the primary GC column was within the quality control limits.

## BLANKS

No issues.

## SURROGATE SPIKE RECOVERIES

The PCB % recovery was less than the quality control limit for the surrogate decachlorobiphenyl (DCB) for samples TRP1-SD-001A-0002, TRP1-SD-001A-0406, TRP1-SD-006A-0203, TRZ4-SD-004A-0204, TRP1-SD-002A-0002, and TRP1-SD-002A-0204 on the primary GC column. No action was necessary as this was a single surrogate quality control limit non-compliance and the secondary GC column recovery for DCB was within the quality control limits.

The PCB % recovery was less than the quality control limit for the surrogate DCB for TRP1-SD-001A-0204, TRP1-SD-003A-0002, TRP1-SD-003A-0204, and TRP1-SD-004A-0002 on both the primary and secondary GC columns. Positive and non-detected results for these samples were qualified estimated, (J) and (UJ), for all PCBs/aroclors.

The ETPH % recovery was less than the quality control limit for the surrogate 5a-androstane in samples TRP1-SD-002B-0001, TRP1-SD-003B-0001, TRP1-SD-004A-0406, and TRP1-SD-006B-001. No action was necessary as this was a single surrogate non-compliance and the % recovery for the other surrogate ortho-terphenyl was within the quality control limits.

## MATRIX SPIKE / MATRIX SPIKE DUPLICATE (MS / MSD)

The PAH Full Scan matrix spike (MS) % recoveries were less than the quality control limit for 2-methylnaphthalene, acenaphthene, phenanthrene, fluoranthene, pyrene, benzo(a)anthracene, chrysene,

benzo(k)fluoranthene, and benzo(a)pyrene. The MSD % recoveries were less than the quality control limit for fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(k)fluoranthene, and benzo(a)pyrene. The RPD for the MS/MSD exceeded the QC limit for benzo(a)anthracene. The sample used for the MS/MSD had high levels for most of these PAH compounds. Due to the elevated PAH concentrations in the native samples the spike recoveries were outside the QC limits and the positives and non-detected results for the associated sample, TRZ4-SD-004A-0406, were not qualified.

## LABORATORY CONTROL SPIKE/LABORATORY CONTROL SPIKE DUPLICATE

No issues.

## INTERNAL STANDARDS

The PAH 8270 SIM internal standard area recoveries were all greater than the quality control limit for all SDG samples. Per the laboratory narrative, the laboratory analyst erred in using the full scan internal standards as the spike for the 8270 lower level SIM method. No action was taken based on this quality control non-compliance.

## COMPOUND QUANTITATION

The %RPD was greater than 25% between the primary and secondary GC columns for the PCB analysis for a number of samples. The samples with %RPDs greater than 25% but less than 100% were qualified estimated, (J). The samples and the %RPDs are listed as follows.

| Sample | Compound | %RPD | Qualifer |
|---|---|---|---|
| TRP1-SD-001A-0002 | Aroclor-1254 | 61.1 | J |
| TRP1-SD-001A-0204 | Aroclor-1254 | 35.6 | J |
| TRP1-SD-003A-0204 | Aroclor-1254 | 31.4 | J |

## ADDITIONAL COMMENTS

Positive results reported below the quantitation limit but above the method detection limit were qualified as estimated, (J).

Hexachlorobenzene results do not meet the reporting limit of 1.0 µg/kg.

The %RPD between the primary and secondary GC columns was manually calculated for the positive PCB detections. The laboratory presented %D between GC columns instead of %RPD.

The PAH 8270 SIM analysis results were reported for all samples in which the compound levels did not exceed the calibration curve. PAH 8270 Full Scan results for those samples with compounds which exceeded the calibration curve of the 8270 SIM analysis were reported for samples re-analyzed using the PAH 8270 Full Scan method. There were 2X dilutions performed for samples TRP1-SD-006A-0203 and TRZ4-SD-004A-0406 in the PAH 8270 Full Scan analysis due to compounds in the undiluted sample which exceeded the calibration range of the PAH 8270 Full Scan method. Results for the undiluted 8270 Full Scan method, diluted samples 8270 Full Scan method, and the 8270 SIM analysis were combined in this report.

The lower PCB result, when choosing between the primary and secondary GC column PCB results, was reported by the laboratory.

## EXECUTIVE SUMMARY

**Laboratory Performance:** The laboratory added the 8270 Full Scan internal standards to the 8270 SIM analytical sample run (instead of the 8270 SIM internal standards). There were PCB surrogate spike % recoveries on both GC columns continuing calibration greater than the quality control limits. There were PCB %RPDs greater than 25% which resulted in PCB data qualification for some samples.

**Other Factors Affecting Data Quality:** None.

The data for these analyses were reviewed with reference to the Region I EPA "Data Validation Functional Guidelines - Part II" (12/96), National Functional Guidelines for Low Concentration Organic Data Review, and the DoD Quality Systems (QSM) (January 2006).

"I attest that the data referenced herein were validated according to the agreed upon validation criteria as specified in the NFESC Guidelines and the DoD QSM."

TetraTech NUS
Joseph Kalinyak
Chemist/Data Validator

TetraTech NUS
Joseph A. Samchuck
Data Validation Quality Assurance Officer

Attachments:
1. Appendix A - Qualified Analytical Results
2. Appendix B - Results as Reported by the Laboratory
3. Appendix C - Regional Worksheets
4. Appendix D - Support Documentation

# APPENDIX A

## QUALIFIED LABORATORY RESULTS

**Qualifier Codes:**

A = Lab Blank Contamination
B = Field Blank Contamination
C = Calibration Noncompliance (i.e., % RSDs, %Ds, ICVs, CCVs, RRFs, etc.)
C01 = GC/MS Tuning Noncompliance
D = MS/MSD Recovery Noncompliance
E = LCS/LCSD Recovery Noncompliance
F = Lab Duplicate Imprecision
G = Field Duplicate Imprecision
H = Holding Time Exceedance
I = ICP Serial Dilution Noncompliance
J = GFAA PDS - GFAA MSA's $r < 0.995$
K = ICP Interference - includes ICS % R Noncompliance
L = Instrument Calibration Range Exceedance
M = Sample Preservation Noncompliance
N = Internal Standard Noncompliance
N01 = Internal Standard Recovery Noncompliance Dioxins
N02 = Recovery Standard Noncompliance Dioxins
N03 = Clean-up Standard Noncompliance Dioxins
O = Poor Instrument Performance (i.e., base-time drifting)
P = Uncertainty near detection limit (< 2 x IDL for inorganics and <CRQL for organics)
Q = Other problems (can encompass a number of issues; i.e.chromatography,interferences, etc.)
R = Surrogates Recovery Noncompliance
S = Pesticide/PCB Resolution
T = % Breakdown Noncompliance for DDT and Endrin
U = % Difference between columns/detectors >25% for positive results determined via GC/HPLC
V = Non-linear calibrations; correlation coefficient $r < 0.995$
W = EMPC result
X = Signal to noise response drop
Y = Percent solids <30%
Z = Uncertainty at 2 sigma deviation is less than sample activity

| PROJ_NO: 00811<br>SDG: G2054<br>FRACTION: OS<br>MEDIA: SOIL | NSAMPLE | TRP1-SD-001A-0204 | | | TRP1-SD-001A-0406 | | | TRP1-SD-001B-0001 | | | TRP1-SD-002A-0204 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LAB_ID | G2054-03A | | | G2054-04A | | | G2054-01A | | | G2054-14A | | |
| | SAMP_DATE | 11/6/2008 | | | 11/6/2008 | | | 11/6/2008 | | | 11/7/2008 | | |
| | QC_TYPE | NM | | | NM | | | NM | | | NM | | |
| | UNITS | UG/KG | | | UG/KG | | | UG/KG | | | UG/KG | | |
| | PCT_SOLIDS | 44.0 | | | 53.0 | | | 46.0 | | | 47.0 | | |
| | DUP_OF | | | | | | | | | | | | |
| PARAMETER | | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD |
| ACENAPHTHENE | | | | | | | | | | | | | |
| ANTHRACENE | | 960 | | | | | | 780 | | | 1900 | | |
| BENZO(A)ANTHRACENE | | 2100 | | | 1400 | | | 2900 | | | 4500 | | |
| BENZO(A)PYRENE | | 1600 | | | 1100 | | | 1900 | | | 3100 | | |
| BENZO(B)FLUORANTHENE | | 2600 | | | 1600 | | | 3100 | | | 4600 | | |
| BENZO(G,H,I)PERYLENE | | | | | | | | | | | 1600 | | |
| BENZO(K)FLUORANTHENE | | 1200 | | | 650 | | | 1200 | | | 2700 | | |
| CHRYSENE | | 2700 | | | 1700 | | | 3800 | | | 6100 | | |
| FLUORANTHENE | | 4200 | | | 3800 | | | 1400 | | | 8900 | | |
| FLUORENE | | | | | | | | | | | | | |
| INDENO(1,2,3-CD)PYRENE | | | | | | | | | | | 1600 | | |
| PHENANTHRENE | | 890 | | | | | | | | | 1700 | | |
| PYRENE | | 5100 | | | 2800 | | | 6000 | | | 9400 | | |

| PROJ_NO: 00811 | NSAMPLE | TRP1-SD-002A-0406 | | | TRP1-SD-002B-0001 | | | TRP1-SD-003A-0204 | | | TRP1-SD-003B-0001 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SDG: G2054 | LAB_ID | G2054-15A | | | G2054-12A | | | G2054-18A | | | G2054-16A | | |
| FRACTION: OS | SAMP_DATE | 11/7/2008 | | | 11/7/2008 | | | 11/7/2008 | | | 11/7/2008 | | |
| MEDIA: SOIL | QC_TYPE | NM | | | NM | | | NM | | | NM | | |
| | UNITS | UG/KG | | | UG/KG | | | UG/KG | | | UG/KG | | |
| | PCT_SOLIDS | 47.0 | | | 42.0 | | | 63.0 | | | 44.0 | | |
| | DUP_OF | | | | | | | | | | | | |
| PARAMETER | | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD |
| ACENAPHTHENE | | | | | | | | | | | | | |
| ANTHRACENE | | 1500 | | | | | | | | | | | |
| BENZO(A)ANTHRACENE | | 2400 | | | 1200 | | | | | | 1000 | | |
| BENZO(A)PYRENE | | 1900 | | | 1400 | | | | | | 1300 | | |
| BENZO(B)FLUORANTHENE | | 2300 | | | 2000 | | | | | | 1800 | | |
| BENZO(G,H,I)PERYLENE | | | | | | | | | | | | | |
| BENZO(K)FLUORANTHENE | | 1900 | | | 1100 | | | | | | 1000 | | |
| CHRYSENE | | 3000 | | | 1600 | | | | | | 1500 | | |
| FLUORANTHENE | | 8500 | | | 1700 | | | 600 | | | 1700 | | |
| FLUORENE | | 600 | J | P | | | | | | | | | |
| INDENO(1,2,3-CD)PYRENE | | | | | | | | | | | | | |
| PHENANTHRENE | | 1900 | | | | | | | | | | | |
| PYRENE | | 6400 | | | 2800 | | | 1400 | | | 2600 | | |

| PROJ_NO: 00811 | NSAMPLE | TRP1-SD-004B-0001 | | | TRP1-SD-006A-0203 | | | TRP1-SD-006A-0203DL | | | TRP1-SD-006B-0001 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SDG: G2054 | LAB_ID | G2054-19A | | | G2054-07A | | | G2054-07ADL | | | G2054-05A | | |
| FRACTION: OS | SAMP_DATE | 11/7/2008 | | | 11/7/2008 | | | 11/7/2008 | | | 11/7/2008 | | |
| MEDIA: SOIL | QC_TYPE | NM | | | NM | | | NM | | | NM | | |
| | UNITS | UG/KG | | | UG/KG | | | UG/KG | | | UG/KG | | |
| | PCT_SOLIDS | 37.0 | | | 44.0 | | | 44.0 | | | 38.0 | | |
| | DUP_OF | | | | | | | | | | | | |
| PARAMETER | | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD |
| ACENAPHTHENE | | | | | 1500 | | | | | | | | |
| ANTHRACENE | | | | | 1400 | | | | | | | | |
| BENZO(A)ANTHRACENE | | 1700 | | | 3100 | | | | | | | | |
| BENZO(A)PYRENE | | 1100 | | | 1200 | | | | | | | | |
| BENZO(B)FLUORANTHENE | | 1800 | | | 2200 | | | | | | | | |
| BENZO(G,H,I)PERYLENE | | | | | | | | | | | | | |
| BENZO(K)FLUORANTHENE | | | | | | | | | | | | | |
| CHRYSENE | | 1700 | | | 3300 | | | | | | | | |
| FLUORANTHENE | | 3100 | | | | | | 15000 | | | 2600 | | |
| FLUORENE | | | | | 1400 | | | | | | | | |
| INDENO(1,2,3-CD)PYRENE | | | | | | | | | | | | | |
| PHENANTHRENE | | | | | 5700 | | | | | | | | |
| PYRENE | | 3600 | | | 8600 | | | | | | 2000 | | |

| PROJ_NO: 00811<br>SDG: G2054<br>FRACTION: OS<br>MEDIA: SOIL | NSAMPLE | TRZ4-SD-004A-0204 | | | TRZ4-SD-004A-0406 | | | TRZ4-SD-004A-0406DL | | | TRZ4-SD-004B-0001 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LAB_ID | G2054-10A | | | G2054-11A | | | G2054-11ADL | | | G2054-08A | | |
| | SAMP_DATE | 11/7/2008 | | | 11/7/2008 | | | 11/7/2008 | | | 11/7/2008 | | |
| | QC_TYPE | NM | | | NM | | | NM | | | NM | | |
| | UNITS | UG/KG | | | UG/KG | | | UG/KG | | | UG/KG | | |
| | PCT_SOLIDS | 80.0 | | | 59.0 | | | 59.0 | | | 72.0 | | |
| | DUP_OF | | | | | | | | | | | | |
| PARAMETER | | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD |
| ACENAPHTHENE | | | | | 1500 | | | | | | | | |
| ANTHRACENE | | | | | 1400 | | | | | | | | |
| BENZO(A)ANTHRACENE | | 890 | | | 3300 | | | | | | | | |
| BENZO(A)PYRENE | | 620 | | | 2100 | | | | | | | | |
| BENZO(B)FLUORANTHENE | | 990 | | | 2300 | | | | | | 610 | | |
| BENZO(G,H,I)PERYLENE | | | | | 1100 | | | | | | | | |
| BENZO(K)FLUORANTHENE | | | | | 2200 | | | | | | | | |
| CHRYSENE | | 870 | | | 3200 | | | | | | 570 | | |
| FLUORANTHENE | | 3100 | | | | | | 12000 | | | 990 | | |
| FLUORENE | | | | | 690 | | | | | | | | |
| INDENO(1,2,3-CD)PYRENE | | | | | 1000 | | | | | | | | |
| PHENANTHRENE | | | | | 2400 | | | | | | | | |
| PYRENE | | 3300 | | | 8200 | | | | | | 1100 | | |

| PROJ_NO: 00811 | NSAMPLE | TRP1-SD-001A-0204 | | | TRP1-SD-001A-0406 | | | TRP1-SD-001B-0001 | | | TRP1-SD-002A-0204 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SDG: G2054 | LAB_ID | G2054-03A | | | G2054-04A | | | G2054-01A | | | G2054-14A | | |
| FRACTION: PAH | SAMP_DATE | 11/6/2008 | | | 11/6/2008 | | | 11/6/2008 | | | 11/7/2008 | | |
| MEDIA: SOIL | QC_TYPE | NM | | | NM | | | NM | | | NM | | |
| | UNITS | UG/KG | | | UG/KG | | | UG/KG | | | UG/KG | | |
| | PCT_SOLIDS | 44.0 | | | 53.0 | | | 46.0 | | | 47.0 | | |
| | DUP_OF | | | | | | | | | | | | |
| PARAMETER | | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD |
| 1-METHYLNAPHTHALENE | | 28 | | | 32 | | | 17 | | | 6.9 | U | |
| 2-METHYLNAPHTHALENE | | 49 | | | 50 | | | 28 | | | 58 | | |
| ACENAPHTHENE | | 92 | | | 77 | | | 40 | | | 110 | | |
| ACENAPHTHYLENE | | 340 | | | 180 | | | 290 | | | 560 | | |
| ANTHRACENE | | | | | 590 | | | | | | | | |
| BENZO(A)ANTHRACENE | | | | | | | | | | | | | |
| BENZO(A)PYRENE | | | | | | | | | | | | | |
| BENZO(B)FLUORANTHENE | | | | | | | | | | | | | |
| BENZO(G,H,I)PERYLENE | | 660 | | | 430 | | | 600 | | | | | |
| BENZO(K)FLUORANTHENE | | | | | | | | | | | | | |
| CHRYSENE | | | | | | | | | | | | | |
| DIBENZO(A,H)ANTHRACENE | | 230 | | | 140 | | | 220 | | | 370 | | |
| FLUORENE | | 220 | | | 130 | | | 110 | | | 310 | | |
| HEXACHLOROBENZENE | | 7.5 | U | | 6.2 | U | | 7.2 | U | | 6.9 | U | |
| INDENO(1,2,3-CD)PYRENE | | 630 | | | 410 | | | 580 | | | | | |
| NAPHTHALENE | | 85 | | | 71 | | | 49 | | | 80 | | |
| PHENANTHRENE | | | | | 470 | | | 450 | | | | | |

| PROJ_NO: 00811 | NSAMPLE | TRP1-SD-002A-0406 | | | TRP1-SD-002B-0001 | | | TRP1-SD-003A-0204 | | | TRP1-SD-003B-0001 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SDG: G2054 | LAB_ID | G2054-15A | | | G2054-12A | | | G2054-18A | | | G2054-16A | | |
| FRACTION: PAH | SAMP_DATE | 11/7/2008 | | | 11/7/2008 | | | 11/7/2008 | | | 11/7/2008 | | |
| MEDIA: SOIL | QC_TYPE | NM | | | NM | | | NM | | | NM | | |
| | UNITS | UG/KG | | | UG/KG | | | UG/KG | | | UG/KG | | |
| | PCT_SOLIDS | 47.0 | | | 42.0 | | | 63.0 | | | 44.0 | | |
| | DUP_OF | | | | | | | | | | | | |
| PARAMETER | | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD |
| 1-METHYLNAPHTHALENE | | 180 | | | 14 | | | 15 | | | 17 | | |
| 2-METHYLNAPHTHALENE | | 150 | | | 20 | | | 24 | | | 23 | | |
| ACENAPHTHENE | | 660 | | | 31 | | | 20 | | | 32 | | |
| ACENAPHTHYLENE | | 360 | | | 220 | | | 120 | | | 220 | | |
| ANTHRACENE | | | | | 380 | | | 150 | | | 430 | | |
| BENZO(A)ANTHRACENE | | | | | | | | 350 | | | | | |
| BENZO(A)PYRENE | | | | | | | | 390 | | | | | |
| BENZO(B)FLUORANTHENE | | | | | | | | 520 | | | | | |
| BENZO(G,H,I)PERYLENE | | 600 | | | 450 | | | 230 | | | 530 | | |
| BENZO(K)FLUORANTHENE | | | | | | | | 290 | | | | | |
| CHRYSENE | | | | | | | | 430 | | | | | |
| DIBENZO(A,H)ANTHRACENE | | 220 | | | 160 | | | 68 | | | 170 | | |
| FLUORENE | | | | | 76 | | | 45 | | | 78 | | |
| HEXACHLOROBENZENE | | 7 | U | | 7.8 | U | | 5.2 | U | | 7.4 | U | |
| INDENO(1,2,3-CD)PYRENE | | 590 | | | 470 | | | 200 | | | 490 | | |
| NAPHTHALENE | | 250 | | | 30 | | | 31 | | | 36 | | |
| PHENANTHRENE | | | | | 330 | | | 210 | | | 450 | | |

| PROJ_NO: 00811<br>SDG: G2054<br>FRACTION: PAH<br>MEDIA: SOIL | NSAMPLE | TRP1-SD-004B-0001 | | | TRP1-SD-006A-0203 | | | TRP1-SD-006B-0001 | | | TRZ4-SD-004A-0204 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LAB_ID | G2054-19A | | | G2054-07A | | | G2054-05A | | | G2054-10A | | |
| | SAMP_DATE | 11/7/2008 | | | 11/7/2008 | | | 11/7/2008 | | | 11/7/2008 | | |
| | QC_TYPE | NM | | | NM | | | NM | | | NM | | |
| | UNITS | UG/KG | | | UG/KG | | | UG/KG | | | UG/KG | | |
| | PCT_SOLIDS | 37.0 | | | 44.0 | | | 38.0 | | | 80.0 | | |
| | DUP_OF | | | | | | | | | | | | |
| PARAMETER | | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD |
| 1-METHYLNAPHTHALENE | | 12 | | | 200 | | | 36 | | | 33 | | |
| 2-METHYLNAPHTHALENE | | 15 | | | 140 | | | 51 | | | 60 | | |
| ACENAPHTHENE | | 100 | | | | | | 290 | | | 93 | | |
| ACENAPHTHYLENE | | 180 | | | 250 | | | 120 | | | 120 | | |
| ANTHRACENE | | 390 | | | | | | 260 | | | 320 | | |
| BENZO(A)ANTHRACENE | | | | | | | | 660 | | | | | |
| BENZO(A)PYRENE | | | | | | | | 470 | | | | | |
| BENZO(B)FLUORANTHENE | | | | | | | | 700 | | | | | |
| BENZO(G,H,I)PERYLENE | | 450 | | | 400 | | | 250 | | | 200 | | |
| BENZO(K)FLUORANTHENE | | 600 | | | 630 | | | 340 | | | 300 | | |
| CHRYSENE | | | | | | | | 790 | | | | | |
| DIBENZO(A,H)ANTHRACENE | | 130 | | | 140 | | | 76 | | | 74 | | |
| FLUORENE | | 85 | | | | | | 180 | | | 89 | | |
| HEXACHLOROBENZENE | | 8.9 | U | | 7.5 | U | | 8.7 | U | | 4.1 | U | |
| INDENO(1,2,3-CD)PYRENE | | 420 | | | 390 | | | 230 | | | 200 | | |
| NAPHTHALENE | | 24 | | | 210 | | | 120 | | | 210 | | |
| PHENANTHRENE | | 420 | | | | | | 760 | | | 280 | | |

| PROJ_NO: 00811 | NSAMPLE | TRZ4-SD-004A-0406 | | | TRZ4-SD-004B-0001 | | |
|---|---|---|---|---|---|---|---|
| SDG: G2054 | LAB_ID | G2054-11A | | | G2054-08A | | |
| FRACTION: PAH | SAMP_DATE | 11/7/2008 | | | 11/7/2008 | | |
| MEDIA: SOIL | QC_TYPE | NM | | | NM | | |
| | UNITS | UG/KG | | | UG/KG | | |
| | PCT_SOLIDS | 59.0 | | | 72.0 | | |
| | DUP_OF | | | | | | |
| PARAMETER | | RESULT | VQL | QLCD | RESULT | VQL | QLCD |
| 1-METHYLNAPHTHALENE | | 240 | | | 7.8 | | |
| 2-METHYLNAPHTHALENE | | 210 | | | 8 | | |
| ACENAPHTHENE | | | | | 35 | | |
| ACENAPHTHYLENE | | 350 | | | 83 | | |
| ANTHRACENE | | | | | 130 | | |
| BENZO(A)ANTHRACENE | | | | | 350 | | |
| BENZO(A)PYRENE | | | | | 360 | | |
| BENZO(B)FLUORANTHENE | | | | | | | |
| BENZO(G,H,I)PERYLENE | | | | | 190 | | |
| BENZO(K)FLUORANTHENE | | | | | 270 | | |
| CHRYSENE | | | | | | | |
| DIBENZO(A,H)ANTHRACENE | | 220 | | | 57 | | |
| FLUORENE | | | | | 53 | | |
| HEXACHLOROBENZENE | | 5.6 | U | | 4.6 | U | |
| INDENO(1,2,3-CD)PYRENE | | | | | 180 | | |
| NAPHTHALENE | | 340 | | | 14 | | |
| PHENANTHRENE | | | | | 320 | | |

| PROJ_NO: 00811<br>SDG: G2054<br>FRACTION: PEST/PCB<br>MEDIA: SOIL | NSAMPLE | TRP1-SD-001A-0002 | | | TRP1-SD-001A-0204 | | | TRP1-SD-001A-0406 | | | TRP1-SD-002A-0002 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LAB_ID | G2054-02A | | | G2054-03A | | | G2054-04A | | | G2054-13A | | |
| | SAMP_DATE | 11/6/2008 | | | 11/6/2008 | | | 11/6/2008 | | | 11/7/2008 | | |
| | QC_TYPE | NM | | | NM | | | NM | | | NM | | |
| | UNITS | UG/KG | | | UG/KG | | | UG/KG | | | UG/KG | | |
| | PCT_SOLIDS | 46.0 | | | 44.0 | | | 53.0 | | | 39.0 | | |
| | DUP_OF | | | | | | | | | | | | |
| PARAMETER | | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD |
| AROCLOR-1016 | | 71 | U | | 74 | UJ | R | 62 | U | | 83 | U | |
| AROCLOR-1221 | | 71 | U | | 74 | UJ | R | 62 | U | | 83 | U | |
| AROCLOR-1232 | | 71 | U | | 74 | UJ | R | 62 | U | | 83 | U | |
| AROCLOR-1242 | | 71 | U | | 74 | UJ | R | 62 | U | | 83 | U | |
| AROCLOR-1248 | | 71 | U | | 74 | UJ | R | 62 | U | | 83 | U | |
| AROCLOR-1254 | | 82 | J | PU | 75 | J | PRU | 62 | U | | 83 | U | |
| AROCLOR-1260 | | 71 | U | | 74 | UJ | R | 62 | U | | 83 | U | |

| PROJ_NO: 00811<br>SDG: G2054<br>FRACTION: PEST/PCB<br>MEDIA: SOIL | NSAMPLE | TRP1-SD-002A-0204 | | | TRP1-SD-002A-0406 | | | TRP1-SD-003A-0002 | | | TRP1-SD-003A-0204 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LAB_ID | G2054-14A | | | G2054-15A | | | G2054-17A | | | G2054-18A | | |
| | SAMP_DATE | 11/7/2008 | | | 11/7/2008 | | | 11/7/2008 | | | 11/7/2008 | | |
| | QC_TYPE | NM | | | NM | | | NM | | | NM | | |
| | UNITS | UG/KG | | | UG/KG | | | UG/KG | | | UG/KG | | |
| | PCT_SOLIDS | 47.0 | | | 47.0 | | | 53.0 | | | 63.0 | | |
| | DUP_OF | | | | | | | | | | | | |
| PARAMETER | | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD |
| AROCLOR-1016 | | 70 | U | | 70 | U | | 62 | UJ | R | 52 | UJ | R |
| AROCLOR-1221 | | 70 | U | | 70 | U | | 62 | UJ | R | 52 | UJ | R |
| AROCLOR-1232 | | 70 | U | | 70 | U | | 62 | UJ | R | 52 | UJ | R |
| AROCLOR-1242 | | 70 | U | | 70 | U | | 62 | UJ | R | 52 | UJ | R |
| AROCLOR-1248 | | 70 | U | | 70 | U | | 62 | UJ | R | 52 | UJ | R |
| AROCLOR-1254 | | 170 | | | 770 | | | 190 | J | R | 57 | J | RU |
| AROCLOR-1260 | | 70 | U | | 360 | | | 160 | J | R | 52 | UJ | R |

| PROJ_NO: 00811<br>SDG: G2054<br>FRACTION: PEST/PCB<br>MEDIA: SOIL | NSAMPLE | TRP1-SD-004A-0002 | | | TRP1-SD-006A-0002 | | | TRP1-SD-006A-0203 | | | TRZ4-SD-004A-0002 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LAB_ID | G2054-20A | | | G2054-06A | | | G2054-07A | | | G2054-09A | | |
| | SAMP_DATE | 11/7/2008 | | | 11/7/2008 | | | 11/7/2008 | | | 11/7/2008 | | |
| | QC_TYPE | NM | | | NM | | | NM | | | NM | | |
| | UNITS | UG/KG | | | UG/KG | | | UG/KG | | | UG/KG | | |
| | PCT_SOLIDS | 36.0 | | | 37.0 | | | 44.0 | | | 79.0 | | |
| | DUP_OF | | | | | | | | | | | | |
| PARAMETER | | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD |
| AROCLOR-1016 | | 90 | UJ | R | 89 | U | | 75 | U | | 42 | U | |
| AROCLOR-1221 | | 90 | UJ | R | 89 | U | | 75 | U | | 42 | U | |
| AROCLOR-1232 | | 90 | UJ | R | 89 | U | | 75 | U | | 42 | U | |
| AROCLOR-1242 | | 90 | UJ | R | 89 | U | | 75 | U | | 42 | U | |
| AROCLOR-1248 | | 90 | UJ | R | 89 | U | | 75 | U | | 42 | U | |
| AROCLOR-1254 | | 90 | UJ | R | 89 | U | | 75 | U | | 42 | U | |
| AROCLOR-1260 | | 90 | UJ | R | 89 | U | | 75 | U | | 42 | U | |

| PROJ_NO: 00811<br>SDG: G2054<br>FRACTION: PEST/PCB<br>MEDIA: SOIL | NSAMPLE | TRZ4-SD-004A-0204 | | | TRZ4-SD-004A-0406 | | |
|---|---|---|---|---|---|---|---|
| | LAB_ID | G2054-10A | | | G2054-11A | | |
| | SAMP_DATE | 11/7/2008 | | | 11/7/2008 | | |
| | QC_TYPE | NM | | | NM | | |
| | UNITS | UG/KG | | | UG/KG | | |
| | PCT_SOLIDS | 80.0 | | | 59.0 | | |
| | DUP_OF | | | | | | |
| PARAMETER | | RESULT | VQL | QLCD | RESULT | VQL | QLCD |
| AROCLOR-1016 | | 41 | U | | 55 | U | |
| AROCLOR-1221 | | 41 | U | | 55 | U | |
| AROCLOR-1232 | | 41 | U | | 55 | U | |
| AROCLOR-1242 | | 41 | U | | 55 | U | |
| AROCLOR-1248 | | 41 | U | | 280 | | |
| AROCLOR-1254 | | 58 | | | 310 | | |
| AROCLOR-1260 | | 41 | U | | 55 | U | |

| PROJ_NO: 00811 | NSAMPLE | TRP1-SD-001A-0204 | | | TRP1-SD-001A-0406 | | | TRP1-SD-001B-0001 | | | TRP1-SD-002A-0204 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SDG: G2054 | LAB_ID | G2054-03A | | | G2054-04A | | | G2054-01A | | | G2054-14A | | |
| FRACTION: PET | SAMP_DATE | 11/6/2008 | | | 11/6/2008 | | | 11/6/2008 | | | 11/7/2008 | | |
| MEDIA: SOIL | QC_TYPE | NM | | | NM | | | NM | | | NM | | |
| | UNITS | MG/KG | | | MG/KG | | | MG/KG | | | MG/KG | | |
| | PCT_SOLIDS | 44.0 | | | 53.0 | | | 46.0 | | | 47.0 | | |
| | DUP_OF | | | | | | | | | | | | |
| PARAMETER | | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD |
| EXTRACTABLE PETROLEUM HYDROCARBONS | | 830 | | | 3000 | | | 3000 | | | 480 | | |

| PROJ_NO: 00811<br>SDG: G2054<br>FRACTION: PET<br>MEDIA: SOIL | NSAMPLE | TRP1-SD-002A-0406 | | | TRP1-SD-002B-0001 | | | TRP1-SD-003A-0204 | | | TRP1-SD-003B-0001 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LAB_ID | G2054-15A | | | G2054-12A | | | G2054-18A | | | G2054-16A | | |
| | SAMP_DATE | 11/7/2008 | | | 11/7/2008 | | | 11/7/2008 | | | 11/7/2008 | | |
| | QC_TYPE | NM | | | NM | | | NM | | | NM | | |
| | UNITS | MG/KG | | | MG/KG | | | MG/KG | | | MG/KG | | |
| | PCT_SOLIDS | 47.0 | | | 42.0 | | | 63.0 | | | 44.0 | | |
| | DUP_OF | | | | | | | | | | | | |
| PARAMETER | | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD |
| EXTRACTABLE PETROLEUM HYDROCARBONS | | 4700 | | | 240 | | | 530 | | | 260 | | |

| PROJ_NO: 00811<br>SDG: G2054<br>FRACTION: PET<br>MEDIA: SOIL | NSAMPLE | TRP1-SD-004B-0001 | | | TRP1-SD-006A-0203 | | | TRP1-SD-006B-0001 | | | TRZ4-SD-004A-0204 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LAB_ID | G2054-19A | | | G2054-07A | | | G2054-05A | | | G2054-10A | | |
| | SAMP_DATE | 11/7/2008 | | | 11/7/2008 | | | 11/7/2008 | | | 11/7/2008 | | |
| | QC_TYPE | NM | | | NM | | | NM | | | NM | | |
| | UNITS | MG/KG | | | MG/KG | | | MG/KG | | | MG/KG | | |
| | PCT_SOLIDS | 37.0 | | | 44.0 | | | 38.0 | | | 80.0 | | |
| | DUP_OF | | | | | | | | | | | | |
| PARAMETER | | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD |
| EXTRACTABLE PETROLEUM HYDROCARBONS | | 290 | | | 160 | | | 200 | | | 3800 | | |

| PROJ_NO: 00811<br>SDG: G2054<br>FRACTION: PET<br>MEDIA: SOIL | NSAMPLE | TRZ4-SD-004A-0406 | | | TRZ4-SD-004B-0001 | | |
|---|---|---|---|---|---|---|---|
| | LAB_ID | G2054-11A | | | G2054-08A | | |
| | SAMP_DATE | 11/7/2008 | | | 11/7/2008 | | |
| | QC_TYPE | NM | | | NM | | |
| | UNITS | MG/KG | | | MG/KG | | |
| | PCT_SOLIDS | 59.0 | | | 72.0 | | |
| | DUP_OF | | | | | | |
| PARAMETER | | RESULT | VQL | QLCD | RESULT | VQL | QLCD |
| EXTRACTABLE PETROLEUM HYDROCARBONS | | 1800 | | | 89 | | |

**Tetra Tech NUS** **INTERNAL CORRESPONDENCE**

| | | | |
|---|---|---|---|
| **TO:** | C. RICH | **DATE:** | **DECEMBER 31, 2008** |
| **FROM:** | **LEANNE M. GANSER** | **COPIES:** | **DV FILE** |

**SUBJECT:** **INORGANIC DATA VALIDATION – SELECT TOTAL AND TCLP METALS, PH, SALINITY, AND TOC**
**CTO 424 NSB NEW LONDON**
**SAMPLE DELIVERY GROUP (SDG) – G2054**

**SAMPLES:** 14/Solid/Total metals and TOC

| | | |
|---|---|---|
| TRP1-SD-001A-0204 | TRP1-SD-001A-0406 | TRP1-SD-001B-0001 |
| TRP1-SD-002A-0204 | TRP1-SD-002A-0406 | TRP1-SD-002B-0001 |
| TRP1-SD-003A-0204 | TRP1-SD-003B-0001 | TRP1-SD-004B-0001 |
| TRP1-SD-006A-0203 | TRP1-SD-006B-0001 | TRZ4-SD-004A-0204 |
| TRZ4-SD-004A-0406 | TRZ4-SD-004B-0001 | |

14/Solid/TCLP metals, pH and Salinity

| | | |
|---|---|---|
| TRP1-SD-001A-0002 | TRP1-SD-001A-0204 | TRP1-SD-001A-0406 |
| TRP1-SD-002A-0002 | TRP1-SD-002A-0204 | TRP1-SD-002A-0406 |
| TRP1-SD-003A-0002 | TRP1-SD-003A-0204 | TRP1-SD-004A-0002 |
| TRP1-SD-006A-0002 | TRP1-SD-006A-0203 | TRZ4-SD-004A-0002 |
| TRZ4-SD-004A-0204 | TRZ4-SD-004A-0406 | |

Overview

The sample set for CTO 424 SDG G2054, NSB New London, consists of twenty (20) solid environmental samples. No field duplicate pairs were included in this SDG.

All environmental samples, except TRP1-SD-001A-0002, TRP1-SD-002A-0002, TRP1-SD-003A-0002, TRP1-SD-004A-0002, TRP1-SD-006A-0002, and TRZ4-SD-004A-0002, were analyzed for select total metals and total organic carbon (TOC). The environmental samples, except TRP1-SD-001B-0001, TRP1-SD-002B-0001, TRP1-SD-003B-0001, TRP1-SD-004B-0001, TRP1-SD-006B-0001, and TRZ4-SD-004B-0001, were also analyzed for TCLP metals, pH and salinity. The samples were collected by Tetra Tech NUS on November 6-7, 2008 and analyzed by Mitkem Laboratories. All analyses were conducted in accordance with SW-846 method 6010C for metals, SW-846 method 7470A/7471A for mercury, SW846 method 9045 for pH, SM 2520 for salinity, and Walkley-Black for TOC.

All samples in this SDG were validated to EPA Region I Tier III protocol.

These data were evaluated based on the following parameters:

* • Data Completeness
* • Holding Times
* • Initial and Continuing Calibrations
  • Laboratory Method / Preparation Blanks
* • ICP Interference Analysis
* • Laboratory Control Sample Results

- Matrix Spike Results
- Laboratory Duplicate Results
- ICP Serial Dilution Results
- * Detection Limits
- * Analyte Quantitation

* - All quality control criteria were met for this parameter.

Laboratory method blanks

For total metal analysis, the following contaminants were detected in the laboratory method blank at the following maximum concentrations:

| Analyte | Maximum Concentration | Action Level |
|---|---|---|
| Cadmium | 0.2 ug/L | 0.2 mg/kg |
| Chromium(1) | 0.083 mg/kg | 0.415 mg/kg |
| Copper(1) | 0.708 mg/kg | 3.54 mg/kg |
| Selenium(2) | 6.9 ug/L | 6.9 mg/kg |
| Zinc(1) | 0.519 mg/kg | 2.595 mg/kg |

(1) Maximum concentration present in prep blank.
(2) Maximum concentration in lab blank affecting samples TRP1-SD-001B-0001, TRP1-SD-001A-0204, TRP1-SD-001A-0406, TRP1-SD-006B-0001, and TRP1-SD-006A-0203.

An action level of 5X the maximum contaminant level has been used to evaluate sample data for blank contamination. Sample aliquot, percent solids, and dilution factors, if applicable, were taken into consideration when evaluating for blank contamination. Positive results less than the action level for selenium were qualified for blank contamination.

For TCLP metal analysis, the following contaminants were detected in the laboratory method blank at the following maximum concentrations:

| Analyte | Maximum Concentration | Action Level |
|---|---|---|
| Cadmium(1) | 0.2 ug/L | 1.0 ug/L |
| Mercury(2) | 0.028 ug/L | 0.14 ug/L |
| Selenium | 27.65 ug/L | 138.27 ug/L |
| Silver | 2.3 ug/L | 11.5 ug/L |

(1) Maximum concentration in lab blank affecting all samples, except TRP1-SD-001A-0002, TRP1-SD-001A-0204, TRP1-SD-001A-0406, AND TRP1-SD-006A-0002.
(2) Maximum concentration present in prep blank.

An action level of 5X the maximum contaminant level has been used to evaluate sample data for blank contamination. Sample aliquot, percent solids, and dilution factors, if applicable, were taken into consideration when evaluating for blank contamination. Positive results for the aforementioned compounds less than the blank action level were qualified for blank contamination.

Laboratory Duplicate Results

For total metal analysis, laboratory duplicate imprecision for arsenic, cadmium, copper, lead, mercury, nickel, and zinc were > 20% relative percent difference. The positive results reported for these compounds for all samples were qualified as estimated, "J".

Matrix Spike Results

For total metal analysis, the matrix spike percent recovery for copper and zinc was >125% quality control limit. The positive results reported for copper and zinc for all samples were qualified as estimated, "J".

ICP Serial Dilution Results

For total metal analysis, the %Ds for ICP serial dilution were >10% quality control limits for cadmium, chromium, lead, nickel, and zinc. The positive results reported for these compounds for all samples were qualified as estimated, "J".

For TCLP metal analysis, the %D for ICP serial dilution was >10% quality control limit for lead. The positive and nondetected results reported for lead for all samples were qualified as estimated, "J" and "UJ", respectively.

Notes

Positive results reported for chromium and lead that were <2x the instrument detection limit (IDL) were qualified as estimated, "J", as a result of uncertainty near the detection limit.

Executive Summary

**Laboratory Performance:** Several contaminants were present in the laboratory blanks in total and TCLP metal analysis. Laboratory duplicate imprecision was noted for several compounds in total metal analysis.

**Other Factors Affecting Data Quality:** The matrix spike percent recovery was outside quality control limits for copper and zinc in total metal analysis. The %D for ICP serial dilution analysis was outside quality control limits for several compounds in total metal analysis and one compound in TCLP metal analysis.

The data for these analyses were reviewed with reference to EPA Region I, "National Functional Guidelines for Inorganic Review", February 1989. The text of this report has been formulated to address only those problem areas affecting data quality.

Leanne M. Ganser

Tetra Tech NUS
Leanne M. Ganser
Environmental Scientist

Edward Redling / for

Tetra Tech NUS
Joseph A. Samchuck
Quality Assurance Officer

Attachments:

1. Appendix A - Qualified Analytical Results
2. Appendix B - Results as reported by the Laboratory
3. Appendix C - Region I Worksheets
4. Appendix D - Support Documentation

# APPENDIX A
# QUALIFIED ANALYTICAL RESULTS

**Data Validation Qualifier Codes:**

A = Lab Blank Contamination
B = Field Blank Contamination
C = Calibration Noncompliance (e.g. % RSDs, %Ds, ICVs, CCVs, RRFs, etc.)
C01 = GC/MS Tuning Noncompliance
D = MS/MSD Recovery Noncompliance
E = LCS/LCSD Recovery Noncompliance
F = Lab Duplicate Imprecision
G = Field Duplicate Imprecision
H = Holding Time Exceedance
I = ICP Serial Dilution Noncompliance
J = GFAA PDS-GFAA MSA's r < 0.995 / ICP PDS Recovery Noncompliance
K = ICP Interference - includes ICS % R Noncompliance
L = Instrument Calibration Range Exceedance
M = Sample Preservation Noncompliance
N = Internal Standard Noncompliance
N01 = Internal Standard Recovery Noncompliance Dioxins
N02 = Recovery Standard Noncompliance Dioxins
N03 = Clean-up Standard Noncompliance Dioxins
O = Poor Instrument Performance (e.g. base-line drifting)
P = Uncertainty near detection limit (< 2 x IDL for inorganics and <CRQL for organics)
Q = Other problems (can encompass a number of issues; e.g. chromatography,interferences, etc.)
R = Surrogates Recovery Noncompliance
S = Pesticide/PCB Resolution
T = % Breakdown Noncompliance for DOT and Endrin
U = % Difference between columns/detectors >25% for positive results determined via GC/HPLC
V = Non-linear calibrations; correlation coefficient r < 0.995
W = EMPC result
X = Signal to noise response drop
Y = Percent solids <30%
Z = Uncertainty at 2 sigma deviation is greater than sample activity

| PROJ_NO: 00811 | NSAMPLE | TRP1-SD-001A-0204 | | | TRP1-SD-001A-0406 | | | TRP1-SD-001B-0001 | | | TRP1-SD-002A-0204 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SDG: G2054 | LAB_ID | G2054-03A | | | G2054-04A | | | G2054-01A | | | G2054-14A | | |
| FRACTION: M | SAMP_DATE | 11/6/2008 | | | 11/6/2008 | | | 11/6/2008 | | | 11/7/2008 | | |
| MEDIA: SOIL | QC_TYPE | NM | | | NM | | | NM | | | NM | | |
| | UNITS | MG/KG | | | MG/KG | | | MG/KG | | | MG/KG | | |
| | PCT_SOLIDS | 44.0 | | | 53.0 | | | 46.0 | | | 47.0 | | |
| | DUP_OF | | | | | | | | | | | | |
| PARAMETER | | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD |
| ARSENIC | | 9.5 | J | F | 8.4 | J | F | 12.1 | J | F | 13 | J | F |
| CADMIUM | | 1.1 | J | FI | 1.5 | J | FI | 0.82 | J | FI | 0.85 | J | FI |
| CHROMIUM | | 88.8 | J | I | 98.4 | J | I | 78.8 | J | I | 84.6 | J | I |
| COPPER | | 182 | J | DF | 142 | J | DF | 260 | J | DF | 519 | J | DF |
| LEAD | | 157 | J | FI | 210 | J | FI | 204 | J | FI | 298 | J | FI |
| MERCURY | | 1.1 | J | F | 1.2 | J | F | 1.2 | J | F | 0.45 | J | F |
| NICKEL | | 27.6 | J | FI | 18.9 | J | FI | 51.6 | J | FI | 124 | J | FI |
| SELENIUM | | 5.1 | U | A | 4.8 | U | A | 5.5 | U | A | 6.8 | | |
| ZINC | | 283 | J | DFI | 208 | J | DFI | 457 | J | DFI | 1130 | J | DFI |

| PROJ_NO: 00811 | NSAMPLE | TRP1-SD-002A-0406 | | | TRP1-SD-002B-0001 | | | TRP1-SD-003A-0204 | | | TRP1-SD-003B-0001 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SDG: G2054 | LAB_ID | G2054-15A | | | G2054-12A | | | G2054-18A | | | G2054-16A | | |
| FRACTION: M | SAMP_DATE | 11/7/2008 | | | 11/7/2008 | | | 11/7/2008 | | | 11/7/2008 | | |
| MEDIA: SOIL | QC_TYPE | NM | | | NM | | | NM | | | NM | | |
| | UNITS | MG/KG | | | MG/KG | | | MG/KG | | | MG/KG | | |
| | PCT_SOLIDS | 47.0 | | | 42.0 | | | 63.0 | | | 44.0 | | |
| | DUP_OF | | | | | | | | | | | | |
| PARAMETER | | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD |
| ARSENIC | | 9.9 | J | F | 16.4 | J | F | 5.1 | J | F | 15 | J | F |
| CADMIUM | | 3.3 | J | FI | 0.6 | J | FI | 0.73 | J | FI | 0.65 | J | FI |
| CHROMIUM | | 110 | J | I | 68.7 | J | I | 61.7 | J | I | 62.2 | J | I |
| COPPER | | 197 | J | DF | 205 | J | DF | 62.1 | J | DF | 106 | J | DF |
| LEAD | | 501 | J | FI | 144 | J | FI | 95.4 | J | FI | 97.9 | J | FI |
| MERCURY | | 1.3 | J | F | 0.34 | J | F | 0.61 | J | F | 0.36 | J | F |
| NICKEL | | 32.5 | J | FI | 31.6 | J | FI | 12.7 | J | FI | 26.6 | J | FI |
| SELENIUM | | 5 | | | 5.3 | | | 2.4 | | | 4.7 | | |
| ZINC | | 601 | J | DFI | 261 | J | DFI | 221 | J | DFI | 212 | J | DFI |

| PROJ_NO: 00811 | NSAMPLE | TRP1-SD-004B-0001 | | | TRP1-SD-006A-0203 | | | TRP1-SD-006B-0001 | | | TRZ4-SD-004A-0204 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SDG: G2054 | LAB_ID | G2054-19A | | | G2054-07A | | | G2054-05A | | | G2054-10A | | |
| FRACTION: M | SAMP_DATE | 11/7/2008 | | | 11/7/2008 | | | 11/7/2008 | | | 11/7/2008 | | |
| MEDIA: SOIL | QC_TYPE | NM | | | NM | | | NM | | | NM | | |
| | UNITS | MG/KG | | | MG/KG | | | MG/KG | | | MG/KG | | |
| | PCT_SOLIDS | 37.0 | | | 44.0 | | | 38.0 | | | 80.0 | | |
| | DUP_OF | | | | | | | | | | | | |
| PARAMETER | | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD |
| ARSENIC | | 13.8 | J | F | 12.8 | J | F | 12.9 | J | F | 4.7 | J | F |
| CADMIUM | | 0.65 | J | FI | 1 | J | FI | 0.48 | J | FI | 0.47 | J | FI |
| CHROMIUM | | 71 | J | I | 60.4 | J | I | 62.7 | J | I | 52.4 | J | I |
| COPPER | | 130 | J | DF | 463 | J | DF | 80.6 | J | DF | 92.1 | J | DF |
| LEAD | | 119 | J | FI | 80.8 | J | FI | 88.4 | J | FI | 157 | J | FI |
| MERCURY | | 0.46 | J | F | 0.48 | J | F | 0.33 | J | F | 0.46 | J | F |
| NICKEL | | 27.5 | J | FI | 28.7 | J | FI | 25.8 | J | FI | 28.1 | J | FI |
| SELENIUM | | 6.5 | | | 4.5 | U | A | 5.9 | U | A | 2.6 | | |
| ZINC | | 230 | J | DFI | 341 | J | DFI | 156 | J | DFI | 273 | J | DFI |

| PROJ_NO: 00811 | NSAMPLE | TRZ4-SD-004A-0406 | | | TRZ4-SD-004B-0001 | | |
|---|---|---|---|---|---|---|---|
| SDG: G2054 | LAB_ID | G2054-11A | | | G2054-08A | | |
| FRACTION: M | SAMP_DATE | 11/7/2008 | | | 11/7/2008 | | |
| MEDIA: SOIL | QC_TYPE | NM | | | NM | | |
| | UNITS | MG/KG | | | MG/KG | | |
| | PCT_SOLIDS | 59.0 | | | 72.0 | | |
| | DUP_OF | | | | | | |
| PARAMETER | | RESULT | VQL | QLCD | RESULT | VQL | QLCD |
| ARSENIC | | 10.9 | J | F | 4.1 | J | F |
| CADMIUM | | 1.5 | J | FI | 0.19 | J | FI |
| CHROMIUM | | 85.3 | J | I | 40.2 | J | I |
| COPPER | | 165 | J | DF | 100 | J | DF |
| LEAD | | 400 | J | FI | 127 | J | FI |
| MERCURY | | 0.78 | J | F | 0.11 | J | F |
| NICKEL | | 24.7 | J | FI | 40.5 | J | FI |
| SELENIUM | | 4.7 | | | 2.6 | | |
| ZINC | | 256 | J | DFI | 359 | J | DFI |

| PROJ_NO: 00811 | NSAMPLE | TRP1-SD-001A-0002 | | | TRP1-SD-001A-0204 | | | TRP1-SD-001A-0406 | | | TRP1-SD-002A-0002 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SDG: G2054 | LAB_ID | G2054-02A | | | G2054-03C | | | G2054-04C | | | G2054-13A | | |
| FRACTION: TCLPM | SAMP_DATE | 11/6/2008 | | | 11/6/2008 | | | 11/6/2008 | | | 11/7/2008 | | |
| MEDIA: TCLP | QC_TYPE | NM | | | NM | | | NM | | | NM | | |
| | UNITS | UG/L | | | UG/L | | | UG/L | | | UG/L | | |
| | PCT_SOLIDS | | | | | | | | | | | | |
| | DUP_OF | | | | | | | | | | | | |
| PARAMETER | | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD |
| ARSENIC | | 12.6 | | | 12 | | | 16.4 | | | 17.8 | | |
| BARIUM | | 151 | | | 248 | | | 186 | | | 179 | | |
| CADMIUM | | 0.14 | U | | 0.14 | U | | 3.1 | | | 0.14 | U | |
| CHROMIUM | | 20.5 | | | 15.7 | | | 12.7 | | | 3.4 | | |
| LEAD | | 3.3 | J | IP | 6.2 | J | I | 397 | J | I | 8.4 | J | I |
| MERCURY | | 0.02 | U | A | 0.031 | U | A | 0.022 | U | A | 0.016 | U | |
| SELENIUM | | 23.4 | U | A | 36.6 | U | A | 16.5 | U | A | 26.3 | U | A |
| SILVER | | 0.59 | U | | 0.59 | U | | 0.59 | U | | 0.59 | U | |

| PROJ_NO: 00811 | NSAMPLE | TRP1-SD-002A-0204 | | | TRP1-SD-002A-0406 | | | TRP1-SD-003A-0002 | | | TRP1-SD-003A-0204 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SDG: G2054 | LAB_ID | G2054-14C | | | G2054-15C | | | G2054-17A | | | G2054-18C | | |
| FRACTION: TCLPM | SAMP_DATE | 11/7/2008 | | | 11/7/2008 | | | 11/7/2008 | | | 11/7/2008 | | |
| MEDIA: TCLP | QC_TYPE | NM | | | NM | | | NM | | | NM | | |
| | UNITS | UG/L | | | UG/L | | | UG/L | | | UG/L | | |
| | PCT_SOLIDS | | | | | | | | | | | | |
| | DUP_OF | | | | | | | | | | | | |
| PARAMETER | | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD |
| ARSENIC | | 15.8 | | | 10.7 | | | 14.3 | | | 12.8 | | |
| BARIUM | | 129 | | | 414 | | | 189 | | | 168 | | |
| CADMIUM | | 0.14 | U | | 0.14 | U | | 0.14 | U | | 2.7 | | |
| CHROMIUM | | 6.4 | | | 18.6 | | | 3.3 | | | 5 | | |
| LEAD | | 3.4 | J | IP | 14.6 | J | I | 20.1 | J | I | 484 | J | I |
| MERCURY | | 0.016 | U | | 0.016 | U | | 0.044 | U | A | 0.016 | U | |
| SELENIUM | | 27.5 | U | A | 28.8 | U | A | 23.8 | U | A | 15.6 | U | A |
| SILVER | | 0.59 | U | | 0.59 | U | | 0.59 | U | | 0.59 | U | |

| PROJ_NO: 00811 | NSAMPLE | TRP1-SD-004A-0002 | | | TRP1-SD-006A-0002 | | | TRP1-SD-006A-0203 | | | TRZ4-SD-004A-0002 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SDG: G2054 | LAB_ID | G2054-20A | | | G2054-06A | | | G2054-07C | | | G2054-09A | | |
| FRACTION: TCLPM | SAMP_DATE | 11/7/2008 | | | 11/7/2008 | | | 11/7/2008 | | | 11/7/2008 | | |
| MEDIA: TCLP | QC_TYPE | NM | | | NM | | | NM | | | NM | | |
| | UNITS | UG/L | | | UG/L | | | UG/L | | | UG/L | | |
| | PCT_SOLIDS | | | | | | | | | | | | |
| | DUP_OF | | | | | | | | | | | | |
| PARAMETER | | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD |
| ARSENIC | | 16.3 | | | 14.5 | | | 25 | | | 14.8 | | |
| BARIUM | | 64.9 | | | 105 | | | 131 | | | 69.5 | | |
| CADMIUM | | 0.14 | U | | 0.14 | U | | 0.14 | U | | 2.5 | | |
| CHROMIUM | | 1.3 | J | P | 5.6 | | | 1.1 | J | P | 4.4 | | |
| LEAD | | 2.2 | UJ | I | 2.2 | UJ | I | 3.6 | J | IP | 539 | J | I |
| MERCURY | | 0.016 | U | | 0.016 | U | | 0.038 | U | A | 0.026 | U | A |
| SELENIUM | | 24.3 | U | A | 28.5 | U | A | 29.7 | U | A | 23.4 | U | A |
| SILVER | | 0.59 | U | | 0.59 | U | | 0.59 | U | | 0.59 | U | |

| PROJ_NO: 00811 | NSAMPLE | TRZ4-SD-004A-0204 | | | TRZ4-SD-004A-0406 | | |
|---|---|---|---|---|---|---|---|
| SDG: G2054 | LAB_ID | G2054-10C | | | G2054-11C | | |
| FRACTION: TCLPM | SAMP_DATE | 11/7/2008 | | | 11/7/2008 | | |
| MEDIA: TCLP | QC_TYPE | NM | | | NM | | |
| | UNITS | UG/L | | | UG/L | | |
| | PCT_SOLIDS | | | | | | |
| | DUP_OF | | | | | | |
| PARAMETER | | RESULT | VQL | QLCD | RESULT | VQL | QLCD |
| ARSENIC | | 15 | | | 16.1 | | |
| BARIUM | | 283 | | | 326 | | |
| CADMIUM | | 1.6 | | | 0.85 | U | A |
| CHROMIUM | | 5.1 | | | 5.1 | | |
| LEAD | | 376 | J | I | 173 | J | I |
| MERCURY | | 0.016 | U | | 0.033 | U | A |
| SELENIUM | | 21.2 | U | A | 17.8 | U | A |
| SILVER | | 0.59 | U | | 0.59 | U | |

# PROJ_NO: 00811

SDG: G2054 MEDIA: SOIL DATA FRACTION: MISC

| | |
|---|---|
| nsample | TRP1-SD-001A-0002 |
| samp_date | 11/6/2008 |
| lab_id | G2054-02A |
| qc_type | NM |
| Pct_Solids | 46.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| PH | S.U. | 9 | | |
| SALINITY | PSU | 0.6 | | |

| | |
|---|---|
| nsample | TRP1-SD-001A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2054-03A |
| qc_type | NM |
| Pct_Solids | 44.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| PH | S.U. | 8.4 | | |
| SALINITY | PSU | 0.6 | | |
| TOTAL ORGANIC CARBON | % | 3.2 | | |

| | |
|---|---|
| nsample | TRP1-SD-001A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2054-04A |
| qc_type | NM |
| Pct_Solids | 53.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| PH | S.U. | 8.4 | | |
| SALINITY | PSU | 0.5 | U | |
| TOTAL ORGANIC CARBON | % | 3.1 | | |

# PROJ_NO: 00811

SDG: G2054 MEDIA: SOIL DATA FRACTION: MISC

| | |
|---|---|
| nsample | TRP1-SD-001B-0001 |
| samp_date | 11/6/2008 |
| lab_id | G2054-01A |
| qc_type | NM |
| Pct_Solids | 46.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| TOTAL ORGANIC CARBON | % | 3 | | |

| | |
|---|---|
| nsample | TRP1-SD-002A-0002 |
| samp_date | 11/7/2008 |
| lab_id | G2054-13A |
| qc_type | NM |
| Pct_Solids | 39.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| PH | S.U. | 8.4 | | |
| SALINITY | PSU | 0.7 | | |

| | |
|---|---|
| nsample | TRP1-SD-002A-0204 |
| samp_date | 11/7/2008 |
| lab_id | G2054-14A |
| qc_type | NM |
| Pct_Solids | 47.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| PH | S.U. | 8.5 | | |
| SALINITY | PSU | 0.5 | | |
| TOTAL ORGANIC CARBON | % | 3.4 | | |

# PROJ_NO: 00811

SDG: G2054 MEDIA: SOIL DATA FRACTION: MISC

| | |
|---|---|
| nsample | TRP1-SD-002A-0406 |
| samp_date | 11/7/2008 |
| lab_id | G2054-15A |
| qc_type | NM |
| Pct_Solids | 47.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| PH | S.U. | 8.5 | | |
| SALINITY | PSU | 0.5 | | |
| TOTAL ORGANIC CARBON | % | 3.5 | | |

| | |
|---|---|
| nsample | TRP1-SD-002B-0001 |
| samp_date | 11/7/2008 |
| lab_id | G2054-12A |
| qc_type | NM |
| Pct_Solids | 42.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| TOTAL ORGANIC CARBON | % | 3.9 | | |

| | |
|---|---|
| nsample | TRP1-SD-003A-0002 |
| samp_date | 11/7/2008 |
| lab_id | G2054-17A |
| qc_type | NM |
| Pct_Solids | 53.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| PH | S.U. | 8 | | |
| SALINITY | PSU | 0.5 | | |

# PROJ_NO: 00811

SDG: G2054 MEDIA: SOIL DATA FRACTION: MISC

| | |
|---|---|
| nsample | TRP1-SD-003A-0204 |
| samp_date | 11/7/2008 |
| lab_id | G2054-18A |
| qc_type | NM |
| Pct_Solids | 63.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| PH | S.U. | 7.9 | | |
| SALINITY | PSU | 0.5 | U | |
| TOTAL ORGANIC CARBON | % | 2.3 | | |

| | |
|---|---|
| nsample | TRP1-SD-003B-0001 |
| samp_date | 11/7/2008 |
| lab_id | G2054-16A |
| qc_type | NM |
| Pct_Solids | 44.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| TOTAL ORGANIC CARBON | % | 3.6 | | |

| | |
|---|---|
| nsample | TRP1-SD-004A-0002 |
| samp_date | 11/7/2008 |
| lab_id | G2054-20A |
| qc_type | NM |
| Pct_Solids | 36.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| PH | S.U. | 8.4 | | |
| SALINITY | PSU | 0.7 | | |

# PROJ_NO: 00811

SDG: G2054 MEDIA: SOIL DATA FRACTION: MISC

| | |
|---|---|
| nsample | TRP1-SD-004B-0001 |
| samp_date | 11/7/2008 |
| lab_id | G2054-19A |
| qc_type | NM |
| Pct_Solids | 37.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| TOTAL ORGANIC CARBON | % | 3.9 | | |

| | |
|---|---|
| nsample | TRP1-SD-006A-0002 |
| samp_date | 11/7/2008 |
| lab_id | G2054-06A |
| qc_type | NM |
| Pct_Solids | 37.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| PH | S.U. | 8.4 | | |
| SALINITY | PSU | 0.8 | | |

| | |
|---|---|
| nsample | TRP1-SD-006A-0203 |
| samp_date | 11/7/2008 |
| lab_id | G2054-07A |
| qc_type | NM |
| Pct_Solids | 44.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| PH | S.U. | 8.5 | | |
| SALINITY | PSU | 0.7 | | |
| TOTAL ORGANIC CARBON | % | 3.7 | | |

# PROJ_NO: 00811

SDG: G2054 MEDIA: SOIL DATA FRACTION: MISC

| | |
|---|---|
| nsample | TRP1-SD-006B-0001 |
| samp_date | 11/7/2008 |
| lab_id | G2054-05A |
| qc_type | NM |
| Pct_Solids | 38.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| TOTAL ORGANIC CARBON | % | 4 | | |

| | |
|---|---|
| nsample | TRZ4-SD-004A-0002 |
| samp_date | 11/7/2008 |
| lab_id | G2054-09A |
| qc_type | NM |
| Pct_Solids | 79.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| PH | S.U. | 8.1 | | |
| SALINITY | PSU | 0.5 | U | |

| | |
|---|---|
| nsample | TRZ4-SD-004A-0204 |
| samp_date | 11/7/2008 |
| lab_id | G2054-10A |
| qc_type | NM |
| Pct_Solids | 80.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| PH | S.U. | 8.2 | | |
| SALINITY | PSU | 0.5 | U | |
| TOTAL ORGANIC CARBON | % | 1.6 | | |

# PROJ_NO: 00811

SDG: G2054 MEDIA: SOIL DATA FRACTION: MISC

| | |
|---|---|
| nsample | TRZ4-SD-004A-0406 |
| samp_date | 11/7/2008 |
| lab_id | G2054-11A |
| qc_type | NM |
| Pct_Solids | 59.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| PH | S.U. | 8.5 | | |
| SALINITY | PSU | 0.5 | U | |
| TOTAL ORGANIC CARBON | % | 3.4 | | |

| | |
|---|---|
| nsample | TRZ4-SD-004B-0001 |
| samp_date | 11/7/2008 |
| lab_id | G2054-08A |
| qc_type | NM |
| Pct_Solids | 72.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| TOTAL ORGANIC CARBON | % | 2 | | |

**Tetra Tech NUS** **INTERNAL CORRESPONDENCE**

| | | | |
|---|---|---|---|
| **TO:** | C. RICH | **DATE:** | **DECEMBER 31, 2008** |
| **FROM:** | **TERRI L. SOLOMON** | **COPIES:** | **DV FILE** |

**SUBJECT:** **INORGANIC DATA VALIDATION – SELECT METALS, TCLP METALS pH, TOTAL ORGANIC CARBON, SALINITY**
**CTO – 424 NSB NEW LONDON**
**SAMPLE DELIVERY GROUP (SDG) – G2049**

**SAMPLES:** 24/Sediments/

| | | |
|---|---|---|
| TRZ4-SD-002B-0001 | TRZ4-SD-002A-0002 | TRZ4-SD-002A-0204 |
| TRZ4-SD-002A-0406 | TR24-SD-005B-0001 | TRZ4-SD-005A-0002 |
| TRZ4-SD-005A-0204 | TRZ4-SD-005A-0406 | TRZ4-SD-007B-0001 |
| TRZ4-SD-007A-0002 | TRZ4-SD-007A-0204 | TRZ4-SD-007A-0406 |
| TRZ4-SD-006B-0001 | TRZ4-SD-006A-0002 | TRZ4-SD-006A-0204 |
| TRZ4-SD-006A-0406 | TRZ4-SD-003B-0001 | TRZ4-SD-003A-0002 |
| TRZ4-SD-003A-0204 | TRZ4-SD-003A-0406 | TRZ4-SD-008B-0001 |
| TRZ4-SD-008A-0002 | TRZ4-SD-008A-0204 | TRZ4-SD-008A-0406 |

Overview

The sample set for NSB New London, CTO 424, SDG G2049 consists of twenty-four (24) sediment environmental samples. No field duplicate pairs were included within this SDG.

Samples TRZ4-SD-002A-0204, TRZ4-SD-002A-0406, TRZ4-SD-005A-0204, TRZ4-SD-005A-0406, TRZ4-SD-007A-0204, TRZ4-SD-007A-0406, TRZ4-SD-006A-0204, TRZ4-SD-006A-0406, TRZ4-SD-003A-0204, TRZ4-SD-003A-0406, TRZ4-SD-008A-0204 and RZ4-SD-008A-0406 were analyzed for select metals including arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium and zinc, TCLP metals, total organic carbon, pH and salinity. Samples TRZ4-SD-002B-0001, TR24-SD-005B-0001, TRZ4-SD-007B-0001, TRZ4-SD-006B-0001, TRZ4-SD-003B-0001 and TRZ4-SD-008B-0001 were analyzed for select metals and total organic carbon. Samples TRZ4-SD-002A-0002, TRZ4-SD-005A-0002, TRZ4-SD-007A-0002, TRZ4-SD-006A-0002, TRZ4-SD-003A-0002 and TRZ4-SD-008A-0002 were analyzed for TCLP metals, pH and salinity. The samples were collected by Tetra Tech NUS on November 6, 2008 and analyzed by Mitkem Corporation under Naval Facilities Engineering Service Center (NFESC) Quality Assurance/Quality Control (QA/QC) criteria. Metals analyses were conducted using SW-846 method 6010. Mercury analyses were conducted using 7471A. Total organic carbon analyses were conducted using the Walkley Black method. Salinity analyses were conducted using Standard Method 2520 and pH analyses were conducted using SW-846 method 9045.

All samples in this SDG were validated to EPA Region I Tier III protocol.

These data were evaluated based on the following parameters:

* • Data Completeness
* • Holding Times

* • Calibration Verification Results
• Laboratory Method/Preparation Blank Analyses
* • ICP Interference Check Sample Results
• Matrix Spike Results
• Laboratory Duplicate Results
* • Laboratory Control Sample Results
* • ICP Serial Dilution Results
* • Detection Limits
* • Sample Quantitation

* - All quality control criteria were met for this parameter.

Laboratory Method/Preparation Blank Analyses

The following contaminants were detected in the laboratory method/preparation blanks at the following maximum concentrations:

| Analyte | Maximum Concentration | Action Level |
|---|---|---|
| Cadmium(1) | 0.2 ug/L | 0.05 mg/kg |
| Chromium(2) | 0.062 mg/kg | 0.31 mg/kg |
| Copper(2) | 1.142 mg/kg | 5.71 mg/kg |
| Mercury(3) | 0.026 ug/L | 0.13 ug/L |
| Selenium(1) | 6.9 ug/L | 1.725 mg/kg |
| Silver(4) | 7.3 ug/L | 36.5 ug/L |
| Zinc(2) | 0.765 mg/kg | 3.825 mg/kg |

(1) Maximum concentration present affecting the soil analyses.
(2) Maximum concentration present in a preparation blank affecting the soil analyses.
(3) Maximum concentration present in a preparation blank affecting the TCLP analyses.
(4) Maximum concentration present affecting the TCLP analyses.

An action level of 5X the maximum contaminant level has been used to evaluate sample data for blank contamination. Sample aliquot and dilution factors, if applicable, were taken into consideration when evaluating for blank contamination. Positive results less than the blank action level for mercury and silver were qualified "U" as a result of laboratory blank contamination.

Matrix Spike Results

The matrix spike percent recoveries for copper, lead and zinc were > 125% quality control limit affecting the soil analyses. The positive results reported for the aforementioned analytes were qualified as estimated, "J".

The matrix spike percent recovery for total organic carbon was < 75% quality control limit. The positive results reported for total organic carbon were qualified as estimated, "J".

Laboratory Duplicate Results

Laboratory duplicate imprecision (relative percent difference > 20% or difference +/- contract required detection limit) was noted for mercury, copper, lead, nickel and zinc affecting the soil analyses. The positive results reported for the aforementioned analytes were qualified as estimated, "J".

Laboratory Control Sample Results

The laboratory control sample percent recovery for cadmium was > 120% quality control limit affecting the TCLP analyses. The positive results reported for cadmium were qualified as estimated, "J".

Notes

Positive results reported for cadmium, lead and selenium that were < 2X the instrument detection limit (IDL) were qualified as estimated, "J", as a result of uncertainty near the detection limit.

The laboratory did not analyze a contract required detection limit sample (CRDL). Therefore, validation compliances could not be evaluated.

Executive Summary

**Laboratory Performance:** Several analytes were present in the laboratory method / preparation blanks. Laboratory duplicate imprecision was noted for mercury, copper, nickel and zinc affecting the soil analyses. The laboratory control sample percent recovery for cadmium was > 120% quality control limit affecting the TCLP analyses.

**Other Factors Affecting Data Quality:** The matrix spike percent recoveries for copper, lead, zinc and total organic carbon were outside the 75-125% quality control limits. Positive results reported for cadmium, lead and selenium were < 2X the IDL.

The data for these analyses were reviewed with reference to the EPA Region I, " National Functional Guidelines for Inorganic Review", February 1989 and the Department of Defense (DoD) document entitled "Quality Systems Manual (QSM) for Environmental Laboratories", January 2006.

The text of this report has been formulated to address only those problem areas affecting data quality.

"I attest that the data referenced herein were validated according to the agreed upon validation criteria as specified in the DOD QSM."

Terri L. Solomon

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Terri L. Solomon
Environmental Scientist

Edward Seellmyer / for

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Attachments:
1. Appendix A - Qualified Analytical Results
2. Appendix B - Results as reported by the Laboratory
3. Appendix C – Regional Worksheets
4. Appendix D – Support Documentation

# APPENDIX A
# QUALIFIED ANALYTICAL RESULTS

**Data Validation Qualifier Codes:**

A = Lab Blank Contamination
B = Field Blank Contamination
C = Calibration Noncompliance (e.g. % RSDs, %Ds, ICVs, CCVs, RRFs, etc.)
C01 = GC/MS Tuning Noncompliance
D = MS/MSD Recovery Noncompliance
E = LCS/LCSD Recovery Noncompliance
F = Lab Duplicate Imprecision
G = Field Duplicate Imprecision
H = Holding Time Exceedance
I = ICP Serial Dilution Noncompliance
J = GFAA PDS-GFAA MSA's r < 0.995 / ICP PDS Recovery Noncompliance
K = ICP Interference - includes ICS % R Noncompliance
L = Instrument Calibration Range Exceedance
M = Sample Preservation Noncompliance
N = Internal Standard Noncompliance
N01 = Internal Standard Recovery Noncompliance Dioxins
N02 = Recovery Standard Noncompliance Dioxins
N03 = Clean-up Standard Noncompliance Dioxins
O - Poor Instrument Performance (e.g. base-line drifting)
P = Uncertainty near detection limit (< 2 x IDL for inorganics and <CRQL for organics)
Q = Other problems (can encompass a number of issues; e.g. chromatography,interferences, etc.)
R = Surrogates Recovery Noncompliance
S = Pesticide/PCB Resolution
T = % Breakdown Noncompliance for DOT and Endrin
U = % Difference between columns/detectors >25% for positive results determined via GC/HPLC
V = Non-linear calibrations; correlation coefficient r < 0.995
W = EMPC result
X = Signal to noise response drop
Y = Percent solids <30%
Z = Uncertainty at 2 sigma deviation is greater than sample activity

# PROJ_NO: 00811

SDG: G2049 MEDIA: SOIL DATA FRACTION: M

| | |
|---|---|
| nsample | TRZ4-SD-002A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2049-03A |
| qc_type | NM |
| units | MG/KG |
| Pct_Solids | 48.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ARSENIC | 15.7 | | |
| CADMIUM | 1.4 | | |
| CHROMIUM | 86.3 | | |
| COPPER | 162 | J | DF |
| LEAD | 178 | J | DF |
| MERCURY | 0.86 | J | F |
| NICKEL | 29.7 | J | F |
| SELENIUM | 5.5 | | |
| ZINC | 323 | J | DF |

| | |
|---|---|
| nsample | TRZ4-SD-002A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2049-04A |
| qc_type | NM |
| units | MG/KG |
| Pct_Solids | 46.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ARSENIC | 12.3 | | |
| CADMIUM | 2.4 | | |
| CHROMIUM | 128 | | |
| COPPER | 171 | J | DF |
| LEAD | 187 | J | DF |
| MERCURY | 0.95 | J | F |
| NICKEL | 30.1 | J | F |
| SELENIUM | 6.1 | | |
| ZINC | 292 | J | DF |

| | |
|---|---|
| nsample | TRZ4-SD-002B-0001 |
| samp_date | 11/6/2008 |
| lab_id | G2049-01A |
| qc_type | NM |
| units | MG/KG |
| Pct_Solids | 49.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ARSENIC | 11.1 | | |
| CADMIUM | 0.9 | | |
| CHROMIUM | 81.7 | | |
| COPPER | 183 | J | DF |
| LEAD | 223 | J | DF |
| MERCURY | 0.46 | J | F |
| NICKEL | 41.5 | J | F |
| SELENIUM | 5 | | |
| ZINC | 523 | J | DF |

# PROJ_NO: 00811

SDG: G2049 MEDIA: SOIL DATA FRACTION: M

| | |
|---|---|
| nsample | TRZ4-SD-003A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2049-19A |
| qc_type | NM |
| units | MG/KG |
| Pct_Solids | 38.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ARSENIC | 17.2 | | |
| CADMIUM | 0.83 | | |
| CHROMIUM | 85.1 | | |
| COPPER | 132 | J | DF |
| LEAD | 162 | J | DF |
| MERCURY | 0.66 | J | F |
| NICKEL | 30.8 | J | F |
| SELENIUM | 6.2 | | |
| ZINC | 242 | J | DF |

| | |
|---|---|
| nsample | TRZ4-SD-003A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2049-20A |
| qc_type | NM |
| units | MG/KG |
| Pct_Solids | 58.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ARSENIC | 6.6 | | |
| CADMIUM | 0.62 | | |
| CHROMIUM | 76.9 | | |
| COPPER | 174 | J | DF |
| LEAD | 206 | J | DF |
| MERCURY | 0.34 | J | F |
| NICKEL | 58.1 | J | F |
| SELENIUM | 4 | | |
| ZINC | 665 | J | DF |

| | |
|---|---|
| nsample | TRZ4-SD-003B-0001 |
| samp_date | 11/6/2008 |
| lab_id | G2049-17A |
| qc_type | NM |
| units | MG/KG |
| Pct_Solids | 44.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ARSENIC | 13.4 | | |
| CADMIUM | 0.61 | | |
| CHROMIUM | 66.5 | | |
| COPPER | 109 | J | DF |
| LEAD | 108 | J | DF |
| MERCURY | 0.35 | J | F |
| NICKEL | 25.2 | J | F |
| SELENIUM | 5 | | |
| ZINC | 239 | J | DF |

# PROJ_NO: 00811

SDG: G2049 MEDIA: SOIL DATA FRACTION: M

| | |
|---|---|
| nsample | TRZ4-SD-005A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2049-07A |
| qc_type | NM |
| units | MG/KG |
| Pct_Solids | 42.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ARSENIC | 16.1 | | |
| CADMIUM | 1.1 | | |
| CHROMIUM | 115 | | |
| COPPER | 348 | J | DF |
| LEAD | 248 | J | DF |
| MERCURY | 0.67 | J | F |
| NICKEL | 61.1 | J | F |
| SELENIUM | 6.7 | | |
| ZINC | 730 | J | DF |

| | |
|---|---|
| nsample | TRZ4-SD-005A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2049-08A |
| qc_type | NM |
| units | MG/KG |
| Pct_Solids | 43.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ARSENIC | 13.2 | | |
| CADMIUM | 1.9 | | |
| CHROMIUM | 109 | | |
| COPPER | 212 | J | DF |
| LEAD | 288 | J | DF |
| MERCURY | 0.83 | J | F |
| NICKEL | 34.8 | J | F |
| SELENIUM | 5.7 | | |
| ZINC | 367 | J | DF |

| | |
|---|---|
| nsample | TRZ4-SD-005B-0001 |
| samp_date | 11/6/2008 |
| lab_id | G2049-05A |
| qc_type | NM |
| units | MG/KG |
| Pct_Solids | 38.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ARSENIC | 17.1 | | |
| CADMIUM | 0.81 | | |
| CHROMIUM | 81 | | |
| COPPER | 144 | J | DF |
| LEAD | 158 | J | DF |
| MERCURY | 0.59 | J | F |
| NICKEL | 30 | J | F |
| SELENIUM | 6.7 | | |
| ZINC | 240 | J | DF |

# PROJ_NO: 00811

SDG: G2049 MEDIA: SOIL DATA FRACTION: M

| | |
|---|---|
| nsample | TRZ4-SD-006A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2049-15A |
| qc_type | NM |
| units | MG/KG |
| Pct_Solids | 36.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ARSENIC | 16.8 | | |
| CADMIUM | 2.6 | | |
| CHROMIUM | 134 | | |
| COPPER | 202 | J | DF |
| LEAD | 197 | J | DF |
| MERCURY | 0.72 | J | F |
| NICKEL | 46.9 | J | F |
| SELENIUM | 6.7 | | |
| ZINC | 353 | J | DF |

| | |
|---|---|
| nsample | TRZ4-SD-006A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2049-16A |
| qc_type | NM |
| units | MG/KG |
| Pct_Solids | 61.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ARSENIC | 8.1 | | |
| CADMIUM | 1.3 | | |
| CHROMIUM | 72.9 | | |
| COPPER | 113 | J | DF |
| LEAD | 147 | J | DF |
| MERCURY | 0.42 | J | F |
| NICKEL | 20.8 | J | F |
| SELENIUM | 3.8 | | |
| ZINC | 209 | J | DF |

| | |
|---|---|
| nsample | TRZ4-SD-006B-0001 |
| samp_date | 11/6/2008 |
| lab_id | G2049-13A |
| qc_type | NM |
| units | MG/KG |
| Pct_Solids | 33.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ARSENIC | 13.9 | | |
| CADMIUM | 0.61 | | |
| CHROMIUM | 69.7 | | |
| COPPER | 104 | J | DF |
| LEAD | 101 | J | DF |
| MERCURY | 0.45 | J | F |
| NICKEL | 26.9 | J | F |
| SELENIUM | 6.3 | | |
| ZINC | 185 | J | DF |

# PROJ_NO: 00811

SDG: G2049 MEDIA: SOIL DATA FRACTION: M

| | |
|---|---|
| nsample | TRZ4-SD-007A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2049-11A |
| qc_type | NM |
| units | MG/KG |
| Pct_Solids | 48.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ARSENIC | 9.3 | | |
| CADMIUM | 0.25 | | |
| CHROMIUM | 38.1 | | |
| COPPER | 27.1 | J | DF |
| LEAD | 21.2 | J | DF |
| MERCURY | 0.042 | J | F |
| NICKEL | 20.9 | J | F |
| SELENIUM | 4.3 | | |
| ZINC | 68.9 | J | DF |

| | |
|---|---|
| nsample | TRZ4-SD-007A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2049-12A |
| qc_type | NM |
| units | MG/KG |
| Pct_Solids | 49.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ARSENIC | 8.6 | | |
| CADMIUM | 0.25 | | |
| CHROMIUM | 36.8 | | |
| COPPER | 14.5 | J | DF |
| LEAD | 7.6 | J | DF |
| MERCURY | 0.013 | U | |
| NICKEL | 21.3 | J | F |
| SELENIUM | 5.5 | | |
| ZINC | 52.4 | J | DF |

| | |
|---|---|
| nsample | TRZ4-SD-007B-0001 |
| samp_date | 11/6/2008 |
| lab_id | G2049-09A |
| qc_type | NM |
| units | MG/KG |
| Pct_Solids | 35.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ARSENIC | 16.4 | | |
| CADMIUM | 0.81 | | |
| CHROMIUM | 91.5 | | |
| COPPER | 165 | J | DF |
| LEAD | 148 | J | DF |
| MERCURY | 0.58 | J | F |
| NICKEL | 35 | J | F |
| SELENIUM | 6.5 | | |
| ZINC | 224 | J | DF |

# PROJ_NO: 00811

SDG: G2049 MEDIA: SOIL DATA FRACTION: M

| | |
|---|---|
| nsample | TRZ4-SD-008A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2049-23A |
| qc_type | NM |
| units | MG/KG |
| Pct_Solids | 37.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ARSENIC | 15.3 | | |
| CADMIUM | 0.99 | | |
| CHROMIUM | 86.1 | | |
| COPPER | 141 | J | DF |
| LEAD | 122 | J | DF |
| MERCURY | 0.52 | J | F |
| NICKEL | 36.5 | J | F |
| SELENIUM | 6.6 | | |
| ZINC | 211 | J | DF |

| | |
|---|---|
| nsample | TRZ4-SD-008A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2049-24A |
| qc_type | NM |
| units | MG/KG |
| Pct_Solids | 37.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ARSENIC | 17 | | |
| CADMIUM | 1.4 | | |
| CHROMIUM | 100 | | |
| COPPER | 166 | J | DF |
| LEAD | 148 | J | DF |
| MERCURY | 0.64 | J | F |
| NICKEL | 39.7 | J | F |
| SELENIUM | 5.7 | | |
| ZINC | 260 | J | DF |

| | |
|---|---|
| nsample | TRZ4-SD-008B-0001 |
| samp_date | 11/6/2008 |
| lab_id | G2049-21A |
| qc_type | NM |
| units | MG/KG |
| Pct_Solids | 34.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ARSENIC | 14.3 | | |
| CADMIUM | 0.7 | | |
| CHROMIUM | 76.9 | | |
| COPPER | 118 | J | DF |
| LEAD | 105 | J | DF |
| MERCURY | 0.43 | J | F |
| NICKEL | 29 | J | F |
| SELENIUM | 6.3 | | |
| ZINC | 206 | J | DF |

# PROJ_NO: 00811

SDG: G2049 MEDIA: TCLP DATA FRACTION: TCLPM

| | |
|---|---|
| nsample | TRZ4-SD-002A-0002 |
| samp_date | 11/6/2008 |
| lab_id | G2049-02A |
| qc_type | NM |
| units | UG/L |
| Pct_Solids | |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ARSENIC | 15.9 | | |
| BARIUM | 159 | | |
| CADMIUM | 0.14 | U | |
| CHROMIUM | 4.5 | | |
| LEAD | 2.2 | U | |
| MERCURY | 0.041 | U | A |
| SELENIUM | 22.2 | | |
| SILVER | 0.59 | U | |

| | |
|---|---|
| nsample | TRZ4-SD-002A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2049-03C |
| qc_type | NM |
| units | UG/L |
| Pct_Solids | |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ARSENIC | 14.4 | | |
| BARIUM | 372 | | |
| CADMIUM | 0.14 | U | |
| CHROMIUM | 13 | | |
| LEAD | 4.4 | | |
| MERCURY | 0.087 | U | A |
| SELENIUM | 8.2 | J | P |
| SILVER | 0.59 | U | |

| | |
|---|---|
| nsample | TRZ4-SD-002A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2049-04C |
| qc_type | NM |
| units | UG/L |
| Pct_Solids | |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ARSENIC | 19.4 | | |
| BARIUM | 319 | | |
| CADMIUM | 0.14 | U | |
| CHROMIUM | 23.5 | | |
| LEAD | 6 | | |
| MERCURY | 0.016 | U | A |
| SELENIUM | 6.6 | U | |
| SILVER | 0.59 | U | |

# PROJ_NO: 00811

SDG: G2049 MEDIA: TCLP DATA FRACTION: TCLPM

| | |
|---|---|
| nsample | TRZ4-SD-003A-0002 |
| samp_date | 11/6/2008 |
| lab_id | G2049-18A |
| qc_type | NM |
| units | UG/L |
| Pct_Solids | |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ARSENIC | 12.5 | | |
| BARIUM | 71.9 | | |
| CADMIUM | 0.14 | U | |
| CHROMIUM | 7.9 | | |
| LEAD | 7.1 | | |
| MERCURY | 0.044 | U | A |
| SELENIUM | 6.6 | U | |
| SILVER | 0.59 | U | |

| | |
|---|---|
| nsample | TRZ4-SD-003A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2049-19C |
| qc_type | NM |
| units | UG/L |
| Pct_Solids | |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ARSENIC | 29 | | |
| BARIUM | 90.3 | | |
| CADMIUM | 0.14 | U | |
| CHROMIUM | 5.6 | | |
| LEAD | 8.9 | | |
| MERCURY | 0.02 | U | |
| SELENIUM | 7.4 | J | P |
| SILVER | 0.59 | U | |

| | |
|---|---|
| nsample | TRZ4-SD-003A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2049-20C |
| qc_type | NM |
| units | UG/L |
| Pct_Solids | |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ARSENIC | 20.5 | | |
| BARIUM | 172 | | |
| CADMIUM | 0.14 | U | |
| CHROMIUM | 5.3 | | |
| LEAD | 4.8 | | |
| MERCURY | 0.057 | U | A |
| SELENIUM | 7.1 | J | P |
| SILVER | 0.59 | U | |

# PROJ_NO: 00811

SDG: G2049 MEDIA: TCLP DATA FRACTION: TCLPM

| | |
|---|---|
| nsample | TRZ4-SD-005A-0002 |
| samp_date | 11/6/2008 |
| lab_id | G2049-06A |
| qc_type | NM |
| units | UG/L |
| Pct_Solids | |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ARSENIC | 12.8 | | |
| BARIUM | 159 | | |
| CADMIUM | 0.14 | U | |
| CHROMIUM | 7.5 | | |
| LEAD | 2.2 | U | |
| MERCURY | 0.032 | U | A |
| SELENIUM | 9.1 | J | P |
| SILVER | 0.59 | U | |

| | |
|---|---|
| nsample | TRZ4-SD-005A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2049-07C |
| qc_type | NM |
| units | UG/L |
| Pct_Solids | |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ARSENIC | 17.5 | | |
| BARIUM | 92.6 | | |
| CADMIUM | 0.14 | U | |
| CHROMIUM | 3.5 | | |
| LEAD | 2.2 | U | |
| MERCURY | 0.018 | U | A |
| SELENIUM | 14.8 | | |
| SILVER | 0.59 | U | |

| | |
|---|---|
| nsample | TRZ4-SD-005A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2049-08C |
| qc_type | NM |
| units | UG/L |
| Pct_Solids | |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ARSENIC | 19.9 | | |
| BARIUM | 227 | | |
| CADMIUM | 0.32 | J | EP |
| CHROMIUM | 4.5 | | |
| LEAD | 140 | | |
| MERCURY | 0.019 | U | A |
| SELENIUM | 6.6 | U | |
| SILVER | 0.59 | U | |

# PROJ_NO: 00811

SDG: G2049 MEDIA: TCLP DATA FRACTION: TCLPM

| | |
|---|---|
| nsample | TRZ4-SD-006A-0002 |
| samp_date | 11/6/2008 |
| lab_id | G2049-14A |
| qc_type | NM |
| units | UG/L |
| Pct_Solids | |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ARSENIC | 14 | | |
| BARIUM | 143 | | |
| CADMIUM | 0.14 | U | |
| CHROMIUM | 15.4 | | |
| LEAD | 3.9 | J | P |
| MERCURY | 0.016 | U | A |
| SELENIUM | 6.6 | U | |
| SILVER | 0.59 | U | |

| | |
|---|---|
| nsample | TRZ4-SD-006A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2049-15C |
| qc_type | NM |
| units | UG/L |
| Pct_Solids | |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ARSENIC | 46 | | |
| BARIUM | 201 | | |
| CADMIUM | 0.14 | U | |
| CHROMIUM | 11 | | |
| LEAD | 24.6 | | |
| MERCURY | 0.023 | U | A |
| SELENIUM | 6.6 | U | |
| SILVER | 0.59 | U | |

| | |
|---|---|
| nsample | TRZ4-SD-006A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2049-16C |
| qc_type | NM |
| units | UG/L |
| Pct_Solids | |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ARSENIC | 15.5 | | |
| BARIUM | 174 | | |
| CADMIUM | 0.48 | J | EP |
| CHROMIUM | 5.9 | | |
| LEAD | 117 | | |
| MERCURY | 0.025 | U | A |
| SELENIUM | 6.8 | J | P |
| SILVER | 0.59 | U | |

# PROJ_NO: 00811

SDG: G2049 MEDIA: TCLP DATA FRACTION: TCLPM

| | |
|---|---|
| nsample | TRZ4-SD-007A-0002 |
| samp_date | 11/6/2008 |
| lab_id | G2049-10A |
| qc_type | NM |
| units | UG/L |
| Pct_Solids | |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ARSENIC | 25.4 | | |
| BARIUM | 86.8 | | |
| CADMIUM | 0.14 | U | |
| CHROMIUM | 8.8 | | |
| LEAD | 3.9 | J | P |
| MERCURY | 0.024 | U | A |
| SELENIUM | 6.6 | U | |
| SILVER | 0.59 | U | |

| | |
|---|---|
| nsample | TRZ4-SD-007A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2049-11C |
| qc_type | NM |
| units | UG/L |
| Pct_Solids | |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ARSENIC | 16 | | |
| BARIUM | 70.3 | | |
| CADMIUM | 0.14 | U | |
| CHROMIUM | 1.9 | | |
| LEAD | 10.4 | | |
| MERCURY | 0.019 | U | A |
| SELENIUM | 8.6 | J | P |
| SILVER | 0.59 | U | |

| | |
|---|---|
| nsample | TRZ4-SD-007A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2049-12C |
| qc_type | NM |
| units | UG/L |
| Pct_Solids | |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ARSENIC | 14 | | |
| BARIUM | 28.9 | | |
| CADMIUM | 0.14 | U | |
| CHROMIUM | 2.3 | | |
| LEAD | 2.2 | U | |
| MERCURY | 0.016 | U | |
| SELENIUM | 7.5 | J | P |
| SILVER | 0.59 | U | |

# PROJ_NO: 00811

SDG: G2049 MEDIA: TCLP DATA FRACTION: TCLPM

| | |
|---|---|
| nsample | TRZ4-SD-008A-0002 |
| samp_date | 11/6/2008 |
| lab_id | G2049-22A |
| qc_type | NM |
| units | UG/L |
| Pct_Solids | |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ARSENIC | 13.1 | | |
| BARIUM | 107 | | |
| CADMIUM | 0.14 | U | |
| CHROMIUM | 12.1 | | |
| LEAD | 2.6 | J | P |
| MERCURY | 0.05 | U | A |
| SELENIUM | 9.7 | J | P |
| SILVER | 0.59 | U | |

| | |
|---|---|
| nsample | TRZ4-SD-008A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2049-23C |
| qc_type | NM |
| units | UG/L |
| Pct_Solids | |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ARSENIC | 48 | | |
| BARIUM | 102 | | |
| CADMIUM | 0.14 | U | |
| CHROMIUM | 11.8 | | |
| LEAD | 6.5 | | |
| MERCURY | 0.019 | U | A |
| SELENIUM | 6.6 | U | |
| SILVER | 1.7 | U | A |

| | |
|---|---|
| nsample | TRZ4-SD-008A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2049-24C |
| qc_type | NM |
| units | UG/L |
| Pct_Solids | |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ARSENIC | 29.8 | | |
| BARIUM | 123 | | |
| CADMIUM | 0.14 | U | |
| CHROMIUM | 15.8 | | |
| LEAD | 4.4 | | |
| MERCURY | 0.022 | U | A |
| SELENIUM | 6.6 | U | |
| SILVER | 0.59 | U | |

# PROJ_NO: 00811

SDG: G2049 MEDIA: SOIL DATA FRACTION: MISC

| | |
|---|---|
| nsample | TRZ4-SD-002A-0002 |
| samp_date | 11/6/2008 |
| lab_id | G2049-02A |
| qc_type | NM |
| Pct_Solids | 45.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| PH | S.U. | 8.1 | | |
| SALINITY | PSU | 0.6 | | |

| | |
|---|---|
| nsample | TRZ4-SD-002A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2049-03A |
| qc_type | NM |
| Pct_Solids | 48.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| PH | S.U. | 8.4 | | |
| SALINITY | PSU | 0.5 | | |
| TOTAL ORGANIC CARBON | % | 3.8 | J | D |

| | |
|---|---|
| nsample | TRZ4-SD-002A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2049-04A |
| qc_type | NM |
| Pct_Solids | 46.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| PH | S.U. | 8.4 | | |
| SALINITY | PSU | 0.5 | | |
| TOTAL ORGANIC CARBON | % | 3.6 | J | D |

# PROJ_NO: 00811

SDG: G2049 MEDIA: SOIL DATA FRACTION: MISC

| | |
|---|---|
| nsample | TRZ4-SD-002B-0001 |
| samp_date | 11/6/2008 |
| lab_id | G2049-01A |
| qc_type | NM |
| Pct_Solids | 49.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| TOTAL ORGANIC CARBON | % | 3 | J | D |

| | |
|---|---|
| nsample | TRZ4-SD-003A-0002 |
| samp_date | 11/6/2008 |
| lab_id | G2049-18A |
| qc_type | NM |
| Pct_Solids | 38.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| PH | S.U. | 8.4 | | |
| SALINITY | PSU | 0.5 | U | |

| | |
|---|---|
| nsample | TRZ4-SD-003A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2049-19A |
| qc_type | NM |
| Pct_Solids | 38.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| PH | S.U. | 8.2 | | |
| SALINITY | PSU | 0.5 | U | |
| TOTAL ORGANIC CARBON | % | 3.6 | J | D |

# PROJ_NO: 00811

SDG: G2049 MEDIA: SOIL DATA FRACTION: MISC

| | |
|---|---|
| nsample | TRZ4-SD-003A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2049-20A |
| qc_type | NM |
| Pct_Solids | 58.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| PH | S.U. | 8.1 | | |
| SALINITY | PSU | 0.5 | U | |
| TOTAL ORGANIC CARBON | % | 1.4 | J | D |

| | |
|---|---|
| nsample | TRZ4-SD-003B-0001 |
| samp_date | 11/6/2008 |
| lab_id | G2049-17A |
| qc_type | NM |
| Pct_Solids | 44.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| TOTAL ORGANIC CARBON | % | 3.2 | J | D |

| | |
|---|---|
| nsample | TRZ4-SD-005A-0002 |
| samp_date | 11/6/2008 |
| lab_id | G2049-06A |
| qc_type | NM |
| Pct_Solids | 40.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| PH | S.U. | 8.2 | | |
| SALINITY | PSU | 0.6 | | |

# PROJ_NO: 00811

SDG: G2049 MEDIA: SOIL DATA FRACTION: MISC

| | |
|---|---|
| nsample | TRZ4-SD-005A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2049-07A |
| qc_type | NM |
| Pct_Solids | 42.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| PH | S.U. | 8.5 | | |
| SALINITY | PSU | 0.5 | U | |
| TOTAL ORGANIC CARBON | % | 4 | J | D |

| | |
|---|---|
| nsample | TRZ4-SD-005A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2049-08A |
| qc_type | NM |
| Pct_Solids | 43.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| PH | S.U. | 8.3 | | |
| SALINITY | PSU | 0.5 | U | |
| TOTAL ORGANIC CARBON | % | 4.1 | J | D |

| | |
|---|---|
| nsample | TRZ4-SD-005B-0001 |
| samp_date | 11/6/2008 |
| lab_id | G2049-05A |
| qc_type | NM |
| Pct_Solids | 38.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| TOTAL ORGANIC CARBON | % | 4.1 | J | D |

# PROJ_NO: 00811

SDG: G2049 MEDIA: SOIL DATA FRACTION: MISC

| | |
|---|---|
| nsample | TRZ4-SD-006A-0002 |
| samp_date | 11/6/2008 |
| lab_id | G2049-14A |
| qc_type | NM |
| Pct_Solids | 36.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| PH | S.U. | 8.5 | | |
| SALINITY | PSU | 0.5 | U | |

| | |
|---|---|
| nsample | TRZ4-SD-006A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2049-15A |
| qc_type | NM |
| Pct_Solids | 36.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| PH | S.U. | 8.5 | | |
| SALINITY | PSU | 0.5 | U | |
| TOTAL ORGANIC CARBON | % | 3.9 | J | D |

| | |
|---|---|
| nsample | TRZ4-SD-006A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2049-16A |
| qc_type | NM |
| Pct_Solids | 61.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| PH | S.U. | 8.5 | | |
| SALINITY | PSU | 0.5 | U | |
| TOTAL ORGANIC CARBON | % | 1.1 | J | D |

# PROJ_NO: 00811

SDG: G2049 MEDIA: SOIL DATA FRACTION: MISC

| | |
|---|---|
| nsample | TRZ4-SD-006B-0001 |
| samp_date | 11/6/2008 |
| lab_id | G2049-13A |
| qc_type | NM |
| Pct_Solids | 33.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| TOTAL ORGANIC CARBON | % | 3 | J | D |

| | |
|---|---|
| nsample | TRZ4-SD-007A-0002 |
| samp_date | 11/6/2008 |
| lab_id | G2049-10A |
| qc_type | NM |
| Pct_Solids | 36.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| PH | S.U. | 8.2 | | |
| SALINITY | PSU | 0.7 | | |

| | |
|---|---|
| nsample | TRZ4-SD-007A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2049-11A |
| qc_type | NM |
| Pct_Solids | 48.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| PH | S.U. | 8.3 | | |
| SALINITY | PSU | 0.5 | | |
| TOTAL ORGANIC CARBON | % | 2.6 | J | D |

# PROJ_NO: 00811

SDG: G2049 MEDIA: SOIL DATA FRACTION: MISC

| | |
|---|---|
| nsample | TRZ4-SD-007A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2049-12A |
| qc_type | NM |
| Pct_Solids | 49.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| PH | S.U. | 8.4 | | |
| SALINITY | PSU | 0.5 | | |
| TOTAL ORGANIC CARBON | % | 3.5 | J | D |

| | |
|---|---|
| nsample | TRZ4-SD-007B-0001 |
| samp_date | 11/6/2008 |
| lab_id | G2049-09A |
| qc_type | NM |
| Pct_Solids | 35.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| TOTAL ORGANIC CARBON | % | 3.9 | J | D |

| | |
|---|---|
| nsample | TRZ4-SD-008A-0002 |
| samp_date | 11/6/2008 |
| lab_id | G2049-22A |
| qc_type | NM |
| Pct_Solids | 34.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| PH | S.U. | 8.1 | | |
| SALINITY | PSU | 0.8 | | |

# PROJ_NO: 00811

SDG: G2049 MEDIA: SOIL DATA FRACTION: MISC

| | |
|---|---|
| nsample | TRZ4-SD-008A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2049-23A |
| qc_type | NM |
| Pct_Solids | 37.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| PH | S.U. | 8.1 | | |
| SALINITY | PSU | 0.7 | | |
| TOTAL ORGANIC CARBON | % | 3.4 | J | D |

| | |
|---|---|
| nsample | TRZ4-SD-008A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2049-24A |
| qc_type | NM |
| Pct_Solids | 37.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| PH | S.U. | 8.4 | | |
| SALINITY | PSU | 0.5 | U | |
| TOTAL ORGANIC CARBON | % | 3.5 | J | D |

| | |
|---|---|
| nsample | TRZ4-SD-008B-0001 |
| samp_date | 11/6/2008 |
| lab_id | G2049-21A |
| qc_type | NM |
| Pct_Solids | 34.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| TOTAL ORGANIC CARBON | % | 3.6 | J | D |

**Tetra Tech NUS** **INTERNAL CORRESPONDENCE**

| | | | |
|---|---|---|---|
| **TO:** | C. RICH | **DATE:** | **DECEMBER 31, 2008** |
| **FROM:** | **LEANNE M. GANSER** | **COPIES:** | **DV FILE** |

**SUBJECT:** **INORGANIC DATA VALIDATION – TOTAL METALS, TCLP METALS, PH, SALINITY, AND TOC**
**CTO 424 NSB NEW LONDON**
**SAMPLE DELIVERY GROUP (SDG) – G2056**

**SAMPLES:** 6/Solid/

| | | |
|---|---|---|
| TRP1-SD-004A-0204 | TRP1-SD-004A-0406 | TRP1-SD-005A-0002 |
| TRP1-SD-005A-0204 | TRP1-SD-005A-0406 | TRP1-SD-005B-0001 |

Overview

The sample set for CTO 424 SDG G2056, NSB New London, consists of six (6) solid environmental samples. No field duplicate pairs were included in this SDG.

All environmental samples, except TRP1-SD-005A-0002, were analyzed for select total metals and total organic carbon (TOC). The environmental samples, except TRP1-SD-005B-001, were also analyzed for TCLP metals, pH and salinity. The samples were collected by Tetra Tech NUS on November 7, 2008 and analyzed by Mitkem Laboratories. All analyses were conducted in accordance with SW-846 method 6010C for metals, SW-846 method 7470A/7471A for mercury, SW846 method 9045 for pH, SM 2520 for salinity, and Walkley-Black for TOC.

All samples in this SDG were validated to EPA Region I Tier III protocol.

These data were evaluated based on the following parameters:

* • Data Completeness
* • Holding Times
* • Initial and Continuing Calibrations
  • Laboratory Method / Preparation Blanks
* • ICP Interference Analysis
* • Laboratory Control Sample Results
  • Matrix Spike Results
  • Laboratory Duplicate Results
  • ICP Serial Dilution Results
* • Detection Limits
* • Analyte Quantitation

* - All quality control criteria were met for this parameter.

Laboratory method blanks

For total metal analysis, the following contaminants were detected in the laboratory method blank at the following maximum concentrations:

| Analyte | Maximum Concentration | Action Level |
|---|---|---|
| Cadmium | 0.2 ug/L | 0.1 mg/kg |
| Chromium(1) | 0.083 mg/kg | 0.415 mg/kg |
| Copper(1) | 0.708 mg/kg | 3.54 mg/kg |
| Zinc(1) | 0.519 mg/kg | 2.595 mg/kg |

(1) Maximum concentration present in prep blank.

An action level of 5X the maximum contaminant level has been used to evaluate sample data for blank contamination. Sample aliquot, percent solids, and dilution factors, if applicable, were taken into consideration when evaluating for blank contamination. No validation actions were taken as the positive results for the aforementioned compounds were greater than the blank action level in all samples.

For TCLP metal analysis, the following contaminants were detected in the laboratory method blank at the following maximum concentrations:

| Analyte | Maximum Concentration | Action Level |
|---|---|---|
| Cadmium | 0.2 ug/L | 1.0 ug/L |
| Mercury | 0.05 ug/L | 0.25 ug/L |
| Selenium | 27.65 ug/L | 138.27 ug/L |
| Silver | 2.3 ug/L | 11.5 ug/L |

(1) Maximum concentration present in prep blank.

An action level of 5X the maximum contaminant level has been used to evaluate sample data for blank contamination. Sample aliquot, percent solids, and dilution factors, if applicable, were taken into consideration when evaluating for blank contamination. Positive results for the aforementioned compounds less than the blank action level were qualified for blank contamination.

Laboratory Duplicate Results

For total metal analysis, laboratory duplicate imprecision for lead, mercury, and zinc were > 20% relative percent difference. The positive results reported for these compounds for all samples were qualified as estimated, "J".

Matrix Spike Results

For total metal analysis, the matrix spike percent recovery for copper and zinc was <80% (but >30%) quality control limit. The positive results reported for copper and zinc for all samples were qualified as estimated, "J".

ICP Serial Dilution Results

For total metal analysis, the %Ds for ICP serial dilution were >10% quality control limits for cadmium, chromium, lead, nickel, and zinc. The positive results reported for these compounds for all samples were qualified as estimated, "J".

Notes

Positive results reported for arsenic and chromium that were <2x the instrument detection limit (IDL) were qualified as estimated, "J", as a result of uncertainty near the detection limit.

Executive Summary

**Laboratory Performance:** Several contaminants were present in the laboratory blanks in total and TCLP metal analysis. Laboratory duplicate imprecision was noted for lead, mercury, and zinc in total metal analysis.

**Other Factors Affecting Data Quality:** The matrix spike percent recovery was outside quality control limits for copper and zinc in total metal analysis. The %D for ICP serial dilution analysis was outside quality control limits for several compounds in total metal analysis.

The data for these analyses were reviewed with reference to EPA Region I, "National Functional Guidelines for Inorganic Review", February 1989. The text of this report has been formulated to address only those problem areas affecting data quality.

Leanne M Ganser

Tetra Tech NUS
Leanne M. Ganser
Environmental Scientist

Edward Sedlmyer / for

Tetra Tech NUS
Joseph A. Samchuck
Quality Assurance Officer

Attachments:

1. Appendix A - Qualified Analytical Results
2. Appendix B - Results as reported by the Laboratory
3. Appendix C - Region I Worksheets
4. Appendix D - Support Documentation

# APPENDIX A
# QUALIFIED ANALYTICAL RESULTS

**Data Validation Qualifier Codes:**

A = Lab Blank Contamination
B = Field Blank Contamination
C = Calibration Noncompliance (e.g. % RSDs, %Ds, ICVs, CCVs, RRFs, etc.)
C01 = GC/MS Tuning Noncompliance
D = MS/MSD Recovery Noncompliance
E = LCS/LCSD Recovery Noncompliance
F = Lab Duplicate Imprecision
G = Field Duplicate Imprecision
H = Holding Time Exceedance
I = ICP Serial Dilution Noncompliance
J = GFAA PDS-GFAA MSA's r < 0.995 / ICP PDS Recovery Noncompliance
K = ICP Interference - includes ICS % R Noncompliance
L = Instrument Calibration Range Exceedance
M = Sample Preservation Noncompliance
N = Internal Standard Noncompliance
N01 = Internal Standard Recovery Noncompliance Dioxins
N02 = Recovery Standard Noncompliance Dioxins
N03 = Clean-up Standard Noncompliance Dioxins
O = Poor Instrument Performance (e.g. base-line drifting)
P = Uncertainty near detection limit (< 2 x IDL for inorganics and <CRQL for organics)
Q = Other problems (can encompass a number of issues; e.g. chromatography,interferences, etc.)
R = Surrogates Recovery Noncompliance
S = Pesticide/PCB Resolution
T = % Breakdown Noncompliance for DOT and Endrin
U = % Difference between columns/detectors >25% for positive results determined via GC/HPLC
V = Non-linear calibrations; correlation coefficient r < 0.995
W = EMPC result
X = Signal to noise response drop
Y = Percent solids <30%
Z = Uncertainty at 2 sigma deviation is greater than sample activity

| PROJ_NO: 00811<br>SDG: G2056<br>FRACTION: M<br>MEDIA: SOIL | NSAMPLE | TRP1-SD-004A-0204 | | | TRP1-SD-004A-0406 | | | TRP1-SD-005A-0204 | | | TRP1-SD-005A-0406 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LAB_ID | G2056-01A | | | G2056-02A | | | G2056-05A | | | G2056-06A | | |
| | SAMP_DATE | 11/7/2008 | | | 11/7/2008 | | | 11/7/2008 | | | 11/7/2008 | | |
| | QC_TYPE | NM | | | NM | | | NM | | | NM | | |
| | UNITS | MG/KG | | | MG/KG | | | MG/KG | | | MG/KG | | |
| | PCT_SOLIDS | 48.0 | | | 56.0 | | | 47.0 | | | 48.0 | | |
| | DUP_OF | | | | | | | | | | | | |
| PARAMETER | | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD |
| ARSENIC | | 12 | | | 7.9 | | | 10.2 | | | 8.7 | | |
| CADMIUM | | 2.3 | J | I | 1.3 | J | I | 0.47 | J | I | 1.3 | J | I |
| CHROMIUM | | 121 | J | I | 96.8 | J | I | 42.6 | J | I | 113 | J | I |
| COPPER | | 203 | J | D | 207 | J | D | 78.7 | J | D | 201 | J | D |
| LEAD | | 260 | J | FI | 192 | J | FI | 62.1 | J | FI | 253 | J | FI |
| MERCURY | | 0.58 | J | F | 1.1 | J | F | 0.33 | J | F | 12.7 | J | F |
| NICKEL | | 28 | J | I | 17.7 | J | I | 18.9 | J | I | 51.3 | J | I |
| SELENIUM | | 5.2 | | | 3.7 | | | 1.5 | | | 3.5 | | |
| ZINC | | 418 | J | DFI | 324 | J | DFI | 111 | J | DFI | 669 | J | DFI |

| | | | | |
|---|---|---|---|---|
| PROJ_NO: 00811 | NSAMPLE | TRP1-SD-005B-0001 | | |
| SDG: G2056 | LAB_ID | G2056-03A | | |
| FRACTION: M | SAMP_DATE | 11/7/2008 | | |
| MEDIA: SOIL | QC_TYPE | NM | | |
| | UNITS | MG/KG | | |
| | PCT_SOLIDS | 40.0 | | |
| | DUP_OF | | | |
| PARAMETER | | RESULT | VQL | QLCD |
| ARSENIC | | 8.3 | | |
| CADMIUM | | 0.38 | J | I |
| CHROMIUM | | 40.1 | J | I |
| COPPER | | 64.9 | J | D |
| LEAD | | 79.8 | J | FI |
| MERCURY | | 0.25 | J | F |
| NICKEL | | 16.4 | J | I |
| SELENIUM | | 1.8 | | |
| ZINC | | 108 | J | DFI |

| PROJ_NO: 00811<br>SDG: G2056<br>FRACTION: TCLPM<br>MEDIA: TCLP | NSAMPLE | TRP1-SD-004A-0204 | | | TRP1-SD-004A-0406 | | | TRP1-SD-005A-0002 | | | TRP1-SD-005A-0204 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LAB_ID | G2056-01C | | | G2056-02C | | | G2056-04A | | | G2056-05C | | |
| | SAMP_DATE | 11/7/2008 | | | 11/7/2008 | | | 11/7/2008 | | | 11/7/2008 | | |
| | QC_TYPE | NM | | | NM | | | NM | | | NM | | |
| | UNITS | UG/L | | | UG/L | | | UG/L | | | UG/L | | |
| | PCT_SOLIDS | | | | | | | | | | | | |
| | DUP_OF | | | | | | | | | | | | |
| PARAMETER | | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD |
| ARSENIC | | 9.5 | J | P | 11.4 | | | 18.2 | | | 19.3 | | |
| BARIUM | | 308 | | | 267 | | | 110 | | | 144 | | |
| CADMIUM | | 0.14 | U | | 1.3 | U | A | 0.14 | U | | 0.14 | U | |
| CHROMIUM | | 7.1 | | | 5.9 | | | 1.6 | J | P | 1.1 | U | |
| LEAD | | 11 | | | 351 | | | 5.7 | | | 2.2 | U | |
| MERCURY | | 0.016 | U | | 0.022 | U | A | 0.016 | U | | 0.016 | U | |
| SELENIUM | | 26.3 | U | A | 14.1 | U | A | 22 | U | A | 21.5 | U | A |
| SILVER | | 0.59 | U | | 0.59 | U | | 0.59 | U | | 0.59 | U | |

| | | |
|---|---|---|
| PROJ_NO: 00811 | NSAMPLE | TRP1-SD-005A-0406 |
| SDG: G2056 | LAB_ID | G2056-06C |
| FRACTION: TCLPM | SAMP_DATE | 11/7/2008 |
| MEDIA: TCLP | QC_TYPE | NM |
| | UNITS | UG/L |
| | PCT_SOLIDS | |
| | DUP_OF | |

| PARAMETER | RESULT | VQL | QLCD |
|---|---|---|---|
| ARSENIC | 8.2 | J | P |
| BARIUM | 209 | | |
| CADMIUM | 0.14 | U | |
| CHROMIUM | 1.7 | J | P |
| LEAD | 2.2 | U | |
| MERCURY | 0.016 | U | |
| SELENIUM | 25.3 | U | A |
| SILVER | 1.6 | U | A |

# PROJ_NO: 00811

SDG: G2056 MEDIA: SOIL DATA FRACTION: MISC

| | |
|---|---|
| nsample | TRP1-SD-004A-0204 |
| samp_date | 11/7/2008 |
| lab_id | G2056-01A |
| qc_type | NM |
| Pct_Solids | 48.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| PH | S.U. | 8.4 | | |
| SALINITY | PSU | 0.6 | | |
| TOTAL ORGANIC CARBON | % | 3.3 | | |

| | |
|---|---|
| nsample | TRP1-SD-004A-0406 |
| samp_date | 11/7/2008 |
| lab_id | G2056-02A |
| qc_type | NM |
| Pct_Solids | 56.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| PH | S.U. | 8.3 | | |
| SALINITY | PSU | 0.5 | U | |
| TOTAL ORGANIC CARBON | % | 2.4 | | |

| | |
|---|---|
| nsample | TRP1-SD-005A-0002 |
| samp_date | 11/7/2008 |
| lab_id | G2056-04A |
| qc_type | NM |
| Pct_Solids | 49.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| PH | S.U. | 8.4 | | |
| SALINITY | PSU | 0.6 | | |

# PROJ_NO: 00811

SDG: G2056 MEDIA: SOIL DATA FRACTION: MISC

| | |
|---|---|
| nsample | TRP1-SD-005A-0204 |
| samp_date | 11/7/2008 |
| lab_id | G2056-05A |
| qc_type | NM |
| Pct_Solids | 47.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| PH | S.U. | 8.4 | | |
| SALINITY | PSU | 0.5 | | |
| TOTAL ORGANIC CARBON | % | 3.6 | | |

| | |
|---|---|
| nsample | TRP1-SD-005A-0406 |
| samp_date | 11/7/2008 |
| lab_id | G2056-06A |
| qc_type | NM |
| Pct_Solids | 48.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| PH | S.U. | 8.4 | | |
| SALINITY | PSU | 0.5 | | |
| TOTAL ORGANIC CARBON | % | 3.1 | | |

| | |
|---|---|
| nsample | TRP1-SD-005B-0001 |
| samp_date | 11/7/2008 |
| lab_id | G2056-03A |
| qc_type | NM |
| Pct_Solids | 40.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| TOTAL ORGANIC CARBON | % | 3.8 | | |

**Tetra Tech NUS** **INTERNAL CORRESPONDENCE**

| | | | |
|---|---|---|---|
| **TO:** | C. RICH | **DATE:** | **DECEMBER 31, 2008** |
| **FROM:** | **LEANNE M. GANSER** | **COPIES:** | **DV FILE** |

**SUBJECT:** **INORGANIC DATA VALIDATION – TOTAL METALS, TCLP METALS, PH, SALINITY, AND TOC**
**CTO 424 NSB NEW LONDON**
**SAMPLE DELIVERY GROUP (SDG) – G2038**

**SAMPLES:** 20/Solid/

| | | |
|---|---|---|
| TRP1-SD-007A-0002 | TRP1-SD-007A-0204 | TRP1-SD-007A-0406 |
| TRP1-SD-007B-001 | TRP1-SD-008A-0002 | TRP1-SD-008A-0204 |
| TRP1-SD-008A-0406 | TRP1-SD-008B-0001 | TRP1-SD-009A-0002 |
| TRP1-SD-009A-0240 | TRP1-SD-009A-0406 | TRP1-SD-009B-0001 |
| TRP1-SD-010A-0002 | TRP1-SD-010A-0204 | TRP1-SD-010A-0406 |
| TRP1-SD-010B-0001 | TRZ4-SD-001A-0002 | TRZ4-SD-001A-0204 |
| TRZ4-SD-001B-0001 | TRZ4-SD-01A-0406 | |

Overview

The sample set for CTO 424 SDG G2038, NSB New London, consists of twenty (20) solid environmental samples. No field duplicate pairs were included in this SDG.

All environmental samples, except TRP1-SD-007A-0002, TRP1-SD-007B-001, TRP1-SD-008A-0002, TRP1-SD-008B-0001, TRP1-SD-009A-0002, TRP1-SD-009B-0001, TRP1-SD-010A-0002, TRP1-SD-010B-0001, TRZ4-SD-001A-0002, and TRZ4-SD-001B-0001 were analyzed for select total and TCLP metals, pH, salinity, and total organic carbon (TOC). Samples TRP1-SD-007A-0002, TRP1-SD-008A-0002, TRP1-SD-009A-0002, TRP1-SD-010A-0002, and TRZ4-SD-001A-0002 were analyzed for TCLP metals, pH, and salinity. Samples TRP1-SD-007B-001, TRP1-SD-008B-0001, TRP1-SD-009B-0001, TRP1-SD-010B-0001, and TRZ4-SD-001B-0001 were analyzed for total metals and TOC. The samples were collected by Tetra Tech NUS on November 5-6, 2008 and analyzed by Mitkem Laboratories. All analyses were conducted in accordance with SW-846 method 6010C for metals, SW-846 method 7470A/7471A for mercury, SW846 method 9045 for pH, SM 2520 for salinity, and Walkley-Black for TOC.

All samples in this SDG were validated to EPA Region I Tier III protocol.

These data were evaluated based on the following parameters:

* • Data Completeness
* • Holding Times
* • Initial and Continuing Calibrations
• Laboratory Method / Preparation Blanks
* • ICP Interference Analysis
* • Laboratory Control Sample Results
• Matrix Spike Results
• Laboratory Duplicate Results
• ICP Serial Dilution Results

* • Detection Limits
* • Analyte Quantitation

* - All quality control criteria were met for this parameter.

Laboratory method blanks

For total metal analysis, the following contaminants were detected in the laboratory method blank at the following maximum concentrations:

| Analyte | Maximum Concentration | Action Level |
|---|---|---|
| Cadmium | 0.3 ug/L | 0.075 mg/kg |
| Copper(1) | 0.466 mg/kg | 2.33 mg/kg |

(1) Maximum concentration present in prep blank.

An action level of 5X the maximum contaminant level has been used to evaluate sample data for blank contamination. Sample aliquot, percent solids, and dilution factors, if applicable, were taken into consideration when evaluating for blank contamination. No validation actions were taken as the positive results for the aforementioned compounds were greater than the blank action level in all samples.

For TCLP metal analysis, the following contaminants were detected in the laboratory method blank at the following maximum concentrations:

| Analyte | Maximum Concentration | Action Level |
|---|---|---|
| Cadmium | 0.4 ug/L | 2.0 ug/L |
| Selenium | 14.74 ug/L | 73.7 ug/L |
| Silver | 3.167 ug/L | 15.835 ug/L |

(1) Maximum concentration present in prep blank.

An action level of 5X the maximum contaminant level has been used to evaluate sample data for blank contamination. Sample aliquot, percent solids, and dilution factors, if applicable, were taken into consideration when evaluating for blank contamination. Positive results less than the blank action level for selenium and silver were qualified for blank contamination.

Laboratory Duplicate Results

For total metal analysis, laboratory duplicate imprecision for arsenic, chromium, mercury, and zinc were > 20% relative percent difference. The positive results reported for these compounds for all samples were qualified as estimated, "J".

Matrix Spike Results

For total metal analysis, the matrix spike percent recovery for copper was >120% quality control limit. The positive results reported for copper for all samples were qualified as estimated, "J".

ICP Serial Dilution Results

For total metal analysis, the %Ds for ICP serial dilution were >10% quality control limits for cadmium and lead. The positive results reported for cadmium and lead for all samples were qualified as estimated, "J".

Notes

Positive results reported for arsenic and lead that were <2x the instrument detection limit (IDL) were qualified as estimated, "J", as a result of uncertainty near the detection limit.

Executive Summary

**Laboratory Performance:** Several contaminants were present in the laboratory blanks in total and TCLP metal analysis. Laboratory duplicate imprecision was noted for arsenic, chromium, mercury, and zinc in total metal analysis.

**Other Factors Affecting Data Quality:** The matrix spike percent recovery was outside quality control limits for copper in total metal analysis. The %D for ICP serial dilution analysis was outside quality control limits for cadmium and lead in total metal analysis.

The data for these analyses were reviewed with reference to EPA Region I, "National Functional Guidelines for Inorganic Review", February 1989. The text of this report has been formulated to address only those problem areas affecting data quality.

Tetra Tech NUS
Leanne M. Ganser
Environmental Scientist

Tetra Tech NUS
Joseph A. Samchuck
Quality Assurance Officer

Attachments:

1. Appendix A - Qualified Analytical Results
2. Appendix B - Results as reported by the Laboratory
3. Appendix C - Region I Worksheets
4. Appendix D - Support Documentation

# APPENDIX A
# QUALIFIED ANALYTICAL RESULTS

**Data Validation Qualifier Codes:**

A = Lab Blank Contamination
B = Field Blank Contamination
C = Calibration Noncompliance (e.g. % RSDs, %Ds, ICVs, CCVs, RRFs, etc.)
C01 = GC/MS Tuning Noncompliance
D = MS/MSD Recovery Noncompliance
E = LCS/LCSD Recovery Noncompliance
F = Lab Duplicate Imprecision
G = Field Duplicate Imprecision
H = Holding Time Exceedance
I = ICP Serial Dilution Noncompliance
J = GFAA PDS-GFAA MSA's r < 0.995 / ICP PDS Recovery Noncompliance
K = ICP Interference - includes ICS % R Noncompliance
L = Instrument Calibration Range Exceedance
M = Sample Preservation Noncompliance
N = Internal Standard Noncompliance
N01 = Internal Standard Recovery Noncompliance Dioxins
N02 = Recovery Standard Noncompliance Dioxins
N03 = Clean-up Standard Noncompliance Dioxins
O = Poor Instrument Performance (e.g. base-line drifting)
P = Uncertainty near detection limit (< 2 x IDL for inorganics and <CRQL for organics)
Q = Other problems (can encompass a number of issues; e.g. chromatography,interferences, etc.)
R = Surrogates Recovery Noncompliance
S = Pesticide/PCB Resolution
T = % Breakdown Noncompliance for DOT and Endrin
U = % Difference between columns/detectors >25% for positive results determined via GC/HPLC
V = Non-linear calibrations; correlation coefficient r < 0.995
W = EMPC result
X = Signal to noise response drop
Y = Percent solids <30%
Z = Uncertainty at 2 sigma deviation is greater than sample activity

| PROJ_NO: 00811<br>SDG: G2038<br>FRACTION: M<br>MEDIA: SOIL | NSAMPLE | TRP1-SD-007A-0204 | | | TRP1-SD-007A-0406 | | | TRP1-SD-007B-001 | | | TRP1-SD-008A-0204 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LAB_ID | G2038-15A | | | G2038-16A | | | G2038-13A | | | G2038-11A | | |
| | SAMP_DATE | 11/6/2008 | | | 11/6/2008 | | | 11/6/2008 | | | 11/5/2008 | | |
| | QC_TYPE | NM | | | NM | | | NM | | | NM | | |
| | UNITS | MG/KG | | | MG/KG | | | MG/KG | | | MG/KG | | |
| | PCT_SOLIDS | 46.0 | | | 51.0 | | | 36.0 | | | 38.0 | | |
| | DUP_OF | | | | | | | | | | | | |
| PARAMETER | | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD |
| ARSENIC | | 18.4 | J | F | 23.3 | J | F | 15.6 | J | F | 13.4 | J | F |
| CADMIUM | | 1.1 | J | I | 3 | J | I | 0.54 | J | I | 0.83 | J | I |
| CHROMIUM | | 167 | J | F | 142 | J | F | 76.3 | J | F | 130 | J | F |
| COPPER | | 1600 | J | D | 8620 | J | D | 791 | J | D | 1010 | J | D |
| LEAD | | 1170 | J | I | 661 | J | I | 192 | J | I | 690 | J | I |
| MERCURY | | 0.97 | J | F | 2.3 | J | F | 0.37 | J | F | 0.64 | J | F |
| NICKEL | | 482 | | | 188 | | | 40.3 | | | 278 | | |
| SELENIUM | | 14.6 | | | 9.8 | | | 7.6 | | | 8.6 | | |
| ZINC | | 4660 | J | F | 2640 | J | F | 410 | J | F | 2470 | J | F |

| PROJ_NO: 00811<br>SDG: G2038<br>FRACTION: M<br>MEDIA: SOIL | NSAMPLE | TRP1-SD-008A-0406 | | | TRP1-SD-008B-0001 | | | TRP1-SD-009A-0240 | | | TRP1-SD-009A-0406 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LAB_ID | G2038-12A | | | G2038-09A | | | G2038-03A | | | G2038-04A | | |
| | SAMP_DATE | 11/5/2008 | | | 11/5/2008 | | | 11/5/2008 | | | 11/5/2008 | | |
| | QC_TYPE | NM | | | NM | | | NM | | | NM | | |
| | UNITS | MG/KG | | | MG/KG | | | MG/KG | | | MG/KG | | |
| | PCT_SOLIDS | 43.0 | | | 31.0 | | | 35.0 | | | 41.0 | | |
| | DUP_OF | | | | | | | | | | | | |
| PARAMETER | | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD |
| ARSENIC | | 12.9 | J | F | 15.4 | J | F | 15.8 | J | F | 12.3 | J | F |
| CADMIUM | | 0.89 | J | I | 0.45 | J | I | 0.7 | J | I | 1.2 | J | I |
| CHROMIUM | | 93.7 | J | F | 66.9 | J | F | 82.9 | J | F | 95.5 | J | F |
| COPPER | | 576 | J | D | 226 | J | D | 181 | J | D | 255 | J | D |
| LEAD | | 416 | J | I | 148 | J | I | 139 | J | I | 228 | J | I |
| MERCURY | | 0.89 | J | F | 0.57 | J | F | 0.52 | J | F | 0.72 | J | F |
| NICKEL | | 127 | | | 28.4 | | | 38.8 | | | 57.1 | | |
| SELENIUM | | 7.9 | | | 6.9 | | | 6.3 | | | 6.1 | | |
| ZINC | | 1200 | J | F | 257 | J | F | 249 | J | F | 433 | J | F |

| PROJ_NO: 00811<br>SDG: G2038<br>FRACTION: M<br>MEDIA: SOIL | NSAMPLE | TRP1-SD-009B-0001 | | | TRP1-SD-010A-0204 | | | TRP1-SD-010A-0406 | | | TRP1-SD-010B-0001 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LAB_ID | G2038-01A | | | G2038-07A | | | G2038-08A | | | G2038-05A | | |
| | SAMP_DATE | 11/5/2008 | | | 11/5/2008 | | | 11/5/2008 | | | 11/5/2008 | | |
| | QC_TYPE | NM | | | NM | | | NM | | | NM | | |
| | UNITS | MG/KG | | | MG/KG | | | MG/KG | | | MG/KG | | |
| | PCT_SOLIDS | 44.0 | | | 61.0 | | | 54.0 | | | 48.0 | | |
| | DUP_OF | | | | | | | | | | | | |
| PARAMETER | | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD |
| ARSENIC | | 10.3 | J | F | 12 | J | F | 14.5 | J | F | 12.4 | J | F |
| CADMIUM | | 1 | J | I | 1.5 | J | I | 1.9 | J | I | 0.47 | J | I |
| CHROMIUM | | 84.3 | J | F | 101 | J | F | 88.9 | J | F | 56.8 | J | F |
| COPPER | | 190 | J | D | 670 | J | D | 625 | J | D | 201 | J | D |
| LEAD | | 228 | J | I | 665 | J | I | 327 | J | I | 163 | J | I |
| MERCURY | | 0.6 | J | F | 1.6 | J | F | 4.3 | J | F | 0.47 | J | F |
| NICKEL | | 41.5 | | | 146 | | | 67.9 | | | 30.9 | | |
| SELENIUM | | 4.7 | | | 5.6 | | | 6 | | | 4.3 | | |
| ZINC | | 387 | J | F | 1860 | J | F | 975 | J | F | 356 | J | F |

| PROJ_NO: 00811 | NSAMPLE | TRZ4-SD-001A-0204 | | | TRZ4-SD-001B-0001 | | | TRZ4-SD-01A-0406 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| SDG: G2038 | LAB_ID | G2038-19A | | | G2038-17A | | | G2038-20A | | |
| FRACTION: M | SAMP_DATE | 11/6/2008 | | | 11/6/2008 | | | 11/6/2008 | | |
| MEDIA: SOIL | QC_TYPE | NM | | | NM | | | NM | | |
| | UNITS | MG/KG | | | MG/KG | | | MG/KG | | |
| | PCT_SOLIDS | 38.0 | | | 37.0 | | | 40.0 | | |
| | DUP_OF | | | | | | | | | |
| PARAMETER | | RESULT | VQL | QLCD | RESULT | VQL | QLCD | RESULT | VQL | QLCD |
| ARSENIC | | 15.2 | J | F | 13.9 | J | F | 16.4 | J | F |
| CADMIUM | | 2 | J | I | 0.62 | J | I | 2.2 | J | I |
| CHROMIUM | | 155 | J | F | 77.7 | J | F | 129 | J | F |
| COPPER | | 372 | J | D | 132 | J | D | 266 | J | D |
| LEAD | | 483 | J | I | 202 | J | I | 308 | J | I |
| MERCURY | | 0.9 | J | F | 0.51 | J | F | 0.78 | J | F |
| NICKEL | | 89.2 | | | 30.1 | | | 72.7 | | |
| SELENIUM | | 5.7 | | | 6 | | | 6.6 | | |
| ZINC | | 2110 | J | F | 264 | J | F | 652 | J | F |

# PROJ_NO: 00811

SDG: G2038 MEDIA: TCLP DATA FRACTION: TCLPM

| | |
|---|---|
| nsample | TRP1-SD-007A-0002 |
| samp_date | 11/6/2008 |
| lab_id | G2038-14A |
| qc_type | NM |
| units | UG/L |
| Pct_Solids | |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ARSENIC | 31.2 | | |
| BARIUM | 66.6 | | |
| CADMIUM | 0.14 | U | |
| CHROMIUM | 1.6 | | |
| LEAD | 2.2 | U | |
| MERCURY | 0.016 | U | |
| SELENIUM | 17.3 | U | A |
| SILVER | 0.59 | U | |

| | |
|---|---|
| nsample | TRP1-SD-007A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2038-15C |
| qc_type | NM |
| units | UG/L |
| Pct_Solids | |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ARSENIC | 25.4 | | |
| BARIUM | 87.5 | | |
| CADMIUM | 0.14 | U | |
| CHROMIUM | 1.4 | | |
| LEAD | 2.2 | U | |
| MERCURY | 0.035 | | |
| SELENIUM | 25.6 | U | A |
| SILVER | 0.59 | U | |

| | |
|---|---|
| nsample | TRP1-SD-007A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2038-16C |
| qc_type | NM |
| units | UG/L |
| Pct_Solids | |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ARSENIC | 5.3 | U | |
| BARIUM | 431 | | |
| CADMIUM | 0.14 | U | |
| CHROMIUM | 8.8 | | |
| LEAD | 2.2 | U | |
| MERCURY | 0.016 | U | |
| SELENIUM | 23.1 | U | A |
| SILVER | 0.59 | U | |

# PROJ_NO: 00811

SDG: G2038 MEDIA: TCLP DATA FRACTION: TCLPM

| | |
|---|---|
| nsample | TRP1-SD-008A-0002 |
| samp_date | 11/5/2008 |
| lab_id | G2038-10A |
| qc_type | NM |
| units | UG/L |
| Pct_Solids | |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ARSENIC | 5.3 | U | |
| BARIUM | 160 | | |
| CADMIUM | 0.14 | U | |
| CHROMIUM | 8 | | |
| LEAD | 2.2 | U | |
| MERCURY | 0.016 | U | |
| SELENIUM | 16.3 | U | A |
| SILVER | 0.59 | U | |

| | |
|---|---|
| nsample | TRP1-SD-008A-0204 |
| samp_date | 11/5/2008 |
| lab_id | G2038-11C |
| qc_type | NM |
| units | UG/L |
| Pct_Solids | |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ARSENIC | 5.3 | U | |
| BARIUM | 137 | | |
| CADMIUM | 0.14 | U | |
| CHROMIUM | 6.3 | | |
| LEAD | 2.2 | U | |
| MERCURY | 0.016 | U | |
| SELENIUM | 14.4 | U | A |
| SILVER | 0.59 | U | |

| | |
|---|---|
| nsample | TRP1-SD-008A-0406 |
| samp_date | 11/5/2008 |
| lab_id | G2038-12C |
| qc_type | NM |
| units | UG/L |
| Pct_Solids | |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ARSENIC | 6 | J | P |
| BARIUM | 134 | | |
| CADMIUM | 0.14 | U | |
| CHROMIUM | 12.8 | | |
| LEAD | 2.2 | U | |
| MERCURY | 0.016 | U | |
| SELENIUM | 32.4 | U | A |
| SILVER | 0.59 | U | |

# PROJ_NO: 00811

SDG: G2038 MEDIA: TCLP DATA FRACTION: TCLPM

| | |
|---|---|
| nsample | TRP1-SD-009A-0002 |
| samp_date | 11/5/2008 |
| lab_id | G2038-02A |
| qc_type | NM |
| units | UG/L |
| Pct_Solids | |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ARSENIC | 5.3 | U | |
| BARIUM | 103 | | |
| CADMIUM | 0.14 | U | |
| CHROMIUM | 6.2 | | |
| LEAD | 2.2 | U | |
| MERCURY | 0.016 | U | |
| SELENIUM | 16.2 | U | A |
| SILVER | 3.6 | U | A |

| | |
|---|---|
| nsample | TRP1-SD-009A-0204 |
| samp_date | 11/5/2008 |
| lab_id | G2038-03C |
| qc_type | NM |
| units | UG/L |
| Pct_Solids | |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ARSENIC | 8.1 | J | P |
| BARIUM | 138 | | |
| CADMIUM | 0.14 | U | |
| CHROMIUM | 9.7 | | |
| LEAD | 2.3 | J | P |
| MERCURY | 0.18 | | |
| SELENIUM | 27.7 | U | A |
| SILVER | 0.59 | U | |

| | |
|---|---|
| nsample | TRP1-SD-009A-0406 |
| samp_date | 11/5/2008 |
| lab_id | G2038-04C |
| qc_type | NM |
| units | UG/L |
| Pct_Solids | |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ARSENIC | 20.4 | | |
| BARIUM | 184 | | |
| CADMIUM | 0.14 | U | |
| CHROMIUM | 11.6 | | |
| LEAD | 2.2 | U | |
| MERCURY | 0.016 | U | |
| SELENIUM | 29.9 | U | A |
| SILVER | 0.59 | U | |

# PROJ_NO: 00811

SDG: G2038 MEDIA: TCLP DATA FRACTION: TCLPM

| | |
|---|---|
| nsample | TRP1-SD-010A-0002 |
| samp_date | 11/5/2008 |
| lab_id | G2038-06A |
| qc_type | NM |
| units | UG/L |
| Pct_Solids | |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ARSENIC | 15.2 | | |
| BARIUM | 84.9 | | |
| CADMIUM | 0.14 | U | |
| CHROMIUM | 7.5 | | |
| LEAD | 6.7 | | |
| MERCURY | 0.016 | U | |
| SELENIUM | 31.7 | U | A |
| SILVER | 0.59 | U | |

| | |
|---|---|
| nsample | TRP1-SD-010A-0204 |
| samp_date | 11/5/2008 |
| lab_id | G2038-07C |
| qc_type | NM |
| units | UG/L |
| Pct_Solids | |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ARSENIC | 9.3 | J | P |
| BARIUM | 232 | | |
| CADMIUM | 0.14 | U | |
| CHROMIUM | 9.1 | | |
| LEAD | 3.1 | J | P |
| MERCURY | 0.016 | U | |
| SELENIUM | 28 | U | A |
| SILVER | 0.59 | U | |

| | |
|---|---|
| nsample | TRP1-SD-010A-0406 |
| samp_date | 11/5/2008 |
| lab_id | G2038-08C |
| qc_type | NM |
| units | UG/L |
| Pct_Solids | |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ARSENIC | 5.3 | U | |
| BARIUM | 541 | | |
| CADMIUM | 0.14 | U | |
| CHROMIUM | 14.7 | | |
| LEAD | 2.2 | U | |
| MERCURY | 0.016 | U | |
| SELENIUM | 25.7 | U | A |
| SILVER | 3.8 | U | A |

# PROJ_NO: 00811

SDG: G2038 MEDIA: TCLP DATA FRACTION: TCLPM

| | |
|---|---|
| nsample | TRZ4-SD-001A-0002 |
| samp_date | 11/6/2008 |
| lab_id | G2038-18A |
| qc_type | NM |
| units | UG/L |
| Pct_Solids | |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ARSENIC | 6.3 | J | P |
| BARIUM | 97.2 | | |
| CADMIUM | 0.14 | U | |
| CHROMIUM | 2.6 | | |
| LEAD | 2.2 | U | |
| MERCURY | 0.016 | U | |
| SELENIUM | 24.3 | U | A |
| SILVER | 0.59 | U | |

| | |
|---|---|
| nsample | TRZ4-SD-001A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2038-19C |
| qc_type | NM |
| units | UG/L |
| Pct_Solids | |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ARSENIC | 8.7 | J | P |
| BARIUM | 163 | | |
| CADMIUM | 0.14 | U | |
| CHROMIUM | 1.9 | | |
| LEAD | 2.2 | U | |
| MERCURY | 0.016 | U | |
| SELENIUM | 32.5 | U | A |
| SILVER | 0.59 | U | |

| | |
|---|---|
| nsample | TRZ4-SD-001A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2038-20C |
| qc_type | NM |
| units | UG/L |
| Pct_Solids | |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| ARSENIC | 20 | | |
| BARIUM | 187 | | |
| CADMIUM | 0.14 | U | |
| CHROMIUM | 11.5 | | |
| LEAD | 2.7 | J | P |
| MERCURY | 0.016 | U | |
| SELENIUM | 30.4 | U | A |
| SILVER | 0.59 | U | |

# PROJ_NO: 00811

SDG: G2038 MEDIA: SOIL DATA FRACTION: MISC

| | |
|---|---|
| nsample | TRP1-SD-007A-0002 |
| samp_date | 11/6/2008 |
| lab_id | G2038-14A |
| qc_type | NM |
| Pct_Solids | 42.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| PH | S.U. | 7.9 | | |
| SALINITY | PSU | 0.7 | | |

| | |
|---|---|
| nsample | TRP1-SD-007A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2038-15A |
| qc_type | NM |
| Pct_Solids | 46.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| PH | S.U. | 8.4 | | |
| SALINITY | PSU | 0.6 | | |
| TOTAL ORGANIC CARBON | % | 3.4 | | |

| | |
|---|---|
| nsample | TRP1-SD-007A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2038-16A |
| qc_type | NM |
| Pct_Solids | 51.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| PH | S.U. | 8.4 | | |
| SALINITY | PSU | 0.5 | | |
| TOTAL ORGANIC CARBON | % | 4.1 | | |

# PROJ_NO: 00811

SDG: G2038 MEDIA: SOIL DATA FRACTION: MISC

| | |
|---|---|
| nsample | TRP1-SD-007B-001 |
| samp_date | 11/6/2008 |
| lab_id | G2038-13A |
| qc_type | NM |
| Pct_Solids | 36.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| TOTAL ORGANIC CARBON | % | 4.4 | | |

| | |
|---|---|
| nsample | TRP1-SD-008A-0002 |
| samp_date | 11/5/2008 |
| lab_id | G2038-10A |
| qc_type | NM |
| Pct_Solids | 46.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| PH | S.U. | 8 | | |
| SALINITY | PSU | 0.5 | | |

| | |
|---|---|
| nsample | TRP1-SD-008A-0204 |
| samp_date | 11/5/2008 |
| lab_id | G2038-11A |
| qc_type | NM |
| Pct_Solids | 38.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| PH | S.U. | 8.4 | | |
| SALINITY | PSU | 0.9 | | |
| TOTAL ORGANIC CARBON | % | 3.2 | | |

# PROJ_NO: 00811

SDG: G2038 MEDIA: SOIL DATA FRACTION: MISC

| | |
|---|---|
| nsample | TRP1-SD-008A-0406 |
| samp_date | 11/5/2008 |
| lab_id | G2038-12A |
| qc_type | NM |
| Pct_Solids | 43.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| PH | S.U. | 8.2 | | |
| SALINITY | PSU | 0.8 | | |
| TOTAL ORGANIC CARBON | % | 3.6 | | |

| | |
|---|---|
| nsample | TRP1-SD-008B-0001 |
| samp_date | 11/5/2008 |
| lab_id | G2038-09A |
| qc_type | NM |
| Pct_Solids | 31.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| TOTAL ORGANIC CARBON | % | 4.5 | | |

| | |
|---|---|
| nsample | TRP1-SD-009A-0002 |
| samp_date | 11/5/2008 |
| lab_id | G2038-02A |
| qc_type | NM |
| Pct_Solids | 35.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| PH | S.U. | 8.1 | | |
| SALINITY | PSU | 0.8 | | |

# PROJ_NO: 00811

SDG: G2038 MEDIA: SOIL DATA FRACTION: MISC

| | |
|---|---|
| nsample | TRP1-SD-009A-0240 |
| samp_date | 11/5/2008 |
| lab_id | G2038-03A |
| qc_type | NM |
| Pct_Solids | 35.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| PH | S.U. | 7.7 | | |
| SALINITY | PSU | 0.8 | | |
| TOTAL ORGANIC CARBON | % | 3.5 | | |

| | |
|---|---|
| nsample | TRP1-SD-009A-0406 |
| samp_date | 11/5/2008 |
| lab_id | G2038-04A |
| qc_type | NM |
| Pct_Solids | 41.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| PH | S.U. | 8.2 | | |
| SALINITY | PSU | 0.6 | | |
| TOTAL ORGANIC CARBON | % | 3.7 | | |

| | |
|---|---|
| nsample | TRP1-SD-009B-0001 |
| samp_date | 11/5/2008 |
| lab_id | G2038-01A |
| qc_type | NM |
| Pct_Solids | 44.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| TOTAL ORGANIC CARBON | % | 3.5 | | |

# PROJ_NO: 00811

SDG: G2038 MEDIA: SOIL DATA FRACTION: MISC

| | |
|---|---|
| nsample | TRP1-SD-010A-0002 |
| samp_date | 11/5/2008 |
| lab_id | G2038-06A |
| qc_type | NM |
| Pct_Solids | 46.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| PH | S.U. | 7.7 | | |
| SALINITY | PSU | 0.5 | | |

| | |
|---|---|
| nsample | TRP1-SD-010A-0204 |
| samp_date | 11/5/2008 |
| lab_id | G2038-07A |
| qc_type | NM |
| Pct_Solids | 61.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| PH | S.U. | 8 | | |
| SALINITY | PSU | 0.5 | U | |
| TOTAL ORGANIC CARBON | % | 2.5 | | |

| | |
|---|---|
| nsample | TRP1-SD-010A-0406 |
| samp_date | 11/5/2008 |
| lab_id | G2038-08A |
| qc_type | NM |
| Pct_Solids | 54.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| PH | S.U. | 8.3 | | |
| SALINITY | PSU | 0.5 | | |
| TOTAL ORGANIC CARBON | % | 3.3 | | |

# PROJ_NO: 00811

SDG: G2038 MEDIA: SOIL DATA FRACTION: MISC

| | |
|---|---|
| nsample | TRP1-SD-010B-0001 |
| samp_date | 11/5/2008 |
| lab_id | G2038-05A |
| qc_type | NM |
| Pct_Solids | 48.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| TOTAL ORGANIC CARBON | % | 4.3 | | |

| | |
|---|---|
| nsample | TRZ4-SD-001A-0002 |
| samp_date | 11/6/2008 |
| lab_id | G2038-18A |
| qc_type | NM |
| Pct_Solids | 36.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| PH | S.U. | 8.4 | | |
| SALINITY | PSU | 0.7 | | |

| | |
|---|---|
| nsample | TRZ4-SD-001A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2038-19A |
| qc_type | NM |
| Pct_Solids | 38.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| PH | S.U. | 8.1 | | |
| SALINITY | PSU | 0.7 | | |
| TOTAL ORGANIC CARBON | % | 3.7 | | |

# PROJ_NO: 00811

SDG: G2038 MEDIA: SOIL DATA FRACTION: MISC

| | |
|---|---|
| nsample | TRZ4-SD-001B-0001 |
| samp_date | 11/6/2008 |
| lab_id | G2038-17A |
| qc_type | NM |
| Pct_Solids | 37.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| TOTAL ORGANIC CARBON | % | 3.9 | | |

| | |
|---|---|
| nsample | TRZ4-SD-01A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2038-20A |
| qc_type | NM |
| Pct_Solids | 40.0 |
| DUP_OF: | |

| Parameter | units | Result | Val Qual | Qual Code |
|---|---|---|---|---|
| PH | S.U. | 8.1 | | |
| SALINITY | PSU | 0.7 | | |
| TOTAL ORGANIC CARBON | % | 4 | | |

**Tetra Tech NUS** **INTERNAL CORRESPONDENCE**

**TO:** **COREY RICH** **DATE: JANUARY 13, 2009**

**FROM:** **JOSEPH KALINYAK** **COPIES: DV FILE**

**SUBJECT:** **ORGANIC DATA VALIDATION: PCB/PEST**
**CTO 424, NSB NEW LONDON**
**SDG G2055**

**SAMPLES:** 19/Sedimentl/PCB/PEST

| | | |
|---|---|---|
| TPR1-SD-001A-0406 | TPR1-SD-006A-0203 | TPR1-SD-006B-0001 |
| TPZ4-SD-004B-0001 | TRP1-SD-001A-0204 | TRP1-SD-002A-0204 |
| TRP1-SD-002A-0406 | TRP1-SD-002B-0001 | TRP1-SD-003A-0204 |
| TRP1-SD-003B-0001 | TRP1-SD-004A-0204 | TRP1-SD-004A-0406 |
| TRP1-SD-004B-0001 | TRP1-SD-005A-0204 | TRP1-SD-005A-0406 |
| TRP1-SD-005B-0001 | TRTP1-SD-001B-0001 | TRZ4-SD-004A-0204 |
| TRZ4-SD-004A-0406 | | |

Overview

The sample set for CTO 424 SDG G2055 NSB New London, consists of nineteen (19) environmental sediment samples. There were no field duplicates associated with this SDG. All samples were analyzed as indicated above.

The samples were collected by Tetra Tech NUS, Inc. on November 6 and 7, 2008 and analyzed by Mitkem Laboratories. All analyses were conducted in accordance with Naval Facilities Engineering Service Center (NFESC) Quality Assurance/Quality Control (QA/QC) criteria using USEPA SW-846 Method 8081 and 8082 analytical and reporting protocol. A USEPA Region I Tier 3 data validation was performed on the referenced samples. The data contained in this SDG were validated with regard to the following parameters:

* • Data Completeness
* • Holding Times
• Initial and Continuing Calibration
* • Laboratory Method and/or Field Quality Control Blanks
• Surrogate Spike Recoveries
* • Laboratory Control Spike / Laboratory Control Spike Duplicate Recoveries
• Matrix Spike/Matrix Spike Duplicate Results
* • Detection Limits
* • Compound Identification
• Sample Quantitation

The asterisk (*) indicates that all quality control criteria were met for this parameter. Qualified (if applicable) analytical results are summarized in Appendix A. Results as reported by the laboratory are presented in Appendix B. Appendix C contains Region I worksheets, and Appendix D contains the documentation to support the findings as discussed in this data validation report. The attached Table summarizes the validation qualifications which are based on the following information:

**CALIBRATIONS**

The continuing calibration %D was greater than the 15% quality control limit for 4,4'-DDE for the primary GC column CLPPest on 12/04/08 @ 11:23 affecting samples TRTP1-SD-001B-0001, TRP1-SD-002A-0406, and TRP1-SD-004A-0204. The non-detected 4,4'-DDE results for samples TRTP1-SD-001B-0001 and TRP1-SD-004A-0204 were not qualified for this issue as the secondary GC column was within the QC limits for 4,4'-DDE. The positive result for sample TRP1-SD-002A-0406 was not qualified due to this issue as the sample result was taken from the secondary GC column.

The continuing calibration %D was greater than the 15% quality control limit for heptachlor, 4,4'-DDE, 4,4'-DDT, methoxychlor, and the surrogate decachlorobiphenyl (DCB) for the primary GC column CLPPest on 12/04/08 @ 16:07 affecting samples TRTP1-SD-001B-0001, TRP1-SD-002A-0406, TRP1-SD-004A-0204, TPR1-SD-006B-0001, and TPZ4-SD-004B-0001. The continuing calibration %D was greater than the 15% quality control limit for 4,4'-DDT for the performance evaluation mixture (PEM) for the secondary GC column CLPPestII on 12/04/08 @ 15:52 affecting the same set of samples. The 4,4'-DDT positive and non-detected results for these samples were qualified estimated, (J) and (UJ), respectively. The 4,4'-DDE and methoxychlor sample results for the aforementioned samples were taken from the secondary GC column and no data qualification was necessary.

The continuing calibration %D was greater than the 15% quality control limit for 4,4'-DDE, methoxychlor, and cis-nonachlor for the primary GC column CLPPest on 12/04/08 @ 20:27 (@ 20:41 for cis-nonachlor) for the primary GC column CLPPEST affecting samples TPR1-SD-006B-0001, TPZ4-SD-004B-0001, TRP1-SD-005B-0001, TRP1-SD-004A-0406, and TRZ4-SD-004A-0406. The continuing calibration %D was greater than the 15% quality control limit for cis-nonachlor, oxychlordane, trans-nonachlor, and the surrogate DCB, for the secondary GC column CLPPestII on 12/04/08 @ 20:41 and also endrin, 4,4'-DDT, and the surrogate DCB for the PEM on 12/04/08 @ 20:13 affecting the same set of samples. The 4,4'-DDE positive result for TRZ4-SD-004A-0406 was qualified estimated, (J), as the result from the primary GC column was reported. The remainder of the associated samples were not qualified for 4,4'-DDE as the secondary GC column (within the QC limits) results were reported. The methoxychlor positive result for TRP1-SD-005B-0001 was qualified estimated, (J), as the result from the primary GC column was reported. The remainder of the associated samples were not qualified for methoxychlor as the secondary GC column (within the QC limits) results were reported. The cis-nonachlor positive and non-detected results for the associated samples were qualified estimated, (J) and (UJ), respectively, except where the samples results were rejected due to the % difference between the primary and secondary GC column. The oxychlordane positive results for samples TPR1-SD-006B-0001 and TRP1-SD-005B-0001 were qualified estimated, (J), as the result from the secondary GC column was reported. The remainder of the associated samples were not qualified for oxychlordane as the primary column (within the QC limits) results were reported. The trans-nonachlor positive result for TPR1-SD-006B-0001, TPZ4-SD-004B-0001, TRP1-SD-005B-0001, was qualified estimated, (J), as the result from the secondary GC column was reported. The remainder of the associated samples were not qualified for trans-nonachlor as the primary GC column (within the QC limits) results were reported. The endrin and 4,4'-DDT results for the associated samples were not qualified as the primary GC column (within the QC limits) results were reported.

The continuing calibration %D was greater than the 15% quality control limit for heptachlor, 4,4'-DDE, 4,4'-DDD, methoxychlor, and cis-nonachlor for the primary GC column CLPPest on 12/05/08 @ 00:58 (@ 01:12 for cis-nonachlor) for the primary GC column CLPPEST affecting samples TRP1-SD-005B-0001, TRP1-SD-004A-0406, TRZ4-SD-004A-0406, TRP1-SD-001A-0204, TPR1-SD-001A-0406, TPR1-SD-006A-0203, TRP1-SD-002B-0001, and TRP1-SD-003B-0001. The continuing calibration %D was greater than the 15% quality control limit for 4,4'-DDT and cis-nonachlor for the secondary GC column CLPPestII on 12/05/08 @ 00:58 (@ 01:12 for cis-nonachlor) affecting the same set of samples. The cis-nonachlor positive and non-detected results for the associated samples were qualified estimated, (J) and (UJ), respectively, except

where rejected due to the % difference between the primary and secondary GC column. The 4,4'-DDE and 4,4'-DDD positive sample results for TRZ4-SD-004A-0406, were qualified estimated, (J), as the result reported was from the primary GC column. The remainder of the associated samples were not qualified for 4,4'-DDE and 4,4'-DDD as the secondary GC column (within the QC limits) results were reported. The methoxychlor positive sample result for TRP1-SD-005B-0001 was qualified estimated, (J), as the result used was from the primary GC column. The remainder of the associated samples were not qualified for methoxychlor as the secondary GC column (within the QC limits) results were reported. The 4,4'-DDT positive sample result for TRP1-SD-001A-0204 was qualified estimated, (J), as the secondary GC column result was reported. The remainder of the associated samples were not qualified for 4,4'-DDT as the secondary GC column (within the QC limits) results were reported.

The continuing calibration %D was greater than the 15% quality control limit for cis-nonachlor for the secondary GC column CLPPestII on 12/05/08 @ 04:32 affecting samples TRP1-SD-001A-0204, TPR1-SD-001A-0406, TPR1-SD-006A-0203, TRP1-SD-002B-0001, TRP1-SD-003B-0001, TRP1-SD-005A-0204, TRP1-SD-005A-0406, TRZ4-SD-004A-0204, TRP1-SD-002A-0204, TRP1-SD-003A-0204, and TRP1-SD-004B-0001. The positive cis-nonachlor results for samples TRP1-SD-001A-0204, TPR1-SD-006A-0203, TRP1-SD-002B-0001, TRP1-SD-003B-0001, TRP1-SD-005A-0406, TRZ4-SD-004A-0204, TRP1-SD-002A-0204, TRP1-SD-003A-0204, and TRP1-SD-004B-0001 were qualified estimated, (J), as the result reported was from the secondary GC column except where rejected due to the % difference between the primary and secondary GC column. The remainder of the associated samples were not qualified for cis-nonachlor as the primary GC column (within the QC limits) results were reported.

The PCB-209 congener %D was greater than the 15% quality control limit on the secondary GC column on 12/08/08 @ 20:23. Sample TPZ4-SD-004B-0001, TRP1-SD-003B-0001, TRP1-SD-003A-0204, and TRP1-SD-002A-0204 PCB-209 positive results were qualified estimated, (J), as they were reported from the secondary GC column. The remainder of the positive and non-detected results were reported from the primary GC column for the affected samples and were not qualified.

The PCB-118 congener %D was greater than the 15% quality control limit on the primary GC column on 12/09/08 @ 00:01. The affected samples TRP1-SD-002A-0204, TRP1-SD-002A-0406, TRP1-SD-003B-0001, TRP1-SD-003A-0204, TRP1-SD-004A-0204, TRP1-SD-004A-0406, and TRP1-SD-005B-0001 positive results were qualified estimated, (J). The PCB-118 congener for sample TRP1-SD-005A-0204 was not qualified as the PCB-118 was reported from the secondary GC column.

The PCB-206 congener %D was greater than the 15% quality control limit on the secondary GC column on 12/09/08 @ 00:01. Sample TRP1-SD-002A-0204, TRP1-SD-002A-0406, TRP1-SD-003B-0001, and TRP1-SD-003A-0204 PCB-206 positive results were qualified estimated, (J), as they were reported from the secondary GC column. The remainder of the positive and non-detected results were reported from the primary GC column for the affected samples and were not qualified.

The PCB-118, PCB-187, PCB-49, PCB-87, and PCB-184 congeners were greater than the 15% quality control limit on the primary GC column on 12/09/08 @ 02:06. The secondary GC column was within the quality control limits. The affected samples TRP1-SD-004A-0406, TRP1-SD-005B-0001, and TRP1-SD-005A-0204 had non-detected results for PCB-187, PCB-49, and PCB-184 which were not qualified. Sample TRP1-SD-005A-0204 non-detected result for PCB-87 was not qualified, and the positive results for PCB-87 for samples TRP1-SD-004A-0406 and TRP1-SD-005B-0001 were qualified estimated, (J), as they were reported from the primary GC column. PCB-118 was previously qualified for the affected samples as stated above.

The PCB-209 congener %D was greater than the 15% quality control limit on the secondary GC column on 12/09/08 @ 02:06. The positive and non-detected results were reported from the primary GC column for the

affected samples and were not qualified.

The PCB-206 and PCB-187 congeners were greater than the 15% quality control limit on the secondary GC column on 12/11/08 @ 13:42. The primary GC column was within the quality control limits. The affected samples were TRTP1-SD-001B-0001, TPR1-SD-006B-0001, TRP1-SD-002B-0001, and TPR1-SD-006A-0203. Samples TRTP1-SD-001B-0001, TPR1-SD-006A-0203, and TPR1-SD-006B-0001 non-detected PCB-187 sample results were not qualified. Sample TRP1-SD-002B-0001 positive result for PCB-187 was reported from the primary GC column which was not qualified. Sample TPR1-SD-006B-0001 PCB-206 positive result was qualified estimated, (J), as it was reported from the secondary GC column. The remaining affected samples PCB-206 positive and non-detected results were not qualified as the within the QC limits primary GC column results were reported.

The PCB-209 congener was greater than the 15% quality control limit on the secondary GC column on 12/11/08 @ 18:44. The positive and non-detected results were reported from the within the QC limits primary GC column for the affected samples and were not qualified.

All the PCB congeners %Ds were greater than the 15% quality control limit on the primary GC column on 12/12/08 @ 06:17. The PCB-28, PCB-52, PCB-187, and PCB-184 congeners %Ds were greater than the 15% quality control limit on the secondary GC column on 12/12/08 @ 06:17. The PCB-28, PCB-66, PCB-101, PCB-105, PCB-184 and PCB-118 %Ds were greater than the 15% quality control limit on the primary GC column on 12/12/08 @ 13:12. The secondary GC column PCB-28, PCB-206, and PCB-209 congener %Ds were greater than the 15% quality control limits on 12/12/08 @ 13:12. The affected samples were TRP1-SD-004B-0001 and TRP1-SD-005A-0406. Sample TRP1-SD-004B-0001 and TRP1-SD-005A-0406 non-detected results for PCB-28, PCB-52, PCB-187, PCB-184, PCB-206, and PCB-209 were qualified estimated, (UJ). The non-detected results for the remainder of the PCB congeners for the samples were not qualified as the secondary GC column had satisfactory QC limit %Ds. The positive result for PCB-118 for sample TRP1-SD-005-A0406 was not qualified as it was reported from the secondary GC column. The positive result for PCB-118 for sample TRP1-SD-004B-0001 was qualified estimated, (J), as it was reported from the primary GC column.

## BLANKS

No qualification of the data was necessary.

## SURROGATE SPIKE RECOVERIES

The PEST % recovery was greater than the quality control limit for the surrogate decachlorobiphenyl (DCB) on the secondary GC column for samples TRP1-SD-006B-0001, TPZ4-SD-004B-0001, TRP1-SD-005B-0001, and TRP1-SD-003A-0204. No action was necessary for the non-detected results. The positive results for these samples which were reported from the secondary GC column were qualified estimated, (J).

The PEST % recovery was greater than the quality control limit for the surrogate DCB on the secondary column and tetrachloro-m-xylene (TCX) on the primary column for samples TRP1-SD-002A-0204 and TRP1-SD-004B-0001. No action was necessary for the non-detected results and the positive results for these samples were qualified estimated, (J).

The PEST % recovery was grater than the quality control limit for the surrogate decachlorobiphenyl (DCB) for sample TRZ4-SD-004A-0204 on both the primary and the secondary GC column. All positive results for sample TRZ4-SD-004A-0204 were qualified estimated, (J), and non-detected results were not qualified.

The PCB congeners surrogate spike % recoveries were greater than the quality control limit for the surrogate TCX on the secondary GC column for samples TRP1-SD-001A-204, TPR1-SD-001A-0406, TRZ4-SD-004A-0204, TRZ4-SD-004A-0406, TRP1-SD-003A-0204, TRP1-SD-005A-0204, TRTP1-SD-001B-0001, TPR1-SD-006B-0001, TRP1-SD-002B-0001, and TRP1-SD-005A-0406. No action was necessary for the non-detected results and positive results for samples which were reported from the secondary GC column were qualified estimated, (J), as listed below.

| Sample | PCB Congeners | Sample Qualifier |
|---|---|---|
| TRP1-SD-001A-204 | PCB-8, PCB-52, PCB-87, PCB-184 | J |
| TPR1-SD-001A-0406 | PCB-52, PCB-153 | J |
| TRZ4-SD-004A-0204 | PCB-52 | J |
| TRZ4-SD-004A-0406 | PCB-87, PCB-101 | J |
| TRP1-SD-003A-0204 | PCB-87, PCB-153, PCB-206, PCB-209 | J |
| TRP1-SD-005A-0204 | PCB-8, PCB-28, PCB-52, PCB-101, PCB-118, PCB-180 | J |
| TRTP1-SD-001B-0001 | PCB-52 | J |
| TPR1-SD-006B-0001 | PCB-28, PCB-52, PCB-101, PCB-105, PCB-118, | J |
| | PCB-153, PCB-206 | J |
| TRP1-SD-002B-0001 | PCB-8, PCB-18, PCB-28, PCB-44, PCB-101 | J |
| TRP1-SD-005A-0406 | PCB-49, PCB-87, PCB-118 | J |

Sample TRP1-SD-002B-0001 PCB-52 was not qualified estimated as it was rejected due to GC column percent difference >100%.

## MATRIX SPIKE / MATRIX SPIKE DUPLICATE (MS / MSD)

The PEST MS/MSD for sample TRP1-SD-004A-0204 had % recoveries both less than and greater than the quality control limit for the primary and secondary GC columns, as well as RPDs that were greater than the quality control limit for the primary and secondary GC columns. The results are tabulated below along with the sample qualifier for each compound.

| PEST | Primary column | | | Secondary Column | | | Sample |
|---|---|---|---|---|---|---|---|
| Compound | MS | MSD | RPD | MS | MSD | RPD | Qualifier |
| Aldrin | < | < | ok | ok | < | > | UJ |
| Endrin | < | < | n/a | < | < | ok | UJ |
| Gamma-BHC | < | < | n/a | ok | < | > | UJ |
| Heptachlor | < | < | ok | < | < | > | UJ |
| Heptachlor epoxide | < | < | ok | > | > | ok | UJ |
| Endosulfan I | > | > | ok | > | ok | > | UJ |
| Dieldrin | ok | ok | ok | > | > | > | U |
| 4,4'-DDE | > | > | ok | > | > | ok | UJ |
| Endosulfan II | ok | ok | ok | > | > | > | U |
| 4,4'-DDD | > | > | ok | > | ok | > | UJ |
| 4,4'-DDT | * | * | * | * | * | * | * |
| Methoxychlor | ok | ok | > | > | > | > | U |
| Alpha-chlordane | < | ok | ok | ok | ok | ok | U |
| Gamma-chlordane | < | < | ok | > | > | > | UJ |

* not applicable due to high level in sample prior to spike

There was also an MS/MSD performed on the dilution sample TRZ4-SD-004A-0406 which was not

evaluated as none of the data from the dilution sample was used for this report. The dilution was not necessary as all PEST compounds were within the calibration limits for sample TRZ4-SD-004A-0406.

The PCB congener MS and MSD for sample TRP1-SD-004A-0204 had % recoveries less than the quality control limit for PCB congeners 8, 18, 28, 44, 52, 101, 105, 118, 123, 138, 153, 180, 183, and 206 on the primary GC column. The positive and non-detected results reported from the primary GC column for all of these congeners were qualified estimated, (J) and (UJ), for sample TRP1-SD-004A-0204.

The PCB congener MS % recovery was greater than the quality control limit for PCB-209 for sample TRP1-SD-004A-0204 from the secondary GC column. No action was taken for the non-detected sample result.

The PCB congener MS/MSD RPD was greater than the quality control limit for PCB-206 and PCB-170 for sample TRP1-SD-004A-0204 from the secondary GC column. No additional data qualification was necessary for PCB-206 and PCB-170 as they were reported from the primary GC column.

The PCB congener MS % recoveries were less than the quality control limit for PCBs 8, 18, 28, 44, 52, 101, 105, 118, 128, 138, 153, 180, and 183 for sample TRZ4-SD-004A-0406 for the primary GC column. The PCB congener MSD % recoveries were less than the quality control limit for PCBs 8, 18, 28, 52, 118, and 180 for the same sample for the primary GC column. Additionally, the MS/MSD RPD was greater than the quality control limit for the primary GC column for the same sample for PCBs 28, 44, 52, 101, and 128. The positive sample results for PCBs 8, 18, 28, 44, 105, 118, 128, 138, 153, 180, and 183 were qualified estimated, (J), for sample TRZ4-SD-004A-0406 as they were reported from the primary GC column.

The PCB congener MS and MSD % recovery was greater than the quality control limit for PCB-128 for sample TRZ4-SD-004A-0406 on the secondary GC column. The PCB congener MS % recovery was less than the quality control limit and the MS/MSD RPD was greater than the QC limit for PCB-180 for the same sample on the secondary GC column. The PCB congener MSD % recovery was greater than the QC limit for PCB-209 and the MS/MSD RPD was greater than the QC limit for PCB-209 for the same sample on the secondary GC column. No action was taken for these QC exceedances as all PCB 128, 180, and 209 results were reported from the primary GC column for sample TRZ4-SD-004A-0406.

## LABORATORY CONTROL SPIKE/LABORATORY CONTROL SPIKE DUPLICATE

No qualification of the data was necessary.

## COMPOUND QUANTITATION

The %RPD was greater than 25% between the primary and secondary GC columns for the PEST analysis for a number of samples. The samples with %RPDs greater than 25% but less than or equal to 100% were qualified estimated, (J). Samples with %RPDs greater than 100% were qualified rejected, (R). All sample %RPDs had to be calculated by hand as the laboratory only calculated % difference values. The samples and the %RPDs are listed as follows.

| Sample | Compound | %RPD | Qualifer |
|---|---|---|---|
| TRTP1-SD-001B-0001 | Gamma-BHC | 82.8 | J |
| | 4,4'-DDT | 35.3 | J |
| | Cis-nonachlor | 143.9 | R |
| TRP1-SD-001A-0204 | Heptachlor epoxide | 38.8 | J |

| | | | |
|---|---|---|---|
| | Endosulfan I | 34.2 | J |
| | Cis-nonachlor | 57.1 | J |
| TRP1-SD-006B-0001 | Gamma-BHC | 40.0 | J |
| | 4,4'-DDE | 82.9 | J |
| | Cis-nonachlor | 176.2 | R |
| | Oxychlordane | 28.6 | J |
| | Trans-nonachlor | 39.1 | J |
| TPR1-SD-006A-0203 | Cis-nonachlor | 135.4 | J |
| TPZ4-SD-004B-0001 | 4,4'-DDE | 79.1 | J |
| | Methoxychlor | 54.0 | J |
| | Trans-nonachlor | 36.9 | J |
| TRZ4-SD-004A-0204 | Heptachlor epoxide | 66.7 | J |
| | Dieldrin | 154.0 | R |
| | 4,4'-DDE | 53.1 | J |
| | 4,4'-DDT | 43.0 | J |
| | Methoxychlor | 50.0 | J |
| | Alpha-Chlordane | 89.2 | J |
| | Gamma-Chlordane | 87.5 | J |
| | Cis-nonachlor | 157.7 | R |
| | Trans-nonachlor | 40.0 | J |
| TRZ4-SD-004A-0406 | Heptachlor | 59.0 | J |
| | Heptachlor epoxide | 58.8 | J |
| | Dieldrin | 63.4 | J |
| | 4,4'-DDT | 66.7 | J |
| | Cis-nonachlor | 100.0 | J |
| | Trans-nonachlor | 160.7 | J |
| TRP1-SD-002B-0001 | 4,4'-DDT | 170.4 | R |
| | Cis-nonachlor | 133.3 | J |
| TRP1-SD-002A-0204 | gamma-BHC | 187.9 | R |
| | Heptachlor epoxide | 34.0 | J |
| | Dieldrin | 93.0 | J |
| | 4,4'-DDE | 40.0 | J |
| | 4,4'-DDT | 84.4 | J |
| | Alpha-Chlordane | 30.8 | J |
| | Gamma-Chlordane | 88.0 | J |
| | Cis-nonachlor | 106.7 | R |
| TRP1-SD-002A-0406 | Heptachlor epoxide | 47.1 | J |
| | 4,4'-DDE | 60.0 | J |
| | Cis-nonachlor | 124.3 | R |
| | Oxychlordane | 55.8 | J |
| | Trans-nonachlor | 28.6 | J |
| TRP1-SD-003B-0001 | 4,4'-DDT | 184.6 | R |

| | | | |
|---|---|---|---|
| | Cis-nonachlor | 147.2 | R |
| TRP1-SD-003A-0204 | Gamma-BHC | 45.6 | J |
| | Heptachlor epoxide | 74.0 | J |
| | 4,4'-DDE | 41.7 | J |
| | 4,4'-DDD | 61.8 | J |
| | 4,4'-DDT | 124.7 | R |
| | Methoxychlor | 66.7 | J |
| | Cis-nonachlor | 90.5 | J |
| | Oxychlordane | 176.0 | R |
| TRP1-SD-004B-0001 | 4,4'-DDE | 34.5 | J |
| | 4,4'-DDT | 129.1 | R |
| | Methoxychlor | 123.5 | R |
| | Gamma-Chlordane | 62.3 | J |
| | Cis-nonachlor | 172.5 | R |
| | Oxychlordane | 191.1 | R |
| TRP1-SD-004A-0204 | 4,4'-DDT | 64.2 | J |
| | Cis-nonachlor | 143.1 | R |
| TRP1-SD-004A-0406 | 4.4'-DDD | 42.4 | J |
| | 4,4'-DDT | 149.2 | R |
| | Oxychlordane | 46.2 | J |
| TRP1-SD-005B-0001 | Gamma-BHC | 79.2 | J |
| | Aldrin | 62.5 | J |
| TRP1-SD-005A-0204 | Oxychlordane | 25.4 | J |
| TRP1-SD-005A-0406 | 4,4'-DDE | 51.9 | J |
| | Gamma-Chlordane | 46.2 | J |
| | Cis-nonachlor | 145.9 | R |
| | Oxychlordane | 45.3 | J |

The %RPD was greater than 25% between the primary and secondary GC columns for the PCB congener analysis for a number of samples. The samples with %RPDs greater than 25% but less than or equal to 100% were qualified estimated, (J). Samples with %RPDs greater than 100% were qualified rejected, (R). All sample %RPDs had to be calculated by hand as the laboratory only calculated % difference values. The %RPDs were only calculated for the borderline 25%D and 100%D sample results due to the large number of positive PCB congeners detected. The samples and the PCB congener qualifications are listed as follows.

| Sample | PCB Compound | Qualifer |
|---|---|---|
| TRP1-SD-001A-0204 | 8, 18, 28, 44, 101, 105, 118, 138, 170, 180 | J |
| | 187, 209 | J |
| TPR1-SD-001A-0406 | 87, 105, 118, 138, 187 | J |
| | 101, 170, 180 | R |

| | | |
|---|---|---|
| TPZ4-SD-004B-0001 | 8, 44, 87, 101, 118, 153, 206, 209<br>28, 52 | J<br>R |
| TRZ4-SD-004A-0204 | 18, 28, 44, 138, 209 | J |
| TRZ4-SD-004A-0406 | 8, 18, 28, 44, 66, 138, 187, 184, 183, 209<br>49, 105, 128, 170 | J<br>R |
| TRP1-SD-002A-0204 | 8, 28, 44, 105, 118, 138, 187, 206<br>49, 170 | J<br>R |
| TRP1-SD-002A-0406 | 8, 18, 28, 66, 105, 118, 138, 170, 180, 187, 183<br>49, 128, 209 | J<br>R |
| TRP1-SD-003B-0001 | 18, 28, 49, 52, 66, 105, 118, 138, 180, 209<br>8, 170, 206 | J<br>R |
| TRP1-SD-003A-0204 | 28, 105, 118, 138, 170, 180 | J |
| TRP1-SD-004A-0204 | 28, 44, 105, 138, 187, 183<br>8, 49, 66, 128, 170 | J<br>R |
| TRP1-SD-004A-0406 | 8, 87, 105, 118, 138, 153, 180, 187, 206, 209<br>101, 170 | J<br>R |
| TRP1-SD-005B-0001 | 8, 44, 87, 153<br>101 | J<br>R |
| TRP1-SD-005A-0204 | 44, 52, 101, 180<br>18 | J<br>R |
| TRTP1-SD-001B-0001 | 8, 18, 28, 44, 66, 105, 118, 138, 153, 180, 209<br>49, 187 | J<br>R |
| TPR1-SD-006B-0001 | 44, 52, 101, 138, 170, 180, 206<br>8, 49, 66 | J<br>R |
| TRP1-SD-002B-0001 | 8, 18, 28, 101, 118, 138, 153, 180<br>44, 52 | J<br>R |
| TPR1-SD-006A-0203 | 87, 118, 153, 180<br>28, 49, 66, 101 | J<br>R |
| TRP1-SD-004B-0001 | 49, 87, 118 | J |
| TRP1-SD-005A-0406 | 49, 87, 118 | J |

## ADDITIONAL COMMENTS

Positive results reported below the quantitation limit but above the method detection limit were qualified as estimated, (J).

The %RPD between the primary and secondary GC columns was manually calculated for the positive PEST/PCB detections. The laboratory presented %D between GC columns instead of %RPD.

The lower PEST/PCB result, when choosing between the primary and secondary GC column PCB results, was reported by the laboratory.

There was no calibration verification run after the initial calibration and prior to the running of samples for the PCB congeners.

The laboratory performed dilutions on some of the samples for PEST analysis as indicated below.

| Sample | Dilution |
|---|---|
| TPR1-SD-001A-0406 | 5X |
| TPR1-SD-006A-0203 | 5X |
| TRP1-SD-001A-0204 | 10X |
| TRP1-SD-002A-0406 | 10X |
| TRP1-SD-002B-0001 | 5X |
| TRP1-SD-004A-0204 | 10X |
| TRP1-SD-004A-0406 | 10X |
| TRP1-SD-005A-0204 | 5X |
| TRP1-SD-005A-0406 | 5X |
| TRTP1-SD-001B-0001 | 4X |
| TRZ4-SD-004A-0406 | 2X |

## EXECUTIVE SUMMARY

**Laboratory Performance:** There were calibration issues associated with both the PEST and PCB congener analyses. There were surrogate spike % recoveries issues for both the PEST and PCB congener analyses. There were both PEST and PCB congener MS/MSD QC issues which resulted in data qualification for some samples. There were many GC column % differences in excess of 25% for both the PEST and PCB congener analyses.

**Other Factors Affecting Data Quality:** None.

The data for these analyses were reviewed with reference to the Region I EPA "Data Validation Functional Guidelines - Part II" (12/96), National Functional Guidelines for Low Concentration Organic Data Review, and the DoD Quality Systems (QSM) (January 2006).

"I attest that the data referenced herein were validated according to the agreed upon validation criteria as specified in the NFESC Guidelines and the DoD QSM."

TetraTech NUS
Joseph Kalinyak
Chemist/Data Validator

TetraTech NUS
Joseph A. Samchuck
Data Validation Quality Assurance Officer

Attachments:

1. Appendix A - Qualified Analytical Results
2. Appendix B - Results as Reported by the Laboratory
3. Appendix C - Regional Worksheets
4. Appendix D - Support Documentation

# APPENDIX A

## QUALIFIED LABORATORY RESULTS

**Qualifier Codes:**

A = Lab Blank Contamination
B = Field Blank Contamination
C = Calibration Noncompliance (i.e., % RSDs, %Ds, ICVs, CCVs, RRFs, etc.)
C01 = GC/MS Tuning Noncompliance
D = MS/MSD Recovery Noncompliance
E = LCS/LCSD Recovery Noncompliance
F = Lab Duplicate Imprecision
G = Field Duplicate Imprecision
H = Holding Time Exceedance
I = ICP Serial Dilution Noncompliance
J = GFAA PDS - GFAA MSA's $r < 0.995$
K = ICP Interference - includes ICS % R Noncompliance
L = Instrument Calibration Range Exceedance
M = Sample Preservation Noncompliance
N = Internal Standard Noncompliance
N01 = Internal Standard Recovery Noncompliance Dioxins
N02 = Recovery Standard Noncompliance Dioxins
N03 = Clean-up Standard Noncompliance Dioxins
O = Poor Instrument Performance (i.e., base-time drifting)
P = Uncertainty near detection limit (< 2 x IDL for inorganics and <CRQL for organics)
Q = Other problems (can encompass a number of issues; i.e.chromatography,interferences, etc.)
R = Surrogates Recovery Noncompliance
S = Pesticide/PCB Resolution
T = % Breakdown Noncompliance for DDT and Endrin
U = % Difference between columns/detectors >25% for positive results determined via GC/HPLC
V = Non-linear calibrations; correlation coefficient $r < 0.995$
W = EMPC result
X = Signal to noise response drop
Y = Percent solids <30%
Z = Uncertainty at 2 sigma deviation is less than sample activity

# PROJ_NO: 00811

SDG: G2055 MEDIA: SOIL DATA FRACTION: PEST/PCB

| | |
|---|---|
| nsample | TPR1-SD-001A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2055-03A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 53.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 4,4'-DDD | 6.2 | U | |
| 4,4'-DDE | 7.5 | | |
| 4,4'-DDT | 6.2 | U | |
| ALDRIN | 3.2 | U | |
| ALPHA-CHLORDANE | 3.2 | U | |
| CIS-NONACHLOR | 3.2 | UJ | C |
| DIELDRIN | 6.2 | U | |
| ENDOSULFAN I | 3.2 | U | |
| ENDOSULFAN II | 6.2 | U | |
| ENDRIN | 6.2 | U | |
| GAMMA-BHC (LINDANE) | 3.2 | U | |
| GAMMA-CHLORDANE | 3.2 | U | |
| HEPTACHLOR | 3.2 | U | |
| HEPTACHLOR EPOXIDE | 3.2 | U | |
| METHOXYCHLOR | 32 | U | |
| OXYCHLORDANE | 12 | | |
| PCB-101 | 3.3 | R | U |
| PCB-105 | 3.2 | J | U |
| PCB-118 | 6.3 | J | U |
| PCB-128 | 1.8 | U | |
| PCB-138 | 7.3 | J | U |
| PCB-153 | 9.4 | J | R |
| PCB-170 | 3.5 | R | U |
| PCB-18 | 1.8 | U | |
| PCB-180 | 3.3 | R | U |
| PCB-183 | 3.1 | | |
| PCB-184 | 2.2 | | |
| PCB-187 | 1.9 | J | U |
| PCB-195 | 1.8 | U | |
| PCB-206 | 15 | | |
| PCB-209 | 18 | | |
| PCB-28 | 1.8 | U | |

| | |
|---|---|
| nsample | TPR1-SD-001A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2055-03A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 53.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| PCB-44 | 1.8 | U | |
| PCB-49 | 1.8 | U | |
| PCB-52 | 6.6 | J | R |
| PCB-66 | 1.8 | U | |
| PCB-8 | 1.8 | U | |
| PCB-87 | 17 | J | U |
| TOXAPHENE | 320 | U | |
| TRANS-NONACHLOR | 7.1 | | |

| | |
|---|---|
| nsample | TPR1-SD-006A-0203 |
| samp_date | 11/7/2008 |
| lab_id | G2055-05A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 44.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 4,4'-DDD | 7.4 | U | |
| 4,4'-DDE | 7.4 | U | |
| 4,4'-DDT | 7.4 | U | |
| ALDRIN | 3.8 | U | |
| ALPHA-CHLORDANE | 3.8 | U | |
| CIS-NONACHLOR | 5.2 | R | U |
| DIELDRIN | 7.4 | U | |
| ENDOSULFAN I | 3.8 | U | |
| ENDOSULFAN II | 7.4 | U | |
| ENDRIN | 7.4 | U | |
| GAMMA-BHC (LINDANE) | 3.8 | U | |
| GAMMA-CHLORDANE | 3.8 | U | |
| HEPTACHLOR | 3.8 | U | |
| HEPTACHLOR EPOXIDE | 3.8 | U | |
| METHOXYCHLOR | 38 | U | |
| OXYCHLORDANE | 21 | | |
| PCB-101 | 4.2 | R | U |
| PCB-105 | 2.3 | U | |
| PCB-118 | 5 | J | U |
| PCB-128 | 2.3 | U | |
| PCB-138 | 5.6 | | |
| PCB-153 | 3.6 | J | U |
| PCB-170 | 2.3 | U | |
| PCB-18 | 3 | | |
| PCB-180 | 2.3 | J | U |
| PCB-183 | 2.3 | U | |
| PCB-184 | 2.3 | U | |
| PCB-187 | 2.3 | U | |
| PCB-195 | 2.3 | U | |
| PCB-206 | 2.3 | U | |
| PCB-209 | 2.3 | U | |
| PCB-28 | 4.1 | R | U |

# PROJ_NO: 00811

SDG: G2055 MEDIA: SOIL DATA FRACTION: PEST/PCB

| | |
|---|---|
| nsample | TPR1-SD-006A-0203 |
| samp_date | 11/7/2008 |
| lab_id | G2055-05A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 44.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| PCB-44 | 2.3 | U | |
| PCB-49 | 4.6 | R | U |
| PCB-52 | 2.3 | U | |
| PCB-66 | 3 | R | U |
| PCB-8 | 2.3 | U | |
| PCB-87 | 3.9 | J | U |
| TOXAPHENE | 380 | U | |
| TRANS-NONACHLOR | 13 | | |

| | |
|---|---|
| nsample | TPR1-SD-006B-0001 |
| samp_date | 11/7/2008 |
| lab_id | G2055-04A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 38.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 4,4'-DDD | 1.7 | U | |
| 4,4'-DDE | 1.2 | J | U |
| 4,4'-DDT | 1.7 | UJ | C |
| ALDRIN | 0.88 | U | |
| ALPHA-CHLORDANE | 0.88 | U | |
| CIS-NONACHLOR | 1.2 | R | U |
| DIELDRIN | 1.7 | U | |
| ENDOSULFAN I | 0.88 | U | |
| ENDOSULFAN II | 1.7 | U | |
| ENDRIN | 1.7 | U | |
| GAMMA-BHC (LINDANE) | 1.2 | J | U |
| GAMMA-CHLORDANE | 0.88 | U | |
| HEPTACHLOR | 0.88 | U | |
| HEPTACHLOR EPOXIDE | 0.88 | U | |
| METHOXYCHLOR | 8.8 | U | |
| OXYCHLORDANE | 12 | J | CU |
| PCB-101 | 7.6 | J | RU |
| PCB-105 | 2.6 | J | R |
| PCB-118 | 8.3 | J | R |
| PCB-128 | 2.5 | U | |
| PCB-138 | 5.3 | J | U |
| PCB-153 | 6.3 | J | R |
| PCB-170 | 3.6 | J | U |
| PCB-18 | 31 | | |
| PCB-180 | 2.8 | J | U |
| PCB-183 | 2.5 | U | |
| PCB-184 | 2.5 | U | |
| PCB-187 | 2.5 | U | |
| PCB-195 | 2.5 | U | |
| PCB-206 | 3 | J | CRU |
| PCB-209 | 2.5 | U | |
| PCB-28 | 23 | J | R |

| | |
|---|---|
| nsample | TPR1-SD-006B-0001 |
| samp_date | 11/7/2008 |
| lab_id | G2055-04A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 38.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| PCB-44 | 8.7 | J | U |
| PCB-49 | 3.5 | R | U |
| PCB-52 | 9.9 | J | RU |
| PCB-66 | 4.8 | R | U |
| PCB-8 | 3.9 | R | U |
| PCB-87 | 5.9 | | |
| TOXAPHENE | 88 | U | |
| TRANS-NONACHLOR | 7.4 | J | CU |

# PROJ_NO: 00811

SDG: G2055 MEDIA: SOIL DATA FRACTION: PEST/PCB

| | |
|---|---|
| nsample | TPZ4-SD-004B-0001 |
| samp_date | 11/7/2008 |
| lab_id | G2055-06A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 72.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 4,4'-DDD | 0.9 | U | |
| 4,4'-DDE | 0.52 | J | RU |
| 4,4'-DDT | 0.9 | UJ | C |
| ALDRIN | 0.47 | U | |
| ALPHA-CHLORDANE | 0.47 | U | |
| CIS-NONACHLOR | 0.47 | UJ | C |
| DIELDRIN | 0.9 | U | |
| ENDOSULFAN I | 0.47 | U | |
| ENDOSULFAN II | 0.9 | U | |
| ENDRIN | 0.9 | U | |
| GAMMA-BHC (LINDANE) | 0.55 | J | R |
| GAMMA-CHLORDANE | 0.64 | J | R |
| HEPTACHLOR | 0.47 | U | |
| HEPTACHLOR EPOXIDE | 0.47 | U | |
| METHOXYCHLOR | 6.9 | J | RU |
| OXYCHLORDANE | 0.47 | U | |
| PCB-101 | 3.3 | J | U |
| PCB-105 | 1.4 | U | |
| PCB-118 | 2.5 | J | U |
| PCB-128 | 1.4 | U | |
| PCB-138 | 1.7 | | |
| PCB-153 | 1.6 | J | U |
| PCB-170 | 1.4 | U | |
| PCB-18 | 2.5 | | |
| PCB-180 | 1.4 | U | |
| PCB-183 | 1.4 | U | |
| PCB-184 | 1.4 | U | |
| PCB-187 | 1.4 | U | |
| PCB-195 | 1.4 | U | |
| PCB-206 | 3.4 | J | U |
| PCB-209 | 4.1 | J | CU |
| PCB-28 | 1.7 | R | U |

| | |
|---|---|
| nsample | TPZ4-SD-004B-0001 |
| samp_date | 11/7/2008 |
| lab_id | G2055-06A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 72.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| PCB-44 | 4 | J | U |
| PCB-49 | 1.4 | U | |
| PCB-52 | 1.7 | R | U |
| PCB-66 | 1.4 | U | |
| PCB-8 | 2.4 | J | U |
| PCB-87 | 2.1 | J | U |
| TOXAPHENE | 47 | U | |
| TRANS-NONACHLOR | 5.3 | J | CRU |

| | |
|---|---|
| nsample | TRP1-SD-001A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2055-02A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 44.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 4,4'-DDD | 15 | U | |
| 4,4'-DDE | 39 | | |
| 4,4'-DDT | 72 | | |
| ALDRIN | 7.6 | U | |
| ALPHA-CHLORDANE | 7.6 | U | |
| CIS-NONACHLOR | 55 | J | CU |
| DIELDRIN | 15 | U | |
| ENDOSULFAN I | 9.2 | J | U |
| ENDOSULFAN II | 15 | U | |
| ENDRIN | 15 | U | |
| GAMMA-BHC (LINDANE) | 7.6 | U | |
| GAMMA-CHLORDANE | 7.6 | U | |
| HEPTACHLOR | 7.6 | U | |
| HEPTACHLOR EPOXIDE | 27 | J | U |
| METHOXYCHLOR | 76 | U | |
| OXYCHLORDANE | 7.6 | U | |
| PCB-101 | 12 | J | U |
| PCB-105 | 7.9 | J | U |
| PCB-118 | 13 | J | U |
| PCB-128 | 2.2 | U | |
| PCB-138 | 12 | J | U |
| PCB-153 | 14 | | |
| PCB-170 | 5.6 | J | U |
| PCB-18 | 3.2 | J | U |
| PCB-180 | 7.5 | J | U |
| PCB-183 | 2.8 | | |
| PCB-184 | 2.5 | J | R |
| PCB-187 | 3.1 | J | U |
| PCB-195 | 2.2 | U | |
| PCB-206 | 7.8 | | |
| PCB-209 | 14 | J | U |
| PCB-28 | 6.7 | J | U |

# PROJ_NO: 00811

SDG: G2055 MEDIA: SOIL DATA FRACTION: PEST/PCB

| | |
|---|---|
| nsample | TRP1-SD-001A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2055-02A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 44.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| PCB-44 | 6.8 | J | U |
| PCB-49 | 2.2 | U | |
| PCB-52 | 19 | J | R |
| PCB-66 | 2.2 | U | |
| PCB-8 | 6 | J | RU |
| PCB-87 | 19 | J | R |
| TOXAPHENE | 760 | U | |
| TRANS-NONACHLOR | 7.6 | U | |

| | |
|---|---|
| nsample | TRP1-SD-002A-0204 |
| samp_date | 11/7/2008 |
| lab_id | G2055-10A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 47.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 4,4'-DDD | 3.6 | J | R |
| 4,4'-DDE | 5.8 | J | RU |
| 4,4'-DDT | 13 | J | RU |
| ALDRIN | 0.72 | U | |
| ALPHA-CHLORDANE | 1.1 | J | RU |
| CIS-NONACHLOR | 7 | R | U |
| DIELDRIN | 1.9 | J | RU |
| ENDOSULFAN I | 0.72 | U | |
| ENDOSULFAN II | 1.4 | U | |
| ENDRIN | 1.4 | U | |
| GAMMA-BHC (LINDANE) | 1.4 | R | U |
| GAMMA-CHLORDANE | 2.1 | J | RU |
| HEPTACHLOR | 0.72 | U | |
| HEPTACHLOR EPOXIDE | 4.4 | J | RU |
| METHOXYCHLOR | 7.2 | U | |
| OXYCHLORDANE | 0.72 | U | |
| PCB-101 | 17 | | |
| PCB-105 | 5 | J | U |
| PCB-118 | 12 | J | CU |
| PCB-128 | 2.1 | U | |
| PCB-138 | 13 | J | U |
| PCB-153 | 13 | | |
| PCB-170 | 3 | R | U |
| PCB-18 | 6.8 | | |
| PCB-180 | 8 | | |
| PCB-183 | 2.1 | U | |
| PCB-184 | 2.1 | U | |
| PCB-187 | 3.6 | J | U |
| PCB-195 | 2.1 | U | |
| PCB-206 | 3.9 | J | C |
| PCB-209 | 3.1 | J | CU |
| PCB-28 | 14 | J | U |

| | |
|---|---|
| nsample | TRP1-SD-002A-0204 |
| samp_date | 11/7/2008 |
| lab_id | G2055-10A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 47.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| PCB-44 | 7.5 | J | U |
| PCB-49 | 3.8 | R | U |
| PCB-52 | 17 | | |
| PCB-66 | 2.1 | U | |
| PCB-8 | 3 | J | U |
| PCB-87 | 6 | | |
| TOXAPHENE | 72 | U | |
| TRANS-NONACHLOR | 9.6 | J | R |

# PROJ_NO: 00811

SDG: G2055 MEDIA: SOIL DATA FRACTION: PEST/PCB

| | |
|---|---|
| nsample | TRP1-SD-002A-0406 |
| samp_date | 11/7/2008 |
| lab_id | G2055-11A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 47.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 4,4'-DDD | 14 | U | |
| 4,4'-DDE | 14 | J | U |
| 4,4'-DDT | 29 | J | C |
| ALDRIN | 7.2 | U | |
| ALPHA-CHLORDANE | 7.2 | U | |
| CIS-NONACHLOR | 14 | R | U |
| DIELDRIN | 14 | U | |
| ENDOSULFAN I | 7.2 | U | |
| ENDOSULFAN II | 14 | U | |
| ENDRIN | 14 | U | |
| GAMMA-BHC (LINDANE) | 7.2 | U | |
| GAMMA-CHLORDANE | 7.2 | U | |
| HEPTACHLOR | 7.2 | U | |
| HEPTACHLOR EPOXIDE | 13 | J | U |
| METHOXYCHLOR | 72 | U | |
| OXYCHLORDANE | 31 | J | U |
| PCB-101 | 48 | | |
| PCB-105 | 16 | J | U |
| PCB-118 | 30 | J | CU |
| PCB-128 | 4.7 | R | U |
| PCB-138 | 38 | J | U |
| PCB-153 | 36 | | |
| PCB-170 | 12 | J | U |
| PCB-18 | 18 | J | U |
| PCB-180 | 21 | J | U |
| PCB-183 | 4.8 | J | U |
| PCB-184 | 2 | U | |
| PCB-187 | 5.8 | J | U |
| PCB-195 | 2.4 | | |
| PCB-206 | 9.4 | J | C |
| PCB-209 | 2.7 | R | U |
| PCB-28 | 25 | J | U |

| | |
|---|---|
| nsample | TRP1-SD-002A-0406 |
| samp_date | 11/7/2008 |
| lab_id | G2055-11A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 47.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| PCB-44 | 22 | | |
| PCB-49 | 5.6 | R | U |
| PCB-52 | 35 | | |
| PCB-66 | 26 | J | U |
| PCB-8 | 7 | J | U |
| PCB-87 | 45 | | |
| TOXAPHENE | 720 | U | |
| TRANS-NONACHLOR | 7.5 | J | U |

| | |
|---|---|
| nsample | TRP1-SD-002B-0001 |
| samp_date | 11/7/2008 |
| lab_id | G2055-09A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 42.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 4,4'-DDD | 7.8 | U | |
| 4,4'-DDE | 7.8 | U | |
| 4,4'-DDT | 12 | R | U |
| ALDRIN | 4 | U | |
| ALPHA-CHLORDANE | 4 | U | |
| CIS-NONACHLOR | 5.2 | R | U |
| DIELDRIN | 7.8 | U | |
| ENDOSULFAN I | 4 | U | |
| ENDOSULFAN II | 7.8 | U | |
| ENDRIN | 7.8 | U | |
| GAMMA-BHC (LINDANE) | 4 | U | |
| GAMMA-CHLORDANE | 4 | U | |
| HEPTACHLOR | 4 | U | |
| HEPTACHLOR EPOXIDE | 4 | U | |
| METHOXYCHLOR | 40 | U | |
| OXYCHLORDANE | 28 | | |
| PCB-101 | 6.2 | J | RU |
| PCB-105 | 2.4 | U | |
| PCB-118 | 8.6 | J | U |
| PCB-128 | 2.4 | U | |
| PCB-138 | 6.5 | J | U |
| PCB-153 | 6.1 | J | U |
| PCB-170 | 2.4 | U | |
| PCB-18 | 4.4 | J | U |
| PCB-180 | 2.7 | J | U |
| PCB-183 | 2.2 | U | |
| PCB-184 | 2.4 | U | |
| PCB-187 | 2.5 | | |
| PCB-195 | 2.4 | U | |
| PCB-206 | 2.4 | U | |
| PCB-209 | 2.4 | U | |
| PCB-28 | 9.5 | J | RU |

# PROJ_NO: 00811

SDG: G2055 MEDIA: SOIL DATA FRACTION: PEST/PCB

| | |
|---|---|
| nsample | TRP1-SD-002B-0001 |
| samp_date | 11/7/2008 |
| lab_id | G2055-09A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 42.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| PCB-44 | 2.7 | R | U |
| PCB-49 | 2.4 | U | |
| PCB-52 | 2.7 | R | U |
| PCB-66 | 2.4 | U | |
| PCB-8 | 4.1 | J | RU |
| PCB-87 | 5 | | |
| TOXAPHENE | 400 | U | |
| TRANS-NONACHLOR | 13 | | |

| | |
|---|---|
| nsample | TRP1-SD-003A-0204 |
| samp_date | 11/7/2008 |
| lab_id | G2055-13A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 63.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 4,4'-DDD | 3.8 | J | U |
| 4,4'-DDE | 3.8 | J | U |
| 4,4'-DDT | 5.8 | R | U |
| ALDRIN | 0.49 | J | R |
| ALPHA-CHLORDANE | 0.54 | U | |
| CIS-NONACHLOR | 4.9 | J | CU |
| DIELDRIN | 7.1 | J | R |
| ENDOSULFAN I | 0.54 | U | |
| ENDOSULFAN II | 1 | U | |
| ENDRIN | 1 | U | |
| GAMMA-BHC (LINDANE) | 0.61 | J | RU |
| GAMMA-CHLORDANE | 0.54 | U | |
| HEPTACHLOR | 0.54 | U | |
| HEPTACHLOR EPOXIDE | 0.69 | J | U |
| METHOXYCHLOR | 7 | J | U |
| OXYCHLORDANE | 0.55 | R | U |
| PCB-101 | 5.6 | | |
| PCB-105 | 2.1 | J | U |
| PCB-118 | 3.8 | J | CU |
| PCB-128 | 1.5 | U | |
| PCB-138 | 5.2 | J | U |
| PCB-153 | 5.2 | J | R |
| PCB-170 | 5 | J | U |
| PCB-18 | 1.5 | U | |
| PCB-180 | 3.5 | J | U |
| PCB-183 | 1.5 | U | |
| PCB-184 | 1.5 | U | |
| PCB-187 | 1.5 | U | |
| PCB-195 | 1.5 | U | |
| PCB-206 | 5.8 | J | CR |
| PCB-209 | 6.7 | J | CR |
| PCB-28 | 1.7 | J | U |

| | |
|---|---|
| nsample | TRP1-SD-003A-0204 |
| samp_date | 11/7/2008 |
| lab_id | G2055-13A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 63.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| PCB-44 | 1.7 | | |
| PCB-49 | 1.5 | U | |
| PCB-52 | 4.9 | | |
| PCB-66 | 1.5 | U | |
| PCB-8 | 1.5 | U | |
| PCB-87 | 4.6 | J | R |
| TOXAPHENE | 54 | U | |
| TRANS-NONACHLOR | 5 | J | R |

# PROJ_NO: 00811

SDG: G2055 MEDIA: SOIL DATA FRACTION: PEST/PCB

| | |
|---|---|
| nsample | TRP1-SD-003B-0001 |
| samp_date | 11/7/2008 |
| lab_id | G2055-12A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 44.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 4,4'-DDD | 4.5 | U | |
| 4,4'-DDE | 4.5 | U | |
| 4,4'-DDT | 7.2 | R | U |
| ALDRIN | 2.3 | U | |
| ALPHA-CHLORDANE | 2.3 | U | |
| CIS-NONACHLOR | 3.8 | R | U |
| DIELDRIN | 4.5 | U | |
| ENDOSULFAN I | 2.3 | U | |
| ENDOSULFAN II | 4.5 | U | |
| ENDRIN | 4.5 | U | |
| GAMMA-BHC (LINDANE) | 2.3 | U | |
| GAMMA-CHLORDANE | 2.3 | U | |
| HEPTACHLOR | 2.3 | U | |
| HEPTACHLOR EPOXIDE | 2.3 | U | |
| METHOXYCHLOR | 23 | U | |
| OXYCHLORDANE | 2.3 | U | |
| PCB-101 | 16 | | |
| PCB-105 | 4.1 | J | U |
| PCB-118 | 9.9 | J | CU |
| PCB-128 | 2.2 | U | |
| PCB-138 | 12 | J | U |
| PCB-153 | 12 | | |
| PCB-170 | 3.7 | R | U |
| PCB-18 | 5.6 | J | U |
| PCB-180 | 3 | J | U |
| PCB-183 | 2.2 | U | |
| PCB-184 | 2.2 | U | |
| PCB-187 | 2.2 | U | |
| PCB-195 | 2.2 | U | |
| PCB-206 | 3.8 | R | U |
| PCB-209 | 5.6 | J | CU |
| PCB-28 | 16 | J | U |

| | |
|---|---|
| nsample | TRP1-SD-003B-0001 |
| samp_date | 11/7/2008 |
| lab_id | G2055-12A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 44.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| PCB-44 | 9.9 | | |
| PCB-49 | 7.2 | J | U |
| PCB-52 | 15 | J | U |
| PCB-66 | 9.2 | J | U |
| PCB-8 | 2.7 | J | J |
| PCB-87 | 5.4 | | |
| TOXAPHENE | 230 | U | |
| TRANS-NONACHLOR | 11 | | |

| | |
|---|---|
| nsample | TRP1-SD-004A-0204 |
| samp_date | 11/7/2008 |
| lab_id | G2055-15A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 48.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 4,4'-DDD | 14 | UJ | D |
| 4,4'-DDE | 14 | UJ | D |
| 4,4'-DDT | 18 | J | CU |
| ALDRIN | 7 | UJ | D |
| ALPHA-CHLORDANE | 7 | U | |
| CIS-NONACHLOR | 8.3 | R | U |
| DIELDRIN | 14 | U | |
| ENDOSULFAN I | 7 | UJ | D |
| ENDOSULFAN II | 14 | U | |
| ENDRIN | 14 | UJ | D |
| GAMMA-BHC (LINDANE) | 7 | UJ | D |
| GAMMA-CHLORDANE | 7 | UJ | D |
| HEPTACHLOR | 7 | UJ | D |
| HEPTACHLOR EPOXIDE | 7 | UJ | D |
| METHOXYCHLOR | 70 | U | |
| OXYCHLORDANE | 32 | | |
| PCB-101 | 28 | | |
| PCB-105 | 8.2 | J | DU |
| PCB-118 | 16 | J | CD |
| PCB-128 | 2.3 | R | U |
| PCB-138 | 20 | J | DU |
| PCB-153 | 21 | J | D |
| PCB-170 | 5.6 | R | U |
| PCB-18 | 7.4 | J | D |
| PCB-180 | 14 | J | D |
| PCB-183 | 3.1 | J | DU |
| PCB-184 | 2 | U | |
| PCB-187 | 3.6 | J | U |
| PCB-195 | 2 | U | |
| PCB-206 | 6.2 | J | D |
| PCB-209 | 2 | U | |
| PCB-28 | 13 | J | DU |

# PROJ_NO: 00811

SDG: G2055 MEDIA: SOIL DATA FRACTION: PEST/PCB

| | |
|---|---|
| nsample | TRP1-SD-004A-0204 |
| samp_date | 11/7/2008 |
| lab_id | G2055-15A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 48.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| PCB-44 | 9.1 | J | DU |
| PCB-49 | 4 | R | U |
| PCB-52 | 19 | J | D |
| PCB-66 | 9.3 | R | U |
| PCB-8 | 3.7 | R | U |
| PCB-87 | 17 | | |
| TOXAPHENE | 700 | U | |
| TRANS-NONACHLOR | 15 | | |

| | |
|---|---|
| nsample | TRP1-SD-004A-0406 |
| samp_date | 11/7/2008 |
| lab_id | G2055-16A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 56.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 4,4'-DDD | 65 | J | U |
| 4,4'-DDE | 12 | U | |
| 4,4'-DDT | 32 | R | U |
| ALDRIN | 6.1 | U | |
| ALPHA-CHLORDANE | 6.1 | U | |
| CIS-NONACHLOR | 6.1 | UJ | C |
| DIELDRIN | 12 | U | |
| ENDOSULFAN I | 6.1 | U | |
| ENDOSULFAN II | 12 | U | |
| ENDRIN | 12 | U | |
| GAMMA-BHC (LINDANE) | 6.1 | U | |
| GAMMA-CHLORDANE | 6.1 | U | |
| HEPTACHLOR | 6.1 | U | |
| HEPTACHLOR EPOXIDE | 6.1 | U | |
| METHOXYCHLOR | 61 | U | |
| OXYCHLORDANE | 15 | J | U |
| PCB-101 | 2.8 | R | U |
| PCB-105 | 3 | J | U |
| PCB-118 | 5.2 | J | CU |
| PCB-128 | 1.7 | U | |
| PCB-138 | 6.2 | J | U |
| PCB-153 | 8.1 | J | U |
| PCB-170 | 2.6 | R | U |
| PCB-18 | 1.7 | U | |
| PCB-180 | 2.7 | J | U |
| PCB-183 | 2.5 | J | U |
| PCB-184 | 1.7 | U | |
| PCB-187 | 1.7 | U | |
| PCB-195 | 1.7 | U | |
| PCB-206 | 12 | J | U |
| PCB-209 | 12 | J | U |
| PCB-28 | 1.7 | U | |

| | |
|---|---|
| nsample | TRP1-SD-004A-0406 |
| samp_date | 11/7/2008 |
| lab_id | G2055-16A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 56.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| PCB-44 | 1.7 | U | |
| PCB-49 | 1.7 | U | |
| PCB-52 | 3.6 | | |
| PCB-66 | 1.7 | U | |
| PCB-8 | 3.5 | J | U |
| PCB-87 | 13 | J | CU |
| TOXAPHENE | 610 | U | |
| TRANS-NONACHLOR | 6.1 | U | |

# PROJ_NO: 00811

SDG: G2055 MEDIA: SOIL DATA FRACTION: PEST/PCB

| | |
|---|---|
| nsample | TRP1-SD-004B-0001 |
| samp_date | 11/7/2008 |
| lab_id | G2055-14A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 37.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 4,4'-DDD | 1.8 | U | |
| 4,4'-DDE | 3.6 | J | RU |
| 4,4'-DDT | 2.8 | R | U |
| ALDRIN | 0.91 | U | |
| ALPHA-CHLORDANE | 0.91 | U | |
| CIS-NONACHLOR | 1.7 | R | U |
| DIELDRIN | 1.8 | U | |
| ENDOSULFAN I | 0.91 | U | |
| ENDOSULFAN II | 1.8 | U | |
| ENDRIN | 1.8 | U | |
| GAMMA-BHC (LINDANE) | 0.91 | U | |
| GAMMA-CHLORDANE | 2.1 | J | RU |
| HEPTACHLOR | 0.91 | U | |
| HEPTACHLOR EPOXIDE | 0.91 | U | |
| METHOXYCHLOR | 9.7 | R | U |
| OXYCHLORDANE | 0.34 | R | U |
| PCB-101 | 2.6 | U | |
| PCB-105 | 2.6 | U | |
| PCB-118 | 8.3 | J | CU |
| PCB-128 | 2.6 | U | |
| PCB-138 | 2.6 | U | |
| PCB-153 | 2.6 | U | |
| PCB-170 | 2.6 | U | |
| PCB-18 | 2.6 | U | |
| PCB-180 | 2.6 | U | |
| PCB-183 | 2.6 | U | |
| PCB-184 | 2.6 | UJ | C |
| PCB-187 | 2.6 | UJ | C |
| PCB-195 | 2.6 | U | |
| PCB-206 | 2.6 | UJ | C |
| PCB-209 | 2.6 | UJ | C |
| PCB-28 | 2.6 | UJ | C |

| | |
|---|---|
| nsample | TRP1-SD-004B-0001 |
| samp_date | 11/7/2008 |
| lab_id | G2055-14A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 37.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| PCB-44 | 2.6 | U | |
| PCB-49 | 21 | J | CU |
| PCB-52 | 2.6 | UJ | C |
| PCB-66 | 2.6 | U | |
| PCB-8 | 2.6 | U | |
| PCB-87 | 4.5 | J | CU |
| TOXAPHENE | 91 | U | |
| TRANS-NONACHLOR | 13 | J | R |

| | |
|---|---|
| nsample | TRP1-SD-005A-0204 |
| samp_date | 11/7/2008 |
| lab_id | G2055-18A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 47.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 4,4'-DDD | 6.9 | U | |
| 4,4'-DDE | 6.9 | U | |
| 4,4'-DDT | 6.9 | U | |
| ALDRIN | 3.6 | U | |
| ALPHA-CHLORDANE | 3.6 | U | |
| CIS-NONACHLOR | 3.6 | U | |
| DIELDRIN | 6.9 | U | |
| ENDOSULFAN I | 3.6 | U | |
| ENDOSULFAN II | 6.9 | U | |
| ENDRIN | 6.9 | U | |
| GAMMA-BHC (LINDANE) | 3.6 | U | |
| GAMMA-CHLORDANE | 3.6 | U | |
| HEPTACHLOR | 3.6 | U | |
| HEPTACHLOR EPOXIDE | 3.6 | U | |
| METHOXYCHLOR | 36 | U | |
| OXYCHLORDANE | 31 | J | U |
| PCB-101 | 8.9 | J | RU |
| PCB-105 | 2.1 | U | |
| PCB-118 | 5.8 | J | R |
| PCB-128 | 2.1 | U | |
| PCB-138 | 6 | | |
| PCB-153 | 6 | | |
| PCB-170 | 2.1 | U | |
| PCB-18 | 9.5 | R | U |
| PCB-180 | 4.9 | J | RU |
| PCB-183 | 2.1 | U | |
| PCB-184 | 2.1 | U | |
| PCB-187 | 2.1 | U | |
| PCB-195 | 2.1 | U | |
| PCB-206 | 2.7 | | |
| PCB-209 | 2.1 | U | |
| PCB-28 | 14 | J | R |

# PROJ_NO: 00811

SDG: G2055 MEDIA: SOIL DATA FRACTION: PEST/PCB

| | |
|---|---|
| nsample | TRP1-SD-005A-0204 |
| samp_date | 11/7/2008 |
| lab_id | G2055-18A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 47.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| PCB-44 | 9.6 | J | U |
| PCB-49 | 2.1 | U | |
| PCB-52 | 13 | J | RU |
| PCB-66 | 2.1 | U | |
| PCB-8 | 9.5 | J | R |
| PCB-87 | 2.1 | U | |
| TOXAPHENE | 360 | U | |
| TRANS-NONACHLOR | 19 | | |

| | |
|---|---|
| nsample | TRP1-SD-005A-0406 |
| samp_date | 11/7/2008 |
| lab_id | G2055-19A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 48.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 4,4'-DDD | 6.7 | U | |
| 4,4'-DDE | 10 | J | U |
| 4,4'-DDT | 20 | | |
| ALDRIN | 3.5 | U | |
| ALPHA-CHLORDANE | 3.5 | U | |
| CIS-NONACHLOR | 10 | J | CU |
| DIELDRIN | 6.7 | U | |
| ENDOSULFAN I | 3.5 | U | |
| ENDOSULFAN II | 6.7 | U | |
| ENDRIN | 6.7 | U | |
| GAMMA-BHC (LINDANE) | 3.5 | U | |
| GAMMA-CHLORDANE | 4.5 | J | U |
| HEPTACHLOR | 3.5 | U | |
| HEPTACHLOR EPOXIDE | 3.5 | U | |
| METHOXYCHLOR | 35 | U | |
| OXYCHLORDANE | 41 | J | U |
| PCB-101 | 2 | U | |
| PCB-105 | 2 | U | |
| PCB-118 | 4.9 | J | RU |
| PCB-128 | 2 | U | |
| PCB-138 | 2 | U | |
| PCB-153 | 2 | U | |
| PCB-170 | 2 | U | |
| PCB-18 | 2 | U | |
| PCB-180 | 2 | U | |
| PCB-183 | 2 | U | |
| PCB-184 | 2 | UJ | C |
| PCB-187 | 2 | UJ | C |
| PCB-195 | 2 | U | |
| PCB-206 | 2 | UJ | C |
| PCB-209 | 2 | UJ | C |
| PCB-28 | 2 | UJ | C |

| | |
|---|---|
| nsample | TRP1-SD-005A-0406 |
| samp_date | 11/7/2008 |
| lab_id | G2055-19A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 48.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| PCB-44 | 2 | U | |
| PCB-49 | 3.2 | J | RU |
| PCB-52 | 2 | UJ | C |
| PCB-66 | 2 | U | |
| PCB-8 | 2 | U | |
| PCB-87 | 4.1 | J | RU |
| TOXAPHENE | 350 | U | |
| TRANS-NONACHLOR | 21 | | |

# PROJ_NO: 00811

SDG: G2055 MEDIA: SOIL DATA FRACTION: PEST/PCB

| | |
|---|---|
| nsample | TRP1-SD-005B-0001 |
| samp_date | 11/7/2008 |
| lab_id | G2055-17A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 40.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 4,4'-DDD | 1.6 | U | |
| 4,4'-DDE | 1.6 | U | |
| 4,4'-DDT | 1.6 | U | |
| ALDRIN | 0.89 | J | RU |
| ALPHA-CHLORDANE | 0.84 | U | |
| CIS-NONACHLOR | 0.84 | UJ | C |
| DIELDRIN | 1.6 | U | |
| ENDOSULFAN I | 0.84 | U | |
| ENDOSULFAN II | 1.6 | U | |
| ENDRIN | 1.6 | U | |
| GAMMA-BHC (LINDANE) | 1.6 | J | U |
| GAMMA-CHLORDANE | 0.84 | U | |
| HEPTACHLOR | 0.84 | U | |
| HEPTACHLOR EPOXIDE | 0.84 | U | |
| METHOXYCHLOR | 9.5 | J | C |
| OXYCHLORDANE | 13 | J | CR |
| PCB-101 | 3.3 | R | U |
| PCB-105 | 2.5 | U | |
| PCB-118 | 5.8 | J | C |
| PCB-128 | 2.5 | U | |
| PCB-138 | 3.8 | | |
| PCB-153 | 3.3 | J | U |
| PCB-170 | 2.5 | U | |
| PCB-18 | 6.9 | | |
| PCB-180 | 2.5 | U | |
| PCB-183 | 2.5 | U | |
| PCB-184 | 2.5 | U | |
| PCB-187 | 2.5 | U | |
| PCB-195 | 2.5 | U | |
| PCB-206 | 2.7 | | |
| PCB-209 | 2.5 | U | |
| PCB-28 | 2.5 | U | |

| | |
|---|---|
| nsample | TRP1-SD-005B-0001 |
| samp_date | 11/7/2008 |
| lab_id | G2055-17A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 40.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| PCB-44 | 3.9 | J | U |
| PCB-49 | 2.5 | U | |
| PCB-52 | 2.5 | U | |
| PCB-66 | 2.5 | U | |
| PCB-8 | 5.9 | J | U |
| PCB-87 | 3.2 | J | CU |
| TOXAPHENE | 84 | U | |
| TRANS-NONACHLOR | 10 | J | CR |

| | |
|---|---|
| nsample | TRTP1-SD-001B-0001 |
| samp_date | 11/6/2008 |
| lab_id | G2055-01A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 46.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 4,4'-DDD | 5.7 | U | |
| 4,4'-DDE | 5.7 | U | |
| 4,4'-DDT | 7 | J | CU |
| ALDRIN | 2.9 | U | |
| ALPHA-CHLORDANE | 2.9 | U | |
| CIS-NONACHLOR | 4.4 | R | U |
| DIELDRIN | 5.7 | U | |
| ENDOSULFAN I | 2.9 | U | |
| ENDOSULFAN II | 5.7 | U | |
| ENDRIN | 5.7 | U | |
| GAMMA-BHC (LINDANE) | 2.9 | J | U |
| GAMMA-CHLORDANE | 4.2 | | |
| HEPTACHLOR | 2.9 | U | |
| HEPTACHLOR EPOXIDE | 2.9 | U | |
| METHOXYCHLOR | 29 | U | |
| OXYCHLORDANE | 2.9 | U | |
| PCB-101 | 16 | | |
| PCB-105 | 4.1 | J | U |
| PCB-118 | 13 | J | U |
| PCB-128 | 2.2 | U | |
| PCB-138 | 13 | J | U |
| PCB-153 | 13 | J | U |
| PCB-170 | 2.2 | U | |
| PCB-18 | 7.3 | J | U |
| PCB-180 | 6.5 | J | U |
| PCB-183 | 2.2 | U | |
| PCB-184 | 2.2 | U | |
| PCB-187 | 2.2 | R | U |
| PCB-195 | 2.2 | U | |
| PCB-206 | 4.4 | | |
| PCB-209 | 7.5 | J | U |
| PCB-28 | 15 | J | U |

# PROJ_NO: 00811

SDG: G2055 MEDIA: SOIL DATA FRACTION: PEST/PCB

| | |
|---|---|
| nsample | TRTP1-SD-001B-0001 |
| samp_date | 11/6/2008 |
| lab_id | G2055-01A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 46.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| PCB-44 | 6.6 | J | U |
| PCB-49 | 2.7 | R | U |
| PCB-52 | 16 | J | R |
| PCB-66 | 14 | J | U |
| PCB-8 | 4.8 | J | U |
| PCB-87 | 7.2 | | |
| TOXAPHENE | 290 | U | |
| TRANS-NONACHLOR | 16 | | |

| | |
|---|---|
| nsample | TRZ4-SD-004A-0204 |
| samp_date | 11/7/2008 |
| lab_id | G2055-07A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 80.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 4,4'-DDD | 2.4 | J | R |
| 4,4'-DDE | 1.8 | J | RU |
| 4,4'-DDT | 4.2 | J | RU |
| ALDRIN | 0.42 | U | |
| ALPHA-CHLORDANE | 0.46 | J | RU |
| CIS-NONACHLOR | 1.3 | R | U |
| DIELDRIN | 1 | R | U |
| ENDOSULFAN I | 1.3 | J | R |
| ENDOSULFAN II | 0.82 | U | |
| ENDRIN | 0.82 | U | |
| GAMMA-BHC (LINDANE) | 0.42 | U | |
| GAMMA-CHLORDANE | 0.9 | J | RU |
| HEPTACHLOR | 0.42 | U | |
| HEPTACHLOR EPOXIDE | 1 | J | RU |
| METHOXYCHLOR | 7.8 | J | RU |
| OXYCHLORDANE | 0.42 | U | |
| PCB-101 | 5.5 | | |
| PCB-105 | 1.3 | U | |
| PCB-118 | 4.4 | | |
| PCB-128 | 1.3 | U | |
| PCB-138 | 6.1 | J | U |
| PCB-153 | 5.4 | | |
| PCB-170 | 1.3 | U | |
| PCB-18 | 4.9 | J | U |
| PCB-180 | 3.2 | | |
| PCB-183 | 1.3 | U | |
| PCB-184 | 1.5 | | |
| PCB-187 | 1.3 | U | |
| PCB-195 | 1.3 | U | |
| PCB-206 | 3 | | |
| PCB-209 | 1.7 | J | U |
| PCB-28 | 5 | J | U |

| | |
|---|---|
| nsample | TRZ4-SD-004A-0204 |
| samp_date | 11/7/2008 |
| lab_id | G2055-07A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 80.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| PCB-44 | 2.1 | J | U |
| PCB-49 | 1.3 | U | |
| PCB-52 | 5 | J | R |
| PCB-66 | 1.3 | U | |
| PCB-8 | 2.9 | | |
| PCB-87 | 4.3 | | |
| TOXAPHENE | 42 | U | |
| TRANS-NONACHLOR | 4.4 | J | U |

# PROJ_NO: 00811

SDG: G2055 MEDIA: SOIL DATA FRACTION: PEST/PCB

| | |
|---|---|
| nsample | TRZ4-SD-004A-0406 |
| samp_date | 11/7/2008 |
| lab_id | G2055-08A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 59.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 4,4'-DDD | 9.9 | J | C |
| 4,4'-DDE | 14 | J | C |
| 4,4'-DDT | 13 | J | U |
| ALDRIN | 1.1 | U | |
| ALPHA-CHLORDANE | 2.3 | | |
| CIS-NONACHLOR | 11 | J | CU |
| DIELDRIN | 4.2 | J | U |
| ENDOSULFAN I | 1.1 | U | |
| ENDOSULFAN II | 2.2 | U | |
| ENDRIN | 2.2 | U | |
| GAMMA-BHC (LINDANE) | 1.1 | U | |
| GAMMA-CHLORDANE | 3.3 | | |
| HEPTACHLOR | 0.98 | J | U |
| HEPTACHLOR EPOXIDE | 6 | J | U |
| METHOXYCHLOR | 11 | U | |
| OXYCHLORDANE | 1.1 | U | |
| PCB-101 | 21 | J | R |
| PCB-105 | 2.5 | R | U |
| PCB-118 | 16 | J | D |
| PCB-128 | 2 | R | U |
| PCB-138 | 17 | J | DU |
| PCB-153 | 18 | J | D |
| PCB-170 | 4.8 | R | U |
| PCB-18 | 29 | J | DU |
| PCB-180 | 21 | J | D |
| PCB-183 | 4.2 | J | U |
| PCB-184 | 5.8 | J | U |
| PCB-187 | 5.5 | J | U |
| PCB-195 | 1.7 | U | |
| PCB-206 | 5.2 | | |
| PCB-209 | 2.5 | J | U |
| PCB-28 | 31 | J | DU |

| | |
|---|---|
| nsample | TRZ4-SD-004A-0406 |
| samp_date | 11/7/2008 |
| lab_id | G2055-08A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 59.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| PCB-44 | 12 | J | DU |
| PCB-49 | 4.7 | R | U |
| PCB-52 | 21 | | |
| PCB-66 | 14 | J | U |
| PCB-8 | 16 | J | DU |
| PCB-87 | 12 | J | R |
| TOXAPHENE | 110 | U | |
| TRANS-NONACHLOR | 1.2 | R | U |

**Tetra Tech NUS** **INTERNAL CORRESPONDENCE**

**TO:** **COREY RICH** **DATE: JANUARY 14, 2009**

**FROM:** **JOSEPH KALINYAK** **COPIES: DV FILE**

**SUBJECT:** **ORGANIC DATA VALIDATION: PCB/PEST**
**CTO 424, NSB NEW LONDON**
**SDG G2050**

**SAMPLES:** 18/Sedimentl/PCB/PEST

| | | |
|---|---|---|
| TRZ4-SD-002A-0204 | TRZ4-SD-002A-0406 | TRZ4-SD-002B-0001 |
| TRZ4-SD-003A-0204 | TRZ4-SD-003A-0406 | TRZ4-SD-003B-0001 |
| TRZ4-SD-005A-0204 | TRZ4-SD-005A-0406 | TRZ4-SD-005B-0001 |
| TRZ4-SD-006A-0204 | TRZ4-SD-006A-0406 | TRZ4-SD-006B-0001 |
| TRZ4-SD-007A-0204 | TRZ4-SD-007B-0001 | TRZ4-SD-007A-0406 |
| TRZ4-SD-008A-0204 | TRZ4-SD-008A-0406 | TRZ4-SD-008B-0001 |

Overview

The sample set for CTO 424 SDG G2050 NSB New London, consists of eighteen (18) environmental sediment samples. There were no field duplicates associated with this SDG. All samples were analyzed as indicated above.

The samples were collected by Tetra Tech NUS, Inc. on November 6, 2008 and analyzed by Mitkem Laboratories. All analyses were conducted in accordance with Naval Facilities Engineering Service Center (NFESC) Quality Assurance/Quality Control (QA/QC) criteria using USEPA SW-846 Method 8081 and 8082 analytical and reporting protocol. A USEPA Region I Tier 3 data validation was performed on the referenced samples. The data contained in this SDG were validated with regard to the following parameters:

* • Data Completeness
* • Holding Times
• Initial and Continuing Calibration
* • Laboratory Method and/or Field Quality Control Blanks
• Surrogate Spike Recoveries
• Laboratory Control Spike / Laboratory Control Spike Duplicate Recoveries
• Matrix Spike/Matrix Spike Duplicate Results
* • Detection Limits
* • Compound Identification
• Sample Quantitation

The asterisk (*) indicates that all quality control criteria were met for this parameter. Qualified (if applicable) analytical results are summarized in Appendix A. Results as reported by the laboratory are presented in Appendix B. Appendix C contains Region I worksheets, and Appendix D contains the documentation to support the findings as discussed in this data validation report. The attached Table summarizes the validation qualifications which are based on the following information:

**CALIBRATIONS**

The continuing calibration %D was greater than the 15% quality control limit for 4,4'-DDE for the primary GC column CLPPest on 12/04/08 @ 23:31 affecting samples TRZ4-SD-002B-0001, TRZ4-SD-002A-0204, TRZ4-SD-002A-0406, TRZ4-SD-007A-0204, TRZ4-SD-007A-0406, TRZ4-SD-006A-0204, TRZ4-SD-006A-0406, TRZ4-SD-003B-0001, TRZ4-SD-003A-0204, TRZ4-SD-003A-0406, TRZ4-SD-008B-0001, and TRZ4-SD-008A-0406. The non-detected 4,4'-DDE results for the affected samples were not qualified for this issue as the secondary GC column was within the QC limits for 4,4'-DDE. The positive results for sample TRZ4-SD-002A-0406 and TRZ4-SD-003A-0406 were qualified estimated, (J), as the sample result was taken from the primary GC column. The remainder of the affected sample positive 4,4'-DDE results were not qualified as they were reported from the secondary within the QC limits GC column

The continuing calibration %D was greater than the 15% quality control limit for trans-nonachlor for the primary GC column CLPPest on 12/05/08 @ 04:30 and for 4,4'-DDE and 4,4'-DDT on the primary GC column on 12/05/08 @ 04:45. The continuing calibration %D was greater than the 15% quality control limit for 4.4'-DDT for the secondary GC column CLPPest II on 12/05/08 @ 04:45. The affected samples were TRZ4-SD-006A-0204, TRZ4-SD-006A-0406, TRZ4-SD-003B-0001, TRZ4-SD-003A-0204, TRZ4-SD-003A-0406, TRZ4-SD-008B-0001, TRZ4-SD-008A-0406, TRZ4-SD-005B-0001, TRZ4-SD-005A-0204, TRZ4-SD-007B-0001, TRZ4-SD-006B-0001, TRZ4-SD-008A-0204, and TRZ4-SD-005A-0406. The 4,4'-DDT positive and non-detected results for these samples were qualified estimated, (J) and (UJ), respectively. The 4,4'-DDE positive and non-detected results for the samples TRZ4-SD-006A-0204, TRZ4-SD-006A-0406, TRZ4-SD-003B-0001, TRZ4-SD-003A-0204, TRZ4-SD-008B-0001, TRZ4-SD-005B-0001, TRZ4-SD-005A-0204, TRZ4-SD-007B-0001, TRZ4-SD-006B-0001, TRZ4-SD-008A-0204, and TRZ4-SD-005A-0406 were taken from the secondary GC column and no data qualification was necessary. Samples TRZ4-SD-003A-0406 and TRZ4-SD-008A-0406 positive 4,4'-DDE results were qualified estimated, (J), as they were reported from the primary GC column. The trans-nonachlor positive and non-detected results for the samples TRZ4-SD-006A-0204, TRZ4-SD-003B-0001, TRZ4-SD-005A-0204, TRZ4-SD-007B-0001, and TRZ4-SD-008A-0204 were taken from the secondary GC column and no data qualification was necessary. Samples TRZ4-SD-003A-0406, TRZ4-SD-008A-0406, TRZ4-SD-006A-0406, TRZ4-SD-003A-0204, TRZ4-SD-008B-0001, TRZ4-SD-005B-0001, TRZ4-SD-006B-0001, and TRZ4-SD-005A-0406 positive trans-nonachlor results were qualified estimated, (J), as they were reported from the primary GC column.

The continuing calibration %D was greater than the 15% quality control limit for 4,4'-DDE and 4,4'-DDT for the primary GC column CLPPest on 12/05/08 @ 17:29 affecting samples TRZ4-SD-005B-0001, TRZ4-SD-005A-0204, TRZ4-SD-007B-0001, TRZ4-SD-006B-0001, TRZ4-SD-008A-0204, and TRZ4-SD-005A-0406. The continuing calibration %D was greater than the 15% quality control limit for 4,4'-DDT for the secondary GC column CLPPestII on 12/05/08 @ 17:29 affecting the same set of samples. The 4,4'-DDT positive and non-detected results for all the aforementioned samples were qualified estimated, (J) and (UJ), respectively. The 4,4'-DDE sample results were previously qualified due to the previous calibration verification and no other data qualification was necessary.

The PCB congener %RSD was greater than the 20% quality control limit on the secondary GC column for the PCB-184 for the initial calibration on 12/08/08. All positive and non-detected sample results were reported from the primary GC column for PCB-184 and no data qualification was necessary.

The PCB congener continuing calibration %D was greater than the 15% quality control limit for PCB-118 on the primary GC column on 12/11/08 @ 22:40, and for PCB-183 and PCB-184 on the primary GC column on 12/11/08 @ 22:24. The PCB congener continuing calibration %D was greater than the 15% quality control limit for PCB-206 on the secondary GC column on 12/11/08 @ 22:40 and for PCB-183 and PCB-184 on the secondary GC column on 12/11/08 @ 22:24. The affected samples were TRZ4-SD-002B-0001, TRZ4-SD-002A-0204, and TRZ4-SD-002A-0406. The positive and non-detected sample results for PCB-183 and

PCB-184 congeners for the associated samples were qualified estimated, (J) and (UJ), respectively. The positive PCB-118 result for sample TRZ4-SD-002B-0001 was qualified estimated, (J), as it was reported from the primary GC column. The PCB-118 results for samples TRZ4-SD-002A-0204 and TRZ4-SD-002A-0406 were previously rejected due to %RPD between the GC columns so no further action was required.

The PCB congener continuing calibration %D was greater than the 15% quality control limit for PCB-28, PCB-101, and PCB-105 on the primary GC column on 12/12/08 @ 02:36, and for PCB-184 on the primary GC column on 12/12/08 @ 02:20. The PCB congener continuing calibration %D was greater than the 15% quality control limit for PCB-66 and PCB-206 on the secondary GC column on 12/12/08 @ 02:36. The affected samples were TRZ4-SD-002B-0001, TRZ4-SD-002A-0204, TRZ4-SD-002A-0406, TRZ4-SD-005B-0001, TRZ4-SD-005A-0204, TRZ4-SD-005A-0406, TRZ4-SD-007B-0001, TRZ4-SD-007A-0204, TRZ4-SD-006A-0204, TRZ4-SD-006A-0406, and TRZ4-SD-003B-0001. The positive sample results for PCB-28, PCB-101, and PCB-105 for the aforementioned samples which were reported from the primary GC column were qualified estimated, (J), unless more severely qualified due to other issues. The non-detected sample results and the remaining sample positive results for PCB-28, PCB-101, and PCB-105 reported from the secondary GC column were not qualified. The positive sample results for PCB-66 and PCB-206 for the aforementioned samples reported from the secondary GC column were qualified estimated, (J), unless more severely qualified due to other issues. The remaining positive and non-detected sample results for PCB-66 and PCB-206 were reported from the primary GC column and were not qualified.

The PCB congener continuing calibration %D was greater than the 15% quality control limit for PCB-18, PCB-28, and PCB-66 on the primary GC column on 12/12/08 @ 06:33, and for PCB-183 on the primary GC column on 12/12/08 @ 06:17. The PCB congener continuing calibration %D was greater than the 15% quality control limit for PCB-28 and PCB-66 on the secondary GC column on 12/12/08 @ 06:33 and for PCB-183 and PCB-184 on the secondary GC column on 12/12/08 @ 06:17. The affected samples were TRZ4-SD-005B-0001, TRZ4-SD-005A-0204, TRZ4-SD-005A-0406, TRZ4-SD-007B-0001, TRZ4-SD-007A-0204, TRZ4-SD-006A-0204, TRZ4-SD-006A-0406, TRZ4-SD-003B-0001, TRZ4-SD-003A-0204, TRZ4-SD-003A-0406, TRZ4-SD-008B-0001, TRZ4-SD-008A-0204, TRZ4-SD-008A-0406, TRZ4-SD-007A-0406, and TRZ4-SD-006B-0001. The positive and non-detected sample results for PCB-28, PCB-66, and PCB-183 for the aforementioned samples were qualified estimated, (J) and (UJ), respectively, unless more severely qualified due to other issues. The positive sample results for PCB-18 for the aforementioned samples reported from the primary GC column were qualified estimated, (J), unless more severely qualified due to other issues. The non-detected sample results for PCB-18 were not qualified as the secondary GC column was within the QC limits for PCB-18. The positive sample result for PCB-184 for sample TRZ4-SD-006A-0406 was reported from the primary GC column and was not qualified. The non-detected sample results for PCB-184 for the remainder of the aforementioned samples were not qualified as the primary GC column was within the QC limits for PCB-184.

The PCB congener continuing calibration %D was greater than the 15% quality control limit for PCB-28, PCB-52, PCB-101, PCB-105, and PCB-118 on the primary GC column on 12/12/08 @ 13:55, and for PCB-184 on the primary GC column on 12/12/08 @ 13:12. The PCB congener continuing calibration %D was greater than the 15% quality control limit for PCB-28, PCB-206 and PCB-209 on the secondary GC column on 12/12/08 @ 13:55. The affected samples were TRZ4-SD-003A-0204, TRZ4-SD-003A-0406, TRZ4-SD-008B-0001, TRZ4-SD-008A-0204, TRZ4-SD-008A-0406, TRZ4-SD-007A-0406, and TRZ4-SD-006B-0001. The positive and non-detected sample results for PCB-28 for the aforementioned samples were qualified estimated, (J) and (UJ), unless more severely qualified due to other issues. The positive sample results for PCB-52, PCB-101, PCB-105, and PCB-184 for the aforementioned samples which were reported from the primary GC column were qualified estimated, (J), unless more severely qualified due to other issues. The non-detected sample results and the remaining sample positive results for PCB-52, PCB-101, PCB-105, and PCB-184 reported from the secondary GC column were not qualified. The positive sample results for PCB-206 and PCB-209 for the aforementioned samples were all reported from the primary GC column and were

not qualified, unless more severely qualified due to other issues. The non-detected sample results for PCB-206 and PCB-209 were reported from the primary GC column and were not qualified.

## BLANKS

No qualification of the data was necessary.

## SURROGATE SPIKE RECOVERIES

The PEST % recovery was greater than the quality control limit for the surrogate decachlorobiphenyl (DCB) on the secondary GC column for samples TRZ4-SD-008B-0001 and TRZ4-SD-008A-0406. No action was necessary for the non-detected results. The positive results for these samples which were reported from the secondary GC column were qualified estimated, (J).

The PEST % recovery was both greater than and less than the quality control limit for the surrogates DCB and TCX on both the primary and secondary columns as a result of sample dilution. No action was necessary as the surrogates were effectively diluted out.

The PCB congeners surrogate spike % recoveries were greater than the quality control limit for the surrogate TCX on the secondary GC column for samples TRZ4-SD-005B-0001, TRZ4-SD-005A-0204, TRZ4-SD-005A-0406, TRZ4-SD-003B-0001, TRZ4-SD-003A-0204, TRZ4-SD-008B-0001, TRZ4-SD-008A-0204, and TRZ4-SD-008A-0406. No action was necessary for the non-detected results and positive results for samples which were reported from the secondary GC column were qualified estimated, (J), as listed below.

| Sample | PCB Congeners | Sample Qualifier |
|---|---|---|
| TRZ4-SD-005B-0001 | PCB-101, PCB-52, PCB-8 | J |
| TRZ4-SD-005A-0204 | PCB-44, PCB-101, PCB-52 | J |
| TRZ4-SD-005A-0406 | PCB-52 | J |
| TRZ4-SD-003B-0001 | PCB-180, PCB-44, PCB-101, PCB-52, PCB-118 | J |
| TRZ4-SD-003A-0204 | PCB-180, PCB-87, PCB-44, PCB-101, PCB-52 | J |
| TRZ4-SD-008B-0001 | PCB-87, PCB-52, PCB-101 | J |
| TRZ4-SD-008A-0204 | PCB-44, PCB-101, PCB-52, PCB-28, PCB-8 | J |
| TRZ4-SD-008A-0406 | PCB-52, PCB-101, PCB-8 | J |

The PCB congener surrogate spike % recovery was greater than the quality control limit for the surrogate TCX on the primary GC column for sample TRZ4-SD-007A-0406. No action was necessary for the non-detected results and the positive results for the sample which were reported from the primary GC column were qualified estimated, (J), as listed below.

| Sample | PCB Congeners | Sample Qualifier |
|---|---|---|
| TRZ4-SD-007A-0406 | PCB-206, PCB-128 | J |

## MATRIX SPIKE / MATRIX SPIKE DUPLICATE (MS / MSD)

The PEST MS/MSD for sample TRZ4-SD-003A-0204 had % recoveries both less than and greater than the quality control limit for the primary and secondary GC columns, as well as RPDs that were greater than the quality control limit for the primary and secondary GC columns. The results are tabulated below along with the sample qualifier for each compound.

| PEST | Primary column | | | Secondary Column | | | Sample |
|---|---|---|---|---|---|---|---|
| Compound | MS | MSD | RPD | MS | MSD | RPD | Qualifier |
| Aldrin | < | < | N/A | > | > | > | UJ |
| Endrin | < | < | > | > | < | > | UJ |
| Gamma-BHC | > | OK | > | > | OK | > | U |
| Heptachlor | > | OK | > | > | OK | > | U |
| Heptachlor epoxide | OK | < | > | OK | OK | > | U |
| Endosulfan I | OK | OK | > | > | < | > | UJ |
| Dieldrin | OK | < | > | > | > | > | U |
| 4,4'-DDE | > | OK | > | > | OK | > | U |
| Endosulfan II | > | OK | > | > | OK | > | U |
| 4,4'-DDD | OK | > | > | > | < | > | U |
| 4,4'-DDT | > | OK | > | > | OK | > | * |
| Methoxychlor | > | < | > | > | > | OK | UJ |
| Alpha-chlordane | OK | < | > | OK | < | > | UJ |
| Gamma-chlordane | > | > | OK | OK | < | > | U |

* Qualified for other issue(s), no further qualification necessary

The PCB congener MS for sample TRZ4-SD-003A-0204 had % recoveries less than the quality control limit for PCB congeners 28, 44, 66, 101, 105, 118, 128, 138, 153, 180, and 187 on the primary GC column. The PCB congener MSD for sample TRZ4-SD-003A-0204 had % recoveries less than the quality control limit for PCB congeners 28, 118, 138, and 187 on the primary GC column. The primary column MS/MSD RPD for PCB-101 was greater than the quality control limit. The secondary GC column had QC non-compliances for the MS PCB-18 congener and the RPD for PCB-138. These results are illustrated in the table below. Positive results for the congeners PCB-28, PCB-118, PCB-138 and PCB-187 were reported from the primary GC column and were qualified estimated, (J), for sample TRZ4-SD-003A-0204.

| PCB | Primary column | | | Secondary Column | | |
|---|---|---|---|---|---|---|
| Congener | MS | MSD | RPD | MS | MSD | RPD |
| 8 | OK | OK | OK | OK | OK | OK |
| 18 | OK | OK | OK | > | OK | OK |
| 28 | < | < | OK | OK | OK | OK |
| 44 | < | OK | OK | OK | OK | OK |
| 52 | OK | OK | OK | OK | OK | OK |
| 66 | < | OK | OK | OK | OK | OK |
| 101 | < | OK | > | OK | OK | OK |
| 105 | < | OK | OK | OK | OK | OK |
| 118 | < | < | OK | OK | OK | OK |
| 128 | < | OK | OK | OK | OK | OK |
| 138 | < | < | OK | < | OK | OK |
| 153 | < | OK | OK | OK | OK | OK |
| 170 | OK | OK | OK | OK | OK | OK |
| 180 | < | OK | OK | OK | OK | OK |
| 187 | < | < | OK | OK | OK | OK |
| 195 | OK | OK | OK | OK | OK | OK |
| 206 | OK | OK | OK | OK | OK | OK |
| 209 | OK | OK | OK | OK | OK | OK |

## LABORATORY CONTROL SPIKE/LABORATORY CONTROL SPIKE DUPLICATE

The PEST laboratory control sample % recovery for gamma-chlordane was greater than the quality control limit for the secondary GC column on 12/04/08. No action was taken as the primary GC column had a % recovery within the quality control limits.

## COMPOUND QUANTITATION

The RPD was greater than 25% between the primary and secondary GC columns for the PEST analysis for a number of samples. The samples with RPDs greater than 25% but less than or equal to 100% were qualified estimated, (J). Samples with RPDs greater than 100% were qualified rejected, (R). All sample RPDs had to be calculated by hand as the laboratory only calculated % difference values. The samples and the RPDs are listed as follows.

| Sample | Compound | %RPD | Qualifer |
|---|---|---|---|
| TRZ4-SD-002B-0001 | Aldrin | 106.3 | R |
| | Gamma-BHC | 195.8 | R |
| | Gamma-chlordane | 30.2 | J |
| | Oxychlordane | 30.7 | J |
| | Trans-nonachlor | 26.3 | J |
| TRZ4-SD-002A-0406 | 4,4'-DDE | 46.6 | J |
| | 4,4'-DDT | 45.4 | J |
| | Cis-nonachlor | 63.1 | J |
| | Dieldrin | 63.4 | J |
| | Gamma-BHC | 119.5 | R |
| | Heptachlor | 34.3 | J |
| | Heptachlor epoxide | 36.7 | J |
| TRZ4-SD-005B-0001 | Cis-nonachlor | 66.5 | J |
| | Gamma-chlordane | 44.2 | J |
| TRZ4-SD-005A-0204 | 4,4'-DDT | 32.6 | J |
| | Aldrin | 84.9 | J |
| | Gamma-BHC | 187.7 | R |
| | Heptachlor | 88.0 | J |
| | Heptachlor epoxide | 34.9 | J |
| | Oxychlordane | 38.6 | J |
| TRZ4-SD-005A-0406 | 4,4'-DDE | 30.7 | J |
| | Aldrin | 53.1 | J |
| | Cis-nonachlor | 141.2 | R |
| | Gamma-BHC | 37.9 | J |
| | Gamma-chlordane | 40.3 | J |
| | Heptachlor | 42.5 | J |
| | Oxychlordane | 47.7 | J |
| | Trans-nonachlor | 52.2 | J |
| TRZ4-SD-007B-0001 | 4,4'-DDT | 40.4 | J |
| | Gamma-chlordane | 31.8 | J |

| | | | |
|---|---|---|---|
| TRZ4-SD-007A-0204 | Gamma-Chlordane | 30.6 | J |
| | Heptachlor | 43.7 | J |
| | Trans-nonachlor | 25.3 | J |
| TRZ4-SD-007A-0406 | Gamma-chlordane | 42.8 | J |
| TRZ4-SD-006A-0204 | Heptachlor epoxide | 35.6 | J |
| | Oxychlordane | 53.2 | J |
| TRZ4-SD-006A-0406 | Aldrin | 39.3 | J |
| | Heptachlor | 48.0 | J |
| | Oxychlordane | 45.2 | J |
| TRZ4-SD-003A-0204 | Cis-nonachlor | 97.5 | J |
| | Trans-nonachlor | 30.5 | J |
| TRZ4-SD-003A-0406 | Cis-nonachlor | 83.9 | J |
| | Gamma-BHC | 52.6 | J |
| | Gamma-chlordane | 41.0 | J |
| | Trans-nonachlor | 42.9 | J |
| TRZ4-SD-008B-0001 | 4,4'-DDE | 55.1 | J |
| | Gamma-BHC | 187.2 | R |
| | Heptachlor | 140.4 | R |
| TRZ4-SD-008A-0406 | 4,4'-DDD | 84.4 | J |
| | 4,4'-DDE | 25.4 | J |
| | 4,4'-DDT | 29.3 | J |
| | Aldrin | 121.1 | R |
| | Alpha-chlordane | 81.6 | J |
| | Cis-nonachlor | 70.1 | J |
| | Endosulfan II | 29.4 | J |
| | Gamma-BHC | 110.2 | R |
| | Heptachlor | 100.6 | R |
| | Heptachlor epoxide | 77.2 | J |
| | Methoxychlor | 83.6 | J |
| | Oxychlordane | 168.4 | R |

The RPD was greater than 25% between the primary and secondary GC columns for the PCB congener analysis for a number of samples. The samples with RPDs greater than 25% but less than or equal to 100% were qualified estimated, (J). Samples with RPDs greater than 100% were qualified rejected, (R). The samples and the PCB congener qualifications are listed as follows.

| Sample | PCB Compound | Qualifer |
|---|---|---|
| TRZ4-SD-002B-0001 | 206, 128, 187, 44, 49, 18, 105, 118, 28 | J |
| TRZ4-SD-002A-0204 | 206, 195, 180, 183, 138, 187, 44, | J |
| | 49, 18, 66, 28, 8 | J |
| | 170, 105, 118 | R |

| | | |
|---|---|---|
| TRZ4-SD-002A-0406 | 206, 195, 170, 183, 138, 187, 101, 49, 18, | J |
| | 105, 66, 28 | J |
| | 118, 209 | R |
| TRZ4-SD-005B-0001 | 206, 180, 138, 87, 153, 101, 49, 52, 105, 66, 209 | J |
| TRZ4-SD-005A-0204 | 170, 180, 138, 187, 101, 52, 18, | J |
| | 105, 118, 66, 8, 209 | J |
| | 49 | R |
| TRZ4-SD-005A-0406 | 170, 128, 138, 187, 44, 49, 18, 118, 28, 8 | J |
| | 105 | R |
| TRZ4-SD-007B-0001 | 170, 101, 105, 118, 28 | J |
| | 209 | R |
| TRZ4-SD-007A-0406 | 206, 128 | J |
| TRZ4-SD-006B-0001 | 206, 180, 87, 44, 101, 52, 118, 8 | J |
| | 49, 18, 66 | R |
| TRZ4-SD-006A-0204 | 206, 180, 138, 44, 101, 49, 18, 105, 118, 28 | J |
| | 170, 128, 187, 66 | R |
| TRZ4-SD-006A-0406 | 195, 170, 138, 184, 187, 101, 18, 66, 28, 209 | J |
| | 49, 105, 118 | R |
| TRZ4-SD-003B-0001 | 206, 138, 87, 44, 101, 52, 18, 105, 66, 8, 209 | J |
| | 170 | R |
| TRZ4-SD-003A-0204 | 206, 180, 138, 101, 49, 52, | J |
| | 18, 105, 118, 66, 28, 209 | J |
| | 170 | R |
| TRZ4-SD-003A-0406 | 206, 170, 180, 183, 138, 187, | J |
| | 44, 18, 105, 118, 28, 8 | J |
| | 49, 209 | R |
| TRZ4-SD-008B-0001 | 206, 180, 44, 101, 49, 52, 118 | J |
| | 170, 18 | R |
| TRZ4-SD-008A-0204 | 138, 44, 101, 52, 18, 105, 118, 8 | J |
| | 170 | R |
| TRZ4-SD-008A-0406 | 206, 138, 44, 52, 18, 105, 118, 66, 28 | J |
| | 49 | R |

## ADDITIONAL COMMENTS

Positive results reported below the quantitation limit but above the method detection limit were qualified as estimated, (J).

The PEST continuing calibration %D was greater than the 15% quality control limit for the surrogates tetrachloro-m-xylene (TCX) and decachlorobiphenyl (DCB) on the primary GC column CLPPest on 12/04/08 @ 16:02. No action was necessary for this surrogate continuing calibration issue.

The RPD between the primary and secondary GC columns was calculated for the positive PEST/PCB detections by the laboratory upon request. The laboratory presented %D between GC columns instead of RPD originally.

The lower PEST/PCB result, when choosing between the primary and secondary GC column PCB results, was reported by the laboratory.

The PEST performance evaluation mixture (PEM) analyses were only used to determine the % breakdown of 4,4'-DDT and endrin and were not used to evaluate %D of the compounds from the expected concentrations. The %Ds for many of the PEM compounds were less than the 15% quality control limit indicative of a problem with the PEM standard as continuing calibration verifications run immediately after the PEM were within the QC limits for the same compounds. No action was taken for the PEM %D QC limit exceedances and the PEM analyses were evaluated for % breakdown QC limit criteria only.

The laboratory performed dilutions on some of the samples for PEST analysis as indicated below.

| Sample | Dilution |
|---|---|
| TRZ4-SD-002B-0001 | 5X |
| TRZ4-SD-002A-0204 | 10X |
| TRZ4-SD-002A-0406 | 5X |
| TRZ4-SD-005B-0001 | 5X |
| TRZ4-SD-005A-0204 | 2X |
| TRZ4-SD-005A-0406 | 5X |
| TRZ4-SD-007B-0001 | 5X |
| TRZ4-SD-006B-0001 | 5X |
| TRZ4-SD-006A-0204 | 10X |
| TRZ4-SD-006A-0406 | 5X |
| TRZ4-SD-003B-0001 | 10X |
| TRZ4-SD-003A-0204 | 10X |
| TRZ4-SD-003A-0406 | 2X |
| TRZ4-SD-008A-0204 | 10X |

## EXECUTIVE SUMMARY

**Laboratory Performance:** There were calibration issues associated with both the PEST and PCB congener analyses. There were surrogate spike % recoveries issues for both the PEST and PCB congener analyses. There were both PEST and PCB congener MS/MSD QC issues which resulted in data qualification for some samples. There were many GC column % differences in excess of 25% for both the PEST and PCB congener analyses.

**Other Factors Affecting Data Quality:** None.

The data for these analyses were reviewed with reference to the Region I EPA "Data Validation Functional Guidelines - Part II" (12/96), National Functional Guidelines for Low Concentration Organic Data Review, and the DoD Quality Systems (QSM) (January 2006).

"I attest that the data referenced herein were validated according to the agreed upon validation criteria as specified in the NFESC Guidelines and the DoD QSM."

TetraTech NUS
Joseph Kalinyak
Chemist/Data Validator

TetraTech NUS
Joseph A. Samchuck
Data Validation Quality Assurance Officer

Attachments:

1. Appendix A - Qualified Analytical Results
2. Appendix B - Results as Reported by the Laboratory
3. Appendix C - Regional Worksheets
4. Appendix D - Support Documentation

# APPENDIX A

## QUALIFIED LABORATORY RESULTS

**Qualifier Codes:**

A = Lab Blank Contamination
B = Field Blank Contamination
C = Calibration Noncompliance (i.e., % RSDs, %Ds, ICVs, CCVs, RRFs, etc.)
C01 = GC/MS Tuning Noncompliance
D = MS/MSD Recovery Noncompliance
E = LCS/LCSD Recovery Noncompliance
F = Lab Duplicate Imprecision
G = Field Duplicate Imprecision
H = Holding Time Exceedance
I = ICP Serial Dilution Noncompliance
J = GFAA PDS - GFAA MSA's $r < 0.995$
K = ICP Interference - includes ICS % R Noncompliance
L = Instrument Calibration Range Exceedance
M = Sample Preservation Noncompliance
N = Internal Standard Noncompliance
N01 = Internal Standard Recovery Noncompliance Dioxins
N02 = Recovery Standard Noncompliance Dioxins
N03 = Clean-up Standard Noncompliance Dioxins
O = Poor Instrument Performance (i.e., base-time drifting)
P = Uncertainty near detection limit (< 2 x IDL for inorganics and <CRQL for organics)
Q = Other problems (can encompass a number of issues; i.e.chromatography,interferences, etc.)
R = Surrogates Recovery Noncompliance
S = Pesticide/PCB Resolution
T = % Breakdown Noncompliance for DDT and Endrin
U = % Difference between columns/detectors >25% for positive results determined via GC/HPLC
V = Non-linear calibrations; correlation coefficient $r < 0.995$
W = EMPC result
X = Signal to noise response drop
Y = Percent solids <30%
Z = Uncertainty at 2 sigma deviation is less than sample activity

# PROJ_NO: 00811

SDG: G2050 MEDIA: SOIL DATA FRACTION: PEST/PCB

| | |
|---|---|
| nsample | TRZ4-SD-002A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2050-02A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 48.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 4,4'-DDD | 68 | U | |
| 4,4'-DDE | 68 | U | |
| 4,4'-DDT | 68 | U | |
| ALDRIN | 35 | U | |
| ALPHA-CHLORDANE | 35 | U | |
| CIS-NONACHLOR | 35 | U | |
| DIELDRIN | 68 | U | |
| ENDOSULFAN I | 35 | U | |
| ENDOSULFAN II | 68 | U | |
| ENDRIN | 68 | U | |
| GAMMA-BHC (LINDANE) | 35 | U | |
| GAMMA-CHLORDANE | 35 | U | |
| HEPTACHLOR | 35 | U | |
| HEPTACHLOR EPOXIDE | 35 | U | |
| METHOXYCHLOR | 350 | U | |
| OXYCHLORDANE | 150 | | |
| PCB-101 | 27 | | |
| PCB-105 | 2.6 | R | U |
| PCB-118 | 40 | R | U |
| PCB-128 | 2.1 | U | |
| PCB-138 | 21 | J | U |
| PCB-153 | 24 | | |
| PCB-170 | 3.9 | R | U |
| PCB-18 | 55 | J | U |
| PCB-180 | 22 | J | U |
| PCB-183 | 5 | J | CU |
| PCB-184 | 2.1 | UJ | C |
| PCB-187 | 7.7 | J | U |
| PCB-195 | 2.9 | J | U |
| PCB-206 | 7.3 | J | U |
| PCB-209 | 2.1 | U | |
| PCB-28 | 48 | J | CU |

| | |
|---|---|
| nsample | TRZ4-SD-002A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2050-02A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 48.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| PCB-44 | 17 | J | U |
| PCB-49 | 10 | J | U |
| PCB-52 | 29 | | |
| PCB-66 | 14 | J | U |
| PCB-8 | 29 | J | U |
| PCB-87 | 17 | | |
| TOXAPHENE | 3500 | U | |
| TRANS-NONACHLOR | 69 | | |

| | |
|---|---|
| nsample | TRZ4-SD-002A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2050-03A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 46.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 4,4'-DDD | 35 | U | |
| 4,4'-DDE | 97 | J | CU |
| 4,4'-DDT | 130 | J | U |
| ALDRIN | 18 | U | |
| ALPHA-CHLORDANE | 18 | U | |
| CIS-NONACHLOR | 130 | J | U |
| DIELDRIN | 49 | J | U |
| ENDOSULFAN I | 18 | U | |
| ENDOSULFAN II | 35 | U | |
| ENDRIN | 35 | U | |
| GAMMA-BHC (LINDANE) | 33 | R | U |
| GAMMA-CHLORDANE | 18 | U | |
| HEPTACHLOR | 83 | J | U |
| HEPTACHLOR EPOXIDE | 110 | J | U |
| METHOXYCHLOR | 180 | U | |
| OXYCHLORDANE | 18 | U | |
| PCB-101 | 28 | J | U |
| PCB-105 | 11 | J | CU |
| PCB-118 | 50 | R | U |
| PCB-128 | 2.1 | U | |
| PCB-138 | 33 | J | U |
| PCB-153 | 36 | | |
| PCB-170 | 23 | J | U |
| PCB-18 | 140 | J | U |
| PCB-180 | 33 | | |
| PCB-183 | 8.5 | J | CU |
| PCB-184 | 2.1 | UJ | C |
| PCB-187 | 9.6 | J | U |
| PCB-195 | 4.3 | J | U |
| PCB-206 | 9.3 | J | U |
| PCB-209 | 3.6 | R | U |
| PCB-28 | 150 | J | CU |

# PROJ_NO: 00811

SDG: G2050 MEDIA: SOIL DATA FRACTION: PEST/PCB

| | |
|---|---|
| nsample | TRZ4-SD-002A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2050-03A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 46.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| PCB-44 | 51 | | |
| PCB-49 | 19 | J | U |
| PCB-52 | 63 | | |
| PCB-66 | 36 | J | U |
| PCB-8 | 84 | | |
| PCB-87 | 24 | | |
| TOXAPHENE | 1800 | U | |
| TRANS-NONACHLOR | 37 | | |

| | |
|---|---|
| nsample | TRZ4-SD-002B-0001 |
| samp_date | 11/6/2008 |
| lab_id | G2050-01A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 49.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 4,4'-DDD | 34 | U | |
| 4,4'-DDE | 34 | U | |
| 4,4'-DDT | 44 | | |
| ALDRIN | 17 | R | U |
| ALPHA-CHLORDANE | 17 | U | |
| CIS-NONACHLOR | 17 | U | |
| DIELDRIN | 34 | U | |
| ENDOSULFAN I | 17 | U | |
| ENDOSULFAN II | 34 | U | |
| ENDRIN | 34 | U | |
| GAMMA-BHC (LINDANE) | 18 | R | U |
| GAMMA-CHLORDANE | 18 | J | U |
| HEPTACHLOR | 17 | U | |
| HEPTACHLOR EPOXIDE | 17 | U | |
| METHOXYCHLOR | 170 | U | |
| OXYCHLORDANE | 99 | J | U |
| PCB-101 | 28 | | |
| PCB-105 | 10 | J | CU |
| PCB-118 | 43 | J | CU |
| PCB-128 | 4.4 | J | U |
| PCB-138 | 22 | | |
| PCB-153 | 19 | | |
| PCB-170 | 6.4 | | |
| PCB-18 | 20 | J | U |
| PCB-180 | 6 | | |
| PCB-183 | 2 | UJ | C |
| PCB-184 | 2 | UJ | C |
| PCB-187 | 3.2 | J | U |
| PCB-195 | 2 | U | |
| PCB-206 | 2.3 | J | CU |
| PCB-209 | 4 | | |
| PCB-28 | 20 | J | CU |

| | |
|---|---|
| nsample | TRZ4-SD-002B-0001 |
| samp_date | 11/6/2008 |
| lab_id | G2050-01A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 49.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| PCB-44 | 13 | J | U |
| PCB-49 | 6 | J | U |
| PCB-52 | 24 | | |
| PCB-66 | 2 | U | |
| PCB-8 | 7.8 | | |
| PCB-87 | 14 | | |
| TOXAPHENE | 1700 | U | |
| TRANS-NONACHLOR | 57 | J | U |

# PROJ_NO: 00811

SDG: G2050 MEDIA: SOIL DATA FRACTION: PEST/PCB

| | |
|---|---|
| nsample | TRZ4-SD-003A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2050-14A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 38.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 4,4'-DDD | 86 | U | |
| 4,4'-DDE | 86 | U | |
| 4,4'-DDT | 86 | UJ | C |
| ALDRIN | 44 | UJ | D |
| ALPHA-CHLORDANE | 44 | UJ | D |
| CIS-NONACHLOR | 49 | J | U |
| DIELDRIN | 86 | U | |
| ENDOSULFAN I | 44 | UJ | D |
| ENDOSULFAN II | 86 | U | |
| ENDRIN | 86 | UJ | D |
| GAMMA-BHC (LINDANE) | 44 | U | |
| GAMMA-CHLORDANE | 44 | U | |
| HEPTACHLOR | 44 | U | |
| HEPTACHLOR EPOXIDE | 44 | U | |
| METHOXYCHLOR | 440 | UJ | D |
| OXYCHLORDANE | 130 | | |
| PCB-101 | 11 | J | CRU |
| PCB-105 | 4.2 | J | U |
| PCB-118 | 20 | J | DU |
| PCB-128 | 2.6 | U | |
| PCB-138 | 12 | J | DU |
| PCB-153 | 14 | | |
| PCB-170 | 2.6 | R | U |
| PCB-18 | 36 | J | CU |
| PCB-180 | 8.5 | J | RU |
| PCB-183 | 3.1 | J | C |
| PCB-184 | 2.6 | U | |
| PCB-187 | 5.2 | J | D |
| PCB-195 | 2.6 | U | |
| PCB-206 | 5 | J | U |
| PCB-209 | 4.8 | J | U |
| PCB-28 | 46 | J | CDU |

| | |
|---|---|
| nsample | TRZ4-SD-003A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2050-14A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 38.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| PCB-44 | 15 | J | R |
| PCB-49 | 11 | J | U |
| PCB-52 | 21 | J | RU |
| PCB-66 | 13 | J | CU |
| PCB-8 | 16 | | |
| PCB-87 | 11 | J | R |
| TOXAPHENE | 4400 | U | |
| TRANS-NONACHLOR | 55 | J | CU |

| | |
|---|---|
| nsample | TRZ4-SD-003A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2050-15A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 58.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 4,4'-DDD | 11 | U | |
| 4,4'-DDE | 23 | J | C |
| 4,4'-DDT | 11 | UJ | C |
| ALDRIN | 5.8 | U | |
| ALPHA-CHLORDANE | 5.8 | U | |
| CIS-NONACHLOR | 37 | J | U |
| DIELDRIN | 11 | U | |
| ENDOSULFAN I | 5.8 | U | |
| ENDOSULFAN II | 11 | U | |
| ENDRIN | 11 | U | |
| GAMMA-BHC (LINDANE) | 6.1 | J | U |
| GAMMA-CHLORDANE | 18 | J | U |
| HEPTACHLOR | 7.1 | | |
| HEPTACHLOR EPOXIDE | 5.8 | U | |
| METHOXYCHLOR | 58 | U | |
| OXYCHLORDANE | 5.8 | U | |
| PCB-101 | 11 | J | C |
| PCB-105 | 2.7 | J | CU |
| PCB-118 | 11 | J | U |
| PCB-128 | 1.7 | U | |
| PCB-138 | 8.7 | J | U |
| PCB-153 | 9.8 | | |
| PCB-170 | 7.6 | J | U |
| PCB-18 | 27 | J | CU |
| PCB-180 | 7.6 | J | U |
| PCB-183 | 2.1 | J | CU |
| PCB-184 | 1.7 | U | |
| PCB-187 | 3.2 | J | U |
| PCB-195 | 1.7 | U | |
| PCB-206 | 6.6 | J | U |
| PCB-209 | 1.5 | R | U |
| PCB-28 | 28 | J | CU |

# PROJ_NO: 00811

SDG: G2050 MEDIA: SOIL DATA FRACTION: PEST/PCB

| | |
|---|---|
| nsample | TRZ4-SD-003A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2050-15A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 58.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| PCB-44 | 10 | J | U |
| PCB-49 | 2.5 | R | U |
| PCB-52 | 15 | J | C |
| PCB-66 | 6.8 | J | CU |
| PCB-8 | 14 | J | U |
| PCB-87 | 6.4 | | |
| TOXAPHENE | 580 | U | |
| TRANS-NONACHLOR | 24 | J | CU |

| | |
|---|---|
| nsample | TRZ4-SD-003B-0001 |
| samp_date | 11/6/2008 |
| lab_id | G2050-13A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 44.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 4,4'-DDD | 75 | U | |
| 4,4'-DDE | 75 | U | |
| 4,4'-DDT | 75 | UJ | C |
| ALDRIN | 38 | U | |
| ALPHA-CHLORDANE | 38 | U | |
| CIS-NONACHLOR | 38 | U | |
| DIELDRIN | 75 | U | |
| ENDOSULFAN I | 38 | U | |
| ENDOSULFAN II | 75 | U | |
| ENDRIN | 75 | U | |
| GAMMA-BHC (LINDANE) | 38 | U | |
| GAMMA-CHLORDANE | 38 | U | |
| HEPTACHLOR | 38 | U | |
| HEPTACHLOR EPOXIDE | 38 | U | |
| METHOXYCHLOR | 380 | U | |
| OXYCHLORDANE | 130 | | |
| PCB-101 | 6.2 | J | RU |
| PCB-105 | 2.9 | J | CU |
| PCB-118 | 6.8 | J | R |
| PCB-128 | 2.2 | U | |
| PCB-138 | 6.9 | J | U |
| PCB-153 | 7.8 | | |
| PCB-170 | 2.4 | R | U |
| PCB-18 | 22 | J | CU |
| PCB-180 | 5.1 | J | R |
| PCB-183 | 2.2 | UJ | C |
| PCB-184 | 2.2 | U | |
| PCB-187 | 2.2 | U | |
| PCB-195 | 2.2 | U | |
| PCB-206 | 5.1 | J | U |
| PCB-209 | 2.8 | J | U |
| PCB-28 | 28 | J | C |

| | |
|---|---|
| nsample | TRZ4-SD-003B-0001 |
| samp_date | 11/6/2008 |
| lab_id | G2050-13A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 44.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| PCB-44 | 8 | J | RU |
| PCB-49 | 6.8 | | |
| PCB-52 | 10 | J | RU |
| PCB-66 | 8.9 | J | CU |
| PCB-8 | 7.7 | J | U |
| PCB-87 | 5.9 | J | U |
| TOXAPHENE | 3800 | U | |
| TRANS-NONACHLOR | 38 | U | |

# PROJ_NO: 00811

SDG: G2050 MEDIA: SOIL DATA FRACTION: PEST/PCB

| | |
|---|---|
| nsample | TRZ4-SD-005A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2050-05A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 42.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 4,4'-DDD | 16 | U | |
| 4,4'-DDE | 27 | | |
| 4,4'-DDT | 150 | J | UC |
| ALDRIN | 14 | J | U |
| ALPHA-CHLORDANE | 8 | U | |
| CIS-NONACHLOR | 99 | | |
| DIELDRIN | 16 | U | |
| ENDOSULFAN I | 8 | U | |
| ENDOSULFAN II | 41 | | |
| ENDRIN | 16 | U | |
| GAMMA-BHC (LINDANE) | 12 | R | U |
| GAMMA-CHLORDANE | 30 | | |
| HEPTACHLOR | 8.7 | J | U |
| HEPTACHLOR EPOXIDE | 15 | J | U |
| METHOXYCHLOR | 80 | U | |
| OXYCHLORDANE | 86 | J | U |
| PCB-101 | 9.1 | J | RU |
| PCB-105 | 3 | J | CU |
| PCB-118 | 8.7 | J | U |
| PCB-128 | 2.3 | U | |
| PCB-138 | 9.5 | J | U |
| PCB-153 | 9.9 | | |
| PCB-170 | 7.1 | J | U |
| PCB-18 | 27 | J | CU |
| PCB-180 | 5.2 | J | U |
| PCB-183 | 2.3 | UJ | C |
| PCB-184 | 2.3 | U | |
| PCB-187 | 2.4 | J | U |
| PCB-195 | 2.3 | U | |
| PCB-206 | 5.5 | | |
| PCB-209 | 4 | J | U |
| PCB-28 | 33 | J | C |

| | |
|---|---|
| nsample | TRZ4-SD-005A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2050-05A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 42.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| PCB-44 | 9.4 | J | R |
| PCB-49 | 3.4 | R | U |
| PCB-52 | 12 | J | RU |
| PCB-66 | 7.1 | J | CU |
| PCB-8 | 13 | J | U |
| PCB-87 | 6.4 | | |
| TOXAPHENE | 800 | U | |
| TRANS-NONACHLOR | 47 | | |

| | |
|---|---|
| nsample | TRZ4-SD-005A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2050-06A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 43.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 4,4'-DDD | 38 | U | |
| 4,4'-DDE | 42 | J | U |
| 4,4'-DDT | 38 | UJ | C |
| ALDRIN | 23 | J | U |
| ALPHA-CHLORDANE | 20 | U | |
| CIS-NONACHLOR | 39 | R | U |
| DIELDRIN | 38 | U | |
| ENDOSULFAN I | 20 | U | |
| ENDOSULFAN II | 38 | U | |
| ENDRIN | 38 | U | |
| GAMMA-BHC (LINDANE) | 22 | J | U |
| GAMMA-CHLORDANE | 32 | J | U |
| HEPTACHLOR | 24 | J | U |
| HEPTACHLOR EPOXIDE | 20 | U | |
| METHOXYCHLOR | 200 | U | |
| OXYCHLORDANE | 120 | J | U |
| PCB-101 | 72 | J | C |
| PCB-105 | 11 | R | U |
| PCB-118 | 59 | J | U |
| PCB-128 | 10 | J | U |
| PCB-138 | 70 | J | U |
| PCB-153 | 76 | | |
| PCB-170 | 18 | J | U |
| PCB-18 | 84 | J | CU |
| PCB-180 | 27 | | |
| PCB-183 | 2.3 | UJ | C |
| PCB-184 | 2.3 | U | |
| PCB-187 | 13 | J | U |
| PCB-195 | 3.3 | | |
| PCB-206 | 7.9 | | |
| PCB-209 | 2.3 | U | |
| PCB-28 | 80 | J | CU |

# PROJ_NO: 00811

SDG: G2050 MEDIA: SOIL DATA FRACTION: PEST/PCB

| | |
|---|---|
| nsample | TRZ4-SD-005A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2050-06A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 43.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| PCB-44 | 27 | J | U |
| PCB-49 | 27 | J | U |
| PCB-52 | 63 | J | R |
| PCB-66 | 2.3 | UJ | C |
| PCB-8 | 46 | J | U |
| PCB-87 | 38 | | |
| TOXAPHENE | 2000 | U | |
| TRANS-NONACHLOR | 86 | J | CU |

| | |
|---|---|
| nsample | TRZ4-SD-005B-0001 |
| samp_date | 11/6/2008 |
| lab_id | G2050-04A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 38.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 4,4'-DDD | 43 | U | |
| 4,4'-DDE | 43 | U | |
| 4,4'-DDT | 45 | J | C |
| ALDRIN | 22 | U | |
| ALPHA-CHLORDANE | 22 | U | |
| CIS-NONACHLOR | 60 | J | U |
| DIELDRIN | 43 | U | |
| ENDOSULFAN I | 22 | U | |
| ENDOSULFAN II | 43 | U | |
| ENDRIN | 43 | U | |
| GAMMA-BHC (LINDANE) | 22 | U | |
| GAMMA-CHLORDANE | 23 | J | U |
| HEPTACHLOR | 22 | U | |
| HEPTACHLOR EPOXIDE | 22 | U | |
| METHOXYCHLOR | 220 | U | |
| OXYCHLORDANE | 87 | | |
| PCB-101 | 9.9 | J | RU |
| PCB-105 | 3.7 | J | CU |
| PCB-118 | 7.7 | | |
| PCB-128 | 2.6 | U | |
| PCB-138 | 9.5 | J | U |
| PCB-153 | 8.3 | J | U |
| PCB-170 | 2.6 | U | |
| PCB-18 | 23 | J | C |
| PCB-180 | 4.8 | J | U |
| PCB-183 | 2.6 | UJ | C |
| PCB-184 | 2.6 | U | |
| PCB-187 | 2.6 | U | |
| PCB-195 | 2.6 | U | |
| PCB-206 | 4.6 | J | U |
| PCB-209 | 3 | J | U |
| PCB-28 | 35 | J | C |

| | |
|---|---|
| nsample | TRZ4-SD-005B-0001 |
| samp_date | 11/6/2008 |
| lab_id | G2050-04A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 38.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| PCB-44 | 21 | | |
| PCB-49 | 8.4 | J | U |
| PCB-52 | 15 | J | RU |
| PCB-66 | 13 | J | CU |
| PCB-8 | 9.3 | J | R |
| PCB-87 | 4.9 | J | U |
| TOXAPHENE | 2200 | U | |
| TRANS-NONACHLOR | 46 | J | C |

# PROJ_NO: 00811

SDG: G2050 MEDIA: SOIL DATA FRACTION: PEST/PCB

| | |
|---|---|
| nsample | TRZ4-SD-006A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2050-11A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 36.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 4,4'-DDD | 90 | U | |
| 4,4'-DDE | 90 | U | |
| 4,4'-DDT | 90 | UJ | C |
| ALDRIN | 46 | U | |
| ALPHA-CHLORDANE | 46 | U | |
| CIS-NONACHLOR | 46 | U | |
| DIELDRIN | 90 | U | |
| ENDOSULFAN I | 46 | U | |
| ENDOSULFAN II | 90 | U | |
| ENDRIN | 90 | U | |
| GAMMA-BHC (LINDANE) | 46 | U | |
| GAMMA-CHLORDANE | 72 | | |
| HEPTACHLOR | 46 | U | |
| HEPTACHLOR EPOXIDE | 48 | J | U |
| METHOXYCHLOR | 460 | U | |
| OXYCHLORDANE | 160 | J | U |
| PCB-101 | 26 | J | U |
| PCB-105 | 9.3 | J | CU |
| PCB-118 | 16 | J | U |
| PCB-128 | 2.9 | R | U |
| PCB-138 | 22 | J | U |
| PCB-153 | 23 | | |
| PCB-170 | 5.3 | R | U |
| PCB-18 | 67 | J | CU |
| PCB-180 | 12 | J | U |
| PCB-183 | 2.8 | UJ | C |
| PCB-184 | 2.8 | U | |
| PCB-187 | 3.7 | R | U |
| PCB-195 | 2.8 | U | |
| PCB-206 | 5.6 | J | U |
| PCB-209 | 2.8 | U | |
| PCB-28 | 97 | J | CU |

| | |
|---|---|
| nsample | TRZ4-SD-006A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2050-11A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 36.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| PCB-44 | 28 | J | U |
| PCB-49 | 19 | J | U |
| PCB-52 | 51 | | |
| PCB-66 | 14 | R | U |
| PCB-8 | 28 | | |
| PCB-87 | 14 | | |
| TOXAPHENE | 4600 | U | |
| TRANS-NONACHLOR | 97 | | |

| | |
|---|---|
| nsample | TRZ4-SD-006A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2050-12A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 61.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 4,4'-DDD | 27 | U | |
| 4,4'-DDE | 27 | U | |
| 4,4'-DDT | 36 | J | C |
| ALDRIN | 20 | J | U |
| ALPHA-CHLORDANE | 14 | U | |
| CIS-NONACHLOR | 14 | U | |
| DIELDRIN | 27 | U | |
| ENDOSULFAN I | 14 | U | |
| ENDOSULFAN II | 27 | U | |
| ENDRIN | 27 | U | |
| GAMMA-BHC (LINDANE) | 14 | U | |
| GAMMA-CHLORDANE | 17 | | |
| HEPTACHLOR | 23 | J | U |
| HEPTACHLOR EPOXIDE | 20 | | |
| METHOXYCHLOR | 140 | U | |
| OXYCHLORDANE | 52 | J | U |
| PCB-101 | 22 | J | U |
| PCB-105 | 3.9 | R | U |
| PCB-118 | 11 | R | U |
| PCB-128 | 1.6 | U | |
| PCB-138 | 19 | J | U |
| PCB-153 | 25 | | |
| PCB-170 | 17 | J | U |
| PCB-18 | 130 | J | CU |
| PCB-180 | 21 | | |
| PCB-183 | 6.5 | J | C |
| PCB-184 | 2.9 | J | U |
| PCB-187 | 12 | J | U |
| PCB-195 | 2.7 | J | U |
| PCB-206 | 9.9 | | |
| PCB-209 | 6 | J | U |
| PCB-28 | 120 | J | CU |

# PROJ_NO: 00811

SDG: G2050 MEDIA: SOIL DATA FRACTION: PEST/PCB

| | |
|---|---|
| nsample | TRZ4-SD-006A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2050-12A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 61.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| PCB-44 | 40 | | |
| PCB-49 | 15 | R | U |
| PCB-52 | 48 | | |
| PCB-66 | 28 | J | CU |
| PCB-8 | 80 | | |
| PCB-87 | 14 | | |
| TOXAPHENE | 1400 | U | |
| TRANS-NONACHLOR | 21 | J | C |

| | |
|---|---|
| nsample | TRZ4-SD-006B-0001 |
| samp_date | 11/6/2008 |
| lab_id | G2050-10A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 33.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 4,4'-DDD | 50 | U | |
| 4,4'-DDE | 50 | U | |
| 4,4'-DDT | 50 | UJ | C |
| ALDRIN | 26 | U | |
| ALPHA-CHLORDANE | 26 | U | |
| CIS-NONACHLOR | 26 | U | |
| DIELDRIN | 50 | U | |
| ENDOSULFAN I | 26 | U | |
| ENDOSULFAN II | 50 | U | |
| ENDRIN | 50 | U | |
| GAMMA-BHC (LINDANE) | 26 | U | |
| GAMMA-CHLORDANE | 26 | U | |
| HEPTACHLOR | 26 | U | |
| HEPTACHLOR EPOXIDE | 26 | U | |
| METHOXYCHLOR | 260 | U | |
| OXYCHLORDANE | 99 | | |
| PCB-101 | 10 | J | U |
| PCB-105 | 2.9 | U | |
| PCB-118 | 8 | J | U |
| PCB-128 | 2.9 | U | |
| PCB-138 | 8.5 | | |
| PCB-153 | 6.7 | | |
| PCB-170 | 2.9 | U | |
| PCB-18 | 4.6 | R | U |
| PCB-180 | 4.1 | J | U |
| PCB-183 | 2.9 | UJ | C |
| PCB-184 | 2.9 | U | |
| PCB-187 | 2.9 | U | |
| PCB-195 | 2.9 | U | |
| PCB-206 | 6.9 | J | U |
| PCB-209 | 7.4 | | |
| PCB-28 | 27 | J | C |

| | |
|---|---|
| nsample | TRZ4-SD-006B-0001 |
| samp_date | 11/6/2008 |
| lab_id | G2050-10A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 33.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| PCB-44 | 11 | J | U |
| PCB-49 | 4.8 | R | U |
| PCB-52 | 13 | J | U |
| PCB-66 | 7.1 | R | U |
| PCB-8 | 3.9 | J | U |
| PCB-87 | 5.8 | J | U |
| TOXAPHENE | 2600 | U | |
| TRANS-NONACHLOR | 55 | J | C |

# PROJ_NO: 00811

SDG: G2050 MEDIA: SOIL DATA FRACTION: PEST/PCB

| | |
|---|---|
| nsample | TRZ4-SD-007A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2050-08A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 48.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 4,4'-DDD | 6.8 | U | |
| 4,4'-DDE | 6.8 | U | |
| 4,4'-DDT | 6.8 | U | |
| ALDRIN | 3.5 | U | |
| ALPHA-CHLORDANE | 3.5 | U | |
| CIS-NONACHLOR | 3.5 | U | |
| DIELDRIN | 6.8 | U | |
| ENDOSULFAN I | 3.5 | U | |
| ENDOSULFAN II | 6.8 | U | |
| ENDRIN | 6.8 | U | |
| GAMMA-BHC (LINDANE) | 3.5 | U | |
| GAMMA-CHLORDANE | 18 | J | U |
| HEPTACHLOR | 3.6 | J | U |
| HEPTACHLOR EPOXIDE | 3.5 | U | |
| METHOXYCHLOR | 35 | U | |
| OXYCHLORDANE | 7 | | |
| PCB-101 | 2.1 | U | |
| PCB-105 | 2.1 | U | |
| PCB-118 | 2.1 | U | |
| PCB-128 | 2.1 | U | |
| PCB-138 | 2.1 | U | |
| PCB-153 | 2.1 | U | |
| PCB-170 | 2.1 | U | |
| PCB-18 | 2.1 | U | |
| PCB-180 | 2.1 | U | |
| PCB-183 | 2.1 | UJ | C |
| PCB-184 | 2.1 | U | |
| PCB-187 | 2.1 | U | |
| PCB-195 | 2.1 | U | |
| PCB-206 | 2.1 | U | |
| PCB-209 | 2.4 | | |
| PCB-28 | 2.1 | UJ | C |

| | |
|---|---|
| nsample | TRZ4-SD-007A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2050-08A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 48.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| PCB-44 | 2.1 | U | |
| PCB-49 | 2.1 | U | |
| PCB-52 | 2.1 | U | |
| PCB-66 | 2.1 | UJ | C |
| PCB-8 | 2.1 | U | |
| PCB-87 | 2.1 | U | |
| TOXAPHENE | 350 | U | |
| TRANS-NONACHLOR | 3.8 | J | U |

| | |
|---|---|
| nsample | TRZ4-SD-007A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2050-09A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 49.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 4,4'-DDD | 6.6 | U | |
| 4,4'-DDE | 6.6 | U | |
| 4,4'-DDT | 6.6 | U | |
| ALDRIN | 3.4 | U | |
| ALPHA-CHLORDANE | 3.4 | U | |
| CIS-NONACHLOR | 3.4 | U | |
| DIELDRIN | 6.6 | U | |
| ENDOSULFAN I | 3.4 | U | |
| ENDOSULFAN II | 6.6 | U | |
| ENDRIN | 6.6 | U | |
| GAMMA-BHC (LINDANE) | 3.4 | U | |
| GAMMA-CHLORDANE | 8.8 | J | U |
| HEPTACHLOR | 3.4 | U | |
| HEPTACHLOR EPOXIDE | 3.4 | U | |
| METHOXYCHLOR | 34 | U | |
| OXYCHLORDANE | 3.4 | U | |
| PCB-101 | 2 | U | |
| PCB-105 | 2 | U | |
| PCB-118 | 2 | U | |
| PCB-128 | 4.9 | J | RU |
| PCB-138 | 2 | U | |
| PCB-153 | 2 | U | |
| PCB-170 | 2 | U | |
| PCB-18 | 2 | U | |
| PCB-180 | 2 | U | |
| PCB-183 | 2 | UJ | C |
| PCB-184 | 2 | U | |
| PCB-187 | 2 | U | |
| PCB-195 | 2 | U | |
| PCB-206 | 2.2 | J | RU |
| PCB-209 | 2 | U | |
| PCB-28 | 2 | UJ | C |

# PROJ_NO: 00811

SDG: G2050 MEDIA: SOIL DATA FRACTION: PEST/PCB

| | |
|---|---|
| nsample | TRZ4-SD-007A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2050-09A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 49.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| PCB-44 | 2 | U | |
| PCB-49 | 2 | U | |
| PCB-52 | 2 | U | |
| PCB-66 | 2 | UJ | C |
| PCB-8 | 2 | U | |
| PCB-87 | 2 | U | |
| TOXAPHENE | 340 | U | |
| TRANS-NONACHLOR | 3.4 | U | |

| | |
|---|---|
| nsample | TRZ4-SD-007B-0001 |
| samp_date | 11/6/2008 |
| lab_id | G2050-07A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 35.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 4,4'-DDD | 46 | U | |
| 4,4'-DDE | 46 | U | |
| 4,4'-DDT | 68 | J | CU |
| ALDRIN | 24 | U | |
| ALPHA-CHLORDANE | 24 | U | |
| CIS-NONACHLOR | 80 | | |
| DIELDRIN | 46 | U | |
| ENDOSULFAN I | 24 | U | |
| ENDOSULFAN II | 47 | | |
| ENDRIN | 46 | U | |
| GAMMA-BHC (LINDANE) | 24 | U | |
| GAMMA-CHLORDANE | 27 | J | U |
| HEPTACHLOR | 24 | U | |
| HEPTACHLOR EPOXIDE | 24 | U | |
| METHOXYCHLOR | 240 | U | |
| OXYCHLORDANE | 120 | | |
| PCB-101 | 9.2 | J | U |
| PCB-105 | 3.3 | J | CU |
| PCB-118 | 7.6 | J | U |
| PCB-128 | 2.8 | U | |
| PCB-138 | 8.5 | | |
| PCB-153 | 8.6 | | |
| PCB-170 | 8.7 | J | U |
| PCB-18 | 15 | J | C |
| PCB-180 | 5.7 | | |
| PCB-183 | 2.8 | UJ | C |
| PCB-184 | 2.8 | U | |
| PCB-187 | 2.8 | U | |
| PCB-195 | 2.8 | U | |
| PCB-206 | 8.3 | | |
| PCB-209 | 3.7 | R | U |
| PCB-28 | 16 | J | CU |

| | |
|---|---|
| nsample | TRZ4-SD-007B-0001 |
| samp_date | 11/6/2008 |
| lab_id | G2050-07A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 35.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| PCB-44 | 6.7 | | |
| PCB-49 | 2.8 | U | |
| PCB-52 | 11 | | |
| PCB-66 | 2.8 | UJ | C |
| PCB-8 | 9.9 | | |
| PCB-87 | 7.9 | | |
| TOXAPHENE | 2400 | U | |
| TRANS-NONACHLOR | 100 | | |

# PROJ_NO: 00811

SDG: G2050 MEDIA: SOIL DATA FRACTION: PEST/PCB

| | |
|---|---|
| nsample | TRZ4-SD-008A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2050-17A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 37.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 4,4'-DDD | 88 | U | |
| 4,4'-DDE | 88 | U | |
| 4,4'-DDT | 88 | UJ | C |
| ALDRIN | 45 | U | |
| ALPHA-CHLORDANE | 45 | U | |
| CIS-NONACHLOR | 110 | | |
| DIELDRIN | 88 | U | |
| ENDOSULFAN I | 45 | U | |
| ENDOSULFAN II | 88 | U | |
| ENDRIN | 88 | U | |
| GAMMA-BHC (LINDANE) | 45 | U | |
| GAMMA-CHLORDANE | 45 | U | |
| HEPTACHLOR | 45 | U | |
| HEPTACHLOR EPOXIDE | 45 | U | |
| METHOXYCHLOR | 450 | U | |
| OXYCHLORDANE | 88 | | |
| PCB-101 | 12 | J | RU |
| PCB-105 | 2.9 | J | CU |
| PCB-118 | 19 | J | U |
| PCB-128 | 2.6 | U | |
| PCB-138 | 10 | J | U |
| PCB-153 | 12 | | |
| PCB-170 | 2.8 | R | U |
| PCB-18 | 12 | J | CU |
| PCB-180 | 6.5 | | |
| PCB-183 | 2.6 | UJ | C |
| PCB-184 | 2.6 | U | |
| PCB-187 | 2.6 | U | |
| PCB-195 | 2.6 | U | |
| PCB-206 | 4.7 | | |
| PCB-209 | 2.6 | U | |
| PCB-28 | 20 | J | CR |

| | |
|---|---|
| nsample | TRZ4-SD-008A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2050-17A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 37.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| PCB-44 | 7.9 | J | RU |
| PCB-49 | 8.8 | | |
| PCB-52 | 9.7 | J | RU |
| PCB-66 | 16 | J | C |
| PCB-8 | 3.6 | J | RU |
| PCB-87 | 9.1 | | |
| TOXAPHENE | 4500 | U | |
| TRANS-NONACHLOR | 45 | U | |

| | |
|---|---|
| nsample | TRZ4-SD-008A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2050-18A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 37.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 4,4'-DDD | 18 | J | U |
| 4,4'-DDE | 36 | J | CU |
| 4,4'-DDT | 35 | J | CRU |
| ALDRIN | 12 | R | U |
| ALPHA-CHLORDANE | 6 | J | RU |
| CIS-NONACHLOR | 70 | J | RU |
| DIELDRIN | 8.8 | U | |
| ENDOSULFAN I | 4.5 | U | |
| ENDOSULFAN II | 29 | J | U |
| ENDRIN | 8.8 | U | |
| GAMMA-BHC (LINDANE) | 6.2 | J | U |
| GAMMA-CHLORDANE | 37 | J | R |
| HEPTACHLOR | 7.2 | J | RU |
| HEPTACHLOR EPOXIDE | 8.9 | J | RU |
| METHOXYCHLOR | 64 | J | U |
| OXYCHLORDANE | 9 | R | U |
| PCB-101 | 13 | J | R |
| PCB-105 | 3.7 | J | CU |
| PCB-118 | 14 | J | U |
| PCB-128 | 2.6 | U | |
| PCB-138 | 14 | J | U |
| PCB-153 | 13 | | |
| PCB-170 | 2.6 | U | |
| PCB-18 | 14 | J | CU |
| PCB-180 | 7.3 | | |
| PCB-183 | 2.6 | UJ | C |
| PCB-184 | 2.6 | U | |
| PCB-187 | 2.6 | U | |
| PCB-195 | 2.6 | U | |
| PCB-206 | 5.9 | J | U |
| PCB-209 | 2.6 | U | |
| PCB-28 | 25 | J | CU |

# PROJ_NO: 00811

SDG: G2050 MEDIA: SOIL DATA FRACTION: PEST/PCB

| | |
|---|---|
| nsample | TRZ4-SD-008A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2050-18A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 37.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| PCB-44 | 9.4 | J | U |
| PCB-49 | 5.6 | R | U |
| PCB-52 | 17 | J | RU |
| PCB-66 | 9 | J | CU |
| PCB-8 | 12 | J | R |
| PCB-87 | 9.3 | | |
| TOXAPHENE | 450 | U | |
| TRANS-NONACHLOR | 58 | J | C |

| | |
|---|---|
| nsample | TRZ4-SD-008B-0001 |
| samp_date | 11/6/2008 |
| lab_id | G2050-16A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 34.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 4,4'-DDD | 9.7 | U | |
| 4,4'-DDE | 11 | J | RU |
| 4,4'-DDT | 9.7 | UJ | C |
| ALDRIN | 5 | U | |
| ALPHA-CHLORDANE | 5 | U | |
| CIS-NONACHLOR | 5 | U | |
| DIELDRIN | 9.7 | U | |
| ENDOSULFAN I | 5 | U | |
| ENDOSULFAN II | 9.7 | U | |
| ENDRIN | 9.7 | U | |
| GAMMA-BHC (LINDANE) | 20 | J | RU |
| GAMMA-CHLORDANE | 31 | | |
| HEPTACHLOR | 6.8 | J | RU |
| HEPTACHLOR EPOXIDE | 5 | U | |
| METHOXYCHLOR | 50 | U | |
| OXYCHLORDANE | 5 | U | |
| PCB-101 | 6.9 | J | RU |
| PCB-105 | 2.9 | U | |
| PCB-118 | 17 | J | U |
| PCB-128 | 2.9 | U | |
| PCB-138 | 7.3 | | |
| PCB-153 | 7.3 | | |
| PCB-170 | 3.1 | R | U |
| PCB-18 | 4.5 | R | U |
| PCB-180 | 4.4 | J | U |
| PCB-183 | 2.9 | UJ | C |
| PCB-184 | 2.9 | U | |
| PCB-187 | 2.9 | U | |
| PCB-195 | 2.9 | U | |
| PCB-206 | 3.8 | J | U |
| PCB-209 | 2.9 | U | |
| PCB-28 | 22 | J | C |

| | |
|---|---|
| nsample | TRZ4-SD-008B-0001 |
| samp_date | 11/6/2008 |
| lab_id | G2050-16A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 34.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| PCB-44 | 11 | J | U |
| PCB-49 | 5.4 | J | U |
| PCB-52 | 11 | J | RU |
| PCB-66 | 2.9 | UJ | C |
| PCB-8 | 2.9 | U | |
| PCB-87 | 5.5 | J | R |
| TOXAPHENE | 500 | U | |
| TRANS-NONACHLOR | 40 | J | C |

**Tetra Tech NUS** **INTERNAL CORRESPONDENCE**

**TO:** **COREY RICH** **DATE: JANUARY 13, 2009**

**FROM:** **JOSEPH KALINYAK** **COPIES: DV FILE**

**SUBJECT:** **ORGANIC DATA VALIDATION: PCB CONGENERS/PEST**
**CTO 424, NSB NEW LONDON**
**SDG G2039**

**SAMPLES:** 15/Soil/PCB Congeners/PEST

| | | |
|---|---|---|
| TRP1-SD-007A-0204 | TRP1-SD-007A-0406 | TRP1-SD-007B-001 |
| TRP1-SD-008A-0204 | TRP1-SD-008A-0406 | TRP1-SD-008B-0001 |
| TRP1-SD-009A-0204 | TRP1-SD-009A-0406 | TRP1-SD-009B-0001 |
| TRP1-SD-010A-0204 | TRP1-SD-010A-0406 | TRP1-SD-010B-0001 |
| TRZ4-SD-001A-0204 | TRZ4-SD-001A-0406 | TRZ4-SD-001B-0001 |

Overview

The sample set for CTO 424 SDG G2039 NSB New London, consists of fifteen (15) environmental soil samples. There were no field duplicates associated with this SDG. All samples were analyzed as indicated above.

The samples were collected by Tetra Tech NUS, Inc. on November 5 and 6, 2008 and analyzed by Mitkem Laboratories. All analyses were conducted in accordance with Naval Facilities Engineering Service Center (NFESC) Quality Assurance/Quality Control (QA/QC) criteria using USEPA SW-846 Method 8081 and 8082 analytical and reporting protocol. A USEPA Region I Tier 3 data validation was performed on the referenced samples. The data contained in this SDG were validated with regard to the following parameters:

* • Data Completeness
* • Holding Times
• Initial and Continuing Calibration
* • Laboratory Method and/or Field Quality Control Blanks
• Surrogate Spike Recoveries
* • Laboratory Control Spike / Laboratory Control Spike Duplicate Recoveries
• Matrix Spike/Matrix Spike Duplicate Results
* • Detection Limits
* • Compound Identification
• Sample Quantitation

The asterisk (*) indicates that all quality control criteria were met for this parameter. Qualified (if applicable) analytical results are summarized in Appendix A. Results as reported by the laboratory are presented in Appendix B. Appendix C contains Region I worksheets, and Appendix D contains the documentation to support the findings as discussed in this data validation report. The attached Table summarizes the validation qualifications which are based on the following information:

**CALIBRATIONS**

The opening calibration verification %D was greater than the 15% quality control limit for 4,4'-DDE, 4,4'-DDT, and endosulfan I for the primary GC column CLPPest on 12/11/08 @ 11:29. The closing calibration verification %D was greater than the 15% quality control limit for 4,4'-DDD, 4,4'-DDT, and methoxychlor for the primary GC column CLPPest on 12/11/08 @ 15:44. The affected samples were TRP1-SD-009B-0001, TRP1-SD-009A-0204, TRP1-SD-010B-0001, TRP1-SD-008A-0406, and TRP1-SD-007B-001. The continuing calibration %D was greater than the 15% quality control limit for heptachlor, 4,4'-DDT, and methoxychlor for the secondary GC column CLPPestII on 12/11/08 @ 11:29. The continuing calibration %D was greater than the 15% quality control limit for 4,4'-DDD, 4,4'-DDT, and methoxychlor for the secondary GC column CLPPestII on 12/11/08 @ 15:44. The affected samples were TRP1-SD-009B-0001, TRP1-SD-009A-0204, TRP1-SD-010B-0001, TRP1-SD-008A-0406, and TRP1-SD-007B-001. As the calibration verification %D was greater than the 15% quality control limit for both the primary and secondary GC columns for 4,4'-DDT, methoxychlor, and 4,4'-DDD for the aforementioned samples, they were qualified estimated, (J) and (UJ), respectively, for the positive and non-detected 4,4'-DDT, methoxychlor, and 4,4'-DDD compounds (except where rejected due to % difference between GC columns). The positive and non-detected results for TRP1-SD-009B-0001, TRP1-SD-009A-0204, TRP1-SD-010B-0001, TRP1-SD-008A-0406, and TRP1-SD-007B-001 for 4,4'-DDE, endosulfan I and heptachlor were not qualified as the alternate within the QC limits GC column results were reported.

The continuing calibration %D was greater than the 15% quality control limit for cis-nonachlor, 4,4'-DDT, and methoxychlor for the primary GC column CLPPest on 12/12/08 @ 13:46 (@ 14:00 for cis-nonachlor). The affected samples were TRP1-SD-007A-0204, TRP1-SD-007A-0406, TRZ4-SD-001B-0001, TRZ4-SD-001A-0204, TRZ4-SD-001A-0406, and TRP1-SD-009A-0406. The continuing calibration %D was greater than the 15% quality control limit for cis-nonachlor, 4,4'-DDT, methoxychlor, endrin ketone, and endrin aldehyde for the secondary GC column CLPPestII on 12/12/08 @ 13:46 (@ 14:00 for cis-nonachlor). The affected samples were TRP1-SD-007A-0204, TRP1-SD-007A-0406, TRZ4-SD-001B-0001, TRZ4-SD-001A-0204, TRZ4-SD-001A-0406, and TRP1-SD-009A-0406. As the calibration verification %D was greater than the 15% quality control limit for both the primary and secondary GC columns for 4,4'-DDT, methoxychlor, and cis-nonachlor, the aforementioned samples were qualified estimated, (J) and (UJ), respectively, for the positive and non-detected 4,4'-DDT, methoxychlor, and cis-nonachlor compounds except where rejected due to % difference between chromatographic columns. The positive and non-detected results for TRP1-SD-007A-0204, TRP1-SD-007A-0406, TRZ4-SD-001B-0001, TRZ4-SD-001A-0204, TRZ4-SD-001A-0406, and TRP1-SD-009A-0406 for endrin aldehyde and endrin ketone were not qualified as the alternate within the QC limits GC column results were reported.

The continuing calibration %D was greater than the 15% quality control limit for 4,4'-DDE and 4,4'-DDT for the primary GC column CLPPest on 12/13/08 @ 09:03 and on 12/13/08 @ 12:08. The affected samples were TRP1-SD-010A-0204, TRP1-SD-10A-0406, TRP1-SD-008B-0001, and TRP1-SD-008A-0204. The continuing calibration %D was greater than the 15% quality control limit for heptachlor and 4,4'-DDT for the secondary GC column CLPPestII on 12/13/08 @ 09:03. The continuing calibration %D was greater than the 15% quality control limit for heptachlor, 4,4'-DDT, and methoxychlor for the secondary GC column CLPPestII on 12/13/08 @ 12:08. The continuing calibration %D was greater than the 15% quality control limit for oxychlordane for the secondary GC column CLPPestII on 12/13/08 @ 12:22. The affected samples were TRP1-SD-010A-0204, TRP1-SD-10A-0406, TRP1-SD-008B-0001, and TRP1-SD-008A-0204. As the calibration verification %D was greater than the 15% quality control limit for both the primary and secondary GC columns for 4,4'-DDT the aforementioned samples were qualified estimated, (J) and (UJ), respectively, for positive and non-detected 4,4'-DDT. The positive and non-detected results for TRP1-SD-10A-0406 and TRP1-SD-008B-0001, for 4,4'-DDE, heptachlor, methoxychlor, and oxychlordane were not qualified as the alternate within the QC limits GC column results were reported. The positive 4,4'-DDE result for TRP1-SD-010A-0204 was qualified rejected, (R), as the % difference between the primary and secondary GC columns

was >100%, and the non-detected results for 4,4'-DDT, heptachlor, methoxychlor, and oxychlordane were not qualified as the alternate within the QC limits GC column was reported for TRP1-SD-010A-0204. The positive 4,4'-DDE result for TRP1-SD-008A-0204 was qualified estimated, (J), as it was reported from the secondary GC column, and the non-detected results for heptachlor and methoxychlor were not qualified as the alternate within the QC limits GC column results were reported for TRP1-SD-008A-0204. The positive oxychlordane result for sample TRP1-SD-008A-0204 was qualified rejected, (R), as the GC column % difference between the primary and secondary was >100%.

The %D was greater than the 15% quality control limit for PCB-187 on both the primary and the secondary GC column for the calibration verification 12/11/08 @ 22:24. All SDG samples were affected and the positive and non-detected sample results for PCB-187 were qualified estimated, (J) and (UJ), respectively, with the exception where they were more severely qualified for another issue.

The %D was greater than the 15% quality control limit for PCB-209 on the secondary GC column for the calibration verification on 12/11/08 @18:44. The non-detected results were not qualified as the primary GC column was within the QC limits. The positive result for sample TRP1-SD-007B-001 was qualified estimated, (J), for PCB-209 as it was reported from the secondary GC column. The remainder of the affected positive sample results were reported from the primary GC column and were not qualified.

The %D was greater than the 15% quality control limit for PCB-118 on the primary GC column for the calibration verification on 12/11/08 @ 22:24. The %D was greater than the 15% quality control limit for PCB-118 on the primary GC column for the calibration verification on 12/12/08 @ 02:20. All SDG samples were affected. The sample results for PCB-118 were qualified as estimated for all SDG samples as all of the sample results were reported from the primary GC column.

The %D was greater than the 15% quality control limit for PCB-206 on the secondary GC column for the calibration verification on 12/11/08 @ 22:24 and on 12/12/08 @ 02:20. All SDG samples were affected. The non-detected sample results were not qualified as the primary GC was within the QC limits for PCB-206. Sample TRP1-SD-007A-0406 was qualified estimated, (J), as the result from the secondary GC column was reported.

The %D was greater than the 15% quality control limit for PCB-28 and PCB-105 on the primary GC column for the calibration verification on 12/12/08 @ 02:20. The affected samples were TRP1-SD-007A-0204, TRP1-SD-007A-0406, TRZ4-SD-001B-0001, TRZ4-SD-001A-0204, and TRZ4-SD-001A-0406. The non-detected result for PCB-105 for sample TRZ4-SD-001B-0001 was not qualified as the secondary GC column was within the %D QC limit for PCB-105. The positive results for PCB-28 and PCB-105 for samples TRP1-SD-007A-0204, TRP1-SD-007A-0406, TRZ4-SD-001B-0001, TRZ4-SD-001A-0204, and TRZ4-SD-001A-0406 were qualified estimated, (J), as they were reported from the primary GC column.

The %D was greater than the 15% quality control limit for PCB-66 on the secondary GC column for the calibration verification on 12/12/08 @ 02:20. The affected samples were TRP1-SD-007A-0204, TRP1-SD-007A-0406, TRZ4-SD-001B-0001, TRZ4-SD-001A-0204, and TRZ4-SD-001A-0406. The positive and non-detected results for PCB-66 for the aforementioned samples were not qualified as the primary GC column %D was within the QC limits for PCB-66 and all sample results were reported from it.

## BLANKS

No qualification of the data was necessary.

## SURROGATE SPIKE RECOVERIES

The PEST % recovery was both less than and greater than the quality control limit for the surrogate decachlorobiphenyl (DCB) on both the primary and secondary GC columns for samples which required dilution. There was also a % recovery for the surrogate tetrachloro-m-xylene (TCX) on a diluted sample on the secondary GC column that was less than the quality control limit. No action was necessary for these surrogate quality control exceedances which were due to sample dilution.

The PEST % recovery was greater than the quality control limit for the surrogate DCB on the secondary GC column for sample TRP1-SD-008A-0204. No action was necessary for the non-detected results and the PESTs which were reported from the primary GC column as it had within the QC limit surrogate recoveries. The PESTs reported from the secondary GC column, 4,4'-DDE, cis-nonachlor, and heptachlor epoxide were qualified estimated, (J), for sample TRP1-SD-008A-0204. The oxychlordane result for sample TRP1-SD-008A-0204 was more severely qualified rejected due to another QC issue and no further action was necessary.

The PCB congeners surrogate spike % recoveries were greater than the quality control limit for the surrogate TCX on the secondary GC column for samples TRP1-SD-008A-0204, TRP1-SD-008A-0406, TRP1-SD-007B-001, TRP1-SD-007A-0204, and TRZ4-SD-001A-0406. No action was necessary for the non-detected results and positive results for samples which were reported from the secondary GC column were qualified estimated, (J), as listed below, except when more severely qualified due to another issue.

| Sample | PCB Congeners |
|---|---|
| TRP1-SD-008A-0204 | PCB-153, PCB-101, PCB-138 |
| TRP1-SD-008A-0406 | PCB-87, PCB-101, PCB-52, PCB-8 |
| TRP1-SD-007B-001 | PCB-87, PCB-44, PCB-52, PCB-28, PCB-209 |
| TRP1-SD-007A-0204 | PCB-87, PCB-101, PCB-153, PCB-52 |

## MATRIX SPIKE / MATRIX SPIKE DUPLICATE (MS / MSD)

The PEST MS/MSD for sample TRZ4-SD-001A-0204 had % recoveries both greater than and less than the quality control limit for the primary and secondary GC columns, as well as RPDs that were greater than the quality control limit for the primary and secondary GC columns. The results are tabulated below along with the sample qualifier for each compound.

| PEST | Primary column | | | Secondary Column | | | Sample |
|---|---|---|---|---|---|---|---|
| Compound | MS | MSD | RPD | MS | MSD | RPD | Qualifier |
| Aldrin | < | < | > | ok | > | > | UJ |
| Endrin | < | < | > | < | OK | > | UJ |
| Gamma-BHC | OK | > | > | OK | > | > | UJ |
| Heptachlor | > | > | > | OK | > | > | UJ |
| Heptachlor epoxide | * | * | * | * | * | * | * |
| Endosulfan I | OK | OK | OK | OK | > | > | U |
| Dieldrin | OK | > | > | > | > | OK | UJ |
| 4,4'-DDE | > | > | OK | OK | > | > | UJ |
| Endosulfan II | OK | OK | OK | > | > | OK | U |
| 4,4'-DDD | < | OK | > | < | OK | > | UJ |
| 4,4'-DDT | OK | > | > | > | > | > | UJ |
| Methoxychlor | OK | < | > | OK | > | > | UJ |
| Alpha-chlordane | < | OK | > | OK | > | > | UJ |
| Gamma-chlordane | OK | OK | OK | > | > | > | U |

* not applicable due to high level in sample prior to spike

The sample TRZ4-SD-001A-0204 matrix spike (MS) had % recoveries less than the quality control limit for PCB congeners 18, 28, 44, 52, 101, 105, 118, 128, and 138, and the matrix spike duplicate (MSD) had % recoveries less than the quality control limit for PCB congeners 18, 28, 105, 118, and 138 on the primary GC column. The MSD on the secondary GC column has a % recovery greater than the QC limit for PCB congener 209. No action was taken for PCB-209 as the alternate GC column MS and MSD results as well as the RPD were within the QC limits. The PCB congeners 18, 28, 105, 118, and 138 results for sample TRZ4-SD-001A-0204 were qualified estimated, (J), as a result of the MS/MSD QC issue since the results for these congeners were reported from the primary GC column. The remaining congeners were not qualified as the secondary GC MS/MSD column results were within the QC limits and the MSD primary column results and RPD were within the QC limits.

## LABORATORY CONTROL SPIKE/LABORATORY CONTROL SPIKE DUPLICATE

No qualification of the data was necessary..

## COMPOUND QUANTITATION

The %RPD was greater than 25% between the primary and secondary GC columns for the PEST analysis for a number of samples. The samples with %RPDs greater than 25% but less than or equal to 100% were qualified estimated, (J). Samples with %RPDs greater than 100% were qualified rejected, (R). The samples and the %RPDs are listed as follows.

| Sample | Compound | %RPD | Qualifer |
|---|---|---|---|
| TRP1-SD-007A-0204 | Gamma-chlordane | 126.4 | R |
| | Heptachlor epoxide | 54.2 | J |
| | Cis-nonachlor | 143.0 | R |
| | Oxychlordane | 129.8 | R |
| TRP1-SD-007A-0406 | 4,4'-DDD | 67.1 | J |
| | 4,4'-DDE | 93.0 | J |
| | Cis-nonachlor | 89.5 | J |
| | Dieldrin | 34.1 | J |
| | Gamma-BHC | 148.0 | R |
| | Heptachlor epoxide | 163.5 | R |
| TRP1-SD-007B-001 | Heptachlor epoxide | 44.4 | J |
| | Dieldrin | 56.4 | J |
| | Cis-nonachlor | 57.1 | J |
| | Gamma-chlordane | 106.7 | R |
| TRP1-SD-008A-0204 | 4,4'-DDE | 84.3 | J |
| | 4,4'-DDT | 36.7 | J |
| | Cis-nonachlor | 67.0 | J |
| | Oxychlordane | 135.1 | R |
| | Trans-nonachlor | 40.6 | J |
| | Heptachlor epoxide | 34.1 | J |
| TRP1-SD-008A-0406 | Cis-nonachlor | 116.5 | R |

| | | | |
|---|---|---|---|
| | Heptachlor epoxide | 29.6 | J |
| | Oxychlordane | 135.3 | R |
| | Trans-nonachlor | 41.3 | J |
| TRP1-SD-008B-0001 | Cis-nonachlor | 121.5 | R |
| | Gamma-Chlordane | 80.9 | J |
| TRP1-SD-009A-0204 | Gamma-chlordane | 26.9 | J |
| TRP1-SD-009A-0406 | Gamma-BHC | 41.4 | J |
| TRP1-SD-009B-0001 | 4,4'-DDE | 58.8 | J |
| | Cis-nonachlor | 114.2 | R |
| | Dieldrin | 87.8 | J |
| | Gamma-Chlordane | 107.5 | R |
| | Oxychlordane | 102.5 | R |
| TRP1-SD-010A-0204 | 4,4'-DDE | 29.8 | J |
| | Cis-nonachlor | 117.8 | R |
| | Gamma-chlordane | 166.0 | R |
| | Heptachlor epoxide | 58.7 | J |
| | Trans-nonachlor | 116.8 | R |
| TRP1-SD-010A-0406 | 4,4'-DDE | 101.2 | R |
| | Dieldrin | 147.2 | R |
| | Gamma-chlordane | 179.5 | R |
| | Oxychlordane | 122.9 | R |
| TRP1-SD-010B-0001 | 4,4'-DDT | 162.8 | R |
| | Cis-nonachlor | 87.6 | J |
| | Trans-nonachlor | 40.4 | J |
| TRZ4-SD-001A-0204 | Cis-nonachlor | 99.3 | J |
| | Oxychlordane | 162.3 | R |
| TRZ4-SD-001A-0406 | 4,4'-DDD | 39.5 | J |
| | Cis-nonachlor | 64.9 | J |
| | Oxychlordane | 143.3 | R |
| TRZ4-SD-001B-0001 | 4,4'-DDE | 28.8 | J |
| | Cis-nonachlor | 139.7 | R |
| | Gamma-chlordane | 167.3 | R |
| | Oxychlordane | 48.1 | J |
| | Trans-nonachlor | 94.4 | J |

The %RPD was greater than 25% between the primary and secondary GC columns for the PCB congener analysis for a number of samples. The samples with %RPDs greater than 25% but less than or equal to 100% were qualified estimated, (J). Samples with %RPDs greater than 100% were qualified rejected, (R). The samples and the PCB congener qualifications are listed as follows.

| Sample | PCB Compound | Qualifer |
|---|---|---|
| TRP1-SD-009B-0001 | 206, 170, 128, 180, 138, 49, 105, 118 | J |
| TRP1-SD-009A-0204 | 206, 180, 138, 87, 101, 52, 18, 105, 118, 66, 8 | J |
| | 170, 49 | R |
| TRP1-SD-009A-0406 | 206, 170, 128, 180, 138, 44, 49, 52, 105, 118, 8 | J |
| TRP1-SD-010B-0001 | 180, 87, 44, 101, 49, 118, | J |
| | 52, 28, 8, | R |
| TRP1-SD-010A-0204 | 170, 128, 180, 138, 49, 105, 118, 8 | J |
| | 187 | R |
| TRP1-SD-010A-0406 | 170, 128, 180, 138, 87, 153, 49, 105, 118, 8 | J |
| | 187, 66, 209 | R |
| TRP1-SD-008B-0001 | 206, 180, 87, 44, 101, 118 | J |
| | 52, 28 | R |
| TRP1-SD-008A-0204 | 170, 128, 180, 105, 118, 28 | J |
| | 187, 18, 8 | R |
| TRP1-SD-008A-0406 | 170, 128, 138, 49, 105, 118, 206 | J |
| | 187 | R |
| TRP1-SD-007B-001 | 180, 87, 44, 153, 52, 18, 105, 209 | J |
| | 28, 8 | R |
| TRP1-SD-007A-0204 | 206, 170, 128, 180, 138, 52, 18, 105, 118 | J |
| | 49 | R |
| TRP1-SD-007A-0406 | 195, 170, 128, 180, 187, 138, 183, 153, 105 | J |
| | 118, 28, 8 | J |
| | 49 | R |
| TRZ4-SD-001B-0001 | 170, 180, 138, 87, 101, 52, 118, 28 | J |
| | 209 | R |
| TRZ4-SD-001A-0204 | 138, 44, 18, 105, 28, 8 | J |
| | 187, 49, 66 | R |
| TRZ4-SD-001A-0406 | 206, 138, 44, 153, 101, 18, 105, 66, 28, 8 | J |
| | 49 | R |

## ADDITIONAL COMMENTS

Positive results reported below the quantitation limit but above the method detection limit were qualified as estimated, (J).

The lower PEST/PCB result, when choosing between the primary and secondary GC column PCB results, was reported by the laboratory.

The laboratory submitted revised Form Xs which calculated the %RPD between the primary and secondary GC columns. These were included in this report. The laboratory originally presented %D between GC columns instead of %RPD.

The laboratory performed dilutions on some of the samples for PEST analysis as indicated below.

| Sample | Dilution |
|---|---|
| TRP1-SD-007A-0204 | 4X |
| TRP1-SD-007A-0406 | 4X |
| TRP1-SD-007B-001 | 4X |
| TRP1-SD-008A-0406 | 4X |
| TRP1-SD-009A-0204 | 2X |
| TRP1-SD-009A-0406 | 2X |
| TRP1-SD-009B-0001 | 5X |
| TRP1-SD-010A-0204 | 2X |
| TRP1-SD-010A-0406 | 5X |
| TRP1-SD-10B-0001 | 5X |
| TRZ4-SD-001A-0204 | 4X |
| TRZ4-SD-001A-0406 | 4X |

## EXECUTIVE SUMMARY

**Laboratory Performance:** There were PEST and PCB calibration verification %Ds that were greater than the quality control limits. There were PEST and PCB congener surrogate spike % recoveries on the secondary GC column greater than the quality control limits. There were both PEST and PCB congener MS/MSD results greater than the QC limits for spiked samples. There were both PEST and PCB congener % differences between primary and secondary GC columns which resulted in the qualification of sample results.

**Other Factors Affecting Data Quality:** The laboratory performed dilutions for the PEST analysis. The laboratory re-submitted Form 1s, 3s, and 10s for the PEST fraction due to a calculation error. The laboratory re-submitted a Form 10 showing the result for the calculation of RPD instead of %D.

The data for these analyses were reviewed with reference to the Region I EPA "Data Validation Functional Guidelines - Part II" (12/96), National Functional Guidelines for Low Concentration Organic Data Review, and the DoD Quality Systems (QSM) (January 2006).

"I attest that the data referenced herein were validated according to the agreed upon validation criteria as specified in the NFESC Guidelines and the DoD QSM."

TetraTech NUS
Joseph Kalinyak
Chemist/Data Validator

TetraTech NUS
Joseph A. Samchuck
Data Validation Quality Assurance Officer

Attachments:

1. Appendix A - Qualified Analytical Results
2. Appendix B - Results as Reported by the Laboratory
3. Appendix C - Regional Worksheets
4. Appendix D - Support Documentation

# APPENDIX A

## QUALIFIED LABORATORY RESULTS

**Qualifier Codes:**

A = Lab Blank Contamination
B = Field Blank Contamination
C = Calibration Noncompliance (i.e., % RSDs, %Ds, ICVs, CCVs, RRFs, etc.)
C01 = GC/MS Tuning Noncompliance
D = MS/MSD Recovery Noncompliance
E = LCS/LCSD Recovery Noncompliance
F = Lab Duplicate Imprecision
G = Field Duplicate Imprecision
H = Holding Time Exceedance
I = ICP Serial Dilution Noncompliance
J = GFAA PDS - GFAA MSA's $r < 0.995$
K = ICP Interference - includes ICS % R Noncompliance
L = Instrument Calibration Range Exceedance
M = Sample Preservation Noncompliance
N = Internal Standard Noncompliance
N01 = Internal Standard Recovery Noncompliance Dioxins
N02 = Recovery Standard Noncompliance Dioxins
N03 = Clean-up Standard Noncompliance Dioxins
O = Poor Instrument Performance (i.e., base-time drifting)
P = Uncertainty near detection limit (< 2 x IDL for inorganics and <CRQL for organics)
Q = Other problems (can encompass a number of issues; i.e.chromatography,interferences, etc.)
R = Surrogates Recovery Noncompliance
S = Pesticide/PCB Resolution
T = % Breakdown Noncompliance for DDT and Endrin
U = % Difference between columns/detectors >25% for positive results determined via GC/HPLC
V = Non-linear calibrations; correlation coefficient $r < 0.995$
W = EMPC result
X = Signal to noise response drop
Y = Percent solids <30%
Z = Uncertainty at 2 sigma deviation is less than sample activity

# PROJ_NO: 00811

SDG: G2039 MEDIA: SOIL DATA FRACTION: PEST/PCB

| | |
|---|---|
| nsample | TRP1-SD-007A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2039-11A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 54.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 4,4'-DDD | 4.8 | U | |
| 4,4'-DDE | 12 | | |
| 4,4'-DDT | 22 | J | C |
| ALDRIN | 2.5 | U | |
| ALPHA-CHLORDANE | 2.5 | U | |
| CIS-NONACHLOR | 5 | R | U |
| DIELDRIN | 4.8 | U | |
| ENDOSULFAN I | 2.5 | U | |
| ENDOSULFAN II | 4.8 | U | |
| ENDRIN | 4.8 | U | |
| GAMMA-BHC (LINDANE) | 2.5 | U | |
| GAMMA-CHLORDANE | 6.9 | R | U |
| HEPTACHLOR | 2.5 | U | |
| HEPTACHLOR EPOXIDE | 9.8 | J | U |
| METHOXYCHLOR | 25 | UJ | C |
| OXYCHLORDANE | 9.6 | R | U |
| PCB-101 | 24 | J | R |
| PCB-105 | 6.9 | J | CU |
| PCB-118 | 15 | J | CU |
| PCB-128 | 2.6 | J | U |
| PCB-138 | 17 | J | U |
| PCB-153 | 16 | J | R |
| PCB-170 | 2.4 | J | U |
| PCB-18 | 3.9 | J | U |
| PCB-180 | 4.6 | J | U |
| PCB-183 | 1.7 | U | |
| PCB-184 | 1.7 | U | |
| PCB-187 | 1.7 | UJ | C |
| PCB-195 | 1.7 | U | |
| PCB-206 | 1.8 | J | U |
| PCB-209 | 1.7 | U | |
| PCB-28 | 10 | J | C |

| | |
|---|---|
| nsample | TRP1-SD-007A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2039-11A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 54.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| PCB-44 | 9.2 | | |
| PCB-49 | 3.5 | R | U |
| PCB-52 | 18 | J | RU |
| PCB-66 | 1.7 | U | |
| PCB-8 | 2.3 | | |
| PCB-87 | 9.8 | J | R |
| TOXAPHENE | 250 | U | |
| TRANS-NONACHLOR | 19 | | |

| | |
|---|---|
| nsample | TRP1-SD-007A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2039-12A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 53.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 4,4'-DDD | 18 | J | U |
| 4,4'-DDE | 27 | J | U |
| 4,4'-DDT | 36 | J | C |
| ALDRIN | 5.9 | | |
| ALPHA-CHLORDANE | 2.5 | U | |
| CIS-NONACHLOR | 25 | J | CU |
| DIELDRIN | 20 | J | U |
| ENDOSULFAN I | 2.5 | U | |
| ENDOSULFAN II | 4.9 | U | |
| ENDRIN | 4.9 | U | |
| GAMMA-BHC (LINDANE) | 5.6 | R | U |
| GAMMA-CHLORDANE | 2.5 | U | |
| HEPTACHLOR | 7.9 | | |
| HEPTACHLOR EPOXIDE | 4.2 | R | U |
| METHOXYCHLOR | 25 | UJ | C |
| OXYCHLORDANE | 2.5 | U | |
| PCB-101 | 47 | | |
| PCB-105 | 17 | J | CU |
| PCB-118 | 75 | J | CU |
| PCB-128 | 5.4 | J | U |
| PCB-138 | 39 | J | U |
| PCB-153 | 33 | J | U |
| PCB-170 | 11 | J | U |
| PCB-18 | 11 | | |
| PCB-180 | 13 | J | U |
| PCB-183 | 2.1 | J | U |
| PCB-184 | 1.8 | U | |
| PCB-187 | 3.5 | J | CU |
| PCB-195 | 1.9 | J | RU |
| PCB-206 | 5 | J | CR |
| PCB-209 | 1.8 | U | |
| PCB-28 | 17 | J | CU |

# PROJ_NO: 00811

SDG: G2039 MEDIA: SOIL DATA FRACTION: PEST/PCB

| | |
|---|---|
| nsample | TRP1-SD-007A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2039-12A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 53.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| PCB-44 | 19 | | |
| PCB-49 | 4.8 | R | U |
| PCB-52 | 34 | | |
| PCB-66 | 1.8 | U | |
| PCB-8 | 5.6 | J | U |
| PCB-87 | 50 | | |
| TOXAPHENE | 250 | U | |
| TRANS-NONACHLOR | 2.5 | U | |

| | |
|---|---|
| nsample | TRP1-SD-007B-001 |
| samp_date | 11/6/2008 |
| lab_id | G2039-10A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 40.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 4,4'-DDD | 6.5 | UJ | C |
| 4,4'-DDE | 19 | | |
| 4,4'-DDT | 59 | J | C |
| ALDRIN | 3.4 | U | |
| ALPHA-CHLORDANE | 3.4 | U | |
| CIS-NONACHLOR | 6.3 | J | U |
| DIELDRIN | 13 | J | U |
| ENDOSULFAN I | 3.4 | U | |
| ENDOSULFAN II | 6.5 | U | |
| ENDRIN | 6.5 | U | |
| GAMMA-BHC (LINDANE) | 3.4 | U | |
| GAMMA-CHLORDANE | 6.6 | R | U |
| HEPTACHLOR | 3.4 | U | |
| HEPTACHLOR EPOXIDE | 17 | J | U |
| METHOXYCHLOR | 34 | UJ | C |
| OXYCHLORDANE | 3.4 | U | |
| PCB-101 | 8.1 | | |
| PCB-105 | 4.5 | J | U |
| PCB-118 | 18 | J | C |
| PCB-128 | 2.5 | U | |
| PCB-138 | 10 | | |
| PCB-153 | 7.5 | J | U |
| PCB-170 | 4.8 | | |
| PCB-18 | 15 | J | U |
| PCB-180 | 4.4 | J | U |
| PCB-183 | 2.5 | U | |
| PCB-184 | 2.5 | U | |
| PCB-187 | 2.5 | UJ | C |
| PCB-195 | 2.5 | U | |
| PCB-206 | 2.5 | U | |
| PCB-209 | 45 | J | CRU |
| PCB-28 | 3.3 | R | U |

| | |
|---|---|
| nsample | TRP1-SD-007B-001 |
| samp_date | 11/6/2008 |
| lab_id | G2039-10A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 40.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| PCB-44 | 6.1 | J | RU |
| PCB-49 | 2.5 | U | |
| PCB-52 | 7.1 | J | RU |
| PCB-66 | 2.5 | U | |
| PCB-8 | 2.7 | R | U |
| PCB-87 | 4.4 | J | RU |
| TOXAPHENE | 340 | U | |
| TRANS-NONACHLOR | 24 | | |

# PROJ_NO: 00811

SDG: G2039 MEDIA: SOIL DATA FRACTION: PEST/PCB

| | |
|---|---|
| nsample | TRP1-SD-008A-0204 |
| samp_date | 11/5/2008 |
| lab_id | G2039-08A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 37.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 4,4'-DDD | 1.8 | U | |
| 4,4'-DDE | 3 | J | CRU |
| 4,4'-DDT | 12 | J | CU |
| ALDRIN | 1 | | |
| ALPHA-CHLORDANE | 0.91 | U | |
| CIS-NONACHLOR | 7.5 | J | RU |
| DIELDRIN | 1.8 | U | |
| ENDOSULFAN I | 0.91 | U | |
| ENDOSULFAN II | 1.8 | U | |
| ENDRIN | 1.8 | U | |
| GAMMA-BHC (LINDANE) | 0.91 | U | |
| GAMMA-CHLORDANE | 3.4 | | |
| HEPTACHLOR | 0.91 | U | |
| HEPTACHLOR EPOXIDE | 5.3 | J | RU |
| METHOXYCHLOR | 9.1 | U | |
| OXYCHLORDANE | 4.6 | R | U |
| PCB-101 | 100 | J | R |
| PCB-105 | 39 | J | U |
| PCB-118 | 140 | J | CU |
| PCB-128 | 13 | J | U |
| PCB-138 | 79 | J | R |
| PCB-153 | 63 | J | R |
| PCB-170 | 10 | J | U |
| PCB-18 | 23 | R | U |
| PCB-180 | 14 | J | U |
| PCB-183 | 2.7 | U | |
| PCB-184 | 2.7 | U | |
| PCB-187 | 3.4 | R | U |
| PCB-195 | 2.7 | U | |
| PCB-206 | 2.7 | U | |
| PCB-209 | 2.7 | U | |
| PCB-28 | 17 | J | U |

| | |
|---|---|
| nsample | TRP1-SD-008A-0204 |
| samp_date | 11/5/2008 |
| lab_id | G2039-08A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 37.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| PCB-44 | 34 | | |
| PCB-49 | 2.7 | U | |
| PCB-52 | 79 | | |
| PCB-66 | 2.7 | U | |
| PCB-8 | 14 | P | |
| PCB-87 | 52 | | |
| TOXAPHENE | 91 | U | |
| TRANS-NONACHLOR | 8.8 | J | U |

| | |
|---|---|
| nsample | TRP1-SD-008A-0406 |
| samp_date | 11/5/2008 |
| lab_id | G2039-09A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 40.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 4,4'-DDD | 7.7 | J | C |
| 4,4'-DDE | 6.6 | U | |
| 4,4'-DDT | 21 | J | C |
| ALDRIN | 3.4 | U | |
| ALPHA-CHLORDANE | 3.4 | U | |
| CIS-NONACHLOR | 8.9 | J | R |
| DIELDRIN | 6.6 | U | |
| ENDOSULFAN I | 3.4 | U | |
| ENDOSULFAN II | 6.6 | U | |
| ENDRIN | 6.6 | U | |
| GAMMA-BHC (LINDANE) | 3.4 | U | |
| GAMMA-CHLORDANE | 3.4 | U | |
| HEPTACHLOR | 3.4 | U | |
| HEPTACHLOR EPOXIDE | 9.7 | J | U |
| METHOXYCHLOR | 34 | UJ | C |
| OXYCHLORDANE | 11 | J | R |
| PCB-101 | 43 | J | R |
| PCB-105 | 12 | J | U |
| PCB-118 | 57 | J | CU |
| PCB-128 | 3.8 | J | U |
| PCB-138 | 28 | J | U |
| PCB-153 | 28 | | |
| PCB-170 | 4.1 | J | U |
| PCB-18 | 8.2 | | |
| PCB-180 | 8.6 | | |
| PCB-183 | 2.5 | U | |
| PCB-184 | 2.5 | U | |
| PCB-187 | 2.7 | R | U |
| PCB-195 | 2.5 | U | |
| PCB-206 | 3.5 | J | U |
| PCB-209 | 2.5 | U | |
| PCB-28 | 18 | | |

# PROJ_NO: 00811

SDG: G2039 MEDIA: SOIL DATA FRACTION: PEST/PCB

| | |
|---|---|
| nsample | TRP1-SD-008A-0406 |
| samp_date | 11/5/2008 |
| lab_id | G2039-09A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 40.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| PCB-44 | 13 | | |
| PCB-49 | 9.4 | J | U |
| PCB-52 | 30 | J | R |
| PCB-66 | 2.5 | U | |
| PCB-8 | 8.6 | J | R |
| PCB-87 | 25 | J | R |
| TOXAPHENE | 340 | U | |
| TRANS-NONACHLOR | 22 | J | U |

| | |
|---|---|
| nsample | TRP1-SD-008B-0001 |
| samp_date | 11/5/2008 |
| lab_id | G2039-07A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 31.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 4,4'-DDD | 2.1 | U | |
| 4,4'-DDE | 2.1 | U | |
| 4,4'-DDT | 2.1 | UJ | C |
| ALDRIN | 1.1 | U | |
| ALPHA-CHLORDANE | 1.1 | U | |
| CIS-NONACHLOR | 2.2 | J | R |
| DIELDRIN | 2.1 | U | |
| ENDOSULFAN I | 1.1 | U | |
| ENDOSULFAN II | 2.1 | U | |
| ENDRIN | 2.1 | U | |
| GAMMA-BHC (LINDANE) | 1.1 | U | |
| GAMMA-CHLORDANE | 1.8 | J | U |
| HEPTACHLOR | 1.1 | U | |
| HEPTACHLOR EPOXIDE | 1.1 | U | |
| METHOXYCHLOR | 11 | U | |
| OXYCHLORDANE | 1.1 | U | |
| PCB-101 | 9.1 | J | U |
| PCB-105 | 3 | U | |
| PCB-118 | 19 | J | CU |
| PCB-128 | 3 | U | |
| PCB-138 | 8.2 | | |
| PCB-153 | 7.7 | | |
| PCB-170 | 3 | U | |
| PCB-18 | 7.2 | | |
| PCB-180 | 3.6 | J | U |
| PCB-183 | 3 | U | |
| PCB-184 | 3 | U | |
| PCB-187 | 3 | UJ | C |
| PCB-195 | 3 | U | |
| PCB-206 | 4.7 | J | U |
| PCB-209 | 3 | U | |
| PCB-28 | 3.6 | R | U |

| | |
|---|---|
| nsample | TRP1-SD-008B-0001 |
| samp_date | 11/5/2008 |
| lab_id | G2039-07A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 31.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| PCB-44 | 7.7 | J | U |
| PCB-49 | 8.4 | | |
| PCB-52 | 5.8 | R | U |
| PCB-66 | 13 | | |
| PCB-8 | 3 | U | |
| PCB-87 | 3.2 | J | U |
| TOXAPHENE | 110 | U | |
| TRANS-NONACHLOR | 7.8 | | |

# PROJ_NO: 00811

SDG: G2039 MEDIA: SOIL DATA FRACTION: PEST/PCB

| | |
|---|---|
| nsample | TRP1-SD-009A-0204 |
| samp_date | 11/5/2008 |
| lab_id | G2039-02A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 38.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 4,4'-DDD | 3.4 | UJ | C |
| 4,4'-DDE | 3.4 | U | |
| 4,4'-DDT | 3.4 | UJ | C |
| ALDRIN | 1.8 | U | |
| ALPHA-CHLORDANE | 1.8 | U | |
| CIS-NONACHLOR | 1.8 | U | |
| DIELDRIN | 3.4 | U | |
| ENDOSULFAN I | 1.8 | U | |
| ENDOSULFAN II | 3.4 | U | |
| ENDRIN | 3.4 | U | |
| GAMMA-BHC (LINDANE) | 3.2 | | |
| GAMMA-CHLORDANE | 6.4 | J | U |
| HEPTACHLOR | 1.8 | U | |
| HEPTACHLOR EPOXIDE | 1.8 | U | |
| METHOXYCHLOR | 18 | UJ | C |
| OXYCHLORDANE | 1.8 | U | |
| PCB-101 | 10 | J | U |
| PCB-105 | 3.3 | J | U |
| PCB-118 | 17 | J | CU |
| PCB-128 | 2.5 | U | |
| PCB-138 | 8.8 | J | U |
| PCB-153 | 8.6 | | |
| PCB-170 | 2.7 | R | U |
| PCB-18 | 13 | J | U |
| PCB-180 | 3.8 | J | U |
| PCB-183 | 2.5 | U | |
| PCB-184 | 2.5 | U | |
| PCB-187 | 2.5 | UJ | C |
| PCB-195 | 2.5 | U | |
| PCB-206 | 3.2 | J | U |
| PCB-209 | 2.5 | U | |
| PCB-28 | 18 | | |

| | |
|---|---|
| nsample | TRP1-SD-009A-0204 |
| samp_date | 11/5/2008 |
| lab_id | G2039-02A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 38.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| PCB-44 | 18 | | |
| PCB-49 | 6.6 | R | U |
| PCB-52 | 15 | J | U |
| PCB-66 | 7.2 | J | U |
| PCB-8 | 4.9 | J | U |
| PCB-87 | 3.1 | J | U |
| TOXAPHENE | 180 | U | |
| TRANS-NONACHLOR | 6.4 | | |

| | |
|---|---|
| nsample | TRP1-SD-009A-0406 |
| samp_date | 11/5/2008 |
| lab_id | G2039-03A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 43.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 4,4'-DDD | 3 | U | |
| 4,4'-DDE | 3 | U | |
| 4,4'-DDT | 3 | UJ | C |
| ALDRIN | 1.6 | | |
| ALPHA-CHLORDANE | 1.6 | U | |
| CIS-NONACHLOR | 1.6 | UJ | C |
| DIELDRIN | 3 | U | |
| ENDOSULFAN I | 1.6 | U | |
| ENDOSULFAN II | 3 | U | |
| ENDRIN | 3 | U | |
| GAMMA-BHC (LINDANE) | 1.7 | J | U |
| GAMMA-CHLORDANE | 1.6 | U | |
| HEPTACHLOR | 1.6 | U | |
| HEPTACHLOR EPOXIDE | 1.8 | | |
| METHOXYCHLOR | 16 | UJ | C |
| OXYCHLORDANE | 1.6 | U | |
| PCB-101 | 41 | | |
| PCB-105 | 18 | J | U |
| PCB-118 | 76 | J | CU |
| PCB-128 | 8.3 | J | U |
| PCB-138 | 47 | J | U |
| PCB-153 | 38 | | |
| PCB-170 | 7.4 | J | U |
| PCB-18 | 6.4 | | |
| PCB-180 | 9.1 | J | U |
| PCB-183 | 2.2 | U | |
| PCB-184 | 2.2 | U | |
| PCB-187 | 2.2 | UJ | C |
| PCB-195 | 2.2 | U | |
| PCB-206 | 2.7 | J | U |
| PCB-209 | 2.2 | U | |
| PCB-28 | 17 | | |

# PROJ_NO: 00811

SDG: G2039 MEDIA: SOIL DATA FRACTION: PEST/PCB

| | |
|---|---|
| nsample | TRP1-SD-009A-0406 |
| samp_date | 11/5/2008 |
| lab_id | G2039-03A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 43.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| PCB-44 | 9.2 | J | U |
| PCB-49 | 5.6 | J | U |
| PCB-52 | 23 | J | U |
| PCB-66 | 2.2 | U | |
| PCB-8 | 4.6 | J | U |
| PCB-87 | 23 | | |
| TOXAPHENE | 160 | U | |
| TRANS-NONACHLOR | 1.6 | U | |

| | |
|---|---|
| nsample | TRP1-SD-009B-0001 |
| samp_date | 11/5/2008 |
| lab_id | G2039-01A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 40.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 4,4'-DDD | 8.2 | UJ | C |
| 4,4'-DDE | 8.4 | J | U |
| 4,4'-DDT | 27 | J | C |
| ALDRIN | 4.2 | U | |
| ALPHA-CHLORDANE | 4.2 | U | |
| CIS-NONACHLOR | 14 | R | U |
| DIELDRIN | 8.8 | J | U |
| ENDOSULFAN I | 4.2 | U | |
| ENDOSULFAN II | 8.2 | U | |
| ENDRIN | 8.2 | U | |
| GAMMA-BHC (LINDANE) | 4.2 | U | |
| GAMMA-CHLORDANE | 5.8 | R | U |
| HEPTACHLOR | 4.2 | U | |
| HEPTACHLOR EPOXIDE | 4.2 | U | |
| METHOXYCHLOR | 42 | UJ | C |
| OXYCHLORDANE | 11 | R | U |
| PCB-101 | 38 | | |
| PCB-105 | 11 | J | U |
| PCB-118 | 48 | J | CU |
| PCB-128 | 3.7 | J | U |
| PCB-138 | 26 | J | U |
| PCB-153 | 25 | | |
| PCB-170 | 3.9 | J | U |
| PCB-18 | 9.3 | | |
| PCB-180 | 7 | J | U |
| PCB-183 | 2.5 | U | |
| PCB-184 | 2.5 | U | |
| PCB-187 | 2.5 | UJ | C |
| PCB-195 | 2.5 | U | |
| PCB-206 | 3.8 | J | U |
| PCB-209 | 2.5 | U | |
| PCB-28 | 18 | | |

| | |
|---|---|
| nsample | TRP1-SD-009B-0001 |
| samp_date | 11/5/2008 |
| lab_id | G2039-01A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 40.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| PCB-44 | 14 | | |
| PCB-49 | 7.4 | J | U |
| PCB-52 | 27 | | |
| PCB-66 | 2.5 | U | |
| PCB-8 | 2.5 | U | |
| PCB-87 | 16 | | |
| TOXAPHENE | 420 | U | |
| TRANS-NONACHLOR | 8.6 | | |

# PROJ_NO: 00811

SDG: G2039 MEDIA: SOIL DATA FRACTION: PEST/PCB

| | |
|---|---|
| nsample | TRP1-SD-010A-0204 |
| samp_date | 11/5/2008 |
| lab_id | G2039-05A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 64.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 4,4'-DDD | 2 | U | |
| 4,4'-DDE | 5 | R | U |
| 4,4'-DDT | 9.3 | J | C |
| ALDRIN | 1 | U | |
| ALPHA-CHLORDANE | 1 | U | |
| CIS-NONACHLOR | 6.8 | R | U |
| DIELDRIN | 2 | U | |
| ENDOSULFAN I | 1 | U | |
| ENDOSULFAN II | 2 | U | |
| ENDRIN | 2 | U | |
| GAMMA-BHC (LINDANE) | 1 | U | |
| GAMMA-CHLORDANE | 3.6 | R | U |
| HEPTACHLOR | 1 | U | |
| HEPTACHLOR EPOXIDE | 3.7 | J | U |
| METHOXYCHLOR | 10 | U | |
| OXYCHLORDANE | 1 | U | |
| PCB-101 | 31 | | |
| PCB-105 | 9.5 | J | U |
| PCB-118 | 47 | J | CU |
| PCB-128 | 2.9 | J | U |
| PCB-138 | 20 | J | U |
| PCB-153 | 19 | | |
| PCB-170 | 5.1 | J | U |
| PCB-18 | 5.2 | | |
| PCB-180 | 5.5 | J | U |
| PCB-183 | 1.5 | U | |
| PCB-184 | 1.5 | U | |
| PCB-187 | 1.8 | R | U |
| PCB-195 | 1.5 | U | |
| PCB-206 | 2.2 | | |
| PCB-209 | 1.5 | U | |
| PCB-28 | 8.3 | | |

| | |
|---|---|
| nsample | TRP1-SD-010A-0204 |
| samp_date | 11/5/2008 |
| lab_id | G2039-05A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 64.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| PCB-44 | 8.1 | | |
| PCB-49 | 5.3 | J | U |
| PCB-52 | 19 | | |
| PCB-66 | 1.5 | U | |
| PCB-8 | 4.5 | J | U |
| PCB-87 | 17 | | |
| TOXAPHENE | 100 | U | |
| TRANS-NONACHLOR | 2.6 | R | U |

| | |
|---|---|
| nsample | TRP1-SD-010A-0406 |
| samp_date | 11/5/2008 |
| lab_id | G2039-06A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 53.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 4,4'-DDD | 6.2 | U | |
| 4,4'-DDE | 35 | R | U |
| 4,4'-DDT | 33 | J | C |
| ALDRIN | 3.2 | U | |
| ALPHA-CHLORDANE | 3.2 | U | |
| CIS-NONACHLOR | 3.2 | U | |
| DIELDRIN | 17 | R | U |
| ENDOSULFAN I | 3.2 | U | |
| ENDOSULFAN II | 6.2 | U | |
| ENDRIN | 6.2 | U | |
| GAMMA-BHC (LINDANE) | 3.2 | U | |
| GAMMA-CHLORDANE | 11 | R | U |
| HEPTACHLOR | 3.2 | U | |
| HEPTACHLOR EPOXIDE | 13 | | |
| METHOXYCHLOR | 32 | U | |
| OXYCHLORDANE | 5.6 | R | U |
| PCB-101 | 82 | | |
| PCB-105 | 21 | J | U |
| PCB-118 | 93 | J | CU |
| PCB-128 | 6.8 | J | U |
| PCB-138 | 47 | J | U |
| PCB-153 | 40 | J | U |
| PCB-170 | 13 | J | U |
| PCB-18 | 12 | | |
| PCB-180 | 12 | J | U |
| PCB-183 | 1.9 | U | |
| PCB-184 | 1.9 | U | |
| PCB-187 | 3.6 | R | U |
| PCB-195 | 1.9 | U | |
| PCB-206 | 6.3 | | |
| PCB-209 | 2.4 | R | U |
| PCB-28 | 18 | | |

# PROJ_NO: 00811

SDG: G2039 MEDIA: SOIL DATA FRACTION: PEST/PCB

| | |
|---|---|
| nsample | TRP1-SD-010A-0406 |
| samp_date | 11/5/2008 |
| lab_id | G2039-06A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 53.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| PCB-44 | 20 | | |
| PCB-49 | 11 | J | U |
| PCB-52 | 46 | | |
| PCB-66 | 2.9 | R | U |
| PCB-8 | 6.7 | J | U |
| PCB-87 | 61 | J | U |
| TOXAPHENE | 320 | U | |
| TRANS-NONACHLOR | 25 | | |

| | |
|---|---|
| nsample | TRP1-SD-010B-0001 |
| samp_date | 11/5/2008 |
| lab_id | G2039-04A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 38.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 4,4'-DDD | 8.5 | UJ | C |
| 4,4'-DDE | 8.5 | U | |
| 4,4'-DDT | 12 | R | U |
| ALDRIN | 4.4 | U | |
| ALPHA-CHLORDANE | 4.4 | U | |
| CIS-NONACHLOR | 11 | J | U |
| DIELDRIN | 8.5 | U | |
| ENDOSULFAN I | 4.4 | U | |
| ENDOSULFAN II | 8.5 | U | |
| ENDRIN | 8.5 | U | |
| GAMMA-BHC (LINDANE) | 4.4 | U | |
| GAMMA-CHLORDANE | 4.4 | U | |
| HEPTACHLOR | 4.4 | U | |
| HEPTACHLOR EPOXIDE | 4.4 | U | |
| METHOXYCHLOR | 44 | UJ | C |
| OXYCHLORDANE | 4.4 | U | |
| PCB-101 | 9.2 | J | U |
| PCB-105 | 2.8 | | |
| PCB-118 | 15 | J | CU |
| PCB-128 | 2.5 | U | |
| PCB-138 | 12 | | |
| PCB-153 | 5.5 | | |
| PCB-170 | 2.5 | U | |
| PCB-18 | 3.5 | | |
| PCB-180 | 2.5 | J | U |
| PCB-183 | 2.5 | U | |
| PCB-184 | 2.5 | U | |
| PCB-187 | 2.5 | UJ | C |
| PCB-195 | 2.5 | U | |
| PCB-206 | 2.5 | U | |
| PCB-209 | 2.5 | U | |
| PCB-28 | 3.1 | R | U |

| | |
|---|---|
| nsample | TRP1-SD-010B-0001 |
| samp_date | 11/5/2008 |
| lab_id | G2039-04A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 38.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| PCB-44 | 13 | J | U |
| PCB-49 | 7.7 | J | U |
| PCB-52 | 5.2 | R | U |
| PCB-66 | 13 | | |
| PCB-8 | 2.8 | R | U |
| PCB-87 | 5.2 | J | U |
| TOXAPHENE | 440 | U | |
| TRANS-NONACHLOR | 17 | J | U |

# PROJ_NO: 00811

SDG: G2039 MEDIA: SOIL DATA FRACTION: PEST/PCB

| | |
|---|---|
| nsample | TRZ4-SD-001A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2039-14A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 39.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 4,4'-DDD | 6.7 | UJ | D |
| 4,4'-DDE | 6.7 | UJ | D |
| 4,4'-DDT | 6.7 | UJ | CD |
| ALDRIN | 3.4 | UJ | D |
| ALPHA-CHLORDANE | 3.4 | UJ | D |
| CIS-NONACHLOR | 9.9 | J | CU |
| DIELDRIN | 6.7 | UJ | D |
| ENDOSULFAN I | 3.4 | U | |
| ENDOSULFAN II | 6.7 | U | |
| ENDRIN | 6.7 | UJ | D |
| GAMMA-BHC (LINDANE) | 3.4 | UJ | D |
| GAMMA-CHLORDANE | 3.4 | U | |
| HEPTACHLOR | 3.4 | UJ | D |
| HEPTACHLOR EPOXIDE | 6.1 | | |
| METHOXYCHLOR | 34 | UJ | CD |
| OXYCHLORDANE | 5.1 | R | U |
| PCB-101 | 14 | | |
| PCB-105 | 5.3 | J | CDU |
| PCB-118 | 12 | J | DC |
| PCB-128 | 2.6 | U | |
| PCB-138 | 12 | J | DU |
| PCB-153 | 12 | | |
| PCB-170 | 2.6 | U | |
| PCB-18 | 32 | J | DU |
| PCB-180 | 10 | | |
| PCB-183 | 2.6 | U | |
| PCB-184 | 2.6 | U | |
| PCB-187 | 2.8 | R | U |
| PCB-195 | 2.6 | U | |
| PCB-206 | 5.6 | | |
| PCB-209 | 2.6 | U | |
| PCB-28 | 36 | J | CDU |

| | |
|---|---|
| nsample | TRZ4-SD-001A-0204 |
| samp_date | 11/6/2008 |
| lab_id | G2039-14A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 39.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| PCB-44 | 11 | J | U |
| PCB-49 | 3.8 | R | U |
| PCB-52 | 22 | | |
| PCB-66 | 7.8 | R | U |
| PCB-8 | 14 | J | U |
| PCB-87 | 8.7 | | |
| TOXAPHENE | 340 | U | |
| TRANS-NONACHLOR | 14 | | |

| | |
|---|---|
| nsample | TRZ4-SD-001A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2039-15A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 39.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 4,4'-DDD | 7 | J | U |
| 4,4'-DDE | 13 | | |
| 4,4'-DDT | 6.7 | UJ | C |
| ALDRIN | 3.5 | U | |
| ALPHA-CHLORDANE | 3.5 | U | |
| CIS-NONACHLOR | 26 | J | CU |
| DIELDRIN | 6.7 | U | |
| ENDOSULFAN I | 3.5 | U | |
| ENDOSULFAN II | 6.7 | U | |
| ENDRIN | 6.7 | U | |
| GAMMA-BHC (LINDANE) | 3.5 | U | |
| GAMMA-CHLORDANE | 3.5 | U | |
| HEPTACHLOR | 3.5 | U | |
| HEPTACHLOR EPOXIDE | 3.5 | U | |
| METHOXYCHLOR | 35 | UJ | C |
| OXYCHLORDANE | 20 | R | U |
| PCB-101 | 11 | J | U |
| PCB-105 | 4.3 | J | CU |
| PCB-118 | 13 | J | C |
| PCB-128 | 2.4 | U | |
| PCB-138 | 13 | J | U |
| PCB-153 | 12 | J | U |
| PCB-170 | 2.4 | U | |
| PCB-18 | 43 | J | U |
| PCB-180 | 9.8 | | |
| PCB-183 | 2.4 | U | |
| PCB-184 | 5.5 | | |
| PCB-187 | 2.4 | UJ | C |
| PCB-195 | 2.4 | U | |
| PCB-206 | 5 | J | U |
| PCB-209 | 2.4 | U | |
| PCB-28 | 42 | J | CU |

# PROJ_NO: 00811

SDG: G2039 MEDIA: SOIL DATA FRACTION: PEST/PCB

| | |
|---|---|
| nsample | TRZ4-SD-001A-0406 |
| samp_date | 11/6/2008 |
| lab_id | G2039-15A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 39.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| PCB-44 | 12 | J | U |
| PCB-49 | 4.7 | R | U |
| PCB-52 | 23 | | |
| PCB-66 | 10 | J | U |
| PCB-8 | 22 | J | U |
| PCB-87 | 11 | | |
| TOXAPHENE | 350 | U | |
| TRANS-NONACHLOR | 52 | | |

| | |
|---|---|
| nsample | TRZ4-SD-001B-0001 |
| samp_date | 11/6/2008 |
| lab_id | G2039-13A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 37.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| 4,4'-DDD | 1.8 | U | |
| 4,4'-DDE | 3.6 | J | U |
| 4,4'-DDT | 7.5 | J | C |
| ALDRIN | 0.92 | U | |
| ALPHA-CHLORDANE | 0.92 | U | |
| CIS-NONACHLOR | 4.2 | R | U |
| DIELDRIN | 1.8 | U | |
| ENDOSULFAN I | 0.92 | U | |
| ENDOSULFAN II | 1.8 | U | |
| ENDRIN | 1.8 | U | |
| GAMMA-BHC (LINDANE) | 0.92 | U | |
| GAMMA-CHLORDANE | 2.1 | R | U |
| HEPTACHLOR | 0.92 | U | |
| HEPTACHLOR EPOXIDE | 0.92 | U | |
| METHOXYCHLOR | 9.2 | UJ | C |
| OXYCHLORDANE | 4.4 | J | U |
| PCB-101 | 7.5 | J | U |
| PCB-105 | 2.6 | U | |
| PCB-118 | 8 | J | CU |
| PCB-128 | 2.6 | U | |
| PCB-138 | 6.8 | J | U |
| PCB-153 | 6.5 | | |
| PCB-170 | 8.1 | J | U |
| PCB-18 | 8.7 | | |
| PCB-180 | 4.3 | J | U |
| PCB-183 | 2.6 | U | |
| PCB-184 | 2.6 | U | |
| PCB-187 | 2.6 | UJ | C |
| PCB-195 | 6.3 | | |
| PCB-206 | 9.6 | | |
| PCB-209 | 4.9 | R | U |
| PCB-28 | 13 | J | CU |

| | |
|---|---|
| nsample | TRZ4-SD-001B-0001 |
| samp_date | 11/6/2008 |
| lab_id | G2039-13A |
| qc_type | NM |
| units | UG/KG |
| Pct_Solids | 37.0 |
| DUP_OF: | |

| Parameter | Result | Val Qual | Qual Code |
|---|---|---|---|
| PCB-44 | 6.3 | | |
| PCB-49 | 2.6 | U | |
| PCB-52 | 8 | J | U |
| PCB-66 | 2.6 | U | |
| PCB-8 | 5.7 | | |
| PCB-87 | 4.2 | J | U |
| TOXAPHENE | 92 | U | |
| TRANS-NONACHLOR | 12 | J | U |

## B.5.2 - ERM-Q CALCULATION TABLES

**TABLE B.5.1**

**COMPREHENSIVE ANALYTICAL DATA SET**
**ZONE 4 ERM-Q CALCULATIONS**
**NSB-NLON, GROTON, CONNECTICUT**



| **PARAMETER** | **ERM** | ZONE-4<br>Z4-33<br>0 - 0.17 ft<br>CAB-36<br>20030617 | ZONE-4<br>Z4-36<br>0 - 0.17 ft<br>CAB-39<br>20030617 | ZONE-4<br>Z4-37<br>0 - 0.17 ft<br>CAB-41<br>20030617 | ZONE-4<br>Z4-39<br>0 - 0.17 ft<br>CAB-43<br>20030617 | ZONE-4<br>Z4-40<br>0 - 0.17 ft<br>CAB-44<br>20030617 | ZONE-4<br>Z4-42<br>0 - 0.17 ft<br>CAB-46<br>20030618 | ZONE-4<br>Z4-43<br>0 - 0.17 ft<br>CAB-47<br>20030618 | ZONE-4<br>Z4-44<br>0 - 0.17 ft<br>CAB-48<br>20030618 |
|---|---|---|---|---|---|---|---|---|---|
| **Low Molecular Weight PAHs (µg/kg)** | | | | | | | | | |
| 2-METHYLNAPHTHALENE | | 61.99 | 78.74 | 55.97 | 113.28 | 73.99 | 281.16 | 42.91 | 23.73 |
| ACENAPHTHENE | | 146.56 | 102.01 | 101.87 | 69.11 | 451.68 | 3252.03 | 55.83 | 62.89 |
| ACENAPHTHYLENE | | 32.44 | 41.69 | 42.32 | 62.42 | 55.49 | 72.34 | 28.12 | 14.43 |
| ANTHRACENE | | 839.21 | 437.17 | 1044.15 | 303.65 | 1961.23 | 2693.41 | 585.41 | 349.54 |
| FLUORENE | | 238.01 | 157.39 | 256.01 | 143.4 | 649.29 | 1851.37 | 132.32 | 103.9 |
| NAPHTHALENE | | 136.21 | 202.38 | 116.25 | 181.77 | 140.38 | 418.56 | 79.65 | 44.68 |
| PHENANTHRENE | | 1850.98 | 1139.08 | 1576.83 | 785.92 | 4692.76 | 11054.61 D | 952.12 | 712.65 |
| LOW MOLECULAR WEIGHT PAHS | 3160 | 3305.4 | 2158.46 | 3193.4 | 1659.55 | 8024.82 | 19623.48 | 1876.36 | 1311.82 |
| **High Molecular Weight PAHs (µg/kg)** | | | | | | | | | |
| BENZO(A)ANTHRACENE | | 2966.39 | 2100.75 | 6041.89 | 1460.46 | 6481.14 | 8873.83 | 2334.77 | 1041.23 |
| BENZO(A)PYRENE | | 2367.77 | 1448.57 | 2790 | 1317.81 | 2864.75 | 2799.79 | 1598.58 | 762.89 |
| CHRYSENE | | 3642.98 | 2498.25 | 6165.57 | 1459.52 | 6616.34 | 9647.16 | 3044.25 | 1370.2 |
| DIBENZO(A,H)ANTHRACENE | | 326.64 | 229.36 | 319.97 | 198.14 | 337.14 | 280.48 | 199.73 | 108.26 |
| FLUORANTHENE | | 6806.9 | 7124.44 | 14468.25 D | 2375.87 | 17289.14 D | 38620.01 D | 3279.46 | 2358.31 |
| PYRENE | | 6603.01 | 6347.87 | 9918.92 D | 3200.83 | 11408.12 D | 24456.92 D | 4347.1 | 2002.7 |
| HIGH MOLECULAR WEIGHT PAHS | 9600 | 22713.69 | 19749.24 | 39704.6 | 10012.63 | 44996.63 | 84678.19 | 14803.89 | 7643.59 |
| **Pesticides/PCBs (µg/kg)** | | | | | | | | | |
| 4,4'-DDD | | 4.35 | 39.01 | 4.36 | 14.14 | 4 | 4.05 | 3.52 | 1.92 |
| 4,4'-DDE | | 3.31 | 16.59 | 4.32 | 7.42 | 4.09 | 4.23 | 3.57 | 1.74 |
| 4,4'-DDT | | 0.99 | 0.71 | 1.27 | 0.49 J | 1.01 | 1.06 | 0.74 J | 0.38 J |
| TOTAL DDT | 46.1 | 8.65 | 56.31 | 9.95 | 22.05 | 9.1 | 9.34 | 7.83 | 4.04 |
| PCB-8 | | 0.58 U | 0.58 U | 0.89 U | 0.69 U | 0.88 U | 1.11 U | 0.84 U | 0.52 U |
| PCB-18 | | 31.29 | 30.27 | 7.26 | 5.49 | 3.92 | 3.94 | 2.73 | 1.44 |
| PCB-28 | | 35.8 | 42.35 | 10.06 | 5.96 | 6.58 | 4.99 | 4.69 | 2.31 |
| PCB-44 | | 11.16 | 31.34 | 5.33 | 7.86 | 3.91 | 4.2 | 3.51 | 1.71 |
| PCB-52 | | 14.7 | 45.54 | 5.86 | 9.72 | 3.68 | 3.98 | 3.65 | 1.86 |
| PCB-66 | | 7.05 | 29.63 | 5.09 | 7.21 | 4.27 | 4.13 | 4.34 | 2.51 |
| PCB-101 | | 6.53 | 70.8 | 4.33 | 10.3 | 4.08 | 4.13 | 3.58 | 1.92 |
| PCB-105 | | 2.91 | 25.93 | 3.08 | 5.49 | 3.18 | 4.37 | 3.26 | 1.47 |
| PCB-118 | | 5.5 | 56.08 | 4.51 | 9.01 | 4.03 | 3.9 | 4.14 | 1.99 |
| PCB-128 | | 0.35 U | 0.35 U | 0.54 U | 0.42 U | 0.53 U | 0.67 U | 0.51 U | 0.31 U |
| PCB-138 | | 5.98 | 59.19 | 3.98 | 9.68 | 3.25 | 2.8 | 3.83 | 1.89 |
| PCB-153 | | 8.7 | 65.78 | 5.44 | 11.53 | 4.47 | 3.61 | 4.66 | 2.41 |
| PCB-170 | | 3.29 | 13.62 | 2.34 | 3.01 | 1.85 | 1.93 | 2.26 | 1.08 |
| PCB-180 | | 5.59 | 24.3 | 3.81 | 6.21 | 2.68 | 3.1 | 2.75 | 1.44 |
| PCB-187 | | 3.87 | 12.38 | 2.81 | 4.04 | 2.04 | 2.64 | 2.13 | 1.21 |
| PCB-195 | | 2.02 | 4.92 | 1.79 | 4.04 | 1.48 | 1.47 | 1.42 | 0.63 |
| PCB-206 | | 2.79 | 6.15 | 2.35 | 7.45 | 2.13 | 2.07 | 2.03 | 0.92 |
| PCB-209 | | 2.59 | 4.04 | 5.17 | 7.99 | 3.53 | 4.24 | 2.78 | 1.06 |
| TOTAL PCB CONGENERS | 180 | 300.47 | 1045.57 | 147.85 | 231.09 | 111.57 | 112.78 | 104.87 | 52.53 |
| ALPHA-CHLORDANE | 6 | 0.75 | 6.07 | 0.66 J | 0.96 | 0.64 J | 0.60 J | 0.59 J | 0.33 J |
| **Inorganics (mg/kg)** | | | | | | | | | |
| ARSENIC | 70 | 13.2 | 10.7 | 14.4 | 10.7 | 14.1 | 14.9 | 11.2 | 11.3 |
| CADMIUM | 9.6 | 1.58 | 3.49 | 0.674 | 1.41 | 0.56 | 0.519 | 0.439 | 0.297 |
| CHROMIUM | 370 | 263 B | 364 B | 98.2 B | 125 B | 98.8 B | 101 B | 93.5 B | 71.1 B |
| COPPER | 270 | 305 | 628 | 103 | 98.6 | 88.6 | 94.4 | 101 | 147 |
| LEAD | 218 | 345 | 1240 | 102 | 109 | 126 | 95.2 | 88.1 | 124 |
| NICKEL | 51.6 | 90.6 | 188 | 28.9 | 25.9 | 28.9 | 30 | 27.2 | 38.1 |
| SELENIUM | 1.4 | 1.13 | 2.24 | 0.915 | 0.89 | 0.931 | 1.02 | 0.811 | 0.661 |
| ZINC | 410 | 3310 B | 4070 B | 194 B | 182 B | 171 B | 170 B | 191 B | 958 B |

B Blank contamination
J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

**TABLE B.5.1**

**COMPREHENSIVE ANALYTICAL DATA SET**
**ZONE 4 ERM-Q CALCULATIONS**
**NSB-NLON, GROTON, CONNECTICUT**



| **PARAMETER** | **ERM** | ZONE-4<br>Z4-46<br>0 - 0.17 ft<br>CAB-50<br>20030618 | ZONE-4<br>Z4-C1<br>2 - 4 ft<br>DAD-8-0204<br>20041011 | ZONE-4<br>Z4-C1<br>4 - 5 ft<br>DAD-8-0405<br>20041011 | ZONE-4<br>Z4-C1<br>5.5 - 7.25 ft<br>DAD-8-0507<br>20041011 | ZONE-4<br>Z4-C2<br>2 - 4 ft<br>DAD-9-0204<br>20041011 | ZONE-4<br>Z4-C2<br>4 - 5.41 ft<br>DAD-9-0405<br>20041011 | ZONE-4<br>Z4-S1<br>0 - 1 ft<br>DAD-1<br>20041012 | ZONE-4<br>Z4-S2<br>0 - 1 ft<br>DAD-2<br>20041013 |
|---|---|---|---|---|---|---|---|---|---|
| **Low Molecular Weight PAHs (µg/kg)** | | | | | | | | | |
| 2-METHYLNAPHTHALENE | | 113.5 | 90 | 109.96 | 0.10 J | 8.68 | 5.24 | 56.49 | 45.2 |
| ACENAPHTHENE | | 39.21 | 402.25 | 513.73 | 0.91 J | 6.35 | 3.22 | 305.69 | 837.1 |
| ACENAPHTHYLENE | | 39.44 | 221.36 | 262.68 | 0.12 J | 21.07 | 8.18 | 210.91 | 153.42 |
| ANTHRACENE | | 318.96 | 1970.89 | 990.78 | 0.20 J | 41.45 | 17.83 | 1197.81 | 1382.52 |
| FLUORENE | | 80.41 | 264.14 | 293.64 | 0.18 J | 12.52 | 6.17 | 366.68 | 392.7 |
| NAPHTHALENE | | 185.11 | 193.87 | 216.55 | 0.36 J | 25.37 | 18.59 | 284.4 | 83.6 |
| PHENANTHRENE | | 605.08 | 1463.13 | 1762.59 | 0.35 J | 67.81 | 30.8 | 2504.56 | 3169.96 |
| LOW MOLECULAR WEIGHT PAHS | 3160 | 1381.71 | 4605.64 | 4149.93 | 2.22 | 183.25 | 90.03 | 4926.54 | 6064.5 |
| **High Molecular Weight PAHs (µg/kg)** | | | | | | | | | |
| BENZO(A)ANTHRACENE | | 955.37 | 3646.51 | 2959.79 | 0.47 J | 125.27 | 39.47 | 3537.48 | 2977.64 |
| BENZO(A)PYRENE | | 1054.17 | 2328.03 | 2175.85 | 0.43 J | 194.61 | 71.26 | 2121.91 | 2426.48 |
| CHRYSENE | | 1155.3 | 4138.77 | 3333.03 | 0.65 J | 153.89 | 54.03 | 5039.4 | 3872.42 |
| DIBENZO(A,H)ANTHRACENE | | 155.77 | 294.02 | 284.04 | 0.29 J | 29.43 | 11.96 | 257.1 | 316.01 |
| FLUORANTHENE | | 1535.05 | 8725.32 | 11841.93 | 1.29 J | 199.44 | 72.56 | 10787.63 | 9175.89 |
| PYRENE | | 2121.86 | 6588.42 | 9014.39 | 1.47 J | 685.96 | 265.93 | 7471.9 | 6116.23 |
| HIGH MOLECULAR WEIGHT PAHS | 9600 | 6977.52 | 25721.07 | 29609.03 | 4.6 | 1388.6 | 515.21 | 29215.42 | 24884.67 |
| **Pesticides/PCBs (µg/kg)** | | | | | | | | | |
| 4,4'-DDD | | 2.03 | NA | NA | NA | NA | NA | NA | NA |
| 4,4'-DDE | | 1.1 | 8.59 | 10.85 | 0.06 UJ | 0.82 | 0.34 | 2.47 | 3.3 |
| 4,4'-DDT | | 0.52 | 2.07 | 2.17 | 0.06 UJ | 0.14 | 0.07 | 2.7 | 1.93 |
| TOTAL DDT | 46.1 | 3.65 | 10.66 | 13.02 | 0.06 | 0.96 | 0.41 | 5.17 | 5.23 |
| PCB-8 | | 0.57 U | 3.52 NJ | 11.17 NJ | 0.08 UJ | 0.41 NJ | 0.22 NJ | 1.29 NJ | 0.25 U |
| PCB-18 | | 1.3 | 6.13 | 26.54 | 0.06 UJ | 1.11 | 0.47 | 2.34 | 15.43 |
| PCB-28 | | 1.57 | 10.94 | 30.54 | 0.06 UJ | 1.97 | 0.84 | 3.69 | 17.41 |
| PCB-44 | | 2.14 | 8.83 | 16.86 | 0.05 UJ | 1.83 | 0.81 | 3.5 | 6.79 |
| PCB-52 | | 2.68 | 9.59 | 21.71 | 0.06 UJ | 2.34 | 0.98 | 2.43 | 7.37 |
| PCB-66 | | 2.11 | 11.69 | 17.62 | 0.07 UJ | 2.41 | 1.08 | 3.8 | 6.98 |
| PCB-101 | | 2.14 | 11.47 | 16.22 | 0.07 UJ | 2.96 | 1.22 | 2.11 | 3.41 |
| PCB-105 | | 2.33 | 3.36 | 4.94 | 0.05 UJ | 1 | 0.44 | 0.82 | 1.88 |
| PCB-118 | | 2 | 9.16 | 12.97 | 0.07 UJ | 2.04 | 0.89 | 1.73 | 2.9 |
| PCB-128 | | 0.34 U | 4.08 | 5.76 | 0.05 UJ | 0.74 | 0.35 | 1.29 | 1.42 |
| PCB-138 | | 2.34 | 9.17 | 13.92 | 0.07 UJ | 2.07 | 0.88 | 1.81 | 3.55 |
| PCB-153 | | 2.76 | 12.58 | 19.45 | 0.08 UJ | 2.52 | 1.07 | 2.53 | 4.89 |
| PCB-170 | | 1.4 | 2.32 | 4.24 | 0.07 UJ | 0.49 | 0.15 | 0.71 | 1.72 |
| PCB-180 | | 2.33 | 5.15 | 9.02 | 0.07 UJ | 0.99 | 0.46 | 1.14 | 2.82 |
| PCB-187 | | 1.81 | 4.3 | 6.53 | 0.06 UJ | 0.68 | 0.31 | 0.91 | 2.21 |
| PCB-195 | | 2.72 | NA | NA | NA | NA | NA | NA | NA |
| PCB-206 | | 5.52 | 2.58 | 4.36 | 0.07 UJ | 0.48 | 0.29 | 0.31 | 0.76 |
| PCB-209 | | 4.56 | 3.75 | 4.97 | 0.07 UJ | 0.56 | 0.38 | 0.95 | 1.18 |
| TOTAL PCB CONGENERS | 180 | 80.33 | 237.24 | 453.64 | 1.11 | 49.2 | 21.68 | 62.72 | 161.69 |
| ALPHA-CHLORDANE | 6 | 0.20 J | 1.97 | 3.29 | 0.05 UJ | 0.31 | 0.11 | 0.68 | 0.9 |
| **Inorganics (mg/kg)** | | | | | | | | | |
| ARSENIC | 70 | 8.13 | 14.2 | 12.5 | 0.094 | 2.55 | 1.16 | 13.2 | 13.9 |
| CADMIUM | 9.6 | 0.363 | 1.34 | 1.72 | 0.029 | 0.314 | 0.136 | 0.212 | 0.583 |
| CHROMIUM | 370 | 83.7 B | 112 | 127 | 14.64 | 28.39 | 22.38 | 61.5 | 84.6 |
| COPPER | 270 | 64.1 | 128 | 129 | 2.84 | 21.77 | 15.47 | 255 | 97.3 J |
| LEAD | 218 | 69.7 | 149 J | 162 J | 1.79 J | 31.46 J | 26.60 J | 54.9 | 102 J |
| NICKEL | 51.6 | 19.1 | 36.90 J | 43.18 J | 3.70 J | 10.71 J | 6.76 J | 14.31 | 26.44 |
| SELENIUM | 1.4 | 0.533 | 0.909 | 0.748 | 0.020 U | 0.106 | 0.031 | 0.396 J | 0.8 |
| ZINC | 410 | 109 B | 275 J | 351 J | 12.58 J | 67.6 J | 37.64 J | 3707 | 321 |

B Blank contamination
J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

**TABLE B.5.1**

**COMPREHENSIVE ANALYTICAL DATA SET**
**ZONE 4 ERM-Q CALCULATIONS**
**NSB-NLON, GROTON, CONNECTICUT**



| **PARAMETER** | **ERM** | ZONE-4<br>Z4-S3<br>0 - 1 ft<br>DAD-3<br>20041013 | ZONE-4<br>Z4-S4<br>0 - 1 ft<br>DAD-4<br>20041013 | ZONE-4<br>Z4-S5<br>0 - 1 ft<br>DAD-5<br>20041012 | ZONE-4<br>Z4-S6<br>0 - 1 ft<br>DAD-6<br>20041012 | ZONE-4<br>Z4-S6R<br>0 - 1 ft<br>DAD-6-D<br>20041012 | ZONE-4<br>Z4-1<br>0 - 0.17 ft<br>GAB-001<br>20070426 | ZONE-4<br>Z4-2<br>0 - 0.17 ft<br>GAB-002<br>20070425 | ZONE-4<br>Z4-3<br>0 - 0.17 ft<br>GAB-003<br>20070426 |
|---|---|---|---|---|---|---|---|---|---|
| **Low Molecular Weight PAHs (µg/kg)** | | | | | | | | | |
| 2-METHYLNAPHTHALENE | | 62.68 | 57.49 | 56.38 | 48.1 | 76.88 | 83.28 J | 64.81 | 147.51 |
| ACENAPHTHENE | | 1059.35 | 956.93 | 59.71 | 39.34 | 59.34 | 343.72 | 231.87 | 1422.81 |
| ACENAPHTHYLENE | | 243.74 | 185.28 | 162.76 | 102.58 | 102.06 | 278.39 | 100.83 | 135.9 |
| ANTHRACENE | | 2016.07 | 1137.64 | 950.28 | 422.31 | 499.62 | 2388.42 J | 662.59 | 1009.9 |
| FLUORENE | | 619.13 | 706.23 | 176.13 | 84.68 | 117.53 | 712.29 | 207.54 | 949.17 |
| NAPHTHALENE | | 122.38 | 91.56 | 88.01 | 76.43 | 101.08 | 126.93 | 162.97 | 507.74 |
| PHENANTHRENE | | 6401.38 | 4634.91 | 1124.54 | 515.4 | 724.41 | 3924.54 | 1153.73 | 3158.23 |
| LOW MOLECULAR WEIGHT PAHS | 3160 | 10524.73 | 7770.04 | 2617.81 | 1288.84 | 1680.92 | 7857.57 | 2584.34 | 7331.26 |
| **High Molecular Weight PAHs (µg/kg)** | | | | | | | | | |
| BENZO(A)ANTHRACENE | | 7278.68 | 4144.95 | 2678.41 | 1309.16 | 1612.68 | 4746.06 | 2169.44 | 1808.03 |
| BENZO(A)PYRENE | | 2927.8 | 2062.66 | 1721.85 | 1117.98 | 1294.67 | 3557.48 | 1510.61 | 1412 |
| CHRYSENE | | 7556.92 | 4313.86 | 3452.61 | 1538.53 | 1747.12 | 5626.7 | 2627.16 | 1771.89 |
| DIBENZO(A,H)ANTHRACENE | | 380.19 | 266.5 | 230.23 | 178.8 | 194.04 | 703.34 J | 266.53 | 207.66 |
| FLUORANTHENE | | 17702.57 | 10432.38 | 7091.56 | 2080.33 | 2534.65 | 9764.36 | 6102.24 | 6684.72 |
| PYRENE | | 12314.22 J | 9491.93 J | 5097.67 | 2880.28 | 4125.34 | 10040.52 | 5786.98 | 5754.68 |
| HIGH MOLECULAR WEIGHT PAHS | 9600 | 48160.38 | 30712.28 | 20272.33 | 9105.08 | 11508.5 | 34438.46 | 18462.96 | 17638.98 |
| **Pesticides/PCBs (µg/kg)** | | | | | | | | | |
| 4,4'-DDD | | NA | NA | NA | NA | NA | 2.3 | 10.28 | 3.29 |
| 4,4'-DDE | | 3.43 J | 3.15 | 3.82 | 4.99 | 7.46 | 5.1 | 13.42 | 5.7 |
| 4,4'-DDT | | 0.15 U | 1.1 | 2.67 | 2.97 | 5.72 | 2.49 | 3.53 | 3 |
| TOTAL DDT | 46.1 | 3.505 | 4.25 | 6.49 | 7.96 | 13.18 | 9.89 | 27.23 | 11.99 |
| PCB-8 | | 2.75 NJ | 0.23 U | 1.81 NJ | 0.61 NJ | 0.14 U | 12.76 | 10.34 | 7.72 |
| PCB-18 | | 6.36 J | 1.94 | 2.33 | 1.57 | 2.61 | 14.4 | 16.48 | 6.3 |
| PCB-28 | | 9.03 J | 4.19 | 5.08 | 2.96 | 3.7 | 14.93 | 18.17 | 9.66 |
| PCB-44 | | 6.14 J | 3.42 | 3.84 | 4.87 | 7.72 | 7.32 | 14.55 | 5.95 |
| PCB-52 | | 5.21 J | 2.89 | 3.64 | 8.8 | 14.83 | 9.59 | 17.38 | 8.57 |
| PCB-66 | | 1.96 J | 5.62 | 5.8 | 4.5 | 6.62 | 6.78 | 15.51 | 6.51 |
| PCB-101 | | 4.01 J | 3.27 | 3.73 | 14.41 | 30.07 | 12.74 | 17.89 | 9.64 |
| PCB-105 | | 3.39 J | 3.42 | 1.48 | 4.15 | 7.97 | 1.78 | 6.86 | 1.88 |
| PCB-118 | | 2.38 J | 2.5 | 3.47 | 10.38 | 16.55 | 5.44 | 15.98 | 6.03 |
| PCB-128 | | 1.24 J | 1.38 | 1.69 | 3.24 | 5.48 | 2.61 | 3.96 | 3.4 |
| PCB-138 | | 2.53 J | 2.55 | 3.72 | 11.3 | 21.65 | 6.46 | 15.39 | 6.82 |
| PCB-153 | | 3.15 J | 3.14 | 4.65 | 14.76 | 36.43 | 9.06 | 14.03 | 8.76 |
| PCB-170 | | 0.95 J | 0.82 | 1.05 | 1.91 | 6.12 | 2.5 | 3.93 | 2.25 |
| PCB-180 | | 1.87 J | 1.59 | 2.37 | 3.48 | 14.69 | 4.45 | 7.56 | 4.26 |
| PCB-187 | | 1.67 J | 1.53 | 2.24 | 2.58 | 10.09 | 3.43 | 5.31 | 3.2 |
| PCB-195 | | NA | NA | NA | NA | NA | 0.03 U | 0.03 U | 0.03 U |
| PCB-206 | | 0.92 J | 0.88 | 1.05 | 1.86 | 3.86 | 0.03 UJ | 0.03 UJ | 0.03 UJ |
| PCB-209 | | 1.06 J | 1.29 | 2.19 | 2.58 | 2.7 | 0.03 UJ | 0.03 UJ | 0.03 UJ |
| TOTAL PCB CONGENERS | 180 | 109.24 | 81.09 | 100.28 | 187.92 | 382.32 | 228.59 | 366.77 | 181.99 |
| ALPHA-CHLORDANE | 6 | 0.84 J | 0.59 | 0.94 | 0.88 | 0.94 | 0.8 | 2.52 | 0.73 |
| **Inorganics (mg/kg)** | | | | | | | | | |
| ARSENIC | 70 | 12.6 | 13.5 | 12.7 | 7.4 | 5.58 | 12.5 | 10.5 | 13.9 |
| CADMIUM | 9.6 | 0.54 | 0.52 | 0.49 | 0.905 | 0.962 | 0.827 | 2.81 | 1.06 |
| CHROMIUM | 370 | 85.7 | 88 | 88.1 | 53.9 | 87.7 | 321 | 313 | 105 |
| COPPER | 270 | 95.2 J | 85.0 J | 83.6 | 59.9 | 132 J | 568 | 735 | 121 |
| LEAD | 218 | 93.9 J | 89.4 J | 84.5 | 119 | 131 J | 524 | 841 | 136 |
| NICKEL | 51.6 | 26.58 | 27.7 | 26.08 | 16.97 | 24.83 | 165 | 286 | 32.25 |
| SELENIUM | 1.4 | 0.613 | 0.68 | 0.747 J | 0.428 J | 0.499 | 1.27 | 1.88 | 1.07 |
| ZINC | 410 | 255 | 202 | 191 | 216 | 468 | 3068 | 3718 | 234 |

B Blank contamination
J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

**TABLE B.5.1**

**COMPREHENSIVE ANALYTICAL DATA SET**
**ZONE 4 ERM-Q CALCULATIONS**
**NSB-NLON, GROTON, CONNECTICUT**



| **PARAMETER** | **ERM** | ZONE-4<br>Z4-4<br>0 - 0.17 ft<br>GAB-004<br>20070426 | ZONE-4<br>Z4-4<br>0 - 0.17 ft<br>GAB-004-D<br>20070426 | ZONE-4<br>Z4-5<br>0 - 0.17 ft<br>GAB-005<br>20070425 | ZONE-4<br>Z4-6<br>0 - 0.17 ft<br>GAB-006<br>20070425 | ZONE-4<br>TRZ4-SD-001<br>2 - 4 ft<br>TRZ4-SD-001A-0204<br>20081106 | ZONE-4<br>TRZ4-SD-001<br>4 - 6 ft<br>TRZ4-SD-001A-0406<br>20081106 | ZONE-4<br>TRZ4-SD-001<br>0 - 1 ft<br>TRZ4-SD-001B-0001<br>20081106 | ZONE-4<br>TRZ4-SD-002<br>2 - 4 ft<br>TRZ4-SD-002A-0204<br>20081106 |
|---|---|---|---|---|---|---|---|---|---|
| **Low Molecular Weight PAHs (µg/kg)** | | | | | | | | | |
| 2-METHYLNAPHTHALENE | | 136.72 | 87.08 | 45.91 | 75.76 | 150 | 280 | 40 | 68 |
| ACENAPHTHENE | | 964.92 | 565.97 | 85.34 | 214.07 | 1800 | 6400 | 80 | 220 |
| ACENAPHTHYLENE | | 124.25 | 81.65 | 107.1 | 88.89 | 790 | 430 | 230 | 170 |
| ANTHRACENE | | 721.42 | 491.13 | 643.71 | 416.18 | 3900 | 3800 | 470 | 1700 |
| FLUORENE | | 529.19 | 321.95 | 148.44 | 194.06 | 1300 | 1800 | 120 | 380 |
| NAPHTHALENE | | 369.35 | 267.18 | 91.28 | 111.41 | 580 | 930 | 98 | 66 |
| PHENANTHRENE | | 2381.3 | 1234.25 | 1145.97 | 927.79 | 5800 | 6400 | 800 | 4300 |
| LOW MOLECULAR WEIGHT PAHS | 3160 | 5227.15 | 3049.21 | 2267.75 | 2028.16 | 14320 | 20040 | 1838 | 6904 |
| **High Molecular Weight PAHs (µg/kg)** | | | | | | | | | |
| BENZO(A)ANTHRACENE | | 1758.4 | 1195.68 | 1562.23 | 1068.78 | 8700 | 4600 | 1200 | 4600 |
| BENZO(A)PYRENE | | 1202.66 | 934.42 | 1229.58 | 1030.7 | 4500 | 2200 | 1100 | 3800 |
| CHRYSENE | | 1739.25 | 1154.41 | 1750.84 | 1258.85 | 9800 | 5200 | 1800 | 5300 |
| DIBENZO(A,H)ANTHRACENE | | 215.95 | 139.46 | 161.78 | 163.74 | 680 J | 340 | 170 | 510 |
| FLUORANTHENE | | 6420.66 | 3954.77 | 4407.07 | 2595.37 | 36000 | 26000 | 3100 | 12000 |
| PYRENE | | 5564.57 | 3500.92 | 4500.55 | 2942.86 | 24000 | 17000 | 3700 | 11000 |
| HIGH MOLECULAR WEIGHT PAHS | 9600 | 16901.49 | 10879.66 | 13612.05 | 9060.3 | 83680 | 55340 | 11070 | 37210 |
| **Pesticides/PCBs (µg/kg)** | | | | | | | | | |
| 4,4'-DDD | | 3.4 | 2.19 | 2.14 | 1.83 | 6.7 UJ | 7 J | 1.8 U | 68 U |
| 4,4'-DDE | | 5.77 | 4.09 | 3.42 | 3.11 | 6.7 UJ | 13 | 3.6 J | 68 U |
| 4,4'-DDT | | 2.32 | 2.23 | 2.46 | 1.71 | 6.7 UJ | 6.7 UJ | 7.5 J | 68 U |
| TOTAL DDT | 46.1 | 11.49 | 8.51 | 8.02 | 6.65 | 10.05 | 23.35 | 12 | 102 |
| PCB-8 | | 4.99 | 3.09 | 2.13 | 1.91 | 14 J | 22 J | 5.7 | 29 J |
| PCB-18 | | 4.01 | 2.31 | 1.42 | 1.26 | 32 J | 43 J | 8.7 | 55 J |
| PCB-28 | | 7.92 | 4.65 | 3.67 | 3.13 | 36 J | 42 J | 13 J | 48 J |
| PCB-44 | | 6.41 | 3.83 | 2.93 | 2.84 | 11 J | 12 J | 6.3 | 17 J |
| PCB-52 | | 9.25 | 4.78 | 3.31 | 2.88 | 22 | 23 | 8 J | 29 |
| PCB-66 | | 6.7 | 5.23 | 3.38 | 3.72 | 7.8 R | 10 J | 2.6 U | 14 J |
| PCB-101 | | 10.55 | 6.34 | 6.15 | 6.12 | 14 | 11 J | 7.5 J | 27 |
| PCB-105 | | 2.5 | 1.39 | 1.32 | 1.27 | 5.3 J | 4.3 J | 2.6 U | 2.6 R |
| PCB-118 | | 7.46 | 4.2 | 3.63 | 3.31 | 12 J | 13 J | 8 J | 40 R |
| PCB-128 | | 3.13 | 1.59 | 1.94 | 1.79 | 2.6 U | 2.4 U | 2.6 U | 2.1 U |
| PCB-138 | | 8.45 | 4.41 | 4.2 | 4.01 | 12 J | 13 J | 6.8 J | 21 J |
| PCB-153 | | 10.44 | 5.23 | 4.51 | 4.22 | 12 | 12 J | 6.5 | 24 |
| PCB-170 | | 2.04 | 1.09 | 1.71 | 1.08 | 2.6 U | 2.4 U | 8.1 J | 3.9 R |
| PCB-180 | | 4.6 | 2.41 | 2.41 | 2.15 | 10 | 9.8 | 4.3 J | 22 J |
| PCB-187 | | 3.32 | 2.03 | 2.08 | 1.77 | 2.8 R | 2.4 UJ | 2.6 UJ | 7.7 J |
| PCB-195 | | 0.03 U | 0.03 U | 0.03 U | 0.03 U | 2.6 U | 2.4 U | 6.3 | 2.9 J |
| PCB-206 | | 0.03 UJ | 0.03 UJ | 0.03 UJ | 0.03 UJ | 5.6 | 5 J | 9.6 | 7.3 J |
| PCB-209 | | 0.03 UJ | 0.03 UJ | 0.03 UJ | 0.03 UJ | 2.6 U | 2.4 U | 4.9 R | 2.1 U |
| TOTAL PCB CONGENERS | 180 | 183.63 | 105.25 | 89.67 | 83.01 | 382.2 | 452.2 | 208 | 612 |
| ALPHA-CHLORDANE | 6 | 0.94 | 0.61 | 0.64 | 0.57 | 3.4 UJ | 3.5 U | 0.92 U | 35 U |
| **Inorganics (mg/kg)** | | | | | | | | | |
| ARSENIC | 70 | 13 | 13.2 | 13.8 | 11 | 15.20 J | 16.40 J | 13.90 J | 15.7 |
| CADMIUM | 9.6 | 0.909 | 0.925 | 0.645 | 0.503 | 2.00 J | 2.20 J | 0.620 J | 1.4 |
| CHROMIUM | 370 | 100 | 99.7 | 86.6 | 79.3 | 155 J | 129 J | 77.7 J | 86.3 |
| COPPER | 270 | 115 | 112 | 198 | 84 | 372 J | 266 J | 132 J | 162 J |
| LEAD | 218 | 112 | 119 | 106 | 78.6 | 483 J | 308 J | 202 J | 178 J |
| NICKEL | 51.6 | 32.01 | 32.53 | 30.01 | 27.59 | 89.2 | 72.7 | 30.1 | 29.70 J |
| SELENIUM | 1.4 | 0.936 | 0.848 | 0.88 | 0.724 | 5.7 | 6.6 | 6 | 5.5 |
| ZINC | 410 | 218 | 209 | 766 | 163 | 2110 J | 652 J | 264 J | 323 J |

B Blank contamination
J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

**TABLE B.5.1**

**COMPREHENSIVE ANALYTICAL DATA SET**
**ZONE 4 ERM-Q CALCULATIONS**
**NSB-NLON, GROTON, CONNECTICUT**



| **PARAMETER** | **ERM** | ZONE-4<br>TRZ4-SD-002<br>4 - 6 ft<br>TRZ4-SD-002A-0406<br>20081106 | ZONE-4<br>TRZ4-SD-002<br>0 - 1 ft<br>TRZ4-SD-002B-0001<br>20081106 | ZONE-4<br>TRZ4-SD-003<br>2 - 4 ft<br>TRZ4-SD-003A-0204<br>20081106 | ZONE-4<br>TRZ4-SD-003<br>4 - 6 ft<br>TRZ4-SD-003A-0406<br>20081106 | ZONE-4<br>TRZ4-SD-003<br>0 - 1 ft<br>TRZ4-SD-003B-0001<br>20081106 | ZONE-4<br>TRZ4-SD-004<br>2 - 4 ft<br>TRZ4-SD-004A-0204<br>20081107 | ZONE-4<br>TRZ4-SD-004<br>4 - 6 ft<br>TRZ4-SD-004A-0406<br>20081107 | ZONE-4<br>TRZ4-SD-004<br>0 - 1 ft<br>TRZ4-SD-004B-0001<br>20081107 |
|---|---|---|---|---|---|---|---|---|---|
| **Low Molecular Weight PAHs (µg/kg)** | | | | | | | | | |
| 2-METHYLNAPHTHALENE | | 170 J | 35 | 43 | 65 | 26 | 60 | 210 | 8 |
| ACENAPHTHENE | | 520 | 350 | 300 | 800 | 140 | 93 | 1500 | 35 |
| ACENAPHTHYLENE | | 120 J | 270 | 260 | 180 | 160 | 120 | 350 | 83 |
| ANTHRACENE | | 430 | 680 | 720 | 1100 | 440 | 320 | 1400 | 130 |
| FLUORENE | | 400 | 200 | 190 | 310 | 95 | 89 | 690 | 53 |
| NAPHTHALENE | | 320 J | 92 | 61 J | 160 | 33 | 210 | 340 | 14 |
| PHENANTHRENE | | 1000 | 1400 | 810 | 1700 | 520 | 280 | 2400 | 320 |
| LOW MOLECULAR WEIGHT PAHS | 3160 | 2960 | 3027 | 2384 | 4315 | 1414 | 1172 | 6890 | 643 |
| **High Molecular Weight PAHs (µg/kg)** | | | | | | | | | |
| BENZO(A)ANTHRACENE | | 470 | 2200 | 2600 | 1900 | 1800 | 890 | 3300 | 350 |
| BENZO(A)PYRENE | | 360 | 1600 | 1500 | 1300 | 1200 | 620 | 2100 | 360 |
| CHRYSENE | | 500 | 3100 | 2400 | 1900 | 1600 | 870 | 3200 | 570 |
| DIBENZO(A,H)ANTHRACENE | | 69 | 230 | 200 | 130 | 150 | 74 | 220 | 57 |
| FLUORANTHENE | | 2100 | 6500 | 8200 | 7700 | 5200 | 3100 | 12000 | 990 |
| PYRENE | | 1600 | 6600 | 6000 | 5700 | 4100 | 3300 | 8200 | 1100 |
| HIGH MOLECULAR WEIGHT PAHS | 9600 | 5099 | 20230 | 20900 | 18630 | 14050 | 8854 | 29020 | 3427 |
| **Pesticides/PCBs (µg/kg)** | | | | | | | | | |
| 4,4'-DDD | | 35 U | 34 U | 86 U | 11 U | 75 U | 2.4 J | 9.9 J | 0.9 U |
| 4,4'-DDE | | 97 J | 34 U | 86 U | 23 J | 75 U | 1.8 J | 14 J | 0.52 J |
| 4,4'-DDT | | 130 J | 44 | 86 UJ | 11 UJ | 75 UJ | 4.2 J | 13 J | 0.9 UJ |
| TOTAL DDT | 46.1 | 244.5 | 78 | 129 | 34 | 112.5 | 8.4 | 36.9 | 1.42 |
| PCB-8 | | 84 | 7.8 | 16 | 14 J | 7.7 J | 2.9 | 16 J | 2.4 J |
| PCB-18 | | 140 J | 20 J | 36 J | 27 J | 22 J | 4.9 J | 29 J | 2.5 |
| PCB-28 | | 150 J | 20 J | 46 J | 28 J | 28 J | 5 J | 31 J | 1.7 R |
| PCB-44 | | 51 | 13 J | 15 J | 10 J | 8 J | 2.1 J | 12 J | 4 J |
| PCB-52 | | 63 | 24 | 21 J | 15 J | 10 J | 5 J | 21 | 1.7 R |
| PCB-66 | | 36 J | 2 U | 13 J | 6.8 J | 8.9 J | 1.3 U | 14 J | 1.4 U |
| PCB-101 | | 28 J | 28 | 11 J | 11 J | 6.2 J | 5.5 | 21 J | 3.3 J |
| PCB-105 | | 11 J | 10 J | 4.2 J | 2.7 J | 2.9 J | 1.3 U | 2.5 R | 1.4 U |
| PCB-118 | | 50 R | 43 J | 20 J | 11 J | 6.8 J | 4.4 | 16 J | 2.5 J |
| PCB-128 | | 2.1 U | 4.4 J | 2.6 U | 1.7 U | 2.2 U | 1.3 U | 2 R | 1.4 U |
| PCB-138 | | 33 J | 22 | 12 J | 8.7 J | 6.9 J | 6.1 J | 17 J | 1.7 |
| PCB-153 | | 36 | 19 | 14 | 9.8 | 7.8 | 5.4 | 18 J | 1.6 J |
| PCB-170 | | 23 J | 6.4 | 2.6 R | 7.6 J | 2.4 R | 1.3 U | 4.8 R | 1.4 U |
| PCB-180 | | 33 | 6 | 8.5 J | 7.6 J | 5.1 J | 3.2 | 21 J | 1.4 U |
| PCB-187 | | 9.6 J | 3.2 J | 5.2 J | 3.2 J | 2.2 U | 1.3 U | 5.5 J | 1.4 U |
| PCB-195 | | 4.3 J | 2 U | 2.6 U | 1.7 U | 2.2 U | 1.3 U | 1.7 U | 1.4 U |
| PCB-206 | | 9.3 J | 2.3 J | 5 J | 6.6 J | 5.1 J | 3 | 5.2 | 3.4 J |
| PCB-209 | | 3.6 R | 4 | 4.8 J | 1.5 R | 2.8 J | 1.7 J | 2.5 J | 4.1 J |
| TOTAL PCB CONGENERS | 180 | 1424.5 | 470.2 | 468.6 | 341.4 | 263 | 106.2 | 460.1 | 60.8 |
| ALPHA-CHLORDANE | 6 | 18 U | 17 U | 44 UJ | 5.8 U | 38 U | 0.46 J | 2.3 | 0.47 U |
| **Inorganics (mg/kg)** | | | | | | | | | |
| ARSENIC | 70 | 12.3 | 11.1 | 17.2 | 6.6 | 13.4 | 4.70 J | 10.90 J | 4.10 J |
| CADMIUM | 9.6 | 2.4 | 0.9 | 0.83 | 0.62 | 0.61 | 0.470 J | 1.50 J | 0.190 J |
| CHROMIUM | 370 | 128 | 81.7 | 85.1 | 76.9 | 66.5 | 52.4 J | 85.3 J | 40.20 J |
| COPPER | 270 | 171 J | 183 J | 132 J | 174 J | 109 J | 92.1 J | 165 J | 100 J |
| LEAD | 218 | 187 J | 223 J | 162 J | 206 J | 108 J | 157 J | 400 J | 127 J |
| NICKEL | 51.6 | 30.10 J | 41.50 J | 30.80 J | 58.1 J | 25.20 J | 28.10 J | 24.70 J | 40.50 J |
| SELENIUM | 1.4 | 6.1 | 5 | 6.2 | 4 | 5 | 2.6 | 4.7 | 2.6 |
| ZINC | 410 | 292 J | 523 J | 242 J | 665 J | 239 J | 273 J | 256 J | 359 J |

B Blank contamination
J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

**TABLE B.5.1**

**COMPREHENSIVE ANALYTICAL DATA SET**
**ZONE 4 ERM-Q CALCULATIONS**
**NSB-NLON, GROTON, CONNECTICUT**



| **PARAMETER** | **ERM** | ZONE-4<br>TRZ4-SD-005<br>2 - 4 ft<br>TRZ4-SD-005A-0204<br>20081106 | ZONE-4<br>TRZ4-SD-005<br>4 - 6 ft<br>TRZ4-SD-005A-0406<br>20081106 | ZONE-4<br>TRZ4-SD-005<br>0 - 1 ft<br>TRZ4-SD-005B-0001<br>20081106 | ZONE-4<br>TRZ4-SD-006<br>2 - 4 ft<br>TRZ4-SD-006A-0204<br>20081106 | ZONE-4<br>TRZ4-SD-006<br>4 - 6 ft<br>TRZ4-SD-006A-0406<br>20081106 | ZONE-4<br>TRZ4-SD-006<br>0 - 1 ft<br>TRZ4-SD-006B-0001<br>20081106 | ZONE-4<br>TRZ4-SD-007<br>2 - 4 ft<br>TRZ4-SD-007A-0204<br>20081106 | ZONE-4<br>TRZ4-SD-007<br>4 - 6 ft<br>TRZ4-SD-007A-0406<br>20081106 |
|---|---|---|---|---|---|---|---|---|---|
| **Low Molecular Weight PAHs (µg/kg)** | | | | | | | | | |
| 2-METHYLNAPHTHALENE | | 67 | 1400 | 15 | 24 | 34 | 25 | 6.9 U | 6.7 U |
| ACENAPHTHENE | | 540 | 9900 | 25 | 200 | 68 | 59 | 6.9 U | 6.7 U |
| ACENAPHTHYLENE | | 230 | 390 J | 160 | 110 | 77 | 140 | 14 | 6.7 U |
| ANTHRACENE | | 1700 | 2600 | 320 | 270 | 310 | 400 | 27 | 6.7 U |
| FLUORENE | | 500 | 6800 | 65 | 95 | 66 | 99 | 7.2 | 6.7 U |
| NAPHTHALENE | | 100 | 3400 | 33 | 42 | 130 | 63 | 8.8 | 6.7 U |
| PHENANTHRENE | | 1100 | 17000 | 320 | 510 | 270 | 630 | 27 | 6.7 U |
| LOW MOLECULAR WEIGHT PAHS | 3160 | 4237 | 41490 | 938 | 1251 | 955 | 1416 | 90.9 | 23.45 |
| **High Molecular Weight PAHs (µg/kg)** | | | | | | | | | |
| BENZO(A)ANTHRACENE | | 1700 | 3200 | 1200 | 570 | 800 | 1400 | 74 | 6.7 U |
| BENZO(A)PYRENE | | 1000 | 1700 | 920 | 470 | 430 | 940 | 83 | 6.7 U |
| CHRYSENE | | 2300 | 3700 | 1300 | 590 | 780 | 1500 | 99 | 6.7 U |
| DIBENZO(A,H)ANTHRACENE | | 150 | 110 | 130 | 75 | 76 | 140 | 15 | 6.7 U |
| FLUORANTHENE | | 4500 | 19000 | 2300 | 2500 | 2700 | 3300 | 160 | 10 |
| PYRENE | | 4500 | 12000 | 2900 | 2000 | 2300 | 4300 | 240 | 12 |
| HIGH MOLECULAR WEIGHT PAHS | 9600 | 14150 | 39710 | 8750 | 6205 | 7086 | 11580 | 671 | 35.4 |
| **Pesticides/PCBs (µg/kg)** | | | | | | | | | |
| 4,4'-DDD | | 16 U | 38 U | 43 U | 90 U | 27 U | 50 U | 6.8 U | 6.6 U |
| 4,4'-DDE | | 27 | 42 J | 43 U | 90 U | 27 U | 50 U | 6.8 U | 6.6 U |
| 4,4'-DDT | | 150 J | 38 UJ | 45 J | 90 UJ | 36 J | 50 UJ | 6.8 U | 6.6 U |
| TOTAL DDT | 46.1 | 185 | 80 | 88 | 135 | 63 | 75 | 10.2 | 9.9 |
| PCB-8 | | 13 J | 46 J | 9.3 J | 28 | 80 | 3.9 J | 2.1 U | 2 U |
| PCB-18 | | 27 J | 84 J | 23 J | 67 J | 130 J | 4.6 R | 2.1 U | 2 U |
| PCB-28 | | 33 J | 80 J | 35 J | 97 J | 120 J | 27 J | 2.1 UJ | 2 UJ |
| PCB-44 | | 9.4 J | 27 J | 21 | 28 J | 40 | 11 J | 2.1 U | 2 U |
| PCB-52 | | 12 J | 63 J | 15 J | 51 | 48 | 13 J | 2.1 U | 2 U |
| PCB-66 | | 7.1 J | 2.3 UJ | 13 J | 14 R | 28 J | 7.1 R | 2.1 UJ | 2 UJ |
| PCB-101 | | 9.1 J | 72 J | 9.9 J | 26 J | 22 J | 10 J | 2.1 U | 2 U |
| PCB-105 | | 3 J | 11 R | 3.7 J | 9.3 J | 3.9 R | 2.9 U | 2.1 U | 2 U |
| PCB-118 | | 8.7 J | 59 J | 7.7 | 16 J | 11 R | 8 J | 2.1 U | 2 U |
| PCB-128 | | 2.3 U | 10 J | 2.6 U | 2.9 R | 1.6 U | 2.9 U | 2.1 U | 4.9 J |
| PCB-138 | | 9.5 J | 70 J | 9.5 J | 22 J | 19 J | 8.5 | 2.1 U | 2 U |
| PCB-153 | | 9.9 | 76 | 8.3 J | 23 | 25 | 6.7 | 2.1 U | 2 U |
| PCB-170 | | 7.1 J | 18 J | 2.6 U | 5.3 R | 17 J | 2.9 U | 2.1 U | 2 U |
| PCB-180 | | 5.2 J | 27 | 4.8 J | 12 J | 21 | 4.1 J | 2.1 U | 2 U |
| PCB-187 | | 2.4 J | 13 J | 2.6 U | 3.7 R | 12 J | 2.9 U | 2.1 U | 2 U |
| PCB-195 | | 2.3 U | 3.3 | 2.6 U | 2.8 U | 2.7 J | 2.9 U | 2.1 U | 2 U |
| PCB-206 | | 5.5 | 7.9 | 4.6 J | 5.6 J | 9.9 | 6.9 J | 2.1 U | 2.2 J |
| PCB-209 | | 4 J | 2.3 U | 3 J | 2.8 U | 6 J | 7.4 | 2.4 | 2 U |
| TOTAL PCB CONGENERS | 180 | 336.4 | 1317 | 346 | 775.4 | 1162.8 | 227.5 | 40.5 | 46.2 |
| ALPHA-CHLORDANE | 6 | 8 U | 20 U | 22 U | 46 U | 14 U | 26 U | 3.5 U | 3.4 U |
| **Inorganics (mg/kg)** | | | | | | | | | |
| ARSENIC | 70 | 16.1 | 13.2 | 17.1 | 16.8 | 8.1 | 13.9 | 9.3 | 8.6 |
| CADMIUM | 9.6 | 1.1 | 1.9 | 0.81 | 2.6 | 1.3 | 0.61 | 0.25 | 0.25 |
| CHROMIUM | 370 | 115 | 109 | 81 | 134 | 72.9 | 69.7 | 38.1 | 36.8 |
| COPPER | 270 | 348 J | 212 J | 144 J | 202 J | 113 J | 104 J | 27.10 J | 14.50 J |
| LEAD | 218 | 248 J | 288 J | 158 J | 197 J | 147 J | 101 J | 21.20 J | 7.60 J |
| NICKEL | 51.6 | 61.1 J | 34.80 J | 30.00 J | 46.90 J | 20.80 J | 26.90 J | 20.90 J | 21.30 J |
| SELENIUM | 1.4 | 6.7 | 5.7 | 6.7 | 6.7 | 3.8 | 6.3 | 4.3 | 5.5 |
| ZINC | 410 | 730 J | 367 J | 240 J | 353 J | 209 J | 185 J | 68.9 J | 52.4 J |

B Blank contamination
J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

**TABLE B.5.1**

**COMPREHENSIVE ANALYTICAL DATA SET**
**ZONE 4 ERM-Q CALCULATIONS**
**NSB-NLON, GROTON, CONNECTICUT**



| **PARAMETER** | **ERM** | ZONE-4<br>TRZ4-SD-007<br>0 - 1 ft<br>TRZ4-SD-007B-0001<br>20081106 | ZONE-4<br>TRZ4-SD-008<br>2 - 4 ft<br>TRZ4-SD-008A-0204<br>20081106 | ZONE-4<br>TRZ4-SD-008<br>4 - 6 ft<br>TRZ4-SD-008A-0406<br>20081106 | ZONE-4<br>TRZ4-SD-008<br>0 - 1 ft<br>TRZ4-SD-008B-0001<br>20081106 |
|---|---|---|---|---|---|
| **Low Molecular Weight PAHs (µg/kg)** | | | | | |
| 2-METHYLNAPHTHALENE | | 39 J | 22 | 43 | 29 |
| ACENAPHTHENE | | 85 | 49 | 300 | 33 |
| ACENAPHTHYLENE | | 240 J | 130 | 200 | 140 |
| ANTHRACENE | | 540 | 300 | 400 | 260 |
| FLUORENE | | 130 | 68 | 190 | 60 |
| NAPHTHALENE | | 190 J | 28 | 57 | 67 |
| PHENANTHRENE | | 500 | 380 | 680 | 310 |
| LOW MOLECULAR WEIGHT PAHS | 3160 | 1724 | 977 | 1870 | 899 |
| **High Molecular Weight PAHs (µg/kg)** | | | | | |
| BENZO(A)ANTHRACENE | | 1800 | 740 | 1100 | 700 |
| BENZO(A)PYRENE | | 1200 | 510 | 640 | 640 |
| CHRYSENE | | 2100 | 740 | 730 | 730 |
| DIBENZO(A,H)ANTHRACENE | | 180 | 88 | 110 | 110 |
| FLUORANTHENE | | 3100 | 3300 | 4000 | 1300 |
| PYRENE | | 5400 | 2500 | 3100 | 2400 |
| HIGH MOLECULAR WEIGHT PAHS | 9600 | 13780 | 7878 | 9680 | 5880 |
| **Pesticides/PCBs (µg/kg)** | | | | | |
| 4,4'-DDD | | 46 U | 88 U | 18 J | 9.7 U |
| 4,4'-DDE | | 46 U | 88 U | 36 J | 11 J |
| 4,4'-DDT | | 68 J | 88 UJ | 35 J | 9.7 UJ |
| TOTAL DDT | 46.1 | 114 | 132 | 89 | 20.7 |
| PCB-8 | | 9.9 | 3.6 J | 12 J | 2.9 U |
| PCB-18 | | 15 J | 12 J | 14 J | 4.5 R |
| PCB-28 | | 16 J | 20 J | 25 J | 22 J |
| PCB-44 | | 6.7 | 7.9 J | 9.4 J | 11 J |
| PCB-52 | | 11 | 9.7 J | 17 J | 11 J |
| PCB-66 | | 2.8 UJ | 16 J | 9 J | 2.9 UJ |
| PCB-101 | | 9.2 J | 12 J | 13 J | 6.9 J |
| PCB-105 | | 3.3 J | 2.9 J | 3.7 J | 2.9 U |
| PCB-118 | | 7.6 J | 19 J | 14 J | 17 J |
| PCB-128 | | 2.8 U | 2.6 U | 2.6 U | 2.9 U |
| PCB-138 | | 8.5 | 10 J | 14 J | 7.3 |
| PCB-153 | | 8.6 | 12 | 13 | 7.3 |
| PCB-170 | | 8.7 J | 2.8 R | 2.6 U | 3.1 R |
| PCB-180 | | 5.7 | 6.5 | 7.3 | 4.4 J |
| PCB-187 | | 2.8 U | 2.6 U | 2.6 U | 2.9 U |
| PCB-195 | | 2.8 U | 2.6 U | 2.6 U | 2.9 U |
| PCB-206 | | 8.3 | 4.7 | 5.9 J | 3.8 J |
| PCB-209 | | 3.7 R | 2.6 U | 2.6 U | 2.9 U |
| TOTAL PCB CONGENERS | 180 | 248.2 | 283 | 327.6 | 201.7 |
| ALPHA-CHLORDANE | 6 | 24 U | 45 U | 6 J | 5 U |
| **Inorganics (mg/kg)** | | | | | |
| ARSENIC | 70 | 16.4 | 15.3 | 17 | 14.3 |
| CADMIUM | 9.6 | 0.81 | 0.99 | 1.4 | 0.7 |
| CHROMIUM | 370 | 91.5 | 86.1 | 100 | 76.9 |
| COPPER | 270 | 165 J | 141 J | 166 J | 118 J |
| LEAD | 218 | 148 J | 122 J | 148 J | 105 J |
| NICKEL | 51.6 | 35.00 J | 36.50 J | 39.70 J | 29.00 J |
| SELENIUM | 1.4 | 6.5 | 6.6 | 5.7 | 6.3 |
| ZINC | 410 | 224 J | 211 J | 260 J | 206 J |

B Blank contamination
J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

**TABLE B.5.2**

**ZONE 4 ERM-Q CALCULATIONS**
**LOWER SUBASE FEASIBILITY STUDY**
**NSB-NLON, GROTON, CONNECTICUT**



| **PARAMETER** | **ERM** | ZONE-4 **Z4-33 CAB-36 20030617** | | ZONE-4 **Z4-36 CAB-39 20030617** | | ZONE-4 **Z4-37 CAB-41 20030617** | | ZONE-4 **Z4-39 CAB-43 20030617** | |
|---|---|---|---|---|---|---|---|---|---|
| | | **RESULT** | ERM_RATIO | **RESULT** | ERM_RATIO | **RESULT** | ERM_RATIO | **RESULT** | ERM_RATIO |
| ARSENIC (mg/kg) | 70 | 13.2 | 0.189 | 10.7 | 0.153 | 14.4 | 0.206 | 10.7 | 0.153 |
| CADMIUM (mg/kg) | 9.6 | 1.58 | 0.165 | 3.49 | 0.364 | 0.674 | 0.070 | 1.41 | 0.147 |
| CHROMIUM (mg/kg) | 370 | 263 B | 0.711 | 364 B | 0.984 | 98.2 B | 0.265 | 125 B | 0.338 |
| COPPER (mg/kg) | 270 | 305 | 1.130 | 628 | 2.326 | 103 | 0.381 | 98.6 | 0.365 |
| LEAD (mg/kg) | 218 | 345 | 1.583 | 1240 | 5.688 | 102 | 0.468 | 109 | 0.500 |
| NICKEL (mg/kg) | 51.6 | 90.6 | 1.756 | 188 | 3.643 | 28.9 | 0.560 | 25.9 | 0.502 |
| SELENIUM (mg/kg) | 1.4 | 1.13 | 0.807 | 2.24 | 1.600 | 0.915 | 0.654 | 0.89 | 0.636 |
| ZINC (mg/kg) | 410 | 3310 B | 8.073 | 4070 B | 9.927 | 194 B | 0.473 | 182 B | 0.444 |
| TOTAL PCB CONGENERS (µg/kg) | 180 | 300.47 | 1.669 | 1045.57 | 5.809 | 147.85 | 0.821 | 231.09 | 1.284 |
| ALPHA-CHLORDANE (µg/kg) | 6 | 0.75 | 0.125 | 6.07 | 1.012 | 0.66 J | 0.110 | 0.96 | 0.160 |
| TOTAL DDT (µg/kg) | 46.1 | 8.65 | 0.188 | 56.31 | 1.221 | 9.95 | 0.216 | 22.05 | 0.478 |
| HIGH MOLECULAR WEIGHT PAHS (µg/kg) | 9600 | 22713.69 | 2.366 | 19749.24 | 2.057 | 39704.6 | 4.136 | 10012.63 | 1.043 |
| LOW MOLECULAR WEIGHT PAHS (µg/kg) | 3160 | 3305.4 | 1.046 | 2158.46 | 0.683 | 3193.4 | 1.011 | 1659.55 | 0.525 |
| Total ERM-Q | | | 1.524 | | 2.728 | | 0.721 | | 0.506 |

J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

**TABLE B.5.2**

**ZONE 4 ERM-Q CALCULATIONS**
**LOWER SUBASE FEASIBILITY STUDY**
**NSB-NLON, GROTON, CONNECTICUT**



| **PARAMETER** | **ERM** | ZONE-4 **Z4-40 CAB-44 20030617** | | ZONE-4 **Z4-42 CAB-46 20030618** | | ZONE-4 **Z4-43 CAB-47 20030618** | | ZONE-4 **Z4-44 CAB-48 20030618** | |
|---|---|---|---|---|---|---|---|---|---|
| | | **RESULT** | ERM_RATIO | **RESULT** | ERM_RATIO | **RESULT** | ERM_RATIO | **RESULT** | ERM_RATIO |
| ARSENIC (mg/kg) | 70 | 14.1 | 0.201 | 14.9 | 0.213 | 11.2 | 0.160 | 11.3 | 0.161 |
| CADMIUM (mg/kg) | 9.6 | 0.56 | 0.058 | 0.519 | 0.054 | 0.439 | 0.046 | 0.297 | 0.031 |
| CHROMIUM (mg/kg) | 370 | 98.8 B | 0.267 | 101 B | 0.273 | 93.5 B | 0.253 | 71.1 B | 0.192 |
| COPPER (mg/kg) | 270 | 88.6 | 0.328 | 94.4 | 0.350 | 101 | 0.374 | 147 | 0.544 |
| LEAD (mg/kg) | 218 | 126 | 0.578 | 95.2 | 0.437 | 88.1 | 0.404 | 124 | 0.569 |
| NICKEL (mg/kg) | 51.6 | 28.9 | 0.560 | 30 | 0.581 | 27.2 | 0.527 | 38.1 | 0.738 |
| SELENIUM (mg/kg) | 1.4 | 0.931 | 0.665 | 1.02 | 0.729 | 0.811 | 0.579 | 0.661 | 0.472 |
| ZINC (mg/kg) | 410 | 171 B | 0.417 | 170 B | 0.415 | 191 B | 0.466 | 958 B | 2.337 |
| TOTAL PCB CONGENERS (µg/kg) | 180 | 111.57 | 0.620 | 112.78 | 0.627 | 104.87 | 0.583 | 52.53 | 0.292 |
| ALPHA-CHLORDANE (µg/kg) | 6 | 0.64 J | 0.107 | 0.60 J | 0.100 | 0.59 J | 0.098 | 0.33 J | 0.055 |
| TOTAL DDT (µg/kg) | 46.1 | 9.1 | 0.197 | 9.34 | 0.203 | 7.83 | 0.170 | 4.04 | 0.088 |
| HIGH MOLECULAR WEIGHT PAHS (µg/kg) | 9600 | 44996.63 | 4.687 | 84678.19 | 8.821 | 14803.89 | 1.542 | 7643.59 | 0.796 |
| LOW MOLECULAR WEIGHT PAHS (µg/kg) | 3160 | 8024.82 | 2.540 | 19623.48 | 6.210 | 1876.36 | 0.594 | 1311.82 | 0.415 |
| Total ERM-Q | | | 0.864 | | 1.462 | | 0.446 | | 0.515 |

J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

**TABLE B.5.2**

**ZONE 4 ERM-Q CALCULATIONS**
**LOWER SUBASE FEASIBILITY STUDY**
**NSB-NLON, GROTON, CONNECTICUT**



| **PARAMETER** | **ERM** | ZONE-4 **Z4-46 CAB-50 20030618** | | ZONE-4 **Z4-C1 DAD-8-0204 20041011** | | ZONE-4 **Z4-C1 DAD-8-0405 20041011** | | ZONE-4 **Z4-C1 DAD-8-0507 20041011** | |
|---|---|---|---|---|---|---|---|---|---|
| | | **RESULT** | ERM_RATIO | **RESULT** | ERM_RATIO | **RESULT** | ERM_RATIO | **RESULT** | ERM_RATIO |
| ARSENIC (mg/kg) | 70 | 8.13 | 0.116 | 14.2 | 0.203 | 12.5 | 0.179 | 0.094 | 0.001 |
| CADMIUM (mg/kg) | 9.6 | 0.363 | 0.038 | 1.34 | 0.140 | 1.72 | 0.179 | 0.029 | 0.003 |
| CHROMIUM (mg/kg) | 370 | 83.7 B | 0.226 | 112 | 0.303 | 127 | 0.343 | 14.64 | 0.040 |
| COPPER (mg/kg) | 270 | 64.1 | 0.237 | 128 | 0.474 | 129 | 0.478 | 2.84 | 0.011 |
| LEAD (mg/kg) | 218 | 69.7 | 0.320 | 149 J | 0.683 | 162 J | 0.743 | 1.79 J | 0.008 |
| NICKEL (mg/kg) | 51.6 | 19.1 | 0.370 | 36.90 J | 0.715 | 43.18 J | 0.837 | 3.70 J | 0.072 |
| SELENIUM (mg/kg) | 1.4 | 0.533 | 0.381 | 0.909 | 0.649 | 0.748 | 0.534 | 0.020 U | 0.007 |
| ZINC (mg/kg) | 410 | 109 B | 0.266 | 275 J | 0.671 | 351 J | 0.856 | 12.58 J | 0.031 |
| TOTAL PCB CONGENERS (µg/kg) | 180 | 80.33 | 0.446 | 237.24 | 1.318 | 453.64 | 2.520 | 1.11 | 0.006 |
| ALPHA-CHLORDANE (µg/kg) | 6 | 0.20 J | 0.033 | 1.97 | 0.328 | 3.29 | 0.548 | 0.05 UJ | 0.004 |
| TOTAL DDT (µg/kg) | 46.1 | 3.65 | 0.079 | 10.66 | 0.231 | 13.02 | 0.282 | 0.06 | 0.001 |
| HIGH MOLECULAR WEIGHT PAHS (µg/kg) | 9600 | 6977.52 | 0.727 | 25721.07 | 2.679 | 29609.03 | 3.084 | 4.6 | 0.000 |
| LOW MOLECULAR WEIGHT PAHS (µg/kg) | 3160 | 1381.71 | 0.437 | 4605.64 | 1.457 | 4149.93 | 1.313 | 2.22 | 0.001 |
| Total ERM-Q | | | 0.283 | | 0.758 | | 0.915 | | 0.014 |

J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

**TABLE B.5.2**

**ZONE 4 ERM-Q CALCULATIONS**
**LOWER SUBASE FEASIBILITY STUDY**
**NSB-NLON, GROTON, CONNECTICUT**



| **PARAMETER** | **ERM** | ZONE-4 **Z4-C2 DAD-9-0204 20041011** | | ZONE-4 **Z4-C2 DAD-9-0405 20041011** | | ZONE-4 **Z4-S1 DAD-1 20041012** | | ZONE-4 **Z4-S2 DAD-2 20041013** | |
|---|---|---|---|---|---|---|---|---|---|
| | | **RESULT** | ERM_RATIO | **RESULT** | ERM_RATIO | **RESULT** | ERM_RATIO | **RESULT** | ERM_RATIO |
| ARSENIC (mg/kg) | 70 | 2.55 | 0.036 | 1.16 | 0.017 | 13.2 | 0.189 | 13.9 | 0.199 |
| CADMIUM (mg/kg) | 9.6 | 0.314 | 0.033 | 0.136 | 0.014 | 0.212 | 0.022 | 0.583 | 0.061 |
| CHROMIUM (mg/kg) | 370 | 28.39 | 0.077 | 22.38 | 0.060 | 61.5 | 0.166 | 84.6 | 0.229 |
| COPPER (mg/kg) | 270 | 21.77 | 0.081 | 15.47 | 0.057 | 255 | 0.944 | 97.3 J | 0.360 |
| LEAD (mg/kg) | 218 | 31.46 J | 0.144 | 26.60 J | 0.122 | 54.9 | 0.252 | 102 J | 0.468 |
| NICKEL (mg/kg) | 51.6 | 10.71 J | 0.208 | 6.76 J | 0.131 | 14.31 | 0.277 | 26.44 | 0.512 |
| SELENIUM (mg/kg) | 1.4 | 0.106 | 0.076 | 0.031 | 0.022 | 0.396 J | 0.283 | 0.8 | 0.571 |
| ZINC (mg/kg) | 410 | 67.6 J | 0.165 | 37.64 J | 0.092 | 3707 | 9.041 | 321 | 0.783 |
| TOTAL PCB CONGENERS (µg/kg) | 180 | 49.2 | 0.273 | 21.68 | 0.120 | 62.72 | 0.348 | 161.69 | 0.898 |
| ALPHA-CHLORDANE (µg/kg) | 6 | 0.31 | 0.052 | 0.11 | 0.018 | 0.68 | 0.113 | 0.9 | 0.150 |
| TOTAL DDT (µg/kg) | 46.1 | 0.96 | 0.021 | 0.41 | 0.009 | 5.17 | 0.112 | 5.23 | 0.113 |
| HIGH MOLECULAR WEIGHT PAHS (µg/kg) | 9600 | 1388.6 | 0.145 | 515.21 | 0.054 | 29215.42 | 3.043 | 24884.67 | 2.592 |
| LOW MOLECULAR WEIGHT PAHS (µg/kg) | 3160 | 183.25 | 0.058 | 90.03 | 0.028 | 4926.54 | 1.559 | 6064.5 | 1.919 |
| Total ERM-Q | | | 0.105 | | 0.057 | | 1.258 | | 0.681 |

J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

**TABLE B.5.2**

**ZONE 4 ERM-Q CALCULATIONS**
**LOWER SUBASE FEASIBILITY STUDY**
**NSB-NLON, GROTON, CONNECTICUT**



| **PARAMETER** | **ERM** | ZONE-4 **Z4-S3 DAD-3 20041013** | | ZONE-4 **Z4-S4 DAD-4 20041013** | | ZONE-4 **Z4-S5 DAD-5 20041012** | | ZONE-4 **Z4-S6 DAD-6 20041012** | |
|---|---|---|---|---|---|---|---|---|---|
| | | **RESULT** | ERM_RATIO | **RESULT** | ERM_RATIO | **RESULT** | ERM_RATIO | **RESULT** | ERM_RATIO |
| ARSENIC (mg/kg) | 70 | 12.6 | 0.180 | 13.5 | 0.193 | 12.7 | 0.181 | 7.4 | 0.106 |
| CADMIUM (mg/kg) | 9.6 | 0.54 | 0.056 | 0.52 | 0.054 | 0.49 | 0.051 | 0.905 | 0.094 |
| CHROMIUM (mg/kg) | 370 | 85.7 | 0.232 | 88 | 0.238 | 88.1 | 0.238 | 53.9 | 0.146 |
| COPPER (mg/kg) | 270 | 95.2 J | 0.353 | 85.0 J | 0.315 | 83.6 | 0.310 | 59.9 | 0.222 |
| LEAD (mg/kg) | 218 | 93.9 J | 0.431 | 89.4 J | 0.410 | 84.5 | 0.388 | 119 | 0.546 |
| NICKEL (mg/kg) | 51.6 | 26.58 | 0.515 | 27.7 | 0.537 | 26.08 | 0.505 | 16.97 | 0.329 |
| SELENIUM (mg/kg) | 1.4 | 0.613 | 0.438 | 0.68 | 0.486 | 0.747 J | 0.534 | 0.428 J | 0.306 |
| ZINC (mg/kg) | 410 | 255 | 0.622 | 202 | 0.493 | 191 | 0.466 | 216 | 0.527 |
| TOTAL PCB CONGENERS (µg/kg) | 180 | 109.24 | 0.607 | 81.09 | 0.451 | 100.28 | 0.557 | 187.92 | 1.044 |
| ALPHA-CHLORDANE (µg/kg) | 6 | 0.84 J | 0.140 | 0.59 | 0.098 | 0.94 | 0.157 | 0.88 | 0.147 |
| TOTAL DDT (µg/kg) | 46.1 | 3.505 | 0.076 | 4.25 | 0.092 | 6.49 | 0.141 | 7.96 | 0.173 |
| HIGH MOLECULAR WEIGHT PAHS (µg/kg) | 9600 | 48160.38 | 5.017 | 30712.28 | 3.199 | 20272.33 | 2.112 | 9105.08 | 0.948 |
| LOW MOLECULAR WEIGHT PAHS (µg/kg) | 3160 | 10524.73 | 3.331 | 7770.04 | 2.459 | 2617.81 | 0.828 | 1288.84 | 0.408 |
| Total ERM-Q | | | 0.923 | | 0.694 | | 0.497 | | 0.384 |

J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

**TABLE B.5.2**

**ZONE 4 ERM-Q CALCULATIONS**
**LOWER SUBASE FEASIBILITY STUDY**
**NSB-NLON, GROTON, CONNECTICUT**



| **PARAMETER** | **ERM** | ZONE-4 **Z4-S6R DAD-6-D 20041012** | | ZONE-4 **Z4-1 GAB-001 20070426** | | ZONE-4 **Z4-2 GAB-002 20070425** | | ZONE-4 **Z4-3 GAB-003 20070426** | |
|---|---|---|---|---|---|---|---|---|---|
| | | **RESULT** | ERM_RATIO | **RESULT** | ERM_RATIO | **RESULT** | ERM_RATIO | **RESULT** | ERM_RATIO |
| ARSENIC (mg/kg) | 70 | 5.58 | 0.080 | 12.5 | 0.179 | 10.5 | 0.150 | 13.9 | 0.199 |
| CADMIUM (mg/kg) | 9.6 | 0.962 | 0.100 | 0.827 | 0.086 | 2.81 | 0.293 | 1.06 | 0.110 |
| CHROMIUM (mg/kg) | 370 | 87.7 | 0.237 | 321 | 0.868 | 313 | 0.846 | 105 | 0.284 |
| COPPER (mg/kg) | 270 | 132 J | 0.489 | 568 | 2.104 | 735 | 2.722 | 121 | 0.448 |
| LEAD (mg/kg) | 218 | 131 J | 0.601 | 524 | 2.404 | 841 | 3.858 | 136 | 0.624 |
| NICKEL (mg/kg) | 51.6 | 24.83 | 0.481 | 165 | 3.198 | 286 | 5.543 | 32.25 | 0.625 |
| SELENIUM (mg/kg) | 1.4 | 0.499 | 0.356 | 1.27 | 0.907 | 1.88 | 1.343 | 1.07 | 0.764 |
| ZINC (mg/kg) | 410 | 468 | 1.141 | 3068 | 7.483 | 3718 | 9.068 | 234 | 0.571 |
| TOTAL PCB CONGENERS (µg/kg) | 180 | 382.32 | 2.124 | 228.59 | 1.270 | 366.77 | 2.038 | 181.99 | 1.011 |
| ALPHA-CHLORDANE (µg/kg) | 6 | 0.94 | 0.157 | 0.8 | 0.133 | 2.52 | 0.420 | 0.73 | 0.122 |
| TOTAL DDT (µg/kg) | 46.1 | 13.18 | 0.286 | 9.89 | 0.215 | 27.23 | 0.591 | 11.99 | 0.260 |
| HIGH MOLECULAR WEIGHT PAHS (µg/kg) | 9600 | 11508.5 | 1.199 | 34438.46 | 3.587 | 18462.96 | 1.923 | 17638.98 | 1.837 |
| LOW MOLECULAR WEIGHT PAHS (µg/kg) | 3160 | 1680.92 | 0.532 | 7857.57 | 2.487 | 2584.34 | 0.818 | 7331.26 | 2.320 |
| Total ERM-Q | | | 0.599 | | 1.917 | | 2.278 | | 0.706 |

J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

**TABLE B.5.2**

**ZONE 4 ERM-Q CALCULATIONS**
**LOWER SUBASE FEASIBILITY STUDY**
**NSB-NLON, GROTON, CONNECTICUT**



| **PARAMETER** | **ERM** | ZONE-4 **Z4-4 GAB-004 20070426** | | ZONE-4 **Z4-4 GAB-004-D 20070426** | | ZONE-4 **Z4-5 GAB-005 20070425** | | ZONE-4 **Z4-6 GAB-006 20070425** | |
|---|---|---|---|---|---|---|---|---|---|
| | | **RESULT** | ERM_RATIO | **RESULT** | ERM_RATIO | **RESULT** | ERM_RATIO | **RESULT** | ERM_RATIO |
| ARSENIC (mg/kg) | 70 | 13 | 0.186 | 13.2 | 0.189 | 13.8 | 0.197 | 11 | 0.157 |
| CADMIUM (mg/kg) | 9.6 | 0.909 | 0.095 | 0.925 | 0.096 | 0.645 | 0.067 | 0.503 | 0.052 |
| CHROMIUM (mg/kg) | 370 | 100 | 0.270 | 99.7 | 0.269 | 86.6 | 0.234 | 79.3 | 0.214 |
| COPPER (mg/kg) | 270 | 115 | 0.426 | 112 | 0.415 | 198 | 0.733 | 84 | 0.311 |
| LEAD (mg/kg) | 218 | 112 | 0.514 | 119 | 0.546 | 106 | 0.486 | 78.6 | 0.361 |
| NICKEL (mg/kg) | 51.6 | 32.01 | 0.620 | 32.53 | 0.630 | 30.01 | 0.582 | 27.59 | 0.535 |
| SELENIUM (mg/kg) | 1.4 | 0.936 | 0.669 | 0.848 | 0.606 | 0.88 | 0.629 | 0.724 | 0.517 |
| ZINC (mg/kg) | 410 | 218 | 0.532 | 209 | 0.510 | 766 | 1.868 | 163 | 0.398 |
| TOTAL PCB CONGENERS (µg/kg) | 180 | 183.63 | 1.020 | 105.25 | 0.585 | 89.67 | 0.498 | 83.01 | 0.461 |
| ALPHA-CHLORDANE (µg/kg) | 6 | 0.94 | 0.157 | 0.61 | 0.102 | 0.64 | 0.107 | 0.57 | 0.095 |
| TOTAL DDT (µg/kg) | 46.1 | 11.49 | 0.249 | 8.51 | 0.185 | 8.02 | 0.174 | 6.65 | 0.144 |
| HIGH MOLECULAR WEIGHT PAHS (µg/kg) | 9600 | 16901.49 | 1.761 | 10879.66 | 1.133 | 13612.05 | 1.418 | 9060.3 | 0.944 |
| LOW MOLECULAR WEIGHT PAHS (µg/kg) | 3160 | 5227.15 | 1.654 | 3049.21 | 0.965 | 2267.75 | 0.718 | 2028.16 | 0.642 |
| Total ERM-Q | | | 0.627 | | 0.479 | | 0.593 | | 0.372 |

J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

**TABLE B.5.2**

**ZONE 4 ERM-Q CALCULATIONS**
**LOWER SUBASE FEASIBILITY STUDY**
**NSB-NLON, GROTON, CONNECTICUT**



| **PARAMETER** | **ERM** | ZONE-4 **TRZ4-SD-001 TRZ4-SD-001A-0204 20081106** | | ZONE-4 **TRZ4-SD-001 TRZ4-SD-001A-0406 20081106** | | ZONE-4 **TRZ4-SD-001 TRZ4-SD-001B-0001 20081106** | | ZONE-4 **TRZ4-SD-002 TRZ4-SD-002A-0204 20081106** | |
|---|---|---|---|---|---|---|---|---|---|
| | | **RESULT** | ERM_RATIO | **RESULT** | ERM_RATIO | **RESULT** | ERM_RATIO | **RESULT** | ERM_RATIO |
| ARSENIC (mg/kg) | 70 | 15.20 J | 0.217 | 16.40 J | 0.234 | 13.90 J | 0.199 | 15.7 | 0.224 |
| CADMIUM (mg/kg) | 9.6 | 2.00 J | 0.208 | 2.20 J | 0.229 | 0.620 J | 0.065 | 1.4 | 0.146 |
| CHROMIUM (mg/kg) | 370 | 155 J | 0.419 | 129 J | 0.349 | 77.7 J | 0.210 | 86.3 | 0.233 |
| COPPER (mg/kg) | 270 | 372 J | 1.378 | 266 J | 0.985 | 132 J | 0.489 | 162 J | 0.600 |
| LEAD (mg/kg) | 218 | 483 J | 2.216 | 308 J | 1.413 | 202 J | 0.927 | 178 J | 0.817 |
| NICKEL (mg/kg) | 51.6 | 89.2 | 1.729 | 72.7 | 1.409 | 30.1 | 0.583 | 29.70 J | 0.576 |
| SELENIUM (mg/kg) | 1.4 | 5.7 | 4.071 | 6.6 | 4.714 | 6 | 4.286 | 5.5 | 3.929 |
| ZINC (mg/kg) | 410 | 2110 J | 5.146 | 652 J | 1.590 | 264 J | 0.644 | 323 J | 0.788 |
| TOTAL PCB CONGENERS (µg/kg) | 180 | 382.2 | 2.123 | 452.2 | 2.512 | 208 | 1.156 | 612 | 3.400 |
| ALPHA-CHLORDANE (µg/kg) | 6 | 3.4 UJ | 0.283 | 3.5 U | 0.292 | 0.92 U | 0.077 | 35 U | 2.917 |
| TOTAL DDT (µg/kg) | 46.1 | 10.05 | 0.218 | 23.35 | 0.507 | 12 | 0.260 | 102 | 2.213 |
| HIGH MOLECULAR WEIGHT PAHS (µg/kg) | 9600 | 83680 | 8.717 | 55340 | 5.765 | 11070 | 1.153 | 37210 | 3.876 |
| LOW MOLECULAR WEIGHT PAHS (µg/kg) | 3160 | 14320 | 4.532 | 20040 | 6.342 | 1838 | 0.582 | 6904 | 2.185 |
| Total ERM-Q | | | 2.404 | | 2.026 | | 0.818 | | 1.685 |

J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

**TABLE B.5.2**

**ZONE 4 ERM-Q CALCULATIONS**
**LOWER SUBASE FEASIBILITY STUDY**
**NSB-NLON, GROTON, CONNECTICUT**



| **PARAMETER** | **ERM** | ZONE-4 **TRZ4-SD-002 TRZ4-SD-002A-0406 20081106** | | ZONE-4 **TRZ4-SD-002 TRZ4-SD-002B-0001 20081106** | | ZONE-4 **TRZ4-SD-003 TRZ4-SD-003A-0204 20081106** | | ZONE-4 **TRZ4-SD-003 TRZ4-SD-003A-0406 20081106** | |
|---|---|---|---|---|---|---|---|---|---|
| | | **RESULT** | ERM_RATIO | **RESULT** | ERM_RATIO | **RESULT** | ERM_RATIO | **RESULT** | ERM_RATIO |
| ARSENIC (mg/kg) | 70 | 12.3 | 0.176 | 11.1 | 0.159 | 17.2 | 0.246 | 6.6 | 0.094 |
| CADMIUM (mg/kg) | 9.6 | 2.4 | 0.250 | 0.9 | 0.094 | 0.83 | 0.086 | 0.62 | 0.065 |
| CHROMIUM (mg/kg) | 370 | 128 | 0.346 | 81.7 | 0.221 | 85.1 | 0.230 | 76.9 | 0.208 |
| COPPER (mg/kg) | 270 | 171 J | 0.633 | 183 J | 0.678 | 132 J | 0.489 | 174 J | 0.644 |
| LEAD (mg/kg) | 218 | 187 J | 0.858 | 223 J | 1.023 | 162 J | 0.743 | 206 J | 0.945 |
| NICKEL (mg/kg) | 51.6 | 30.10 J | 0.583 | 41.50 J | 0.804 | 30.80 J | 0.597 | 58.1 J | 1.126 |
| SELENIUM (mg/kg) | 1.4 | 6.1 | 4.357 | 5 | 3.571 | 6.2 | 4.429 | 4 | 2.857 |
| ZINC (mg/kg) | 410 | 292 J | 0.712 | 523 J | 1.276 | 242 J | 0.590 | 665 J | 1.622 |
| TOTAL PCB CONGENERS (µg/kg) | 180 | 1424.5 | 7.914 | 470.2 | 2.612 | 468.6 | 2.603 | 341.4 | 1.897 |
| ALPHA-CHLORDANE (µg/kg) | 6 | 18 U | 1.500 | 17 U | 1.417 | 44 UJ | 3.667 | 5.8 U | 0.483 |
| TOTAL DDT (µg/kg) | 46.1 | 244.5 | 5.304 | 78 | 1.692 | 129 | 2.798 | 34 | 0.738 |
| HIGH MOLECULAR WEIGHT PAHS (µg/kg) | 9600 | 5099 | 0.531 | 20230 | 2.107 | 20900 | 2.177 | 18630 | 1.941 |
| LOW MOLECULAR WEIGHT PAHS (µg/kg) | 3160 | 2960 | 0.937 | 3027 | 0.958 | 2384 | 0.754 | 4315 | 1.366 |
| Total ERM-Q | | | 1.854 | | 1.278 | | 1.493 | | 1.076 |

J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

**TABLE B.5.2**

**ZONE 4 ERM-Q CALCULATIONS**
**LOWER SUBASE FEASIBILITY STUDY**
**NSB-NLON, GROTON, CONNECTICUT**



| **PARAMETER** | **ERM** | ZONE-4 **TRZ4-SD-003 TRZ4-SD-003B-0001 20081106** | | ZONE-4 **TRZ4-SD-004 TRZ4-SD-004A-0204 20081107** | | ZONE-4 **TRZ4-SD-004 TRZ4-SD-004A-0406 20081107** | | ZONE-4 **TRZ4-SD-004 TRZ4-SD-004B-0001 20081107** | |
|---|---|---|---|---|---|---|---|---|---|
| | | **RESULT** | ERM_RATIO | **RESULT** | ERM_RATIO | **RESULT** | ERM_RATIO | **RESULT** | ERM_RATIO |
| ARSENIC (mg/kg) | 70 | 13.4 | 0.191 | 4.70 J | 0.067 | 10.90 J | 0.156 | 4.10 J | 0.059 |
| CADMIUM (mg/kg) | 9.6 | 0.61 | 0.064 | 0.470 J | 0.049 | 1.50 J | 0.156 | 0.190 J | 0.020 |
| CHROMIUM (mg/kg) | 370 | 66.5 | 0.180 | 52.4 J | 0.142 | 85.3 J | 0.231 | 40.20 J | 0.109 |
| COPPER (mg/kg) | 270 | 109 J | 0.404 | 92.1 J | 0.341 | 165 J | 0.611 | 100 J | 0.370 |
| LEAD (mg/kg) | 218 | 108 J | 0.495 | 157 J | 0.720 | 400 J | 1.835 | 127 J | 0.583 |
| NICKEL (mg/kg) | 51.6 | 25.20 J | 0.488 | 28.10 J | 0.545 | 24.70 J | 0.479 | 40.50 J | 0.785 |
| SELENIUM (mg/kg) | 1.4 | 5 | 3.571 | 2.6 | 1.857 | 4.7 | 3.357 | 2.6 | 1.857 |
| ZINC (mg/kg) | 410 | 239 J | 0.583 | 273 J | 0.666 | 256 J | 0.624 | 359 J | 0.876 |
| TOTAL PCB CONGENERS (µg/kg) | 180 | 263 | 1.461 | 106.2 | 0.590 | 460.1 | 2.556 | 60.8 | 0.338 |
| ALPHA-CHLORDANE (µg/kg) | 6 | 38 U | 3.167 | 0.46 J | 0.077 | 2.3 | 0.383 | 0.47 U | 0.039 |
| TOTAL DDT (µg/kg) | 46.1 | 112.5 | 2.440 | 8.4 | 0.182 | 36.9 | 0.800 | 1.42 | 0.031 |
| HIGH MOLECULAR WEIGHT PAHS (µg/kg) | 9600 | 14050 | 1.464 | 8854 | 0.922 | 29020 | 3.023 | 3427 | 0.357 |
| LOW MOLECULAR WEIGHT PAHS (µg/kg) | 3160 | 1414 | 0.447 | 1172 | 0.371 | 6890 | 2.180 | 643 | 0.203 |
| Total ERM-Q | | | 1.150 | | 0.502 | | 1.261 | | 0.433 |

J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

**TABLE B.5.2**

**ZONE 4 ERM-Q CALCULATIONS**
**LOWER SUBASE FEASIBILITY STUDY**
**NSB-NLON, GROTON, CONNECTICUT**



| **PARAMETER** | **ERM** | ZONE-4 **TRZ4-SD-005 TRZ4-SD-005A-0204 20081106** | | ZONE-4 **TRZ4-SD-005 TRZ4-SD-005A-0406 20081106** | | ZONE-4 **TRZ4-SD-005 TRZ4-SD-005B-0001 20081106** | | ZONE-4 **TRZ4-SD-006 TRZ4-SD-006A-0204 20081106** | |
|---|---|---|---|---|---|---|---|---|---|
| | | **RESULT** | ERM_RATIO | **RESULT** | ERM_RATIO | **RESULT** | ERM_RATIO | **RESULT** | ERM_RATIO |
| ARSENIC (mg/kg) | 70 | 16.1 | 0.230 | 13.2 | 0.189 | 17.1 | 0.244 | 16.8 | 0.240 |
| CADMIUM (mg/kg) | 9.6 | 1.1 | 0.115 | 1.9 | 0.198 | 0.81 | 0.084 | 2.6 | 0.271 |
| CHROMIUM (mg/kg) | 370 | 115 | 0.311 | 109 | 0.295 | 81 | 0.219 | 134 | 0.362 |
| COPPER (mg/kg) | 270 | 348 J | 1.289 | 212 J | 0.785 | 144 J | 0.533 | 202 J | 0.748 |
| LEAD (mg/kg) | 218 | 248 J | 1.138 | 288 J | 1.321 | 158 J | 0.725 | 197 J | 0.904 |
| NICKEL (mg/kg) | 51.6 | 61.1 J | 1.184 | 34.80 J | 0.674 | 30.00 J | 0.581 | 46.90 J | 0.909 |
| SELENIUM (mg/kg) | 1.4 | 6.7 | 4.786 | 5.7 | 4.071 | 6.7 | 4.786 | 6.7 | 4.786 |
| ZINC (mg/kg) | 410 | 730 J | 1.780 | 367 J | 0.895 | 240 J | 0.585 | 353 J | 0.861 |
| TOTAL PCB CONGENERS (µg/kg) | 180 | 336.4 | 1.869 | 1317 | 7.317 | 346 | 1.922 | 775.4 | 4.308 |
| ALPHA-CHLORDANE (µg/kg) | 6 | 8 U | 0.667 | 20 U | 1.667 | 22 U | 1.833 | 46 U | 3.833 |
| TOTAL DDT (µg/kg) | 46.1 | 185 | 4.013 | 80 | 1.735 | 88 | 1.909 | 135 | 2.928 |
| HIGH MOLECULAR WEIGHT PAHS (µg/kg) | 9600 | 14150 | 1.474 | 39710 | 4.136 | 8750 | 0.911 | 6205 | 0.646 |
| LOW MOLECULAR WEIGHT PAHS (µg/kg) | 3160 | 4237 | 1.341 | 41490 | 13.130 | 938 | 0.297 | 1251 | 0.396 |
| Total ERM-Q | | | 1.554 | | 2.801 | | 1.125 | | 1.630 |

J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

**TABLE B.5.2**

**ZONE 4 ERM-Q CALCULATIONS**
**LOWER SUBASE FEASIBILITY STUDY**
**NSB-NLON, GROTON, CONNECTICUT**



| **PARAMETER** | **ERM** | ZONE-4 **TRZ4-SD-006 TRZ4-SD-006A-0406 20081106** | | ZONE-4 **TRZ4-SD-006 TRZ4-SD-006B-0001 20081106** | | ZONE-4 **TRZ4-SD-007 TRZ4-SD-007A-0204 20081106** | | ZONE-4 **TRZ4-SD-007 TRZ4-SD-007A-0406 20081106** | |
|---|---|---|---|---|---|---|---|---|---|
| | | **RESULT** | ERM_RATIO | **RESULT** | ERM_RATIO | **RESULT** | ERM_RATIO | **RESULT** | ERM_RATIO |
| ARSENIC (mg/kg) | 70 | 8.1 | 0.116 | 13.9 | 0.199 | 9.3 | 0.133 | 8.6 | 0.123 |
| CADMIUM (mg/kg) | 9.6 | 1.3 | 0.135 | 0.61 | 0.064 | 0.25 | 0.026 | 0.25 | 0.026 |
| CHROMIUM (mg/kg) | 370 | 72.9 | 0.197 | 69.7 | 0.188 | 38.1 | 0.103 | 36.8 | 0.099 |
| COPPER (mg/kg) | 270 | 113 J | 0.419 | 104 J | 0.385 | 27.10 J | 0.100 | 14.50 J | 0.054 |
| LEAD (mg/kg) | 218 | 147 J | 0.674 | 101 J | 0.463 | 21.20 J | 0.097 | 7.60 J | 0.035 |
| NICKEL (mg/kg) | 51.6 | 20.80 J | 0.403 | 26.90 J | 0.521 | 20.90 J | 0.405 | 21.30 J | 0.413 |
| SELENIUM (mg/kg) | 1.4 | 3.8 | 2.714 | 6.3 | 4.500 | 4.3 | 3.071 | 5.5 | 3.929 |
| ZINC (mg/kg) | 410 | 209 J | 0.510 | 185 J | 0.451 | 68.9 J | 0.168 | 52.4 J | 0.128 |
| TOTAL PCB CONGENERS (µg/kg) | 180 | 1162.8 | 6.460 | 227.5 | 1.264 | 40.5 | 0.225 | 46.2 | 0.257 |
| ALPHA-CHLORDANE (µg/kg) | 6 | 14 U | 1.167 | 26 U | 2.167 | 3.5 U | 0.292 | 3.4 U | 0.283 |
| TOTAL DDT (µg/kg) | 46.1 | 63 | 1.367 | 75 | 1.627 | 10.2 | 0.221 | 9.9 | 0.215 |
| HIGH MOLECULAR WEIGHT PAHS (µg/kg) | 9600 | 7086 | 0.738 | 11580 | 1.206 | 671 | 0.070 | 35.4 | 0.004 |
| LOW MOLECULAR WEIGHT PAHS (µg/kg) | 3160 | 955 | 0.302 | 1416 | 0.448 | 90.9 | 0.029 | 23.45 | 0.007 |
| Total ERM-Q | | | 1.169 | | 1.037 | | 0.380 | | 0.429 |

J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

**TABLE B.5.2**

**ZONE 4 ERM-Q CALCULATIONS**
**LOWER SUBASE FEASIBILITY STUDY**
**NSB-NLON, GROTON, CONNECTICUT**



| **PARAMETER** | **ERM** | ZONE-4 **TRZ4-SD-007 TRZ4-SD-007B-0001 20081106** | | ZONE-4 **TRZ4-SD-008 TRZ4-SD-008A-0204 20081106** | | ZONE-4 **TRZ4-SD-008 TRZ4-SD-008A-0406 20081106** | | ZONE-4 **TRZ4-SD-008 TRZ4-SD-008B-0001 20081106** | |
|---|---|---|---|---|---|---|---|---|---|
| | | **RESULT** | ERM_RATIO | **RESULT** | ERM_RATIO | **RESULT** | ERM_RATIO | **RESULT** | ERM_RATIO |
| ARSENIC (mg/kg) | 70 | 16.4 | 0.234 | 15.3 | 0.219 | 17 | 0.243 | 14.3 | 0.204 |
| CADMIUM (mg/kg) | 9.6 | 0.81 | 0.084 | 0.99 | 0.103 | 1.4 | 0.146 | 0.7 | 0.073 |
| CHROMIUM (mg/kg) | 370 | 91.5 | 0.247 | 86.1 | 0.233 | 100 | 0.270 | 76.9 | 0.208 |
| COPPER (mg/kg) | 270 | 165 J | 0.611 | 141 J | 0.522 | 166 J | 0.615 | 118 J | 0.437 |
| LEAD (mg/kg) | 218 | 148 J | 0.679 | 122 J | 0.560 | 148 J | 0.679 | 105 J | 0.482 |
| NICKEL (mg/kg) | 51.6 | 35.00 J | 0.678 | 36.50 J | 0.707 | 39.70 J | 0.769 | 29.00 J | 0.562 |
| SELENIUM (mg/kg) | 1.4 | 6.5 | 4.643 | 6.6 | 4.714 | 5.7 | 4.071 | 6.3 | 4.500 |
| ZINC (mg/kg) | 410 | 224 J | 0.546 | 211 J | 0.515 | 260 J | 0.634 | 206 J | 0.502 |
| TOTAL PCB CONGENERS (µg/kg) | 180 | 248.2 | 1.379 | 283 | 1.572 | 327.6 | 1.820 | 201.7 | 1.121 |
| ALPHA-CHLORDANE (µg/kg) | 6 | 24 U | 2.000 | 45 U | 3.750 | 6 J | 1.000 | 5 U | 0.417 |
| TOTAL DDT (µg/kg) | 46.1 | 114 | 2.473 | 132 | 2.863 | 89 | 1.931 | 20.7 | 0.449 |
| HIGH MOLECULAR WEIGHT PAHS (µg/kg) | 9600 | 13780 | 1.435 | 7878 | 0.821 | 9680 | 1.008 | 5880 | 0.613 |
| LOW MOLECULAR WEIGHT PAHS (µg/kg) | 3160 | 1724 | 0.546 | 977 | 0.309 | 1870 | 0.592 | 899 | 0.284 |
| Total ERM-Q | | | 1.197 | | 1.299 | | 1.060 | | 0.758 |

J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

TABLE B.5.3

COMPREHENSIVE SEDIMENT ANALYTICAL DATA SET
INNER AND OUTER PIER 1 ERM-Q CALCULATIONS
LOWER SUBASE FEASIBILITY STUDY
NSB-NLON, GROTON, CONNECTICUT



| PARAMETER | ERM | INNER PIER 1<br>SBP-1<br>0 - 0.5 ft<br>SBP-1-GRAB<br>19991028 | INNER PIER 1<br>SBP-2<br>0 - 0.5 ft<br>SBP-2-GRAB<br>19991028 | INNER PIER 1<br>SBP-3<br>0 - 0.5 ft<br>SBP-3-GRAB<br>19991028 | INNER PIER 1<br>SBP-4<br>0 - 0.5 ft<br>SBP-4-GRAB<br>19991028 | INNER PIER 1<br>SBP-4<br>0.75 - 1.0 ft<br>SBP-4-CORE<br>19991028 | OUTER PIER 1<br>SBP-5<br>0 - 0.5 ft<br>SBP-5-GRAB<br>19991028 | OUTER PIER 1<br>SBP-6<br>0 - 0.5 ft<br>SBP-6-GRAB<br>19991028 | OUTER PIER 1<br>SBP-7<br>0 - 0.5 ft<br>SBP-7-GRAB<br>19991028 |
|---|---|---|---|---|---|---|---|---|---|
| **Low Molecular Weight PAHs (µg/kg)** | | | | | | | | | |
| 2-METHYLNAPHTHALENE | | 310 U | 14 | 60 U | 8 | 38 U | 10 | 10 | 69 U |
| ACENAPHTHENE | | 4000 | 64 | 630 | 36 | 74 | 17 | 16 | 300 |
| ACENAPHTHYLENE | | 380 | 140 | 330 | 49 | 80 | 81 | 55 | 79 |
| ANTHRACENE | | 22000 | 780 | 3700 | 290 | 2500 | 250 | 180 | 1300 |
| FLUORENE | | 6100 | 120 | 860 | 43 | 120 | 29 | 24 | 230 |
| NAPHTHALENE | | 310 U | 29 | 93 | 13 | 38 U | 38 | 21 | 69 U |
| PHENANTHRENE | | 65000 | 1300 | 13000 | 1100 | 2900 | 370 | 360 | 5700 |
| LOW MOLECULAR WEIGHT PAHS | 3160 | 97790 | 2447 | 18643 | 1539 | 5712 | 795 | 666 | 7678 |
| **High Molecular Weight PAHs (µg/kg)** | | | | | | | | | |
| BENZO(A)ANTHRACENE | | 22000 | 1500 | 6200 | 910 | 3000 | 630 | 430 | 6300 |
| BENZO(A)PYRENE | | 13000 | 1200 | 3900 | 940 | 2600 | 610 | 390 | 5300 |
| CHRYSENE | | 24000 | 1800 | 8500 | 1300 | 4900 | 730 | 850 | 8200 |
| DIBENZO(A,H)ANTHRACENE | | 1600 | 180 | 580 | 150 | 400 | 89 | 58 | 1000 |
| FLUORANTHENE | | 68000 | 3600 | 18000 | 2200 | 6900 | 1200 | 990 | 12000 |
| PYRENE | | 56000 | 2300 | 15000 | 2100 | 7000 | 810 | 790 | 9400 |
| HIGH MOLECULAR WEIGHT PAHS | 9600 | 184600 | 10580 | 52180 | 7600 | 24800 | 4069 | 3508 | 42200 |
| **Pesticides/PCBs (µg/kg)** | | | | | | | | | |
| 4,4'-DDD | | 16 U | 2.2 U | 2.4 U | 8.1 | 15 U | 1.5 U | 1.5 U | 17 |
| 4,4'-DDE | | 16 U | 2.2 U | 2.4 U | 0.90 U | 15 U | 1.5 U | 1.5 U | 1.4 U |
| 4,4'-DDT | | 16 U | 2.2 U | 2.4 U | 0.90 U | 15 U | 1.5 U | 1.5 U | 1.4 U |
| TOTAL DDT | 46.1 | 24 | 3.3 | 3.6 | 9 | 22.5 | 2.25 | 2.25 | 18.4 |
| PCB-8 | | 16 U | 2.2 U | 2.4 U | 1 U | 15 U | 1.5 U | 1.5 U | 1.4 U |
| PCB-18 | | 16 U | 2.2 U | 2.4 U | 1 U | 15 U | 1.5 U | 1.5 U | 1.4 U |
| PCB-28 | | 16 U | 2.2 U | 2.4 U | 0.99 U | 15 U | 1.5 U | 1.5 U | 1.4 U |
| PCB-44 | | 230 | 2.2 U | 2.4 U | 2.6 U | 15 U | 1.5 U | 1.5 U | 1.4 U |
| PCB-52 | | 340 | 5.2 | 6.9 | 3.2 U | 33 | 1.5 U | 1.5 U | 1.4 U |
| PCB-66 | | 310 | 2.2 U | 9.3 | 3 U | 20 | 1.5 U | 1.5 U | 1.4 U |
| PCB-101 | | 470 | 23 | 86 | 16 | 130 | 6.6 | 2.2 | 18 |
| PCB-105 | | 410 | 4.8 | 24 | 4.8 | 50 | 2.1 | 1.5 U | 1.4 U |
| PCB-118 | | 603 | 13 | 41 | 7.6 U | 92 | 1.5 U | 1.5 U | 1.4 U |
| PCB-128 | | 220 | 2.8 | 6 | 0.90 U | 26 | 1.5 U | 1.5 U | 1.4 U |
| PCB-138 | | 590 | 18 | 52 | 6.8 | 120 | 2.3 | 1.5 U | 1.4 U |
| PCB-153 | | 560 | 10 | 39 | 7.9 | 73 | 3.5 | 1.5 U | 11 |
| PCB-170 | | 84 | 2.2 U | 32 | 2.1 | 15 U | 1.6 | 1.5 U | 1.4 U |
| PCB-180 | | 150 | 2.2 U | 5.2 | 0.90 U | 15 U | 1.5 U | 1.5 U | 1.4 U |
| PCB-187 | | 58 | 2.2 U | 2.4 U | 0.90 U | 15 | 1.5 U | 1.5 U | 1.4 U |
| PCB-195 | | 16 U | 2.2 U | 2.4 U | 0.90 U | 15 U | 1.5 U | 1.5 U | 1.4 U |
| PCB-206 | | 16 U | 2.2 U | 2.4 U | 0.90 U | 15 U | 1.5 U | 1.5 U | 1.4 U |
| PCB-209 | | 16 U | 8 | 59 | 16 | 15 U | 6 | 5 | 42 |
| TOTAL PCB CONGENERS | 180 | 8146 | 191.6 | 737.6 | 131.09 | 1253 | 62.2 | 38.4 | 163 |
| ALPHA-CHLORDANE | 6 | 16 U | 2.2 U | 2.4 U | 0.90 U | 15 U | 1.5 U | 1.5 U | 1.4 U |
| **Inorganics (mg/kg)** | | | | | | | | | |
| ARSENIC | 70 | 16 | 16 | 19 | 14 | 13 | 12 | 13 | 8.3 |
| CADMIUM | 9.6 | 0.94 | 0.88 | 0.64 | 0.34 | 0.39 | 0.5 | 0.42 | 0.91 |
| CHROMIUM | 370 | 130 | 71 | 100 | 58 | 64 | 61 | 58 | 39 |
| COPPER | 270 | 980 | 430 | 870 | 300 | 570 | 120 | 79 | 140 |
| LEAD | 218 | 620 | 290 | 350 | 330 | 350 | 110 | 86 | 100 |
| NICKEL | 51.6 | 130 | 53 | 89 | 56 | 120 | 25 | 22 | 14 |
| SELENIUM | 1.4 | NA | NA | NA | NA | NA | NA | NA | NA |
| ZINC | 410 | 1900 | 690 | 970 | 1200 | 1900 | 220 | 160 | 250 |

B Blank contamination
J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

TABLE B.5.3

COMPREHENSIVE SEDIMENT ANALYTICAL DATA SET
INNER AND OUTER PIER 1 ERM-Q CALCULATIONS
LOWER SUBASE FEASIBILITY STUDY
NSB-NLON, GROTON, CONNECTICUT



| PARAMETER | ERM | INNER PIER 1 P1-48 0 - 0.17 ft CAB-53 20030617 | OUTER PIER 1 P1-50 0 - 0.17 ft CAB-56 20030617 | OUTER PIER 1 P1-53 0 - 0.17 ft CAB-59 20030617 | OUTER PIER 1 P1-55 0 - 0.17 ft CAB-61 20030617 | INNER PIER 1 P1-C2 0 - 2.0 ft DAD-28-0002 20041011 | INNER PIER 1 P1-C2 2.0 - 4.0 ft DAD-28-0204 20041011 | INNER PIER 1 P1-C2 4.0 - 5.0 ft DAD-28-0405 20041011 | OUTER PIER 1 P1-C3 0 - 2.58 ft DAD-29 -0003 20041011 |
|---|---|---|---|---|---|---|---|---|---|
| **Low Molecular Weight PAHs (µg/kg)** | | | | | | | | | |
| 2-METHYLNAPHTHALENE | | 106.03 | 61.97 | 38.23 | 34.64 | 52.19 | 26.55 | 19.18 | 52.41 |
| ACENAPHTHENE | | 2616.45 | 220.72 | 29.04 | 22.79 | 121.15 | 64.73 | 213.17 | 44 |
| ACENAPHTHYLENE | | 64.48 | 64.12 | 27.7 | 21.73 | 74.97 | 40.63 | 16.01 | 175.19 |
| ANTHRACENE | | 9578.41 D | 952.08 | 334.34 | 239.39 | 1116 | 942.73 | 601.02 | 522.33 |
| FLUORENE | | 4166.58 | 355.3 | 67.58 | 48.49 | 192.65 | 123.57 | 83.74 | 105.31 |
| NAPHTHALENE | | 124.23 | 101.48 | 63.81 | 55.34 | 92.79 | 63.33 | 61.61 | 90.5 |
| PHENANTHRENE | | 41362.46 D | 3258.73 | 596.82 | 400.77 | 2317.82 | 1786.14 | 993.49 | 737.51 |
| LOW MOLECULAR WEIGHT PAHS | 3160 | 58018.64 | 5014.4 | 1157.52 | 823.15 | 3967.57 | 3047.68 | 1988.22 | 1727.25 |
| **High Molecular Weight PAHs (µg/kg)** | | | | | | | | | |
| BENZO(A)ANTHRACENE | | 26359.94 D | 4769.39 | 1270.48 | 742.9 | 3865.98 | 2659.19 | 1101.7 | 2238.4 |
| BENZO(A)PYRENE | | 17068.78 D | 3420.77 | 1195.76 | 722.2 | 4329.69 | 2644.52 | 657.17 | 1864.69 |
| CHRYSENE | | 24955.11 D | 5702.15 | 1735.59 | 1025.88 | 4350.83 | 3141.59 | 1147.05 | 2585.02 |
| DIBENZO(A,H)ANTHRACENE | | 2232.49 D | 473.32 | 198.53 | 117.51 | 636.02 | 656.51 | 94.26 | 271.4 |
| FLUORANTHENE | | 79548.58 D | 8369.87 | 2169.83 | 1592.9 | 7427.24 | 4827.17 | 2618.69 | 2864.06 |
| PYRENE | | 61819.33 D | 10927.01 | 1918.82 | 1314.09 | 13809.73 | 9497.79 | 2623.55 | 5269.8 |
| HIGH MOLECULAR WEIGHT PAHS | 9600 | 211984.23 | 33662.51 | 8489.01 | 5515.48 | 34419.49 | 23426.77 | 8242.42 | 15093.37 |
| **Pesticides/PCBs (µg/kg)** | | | | | | | | | |
| 4,4'-DDD | | 78.16 D | 8.39 | 4.91 | 3.33 | 118.8 | 5.04 | 1.08 | 7.49 |
| 4,4'-DDE | | 2.58 | 4.56 | 4.08 | 3.01 | 14.21 J | 3.99 | 0.07 U | 6.46 |
| 4,4'-DDT | | 3.53 | 59.65 D | 3.7 | 0.98 | 3.72 J | 0.19 | 0.06 U | 1.83 |
| TOTAL DDT | 46.1 | 84.27 | 72.6 | 12.69 | 7.32 | 136.73 | 9.22 | 1.145 | 15.78 |
| PCB-8 | | 5.7 | 0.94 U | 0.88 U | 0.82 U | 5.01 NJ | 0.11 U | 0.09 U | 0.50 UJ |
| PCB-18 | | 16.62 | 2.38 | 1.49 | 1.23 | 10.9 J | 1.55 | 0.24 | 1.88 |
| PCB-28 | | 16.14 | 3.79 | 3.68 | 3.82 | 13.52 J | 2.27 | 0.07 U | 5.23 |
| PCB-44 | | 547.5 D | 7.63 | 3.35 | 2.74 | 71.09 | 16.37 | 5.61 | 6.94 |
| PCB-52 | | 1206.27 D | 11.14 | 3.15 | 2.56 | 157.97 | 35.99 | 23.43 | 9.7 |
| PCB-66 | | 245.52 D | 4.86 | 4.14 | 3.83 | 37.53 | 6.61 | 2.29 | 9.18 |
| PCB-101 | | 2096.07 D | 16.81 | 4.42 | 2.77 | 301.58 | 52.16 | 26.53 | 16.08 |
| PCB-105 | | 718.93 D | 7.39 | 2.87 | 2.63 | 99.52 | 12.28 | 7.85 | 5.08 |
| PCB-118 | | 1591.08 D | 14.41 | 4.83 | 3.41 | 244.42 | 44.71 | 21.23 | 11.65 |
| PCB-128 | | 0.37 U | 0.57 U | 0.53 U | 0.50 U | 53.2 | 7.02 | 4.67 | 3.35 |
| PCB-138 | | 1378.02 D | 13.01 | 4.67 | 3.45 | 277.25 | 44.25 | 20.44 | 12.25 |
| PCB-153 | | 1364.96 D | 15.17 | 6.02 | 4.28 | 268.18 | 44.33 | 21.78 | 14.19 |
| PCB-170 | | 138.25 D | 3.2 | 1.87 | 1.33 | 11.31 J | 3.32 | 1.88 | 2.15 |
| PCB-180 | | 176.34 D | 3.76 | 3.28 | 2.67 | 44.77 | 5.47 | 2.92 | 4.33 |
| PCB-187 | | 78.91 D | 2.52 | 2.16 | 1.66 | 9.32 J | 2.89 | 1.6 | 3.4 |
| PCB-195 | | 6.97 | 2.74 | 1.61 | 1.3 | NA | NA | NA | NA |
| PCB-206 | | 4.62 | 6.2 | 2.04 | 2.11 | 1.67 J | 0.81 | 0.95 | 1.63 |
| PCB-209 | | 3.21 | 16.03 | 3.13 | 3.16 | 1.08 J | 0.82 | 0.46 | 2.65 |
| TOTAL PCB CONGENERS | 180 | 19190.59 | 263.59 | 106.83 | 87.22 | 3218.64 | 563.81 | 285.92 | 221.88 |
| ALPHA-CHLORDANE | 6 | 3.78 D | 0.89 | 1.2 | 0.54 J | 14.54 J | 0.9 | 0.06 U | 1.81 |
| **Inorganics (mg/kg)** | | | | | | | | | |
| ARSENIC | 70 | 15.5 | 15.2 | 14.4 | 14.6 | 8.66 | 6.08 | 6.23 | 11.6 |
| CADMIUM | 9.6 | 1.13 | 0.733 | 0.413 | 0.436 | 1.82 | 0.401 | 0.020 U | 0.734 |
| CHROMIUM | 370 | 250 B | 98.9 B | 94.7 B | 93.5 B | 112 | 62 | 68.4 | 101 |
| COPPER | 270 | 1630 | 136 | 84 | 74 | 624 | 503 | 231 J | 203 |
| LEAD | 218 | 1130 | 140 | 94 | 88 | 399 J | 230 J | 415 J | 165 J |
| NICKEL | 51.6 | 316 | 31.6 | 28.6 | 30.4 | 93.2 J | 28.12 J | 53.2 | 42.27 J |
| SELENIUM | 1.4 | 2.23 | 0.969 | 0.827 | 0.868 | 1.03 | 0.252 | 0.444 | 0.828 |
| ZINC | 410 | 3180 B | 300 B | 167 B | 149 B | 1744 J | 573 J | 2300 | 368 J |

B Blank contamination
J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

TABLE B.5.3

COMPREHENSIVE SEDIMENT ANALYTICAL DATA SET
INNER AND OUTER PIER 1 ERM-Q CALCULATIONS
LOWER SUBASE FEASIBILITY STUDY
NSB-NLON, GROTON, CONNECTICUT



| PARAMETER | ERM | OUTER PIER 1<br>P1-C4<br>0 - 2.0 ft<br>DAD-30-0002<br>20041011 | OUTER PIER 1<br>P1-C5<br>2.0 - 4.0 ft<br>DAD-31-0204<br>20041011 | OUTER PIER 1<br>P1-C5<br>4.0 - 6.0 ft<br>DAD-31-0406<br>20041011 | INNER PIER 1<br>P1<br>0 - 1.0 ft<br>DAD-20<br>20041012 | INNER PIER 1<br>P1-C1<br>0 - 1.0 ft<br>DAD-27<br>20041012 | OUTER PIER 1<br>P2<br>0 - 1.0 ft<br>DAD-21<br>20041012 | OUTER PIER 1<br>P3<br>0 - 1.0 ft<br>DAD-22<br>20041012 | OUTER PIER 1<br>P4<br>0 - 1.0 ft<br>DAD-23<br>20041012 |
|---|---|---|---|---|---|---|---|---|---|
| **Low Molecular Weight PAHs (µg/kg)** | | | | | | | | | |
| 2-METHYLNAPHTHALENE | | 30.61 | 86.52 | 83.48 | 1122.56 | 40.17 | 49.47 | 46.58 | 41.23 |
| ACENAPHTHENE | | 54.02 | 111.71 | 127.88 | 19264.51 | 396.85 | 39.46 | 33.72 | 40.27 |
| ACENAPHTHYLENE | | 92.39 | 151.18 | 83.75 | 199.99 | 106.04 | 210.73 | 171.51 | 175.84 |
| ANTHRACENE | | 380.23 | 447.88 | 474.39 | 106693.76 | 5628.99 | 3194.92 | 685.4 | 806 |
| FLUORENE | | 86.29 | 201.38 | 224.3 | 30848.56 | 740.55 | 216.3 | 101.04 | 110.99 |
| NAPHTHALENE | | 60.26 | 129.53 | 136.18 | 2397.65 | 79.33 | 72.91 | 72.96 | 81.95 |
| PHENANTHRENE | | 822.69 | 985.24 | 877.34 | 305756.05 | 10987.62 | 1264.24 | 883.87 | 852.09 |
| LOW MOLECULAR WEIGHT PAHS | 3160 | 1526.49 | 2113.44 | 2007.32 | 466283.08 | 17979.55 | 5048.03 | 1995.08 | 2108.37 |
| **High Molecular Weight PAHs (µg/kg)** | | | | | | | | | |
| BENZO(A)ANTHRACENE | | 1167.16 | 1325.63 | 908.78 | 143323.46 | 17586.11 | 4037.05 | 2013.88 | 2810.79 |
| BENZO(A)PYRENE | | 1510.91 | 1374.96 | 828.52 | 88770.69 | 13934.4 | 2957.26 | 2069.45 | 2472.81 |
| CHRYSENE | | 1635.16 | 1692.79 | 1047.95 | 136491.42 | 17333.41 | 5542.68 | 3113.26 | 4328.2 |
| DIBENZO(A,H)ANTHRACENE | | 233.45 | 216.24 | 137.37 | 11119.14 | 1849.28 | 459.88 | 301.32 | 376.36 |
| FLUORANTHENE | | 2422.82 | 3997.81 | 2604.65 | 499501.99 | 41012.43 | 5468.48 | 2965.52 | 4095.51 |
| PYRENE | | 4123.02 | 3534.56 | 2652.9 | 375349.34 | 35029.09 | 6238.28 | 3273.45 | 4287.16 J |
| HIGH MOLECULAR WEIGHT PAHS | 9600 | 11092.52 | 12141.99 | 8180.17 | 1254556.04 | 126744.72 | 24703.63 | 13736.88 | 18370.83 |
| **Pesticides/PCBs (µg/kg)** | | | | | | | | | |
| 4,4'-DDD | | 72.23 | 12.16 | 19.69 | 2.79 J | 59.15 | 3.09 | 5.74 | 2.58 J |
| 4,4'-DDE | | 17.96 | 11.04 | 13.05 | 10.21 J | 0.11 U | 3.98 | 5.83 | 3.69 J |
| 4,4'-DDT | | 31.41 | 3.46 | 1.02 | 0.09 U | 0.74 J | 2.16 | 7.34 | 1.67 J |
| TOTAL DDT | 46.1 | 121.6 | 26.66 | 33.76 | 13.045 | 59.945 | 9.23 | 18.91 | 7.94 |
| PCB-8 | | 15.52 U | 7.04 NJ | 2.5 NJ | 0.13 U | 2.12 NJ | 0.23 U | 0.49 U | 0.21 U |
| PCB-18 | | 11 U | 10.81 | 10.89 | 0.09 U | 2.96 J | 0.95 | 0.35 U | 1.16 J |
| PCB-28 | | 11.62 U | 18.93 | 18.86 | 7.72 J | 4.49 J | 2.96 | 2.95 | 3.45 J |
| PCB-44 | | 20.68 | 17.16 | 17.67 | 334.21 | 119.58 | 3.58 | 3.84 | 4.13 J |
| PCB-52 | | 16.81 | 22.02 | 23.21 | 772.95 | 285.58 | 3.98 | 4.29 | 5.12 J |
| PCB-66 | | 20.54 | 23.61 | 20.97 | 163.84 | 60.06 | 5.88 | 5.3 | 5.65 J |
| PCB-101 | | 33.7 | 31.94 | 24.13 | 1197.92 | 443.53 | 7.84 | 6.77 | 8.04 J |
| PCB-105 | | 10.36 U | 9.78 | 8.64 | 359.91 | 157.22 | 4.52 | 2.42 | 4.61 J |
| PCB-118 | | 21.11 | 21.94 | 18.68 | 950.37 | 381.95 | 4.75 | 6.02 | 5.21 J |
| PCB-128 | | 9.37 U | 8.81 | 5.09 | 164.16 | 75.03 | 1.98 | 2.69 | 1.81 J |
| PCB-138 | | 24.8 | 23.54 | 18 | 778.77 | 353.52 | 4.94 | 6.62 | 5.19 J |
| PCB-153 | | 29.57 | 28.01 | 22.4 | 848.93 | 341.84 | 5.69 | 7.93 | 6.13 J |
| PCB-170 | | 13.04 U | 5.46 | 3.43 | 5.29 J | 10.54 J | 1 | 1.27 | 1.07 J |
| PCB-180 | | 12.92 U | 11.02 | 7.87 | 0.11 U | 52.62 | 2.12 | 2.77 | 2.07 J |
| PCB-187 | | 11.29 U | 8.07 | 5.17 | 2.39 J | 7.48 J | 2.05 | 2.84 | 1.86 J |
| PCB-195 | | NA | NA | NA | NA | NA | NA | NA | NA |
| PCB-206 | | 13.05 U | 4.33 | 3.87 | 0.11 U | 0.58 J | 0.59 | 0.86 | 0.87 J |
| PCB-209 | | 13.44 U | 4.02 | 3.78 | 0.11 U | 0.58 J | 0.89 | 2.47 | 1.5 J |
| TOTAL PCB CONGENERS | 180 | 456.03 | 512.98 | 430.32 | 11173.47 | 4599.36 | 107.67 | 118.92 | 115.95 |
| ALPHA-CHLORDANE | 6 | 21.2 | 4.45 | 2.5 | 4.61 J | 2.16 J | 0.66 | 1 | 0.71 J |
| **Inorganics (mg/kg)** | | | | | | | | | |
| ARSENIC | 70 | 7.22 | 12.9 | 10.3 | 15.6 | 20.2 | 12.7 | 12.5 | 13.1 |
| CADMIUM | 9.6 | 0.746 | 1.88 | 1.84 | 0.020 U | 0.598 | 0.6 | 0.501 | 0.563 |
| CHROMIUM | 370 | 73.8 | 123 | 111 | 406 | 254 | 92 | 78.9 | 89.6 |
| COPPER | 270 | 261 | 180 | 142 | 2590 J | 2019 J | 120 | 102 | 136 J |
| LEAD | 218 | 157 J | 165 J | 147 J | 2834 J | 2435 J | 111 | 90.8 | 123 J |
| NICKEL | 51.6 | 30.70 J | 56.0 J | 35.60 J | 1048 | 294 | 27.12 | 25.11 | 28.95 |
| SELENIUM | 1.4 | 0.541 | 0.885 | 0.794 | 3.2 | 1.82 | 0.624 J | 0.630 J | 0.722 |
| ZINC | 410 | 706 J | 405 J | 281 J | 13740 | 3742 | 262 | 207 | 261 |

B Blank contamination
J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

TABLE B.5.3

COMPREHENSIVE SEDIMENT ANALYTICAL DATA SET
INNER AND OUTER PIER 1 ERM-Q CALCULATIONS
LOWER SUBASE FEASIBILITY STUDY
NSB-NLON, GROTON, CONNECTICUT



| PARAMETER | ERM | OUTER PIER 1<br>P4R<br>0 - 1.0 ft<br>DAD-23-D<br>20041012 | OUTER PIER 1<br>P5<br>0 - 1.0 ft<br>DAD-25<br>20041012 | OUTER PIER 1<br>P6<br>0 - 1.0 ft<br>DAD-26<br>20041012 | OUTER PIER 1<br>TRP1-SD-001<br>0 - 1.0 ft<br>TRP1-SD-001B-0001<br>20081106 | OUTER PIER 1<br>TRP1-SD-001<br>2.0 - 4.0 ft<br>TRP1-SD-001A-0204<br>20081106 | OUTER PIER 1<br>TRP1-SD-001<br>4.0 - 6.0 ft<br>TRP1-SD-001A-0406<br>20081106 | OUTER PIER 1<br>TRP1-SD-002<br>0 - 1.0 ft<br>TRP1-SD-002B-0001<br>20081107 |
|---|---|---|---|---|---|---|---|---|
| **Low Molecular Weight PAHs (µg/kg)** | | | | | | | | |
| 2-METHYLNAPHTHALENE | | 51.96 | 46.47 | 29.22 J | 28 | 49 | 50 | 20 |
| ACENAPHTHENE | | 49.76 | 45.12 | 66.65 | 40 | 92 | 77 | 31 |
| ACENAPHTHYLENE | | 232.75 | 96 | 161.48 J | 290 | 340 | 180 | 220 |
| ANTHRACENE | | 1143.91 J | 561.83 | 788.56 J | 780 | 960 | 590 | 380 |
| FLUORENE | | 126.51 | 122.98 | 148.73 | 110 | 220 | 130 | 76 |
| NAPHTHALENE | | 65.35 | 77.62 | 40.42 J | 49 | 85 | 71 | 30 |
| PHENANTHRENE | | 953.66 J | 1218.22 | 1929.12 | 450 | 890 | 470 | 330 |
| LOW MOLECULAR WEIGHT PAHS | 3160 | 2623.9 | 2168.24 | 3164.18 | 1747 | 2636 | 1568 | 1087 |
| **High Molecular Weight PAHs (µg/kg)** | | | | | | | | |
| BENZO(A)ANTHRACENE | | 2888.87 J | 2004.52 | 3292.41 J | 2900 | 2100 | 1400 | 1200 |
| BENZO(A)PYRENE | | 2665.4 J | 1243.82 | 1954.41 J | 1900 | 1600 | 1100 | 1400 |
| CHRYSENE | | 4166.44 J | 2080.32 | 3797.91 | 3800 | 2700 | 1700 | 1600 |
| DIBENZO(A,H)ANTHRACENE | | 363.71 | 160.14 | 220.56 J | 220 | 230 | 140 | 160 |
| FLUORANTHENE | | 5039.17 J | 4301.28 | 7992.24 | 1400 | 4200 | 3800 | 1700 |
| PYRENE | | 3848.12 J | 3961.3 | 6207.26 J | 6000 | 5100 | 2800 | 2800 |
| HIGH MOLECULAR WEIGHT PAHS | 9600 | 18971.71 | 13751.38 | 23464.79 | 16220 | 15930 | 10940 | 8860 |
| **Pesticides/PCBs (µg/kg)** | | | | | | | | |
| 4,4'-DDD | | 2.83 | 7.96 | 1.49 J | 5.7 U | 15 U | 6.2 U | 7.8 U |
| 4,4'-DDE | | 4.41 | 4.14 | 3.02 J | 5.7 U | 39 | 7.5 | 7.8 U |
| 4,4'-DDT | | 2.78 | 2.22 | 0.14 U | 7 J | 72 J | 6.2 U | 12 R |
| TOTAL DDT | 46.1 | 10.02 | 14.32 | 4.58 | 12.7 | 118.5 | 13.7 | 7.8 |
| PCB-8 | | 0.58 U | 0.67 NJ | 0.19 U | 4.8 J | 6 J | 1.8 U | 4.1 J |
| PCB-18 | | 1.14 | 1.62 | 0.14 U | 7.3 J | 3.2 J | 1.8 U | 4.4 J |
| PCB-28 | | 3.22 | 2.83 | 2.7 J | 15 J | 6.7 J | 1.8 U | 9.5 J |
| PCB-44 | | 3.64 | 5.21 | 3.21 J | 6.6 J | 6.8 J | 1.8 U | 2.7 R |
| PCB-52 | | 2.88 | 9.29 | 3.11 J | 16 J | 19 J | 6.6 J | 2.7 R |
| PCB-66 | | 5.71 | 4.46 | 3.34 J | 14 J | 2.2 U | 1.8 U | 2.4 U |
| PCB-101 | | 5.29 | 16.02 | 3.96 J | 16 | 12 J | 3.3 R | 6.2 J |
| PCB-105 | | 1.44 | 3.85 | 1.43 J | 4.1 J | 7.9 J | 3.2 J | 2.4 U |
| PCB-118 | | 3.51 | 9.75 | 2.78 J | 13 J | 13 J | 6.3 J | 8.6 J |
| PCB-128 | | 2.01 | 2.87 | 2.02 J | 2.2 U | 2.2 U | 1.8 U | 2.4 U |
| PCB-138 | | 3.78 | 10.37 | 3.02 J | 13 J | 12 J | 7.3 J | 6.5 J |
| PCB-153 | | 4.75 | 13.27 | 3.75 J | 13 J | 14 | 9.4 J | 6.1 J |
| PCB-170 | | 1.09 | 1.8 | 1.14 J | 2.2 U | 5.6 J | 3.5 R | 2.4 U |
| PCB-180 | | 1.94 | 3.72 | 1.8 J | 6.5 J | 7.5 J | 3.3 R | 2.7 J |
| PCB-187 | | 2.37 | 2.39 | 2.42 J | 2.2 R | 3.1 J | 1.9 J | 2.5 |
| PCB-195 | | NA | NA | NA | 2.2 U | 2.2 U | 1.8 U | 2.4 U |
| PCB-206 | | 0.85 | 1.74 | 0.54 J | 4.4 | 7.8 | 15 | 2.4 U |
| PCB-209 | | 2.18 | 2.37 | 1.17 J | 7.5 J | 14 J | 18 | 2.4 U |
| TOTAL PCB CONGENERS | 180 | 92.18 | 184.46 | 73.11 | 289 | 283.8 | 148 | 118 |
| ALPHA-CHLORDANE | 6 | 0.83 | 1.11 | 0.96 J | 2.9 U | 7.6 U | 3.2 U | 4 U |
| **Inorganics (mg/kg)** | | | | | | | | |
| ARSENIC | 70 | 14.8 | 15.3 | 14.1 | 12.10 J | 9.50 J | 8.40 J | 16.40 J |
| CADMIUM | 9.6 | 0.532 | 0.41 | 0.439 | 0.820 J | 1.10 J | 1.50 J | 0.600 J |
| CHROMIUM | 370 | 84.6 | 88.6 | 76.7 | 78.8 J | 88.8 J | 98.4 J | 68.7 J |
| COPPER | 270 | 82.9 | 76.5 | 95.2 J | 260 J | 182 J | 142 J | 205 J |
| LEAD | 218 | 83.8 | 78.9 | 295 J | 204 J | 157 J | 210 J | 144 J |
| NICKEL | 51.6 | 25.46 | 26.48 | 26.03 | 51.6 J | 27.60 J | 18.90 J | 31.60 J |
| SELENIUM | 1.4 | 0.727 J | 0.805 J | 0.833 | 5.50 U | 5.10 U | 4.80 U | 5.3 |
| ZINC | 410 | 199 | 183 | 218 | 457 J | 283 J | 208 J | 261 J |

B Blank contamination
J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

TABLE B.5.3

COMPREHENSIVE SEDIMENT ANALYTICAL DATA SET
INNER AND OUTER PIER 1 ERM-Q CALCULATIONS
LOWER SUBASE FEASIBILITY STUDY
NSB-NLON, GROTON, CONNECTICUT



| PARAMETER | ERM | OUTER PIER 1 TRP1-SD-002 2.0 - 4.0 ft TRP1-SD-002A-0204 20081107 | OUTER PIER 1 TRP1-SD-002 4.0 - 6.0 ft TRP1-SD-002A-0406 20081107 | OUTER PIER 1 TRP1-SD-003 0 - 1.0 ft TRP1-SD-003B-0001 20081107 | OUTER PIER 1 TRP1-SD-003 2.0 - 4.0 ft TRP1-SD-003A-0204 20081107 | OUTER PIER 1 TRP1-SD-004 0 - 1.0 ft TRP1-SD-004B-0001 20081107 | OUTER PIER 1 TRP1-SD-004 2.0 - 4.0 ft TRP1-SD-004A-0204 20081107 | OUTER PIER 1 TRP1-SD-004 4.0 - 6.0 ft TRP1-SD-004A-0406 20081107 |
|---|---|---|---|---|---|---|---|---|
| **Low Molecular Weight PAHs (µg/kg)** | | | | | | | | |
| 2-METHYLNAPHTHALENE | | 58 | 150 | 23 | 24 | 15 | 53 | 65 |
| ACENAPHTHENE | | 110 | 660 | 32 | 20 | 100 | 790 | 450 |
| ACENAPHTHYLENE | | 560 | 360 | 220 | 120 | 180 | 150 | 140 |
| ANTHRACENE | | 1900 | 1500 | 430 | 150 | 390 | 480 | 620 |
| FLUORENE | | 310 | 600 J | 78 | 45 | 85 | 690 | 520 J |
| NAPHTHALENE | | 80 | 250 | 36 | 31 | 24 | 55 | 74 |
| PHENANTHRENE | | 1700 | 1900 | 450 | 210 | 420 | 1700 | 2000 |
| LOW MOLECULAR WEIGHT PAHS | 3160 | 4718 | 5420 | 1269 | 600 | 1214 | 3918 | 3869 |
| **High Molecular Weight PAHs (µg/kg)** | | | | | | | | |
| BENZO(A)ANTHRACENE | | 4500 | 2400 | 1000 | 350 | 1700 | 1100 | 1100 |
| BENZO(A)PYRENE | | 3100 | 1900 | 1300 | 390 | 1100 | 620 | 720 |
| CHRYSENE | | 6100 | 3000 | 1500 | 430 | 1700 | 1200 | 1200 |
| DIBENZO(A,H)ANTHRACENE | | 370 | 220 | 170 | 68 | 130 | 110 | 97 |
| FLUORANTHENE | | 8900 | 8500 | 1700 | 600 | 3100 | 3400 | 4100 |
| PYRENE | | 9400 | 6400 | 2600 | 1400 | 3600 | 3200 | 2800 |
| HIGH MOLECULAR WEIGHT PAHS | 9600 | 32370 | 22420 | 8270 | 3238 | 11330 | 9630 | 10017 |
| **Pesticides/PCBs (µg/kg)** | | | | | | | | |
| 4,4'-DDD | | 3.6 J | 14 U | 4.5 U | 3.8 J | 1.8 U | 14 UJ | 65 J |
| 4,4'-DDE | | 5.8 J | 14 J | 4.5 U | 3.8 J | 3.6 J | 14 UJ | 12 U |
| 4,4'-DDT | | 13 J | 29 J | 7.2 R | 5.8 R | 2.8 R | 18 J | 32 R |
| TOTAL DDT | 46.1 | 22.4 | 50 | 4.5 | 7.6 | 4.5 | 32 | 71 |
| PCB-8 | | 3 J | 7 J | 2.7 J | 1.5 U | 2.6 U | 3.7 R | 3.5 J |
| PCB-18 | | 6.8 | 18 J | 5.6 J | 1.5 U | 2.6 U | 7.4 J | 1.7 U |
| PCB-28 | | 14 J | 25 J | 16 J | 1.7 J | 2.6 UJ | 13 J | 1.7 U |
| PCB-44 | | 7.5 J | 22 | 9.9 | 1.7 | 2.6 U | 9.1 J | 1.7 U |
| PCB-52 | | 17 | 35 | 15 J | 4.9 | 2.6 UJ | 19 J | 3.6 |
| PCB-66 | | 2.1 U | 26 J | 9.2 J | 1.5 U | 2.6 U | 9.3 R | 1.7 U |
| PCB-101 | | 17 | 48 | 16 | 5.6 | 2.6 U | 28 | 2.8 R |
| PCB-105 | | 5 J | 16 J | 4.1 J | 2.1 J | 2.6 U | 8.2 J | 3 J |
| PCB-118 | | 12 J | 30 J | 9.9 J | 3.8 J | 8.3 J | 16 J | 5.2 J |
| PCB-128 | | 2.1 U | 4.7 R | 2.2 U | 1.5 U | 2.6 U | 2.3 R | 1.7 U |
| PCB-138 | | 13 J | 38 J | 12 J | 5.2 J | 2.6 U | 20 J | 6.2 J |
| PCB-153 | | 13 | 36 | 12 | 5.2 J | 2.6 U | 21 J | 8.1 J |
| PCB-170 | | 3 R | 12 J | 3.7 R | 5 J | 2.6 U | 5.6 R | 2.6 R |
| PCB-180 | | 8 | 21 J | 3 J | 3.5 J | 2.6 U | 14 J | 2.7 J |
| PCB-187 | | 3.6 J | 5.8 J | 2.2 U | 1.5 U | 2.6 UJ | 3.6 J | 1.7 U |
| PCB-195 | | 2.1 U | 2.4 | 2.2 U | 1.5 U | 2.6 U | 2 U | 1.7 U |
| PCB-206 | | 3.9 J | 9.4 J | 3.8 R | 5.8 J | 2.6 UJ | 6.2 J | 12 J |
| PCB-209 | | 3.1 J | 2.7 R | 5.6 J | 6.7 J | 2.6 UJ | 2 U | 12 J |
| TOTAL PCB CONGENERS | 180 | 260.1 | 703.2 | 248.6 | 111.4 | 60.8 | 335 | 124.5 |
| ALPHA-CHLORDANE | 6 | 1.1 J | 7.2 U | 2.3 U | 0.54 U | 0.91 U | 7 U | 6.1 U |
| **Inorganics (mg/kg)** | | | | | | | | |
| ARSENIC | 70 | 13.00 J | 9.90 J | 15.00 J | 5.10 J | 13.80 J | 12 | 7.9 |
| CADMIUM | 9.6 | 0.850 J | 3.30 J | 0.650 J | 0.730 J | 0.650 J | 2.30 J | 1.30 J |
| CHROMIUM | 370 | 84.6 J | 110 J | 62.2 J | 61.7 J | 71.0 J | 121 J | 96.8 J |
| COPPER | 270 | 519 J | 197 J | 106 J | 62.1 J | 130 J | 203 J | 207 J |
| LEAD | 218 | 298 J | 501 J | 97.9 J | 95.4 J | 119 J | 260 J | 192 J |
| NICKEL | 51.6 | 124 J | 32.50 J | 26.60 J | 12.70 J | 27.50 J | 28.00 J | 17.70 J |
| SELENIUM | 1.4 | 6.8 | 5 | 4.7 | 2.4 | 6.5 | 5.2 | 3.7 |
| ZINC | 410 | 1130 J | 601 J | 212 J | 221 J | 230 J | 418 J | 324 J |

B Blank contamination
J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

TABLE B.5.3

COMPREHENSIVE SEDIMENT ANALYTICAL DATA SET
INNER AND OUTER PIER 1 ERM-Q CALCULATIONS
LOWER SUBASE FEASIBILITY STUDY
NSB-NLON, GROTON, CONNECTICUT



| PARAMETER | ERM | OUTER PIER 1<br>TRP1-SD-005<br>0 - 1.0 ft<br>TRP1-SD-005B-0001<br>20081107 | OUTER PIER 1<br>TRP1-SD-005<br>2.0 - 4.0 ft<br>TRP1-SD-005A-0204<br>20081107 | OUTER PIER 1<br>TRP1-SD-005<br>4.0 - 6.0 ft<br>TRP1-SD-005A-0406<br>20081107 | OUTER PIER 1<br>TRP1-SD-006<br>0 - 1.0 ft<br>TRP1-SD-006B-0001<br>20081107 | OUTER PIER 1<br>TRP1-SD-006<br>2.0 - 3.0 ft<br>TRP1-SD-006A-0203<br>20081107 | OUTER PIER 1<br>TRP1-SD-007<br>0 - 1.0 ft<br>TRP1-SD-007B-0001<br>20081106 | OUTER PIER 1<br>TRP1-SD-007<br>2.0 - 4.0 ft<br>TRP1-SD-007A-0204<br>20081106 |
|---|---|---|---|---|---|---|---|---|
| **Low Molecular Weight PAHs (µg/kg)** | | | | | | | | |
| 2-METHYLNAPHTHALENE | | 19 | 45 | 270 | 51 | 140 | 60 | 20 |
| ACENAPHTHENE | | 110 | 140 | 620 | 290 | 1500 | 490 | 30 |
| ACENAPHTHYLENE | | 170 | 340 | 560 | 120 | 250 | 760 | 170 |
| ANTHRACENE | | 620 | 1300 | 3000 | 260 | 1400 | 3100 | 330 |
| FLUORENE | | 140 | 300 | 450 | 180 | 1400 | 800 | 59 |
| NAPHTHALENE | | 21 | 320 | 2700 | 120 | 210 | 51 | 22 |
| PHENANTHRENE | | 630 | 1400 | 2200 | 760 | 5700 | 2400 | 430 |
| LOW MOLECULAR WEIGHT PAHS | 3160 | 1710 | 3845 | 9800 | 1781 | 10600 | 7661 | 1061 |
| **High Molecular Weight PAHs (µg/kg)** | | | | | | | | |
| BENZO(A)ANTHRACENE | | 1700 | 4700 | 8700 | 660 | 3100 | 12000 | 960 |
| BENZO(A)PYRENE | | 1200 | 2300 | 4400 | 470 | 1200 | 5300 | 980 |
| CHRYSENE | | 1900 | 4400 | 8300 | 790 | 3300 | 13000 | 1200 |
| DIBENZO(A,H)ANTHRACENE | | 150 | 280 | 450 | 76 | 140 | 710 J | 170 |
| FLUORANTHENE | | 4100 | 16000 | 23000 | 2600 | 15000 | 52000 | 1500 |
| PYRENE | | 3000 | 11000 | 19000 | 2000 | 8600 | 36000 | 2800 |
| HIGH MOLECULAR WEIGHT PAHS | 9600 | 12050 | 38680 | 63850 | 6596 | 31340 | 119010 | 7610 |
| **Pesticides/PCBs (µg/kg)** | | | | | | | | |
| 4,4'-DDD | | 1.6 U | 6.9 U | 6.7 U | 1.7 U | 7.4 U | 6.5 UJ | 4.8 U |
| 4,4'-DDE | | 1.6 U | 6.9 U | 10 J | 1.2 J | 7.4 U | 19 | 12 |
| 4,4'-DDT | | 1.6 U | 6.9 U | 20 | 1.7 UJ | 7.4 U | 59 J | 22 J |
| TOTAL DDT | 46.1 | 2.4 | 10.35 | 33.35 | 2.9 | 11.1 | 81.25 | 36.4 |
| PCB-8 | | 5.9 J | 9.5 J | 2 U | 3.9 R | 2.3 U | 2.7 R | 2.3 |
| PCB-18 | | 6.9 | 9.5 R | 2 U | 31 | 3 | 15 J | 3.9 J |
| PCB-28 | | 2.5 U | 14 J | 2 UJ | 23 J | 4.1 R | 3.3 R | 10 J |
| PCB-44 | | 3.9 J | 9.6 J | 2 U | 8.7 J | 2.3 U | 6.1 J | 9.2 |
| PCB-52 | | 2.5 U | 13 J | 2 UJ | 9.9 J | 2.3 U | 7.1 J | 18 J |
| PCB-66 | | 2.5 U | 2.1 U | 2 U | 4.8 R | 3 R | 2.5 U | 1.7 U |
| PCB-101 | | 3.3 R | 8.9 J | 2 U | 7.6 J | 4.2 R | 8.1 | 24 J |
| PCB-105 | | 2.5 U | 2.1 U | 2 U | 2.6 J | 2.3 U | 4.5 J | 6.9 J |
| PCB-118 | | 5.8 J | 5.8 J | 4.9 J | 8.3 J | 5 J | 18 J | 15 J |
| PCB-128 | | 2.5 U | 2.1 U | 2 U | 2.5 U | 2.3 U | 2.5 U | 2.6 J |
| PCB-138 | | 3.8 | 6 | 2 U | 5.3 J | 5.6 | 10 | 17 J |
| PCB-153 | | 3.3 J | 6 | 2 U | 6.3 J | 3.6 J | 7.5 J | 16 J |
| PCB-170 | | 2.5 U | 2.1 U | 2 U | 3.6 J | 2.3 U | 4.8 | 2.4 J |
| PCB-180 | | 2.5 U | 4.9 J | 2 U | 2.8 J | 2.3 J | 4.4 J | 4.6 J |
| PCB-187 | | 2.5 U | 2.1 U | 2 UJ | 2.5 U | 2.3 U | 2.5 UJ | 1.7 UJ |
| PCB-195 | | 2.5 U | 2.1 U | 2 U | 2.5 U | 2.3 U | 2.5 U | 1.7 U |
| PCB-206 | | 2.7 | 2.7 | 2 UJ | 3 J | 2.3 U | 2.5 U | 1.8 J |
| PCB-209 | | 2.5 U | 2.1 U | 2 UJ | 2.5 U | 2.3 U | 45 J | 1.7 U |
| TOTAL PCB CONGENERS | 180 | 89.6 | 175.5 | 43.8 | 234.2 | 62 | 273.5 | 274.2 |
| ALPHA-CHLORDANE | 6 | 0.84 U | 3.6 U | 3.5 U | 0.88 U | 3.8 U | 3.4 U | 2.5 U |
| **Inorganics (mg/kg)** | | | | | | | | |
| ARSENIC | 70 | 8.3 | 10.2 | 8.7 | 12.90 J | 12.80 J | 15.60 J | 18.40 J |
| CADMIUM | 9.6 | 0.380 J | 0.470 J | 1.30 J | 0.480 J | 1.00 J | 0.540 J | 1.10 J |
| CHROMIUM | 370 | 40.10 J | 42.60 J | 113 J | 62.7 J | 60.4 J | 76.3 J | 167 J |
| COPPER | 270 | 64.9 J | 78.7 J | 201 J | 80.6 J | 463 J | 791 J | 1600 J |
| LEAD | 218 | 79.8 J | 62.1 J | 253 J | 88.4 J | 80.8 J | 192 J | 1170 J |
| NICKEL | 51.6 | 16.40 J | 18.90 J | 51.3 J | 25.80 J | 28.70 J | 40.3 | 482 |
| SELENIUM | 1.4 | 1.8 | 1.5 | 3.5 | 5.90 U | 4.50 U | 7.6 | 14.6 |
| ZINC | 410 | 108 J | 111 J | 669 J | 156 J | 341 J | 410 J | 4660 J |

B Blank contamination
J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

TABLE B.5.3

COMPREHENSIVE SEDIMENT ANALYTICAL DATA SET
INNER AND OUTER PIER 1 ERM-Q CALCULATIONS
LOWER SUBASE FEASIBILITY STUDY
NSB-NLON, GROTON, CONNECTICUT



| PARAMETER | ERM | OUTER PIER 1 TRP1-SD-007 4.0 - 6.0 ft TRP1-SD-007A-0406 20081106 | OUTER PIER 1 TRP1-SD-008 0 - 1.0 ft TRP1-SD-008B-0001 20081105 | OUTER PIER 1 TRP1-SD-008 2.0 - 4.0 ft TRP1-SD-008A-0204 20081105 | OUTER PIER 1 TRP1-SD-008 4.0 - 6.0 ft TRP1-SD-008A-0406 20081105 | OUTER PIER 1 TRP1-SD-009 0 - 1.0 ft TRP1-SD-009B-0001 20081105 | OUTER PIER 1 TRP1-SD-009 2.0 - 4.0 ft TRP1-SD-009A-0204 20081105 | OUTER PIER 1 TRP1-SD-009 4.0 - 6.0 ft TRP1-SD-009A-0406 20081105 |
|---|---|---|---|---|---|---|---|---|
| **Low Molecular Weight PAHs (µg/kg)** | | | | | | | | |
| 2-METHYLNAPHTHALENE | | 51 | 31 | 78 | 35 | 16 | 21 | 32 |
| ACENAPHTHENE | | 2100 | 150 | 4900 | 250 | 32 | 600 | 290 |
| ACENAPHTHYLENE | | 230 | 440 | 490 | 260 | 150 | 150 | 180 |
| ANTHRACENE | | 2300 | 1200 | 2700 | 620 | 480 | 660 | 750 |
| FLUORENE | | 1500 | 240 | 2300 | 200 | 77 | 280 | 340 |
| NAPHTHALENE | | 59 | 34 | 120 | 94 | 21 | 24 | 41 |
| PHENANTHRENE | | 6800 | 1200 | 4600 | 1100 | 520 | 650 | 2200 |
| LOW MOLECULAR WEIGHT PAHS | 3160 | 13040 | 3295 | 15188 | 2559 | 1296 | 2385 | 3833 |
| **High Molecular Weight PAHs (µg/kg)** | | | | | | | | |
| BENZO(A)ANTHRACENE | | 3800 | 3300 | 5100 | 2000 | 1600 | 2100 | 1700 |
| BENZO(A)PYRENE | | 2700 | 2400 | 2700 | 1700 | 1100 | 1100 | 1200 |
| CHRYSENE | | 4700 | 4100 | 6100 | 2400 | 1800 | 2100 | 2000 |
| DIBENZO(A,H)ANTHRACENE | | 640 | 370 | 450 J | 280 | 160 | 150 | 180 |
| FLUORANTHENE | | 14000 | 7800 | 21000 | 4500 | 1800 | 6400 | 4900 |
| PYRENE | | 12000 | 6100 | 16000 | 4700 | 3200 | 4200 | 3900 |
| HIGH MOLECULAR WEIGHT PAHS | 9600 | 37840 | 24070 | 51350 | 15580 | 9660 | 16050 | 13880 |
| **Pesticides/PCBs (µg/kg)** | | | | | | | | |
| 4,4'-DDD | | 18 J | 2.1 U | 1.8 U | 7.7 J | 8.2 UJ | 3.4 UJ | 3 U |
| 4,4'-DDE | | 27 J | 2.1 U | 3 J | 6.6 U | 8.4 J | 3.4 U | 3 U |
| 4,4'-DDT | | 36 J | 2.1 UJ | 12 J | 21 J | 27 J | 3.4 UJ | 3 UJ |
| TOTAL DDT | 46.1 | 81 | 3.15 | 15.9 | 32 | 39.5 | 5.1 | 4.5 |
| PCB-8 | | 5.6 J | 3 U | 14 R | 8.6 J | 2.5 U | 4.9 J | 4.6 J |
| PCB-18 | | 11 | 7.2 | 23 R | 8.2 | 9.3 | 13 J | 6.4 |
| PCB-28 | | 17 J | 3.6 R | 17 J | 18 | 18 | 18 | 17 |
| PCB-44 | | 19 | 7.7 J | 34 | 13 | 14 | 18 | 9.2 J |
| PCB-52 | | 34 | 5.8 R | 79 | 30 J | 27 | 15 J | 23 J |
| PCB-66 | | 1.8 U | 13 | 2.7 U | 2.5 U | 2.5 U | 7.2 J | 2.2 U |
| PCB-101 | | 47 | 9.1 J | 100 J | 43 J | 38 | 10 J | 41 |
| PCB-105 | | 17 J | 3 U | 39 J | 12 J | 11 J | 3.3 J | 18 J |
| PCB-118 | | 75 J | 19 J | 140 J | 57 J | 48 J | 17 J | 76 J |
| PCB-128 | | 5.4 J | 3 U | 13 J | 3.8 J | 3.7 J | 2.5 U | 8.3 J |
| PCB-138 | | 39 J | 8.2 | 79 J | 28 J | 26 J | 8.8 J | 47 J |
| PCB-153 | | 33 J | 7.7 | 63 J | 28 | 25 | 8.6 | 38 |
| PCB-170 | | 11 J | 3 U | 10 J | 4.1 J | 3.9 J | 2.7 R | 7.4 J |
| PCB-180 | | 13 J | 3.6 J | 14 J | 8.6 | 7 J | 3.8 J | 9.1 J |
| PCB-187 | | 3.5 J | 3 UJ | 3.4 R | 2.7 R | 2.5 UJ | 2.5 UJ | 2.2 UJ |
| PCB-195 | | 1.9 J | 3 U | 2.7 U | 2.5 U | 2.5 U | 2.5 U | 2.2 U |
| PCB-206 | | 5 J | 4.7 J | 2.7 U | 3.5 J | 3.8 J | 3.2 J | 2.7 J |
| PCB-209 | | 1.8 U | 3 U | 2.7 U | 2.5 U | 2.5 U | 2.5 U | 2.2 U |
| TOTAL PCB CONGENERS | 180 | 678.4 | 181.4 | 1186.8 | 539.1 | 481.9 | 271.6 | 624.2 |
| ALPHA-CHLORDANE | 6 | 2.5 U | 1.1 U | 0.91 U | 3.4 U | 4.2 U | 1.8 U | 1.6 U |
| **Inorganics (mg/kg)** | | | | | | | | |
| ARSENIC | 70 | 23.30 J | 15.40 J | 13.40 J | 12.90 J | 10.30 J | 15.80 J | 12.30 J |
| CADMIUM | 9.6 | 3.00 J | 0.450 J | 0.830 J | 0.890 J | 1.00 J | 0.700 J | 1.20 J |
| CHROMIUM | 370 | 142 J | 66.9 J | 130 J | 93.7 J | 84.3 J | 82.9 J | 95.5 J |
| COPPER | 270 | 8620 J | 226 J | 1010 J | 576 J | 190 J | 181 J | 255 J |
| LEAD | 218 | 661 J | 148 J | 690 J | 416 J | 228 J | 139 J | 228 J |
| NICKEL | 51.6 | 188 | 28.4 | 278 | 127 | 41.5 | 38.8 | 57.1 |
| SELENIUM | 1.4 | 9.8 | 6.9 | 8.6 | 7.9 | 4.7 | 6.3 | 6.1 |
| ZINC | 410 | 2640 J | 257 J | 2470 J | 1200 J | 387 J | 249 J | 433 J |

B Blank contamination
J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

TABLE B.5.3

COMPREHENSIVE SEDIMENT ANALYTICAL DATA SET
INNER AND OUTER PIER 1 ERM-Q CALCULATIONS
LOWER SUBASE FEASIBILITY STUDY
NSB-NLON, GROTON, CONNECTICUT



| PARAMETER | ERM | OUTER PIER 1<br>TRP1-SD-010<br>0 - 1.0 ft<br>TRP1-SD-010B-0001<br>20081105 | OUTER PIER 1<br>TRP1-SD-010<br>2.0 - 4.0 ft<br>TRP1-SD-010A-0204<br>20081105 | OUTER PIER 1<br>TRP1-SD-010<br>4.0 - 6.0 ft<br>TRP1-SD-010A-0406<br>20081105 |
|---|---|---|---|---|
| **Low Molecular Weight PAHs (µg/kg)** | | | | |
| 2-METHYLNAPHTHALENE | | 21 | 19 | 49 |
| ACENAPHTHENE | | 31 | 82 | 220 |
| ACENAPHTHYLENE | | 180 | 140 | 120 |
| ANTHRACENE | | 410 | 840 | 770 |
| FLUORENE | | 71 | 170 | 320 |
| NAPHTHALENE | | 16 | 19 | 130 |
| PHENANTHRENE | | 670 | 2800 | 2300 |
| LOW MOLECULAR WEIGHT PAHS | 3160 | 1399 | 4070 | 3909 |
| **High Molecular Weight PAHs (µg/kg)** | | | | |
| BENZO(A)ANTHRACENE | | 950 | 1600 | 2100 |
| BENZO(A)PYRENE | | 930 | 1200 | 1600 |
| CHRYSENE | | 1300 | 1700 | 2400 |
| DIBENZO(A,H)ANTHRACENE | | 180 | 190 | 240 |
| FLUORANTHENE | | 1800 | 5300 | 7000 |
| PYRENE | | 3200 | 4700 | 5900 |
| HIGH MOLECULAR WEIGHT PAHS | 9600 | 8360 | 14690 | 19240 |
| **Pesticides/PCBs (µg/kg)** | | | | |
| 4,4'-DDD | | 8.5 UJ | 2 U | 6.2 U |
| 4,4'-DDE | | 8.5 U | 5 R | 35 R |
| 4,4'-DDT | | 12 R | 9.3 J | 33 J |
| TOTAL DDT | 46.1 | 8.5 | 10.3 | 36.1 |
| PCB-8 | | 2.8 R | 4.5 J | 6.7 J |
| PCB-18 | | 3.5 | 5.2 | 12 |
| PCB-28 | | 3.1 R | 8.3 | 18 |
| PCB-44 | | 13 J | 8.1 | 20 |
| PCB-52 | | 5.2 R | 19 | 46 |
| PCB-66 | | 13 | 1.5 U | 2.9 R |
| PCB-101 | | 9.2 J | 31 | 82 |
| PCB-105 | | 2.8 | 9.5 J | 21 J |
| PCB-118 | | 15 J | 47 J | 93 J |
| PCB-128 | | 2.5 U | 2.9 J | 6.8 J |
| PCB-138 | | 12 | 20 J | 47 J |
| PCB-153 | | 5.5 | 19 | 40 J |
| PCB-170 | | 2.5 U | 5.1 J | 13 J |
| PCB-180 | | 2.5 J | 5.5 J | 12 J |
| PCB-187 | | 2.5 UJ | 1.8 R | 3.6 R |
| PCB-195 | | 2.5 U | 1.5 U | 1.9 U |
| PCB-206 | | 2.5 U | 2.2 | 6.3 |
| PCB-209 | | 2.5 U | 1.5 U | 2.4 R |
| TOTAL PCB CONGENERS | 180 | 168 | 379.1 | 849.5 |
| ALPHA-CHLORDANE | 6 | 4.4 U | 1 U | 3.2 U |
| **Inorganics (mg/kg)** | | | | |
| ARSENIC | 70 | 12.40 J | 12.00 J | 14.50 J |
| CADMIUM | 9.6 | 0.470 J | 1.50 J | 1.90 J |
| CHROMIUM | 370 | 56.8 J | 101 J | 88.9 J |
| COPPER | 270 | 201 J | 670 J | 625 J |
| LEAD | 218 | 163 J | 665 J | 327 J |
| NICKEL | 51.6 | 30.9 | 146 | 67.9 |
| SELENIUM | 1.4 | 4.3 | 5.6 | 6 |
| ZINC | 410 | 356 J | 1860 J | 975 J |

B Blank contamination
J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

**TABLE B.5.4**

**INNER AND OUTER PIER 1 ERM-Q CALCULATIONS**
**LOWER SUBASE FEASIBILITY STUDY**
**NSB-NLON, GROTON, CONNECTICUT**



| PARAMETER | ERM | INNER PIER 1 SBP-1 SBP-1-GRAB 19991028 | | INNER PIER 1 SBP-2 SBP-2-GRAB 19991028 | | INNER PIER 1 SBP-3 SBP-3-GRAB 19991028 | | INNER PIER 1 SBP-4 SBP-4-CORE 19991028 | |
|---|---|---|---|---|---|---|---|---|---|
| | | RESULT | ERM_RATIO | RESULT | ERM_RATIO | RESULT | ERM_RATIO | RESULT | ERM_RATIO |
| ARSENIC (mg/kg) | 70 | 16 | 0.229 | 16 | 0.229 | 19 | 0.271 | 13 | 0.186 |
| CADMIUM (mg/kg) | 9.6 | 0.94 | 0.098 | 0.88 | 0.092 | 0.64 | 0.067 | 0.39 | 0.041 |
| CHROMIUM (mg/kg) | 370 | 130 | 0.351 | 71 | 0.192 | 100 | 0.270 | 64 | 0.173 |
| COPPER (mg/kg) | 270 | 980 | 3.630 | 430 | 1.593 | 870 | 3.222 | 570 | 2.111 |
| LEAD (mg/kg) | 218 | 620 | 2.844 | 290 | 1.330 | 350 | 1.606 | 350 | 1.606 |
| NICKEL (mg/kg) | 51.6 | 130 | 2.519 | 53 | 1.027 | 89 | 1.725 | 120 | 2.326 |
| SELENIUM (mg/kg) | 1.4 | NA | NA | NA | NA | NA | NA | NA | NA |
| ZINC (mg/kg) | 410 | 1900 | 4.634 | 690 | 1.683 | 970 | 2.366 | 1900 | 4.634 |
| TOTAL PCB CONGENERS (µg/kg) | 180 | 8146 | 45.256 | 191.6 | 1.064 | 737.6 | 4.098 | 1253 | 6.961 |
| ALPHA-CHLORDANE (µg/kg) | 6 | 16 U | 1.333 | 2.2 U | 0.183 | 2.4 U | 0.200 | 15 U | 1.250 |
| TOTAL DDT (µg/kg) | 46.1 | 24 | 0.521 | 3.3 | 0.072 | 3.6 | 0.078 | 22.5 | 0.488 |
| HIGH MOLECULAR WEIGHT PAHs (µg/kg) | 9600 | 184600 | 19.229 | 10580 | 1.102 | 52180 | 5.435 | 24800 | 2.583 |
| LOW MOLECULAR WEIGHT PAHs (µg/kg) | 3160 | 97790 | 30.946 | 2447 | 0.774 | 18643 | 5.900 | 5712 | 1.808 |
| Total ERM-Q | | | 9.299 | | 0.778 | | 2.103 | | 2.014 |

J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

**TABLE B.5.4**

**INNER AND OUTER PIER 1 ERM-Q CALCULATIONS**
**LOWER SUBASE FEASIBILITY STUDY**
**NSB-NLON, GROTON, CONNECTICUT**



| PARAMETER | ERM | INNER PIER 1 SBP-4 SBP-4-GRAB 19991028 | | OUTER PIER 1 SBP-5 SBP-5-GRAB 19991028 | | OUTER PIER 1 SBP-6 SBP-6-GRAB 19991028 | | OUTER PIER 1 SBP-7 SBP-7-GRAB 19991028 | |
|---|---|---|---|---|---|---|---|---|---|
| | | RESULT | ERM_RATIO | RESULT | ERM_RATIO | RESULT | ERM_RATIO | RESULT | ERM_RATIO |
| ARSENIC (mg/kg) | 70 | 14 | 0.200 | 12 | 0.171 | 13 | 0.186 | 8.3 | 0.119 |
| CADMIUM (mg/kg) | 9.6 | 0.34 | 0.035 | 0.5 | 0.052 | 0.42 | 0.044 | 0.91 | 0.095 |
| CHROMIUM (mg/kg) | 370 | 58 | 0.157 | 61 | 0.165 | 58 | 0.157 | 39 | 0.105 |
| COPPER (mg/kg) | 270 | 300 | 1.111 | 120 | 0.444 | 79 | 0.293 | 140 | 0.519 |
| LEAD (mg/kg) | 218 | 330 | 1.514 | 110 | 0.505 | 86 | 0.394 | 100 | 0.459 |
| NICKEL (mg/kg) | 51.6 | 56 | 1.085 | 25 | 0.484 | 22 | 0.426 | 14 | 0.271 |
| SELENIUM (mg/kg) | 1.4 | NA | NA | NA | NA | NA | NA | NA | NA |
| ZINC (mg/kg) | 410 | 1200 | 2.927 | 220 | 0.537 | 160 | 0.390 | 250 | 0.610 |
| TOTAL PCB CONGENERS (µg/kg) | 180 | 131.09 | 0.728 | 62.2 | 0.346 | 38.4 | 0.213 | 163 | 0.906 |
| ALPHA-CHLORDANE (µg/kg) | 6 | 0.90 U | 0.075 | 1.5 U | 0.125 | 1.5 U | 0.125 | 1.4 U | 0.117 |
| TOTAL DDT (µg/kg) | 46.1 | 9 | 0.195 | 2.25 | 0.049 | 2.25 | 0.049 | 18.4 | 0.399 |
| HIGH MOLECULAR WEIGHT PAHs (µg/kg) | 9600 | 7600 | 0.792 | 4069 | 0.424 | 3508 | 0.365 | 42200 | 4.396 |
| LOW MOLECULAR WEIGHT PAHs (µg/kg) | 3160 | 1539 | 0.487 | 795 | 0.252 | 666 | 0.211 | 7678 | 2.430 |
| Total ERM-Q | | | 0.776 | | 0.296 | | 0.238 | | 0.869 |

J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

**TABLE B.5.4**

**INNER AND OUTER PIER 1 ERM-Q CALCULATIONS**
**LOWER SUBASE FEASIBILITY STUDY**
**NSB-NLON, GROTON, CONNECTICUT**



| **PARAMETER** | **ERM** | INNER PIER 1 **P1-48 CAB-53 20030617** | | OUTER PIER 1 **P1-50 CAB-56 20030617** | | OUTER PIER 1 **P1-53 CAB-59 20030617** | | OUTER PIER 1 **P1-55 CAB-61 20030617** | |
|---|---|---|---|---|---|---|---|---|---|
| | | **RESULT** | ERM_RATIO | **RESULT** | ERM_RATIO | **RESULT** | ERM_RATIO | **RESULT** | ERM_RATIO |
| ARSENIC (mg/kg) | 70 | 15.5 | 0.221 | 15.2 | 0.217 | 14.4 | 0.206 | 14.6 | 0.209 |
| CADMIUM (mg/kg) | 9.6 | 1.13 | 0.118 | 0.733 | 0.076 | 0.413 | 0.043 | 0.436 | 0.045 |
| CHROMIUM (mg/kg) | 370 | 250 B | 0.676 | 98.9 B | 0.267 | 94.7 B | 0.256 | 93.5 B | 0.253 |
| COPPER (mg/kg) | 270 | 1630 | 6.037 | 136 | 0.504 | 84 | 0.311 | 74 | 0.274 |
| LEAD (mg/kg) | 218 | 1130 | 5.183 | 140 | 0.642 | 94 | 0.431 | 88 | 0.404 |
| NICKEL (mg/kg) | 51.6 | 316 | 6.124 | 31.6 | 0.612 | 28.6 | 0.554 | 30.4 | 0.589 |
| SELENIUM (mg/kg) | 1.4 | 2.23 | 1.593 | 0.969 | 0.692 | 0.827 | 0.591 | 0.868 | 0.620 |
| ZINC (mg/kg) | 410 | 3180 B | 7.756 | 300 B | 0.732 | 167 B | 0.407 | 149 B | 0.363 |
| TOTAL PCB CONGENERS (µg/kg) | 180 | 19190.59 | 106.614 | 263.59 | 1.464 | 106.83 | 0.594 | 87.22 | 0.485 |
| ALPHA-CHLORDANE (µg/kg) | 6 | 3.78 D | 0.630 | 0.89 | 0.148 | 1.2 | 0.200 | 0.54 J | 0.090 |
| TOTAL DDT (µg/kg) | 46.1 | 84.27 | 1.828 | 72.6 | 1.575 | 12.69 | 0.275 | 7.32 | 0.159 |
| HIGH MOLECULAR WEIGHT PAHs (µg/kg) | 9600 | 211984.23 | 22.082 | 33662.51 | 3.507 | 8489.01 | 0.884 | 5515.48 | 0.575 |
| LOW MOLECULAR WEIGHT PAHs (µg/kg) | 3160 | 58018.64 | 18.360 | 5014.4 | 1.587 | 1157.52 | 0.366 | 823.15 | 0.260 |
| Total ERM-Q | | | 13.633 | | 0.925 | | 0.394 | | 0.333 |

J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

**TABLE B.5.4**

**INNER AND OUTER PIER 1 ERM-Q CALCULATIONS**
**LOWER SUBASE FEASIBILITY STUDY**
**NSB-NLON, GROTON, CONNECTICUT**



| **PARAMETER** | **ERM** | INNER PIER 1 **P1-C2 DAD-28-0002 20041011** | | INNER PIER 1 **P1-C2 DAD-28-0204 20041011** | | INNER PIER 1 **P1-C2 DAD-28-0405 20041011** | | OUTER PIER 1 **P1-C3 DAD-29 -0003 20041011** | |
|---|---|---|---|---|---|---|---|---|---|
| | | **RESULT** | ERM_RATIO | **RESULT** | ERM_RATIO | **RESULT** | ERM_RATIO | **RESULT** | ERM_RATIO |
| ARSENIC (mg/kg) | 70 | 8.66 | 0.124 | 6.08 | 0.087 | 6.23 | 0.089 | 11.6 | 0.166 |
| CADMIUM (mg/kg) | 9.6 | 1.82 | 0.190 | 0.401 | 0.042 | 0.020 U | 0.001 | 0.734 | 0.076 |
| CHROMIUM (mg/kg) | 370 | 112 | 0.303 | 62 | 0.168 | 68.4 | 0.185 | 101 | 0.273 |
| COPPER (mg/kg) | 270 | 624 | 2.311 | 503 | 1.863 | 231 J | 0.856 | 203 | 0.752 |
| LEAD (mg/kg) | 218 | 399 J | 1.830 | 230 J | 1.055 | 415 J | 1.904 | 165 J | 0.757 |
| NICKEL (mg/kg) | 51.6 | 93.2 J | 1.806 | 28.12 J | 0.545 | 53.2 | 1.031 | 42.27 J | 0.819 |
| SELENIUM (mg/kg) | 1.4 | 1.03 | 0.736 | 0.252 | 0.180 | 0.444 | 0.317 | 0.828 | 0.591 |
| ZINC (mg/kg) | 410 | 1744 J | 4.254 | 573 J | 1.398 | 2300 | 5.610 | 368 J | 0.898 |
| TOTAL PCB CONGENERS (µg/kg) | 180 | 3216.64 | 17.881 | 561.81 | 3.132 | 283.92 | 1.588 | 219.88 | 1.233 |
| ALPHA-CHLORDANE (µg/kg) | 6 | 14.54 J | 2.423 | 0.9 | 0.150 | 0.06 U | 0.005 | 1.81 | 0.302 |
| TOTAL DDT (µg/kg) | 46.1 | 136.73 | 2.966 | 9.22 | 0.200 | 1.145 | 0.025 | 15.78 | 0.342 |
| HIGH MOLECULAR WEIGHT PAHs (µg/kg) | 9600 | 34419.49 | 3.585 | 23426.77 | 2.440 | 8242.42 | 0.859 | 15093.37 | 1.572 |
| LOW MOLECULAR WEIGHT PAHs (µg/kg) | 3160 | 3967.57 | 1.256 | 3047.68 | 0.964 | 1988.22 | 0.629 | 1727.25 | 0.547 |
| Total ERM-Q | | | 3.050 | | 0.939 | | 1.007 | | 0.640 |

J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

**TABLE B.5.4**

**INNER AND OUTER PIER 1 ERM-Q CALCULATIONS**
**LOWER SUBASE FEASIBILITY STUDY**
**NSB-NLON, GROTON, CONNECTICUT**



| PARAMETER | ERM | OUTER PIER 1 P1-C4 DAD-30-0002 20041011 | | OUTER PIER 1 P1-C5 DAD-31-0204 20041011 | | OUTER PIER 1 P1-C5 DAD-31-0406 20041011 | | INNER PIER 1 P1 DAD-20 20041012 | |
|---|---|---|---|---|---|---|---|---|---|
| | | RESULT | ERM_RATIO | RESULT | ERM_RATIO | RESULT | ERM_RATIO | RESULT | ERM_RATIO |
| ARSENIC (mg/kg) | 70 | 7.22 | 0.103 | 12.9 | 0.184 | 10.3 | 0.147 | 15.6 | 0.223 |
| CADMIUM (mg/kg) | 9.6 | 0.746 | 0.078 | 1.88 | 0.196 | 1.84 | 0.192 | 0.020 U | 0.001 |
| CHROMIUM (mg/kg) | 370 | 73.8 | 0.199 | 123 | 0.332 | 111 | 0.300 | 406 | 1.097 |
| COPPER (mg/kg) | 270 | 261 | 0.967 | 180 | 0.667 | 142 | 0.526 | 2590 J | 9.593 |
| LEAD (mg/kg) | 218 | 157 J | 0.720 | 165 J | 0.757 | 147 J | 0.674 | 2834 J | 13.000 |
| NICKEL (mg/kg) | 51.6 | 30.70 J | 0.595 | 56.0 J | 1.085 | 35.60 J | 0.690 | 1048 | 20.310 |
| SELENIUM (mg/kg) | 1.4 | 0.541 | 0.386 | 0.885 | 0.632 | 0.794 | 0.567 | 3.2 | 2.286 |
| ZINC (mg/kg) | 410 | 706 J | 1.722 | 405 J | 0.988 | 281 J | 0.685 | 13740 | 33.512 |
| TOTAL PCB CONGENERS (µg/kg) | 180 | 456.03 | 2.545 | 512.98 | 2.861 | 430.32 | 2.402 | 11173.47 | 62.086 |
| ALPHA-CHLORDANE (µg/kg) | 6 | 21.2 | 3.533 | 4.45 | 0.742 | 2.5 | 0.417 | 4.61 J | 0.768 |
| TOTAL DDT (µg/kg) | 46.1 | 121.6 | 2.638 | 26.66 | 0.578 | 33.76 | 0.732 | 13.045 | 0.283 |
| HIGH MOLECULAR WEIGHT PAHs (µg/kg) | 9600 | 11092.52 | 1.155 | 12141.99 | 1.265 | 8180.17 | 0.852 | 1254556.04 | 130.683 |
| LOW MOLECULAR WEIGHT PAHs (µg/kg) | 3160 | 1526.49 | 0.483 | 2113.44 | 0.669 | 2007.32 | 0.635 | 466283.08 | 147.558 |
| Total ERM-Q | | | 1.163 | | 0.842 | | 0.678 | | 32.415 |

J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

**TABLE B.5.4**

**INNER AND OUTER PIER 1 ERM-Q CALCULATIONS**
**LOWER SUBASE FEASIBILITY STUDY**
**NSB-NLON, GROTON, CONNECTICUT**



| PARAMETER | ERM | INNER PIER 1 P1-C1 DAD-27 20041012 | | OUTER PIER 1 P2 DAD-21 20041012 | | OUTER PIER 1 P3 DAD-22 20041012 | | OUTER PIER 1 P4 DAD-23 20041012 | |
|---|---|---|---|---|---|---|---|---|---|
| | | RESULT | ERM_RATIO | RESULT | ERM_RATIO | RESULT | ERM_RATIO | RESULT | ERM_RATIO |
| ARSENIC (mg/kg) | 70 | 20.2 | 0.289 | 12.7 | 0.181 | 12.5 | 0.179 | 13.1 | 0.187 |
| CADMIUM (mg/kg) | 9.6 | 0.598 | 0.062 | 0.6 | 0.063 | 0.501 | 0.052 | 0.563 | 0.059 |
| CHROMIUM (mg/kg) | 370 | 254 | 0.686 | 92 | 0.249 | 78.9 | 0.213 | 89.6 | 0.242 |
| COPPER (mg/kg) | 270 | 2019 J | 7.478 | 120 | 0.444 | 102 | 0.378 | 136 J | 0.504 |
| LEAD (mg/kg) | 218 | 2435 J | 11.170 | 111 | 0.509 | 90.8 | 0.417 | 123 J | 0.564 |
| NICKEL (mg/kg) | 51.6 | 294 | 5.698 | 27.12 | 0.526 | 25.11 | 0.487 | 28.95 | 0.561 |
| SELENIUM (mg/kg) | 1.4 | 1.82 | 1.300 | 0.624 J | 0.446 | 0.630 J | 0.450 | 0.722 | 0.516 |
| ZINC (mg/kg) | 410 | 3742 | 9.127 | 262 | 0.639 | 207 | 0.505 | 261 | 0.637 |
| TOTAL PCB CONGENERS (µg/kg) | 180 | 4599.36 | 25.563 | 107.67 | 0.609 | 118.92 | 0.672 | 115.95 | 0.655 |
| ALPHA-CHLORDANE (µg/kg) | 6 | 2.16 J | 0.360 | 0.66 | 0.110 | 1 | 0.167 | 0.71 J | 0.118 |
| TOTAL DDT (µg/kg) | 46.1 | 59.945 | 1.300 | 9.23 | 0.200 | 18.91 | 0.410 | 7.94 | 0.172 |
| HIGH MOLECULAR WEIGHT PAHs (µg/kg) | 9600 | 126744.72 | 13.203 | 24703.63 | 2.573 | 13736.88 | 1.431 | 18370.83 | 1.914 |
| LOW MOLECULAR WEIGHT PAHs (µg/kg) | 3160 | 17979.55 | 5.690 | 5048.03 | 1.597 | 1995.08 | 0.631 | 2108.37 | 0.667 |
| Total ERM-Q | | | 6.301 | | 0.626 | | 0.460 | | 0.522 |

J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

**TABLE B.5.4**

**INNER AND OUTER PIER 1 ERM-Q CALCULATIONS**
**LOWER SUBASE FEASIBILITY STUDY**
**NSB-NLON, GROTON, CONNECTICUT**



| PARAMETER | ERM | OUTER PIER 1 P4R DAD-23-D 20041012 | | OUTER PIER 1 P5 DAD-25 20041012 | | OUTER PIER 1 P6 DAD-26 20041012 | | OUTER PIER 1 TRP1-SD-001 TRP1-SD-001B-0001 20081106 | |
|---|---|---|---|---|---|---|---|---|---|
| | | RESULT | ERM_RATIO | RESULT | ERM_RATIO | RESULT | ERM_RATIO | RESULT | ERM_RATIO |
| ARSENIC (mg/kg) | 70 | 14.8 | 0.211 | 15.3 | 0.219 | 14.1 | 0.201 | 12.10 J | 0.173 |
| CADMIUM (mg/kg) | 9.6 | 0.532 | 0.055 | 0.41 | 0.043 | 0.439 | 0.046 | 0.820 J | 0.085 |
| CHROMIUM (mg/kg) | 370 | 84.6 | 0.229 | 88.6 | 0.239 | 76.7 | 0.207 | 78.8 J | 0.213 |
| COPPER (mg/kg) | 270 | 82.9 | 0.307 | 76.5 | 0.283 | 95.2 J | 0.353 | 260 J | 0.963 |
| LEAD (mg/kg) | 218 | 83.8 | 0.384 | 78.9 | 0.362 | 295 J | 1.353 | 204 J | 0.936 |
| NICKEL (mg/kg) | 51.6 | 25.46 | 0.493 | 26.48 | 0.513 | 26.03 | 0.504 | 51.6 J | 1.000 |
| SELENIUM (mg/kg) | 1.4 | 0.727 J | 0.519 | 0.805 J | 0.575 | 0.833 | 0.595 | 5.50 U | 1.964 |
| ZINC (mg/kg) | 410 | 199 | 0.485 | 183 | 0.446 | 218 | 0.532 | 457 J | 1.115 |
| TOTAL PCB CONGENERS (µg/kg) | 180 | 92.18 | 0.523 | 184.46 | 1.036 | 73.11 | 0.417 | 289 | 1.606 |
| ALPHA-CHLORDANE (µg/kg) | 6 | 0.83 | 0.138 | 1.11 | 0.185 | 0.96 J | 0.160 | 2.9 U | 0.242 |
| TOTAL DDT (µg/kg) | 46.1 | 10.02 | 0.217 | 14.32 | 0.311 | 4.58 | 0.099 | 12.7 | 0.275 |
| HIGH MOLECULAR WEIGHT PAHs (µg/kg) | 9600 | 18971.71 | 1.976 | 13751.38 | 1.432 | 23464.79 | 2.444 | 16220 | 1.690 |
| LOW MOLECULAR WEIGHT PAHs (µg/kg) | 3160 | 2623.9 | 0.830 | 2168.24 | 0.686 | 3164.18 | 1.001 | 1747 | 0.553 |
| Total ERM-Q | | | 0.489 | | 0.486 | | 0.608 | | 0.832 |

J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

**TABLE B.5.4**

**INNER AND OUTER PIER 1 ERM-Q CALCULATIONS**
**LOWER SUBASE FEASIBILITY STUDY**
**NSB-NLON, GROTON, CONNECTICUT**



| PARAMETER | ERM | OUTER PIER 1 TRP1-SD-001 TRP1-SD-001A-0204 20081106 | | OUTER PIER 1 TRP1-SD-001 TRP1-SD-001A-0406 20081106 | | OUTER PIER 1 TRP1-SD-002 TRP1-SD-002B-0001 20081107 | | OUTER PIER 1 TRP1-SD-002 TRP1-SD-002A-0204 20081107 | |
|---|---|---|---|---|---|---|---|---|---|
| | | RESULT | ERM_RATIO | RESULT | ERM_RATIO | RESULT | ERM_RATIO | RESULT | ERM_RATIO |
| ARSENIC (mg/kg) | 70 | 9.50 J | 0.136 | 8.40 J | 0.120 | 16.40 J | 0.234 | 13.00 J | 0.186 |
| CADMIUM (mg/kg) | 9.6 | 1.10 J | 0.115 | 1.50 J | 0.156 | 0.600 J | 0.063 | 0.850 J | 0.089 |
| CHROMIUM (mg/kg) | 370 | 88.8 J | 0.240 | 98.4 J | 0.266 | 68.7 J | 0.186 | 84.6 J | 0.229 |
| COPPER (mg/kg) | 270 | 182 J | 0.674 | 142 J | 0.526 | 205 J | 0.759 | 519 J | 1.922 |
| LEAD (mg/kg) | 218 | 157 J | 0.720 | 210 J | 0.963 | 144 J | 0.661 | 298 J | 1.367 |
| NICKEL (mg/kg) | 51.6 | 27.60 J | 0.535 | 18.90 J | 0.366 | 31.60 J | 0.612 | 124 J | 2.403 |
| SELENIUM (mg/kg) | 1.4 | 5.10 U | 1.821 | 4.80 U | 1.714 | 5.3 | 3.786 | 6.8 | 4.857 |
| ZINC (mg/kg) | 410 | 283 J | 0.690 | 208 J | 0.507 | 261 J | 0.637 | 1130 J | 2.756 |
| TOTAL PCB CONGENERS (µg/kg) | 180 | 283.8 | 1.577 | 148 | 0.822 | 118 | 0.656 | 260.1 | 1.445 |
| ALPHA-CHLORDANE (µg/kg) | 6 | 7.6 U | 0.633 | 3.2 U | 0.267 | 4 U | 0.333 | 1.1 J | 0.183 |
| TOTAL DDT (µg/kg) | 46.1 | 118.5 | 2.570 | 13.7 | 0.297 | 7.8 | 0.169 | 22.4 | 0.486 |
| HIGH MOLECULAR WEIGHT PAHs (µg/kg) | 9600 | 15930 | 1.659 | 10940 | 1.140 | 8860 | 0.923 | 32370 | 3.372 |
| LOW MOLECULAR WEIGHT PAHs (µg/kg) | 3160 | 2636 | 0.834 | 1568 | 0.496 | 1087 | 0.344 | 4718 | 1.493 |
| Total ERM-Q | | | 0.939 | | 0.588 | | 0.720 | | 1.599 |

J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

**TABLE B.5.4**

**INNER AND OUTER PIER 1 ERM-Q CALCULATIONS**
**LOWER SUBASE FEASIBILITY STUDY**
**NSB-NLON, GROTON, CONNECTICUT**



| **PARAMETER** | **ERM** | OUTER PIER 1 **TRP1-SD-002 TRP1-SD-002A-0406 20081107** | | OUTER PIER 1 **TRP1-SD-003 TRP1-SD-003B-0001 20081107** | | OUTER PIER 1 **TRP1-SD-003 TRP1-SD-003A-0204 20081107** | | OUTER PIER 1 **TRP1-SD-004 TRP1-SD-004B-0001 20081107** | |
|---|---|---|---|---|---|---|---|---|---|
| | | **RESULT** | ERM_RATIO | **RESULT** | ERM_RATIO | **RESULT** | ERM_RATIO | **RESULT** | ERM_RATIO |
| ARSENIC (mg/kg) | 70 | 9.90 J | 0.141 | 15.00 J | 0.214 | 5.10 J | 0.073 | 13.80 J | 0.197 |
| CADMIUM (mg/kg) | 9.6 | 3.30 J | 0.344 | 0.650 J | 0.068 | 0.730 J | 0.076 | 0.650 J | 0.068 |
| CHROMIUM (mg/kg) | 370 | 110 J | 0.297 | 62.2 J | 0.168 | 61.7 J | 0.167 | 71.0 J | 0.192 |
| COPPER (mg/kg) | 270 | 197 J | 0.730 | 106 J | 0.393 | 62.1 J | 0.230 | 130 J | 0.481 |
| LEAD (mg/kg) | 218 | 501 J | 2.298 | 97.9 J | 0.449 | 95.4 J | 0.438 | 119 J | 0.546 |
| NICKEL (mg/kg) | 51.6 | 32.50 J | 0.630 | 26.60 J | 0.516 | 12.70 J | 0.246 | 27.50 J | 0.533 |
| SELENIUM (mg/kg) | 1.4 | 5 | 3.571 | 4.7 | 3.357 | 2.4 | 1.714 | 6.5 | 4.643 |
| ZINC (mg/kg) | 410 | 601 J | 1.466 | 212 J | 0.517 | 221 J | 0.539 | 230 J | 0.561 |
| TOTAL PCB CONGENERS (µg/kg) | 180 | 703.2 | 3.907 | 248.6 | 1.381 | 111.4 | 0.619 | 60.8 | 0.338 |
| ALPHA-CHLORDANE (µg/kg) | 6 | 7.2 U | 0.600 | 2.3 U | 0.192 | 0.54 U | 0.045 | 0.91 U | 0.076 |
| TOTAL DDT (µg/kg) | 46.1 | 50 | 1.085 | 4.5 | 0.098 | 7.6 | 0.165 | 4.5 | 0.098 |
| HIGH MOLECULAR WEIGHT PAHs (µg/kg) | 9600 | 22420 | 2.335 | 8270 | 0.861 | 3238 | 0.337 | 11330 | 1.180 |
| LOW MOLECULAR WEIGHT PAHs (µg/kg) | 3160 | 5420 | 1.715 | 1269 | 0.402 | 600 | 0.190 | 1214 | 0.384 |
| Total ERM-Q | | | 1.471 | | 0.663 | | 0.372 | | 0.715 |

J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

**TABLE B.5.4**

**INNER AND OUTER PIER 1 ERM-Q CALCULATIONS**
**LOWER SUBASE FEASIBILITY STUDY**
**NSB-NLON, GROTON, CONNECTICUT**



| **PARAMETER** | **ERM** | OUTER PIER 1 **TRP1-SD-004 TRP1-SD-004A-0204 20081107** | | OUTER PIER 1 **TRP1-SD-004 TRP1-SD-004A-0406 20081107** | | OUTER PIER 1 **TRP1-SD-005 TRP1-SD-005B-0001 20081107** | | OUTER PIER 1 **TRP1-SD-005 TRP1-SD-005A-0204 20081107** | |
|---|---|---|---|---|---|---|---|---|---|
| | | **RESULT** | ERM_RATIO | **RESULT** | ERM_RATIO | **RESULT** | ERM_RATIO | **RESULT** | ERM_RATIO |
| ARSENIC (mg/kg) | 70 | 12 | 0.171 | 7.9 | 0.113 | 8.3 | 0.119 | 10.2 | 0.146 |
| CADMIUM (mg/kg) | 9.6 | 2.30 J | 0.240 | 1.30 J | 0.135 | 0.380 J | 0.040 | 0.470 J | 0.049 |
| CHROMIUM (mg/kg) | 370 | 121 J | 0.327 | 96.8 J | 0.262 | 40.10 J | 0.108 | 42.60 J | 0.115 |
| COPPER (mg/kg) | 270 | 203 J | 0.752 | 207 J | 0.767 | 64.9 J | 0.240 | 78.7 J | 0.291 |
| LEAD (mg/kg) | 218 | 260 J | 1.193 | 192 J | 0.881 | 79.8 J | 0.366 | 62.1 J | 0.285 |
| NICKEL (mg/kg) | 51.6 | 28.00 J | 0.543 | 17.70 J | 0.343 | 16.40 J | 0.318 | 18.90 J | 0.366 |
| SELENIUM (mg/kg) | 1.4 | 5.2 | 3.714 | 3.7 | 2.643 | 1.8 | 1.286 | 1.5 | 1.071 |
| ZINC (mg/kg) | 410 | 418 J | 1.020 | 324 J | 0.790 | 108 J | 0.263 | 111 J | 0.271 |
| TOTAL PCB CONGENERS (µg/kg) | 180 | 335 | 1.861 | 124.5 | 0.692 | 89.6 | 0.498 | 175.5 | 0.975 |
| ALPHA-CHLORDANE (µg/kg) | 6 | 7 U | 0.583 | 6.1 U | 0.508 | 0.84 U | 0.070 | 3.6 U | 0.300 |
| TOTAL DDT (µg/kg) | 46.1 | 32 | 0.694 | 71 | 1.540 | 2.4 | 0.052 | 10.35 | 0.225 |
| HIGH MOLECULAR WEIGHT PAHs (µg/kg) | 9600 | 9630 | 1.003 | 10017 | 1.043 | 12050 | 1.255 | 38680 | 4.029 |
| LOW MOLECULAR WEIGHT PAHs (µg/kg) | 3160 | 3918 | 1.240 | 3869 | 1.224 | 1710 | 0.541 | 3845 | 1.217 |
| Total ERM-Q | | | 1.026 | | 0.842 | | 0.397 | | 0.718 |

J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

**TABLE B.5.4**

**INNER AND OUTER PIER 1 ERM-Q CALCULATIONS**
**LOWER SUBASE FEASIBILITY STUDY**
**NSB-NLON, GROTON, CONNECTICUT**



| PARAMETER | ERM | OUTER PIER 1 TRP1-SD-005 TRP1-SD-005A-0406 20081107 | | OUTER PIER 1 TRP1-SD-006 TRP1-SD-006B-0001 20081107 | | OUTER PIER 1 TRP1-SD-006 TRP1-SD-006A-0203 20081107 | | OUTER PIER 1 TRP1-SD-007 TRP1-SD-007B-0001 20081106 | |
|---|---|---|---|---|---|---|---|---|---|
| | | RESULT | ERM_RATIO | RESULT | ERM_RATIO | RESULT | ERM_RATIO | RESULT | ERM_RATIO |
| ARSENIC (mg/kg) | 70 | 8.7 | 0.124 | 12.90 J | 0.184 | 12.80 J | 0.183 | 15.60 J | 0.223 |
| CADMIUM (mg/kg) | 9.6 | 1.30 J | 0.135 | 0.480 J | 0.050 | 1.00 J | 0.104 | 0.540 J | 0.056 |
| CHROMIUM (mg/kg) | 370 | 113 J | 0.305 | 62.7 J | 0.169 | 60.4 J | 0.163 | 76.3 J | 0.206 |
| COPPER (mg/kg) | 270 | 201 J | 0.744 | 80.6 J | 0.299 | 463 J | 1.715 | 791 J | 2.930 |
| LEAD (mg/kg) | 218 | 253 J | 1.161 | 88.4 J | 0.406 | 80.8 J | 0.371 | 192 J | 0.881 |
| NICKEL (mg/kg) | 51.6 | 51.3 J | 0.994 | 25.80 J | 0.500 | 28.70 J | 0.556 | 40.3 | 0.781 |
| SELENIUM (mg/kg) | 1.4 | 3.5 | 2.500 | 5.90 U | 2.107 | 4.50 U | 1.607 | 7.6 | 5.429 |
| ZINC (mg/kg) | 410 | 669 J | 1.632 | 156 J | 0.380 | 341 J | 0.832 | 410 J | 1.000 |
| TOTAL PCB CONGENERS (µg/kg) | 180 | 43.8 | 0.243 | 234.2 | 1.301 | 62 | 0.344 | 273.5 | 1.519 |
| ALPHA-CHLORDANE (µg/kg) | 6 | 3.5 U | 0.292 | 0.88 U | 0.073 | 3.8 U | 0.317 | 3.4 U | 0.283 |
| TOTAL DDT (µg/kg) | 46.1 | 33.35 | 0.723 | 2.9 | 0.063 | 11.1 | 0.241 | 81.25 | 1.762 |
| HIGH MOLECULAR WEIGHT PAHs (µg/kg) | 9600 | 63850 | 6.651 | 6596 | 0.687 | 31340 | 3.265 | 119010 | 12.397 |
| LOW MOLECULAR WEIGHT PAHs (µg/kg) | 3160 | 9800 | 3.101 | 1781 | 0.564 | 10600 | 3.354 | 7661 | 2.424 |
| Total ERM-Q | | | 1.431 | | 0.522 | | 1.004 | | 2.299 |

J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

**TABLE B.5.4**

**INNER AND OUTER PIER 1 ERM-Q CALCULATIONS**
**LOWER SUBASE FEASIBILITY STUDY**
**NSB-NLON, GROTON, CONNECTICUT**



| PARAMETER | ERM | OUTER PIER 1 TRP1-SD-007 TRP1-SD-007A-0204 20081106 | | OUTER PIER 1 TRP1-SD-007 TRP1-SD-007A-0406 20081106 | | OUTER PIER 1 TRP1-SD-008 TRP1-SD-008B-0001 20081105 | | OUTER PIER 1 TRP1-SD-008 TRP1-SD-008A-0204 20081105 | |
|---|---|---|---|---|---|---|---|---|---|
| | | RESULT | ERM_RATIO | RESULT | ERM_RATIO | RESULT | ERM_RATIO | RESULT | ERM_RATIO |
| ARSENIC (mg/kg) | 70 | 18.40 J | 0.263 | 23.30 J | 0.333 | 15.40 J | 0.220 | 13.40 J | 0.191 |
| CADMIUM (mg/kg) | 9.6 | 1.10 J | 0.115 | 3.00 J | 0.313 | 0.450 J | 0.047 | 0.830 J | 0.086 |
| CHROMIUM (mg/kg) | 370 | 167 J | 0.451 | 142 J | 0.384 | 66.9 J | 0.181 | 130 J | 0.351 |
| COPPER (mg/kg) | 270 | 1600 J | 5.926 | 8620 J | 31.926 | 226 J | 0.837 | 1010 J | 3.741 |
| LEAD (mg/kg) | 218 | 1170 J | 5.367 | 661 J | 3.032 | 148 J | 0.679 | 690 J | 3.165 |
| NICKEL (mg/kg) | 51.6 | 482 | 9.341 | 188 | 3.643 | 28.4 | 0.550 | 278 | 5.388 |
| SELENIUM (mg/kg) | 1.4 | 14.6 | 10.429 | 9.8 | 7.000 | 6.9 | 4.929 | 8.6 | 6.143 |
| ZINC (mg/kg) | 410 | 4660 J | 11.366 | 2640 J | 6.439 | 257 J | 0.627 | 2470 J | 6.024 |
| TOTAL PCB CONGENERS (µg/kg) | 180 | 274.2 | 1.523 | 678.4 | 3.769 | 181.4 | 1.008 | 1186.8 | 6.593 |
| ALPHA-CHLORDANE (µg/kg) | 6 | 2.5 U | 0.208 | 2.5 U | 0.208 | 1.1 U | 0.092 | 0.91 U | 0.076 |
| TOTAL DDT (µg/kg) | 46.1 | 36.4 | 0.790 | 81 | 1.757 | 3.15 | 0.068 | 15.9 | 0.345 |
| HIGH MOLECULAR WEIGHT PAHs (µg/kg) | 9600 | 7610 | 0.793 | 37840 | 3.942 | 24070 | 2.507 | 51350 | 5.349 |
| LOW MOLECULAR WEIGHT PAHs (µg/kg) | 3160 | 1061 | 0.336 | 13040 | 4.127 | 3295 | 1.043 | 15188 | 4.806 |
| Total ERM-Q | | | 3.608 | | 5.144 | | 0.984 | | 3.251 |

J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

**TABLE B.5.4**

**INNER AND OUTER PIER 1 ERM-Q CALCULATIONS**
**LOWER SUBASE FEASIBILITY STUDY**
**NSB-NLON, GROTON, CONNECTICUT**



| **PARAMETER** | **ERM** | OUTER PIER 1 **TRP1-SD-008 TRP1-SD-008A-0406 20081105** | | OUTER PIER 1 **TRP1-SD-009 TRP1-SD-009B-0001 20081105** | | OUTER PIER 1 **TRP1-SD-009 TRP1-SD-009A-0204 20081105** | | OUTER PIER 1 **TRP1-SD-009 TRP1-SD-009A-0406 20081105** | |
|---|---|---|---|---|---|---|---|---|---|
| | | **RESULT** | ERM_RATIO | **RESULT** | ERM_RATIO | **RESULT** | ERM_RATIO | **RESULT** | ERM_RATIO |
| ARSENIC (mg/kg) | 70 | 12.90 J | 0.184 | 10.30 J | 0.147 | 15.80 J | 0.226 | 12.30 J | 0.176 |
| CADMIUM (mg/kg) | 9.6 | 0.890 J | 0.093 | 1.00 J | 0.104 | 0.700 J | 0.073 | 1.20 J | 0.125 |
| CHROMIUM (mg/kg) | 370 | 93.7 J | 0.253 | 84.3 J | 0.228 | 82.9 J | 0.224 | 95.5 J | 0.258 |
| COPPER (mg/kg) | 270 | 576 J | 2.133 | 190 J | 0.704 | 181 J | 0.670 | 255 J | 0.944 |
| LEAD (mg/kg) | 218 | 416 J | 1.908 | 228 J | 1.046 | 139 J | 0.638 | 228 J | 1.046 |
| NICKEL (mg/kg) | 51.6 | 127 | 2.461 | 41.5 | 0.804 | 38.8 | 0.752 | 57.1 | 1.107 |
| SELENIUM (mg/kg) | 1.4 | 7.9 | 5.643 | 4.7 | 3.357 | 6.3 | 4.500 | 6.1 | 4.357 |
| ZINC (mg/kg) | 410 | 1200 J | 2.927 | 387 J | 0.944 | 249 J | 0.607 | 433 J | 1.056 |
| TOTAL PCB CONGENERS (µg/kg) | 180 | 539.1 | 2.995 | 481.9 | 2.677 | 271.6 | 1.509 | 624.2 | 3.468 |
| ALPHA-CHLORDANE (µg/kg) | 6 | 3.4 U | 0.283 | 4.2 U | 0.350 | 1.8 U | 0.150 | 1.6 U | 0.133 |
| TOTAL DDT (µg/kg) | 46.1 | 32 | 0.694 | 39.5 | 0.857 | 5.1 | 0.111 | 4.5 | 0.098 |
| HIGH MOLECULAR WEIGHT PAHs (µg/kg) | 9600 | 15580 | 1.623 | 9660 | 1.006 | 16050 | 1.672 | 13880 | 1.446 |
| LOW MOLECULAR WEIGHT PAHs (µg/kg) | 3160 | 2559 | 0.810 | 1296 | 0.410 | 2385 | 0.755 | 3833 | 1.213 |
| Total ERM-Q | | | 1.693 | | 0.972 | | 0.914 | | 1.187 |

J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

**TABLE B.5.4**

**INNER AND OUTER PIER 1 ERM-Q CALCULATIONS**
**LOWER SUBASE FEASIBILITY STUDY**
**NSB-NLON, GROTON, CONNECTICUT**



| **PARAMETER** | **ERM** | OUTER PIER 1 **TRP1-SD-010 TRP1-SD-010B-0001 20081105** | | OUTER PIER 1 **TRP1-SD-010 TRP1-SD-010A-0204 20081105** | | OUTER PIER 1 **TRP1-SD-010 TRP1-SD-010A-0406 20081105** | |
|---|---|---|---|---|---|---|---|
| | | **RESULT** | ERM_RATIO | **RESULT** | ERM_RATIO | **RESULT** | ERM_RATIO |
| ARSENIC (mg/kg) | 70 | 12.40 J | 0.177 | 12.00 J | 0.171 | 14.50 J | 0.207 |
| CADMIUM (mg/kg) | 9.6 | 0.470 J | 0.049 | 1.50 J | 0.156 | 1.90 J | 0.198 |
| CHROMIUM (mg/kg) | 370 | 56.8 J | 0.154 | 101 J | 0.273 | 88.9 J | 0.240 |
| COPPER (mg/kg) | 270 | 201 J | 0.744 | 670 J | 2.481 | 625 J | 2.315 |
| LEAD (mg/kg) | 218 | 163 J | 0.748 | 665 J | 3.050 | 327 J | 1.500 |
| NICKEL (mg/kg) | 51.6 | 30.9 | 0.599 | 146 | 2.829 | 67.9 | 1.316 |
| SELENIUM (mg/kg) | 1.4 | 4.3 | 3.071 | 5.6 | 4.000 | 6 | 4.286 |
| ZINC (mg/kg) | 410 | 356 J | 0.868 | 1860 J | 4.537 | 975 J | 2.378 |
| TOTAL PCB CONGENERS (µg/kg) | 180 | 168 | 0.933 | 379.1 | 2.106 | 849.5 | 4.719 |
| ALPHA-CHLORDANE (µg/kg) | 6 | 4.4 U | 0.367 | 1 U | 0.083 | 3.2 U | 0.267 |
| TOTAL DDT (µg/kg) | 46.1 | 8.5 | 0.184 | 10.3 | 0.223 | 36.1 | 0.783 |
| HIGH MOLECULAR WEIGHT PAHs (µg/kg) | 9600 | 8360 | 0.871 | 14690 | 1.530 | 19240 | 2.004 |
| LOW MOLECULAR WEIGHT PAHs (µg/kg) | 3160 | 1399 | 0.443 | 4070 | 1.288 | 3909 | 1.237 |
| Total ERM-Q | | | 0.708 | | 1.748 | | 1.650 |

J Estimated value
NA Not analyzed
U Undetected at indicated analytical detection limit

# APPENDIX C

## COMPUTATION OF CONTAMINATED MEDIA VOLUMES

**C.1 - NAPL DETERMINATION CALCULATION**

**C.2 - VOLUME OF TPH CONTAMINATED SOIL AND LNAPL**

**C.3 - VOLUME OF CONTAMINATED SOIL**
**INDUSTRIAL/COMMERCIAL AND RESIDENTIAL SCENARIOS**

**C.4 - MASS OF LEAD IN SOIL**

**C.5 - VOLUME OF CONTAMINATED THAMES RIVER SEDIMENT**

**C.6 – VOLUME OF CONTAMINATED GROUNDWATER**

# APPENDIX C.1

# NAPL DETERMINATION CALCULATION

| CLIENT: NSB_NLON, Groton, CT | | | JOB NUMBER N112G00811 |
|---|---|---|---|
| SUBJECT: Determining Presence of NAPL in Soil | | | |
| BASED ON: Lower Subase RI Data | | | DRAWING NUMBER: |
| BY: CAR<br>Date: 01-29-09 | REVISED BY: JLG<br>Date: 01-29-09 | | APPROVED BY: DATE: |

**OBJECTIVE:**

Section 22a-133k-2(c)(3) of the Connecticut Remediation Standard Regulations (RSRs) require calculations be done to determine the presence of non-aqueous phase liquids (NAPL) in soil. Section 22a-133k-2(g) of the Connecticut RSRs also requires that NAPL be contained or removed from soil and groundwater to the maximum extent practicable.

Based on concentrations of TPH detected in soil during previous investigations at the Lower Subase, NAPL is suspected to be present in the soil. The NAPL is comprised of diesel, No. 2 fuel oil, and No. 6 fuel oil. This calculation was performed to determine the concentration at or above which NAPL might be present in soil at the Lower Subase.

**METHOD:**

The following equation, from Section 22a-133k-2(c)(3) of the RSRs, was used to calculate the soil concentration at or above which NAPL is expected:

$$C_{nap} = (S/2p_b) * (K_d p_b + \Theta_w + H'\Theta_a)$$

**Where:**

Cnap = concentration of organic substance at which or above which such substance may be present in a non-aqueous phase (mg/kg)
S = Effective Solubility (mg/L)
$p_b$ = Bulk Density (kg/L) (1.8)
$K_d$ = Soil-Water Partition Coefficient (Koc * foc) (L/kg)
$\Theta_w$ = Water-filled soil porosity (Lwater/Lsoil) (0.15)
$\Theta_a$ = Air-filled soil porosity (Lair/Lsoil) (0.28)
H' = Henry's Law constant (dimensionless)

Because the expected NAPL is comprised of various fuel oils which have many individual petroleum hydrocarbon components, a unique S, $K_d$, and H' are not available to use in the calculation. Reference 2 provides physical and chemical properties for the various hydrocarbon fractions that make up the fuel oils. The reference also provides a methodology for calculating the effective solubility of the mixture by Raoult's Law and the mole fraction of each hydrocarbon fraction. The resulting equation is the following:

$$C_{nap} = (SX_i/2p_b) * (K_{di} p_b + \Theta_w + H_i'\Theta_a)$$

**Where:**

X = mole fraction of component i (moles i/moles total)
i = individual fraction

| CLIENT: NSB_NLON, Groton, CT | | | JOB NUMBER N112G00811 |
|---|---|---|---|
| SUBJECT: Determining Presence of NAPL in Soil | | | |
| BASED ON: Lower Subase RI Data | | | DRAWING NUMBER: |
| BY: CAR<br>Date: 01-29-09 | REVISED BY: JLG<br>Date: 01-29-09 | | APPROVED BY: DATE: |

Using the fraction-specific physical-chemical properties provided in Table 8 from Reference 2 (see Page 3 of 8) and default weathered diesel fuel composition percentages (see Page 4 of 8), the calculations were performed in the spreadsheet included on Page 5 of 8. The calculation indicates that NAPL would be expected when TPH concentrations exceed 34 mg/kg. This concentration is unrealistically low given that the TPH Direct Exposure RSR under a residential scenario is 500 mg/kg and under an industrial scenario is 2,500 mg/kg and that there is widespread emprical evidence that such concentrations do not result in the presence of NAPL. Reference 2 indicates that the Cnap is only a conservative indication of where limits of solubility and vapor pressure will be reached for a chemical and it is not an indication of when residual or free phase hydrocarbon (NAPL) will be present. Reference 2 further states that the calculation is limited by the partitioning equations used in it primarily due to the limits of applicability of Henry's law constant. References 2 and 3 suggest the following to estimate the residual saturation of most NAPLs.

"In unsaturated soils, the residual (immobile) concentration of product ranges from 5% to 20% of total pore volume, while in the saturated zone these concentrations are higher, with typical values ranging from 15% to 50% of total pore volume."

Using this information and the following formula from Reference 5, $C_{nap}$ can be calculated.

$$Sr = [C_{nap} * (p_b/p_{nap})]/\Theta$$

or

$$C_{nap} = Sr * \Theta * (p_{nap}/p_b)$$

where:

$C_{nap}$ = Threshold TPH soil concentration above which NAPL might occur (mg/kg)
Sr = Residual NAPL saturation (% of soil pore volume)
$p_b$ = Soil bulk density (kg/L) (1.8 kg/L)
$p_{nap}$ = NAPL density (mg/L) (900,000, using a specific gravity of 0.9)
$\Theta$ = Total soil porosity (0.30)

Unsaturated

For Sr = 5%, Cnap = 7,500 mg/kg
For Sr = 20%, Cnap = 30,000 mg/kg

Saturated

For Sr = 15%, Cnap = 22,500 mg/kg
For Sr = 50%, Cnap = 75,000 mg/kg

Because TPH contamination has been detected above and below the water table at the Lower Subase, NAPL could occur in unsaturated and/or saturated soil. It was therefore conservatively estimated that NAPL might be present in unsaturated soil at a TPH concentration greater than 7,500 mg/kg and in saturated soil at a TPH concentration greater than 22,500 mg/kg.

| CLIENT: NSB_NLON, Groton, CT | | | JOB NUMBER N112G00811 |
|---|---|---|---|
| SUBJECT: Determining Presence of NAPL in Soil | | | |
| BASED ON: Lower Subase RI Data | | | DRAWING NUMBER: |
| BY: CAR | REVISED BY: JLG | | APPROVED BY: DATE: |
| Date: 01-29-09 | Date: 01-29-09 | | |

**Table 8.** Fraction-Specific Physical-Chemical Properties

| Fraction | BP (°C) | EC | MW (g/mole) | S (mg/L) | VP (atm) | H ($cm^3/cm^3$)[b] | log $K_{oc}$ |
|---|---|---|---|---|---|---|---|
| **ALIPHATICS** | | | | | | | |
| EC 5-6 | 5.1E+01 | 5.5E+00 | 8.1E+01 | 3.6E+01 | 3.5E-01 | 3.3E+01 | 2.9E+00 |
| EC >6-8 | 9.6E+01 | 7.0E+00 | 1.0E+02 | 5.4E+00 | 6.3E-02 | 5.0E+01 | 3.6E+00 |
| EC >8-10 | 1.5E+02 | 9.0E+00 | 1.3E+02 | 4.3E-01 | 6.3E-03 | 8.0E+01 | 4.5E+00 |
| EC >10-12 | 2.0E+02 | 1.1E+01 | 1.6E+02 | 3.4E-02 | 6.3E-04 | 1.2E+02 | 5.4E+00 |
| EC >12-16 | 2.6E+02 | 1.4E+01 | 2.0E+02 | 7.6E-04 | 4.8E-05 | 5.2E+02 | 6.7E+00 |
| EC >16-21 | 3.2E+02 | 1.9E+01 | 2.7E+02 | 2.5E-06 | 1.1E-06 | 4.9E+03 | 8.8E+00 |
| **AROMATICS** | | | | | | | |
| Benzene (EC 5-7)[a] | 8.0E+01 | 6.5E+00 | 7.8E+01 | 1.8E+03 | 1.3E-01 | 2.3E-01 | 1.9E+00 |
| Toluene (EC >7-8)[a] | 1.1E+02 | 7.6E+00 | 9.2E+01 | 5.2E+02 | 3.8E-02 | 2.7E-01 | 2.4E+00 |
| EC >8-10 | 1.5E+02 | 9.0E+00 | 1.2E+02 | 6.5E+01 | 6.3E-03 | 4.8E-01 | 3.2E+00 |
| EC >10-12 | 2.0E+02 | 1.1E+01 | 1.3E+02 | 2.5E+01 | 6.3E-04 | 1.4E-01 | 3.4E+00 |
| EC >12-16 | 2.6E+02 | 1.4E+01 | 1.5E+02 | 5.8E+00 | 4.8E-05 | 5.3E-02 | 3.7E+00 |
| EC >16-21 | 3.2E+02 | 1.9E+01 | 1.9E+02 | 6.5E-01 | 1.1E-06 | 1.3E-02 | 4.2E+00 |
| EC >21-35 | 3.4E+02 | 2.8E+01 | 2.4E+02 | 6.6E-03 | 4.4E-10 | 6.7E-04 | 5.1E+00 |

[a] Actual values of benzene and toluene, not based on correlation.
[b] Calculated Henry's law constant based on vapor pressure, solubility, and molecular weight relationship.

FROM REFERENCE 2

| CLIENT: NSB_NLON, Groton, CT | | | JOB NUMBER N112G00811 |
|---|---|---|---|
| SUBJECT: Determining Presence of NAPL in Soil | | | |
| BASED ON: Lower Subase RI Data | | | DRAWING NUMBER: |
| BY: CAR | REVISED BY: JLG | | APPROVED BY: DATE: |
| Date: 01-29-09 | Date: 01-29-09 | | |

**Table 6: Default Fuel Compositions.**

| | Fresh Gasoline | Weathered Gasoline | Fresh Diesel | Weathered Diesel | Heavy Fuel Oil |
|---|---|---|---|---|---|
| Aliphatic | | | | | |
| AL >5-6 | 28.48% | 2.64% | 0.06% | 0.003% | |
| AL >6-8 | 17.18% | 14.13% | 0.31% | 0.12% | |
| AL >8-10 | 4.59% | 9.94% | 1.02% | 0.91% | 0.57% |
| AL >10-12 | 5.52% | 13.81% | 4.18% | 4.19% | 1.25% |
| AL >12-16 | | | 29.98% | 30.46% | 10.64% |
| AL >16-35 | | | 42.55% | 43.28% | 60.63% |
| Aromatic | | | | | |
| AR >8-10 | 5.52% | 10.25% | 0.75% | 0.57% | |
| AR >10-12 | 9.22% | 20.24% | 3.53% | 3.15% | 0.57% |
| AR >12-16 | 6.62% | 16.11% | 9.67% | 9.47% | 0.83% |
| AR >16-21 | | | 7.60% | 7.70% | 4.48% |
| AR >21-35 | | | 0.07% | 0.07% | 21.03% |
| B | 2.91% | 0.13% | 0.01% | 0.0002% | |
| T | 7.69% | 2.00% | 0.03% | 0.004% | |
| E | 1.70% | 1.14% | 0.02% | 0.01% | |
| X | 8.93% | 6.43% | 0.11% | 0.04% | |
| Naphthalene | 1.64% | 3.20% | 0.03% | 0.02% | |
| | 100.00% | 100.00% | 99.92% | 100.00% | 100.00% |

Note: the composition ratios published in this table are for information purposes only. You may use them to check site conditions; however, site-specific (Method B or C) soil cleanup levels must be based on site-specific VPH or EPH measurements (see Section 2.4, p. 3).

WASHINGTON DEPARTMENT OF ECOLOGY, UNKNOWN REFERENCE

| CLIENT: | NSB_NLON, Groton, CT | JOB NUMBER | N112G00811 |
|---|---|---|---|
| SUBJECT: | Determining Presence of NAPL in Soil | | |
| BASED ON: | Lower Subase RI Data | DRAWING NUMBER: | |
| BY: CAR Date: 01-29-09 | REVISED BY: JLG Date: 01-29-09 | APPROVED BY: | DATE: |

| Fuel Components | Weathered Fuel Composition (percent) | Molecular Weight (g/mol) | Component in 1 g of Fuel (moles) | Fraction Xi (unitless) | Solubility S (mg/L) | Bulk Density $\rho_b$ (kg/L) | log Koc (L/kg) | foc (g/g) | Kd (L/kg) | Θw (Lw/Ls) | Θa (La/Ls) | Henry's Law Constant, H' (dimensionless) | Cnap(i) (mg/kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Aliphatics | | | | | | | | | | | | | |
| EC >5-6 | 3.00E-03 | 8.10E+01 | 3.70E-07 | 7.72E-05 | 3.60E+01 | 1.80E+00 | 2.90E+00 | 6.00E-03 | 4.77E+00 | 1.50E-01 | 2.80E-01 | 3.30E+01 | 1.39E-02 |
| EC >6-8 | 1.20E-01 | 1.00E+02 | 1.20E-05 | 2.50E-03 | 5.40E+00 | 1.80E+00 | 3.60E+00 | 6.00E-03 | 2.39E+01 | 1.50E-01 | 2.80E-01 | 5.00E+01 | 2.14E-01 |
| EC >8-10 | 9.10E-01 | 1.30E+02 | 7.00E-05 | 1.46E-02 | 4.30E-01 | 1.80E+00 | 4.50E+00 | 6.00E-03 | 1.90E+02 | 1.50E-01 | 2.80E-01 | 8.00E+01 | 6.34E-01 |
| EC >10-12 | 4.19E+00 | 1.60E+02 | 2.62E-04 | 5.46E-02 | 3.40E-02 | 1.80E+00 | 5.40E+00 | 6.00E-03 | 1.51E+03 | 1.50E-01 | 2.80E-01 | 1.20E+02 | 1.42E+00 |
| EC >12-16 | 3.05E+01 | 2.00E+02 | 1.52E-03 | 3.17E-01 | 7.60E-04 | 1.80E+00 | 6.70E+00 | 6.00E-03 | 3.01E+04 | 1.50E-01 | 2.80E-01 | 5.20E+02 | 3.64E+00 |
| EC >16-21 | 4.33E+01 | 2.70E+02 | 1.60E-03 | 3.34E-01 | 2.50E-06 | 1.80E+00 | 8.80E+00 | 6.00E-03 | 3.79E+06 | 1.50E-01 | 2.80E-01 | 4.90E+03 | 1.58E+00 |
| Aromatics | | | | | | | | | | | | | |
| EC 5-7 | 2.00E-04 | 7.80E+01 | 2.56E-08 | 5.34E-06 | 1.80E+03 | 1.80E+00 | 1.90E+00 | 6.00E-03 | 4.77E-01 | 1.50E-01 | 2.80E-01 | 2.30E-01 | 2.86E-03 |
| EC >7-8 | 4.00E-03 | 9.20E+01 | 4.35E-07 | 9.06E-05 | 5.20E+02 | 1.80E+00 | 2.40E+00 | 6.00E-03 | 1.51E+00 | 1.50E-01 | 2.80E-01 | 2.70E-01 | 3.84E-02 |
| EC >8-10 | 5.70E-01 | 1.20E+02 | 4.75E-05 | 9.90E-03 | 6.50E+01 | 1.80E+00 | 3.20E+00 | 6.00E-03 | 9.51E+00 | 1.50E-01 | 2.80E-01 | 4.80E-01 | 3.11E+00 |
| EC >10-12 | 3.15E+00 | 1.30E+02 | 2.42E-04 | 5.05E-02 | 2.50E+01 | 1.80E+00 | 3.40E+00 | 6.00E-03 | 1.51E+01 | 1.50E-01 | 2.80E-01 | 1.40E-01 | 9.58E+00 |
| EC >12-16 | 9.47E+00 | 1.50E+02 | 6.31E-04 | 1.32E-01 | 5.80E+00 | 1.80E+00 | 3.70E+00 | 6.00E-03 | 3.01E+01 | 1.50E-01 | 2.80E-01 | 5.30E-02 | 1.15E+01 |
| EC >16-21 | 7.70E+00 | 1.90E+02 | 4.05E-04 | 8.44E-02 | 6.50E-01 | 1.80E+00 | 4.20E+00 | 6.00E-03 | 9.51E+01 | 1.50E-01 | 2.80E-01 | 1.30E-02 | 2.61E+00 |
| EC >21-35 | 7.00E-02 | 2.40E+02 | 2.92E-06 | 6.08E-04 | 6.60E-03 | 1.80E+00 | 5.10E+00 | 6.00E-03 | 7.55E+02 | 1.50E-01 | 2.80E-01 | 6.70E-04 | 1.51E-03 |
| Sum | 9.99E+01 | 1.94E+03 | 4.80E-03 | 1.00E+00 | | | | | | | | Cnap = | 3.43E+01 |

EC = Equivalent Carbon Number
foc = fraction of organic carbon
Koc = soil organic carbon-water partition coefficient

Example Calculations:

EC>5-6 Moles of Component = (Weathered Fuel Composition (Percent) / 100) / Molecular Weight = (3.00E-03/100) / 8.10E+01 = 3.70E-07

X (EC>5-6) Mole Fraction = EC>5-6 Moles of Component / Total Moles in 1 g of Fuel = (3.70E-07)/(4.80E-03) = 7.72E-05

Cnap (EC>5-6) = $(SX_i/2\rho_b) * (K_{di}\rho_b + \Theta w + H_i'\Theta a)$ = [(36*7.72E-05)/(2 * 1.8)]*[(4.77*1.8)+0.15+(0.28*33)] = 1.39E-02

| CLIENT: NSB_NLON, Groton, CT | | | | JOB NUMBER N112G00811 | |
|---|---|---|---|---|---|
| SUBJECT: Determining Presence of NAPL in Soil | | | | | |
| BASED ON: Lower Subase RI Data | | | | DRAWING NUMBER: | |
| BY: | CAR | REVISED BY: | JLG | APPROVED BY: | DATE: |
| Date: | 01-29-09 | Date: | 01-29-09 | | |

Based on TPH concentrations and other information presented in the Lower Subase RI (Ref 6), the following evaluations were performed to determine if NAPL is likely in the soil of each of the Lower Subase zones.

**Zone 1**

The maximum concentration of TPH detected in the unsaturated soil of Zone 1 was 2,300 mg/kg at TB6-1RI. Because this concentration is lower than the 7,500 mg/kg NAPL-inducing threshold, it is not anticipated that the Zone 1 unsaturated soil can result in the presence of NAPL. However, concentrations of TPH detected in the Zone 1 saturated soil exceeded the 22,500 mg/kg NAPL-inducing threshold at two locations (GS-32L and 13MW18) with a maximum of 51,600 mg/kg at 13MW18. Therefore, NAPL is anticipated to be present in the vicinity of these two locations. NAPL was actually observed during the 2007 Monitoring Well Inventory (7) in a well near 13MW18, which is the same location where the maximum soil concentration was detected and provides some confirmation on the validity of the NAPL-predicting calculations.

**Zone 2**

No TPH was detected in the unsaturated soil of Zone 2. Therefore, it is not anticipated that this soil can result in the presence of NAPL. The maximum concentration of TPH detected in the saturated soil of Zone 2 was 8,210 mg/kg at GS-22L. Because this concentration is below the 22,500 mg/kg NAPL-inducing threshold, it is not anticipated that the Zone 2 saturated soil can result in the presence of NAPL. No NAPL was observed in any of the Zone 2 wells. Some NAPL was observed in a utility manhole, but because this manhole is located north of Building 16 at the boundary with Zone 1 and in the vicinity of the previously mentioned Zone 1 sampling location GS-32L where a NAPL-inducing TPH concentration (26,800 mg/kg) was detected in saturated soil, this observation is deemed to be relevant of the known presence of NAPL in Zone 1 rather than to provide evidence of the potential presence of NAPL in Zone 2.

**Zone 3**

The maximum concentration of TPH detected in the unsaturated soil of Zone 3 was 1,600 mg/kg at MW2-3RI. Because this concentration is lower than the 7,500 mg/kg NAPL-inducing threshold, it is not anticipated that the Zone 3 unsaturated soil can result in the presence of NAPL. The maximum concentration of TPH detected in Zone 2 saturated soil was 3,400 mg/kg at 13MW12. Because this TPH concentration is below the 22,500 mg/kg NAPL-inducing threshold, it is not anticipated that the Zone 3 saturated soil can result in the presence of NAPL. NAPL was not observed in any of the Zone 3 wells.

**Zone 4**

The maximum concentration of TPH detected in the unsaturated soil of Zone 4 was 3,440 mg/kg at 13TB4A. Because this concentration is below the 7,500 mg/kg NAPL-inducing threshold, it is not anticipated that the Zone 4 unsaturated soil can result in the presence of NAPL. The maximum concentration of TPH detected in the Zone 4 saturated soil was 11,800 mg/kg at 13TB2A.

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| BY: | CAR | REVISED BY: | JLG | APPROVED BY: | DATE: |
| Date: | 01-29-09 | Date: | 01-29-09 | | |

Because this TPH concentration is below the 22,500 mg/kg NAPL-inducing threshold, it is not anticipated that the Zone 4 saturated soil can result in the presence of NAPL. Although NAPL was historically detected at Zone 4 and approximately 800 gallons were recovered during a removal action in 1994, NAPL was not observed in any of the Zone 4 wells during the 1998 Phase II RI (6) and the 2007 Monitoring Well Inventory (7).

**Zone 5**

The maximum concentration of TPH detected in the Zone 5 unsaturated soil was 6,800 mg/kg at 19SS1. Because this concentration is below the 7,500 mg/kg NAPL-inducing threshold, it is not anticipated that the Zone 5 unsaturated soil can result in the presence of NAPL. The maximum concentration of TPH detected in the Zone 5 saturated soil was 6,200 mg/kg at 19TB2. Because this concentration is below the 22,500 mg/kg NAPL-inducing threshold, it is not anticipated that the Zone 5 saturated soil can result in the presence of NAPL. NAPL was not observed in any of the Zone 5 wells, but petroleum-stained soils were found.

**Zone 6**

The maximum concentration of TPH detected in the Zone 6 unsaturated soil was 4,000 mg/kg at MW5-6RI. Because this concentration is below the 7,500 mg/kg NAPL-inducing threshold, it is not anticipated that the Zone 6 unsaturated soil can result in the presence of NAPL. The maximum concentration of TPH detected in the Zone 6 soil was 1,200 mg/kg at MW2-6RI. Because this concentration is below the 22,500 mg/kg NAPL-inducing threshold, it is not anticipated that the Zone 6 saturated soil can result in the presence of NAPL. NAPL was not observed in any of the Zone 6 wells.

**Zone 7**

The maximum concentration of TPH detected in the Zone 7 unsaturated soil was 2,600 mg/kg at MW5-7RI. Because this concentration is below the 7,500 mg/kg NAPL-inducing threshold, it is not anticipated that the Zone 7 unsaturated soil can result in the presence of NAPL. The maximum concentration of TPH detected in the Zone 7 saturated soil was 2,500 mg/kg at 20MW7. Because this concentration is below the 22,500 mg/kg NAPL-inducing threshold, it is not anticipated that the Zone 7 saturated soil can result in the presence of NAPL. NAPL was not observed in any of the Zone 7 wells, but petroleum-stained soils were found.

**CONCLUSIONS:**

The following conclusions were made based on the results of these calculations:

NAPL is expected at Zone 1 and its actual presence was confirmed by historical and recent observations.

| CLIENT: NSB_NLON, Groton, CT | | | JOB NUMBER N112G00811 |
|---|---|---|---|
| SUBJECT: Determining Presence of NAPL in Soil | | | |
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| BY: CAR<br>Date: 01-29-09 | REVISED BY: JLG<br>Date: 01-29-09 | | APPROVED BY: DATE: |

NAPL is no longer expected at Zone 4 and, although NAPL has been historically observed at this site, it has been successfully removed as confirmed by the results of multiple subsequent investigations.

NAPL is not expected at Zones 2, 3, 5, 6, and 7and it has not been observed at those sites.

**REFERENCES:**

(1) State of Connecticut Remediation Standard Regulations, Section 22a-133k, January 1996.

(2) Gustafson, J.B., J.G. Tell, and D. Orem, Selection of Representative TPH Fractions Based on Fate and Transport Considerations, Volume 3, Total Petroleum Hydrocarbon Criteria Working Group Series, Amherst Scientific Publishers, ISBN 1-884-940-12-9, July 1997.

(3) Newell, C.J., S.D. Acree, R.R. Ross, and S.G. Huling, Light Nonaqueous Phase Liquids, Ground Water Issue, EPA, OSWER, EPA/540/S-95/500, 1995.

(4) Estimating Potential for Occurrence of DNAPL at Superfund Sites, EPA, OSWER, Publication: 9355.4-07FS, January 1992.

(5) G. Rucker, Calculations and Software to Determine the Presence of Non-Aqueous Phase Liquids in Environmental Media, Q-CLC-G-00059, Rev. 0, U.S. Department of Energy, Savannah River Site, August 2003.

(6) Tetra Tech NUS, Inc., Lower Subase Remedial Investigation for Naval Submarine Base - New London, Groton, Connecticut, King of Prussia, Pennsylvania, January 1999.

(7) TetraTech NUS, Inc., Monitoring Well Inventory Report and Abandonment Plan, Naval Submarine Base New London, Groton, Connecticut, King of Prussia, Pennsylvania, September 2007.

# APPENDIX C.2

# VOLUME OF TPH CONTAMINATED SOIL AND LNAPL

| | | | |
|---|---|---|---|
| CLIENT: | Naval Submarine Base New London | JOB NUMBER: | 0811 0265 |
| SUBJECT: | Mass and Volume Calculations for TPH and LNAPL Free Product in Lower Subase | | |
| BASED ON: | Attached Figures | DRAWING NUMBER: | |
| BY: NJB<br>Date: 1/11/10 | CHECKED BY: JLG<br>Date: 1/11/10 | APPROVED BY: | DATE: |

**OBJECTIVE:**

Calculate the mass of petroleum in the Lower Subase soil.

**REFERENCES:**

(1) Tetra Tech NUS, Inc. (TtNUS), 1999. Lower Subase Remedial Investigation, Naval Submarine Base New London, Groton, Connecticut. January

(2) U. S. Environmental Protection Agency (USEPA), 1992. Estimating Potential Occurrence for DNAPL at Superfund Sites. U. S. Environmental Protection Agency, Publication 9355.4-07FS, Washington, DC, January.

(3) U. S. Department of Energy (USDOE), 2003. Calculations and Software to Determine the Presence of Non-Aqueous Phase Liquids in Environmental Media, Q-CLC-G-00059, Rev.0, August. http://www.srs.gov/general/programs/soil/gen/naplcalc.pdf

**DISCUSSION:**

The purpose of this calculation is to determine the volume and mass of petroleum at the Lower Subase. Total petroleum hydrocarbons from leaking USTs, fuel line leaks, and surface spills were investigated during the Lower Subase RI (TtNUS, 1999) and TPH contaminated soils were analyzed with measured concentrations up to 51,600 mg/kg.

In Zone 4, 800-gallons of petroleum product were removed during a time critical removal action in 1994 but TPH was not detected in any Zone 4 groundwater samples collected during the RI. Free product was not reported in Zone 4 during the RI and the maximum detection of TPH in Zone 4 soil was 11,800 mg/kg.

Diesel fuel, No. 6 fuel oil, and No. 2 fuel oil were reported in well and boring logs in the Lower Subase RI. The specific gravity for these fuels is estimated at 0.9, which results in a density of 56.2 pounds/cubic feet or 900,000 mg/L.

Both a review of Lower Subase boring logs and a comparison of boring logs to Drawing 1, Potentiometric Surface Map, High Tide – October 27, 1997, Zones 1-4 (Ref. 1) indicate that TPH-contaminated soils are below the high tide groundwater table. Where present, the location of visible sheen or stain, petroleum odor, or gray or black soil recorded on boring logs typically coincides with the top of the water table and wet soil. In some Zone 1 boring logs, the thickness of petroleum-contaminated soil extends downward for several feet. It appears that TPH/free product has smeared onto the soil as a result of fluctuating groundwater table elevations. The source of TPH is likely from buried pipelines throughout the Lower Subase, and from USTs in Zone 1.

Exceptions to evidence of high TPH existing only below the water table are surface sample 19SS1 in Zone 5, shallow sample MW5-6RI in Zone 6, and shallow sample MW5-7RI in Zone 7.

Several investigations have been performed at the Lower Subase. Data from these investigations was compiled in the Lower Subase Remedial Investigation (Ref. 1). For Zones 1, 2, 3, 4, and 7, the TPH data from Ref. 1 was input into a geostatistical program to develop a 3-dimensional contours (kriging) of soil exceeding various concentrations, based on analytical results, 3-dimensinal coordinates, and sample spacing. These 3-D kriging maps are attached as worksheets.

Volumes for TPH-contaminated soi lin Zones 1, 2, 3, 4, and 7 were computed using the Volumetrics module in the Mining Visualization System (MVS) software package.

| CLIENT: Naval Submarine Base New London | | | JOB NUMBER: 0811 0265 |
|---|---|---|---|
| SUBJECT: Mass and Volume Calculations for TPH and LNAPL Free Product in Lower Subase | | | |
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| BY: NJB<br>Date: 1/11/10 | CHECKED BY: JLG<br>Date: 1/11/10 | | APPROVED BY: DATE: |

TPH concentrations in soil greater than 2,500 mg/kg, the CTDEP Industrial/Commercial RSR, occur in Zones 1 through 7. The total volume of soil contaminated at greater than 2,500 mg/kg and mass of petroleum in contaminated soil were determined as a first step to evaluate soil treatment. In addition, the maximum potential mass and volumes of free product in Zones 1, 2, and 4 were determined based on the calculated estimate that free product may occur at a concentration as low as 22,500 mg/kg in saturated soil.

Volumes of TPH-contaminated soil in Zones 5 and 6 were based on 2-dimensional kriging maps (Ref. 1.) Using an assumed soil density based on soil types, and estimated TPH concentrations within the soil based on the krigging maps, the mass of TPH contamination in the soil was calculated. Worksheets 1 through 11 show the extent of the soil contamination at Zones 1 through 7.

**(1) Estimate Concentration of TPH in Soil that Results in Free Product**
Residual (immobile) concentration of petroleum ranges for 5% to 20% of total pore volume in unsaturated soil and from 15% to 50% in saturated soil (Ref 2).

Use DOE method (Ref. 3, Equation 17)
Given:
$S_r = (NAPL_t * \gamma_t/\gamma_{TPH})/n_t$
Where:
$S_r$ = Percent Residual NAPL Saturation (%)
$NAPL_t$ = Total mass of NAPL in soil sample (mg/kg)
$\gamma_t$ = Wet bulk density of soil (kg/L)
$n_t$ = Total soil porosity (%, L/L)
$\gamma_{TPH}$= Density of NAPL mixture (mg/L)

Then:

$NAPL_t = (\gamma_{TPH} \times S_r \times n_t)/\gamma_t$
$=(900{,}000 \text{ mg/L} \times S_r \times 0.3) / 1.8 \text{ kg/L}$
$= 150{,}000 \times S_r$

| $S_r$ | $NAPL_t$ | | |
|---|---|---|---|
| 0.05 | 7,500 | mg/kg | for unsaturated soil |
| 0.20 | 30,000 | mg/kg | for unsaturated soil |
| 0.15 | 22,500 | mg/kg | for saturated soil |
| 0.50 | 75,000 | mg/kg | for saturated soil |

Therefore, assuming a soil porosity of 0.3, concentrations of 7,500 mg/kg to 30,000 mg/kg in unsaturated soil and 22,500 mg/kg to 75,000 mg/kg in saturated soil would indicate the possible presence of free petroleum product.

Because most elevated TPH concentrations actually occurred in saturated soil and because free product was only detected in saturated soil (9-11 ft bgs) in Zone 1, 22,500 mg/kg TPH will be used as the LNAPL release threshold for this FS.

**Conclusion:** Based on boring logs, assume no free product in unsaturated soil.
Use 22,500 mg/kg as the lower limit of TPH in soil indicating free product in saturated soil.

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**(2) Estimate Mass and Volume of Petroleum in Soil (where TPH > 2500 mg/kg)**
**Zone 1**

Location 1: Area that includes 13MW2, 13MW3, 13MW5, 13MW8, 13MW18, GS-32L, and TB8-1RI on Worksheets 2, 3, 4, and 5.
The area with soil exceeding 22,500 mg/kg is shown on Worksheet 6. This areas was multipled by a 3-foot thick smear zone to determine the volume of soil with TPH > 22,500 mg/kg.
Volume of soil with specified TPH concentration from groundwater table (El 1) to 15 feet bgs.
Assume no TPH > 2,500 mg/kg above groundwater table based on Worksheet 1 and boring logs.
Assume that none of the tanks or buildings go below El. 1 - don't need to subtract tank volumes.
Extend area to railroad embankment.

| TPH Conc. (mg/kg) | Total Volume (cubic feet) | Incremental Volume (cubic feet) | Avg. TPH Conc. (mg/kg) | Avg. TPH Concentration (mg/mg) | Mass of Petroleum (lb) |
|---|---|---|---|---|---|
| ≥ 2,500 | 379,485 | | | | |
| | | 220,219 | 5,000 | 0.005 | 121,120 |
| ≥ 7,500 | 159,266 | | | | |
| | | 129,506 | 15,000 | 0.015 | 213,685 |
| ≥ 22,500 | 29,760 | | | | |
| | | 29,760 | 37,050 | 0.037 | 121,287 |
| 51,600 | 0 | | | | |
| | | | | **Total** | **456,092** |

Location 2: Area around GS25L and GS29L on Worksheets 2 and 3.
Volume of soil with specified TPH concentration from groundwater table (El 1) to 15 feet bgs.
Assumes no TPH > 2,500 mg/kg above groundwater table.

| | | | | | |
|---|---|---|---|---|---|
| ≥ 2,500 | 10,811 | | | | |
| | | 10,052 | 5,000 | 0.005 | 5,529 |
| ≥ 7,500 | 759 | | | | |
| | | 759 | 11,200 | 0.011 | 935 |
| 14,900 | 0 | | | | |
| | | | | **Total** | **6,464** |

**Cumulative Zone 1 Mass of Petroleum 462,556 lb.**

**Cumulative Zone 1 Volume of Petroleum 61,564 gal.**

Petroleum (lb) = volume of contaminated soil (cf) x density of soil (110 lb/cf) x average concentration (mg/mg)

Petroleum (gal) = mass of petroleum (lb) / (56.2 lb/cf x 7.48 cf/gal)

Assume building foundations and tanks do not extend below the groundwater table, therefore do not subtract building foundation or tank volumes from the total soil volume.

**Zone 2**

Location 1: Area around GS22L on Worksheets 2 and 3.
Volume of soil with specified TPH concentration from groundwater table (El 1) to 15 feet bgs.
Assumes no TPH > 2,500 mg/kg above groundwater table.

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| | | | | | |
|---|---|---|---|---|---|
| ≥ 2,500 | 5,000 | | | | |
| | | 5,000 | 5,000 | 0.005 | 2,750 |
| ≥ 7,500 | 0.3 | | | | |
| | | 0 | 7,855 | 0.008 | 0 |
| 8,210 | 0 | | | | |
| | | | | **Total** | **2,750** |
| | | | | **Zone 2 Mass of Petroleum** | **2,750 lb.** |
| | | | | **Zone 2 Volume of Petroleum** | **366 gal.** |

**Zone 3**

Location 1: Area around 13MW12 on Worksheets 2 and 4.
Volume of soil with specified TPH concentration from groundwater table (El 1) to 15 feet bgs.
Assumes no TPH > 2,500 mg/kg above groundwater table.

| | | | | | |
|---|---|---|---|---|---|
| ≥ 2,500 | 21 | | | | |
| | | 21 | 2,950 | 0.003 | 7 |
| 3,400 | 0 | | | | |
| | | | | **Total** | **7** |
| | | | | **Zone 3 Mass of Petroleum** | **7 lb.** |
| | | | | **Zone 3 Volume of Petroleum** | **1 gal.** |

**Zone 4**

Location 1: Area around 13TB2A on Worksheets 2 and 3.
Volume of soil with specified TPH concentration from groundwater table (El 1) to 15 feet bgs.
Assumes no TPH > 2,500 mg/kg above groundwater table.

| | | | | | |
|---|---|---|---|---|---|
| ≥ 2,500 | 5,183 | | | | |
| | | 5,159 | 5,000 | 0.005 | 2,837 |
| ≥ 7,500 | 24 | | | | |
| | | 24 | 9,650 | 0.010 | 25 |
| 11,800 | 0 | | | | |
| | | | | **Total** | **2,863** |

Location 2: Area around 13TB4A on Worksheets 2 and 3.
Surface sample - Include soil from ground surface to 15 feet deep.

| | | | | | |
|---|---|---|---|---|---|
| ≥ 2,500 | 10,282 | | | | |
| | | 10,282 | 2,970 | 0.003 | 3,359 |
| 3,440 | 0 | | | | |
| | | | | **Total** | **3,359** |

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Location 3: Area around GS-9L on Worksheets 2 and 4.
Volume of soil with specified TPH concentration from groundwater table (El 1) to 15 feet bgs.
Assumes no TPH > 2,500 mg/kg above groundwater table.

| | | | | | | |
|---|---|---|---|---|---|---|
| ≥ 2,500 | 5,785 | | | | | |
| | | 5,782 | 5,000 | 0.005 | 3,180 | |
| ≥ 7,500 | 3 | | | | | |
| | | 3 | 8,430 | 0.008 | 3 | |
| 9360 | 0 | | | | | |
| | | | | **Total** | **3,183** | |
| | | | **Cumulative Zone 4 Mass of Petroleum** | | **9,405** | **lb.** |
| | | | **Cumulative Zone 4 Volume of Petroleum** | | **1,252** | **gal.** |

**Zone 5**

| TPH Conc. (mg/mg) | Area ($in^2$) | Area (sf) | Average TPH Conc. (mg/mg) | Area of Avg. Conc. (sf) | Thickness of Smear Zone (ft) | Volume of Cont. Soil (cf) | Mass of Petroleum (lb) |
|---|---|---|---|---|---|---|---|
| | | | **Zone 5 - Shallow Soil** | | | | |
| | | | Area and concentration contour presented on Worksheet 7 | | | | |
| Area around 19SS1 | | | | | | | |
| 0.0068 | 0.0 | 0 | | | | | |
| | | | 0.00465 | 2,600 | 3 | 7,800 | **3,990** |
| 0.0025 | 0.26 | 2,600 | | | | | |
| | | | **Zone 5 - Deep Soil** | | | | |
| | | | Area and concentration contours presented on Worksheet 8 | | | | |
| Area around 19TB2 | | | | | | | |
| 0.0062 | 0.00 | 0 | | | | | |
| | | | 0.0056 | 5,000 | 3 | 15,000 | **9,240** |
| 0.005 | 0.50 | 5,000 | | | | | |
| | | | 0.00375 | 13,000 | 3 | 39,000 | **16,088** |
| 0.0025 | 1.80 | 18,000 | | | | | |
| | | | **Cumulative Zone 5 Mass of Petroleum** | | | **29,317** | **lb.** |
| | | | **Cumulative Zone 5 Volume of Petroleum** | | | **3,902** | **gal.** |

Zone 5 UST has a 1,000 gallon capacity.
1,000 gallon / 7.48 gal/cf =
134 gallon / 7.48 gal/cf = cf / estimated 6 ft deep = 22 sf, ignore

**Zone 6**

| TPH Conc. (mg/mg) | Area ($in^2$) | Area (sf) | Average TPH Conc. (mg/mg) | Area of Avg. Conc. (sf) | Thickness of Smear Zone (ft) | Volume of Cont. Soil (cf) | Mass of Petroleum (lb) |
|---|---|---|---|---|---|---|---|
| | | | **Zone 6 - Shallow Soil** | | | | |
| | | | Area and concentration contour presented on Worksheet 7 | | | | |
| Area around MW5-6RI | | | | | | | |
| 0.004 | 0.0 | 0 | | | | | |
| | | | 0.00325 | 7,200 | 3 | 21,600 | **7,722** |
| 0.0025 | 0.72 | 7,200 | | | | | |
| | | | **Cumulative Zone 6 Mass of Petroleum** | | | **7,722** | **lb.** |
| | | | **Cumulative Zone 6 Volume of Petroleum** | | | **1,028** | **gal.** |

No TPH greater than 2500 mg/kg in deep soil in Zone 7, as presented on Worksheet 8.

| CLIENT: Naval Submarine Base New London | | | JOB NUMBER: 0811 0265 |
|---|---|---|---|
| SUBJECT: Mass and Volume Calculations for TPH and LNAPL Free Product in Lower Subase | | | |
| BASED ON: Attached Figures | | | DRAWING NUMBER: |
| BY: NJB<br>Date: 1/11/10 | CHECKED BY: JLG<br>Date: 1/11/10 | | APPROVED BY: DATE: |

**Zone 7**

Location 1: Area around MW5-7RI (shallow sample)on Worksheets 9, 10, and 11.
Include depth from ground surface to 15 feet deep.

| | | | | | |
|---|---|---|---|---|---|
| ≥ 2,500 | 109 | | | | |
| | | 109 | 2,550 | 0.003 | 31 |
| 2,600 | 0 | | | | |
| | | | | **Zone 7 Mass of Petroleum** | **31 lb.** |
| | | | | **Zone 7 Volume of Petroleum** | **4 gal.** |

**Lower Subase Summary - Petroleum in soil greater than 2500 mg/kg**

| Zone | Vol. of TPH Cont. Soil (cf) | Vol. of TPH Cont. Soil (cy) | Mass of TPH (lb) | Volume of TPH (gal) |
|---|---|---|---|---|
| 1 | 390,296 | 14,455 | 462,556 | 61,564 |
| 2 | 5,000 | 185 | 2,750 | 366 |
| 3 | 21 | 1 | 7 | 1 |
| 4 | 21,250 | 787 | 3,183 | 9,405 |
| 5 | 61,800 | 2,289 | 29,317 | 3,902 |
| 6 | 21,600 | 800 | 7,722 | 1,028 |
| 7 | 109 | 4 | 31 | 4 |
| **Total** | **500,076** | **18,521** | **505,565** | **76,270** |

**(3) Estimate Mass and Volume of TPH for Groundwater Treatment**

**Zone 1**

Location 1: 100 foot diameter circular areas around monitoring well FOMW14. Assume 3-foot thick smear zone. Use kriging map at groundwater level [El 0 to 2 feet msl (NAVD88)] (Worksheet 12).
Assume that none of the tanks or buildings go below El. 1 - don't need to subtract tank volumes.

| TPH Concentratio (mg/kg) | Total Volume (cubic feet) | Incremental Volume (cubic feet) | Avg. TPH Concentratio (mg/kg) | Avg. TPH Concentration (mg/mg) | Total TPH (lb) |
|---|---|---|---|---|---|
| ≥ 500 | 23,562 | | | | |
| | | 19,962 | 1,500 | 0.002 | 3,294 |
| ≥ 2,500 | 3,600 | | | | |
| | | 3,600 | 5,000 | 0.005 | 1,980 |
| ≥ 7,500 | 0 | | | | |
| | | | | **Mass of TPH** | **5,274 lb.** |
| | | | | **Volume of TPH** | **702 gal.** |

| CLIENT: Naval Submarine Base New London | | | JOB NUMBER: 0811 0265 |
|---|---|---|---|
| SUBJECT: Mass and Volume Calculations for TPH and LNAPL Free Product in Lower Subase | | | |
| BASED ON: Attached Figures | | | DRAWING NUMBER: |
| BY: NJB<br>Date: 1/11/10 | CHECKED BY: JLG<br>Date: 1/11/10 | | APPROVED BY: DATE: |

**Zone 4**

Location 1: 100 foot diameter area around 13MW16 (area is slightly less than 7,854 sf because 13MW16 is slightly less than 50 feet from the Quay Wall) (Worksheet 12). Assume at 3-foot thick smear zone.

| TPH Concentratio (mg/kg) | Total Volume (cubic feet) | Incremental Volume (cubic feet) | Avg. TPH Concentratio (mg/kg) | Avg. TPH Concentration (mg/mg) | Total TPH (lb) |
|---|---|---|---|---|---|
| 500 | 18,600 | 18,600 | 500 | 0.001 | 1,023 |
| | | | | **Mass of TPH** | **1,023 lb.** |
| | | | | **Volume of TPH** | **136 gal.** |

**(4) Determine potential volume of free product in saturated soil (where TPH concentration > 22,500 mg/kg)**

**Zone 1**

The area with soil exceeding 22,500 mg/kg is shown on Worksheet 6. This areas was multipled by a 3-foot thick smear zone to determine the volume of soil with TPH > 22,500 mg/kg.
Assume that none of the tanks or buildings go below El. 1 - don't need to subtract tank volumes.

| TPH Conc. (mg/kg) | Total Volume (cubic feet) | Incremental Volume (cubic feet) | Avg. TPH Concentration (mg/kg) | Avg. TPH Conc. (mg/mg) | Total TPH (lb) | TPH in Soil (lb) | Free Product (lb) |
|---|---|---|---|---|---|---|---|
| 22,500 | 29,760 | | | | | | |
| | | 29,760 | 37,050 | 0.037 | 121,287 | 91,699 | 29,588 |
| 51,600 | 0 | | | | | | |
| | | | **Zone 1 Mass of Free Product** | | **29,588 lb.** | | |
| | | | **Zone 1 Volume of Free Product** | | **3,938 gal.** | | |

**Lower Subase Summary - Potential Free Product in Saturated Soil (LNAPL to remediate)**

| Zone | Mass (lb) | Volume (gal) |
|---|---|---|
| 1 | 29,600 | 3,900 |

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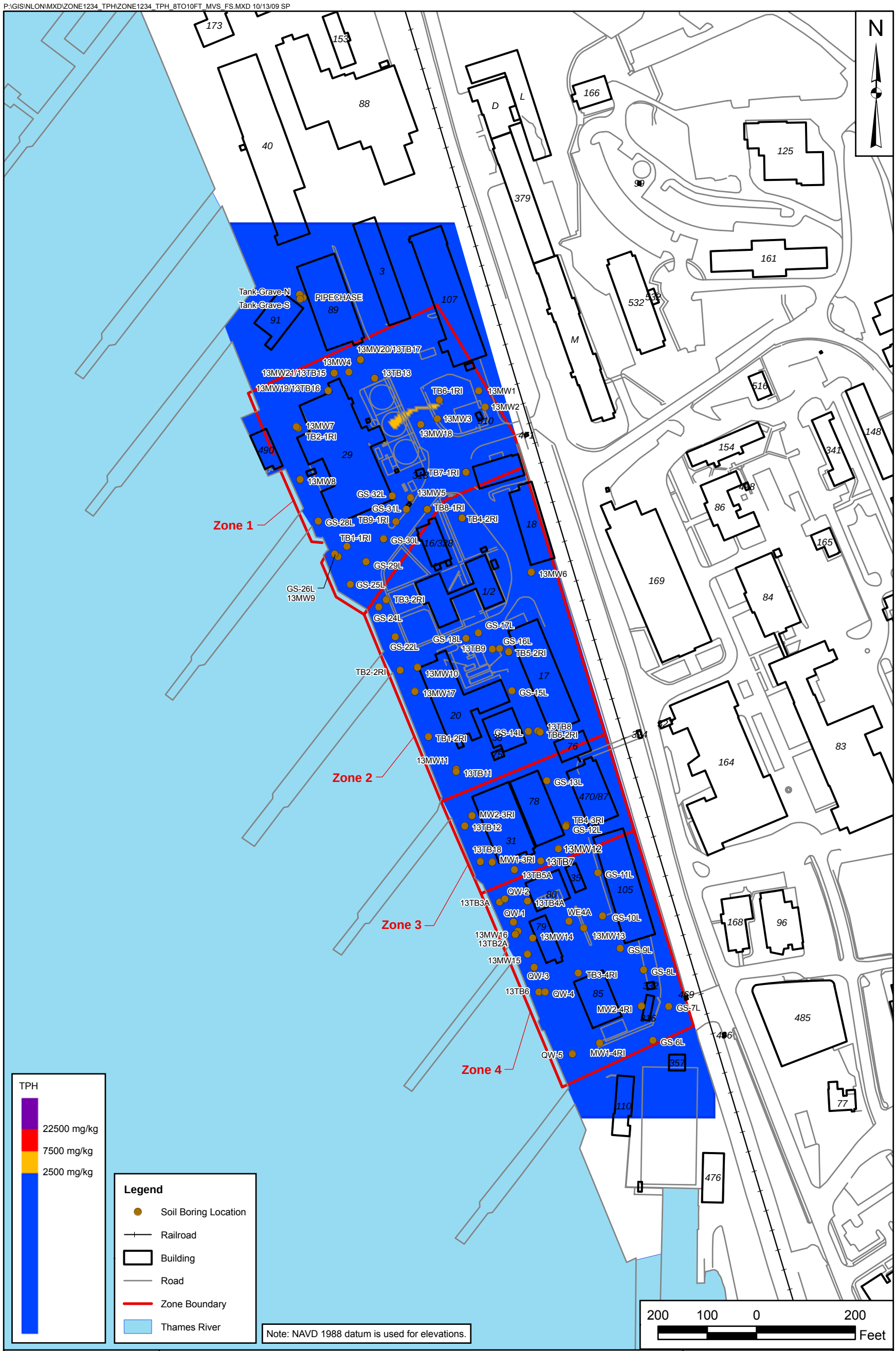


| | | | |
|---|---|---|---|
| DRAWN BY S. PAXTON | DATE 4/02/09 | Tetra Tech NUS, Inc. | CONTRACT NO. 0811 |
| CHECKED BY N. BALSAMO | DATE 10/13/09 | ESTIMATED TPH CONCENTRATIONS (KRIGING RESULTS)<br>ELEVATION: 8 TO 10 FEET<br>ZONES 1, 2, 3, AND 4<br>NAVAL SUBMARINE BASE - NEW LONDON<br>GROTON, CONNECTICUT | APPROVED BY _ / DATE -- |
| COST/SCHED-AREA | | | APPROVED BY -- / DATE -- |
| SCALE AS NOTED | | | FIGURE NO. WORKSHEET 1 / REV. |

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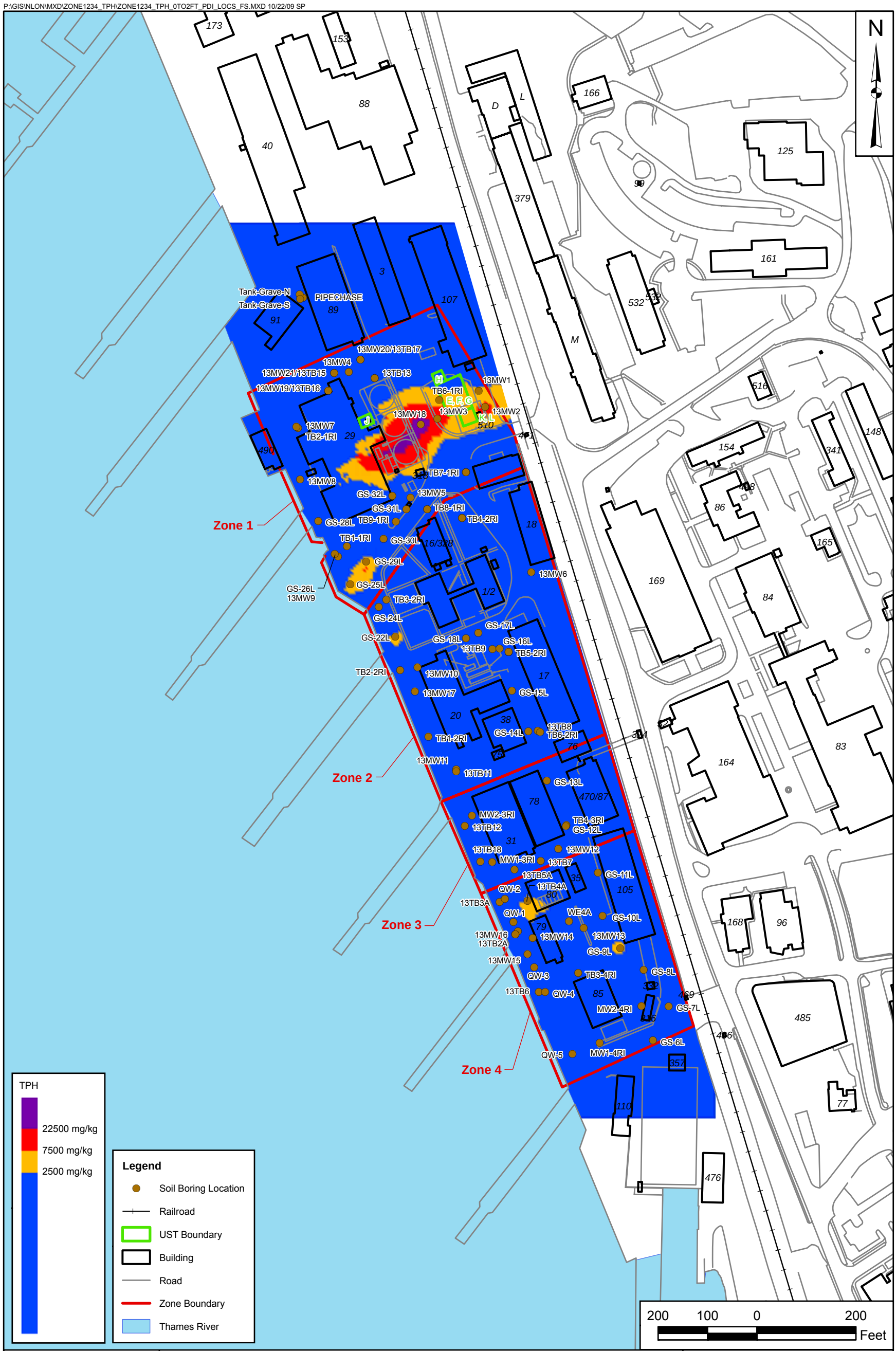


| DRAWN BY | DATE | Tetra Tech NUS, Inc. | CONTRACT NO. |
|---|---|---|---|
| S. PAXTON | 4/02/09 | | 2195 |
| CHECKED BY | DATE | ESTIMATED TPH CONCENTRATIONS (KRIGING RESULTS)<br>ELEVATION: 0 TO 2 FEET<br>ZONES 1, 2, 3, AND 4<br>NAVAL SUBMARINE BASE - NEW LONDON<br>GROTON, CONNECTICUT | APPROVED BY / DATE |
| N. BALSAMO | 10/22/09 | | _ / -- |
| COST/SCHED-AREA | | | APPROVED BY / DATE |
| | | | -- / -- |
| SCALE | | | FIGURE NO. / REV. |
| AS NOTED | | | WORKSHEET 2 |

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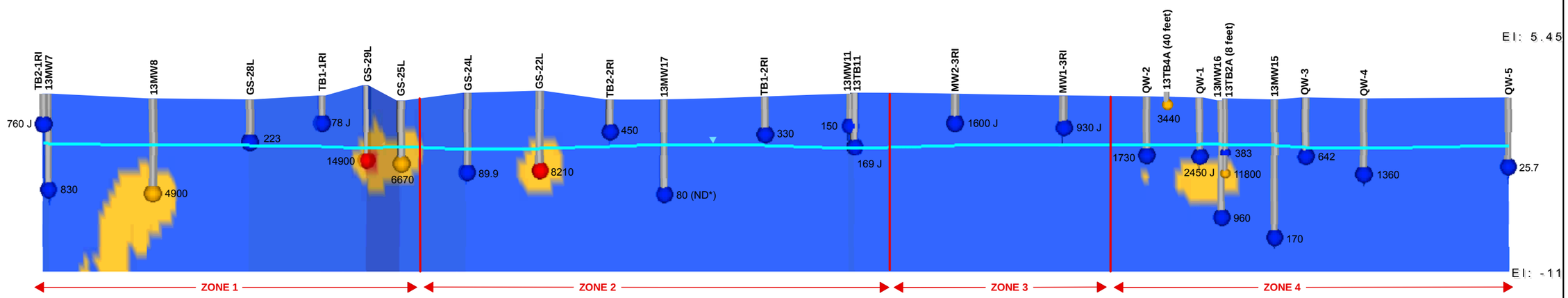


**LEGEND**

TPH

22500 mg/kg

7500 mg/kg

2500 mg/kg

Boring Offset from Cross-Section

Boring Included in Cross-Section

Notes:
1) * indicates the result is a non-detect and one half of the detection limit was used for kriging.
2) NAVD 1988 datum is used for elevations.

| | | | | |
|---|---|---|---|---|
| DRAWN BY S. PAXTON | DATE 4/28/09 | Tetra Tech NUS, Inc. | CONTRACT NO. 2195 | OWNER NO. WE24 |
| CHECKED BY N. BALSAMO | DATE 10/22/09 | TPH CROSS-SECTION A-A' ZONES 1, 2, 3, AND 4 NAVAL SUBMARINE BASE - NEW LONDON GROTON, CONNECTICUT | APPROVED BY -- | DATE -- |
| REVISED BY S. PAXTON | DATE 10/22/09 | | APPROVED BY -- | DATE -- |
| SCALE AS NOTED | | | FIGURE NO. WORKSHEET 3 | REV. 0 |

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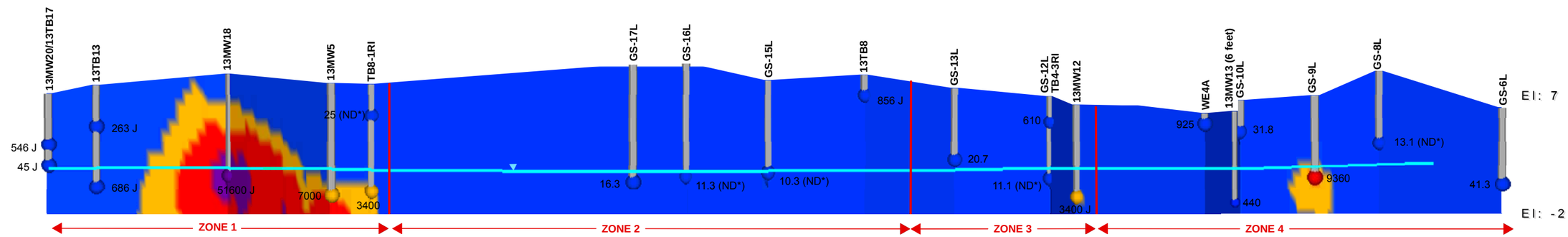


**LEGEND**

TPH

22500 mg/kg
7500 mg/kg
2500 mg/kg

Boring Offset from Cross-Section

Boring Included in Cross-Section

Notes:
1) * indicates the result is a non-detect and one half of the detection limit was used for kriging.
2) NAVD 1988 datum is used for elevations.

| | | | | |
|---|---|---|---|---|
| DRAWN BY S. PAXTON | DATE 4/28/09 | Tetra Tech NUS, Inc. | CONTRACT NO. 2195 | OWNER NO. WE24 |
| CHECKED BY N. BALSAMO | DATE 10/22/09 | TPH CROSS-SECTION B-B' ZONES 1, 2, 3, AND 4 NAVAL SUBMARINE BASE - NEW LONDON GROTON, CONNECTICUT | APPROVED BY -- | DATE -- |
| REVISED BY S. PAXTON | DATE 10/22/09 | | APPROVED BY -- | DATE -- |
| SCALE AS NOTED | | | FIGURE NO. WORKSHEET 4 | REV. 0 |

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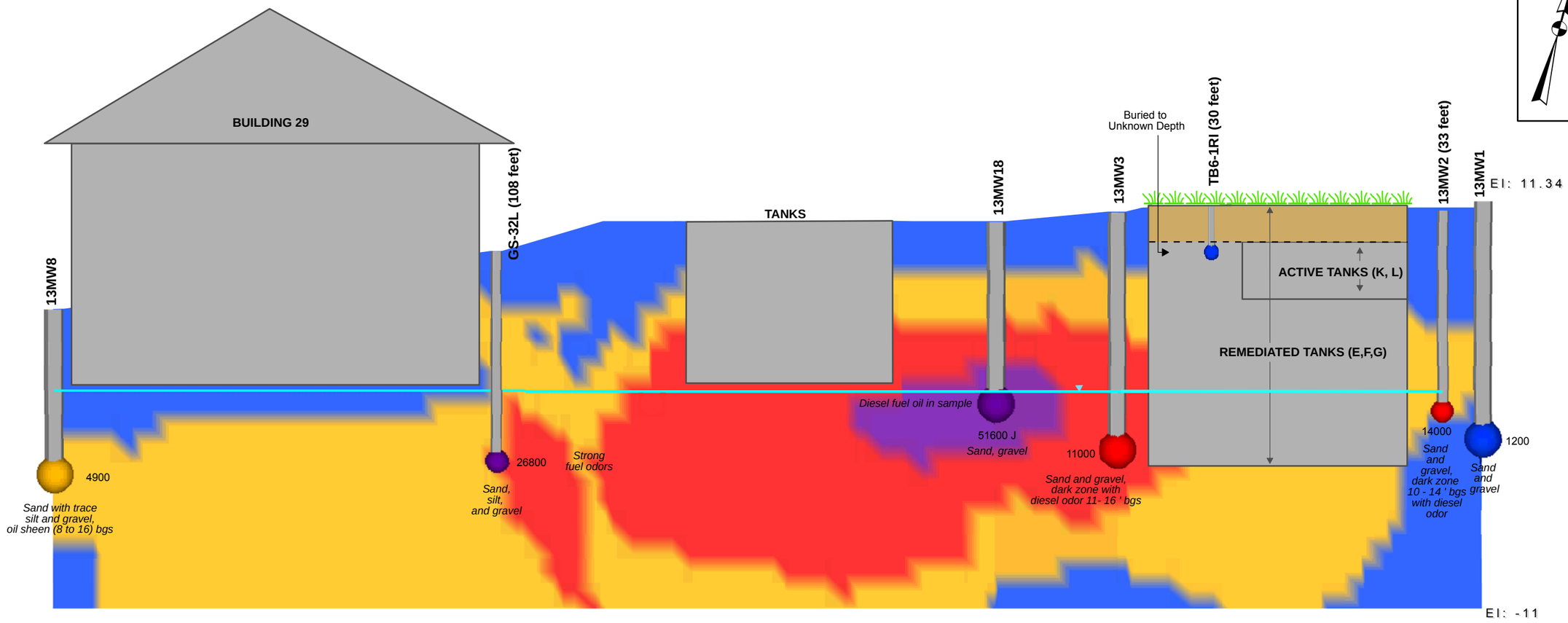



**LEGEND**

TPH

- 22500 mg/kg
- 7500 mg/kg
- 2500 mg/kg

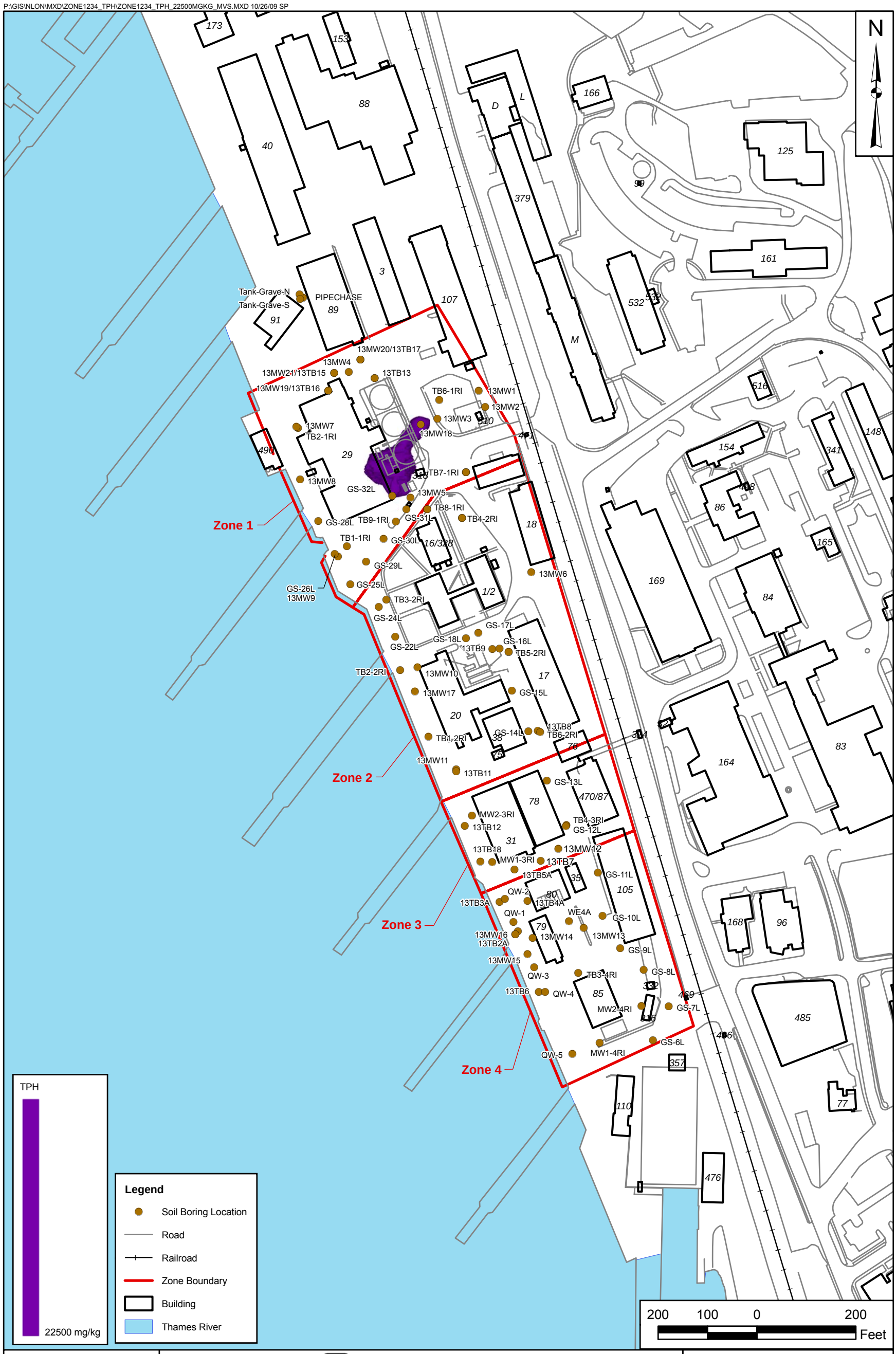
Boring Offset from Cross-Section

Boring Included in Cross-Section

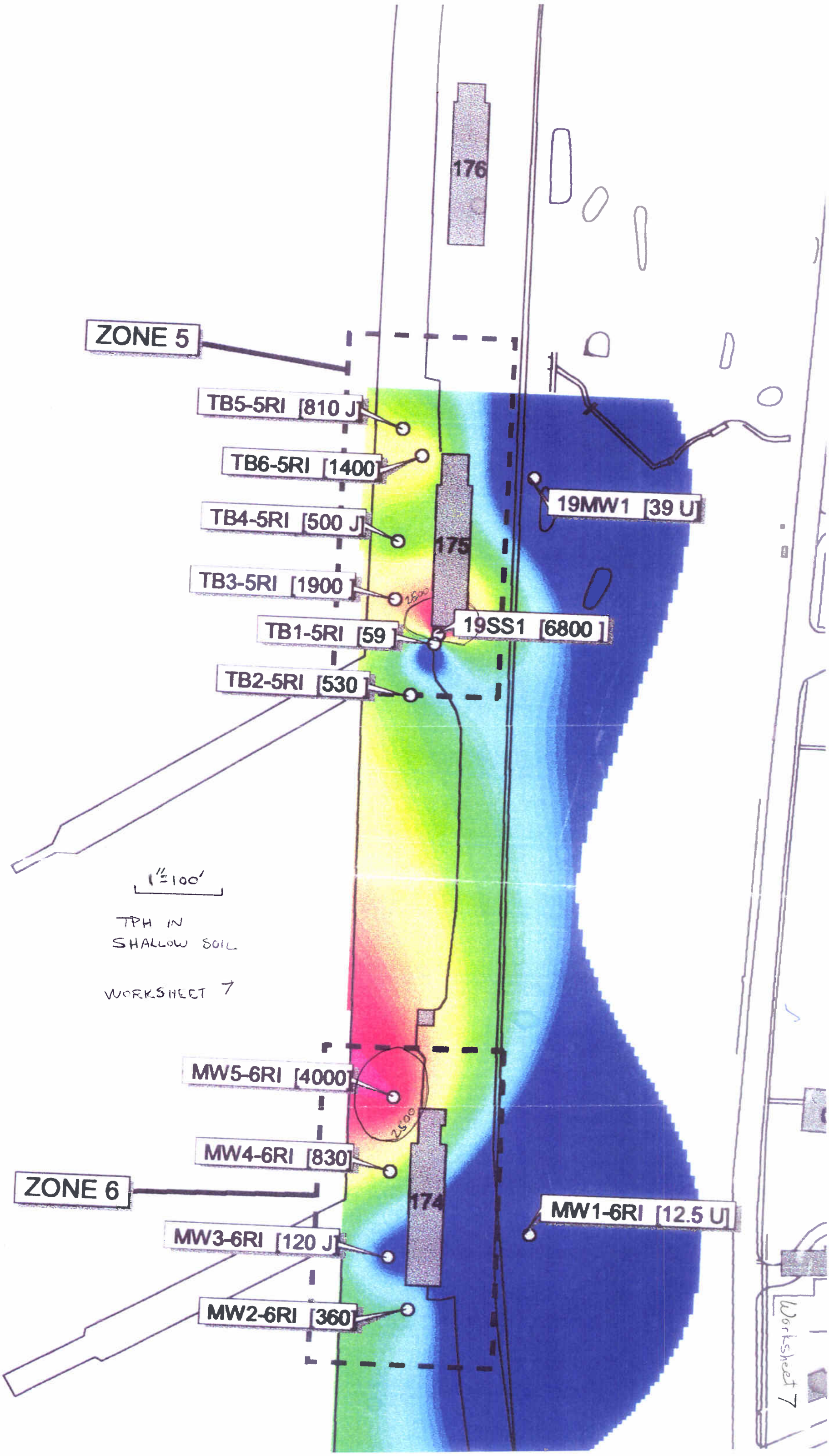
Note: NAVD 1988 datum is used for elevations.

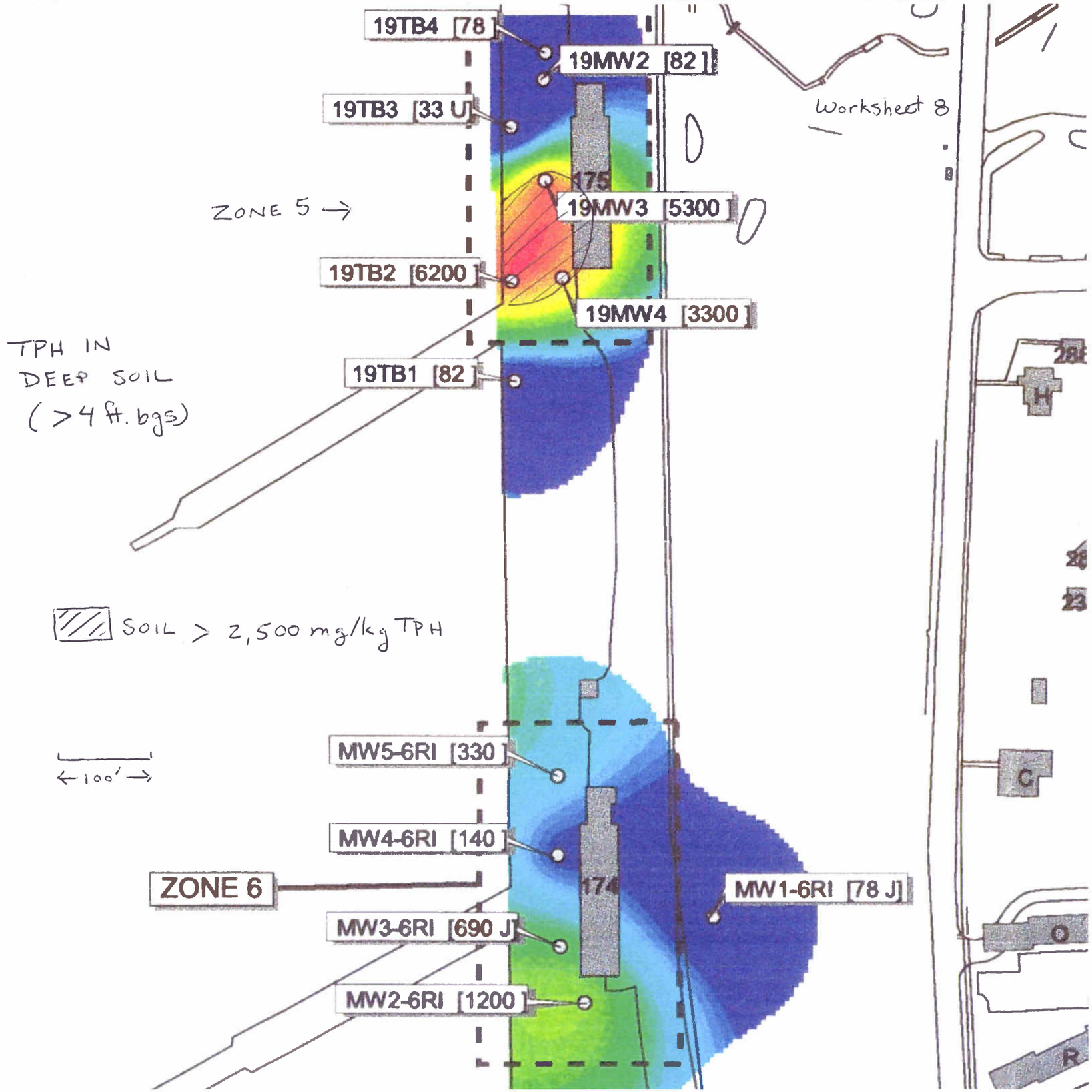
| | | | | |
|---|---|---|---|---|
| DRAWN BY S. PAXTON | DATE 4/28/09 | Tetra Tech NUS, Inc. | CONTRACT NO. 2195 | OWNER NO. WE24 |
| CHECKED BY N. BALSAMO | DATE 10/22/09 | TPH CROSS-SECTION C-C' ZONE 1 NAVAL SUBMARINE BASE - NEW LONDON GROTON, CONNECTICUT | APPROVED BY -- | DATE -- |
| REVISED BY S. PAXTON | DATE 10/22/09 | | APPROVED BY -- | DATE -- |
| SCALE AS NOTED | | | FIGURE NO. WORKSHEET 5 | REV. 0 |

P:\GIS\NLON\MXD\ZONE1234_TPH\ZONE1234_TPH_22500MGKG_MVS.MXD 10/26/09 SP




| | | | |
|---|---|---|---|
| DRAWN BY S. PAXTON | DATE 4/02/09 | Tetra Tech NUS, Inc. | CONTRACT NO. 2195 |
| CHECKED BY N. BALSAMO | DATE 10/26/09 | ESTIMATED TPH CONCENTRATIONS (KRIGING RESULTS)<br>ELEVATION: 11 TO -11 FEET<br>ZONES 1, 2, 3, AND 4<br>NAVAL SUBMARINE BASE - NEW LONDON<br>GROTON, CONNECTICUT | APPROVED BY – / DATE -- |
| COST/SCHED-AREA | | | APPROVED BY -- / DATE -- |
| SCALE AS NOTED | | | FIGURE NO. WORKSHEET 6 / REV. |


176
ZONE 5
TB5-5RI [810 J]
TB6-5RI [1400]
TB4-5RI [500 J]
TB3-5RI [1900]
TB1-5RI [59]
TB2-5RI [530]
19MW1 [39 U]
175
19SS1 [6800]
2500
1" = 100'
TPH IN
SHALLOW SOIL
WORKSHEET 7
MW5-6RI [4000]
2500
MW4-6RI [830]
ZONE 6
174
MW1-6RI [12.5 U]
MW3-6RI [120 J]
MW2-6RI [360]
Worksheet 7


19TB4 [78
19MW2 [82]
19TB3 [33 U]
Worksheet 8
175
ZONE 5 →
19MW3 [5300]
19TB2 [6200]
19MW4 [3300]
TPH IN
DEEP SOIL
(>4 ft. bgs)
19TB1 [82]
SOIL > 2,500 mg/kg TPH
←100'→
MW5-6RI [330
MW4-6RI [140
ZONE 6
174
MW1-6RI [78 J]
MW3-6RI [690 J]
MW2-6RI [1200
H
C
O
R

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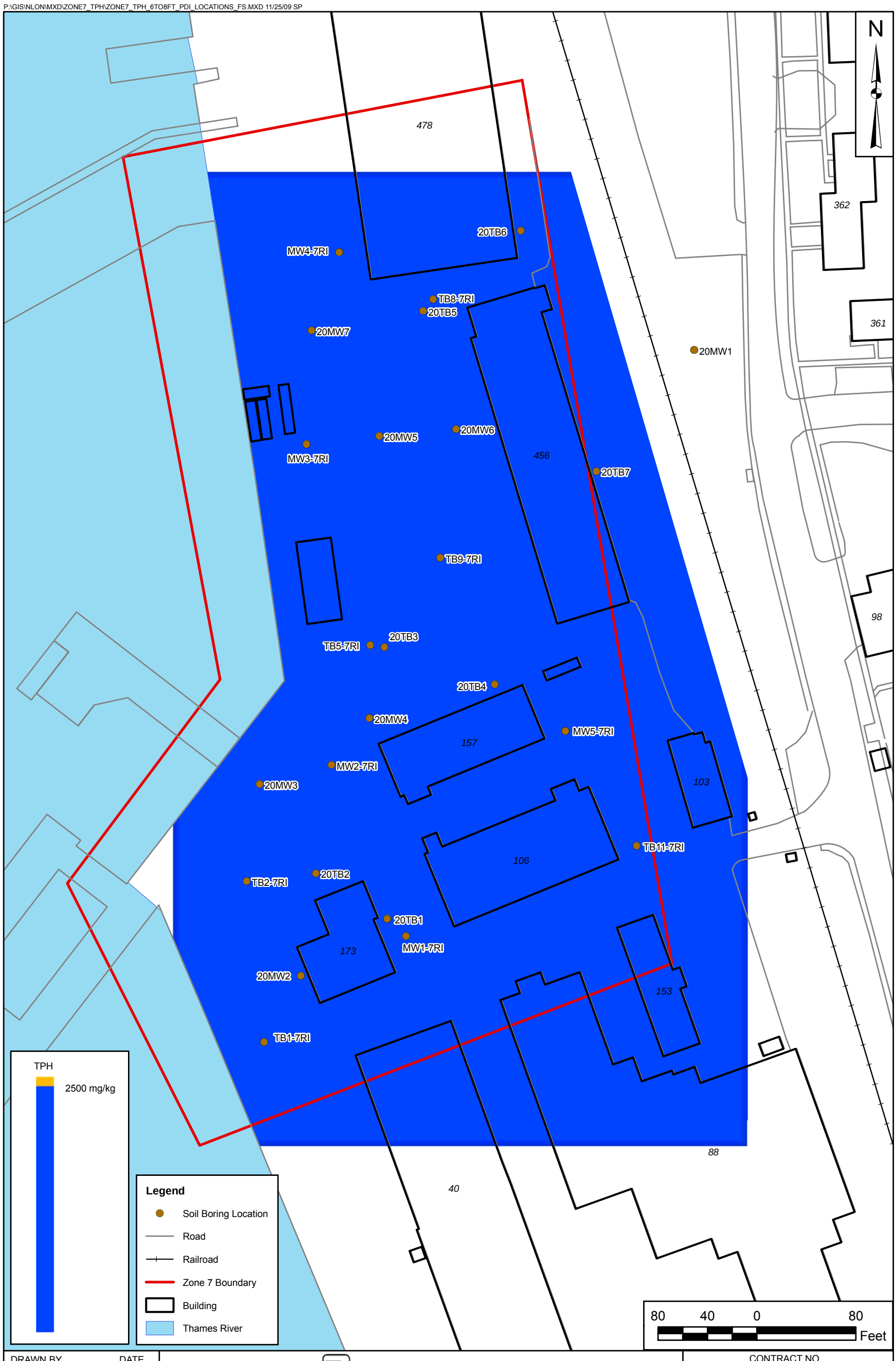
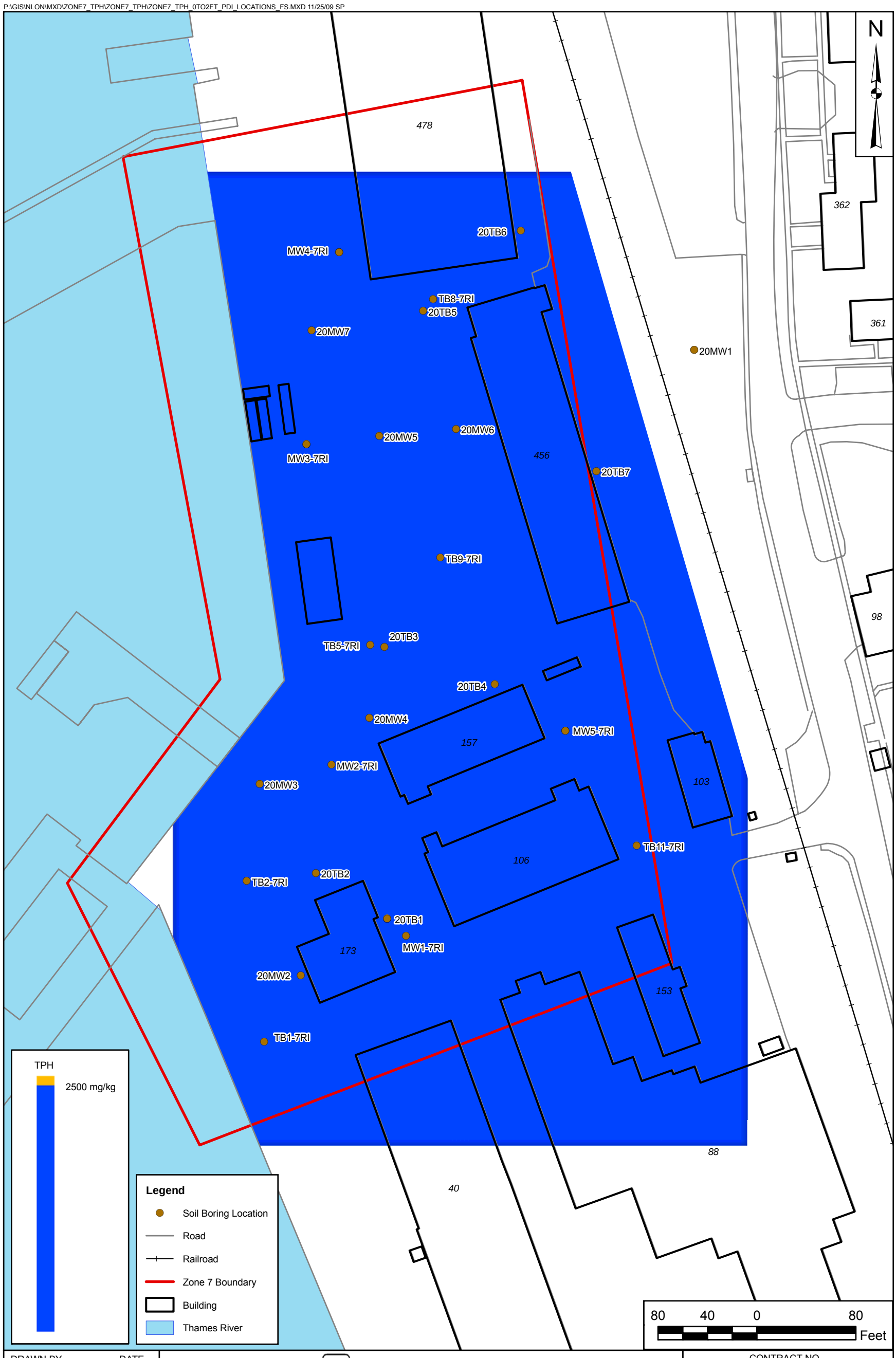


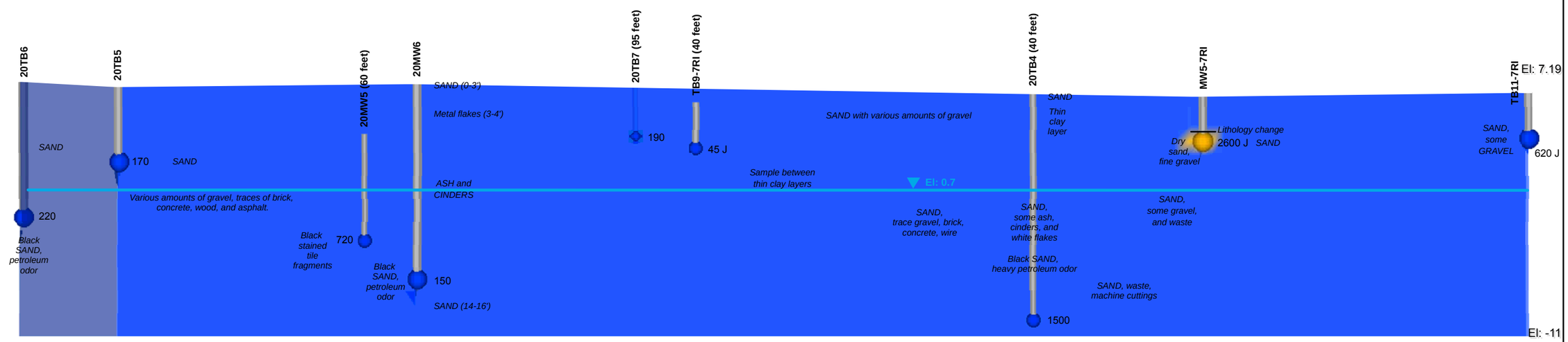

| | | | |
|---|---|---|---|
| DRAWN BY S. PAXTON | DATE 4/02/09 | Tetra Tech NUS, Inc. | CONTRACT NO. 2195 |
| CHECKED BY N. BALSAMO | DATE 11/25/09 | ESTIMATED TPH CONCENTRATIONS (KRIGING RESULTS)<br>ELEVATION: 6 TO 8 FEET<br>ZONE 7<br>NAVAL SUBMARINE BASE - NEW LONDON<br>GROTON, CONNECTICUT | APPROVED BY _ / DATE -- |
| COST/SCHED-AREA | | | APPROVED BY -- / DATE -- |
| SCALE AS NOTED | | | FIGURE NO. WORKSHEET 9 / REV. |

P:\GIS\NLON\MXD\ZONE7_TPH\ZONE7_TPH\ZONE7_TPH_0TO2FT_PDI_LOCATIONS_FS.MXD 11/25/09 SP




| | | | |
|---|---|---|---|
| DRAWN BY S. PAXTON | DATE 4/02/09 | Tetra Tech NUS, Inc. | CONTRACT NO. 2195 |
| CHECKED BY N. BALSAMO | DATE 11/25/09 | ESTIMATED TPH CONCENTRATIONS (KRIGING RESULTS)<br>ELEVATION: 0 TO 2 FEET<br>ZONE 7<br>NAVAL SUBMARINE BASE - NEW LONDON<br>GROTON, CONNECTICUT | APPROVED BY _ / DATE -- |
| COST/SCHED-AREA | | | APPROVED BY -- / DATE -- |
| SCALE AS NOTED | | | FIGURE NO. WORKSHEET 10 / REV. 0 |

P:\GIS\NLON\MXD\ZONE7_TPH\ZONE7_TPH_XSECT_BB_FS.MXD 11/25/09 SP




**LEGEND**

TPH
2500 mg/kg

Boring Offset from Cross-Section

Boring Included in Cross-Section

| | | | | |
|---|---|---|---|---|
| DRAWN BY S. PAXTON | DATE 4/28/09 | Tetra Tech NUS, Inc. | CONTRACT NO. 2195 | OWNER NO. WE24 |
| CHECKED BY N. BALSAMO | DATE 11/25/09 | TPH CROSS-SECTION B-B' ZONE 7 NAVAL SUBMARINE BASE - NEW LONDON GROTON, CONNECTICUT | APPROVED BY -- | DATE -- |
| REVISED BY S. PAXTON | DATE 11/25/09 | | APPROVED BY -- | DATE -- |
| SCALE AS NOTED | | | FIGURE NO. WORKSHEET 11 | REV. 0 |

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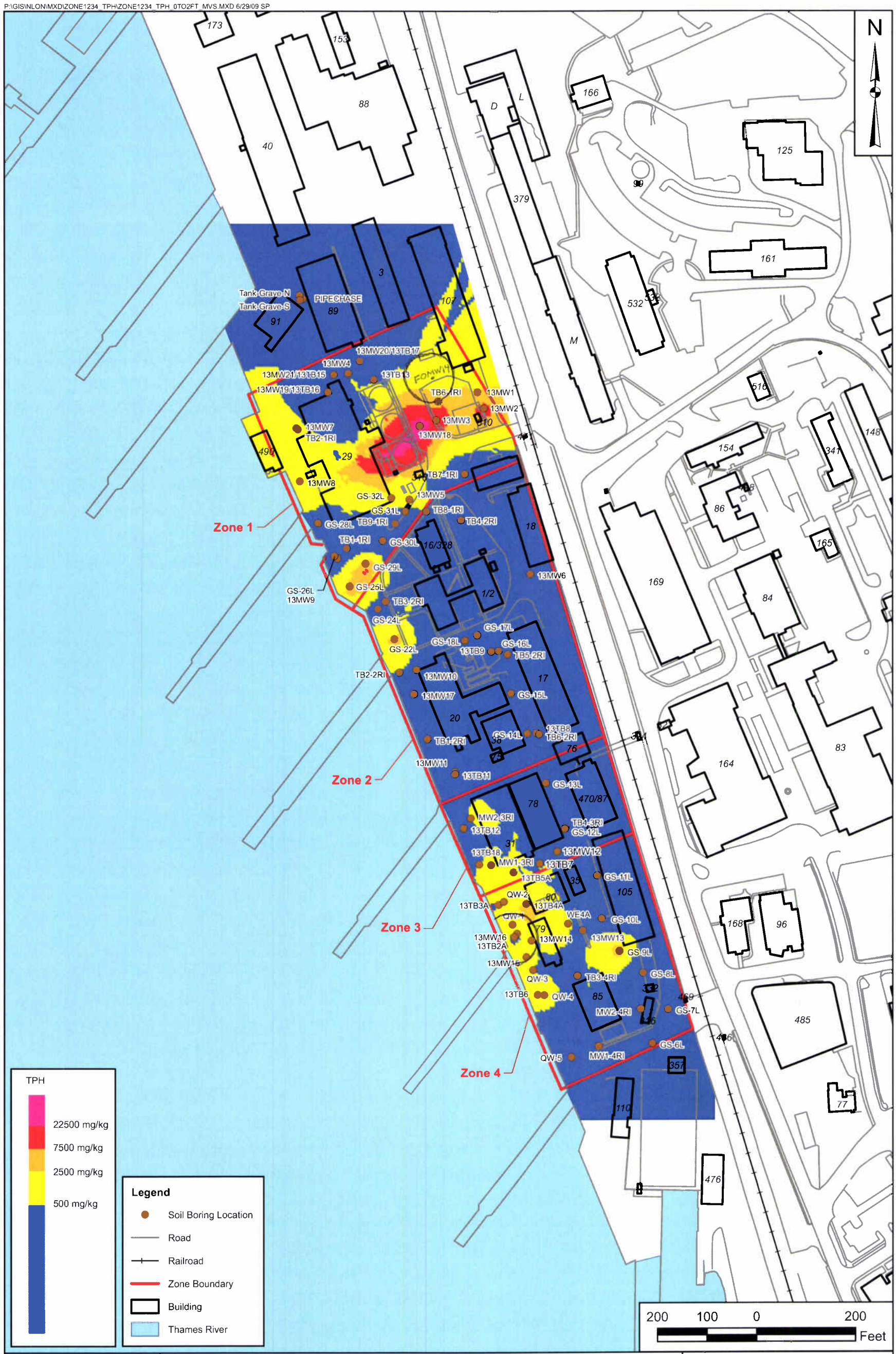



| DRAWN BY | DATE | Tetra Tech NUS, Inc. | CONTRACT NO. |
|---|---|---|---|
| S. PAXTON | 4/02/09 | | 0811 |
| CHECKED BY | DATE | ESTIMATED TPH CONCENTRATIONS (KRIGING RESULTS)<br>ELEVATION: 0 TO 2 FEET<br>ZONES 1, 2, 3, AND 4<br>NAVAL SUBMARINE BASE - NEW LONDON<br>GROTON, CONNECTICUT | APPROVED BY / DATE |
| N. BALSAMO | 6/29/09 | | – / -- |
| COST/SCHED-AREA | | | APPROVED BY / DATE |
| | | | -- / -- |
| SCALE | | | FIGURE NO. / REV. |
| AS NOTED | | | — |

WORKSHEET 12

# APPENDIX C.3

## VOLUME OF CONTAMINATED SOIL
## INDUSTRIAL/COMMERCIAL AND RESIDENTIAL SCENARIOS

## References


1. HNUS (Halliburton NUS Corporation), 1995a. Post-Removal Action Report for Building 31 Lead Remediation, Naval Submarine Base – New London, Groton, Connecticut. Wayne, Pennsylvania. January.

2. HNUS,1995b. Final Action Memorandum for Quay Wall Site, Response to Discharge of Petroleum Product, U. S. Naval Submarine Base New London, Groton, Connecticut. Pittsburgh, Pennsylvania. January.

3. TtNUS (Tetra Tech NUS, Inc.), 1999. Final Lower Subase Remedial Investigation Report, Naval Submarine Base – New London, Groton, Connecticut. King of Prussia, Pennsylvania. January.


## Purpose

The purpose of these calculations is to determine the areas and volumes of soil exceeding criteria for use in alternative-specific excavation, treatment, and capping calculations and cost estimates.

## Industrial/Commercial Scenario

Under the I/C Scenario, based on the Connecticut (CT) Remediation Standard Regulations (RSRs), volumes are estimated for soil remediation using the following rules (when ELURs are in place):

- Direct exposure criteria (DEC) in the top 2 feet for soil beneath pavement.
- DEC in the top 4 feet for soil in unpaved areas.
- Pollutant mobility criteria (PMC) from the ground surface to the seasonal high groundwater table.
- No DEC or PMC soil remediation necessary beneath buildings.
- Non-aqueous phase liquid (NAPL) to be removed to the extent practical.

### Geostatistical Kriging

Geostatistical kriging was performed based on the Lower Subase RI (Ref 3) analytical data base. Analytical results, data density, and sample locations (x-y-z coordinates for 3-D kriging or x-y coordinates for 2-D kriging) were incorporated into the kriging. A technical memorandum describing the approach taken for 3-D kriging has been attached to this appendix. A description of the approach taken for 2-D kriging was provided in the Lower Subase RI (Ref 3). Where possible and appropriate, geostatistical kriging was used to estimate the volume of soil exceeding DEC or PMC ("exceedance soil,"). In general, kriging was used to estimate soil volumes where

sufficient mass analysis data was available to perform statistical evaluations. Because few data were available for leachate results, and available results were from two different test methods (TCLP and SPLP), leachate results were not kriged.

It should be noted that the geostatistics are not able to consider contaminant source, method of deposition, groundwater level, groundwater flow, sequence of site construction, or boring log comments. Therefore, while geostatistics were used as a tool, additional factors have been considered to determine a realistic volume estimate.

To simplify evaluation of numerous PAHs, a benzo(a)pyrene (BAP) equivalent concentration was used to represent all PAHs. Determination of BAP equivalent concentrations is explained on attached Sheet 16. Because 1,000 µg/kg (1 mg/kg) is the I/C DEC and GB PMC for BAP, 1,000 µg/kg was used as the I/C DEC and GB PMC for the BAP equivalent concentration. With the exception of Zone 7 PMCs, soil exceeding a BAP equivalent concentration of 1,000 µg/kg (1 mg/kg) was considered exceeding the DEC and PMC for PAHs. In Zone 7, B(b)F was the only PMC COC, therefore B(b)F was evaluated individually. In addition, if any individual PAHs were exceeded outside of the kriged area for the BaP equivalent concentration, the area and volume of that individual PAH exceedance was added.

2-D geostatistics from the Lower Subase RI (Ref 3) were used to estimate soil exceeding I/C TPH for DEC (2,500 mg/kg) and PMC (2,500 mg/kg) in Zones 5 and 6.

**Volume Estimates**

Soil was considered to be “High Lead” and incur a higher disposal cost if the mass analysis exceeded the I/C DEC criterion, i.e., 1,090 mg/kg.

Soil with TPH exceeding 2,500 mg/kg that is not ”High Lead” was considered “High TPH”. High TPH soil was identified separately because it was assumed for costing purposes that this soil would require treatment prior to disposal and because it exceeded both Industrial Direct Exposure Criteria and Pollutant Mobility Criteria for Soil at GB groundwater areas.

Soil with any PAH exceeding CTDEP I/C Direct Exposure Criteria, such as a benzo(a)pyrene concentration greater than 1,000 µg/kg, was considered “High PAH” soil. High PAH soil was identified separately because it was assumed for costing purposes that this soil would require treatment prior to disposal.

For Zones 1, 2, 3, 4, and 7, three-dimensional (3-D) geostatistical concentration estimates (kriging) were used to determine the estimated volumes of soil with concentrations of TPH, lead, and PAHs greater than criteria. Two-dimensional kriging from the Lower Subase RI was used for Zones 5 and 6. In general, volumes were estimated as the kriged area times 2 feet for soil exceeding DEC or the kriged area times the thickness of soil from the ground surface to mean high water (approximately El. 1).

For Zone 7 lead, the kriged area varied with depth, therefore the contaminated volume was obtained using the Volumetrics module in the Mining Visualization System (MVS) software package. The data was subset to Zone 7, the elevation intervals corresponding to the ground

surface and mean high water, and the isoconcentration of 1090 mg/kg for lead. The Total Soil Volume from the Volumetrics module was used as the Volume of Contaminated Soil and this was confirmed by support staff at CTech (Sheet 19).

In addition, sample and groundwater depths were compared for each zone on Tables PMC-1 through PMC-12 (included in Appendix B.2). Only I/C exceedance samples with the entire sample above the water table were highlighted as exceedances.

Asphalt was assumed to be 3 inches thick over all excavation areas except for the grassed portions of Zone 5. Excavated asphalt would be segregated and handled separately. For the purpose of the I/C scenario volume and cost estimates, small grassed and gravel areas in zones other than Zone 5 would be treated as asphalt covered. Pavement would be replaced over all currently paved areas, and the grassed area in Zone 5 would be restored with 6 inches of topsoil.

For costing purposes, it was assumed that hand excavation would be used as required around buried utilities. It was assumed that most utilities are buried 3 feet deep or deeper. Excavation volumes were determined assuming vertical sidewalls without shoring of building foundations, sheet piles, or cutting back excavation sidewalls because soil has been previously excavated at Zone 3 to a depth of 6 feet with vertical sidewalls. Dewatering of excavated soil is not considered because I/C scenario criteria apply to soil above the water table.

Ground surface elevations vary across the Lower Subase, and generally range from El. 5 feet North American Vertical Datum of 1988 (NAVD88) mean sea level (msl) near the river to El. 11 near the railroad tracks.

**Tabulated Volumes**

Total excavation areas and volumes for each zone and the combined totals for the Lower Subase under the I/C Scenario are presented on Sheet 17.

**Zone 1**

**Lead** - Tables Soil-30 and Soil-32,(Appendix B.2) indicate that in Zone 1, lead is a PMC COC but not a DEC COC. To further evaluate Zone 1 results, Table PMC-1 (Appendix B.2) shows which results exceed the PMC and whether or not they are above the water table. Table PMC-1 shows that one location slightly exceeds the lead PMC of 0.15 mgL – 13MW20 (0.194 mg/L based on TCLP). SPLP testing is planned for the Pre-Design Investigation (PDI) at this location. It is anticipated that soil at this location will pass SPLP testing, therefore the estimated volume of soil to remediate for PMC lead is zero.

**TPH** – Table PMC-1 determines that all of the soil samples exceeding 2,500 mg/kg are below the water table and not applicable to the PMC. Although 3-D kriging estimated some soil above the water table exceeded the DEC/PMC criteria (2,500 mg/kg), none of the few samples analyzed above groundwater exceeded criteria, and boring logs did not indicate stains, diesel odors, or oily contamination above the water table. Therefore, for the purpose of estimating TPH soil remediation volumes for this FS, it is assumed that no Zone 1 soil above the water table exceeds 2,500 mg/kg.

**PAHs -**

- **DEC -** There were no PAH surface (top 2 feet) samples in Zone 1; therefore estimates of surface soil contamination was based on 3-D kriging. Kriging of BAP equivalent concentration in the top 2 feet, based on kriging of deeper samples, is presented on Worksheet 1. The kriged area exceeding a BAP equivalent concentration of 1,000 µg/kg is indicated in yellow and orange. The yellow and orange red-lined area on Worksheet 1 area multiplied by a 2-foot depth was used to estimate the volume of soil exceeding PAH DEC.

- **PMC** – Although Alternative PMCs are not applicable in areas with NAPL, the three locations with BAP equivalent concentrations > 1 mg/kg have TPH < 7,500 mg/kg, therefore those locations do not have NAPL (see Appendix C.2) and alternative PMCs may be used. Alternative PAH PMCs (Table Soil-4) are exceeded only at TB2-1RI and TB4-1RI. Using the Alternative PMCs presented on Table Soil-4, soil would need a BAP equivalent concentration of 37,000 µg/kg to exceed Alternative PMCs. However, because TB2-1RI did not have a BAP equivalent concentration greater than 37,000 µg/kg, a BAP equivalent concentration of 10,000 µg/kg was used to estimate exceedance soil around TB2-1RI. The cross-hatched orange area exceeding a BAP equivalent concentration of 10 is shown on Worksheet 1. The soil thickness from ground surface to the water table was used to estimate soil exceeding PAH PMC. Ground surface at TB2-1RI is approximately El. 6 ft msl. The groundwater table is at El. 1 ft msl and a 2 ft thickness was already accounted for to comply with the DEC, which leaves a 3-ft additional PMC thickness. At TB4-1RI, the B(b)F result at 2 to 4 feet bgs (7400 ug/kg) only slightly exceeded the criteria of 7000 ug/kg, therefore a small area of 10 feet by 10 feet to a depth of 4 feet bgs was estimated for that location.

**<u>Zone 2</u>**

**Lead** - Tables Soil-30and Soil-32 (Appendix B.2) indicate that in Zone 2, lead is a PMC COC but not a DEC COC. Table PMC-2 (Appendix B.2) shows one location that exceeds the lead PMC of 0.15 mgL – 13MW11 at 2 to 4 feet bgs (above the water table) has a mass lead of 178 J mg/kg but a TCLP lead of 8.6 mg/L. This sample is at the south end of Zone 2. Kriging delineates mass lead < 400 mg/kg, therefore kriging cannot be used to estimate soil exceeding the lead PMC. Lead in Zone 2 is believed to be related to Zone 3 soil contamination; therefore, the remediation area will extend to Zone 3, 50 ft away. The soil remediation area is a 80 ft x 80 ft square shown on Worksheet 2. A 5 ft thickness [from the ground surface (approx. El. 6) to the groundwater table (El. 1)] was used to estimate remediation volume.

**TPH** – As presented on Tables Soil-6, and Soil-8 (Appendix B.2), TPH exceeded 2,500 mg/kg. The only exceedance was at GS-22L, but as shown on Table PMC-2, this sample was below the water table. The GS-22L boring log did not indicate stains, diesel odors, or oily contamination above the water table. Therefore, for the purpose of estimating TPH soil remediation volumes for this FS, it is assumed that no Zone 2 soil above the water table exceeds 2,500 mg/kg.

**PAHs** – No PAHs are COCs in Zone 2.

## Zone 3

**Lead** - Tables Soil-30 and Soil-32 (Appendix B.2) indicate that in Zone 3, lead is a COC for both DEC and PMC. Tables PMC-3 and PMC-4 (Appendix B.2) were used to determine PMC exceedances that were above the water table. Soil beneath former Building 31 is indicated on Tables PMC-3 and PMC-4 in yellow. Lead-contaminated soil beneath Building 31 was remediated and the concrete floor was replaced. The building (but not the concrete floor) has since been demolished and the area has been paved. Because the concrete building floor remains, soil beneath former Building 31 is considered inaccessible for direct exposure and environmentally isolated for pollutant mobility.

Lead-contaminated soil around Building 31 at Bullhead Road and between Buildings 31 and 78 was excavated laterally to clean soil (< 500 mg/kg lead), and vertically to groundwater, then replaced with clean fill. At Albacore Road, however, the 140-foot long 6-foot deep excavation was stopped at a width of approximately 10 feet even though composite samples from the south wall (EXSW-ALBACORE-06), south end of the west wall (EXWW-ALBACORE-06), and north end of the west wall (2-EXWW-ALBACORE-06) exceeded 1090 mg/kg. Note that although EXSW-ALBACORE-06, EXWW-ALBACORE-06, 2-EXWW-ALBACORE-06, and EXNW-ALBACORE-06 are presented as samples at specific depths; these are actually composites of grab samples at various depths along the respective excavation wall. Because kriging uses only point data, samples EXWW-ALBACORE-06 and 2-EXWW-ALBACORE-06 were incorporated using nine points at three elevations along the length and depth of the west wall of the Albacore Road excavation. In addition, as shown on Table PMC-4, soil exceeded the lead DEC and/or PMC at 13TB18, 13TB5A, and MW1-3R1. The TCLP result at 13TB5A (south of the Albacore south wall) only slightly exceeds the Alternative PMC, and is expected to pass SPLP testing during the PDI. However, the other exceedances indicate the soil west of the Albacore Road trench is generally contaminated with lead. The area estimated to exceed I/C lead criteria is indicated with cross-hatching on Worksheet 2.

**TPH** – In Zone 3, TPH exceeded 2,500 mg/kg only at 13MW12, but as shown on Table PMC-4, this sample was below the water table. The 13MW12 boring log did not indicate stains, diesel odors, or oily contamination above the water table. Therefore, for the purpose of estimating TPH soil remediation volumes for this FS, it is assumed that no Zone 3 soil above the water table exceeds 2,500 mg/kg.

**PAHs** – No PAHs are COCs in Zone 3.

## Zone 4

**Lead** – As shown on Tables SOIL-30 and SOIL-32, lead is both a DEC and PMC COC in Zone 4. The average ground surface elevation in Zone 4 is El. 6 and groundwater table is at approximately El. 1, so the average thickness of soil above groundwater is 5 feet. The lead areas exceeding 1090 mg/kg near 13TB3A and WE4A are shown on Worksheet 2. Although SPLP results are less than the PMC, several TCLP results above the water table in the 13TB3A area exceed the PMC, therefore it is estimated that soil exceeding 1090 mg/kg also exceeds the lead

PMC. The volume of soil exceeding the lead criterion was estimated by multiplying the high lead (orange cross-hatched) area on Worksheet 2 by a 5 ft thickness.

**Arsenic** – Arsenic is identified as an I/C PMC in Zone 4 on Table SOIL-16, based on a comparison of all data to the PRG. However, arsenic was later screened out on Tables PMC-5 and PMC-6. No samples above the mean high water exceeded the arsenic zone-specific PMC PRG; therefore, arsenic is not a Zone 4 I/C PMC.

**TPH** – The only exceedance of TPH DEC/PMC (2,500 mg/kg) above the water table is 3440 mg/kg at 13TB4, 0 to 2 feet on Worksheet 3. Because this only slightly exceeds the DEC, the kriged area is very small.

**PAHs** – As shown on Tables SOIL-30 and SOIL-32,, PAHs are DEC COCs but not PMC COCs in Zone 4. BAP equivalent concentrations > 1 mg/kg in the top 2 feet is shown as the cross-hatched area on Worksheet 4.

## Zone 5

**Lead** – Lead is not a COC in Zone 5.

**TPH** – As shown on Tables SOIL-30 and SOIL-32, TPH is both a DEC and PMC COC in Zone 5. As shown on Tables PMC-7 and PMC-8, the only TPH exceedance is at surface soil sample 19SS1. The estimated volume of soil exceeding 2500 mg/kg is based on the 2-D kriging from the Lower Subase RI (Worksheet 5, Sheet 17). The area covered by Building 175 was not included in the remediation area. It was estimated that half of the area to be remediated is paved.

**PAHs** – No PAHs are COCs in Zone 5.

## Zone 6

**Lead** – Lead is not a COC in Zone 6.

**TPH** – As shown on Tables SOIL-30 and SOIL-32, TPH is both a DEC and PMC COC in Zone 6. As shown on Tables PMC-9 and PMC-10, the only exceedance is surface soil sample MW5-6RI. The estimated volume of soil exceeding 2500 mg/kg is based on the 2-D kriging from the Lower Subase RI (Worksheet 5).

**PAHs** – No PAHs are COCs in Zone 6.

## Zone 7

**TPH**- As shown on Tables SOIL-30 and SOIL-32, TPH is not a COC in Zone 7.

**Lead –** As shown on Tables SOIL-30 and SOIL-32, lead is both a DEC and PMC COC in Zone 7.

– **DEC -** There were five surface samples collected in Zone 7. Although none of the surface samples exceeded lead DEC or PMC, surface samples were not collected from borings with the highest subsurface lead (20MW6 and MW5-7RI); therefore estimates of surface soil contamination were based on 3-D kriging. This area is shown on Worksheet 6.

– **PMC –** PMC compliance can be determined by TCLP or SPLP testing. Not all lead mass samples locations were also tested for leachate lead. As a result, insufficient lead leachate data using a consistent test method is available for kriging.

All available lead results, both mass and leachate analyses, are presented on Tables PMC-11 and PMC-12. Cross-Section B-B (Worksheet 7) shows mass lead kriging through borings 20TB6, 20TB5, 20MMW6, MW5-7RI, and TB11-7RI, but also shows borings that are offset (and offset distances) from Cross-Section B-B to demonstrate additional lead leachate results.

Both the cross-section and tables demonstrate an extremely poor correlation between lead mass and leachate lead. Based on leachate testing, as shown on PMC-12, only one sample above groundwater, 20TB7 at 4 to 5 feet bgs (1.31 mg/L), exceeds the Zone 7 lead Alternative PMC of 0.26 mg/L. This sample is below the RCRA criteria of 5 mg/L. The lead mass concentration at 20TB7 is below 400 mg/kg.

Soil mass lead exceeding 1090 mg/kg is presented in orange at El. 0 to 2 ft. msl, the elevation of the groundwater table (Worksheet 8), and on Cross-Section B-B (Worksheet 7). Due to lack of consistent leachate data, the volume of soil mass > 1090 mg/L was used as an estimate of soil exceeding the PMC. Using MVS software, this volume was determined to be 5,724 cubic yards between El. 7 and El. 1. Subtracting 251 cubic yards for asphalt, that leaves 5,473 cubic yards of soil > 1,090 mg/kg above groundwater. Because the area of soil exceeding lead criteria increases with depth (comparing Worksheets 6 and 8), some soil with lower lead concentrations will be excavated to access soil with higher lead concentrations. This additional soil volume was considered to be suitable for reuse at NS-NLON.

In addition, volume is included for a 10 ft x 40 ft area between Building 456 and the railroad embankment (around 20TB7, see Worksheet 8).

**PAHs –**

– **DEC** - Areas exceeding a BAP equivalent concentration of 1 mg/kg (DEC) in the top 2 feet are shown as yellow and orange on Worksheet 9. The outline of the lead exceedance area already accounted for is also shown on Worksheet 9. Additional remediation areas for soil exceeding a BAP equivalent concentration of 1 mg/kg are identified as cross-hatched Areas A, B, C, D, and E on Worksheet 9. These areas would be remediated to a depth of 2 feet.

– **PMC** – Only B(b)F exceeded its Alternative PMC in Zone 7 soil. Soil areas exceeding the B(b)F Alternative PMC of 7.8 mg/kg are shown at 20MW3, 20MW5 and TB11-1RI, as shown on Worksheets 10 and 11. The soil around 20MW6 is already accounted for within the lead PMC volumes. The additional areas of PMC exceedance at 20MW3 (2 to 4 feet bgs) and TB11-1RI (2 to 4 bgs) are estimated as 10 ft x 10 ft each.

**Antimony –** Antinomy data is presented on Tables PMC-11 and PMC-12. Because there were no antimony leachate tests in Zone 7, the I/C direct exposure PRG of 410 mg/kg was used to estimate samples that would exceed the PMC. It was determined on Tables PMC-11 and PMC-12 that no antimony result above the groundwater table exceeded 410 mg/kg, so no results are expected to exceed the antimony PMC. A possible exception is the non-detect result at 20MW6 at 2 to 4 feet bgs, which had a high detection limit. This location will be remediated for lead.

**Arsenic** – Arsenic is an I/C PMC in Zone 7. However, the arsenic exceedance is co-located with a lead exceedance, therefore no additional area or volume is necessary for arsenic remediation.

## Residential Scenarios

Residential Scenarios were evaluated to satisfy the Navy requirement to evaluate “clean closure”. Residential Scenario COCs per zone are determined on Tables Soil-31 (DEC) and Table Soil-33 (PMC). In general, with the following COC concentrations would require remediation under the residential scenario:

- Lead concentrations > 400 mg/kg (CTDEP Residential DEC) from ground surface to a depth of 15 feet
- TPH > 500 mg/kg (CTDEP Residential DEC) from ground surface to a depth of 15 feet
- DEC of PAH COCs (vary by zone) from ground surface to a depth of 15 feet. As with the I/C scenario, multiple PAHs were represented by a BAP equivalent concentration to simplify volume estimating. Because 1,000 µg/kg (1 mg/kg) is the Residential DEC and GB PMC for BAP, 1,000 µg/kg was used as the Residential DEC and GB PMC for the BAP equivalent concentration.
- Residential PMC COCs (vary by zone) from ground surface to the seasonal high water table.

Because the DEC apply to depths of 15 feet, and because the kriged area of exceedance varies with depth, 3-D kriging of 2-foot intervals were overlaid to show the areas exceeding criteria at all depths. For Zones 1, 2, 3, 4 and 7, the ground surface elevation varies from approximately El. 5 to El 10. For a ground surface of El. 5, a depth of 15 feet bgs would be El. -10 msl. Therefore, kriged intervals from El 10 to El -10 were overlaid to show soil exceeding DEC in Zones 1, 2, 3, 4, and 7. For example, Worksheet 12 presented the areas exceeding the TPH concentration of 500 mg/kg from El 10 to El -10 in Zones 1, 2, 3, and 4.

Although the Lower Subase currently has numerous buildings and buried utilities, these will no longer be in use under the Residential Scenario; therefore these will not need to be protected during excavation under the residential scenario. It is assumed that buildings, building foundations, and utilities will be removed prior to remediation, therefore excavation and disposal cost for these items were not considered.

For excavations greater than 6 feet deep or deeper than the groundwater table, sheet piles are expected to be used; therefore, excavation volumes were estimated assuming vertical side walls.

For the residential scenario, soil below the groundwater table was identified separately because it would require dewatering prior to disposal.

Under the Residential Scenario, the top 6 inches of all excavated areas will be covered with topsoil and vegetated after the contaminated soil is excavated and the excavation is backfilled with common fill.

As with the I/C Scenario, for costing purposes, soil with lead greater than, 1,090 mg/kg was considered to be “High Lead”, soil with TPH greater than 2,500 mg/kg that is not “High Lead” is “High TPH”, and soil with a BAP concentration greater than 1,000 µg/kg was considered “High PAH” soil.

Soil with lead concentrations between 400 mg/kg and 1,090 mg/kg or TPH concentrations between 500 mg/kg and 2500 mg/kg is identified as such and will have lower disposal costs than “High Lead” or “High TPH” soil. Soil below Residential DEC criteria is considered clean and suitable for on-site re-use.

In general, volumes were estimated as the kriged area times 15 feet for soil exceeding DEC or the kriged area times the thickness of soil from the ground surface to mean high water (approximately El. 1.2 feet) for soil exceeding only the PMC. For Zones 1 and 2 TPH and Zones 4 and 7 lead, the contaminated volumes were obtained using the Volumetrics module in the MVS software package. The data was subset to the appropriate zone, the elevation intervals corresponding to the ground surface and 15 ft bgs, and the isoconcentration of 500 mg/kg for TPH or 1090 mg/kg for lead. The Total Soil Volume from the Volumetrics module was used as the Volume of Contaminated Soil and this was confirmed by support staff at CTech (Sheet 19). The volume estimates for soil exceeding 2,500 mg/kg TPH (“High TPH” disposal cost) to a depth of 15 feet bgs in Zones 1, 2, 3, and 4 presented on Sheet 20 were from Appendix C.2.

**Tabulated Volumes**

Total excavation areas and volumes for each zone and the combined totals for the Lower Subase under the Residential Scenario are presented on Sheet 18.

**Zone 1**

It is estimated that the Building 29 foundation, USTs east of Building 29, and USTs east of TB6-1RI extend down vertically to the high tide water elevation, El. 1. Therefore these areas will be subtracted from excavation volumes of soil above the water table.

It is assumed that Building 490 is constructed on a pier and no soil exists beneath this building, therefore the area beneath this building was not included in the estimated soil volumes.

**Lead** - Tables Soil-31 and Soil-33 (Appendix B.2) indicate that in Zone 1, lead is a PMC COC but not a DEC COC. To further evaluate Zone 1 results, Table PMC-1 (Appendix B.2) determines which results exceed the PMC and whether or not they are above the water table. Where there are no leachate tests, it is assumed that mass lead > 1090 mg/kg will exceed the PMC. Table PMC-1 shows that one location slightly exceeds the lead PMC of 0.15 mgL – 13MW20 (0.194 mg/L based on TCLP). SPLP testing is planned for the PDI at this location. It would be expected that soil this location will pass SPLP testing, therefore the estimated volume of soil to remediate for PMC lead is zero.

**TPH** –Three-dimensional kriging of the Residential TPH DEC criteria on Worksheet 12 reveals that nearly all of Zone 1 exceeds 500 mg/kg TPH. At locations where 500 mg/kg is not exceeded near the surface but is exceeded at depth, surface soil would require excavation to access deep contaminated soil.

The average ground surface elevation in Zone 1 is approximately El. 8 msl (Sheet 19). The Volumetrics module of the Mining Visualization System (MVS) software determined 59,985 cubic yards of soil exceeding 500 mg/kg TPH within Zone 1 boundaries between E.l. 8 and E. -7 (Sheet 19) of which 14,455 cy exceeded 2,500 mg/kg TPH (Sheet 20). The groundwater table is a approximately El l, so on average across Zone 1, 7 ft of soil is above the water table and 8 feet of soil is below the water table.

The MVS software estimate did not account for the Building 29 foundation and USTs ABCD and EFGKL, so soil at these locations was be subtracted from the kriged soil volumes. Kriged TPH concentrations > 500 mg/kg beneath Building 29 were mostly below El 1, however, this volume was not subtracted from high TPH soils.

**PAHs** - Samples exceeded the BAP equivalent concentration of 1 mg/kg at TB2-1RI, TB3-1RI, and TB4-1RI at ground surface, and at TB2-1RI and TB4-1RI in deeper samples. Overlaying Worksheet 12 (TPH for El 10 to El -10) with Worksheet 1 (PAH at El 8 to 10), the low TPH concentration soil around 13MW20 on Worksheet 12 is filled in by PAH exceedance soil around TB4-1RI (Worksheet 13). Only the areas near GS-26L and TB7-1RI and a small area near 13MW20 (shown in green on Worksheet 13) remain acceptable for residential use. The PAH concentrations near 13MW20 fall below 1,000 ug/kg at El. -4, so this area has a thickness of 12 ft (El. 8 minus -El.4)

Where soil exceeds criteria for both TPH and PAHs, it is identified as high TPH for costing disposal. Only soil exceeding BAP equivalent concentration on 1,000 ug/kg that is below 500 mg/kg TPH was identified as high PAH soil. Comparing Worksheets 1 and 12, the volume of high PAH soil overlying high TPH soil was estimated at 150ft x 70 ft x 7 ft = 2700 cy

**Zone 2**

**Lead** - Tables Soil-31 and Soil-33 (Appendix B.2) indicate that in Zone 2, lead is a PMC COC but not a DEC COC. As discussed under the Industrial Scenario, 80 ft x 80 ft square shown on Worksheet 2 (Sheets 4 and 17) will be used to estimate PMC lead exceedance soil near 13MW11. A 5 ft thickness [from the ground surface (approx. El. 6) to the groundwater table (El. 1)] was used to estimate remediation volume. As shown on Table PMC-2, only 13TB11 (404 mg/kg) at 4 to 6 feet bgs exceeded the DEC PRG of 400 mg/kg.

**TPH** – TPH 3-D kriging for Zone 2 is presented on Worksheet 12. MVS software determined a volume of 6,115 cubic yards of soil exceeding 500 mg/kg TPH in Zone 2 from the average ground surface elevation of El 9 to a depth of 15 feet (Sheet 19), of which 185 cubic yards exceeded 2,500 mg/kg TPH (Sheet 20). The groundwater table is a approximately El I, so on average across Zone 2, 8 ft of soil is above the water table and 7 feet of soil is below the water table.

**PAHs** – No PAHs are COCs in Zone 2.

**Zone 3**

**Lead –** Tables Soil-31 and Soil-33 (Appendix B.2) indicate that in Zone 3, lead is a DEC and PMC COC.

A review of the Lower Subase RI (TtNUS, 1999) and Post-Removal Action Report for Building 31 Lead Remediation (HNUS, 1995a) reveals that soil beneath the floor of Building 31 that exceeded 500 mg/kg total lead was excavated, stabilized, and replaced. Figure 1-7 based on the Post-Removal Action Report (Sheet 21) shows the excavation cells within Building 31, excavation areas outside Building 31, and the excavation bottom elevations.

Although stabilized soil needed to meet a criteria of 5 mg/L TCLP extractable lead prior to replacement under Building 31, the stabilized soil TCLP actually averaged 0.093 mg/L. Therefore stabilized soil under Building 31 passes the residential PMC. However, stabilization did not change the total lead concentration; therefore none of the stabilized soil will pass the residential DEC criteria (500 mg/kg) and so must be re-excavated under the Residential Scenario.

Excavation under Building 31 was continued until soil passed criteria or until the excavation depth met mean low tide. Verification samples were not required for Cells 4, 5, 6, 8, and 9 because the bottom of the excavations coincided with mean low tide (approximate El 2).

Although the DEC applies to a depth of 15 ft, analyses within the building were performed to a depth of only 7 ft, so the analyses of soil between 7 and 15 ft bgs are unknown. A contamination depth of 10 ft bgs was assumed for soil beneath former Building 31 and Albacore Road. Building 31 and cell dimensions were based on Figure 1-7 (Sheet 21). The concrete foundation slab was assumed to be 9 inches thick and the overlying asphalt was assumed to be 3 inches thick. Sheet 18 presents the estimated volumes of high lead soil (stabilized and unstabilized), asphalt, and concrete to be excavated from within the footprint of former Building 31. TCLP lead exceedances

at SB13, SB15, SB27 and 13TB7 would be expected to pass SPLP testing. Lead exceedances at SB13, BLDG31/78_N, and 13TB7 would be expected to add minimal additional soil volumes.

As discussed in the Post-Removal Action Report, a laboratory study was performed to determine the shear strength of the stabilized sandy soil. To simulate expected field procedures, soil was stabilized with 5 percent Portland cement and left in a loose pile for 3 or 4 days prior to compaction, curing, and testing. This method did not achieve an unconfined compressive strength of 50 psi, but did achieve direct shear test results with strength at least equal to those of the original untreated soil, thus was considered acceptable. Based on this information, excavation of the stabilized soil should be similar to that of unstabilized soil. However, if the stabilized soil was compacted immediately after stabilization, material strength could be significantly higher and excavation will be difficult. Also, the additional curing time may have allowed for a significant increase in material strength.

Previously excavated areas outside of Building 31 (along Albacore Road, Bullhead Road, and the space between Buildings 31 and 78) were backfilled with clean soil. The Bullhead Road and space between Building 31 and 78 excavations were discontinued when the bottom of the excavation passed criteria. The Albacore Road excavation was discontinued at a depth of 6 feet because of concrete structures and pipes even though the composite sample indicated that the bottom was still contaminated.

The Albacore Road excavation is identical to the I/C scenario, except that under the Residential Scenario, the Albacore Road excavation bottom also exceeds criteria. Therefore, Albacore Road would have to be re-excavated under the Residential Scenario to the previous excavation elevation. The clean backfill will be excavated and stockpiled. From there, the bottom would be further excavated until soil passed criteria. It is estimated that this location would require an additional 4 feet of excavation to reach soil that passes criteria. The additional 4 feet below the Albacore Road will be “High Lead” soil, based on a lead level greater than 1,090 mg/kg.

The remaining Zone 3 excavation volumes were calculated as discrete areas around each tag, following the same general method as for the I/C Scenario.

Excavation volumes and areas outside Building 31, as well as Zone 3 totals, are presented on Sheet 18.

**TPH –** Tables Soil-31 and Soil-33 (Appendix B.2) indicate that in Zone 3, TPH is a DEC and PMC COC. As shown on Table PMC-4A, TPH greater than 500 mg/kg occur at 13TB5A (1.5 to 3.5 feet bgs), MW1-3RI (2 to 4 feet bgs), MW2-3RI (2 to 3.5 feet bgs), and 13MW12 (8 to 10 feet bgs). Locations 13TB5A, MW1-3RI, and MW2-3RI are included in soil exceeding lead criteria. The area of soil exceeding 500 mg/kg near 13TB5 and 13MW12 is shown on Worksheet 12. It is expected that soil to 6 feet bgs is less than 500 mg/kg and soil from 6 ft to 14 feet bgs exceeds 500 mg/kg TPH at 13MW12. MVS software determined a soil volume of 1 cubic yard of soil exceeding 2500 mg/kg TPH in Zone 3 at 13MW12 (Sheet 20).

Kriging indicating soil greater than 500 mg/kg under Buildings 31 and 78 is considered to be due to anomalies.

**PAHs -** Tables Soil-31 and Soil-33 (Appendix B.2) indicate that in Zone 3, benzo(a)anthracene is a DEC COC but not a PMC COC. The area exceeding a BAP equivalent concentration of 1,000 µg/kg on Worksheet 1 is approximately 80 feet by 100 feet. Because the BAP equivalent concentration exceeded 1,000 ug/kg at both depths sampled at TB4-3RI, a depth of 15 feet was estimated for this area.

**Zone 4**

As shown on Tables SOIL-31 and SOIL-33, lead, TPH, and PAHs are all both DEC and PMC COCs for the Residential Scenario. Overlying lead (Worksheet 2), PAHs, (Worksheet 4), and TPH (Worksheet 12) results in the remediation area shown on Worksheet 14. It is estimated that the lead/TPH areas is contaminated to a depth of 12 feet. As shown on Worksheet 15, kriging of the BAP equivalent concentration greater than 1,000 ug/kg at MW1-4RI extends only to a depth of 4 feet.

MVS software determined 4,202 cubic yards of lead greater than 1,090 mg/kg (the criteria for "High Lead" soil) (Sheet 19) and 787 cubic yards of soil with TPH greater than 2,500 mg/kg (the criteria for "High TPH" soil) (sheet 20).

**Arsenic** – Arsenic is identified as a Residential PMC in Zone 4 on Table SOIL-17, based on a comparison of all data to the PRG. However, arsenic was later screened out on Tables PMC-5 and PMC-6A. No samples above the mean high water exceeded the arsenic zone-specific residential PMC PRG of 0.10 mg/L; therefore arsenic is not a Zone 4 PMC.

**Zone 5**

**Lead –** Tables Soil-31 and Soil-33 (Appendix B.2) indicate that in Zone 5, lead is a not DEC COC but is a PMC COC. Soil exceeds the lead PMC at 19MW2 (4 to 6 feet bgs) based on TCLP testing, but SPLP results at nearby TB6-5RI are 2J ug/L at 2 to 4 feet bgs and 1.6J ug/L at 5.5 to 6.5 feet bgs. Also, all mass lead results in Zone 5 are less than 100 mg/kg. Soil at 19MW2 will be tested using SPLP during the PDI and is expected to pass the Zone 5 lead residential PMC based on SPLP testing. Soil at 19SS1 (0 to 0.5 feet bgs), also exceeds the residential lead PMC, but is within the TPH area. As a result, soil results exceeding PMC lead in Zone 5 do not increase the soil volume.

**TPH –** Tables Soil-31 and Soil-33 (Appendix B.2) indicate that in Zone 5, TPH is a DEC and PMC COC. The area of shallow soil (to 4 feet bgs) exceeding 500 mg/kg TPH is estimated on Worksheet 16, using 2-D kriging presented in the Lower Subase RI Report. As shown on Table PMC-8, groundwater occurs at an approximate depth of 3 feet bgs. The area of deep soil exceeding 500 mg/kg TPH is estimated using the kriging presented on Worksheet 17. It is estimated that deep soil exceeds 500 mg/kg for an additional 4 foot depth. On Worksheet 16, the deep and shallow areas of TPH greater than 500 mg/kg are overlaid to show the total area requiring remediation. "High TPH" shallow soil was estimated at 234 cubic yards, from Sheet 17 (I/C Scenario). "High TPH" deep soil was estimated using kriging for soil greater than 2,500 mg/kg on Worksheet 17.

**PAHs –** Tables Soil-31 and Soil-33 (Appendix B.2) indicate that in Zone 5, PAHs are DEC and PMC COCs. As shown on Figure 2-10, DEC exceedances of benzo(a)pyrene and benzo(b)fluoranthene are at TB4-5RI and PMC exceedances of methylene chloride and 2-methylnaphthalene are at 19MW3 and TB1-5RI. These locations are within the TPH area, so no additional volume is estimated for PAHs.

**Zone 6**

**Lead –** Tables Soil-31 and Soil-33 (Appendix B.2) indicate that in Zone 6, lead is a not DEC or PMC COC.

**TPH –** Tables Soil-31 and Soil-33 (Appendix B.2) indicate that in Zone 6, TPH is a DEC and PMC COC. The area of shallow soil exceeding 500 mg/kg TPH is estimated on Worksheet 16, using 2-D kriging presented in the Lower Subase RI Report. As shown on Table PMC-10, groundwater occurs at an approximate depth of 3 feet bgs. The area of deep soil exceeding 500 mg/kg TPH is estimated using the kriging presented on Worksheet 17A. It is estimated that deep soil exceeds 500 mg/kg for an additional 4 foot depth. The deep and shallow areas of TPH greater than 500 mg/kg do not overlap, so these areas are added to determine the total remediation area. "High TPH" shallow soil was estimated at 733 cubic yards, from Sheet 17 (I/C Scenario). Worksheet 17 and Table PMC-10 indicate that none of the deep soil exceeds 2,500 mg/kg.

**PAHs –** Tables Soil-31 and Soil-33 (Appendix B.2) indicate that in Zone 6, PAHs are not DEC or PMC COCs.

**Zone 7**

Because the DEC applies to a depth of 15 feet, and because the kriged area of exceedance varied with depth, 3-D kriging of 2-foot intervals were overlaid to show the areas exceeding criteria at all depths. For Zone 7, the ground surface elevation varies from approximately El. 5 to El 10. For a ground surface of El. 5, a depth of 15 feet bgs would be El. -10 msl. Therefore, kriged intervals from El 10 to El -10 were overlaid to show soil exceeding DEC COCs.

**Lead –** Tables Soil-31 and Soil-33 (Appendix B.2) indicate that in Zone 7, lead is a residential DEC and PMC COC. Areas exceeding 400 mg/kg lead at 2-foot depth intervals from El 10 to El. -10 is presented on Worksheet 18. The average ground surface elevation in Zone 7 is El. 7. MVS software (sheet 19) was used to determine 20,663 cubic yards of soil exceeds the "High Lead" disposal criteria of 1,090 mg/kg between El. 7 and El. -8 (sheet 19).

**Antimonyand Copper–** Tables Soil-31 and Soil-33 (Appendix B.2) indicate that in Zone 7, antimony is a DEC and PMC COC and copper is a residential DEC COC. These metals are expected to be co-located with lead.

**Arsenic** – Arsenic is a residential DEC and PMC COC. However, the arsenic exceedances are co-located with lead exceedances; therefore, no additional area or volume is necessary for arsenic remediation.

**TPH –** Tables Soil-31 and Soil-33 (Appendix B.2) indicate that in Zone 7, TPH is a residential DEC COC but not a PMC COC. Areas exceeding 500 mg/kg TPH a 2-foot depth intervals from El 10 to El. -10 is presented on Worksheet 19. As only one sample (MW5-7RI at 2 to 4 feet bgs, 2600 J) exceeded the "High TPH" criteria of 2,500 mg/kg and this location was within the "High Lead" area, no "High TPH" volume was identified.

**PAHs –** As shown on Table Soil-31 (Appendix B.2), benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene are Residential DEC COCs in Zone 7. As shown on Table Soil-33 (Appendix B.2), benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, and chrysene are Residential PMC COCs in Zone 7. Because 1,000 µg/kg (1 mg/kg) is the Residential DEC and GB PMC for BAP, 1,000 µg/kg was used as the Residential DEC and GB PMC for the BAP equivalent concentration. Areas exceeding 1,000 ug/kg BAP equivalent concentration at 2-foot depth intervals from El 10 to El. -10 is presented on Worksheet 20.

Overlaying Worksheets 18, 19, and 20, only the area indicated with red hatching does not exceed Residential DEC for lead, TPH, or PAHs. There were five locations at a depth of 6 feet with a BAP equivalent concentration greater than 1,000 ug/kg (MW2-7RI, MW5-7RI, TB1-7RI, TB2-7RI, and TB11-7RI) At depths greater than 8 feet, there are no locations exceeding BAP criteria, but there are six locations with a BAP equivalent concentration of non-detect or less than 1,000 ug/kg (20MW3, 20MW6, 20TB2, 20TB3, 20TB4, and 20TB6). Therefore it is estimated the PAH contamination extends to a depth of 8 feet bgs. As shown on Sheet 18, kriging estimates "High PAH" soil (soil exceeding 1,000 ug/kg BAP equivalent concentration) that was not also "High Lead" soil volume was estimated at 66,000 square feet times 8 feet or 19,555 cubic yards. Some TPH and Lead samples exceed criteria at depths of 12 to 14 feet. To estimate the total volume of soil exceeding any criteria, an "average" exceedance depth of 8 feet was used.

## CALCULATION OF BENZO(A)PYRENE EQUIVALENT CONCENTRATIONS

Carcinogenic polycyclic aromatic hydrocarbons (PAHs) are found as mixtures in contaminated media. Given that carcinogenic PAHs have a common toxicity mechanism, but display difference toxic potencies, a toxicity equivalency factor (TEF) approach can be used to convert individual PAH concentrations into a single concentration of the index chemical, benzo(a)pyrene. TEFs based on the potency of each carcinogenic PAH relative to that of benzo(a)pyrene are presented in USEPA's *Provisional Guidance for Quantitative Risk Assessment of Polycyclic Aromatic Hydrocarbons*, *July 1993*. The TEFs are used to convert each individual carcinogenic PAH concentration into an equivalent concentration of benzo(a)pyrene.

The benzo(a)pyrene equivalent concentration is calculated by multiplying the individual carcinogenic PAH concentration by its TEF and then summing the results. One half the detection limit was used for non-detected values. If all carcinogenic PAHs were not detected in a sample, then the detection limit for benzo(a)pyrene was used as the benzo(a)pyrene equivalent concentration. The following table presents the TEFs for the carcinogenic PAHs and a sample calculation.

| Carcinogenic PAH | Toxicity Equivalency Factor | Concentration (µg/kg) | Benzo(a)pyrene Equivalent Concentration (µg/kg) |
|---|---|---|---|
| Benzo(a)anthracene | 0.1 | 310 | 31 |
| Benzo(a)pyrene | 1 | 300 | 300 |
| Benzo(b)fluoranthene | 0.1 | 400 U | 20 |
| Benzo(k)fluoranthene | 0.01 | 190 | 1.9 |
| Chrysene | 0.001 | 430 | 0.43 |
| Dibenzo(a,h)anthracene | 1 | 87 | 87 |
| Indeno(1,2,3-cd)pyrene | 0.1 | 290 | 29 |
| Total Benzo(a)pyrene Equivalent Concentration | | | 469.33 |

| CLIENT: | Naval Submarine Base New London Lower Subase Feasibility Study | JOB NUMBER: | CTO 0424 | SUBJECT: | Excavation and Capping Quantity Calculations | | |
|---|---|---|---|---|---|---|---|
| BASED ON: | Design Drawings | DRAWING NUMBER: | | BY: | NJB | CHECKED BY: JLG | APPROVED BY: DATE: |
| | | | | Date: | 7-15-10 | Date: 12-09-09 | |

**Industrial/Commercial Scenario Summary of Soil Excavation Volumes**

| | | | | | | Volume to Excavate | | | | | | | Backfill/Restoration | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Zone | Area/Well/Boring | Excavation Area (sf) | Thickness (ft) | Total Volume (cf) | Total Volume (cy) | High Lead (cy) | Asphalt (cy) | Non-Haz (cy) | High PAH (cy) | High TPH (cy) | Vol to Re-use (cy) | Buy Clean Fill (cy) | Replace Asphalt (sf) | Buy Topsoil (sf) | Buy Topsoil (cy) | Comments |
| 1 | PAH DEC | 33,200 | 2 | 66,400 | 2,459 | 0 | 307.4 | 0 | 2,152 | 0 | 0 | 2,152 | 33,200 | 0 | 0 | |
| | Add. depth at TB2-1RI | 5,600 | 3 | 16,800 | 622 | 0 | 0.0 | 0 | 622 | 0 | 0 | 622 | 0 | 0 | 0 | |
| | Add. depth at TB4-1RI | 100 | 6 | 600 | 22 | 0 | 0.0 | 0 | 22 | 0 | 0 | 22 | 0 | 0 | 0 | |
| | **Total** | **33,200** | | **83,800** | **3,104** | **0** | **307** | **0** | **2,796** | **0** | **0** | **2,796** | **33,200** | **0** | **0** | |
| 2 | 13MW11 | 6,400 | 5 | 32,000 | 1,185 | 1126 | 59.3 | 0 | 0 | 0 | 0 | 1,126 | 6,400 | 0 | 0 | |
| | | **6,400** | | **32,000** | **1,185** | **1,126** | **59** | **0** | **0** | **0** | **0** | **1,126** | **6,400** | **0** | **0** | |
| 3 | Albacore Road | 8,775 | 5 | 43,875 | 1,625 | 1544 | 81.3 | 0 | 0 | 0 | 0 | 1,544 | 8,775 | 0 | 0 | |
| | **Total** | **8,775** | | **43,875** | **1,625** | **1544** | **81** | **0** | **0** | **0** | **0** | **1,544** | **8,775** | **0** | **0** | |
| 4 | 13TB4 | 1,200 | 2 | 2,400 | 89 | 0 | 11 | 0 | 0 | 78 | 0 | 78 | 1,200 | 0 | 0 | |
| | 13TB3A | 6,200 | 5 | 31,000 | 1,148 | 1091 | 57.4 | 0 | 0 | 0 | 0 | 1,091 | 6,200 | 0 | 0 | |
| | WE4A | 11,200 | 5 | 56,000 | 2,074 | 1970 | 103.7 | 0 | 0 | 0 | 0 | 1,970 | 11,200 | 0 | 0 | |
| | MW1-4RI | 14,800 | 2 | 29,600 | 1,096 | 0 | 137.0 | 0 | 959 | 0 | 0 | 959 | 14,800 | 0 | 0 | |
| | **Total** | **33,400** | | **119,000** | **4,408** | **3,061** | **309** | **0** | **959** | **78** | **0** | **4,098** | **33,400** | **0** | **0** | |
| 5 | 19SS1 | 2,200 | 3 | 6,600 | 244 | 0 | 10.2 | 0 | 0 | 234 | 0 | 234 | 1,100 | 1,100 | 20 | |
| | **Total** | **2,200** | | **6,600** | **244** | **0** | **10** | **0** | **0** | **234** | **0** | **234** | **1,100** | **1,100** | **20** | |
| 6 | MW5-6RI | 7,200 | 3 | 21,600 | 800 | 0 | 66.7 | 0 | 0 | 733 | 0 | 733 | 7,200 | 0 | 0 | |
| | **Total** | **7,200** | | **21,600** | **800** | **0** | **67** | **0** | **0** | **733** | **0** | **733** | **7,200** | **0** | **0** | |
| 7 | Lead > 1090 | 27,136 | 6 | 162,816 | 6,030 | 5,473 | 251 | 0 | 0 | 0 | 306 | 5,473 | 27,136 | 0 | 0 | |
| | 20TB7 (>PMC, <DEC) | 400 | 7 | 2,800 | 104 | 0 | 3.7 | 100 | 0 | 0 | 0 | 100 | 400 | 0 | 0 | |
| | PAH Area A | 13,056 | 2 | 26,112 | 967 | 0 | 120.9 | 0 | 846 | 0 | 0 | 846 | 13,056 | 0 | 0 | |
| | PAH Area B | 1,600 | 2 | 3,200 | 119 | 0 | 14.8 | 0 | 104 | 0 | 0 | 104 | 1,600 | 0 | 0 | |
| | PAH Area C | 1,664 | 2 | 3,328 | 123 | 0 | 15.4 | 0 | 108 | 0 | 0 | 108 | 1,664 | 0 | 0 | |
| | PAH Area D | 13,120 | 2 | 26,240 | 972 | 0 | 121.5 | 0 | 850 | 0 | 0 | 850 | 13,120 | 0 | 0 | |
| | PAH Area E | 30,400 | 2 | 60,800 | 2,252 | 0 | 281.5 | 0 | 1,970 | 0 | 0 | 1,970 | 30,400 | 0 | 0 | |
| | 20MW3,add 2 to 4 ft bgs | 100 | 2 | 200 | 7 | 0 | 0.0 | 0 | 7 | 0 | 0 | 7 | 0 | 0 | 0 | |
| | TB11-1RI,add 2 to 4 ft bgs | 100 | 2 | 200 | 7 | 0 | 0.0 | 0 | 7 | 0 | 0 | 7 | 0 | 0 | 0 | |
| | **Total** | **87,376** | | **285,696** | **10,581** | **5473** | **809** | **100** | **3,893** | **0** | **306** | **9,466** | **87,376** | **0** | **0** | |
| **Lower Subase Grand Total** | | **178,551** | | | **21,947** | **11,204** | **1,643** | **100** | **7,649** | **1,045** | **306** | **19,998** | **177,451** | **1,100** | **20** | |

DEC - Direct Exposure Criteria
PAH - Polycyclic aromatic hydrocarbons
PMC - Pollutant Mobility Criteria
TPH - Total petroleum hydrocarbons
High Lead - Mass lead > 1090 mg/kg or TCLP lead > 5 mg/L
High PAH - Mass Benzo(a)pyrene (BAP) Equivalents > 1 mg/kg
High TPH - Mass TPH > 2500 mg/kg and not "High Lead"
Asphalt assumed to be 3 inches thick across the Lower Subase.
Assume topsoil will be 6" thick

| CLIENT: | Naval Submarine Base New London<br>Lower Subase Feasibility Study | JOB NUMBER: | CTO 0811 | SUBJECT: | Excavation and Capping Quantity Calculations | | | |
|---|---|---|---|---|---|---|---|---|
| BASED ON: | Design Drawings | DRAWING NUMBER: | | BY:<br>Date: | NJB<br>12-09-09 | CHECKED BY: JLG<br>Date: 12-09-09 | APPROVED BY: | DATE: |

**Residential Scenario Summary of Soil Excavation Volumes**

| | | | | | | | | | Volume to Excavate | | | | | | | | Backfill/Restoration | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Zone** | **Well/Boring** | **Area (sf)** | **Thickness (ft)** | **Total Volume (cf)** | **Total Volume (cy)** | **Zone Average Depth to GWL (ft)** | **Volume above GWL (cy)** | **Volume Below GWL (cy)** | **High Lead (cy)** | **Asphalt (cy)** | **Concrete (cy)** | **Vol Non-Haz (cy)** | **Vol High PAH (cy)** | **Vol High TPH (cy)** | **Vol to Dewater (cy)** | **Vol to Re-use (cy)** | **Buy Clean Fill (cy)** | **Buy Topsoil (sf)** | **Buy Topsoil (cy)** |
| 1 | TPH area | 145,600 | 15 | 2,184,000 | 80,889 | 7 | 37,748 | 43,141 | 0 | 1,348 | | 44,182 | 2,700 | 14,455 | 43,141 | 18,204 | | 145,600 | |
| | Additional PAH area (13MW20) | 6,400 | 12 | 76,800 | 2,844 | 7 | 1,659 | 1,185 | 0 | 59 | | | 2,785 | | 1,185 | 0 | | 6,400 | |
| | Building 29 | -28,000 | 7 | -196,000 | -7,259 | 7 | -7,259 | 0 | 0 | -259 | | | 0 | | 0 | -7,000 | | | |
| | USTs ABCD | -9,000 | 7 | -63,000 | -2,333 | 7 | -2,333 | 0 | 0 | -83 | | -2,250 | 0 | | 0 | 0 | | | |
| | USTs EFGKL | -6,000 | 7 | -42,000 | -1,556 | 7 | -1,556 | 0 | 0 | -56 | | -1,500 | 0 | | 0 | 0 | | | |
| | **Total** | **109,000** | | | **72,585** | | **28,259** | **44,326** | **0** | **1,009** | **0** | **40,432** | **5,485** | **14,455** | **44,326** | **11,204** | **58,566.5** | **152,000** | **2,815** |
| 2 | GS-22L/TB8-1RI | 24,000 | 15 | 360,000 | 13,333 | 7 | | | | | | | | | | | | | |
| | 13TB8 | 1,600 | 15 | 24,000 | 889 | 7 | | | | | | | | | | | | | |
| | 13MW11 | 6,400 | 5 | 32,000 | 1,185 | 7 | | | 1,126 | 59 | | 0 | 0 | 0 | 0 | 0 | 1,126 | 6,400 | 0 |
| | **Total** | **32,000** | | | **15,407** | | **8,217** | **7,190** | **1,126** | **296** | **0** | **5,634** | **0** | **185** | **7,190** | **8,166** | **6,648.4** | **32,000** | **593** |
| 3 | Albacore Road | 1,400 | 10 | 14,000 | 519 | 6 | 311 | 207 | 207 | 13 | | 0 | 0 | 0 | 207 | 298 | 194 | 1,400 | 26 |
| | west of Albacore Road | 9,200 | 10 | 92,000 | 3,407 | 6 | 2,044 | 1,363 | 3,322 | 85 | | 0 | 0 | 0 | 1,363 | 0 | 3,237 | 9,200 | 170 |
| | Building 31 | 5,080 | 10 | 50,800 | 1,881 | 6 | 1,129 | 753 | 1,693 | 47 | 141 | 0 | 0 | 0 | 753 | 0 | 1,787 | 5,080 | 94 |
| | 13TB7/13MW12 | 3,200 | 14 | 44,800 | 1,659 | 6 | 711 | 948 | 0 | 30 | | 710 | 0 | 1 | 948 | 919 | 681 | 3,200 | 59 |
| | TB4-3RI area | 8,000 | 15 | 120,000 | 4,444 | 6 | 1,778 | 2,667 | | | | | 4,444 | | 2,667 | | | | |
| | **Total** | **26,880** | | | **11,911** | | **5,973** | **5,938** | **5,223** | **175** | **141** | **710** | **4,444** | **1** | **5,938** | **1,217** | **5,900** | **18,880** | **350** |
| 4 | Lead/TPH excavation area | 42,000 | 12 | 504,000 | 18,667 | 6 | 9,333 | 9,333 | | | | | | | | | | | |
| | MW1-4RI | 18,000 | 4 | 72,000 | 2,667 | 6 | 2,667 | 0 | | | | | 2,667 | | | | | | |
| | **Total** | **60,000** | | | **21,333** | | **12,000** | **9,333** | **4,202** | **556** | **0** | **8,748** | **2,667** | **787** | **9,333** | **4,374** | **15,848** | **60,000** | **1,111** |
| 5 | Shallow TPH > 500 mg/kg | 42,998 | 4 | 171,990 | 6,370 | 3 | 4,778 | 1,593 | 0 | 398 | | 5,123 | 0 | 234 | 1,593 | 615 | 4,958 | 42,998 | 796 |
| | Deep TPH > 500 mg/kg | 26,460 | 4 | 105,840 | 3,920 | 3 | 0 | 3,920 | 0 | 0 | 0 | 3,491 | 0 | 429 | 3,920 | 0 | 3,920 | 0 | 0 |
| | **Total** | **42,998** | | | **10,290** | | **4,778** | **5,513** | **0** | **398** | **0** | **8,614** | **0** | **663** | **5,513** | **615** | **8,878** | **42,998** | **796** |
| 6 | Shallow TPH > 500 mg/kg | 41,675 | 4 | 166,698 | 6,174 | 3 | 4,631 | 1,544 | 0 | 386 | | 5,055 | 0 | 733 | 1,544 | 0 | 5,402.3 | 41,675 | 772 |
| | Deep TPH > 500 mg/kg | 17,420 | 8 | 139,356 | 5,161 | 3 | 1,936 | 3,226 | 0 | 161 | | 2,581 | 0 | 0 | 3,226 | 2,419 | 2,419 | 17,420 | 323 |
| | **Total** | **59,094** | | | **11,335** | | **6,566** | **4,769** | **0** | **547** | **0** | **7,636** | **0** | **733** | **4,769** | **2,419** | **7,822** | **59,094** | **1,094** |
| 7 | Worksheet 20 | 213,760 | 8 | 1,710,080 | 63,336 | 6 | 25,335 | 38,002 | 20,663 | 1,979 | | 20,760 | 19,555 | 0 | 38,002 | 379 | 58,999 | 213,760 | 3,959 |
| | **Total** | **213,760** | | | **63,336** | | **25,335** | **38,002** | **20,663** | **1,979** | **0** | **20,760** | **19,555** | **0** | **38,002** | **379** | **58,999** | **213,760** | **3,959** |
| **Lower Subase Grand Total** | | **543,732** | | | **206,199** | | **91,128** | **115,071** | **31,214** | **4,960** | **141** | **92,533** | **32,151** | **16,824** | **115,071** | **28,375** | **162,662** | **578,732** | **10,717** |

DEC - Direct Exposure Criteria
PAH - Polycyclic aromatic hydrocarbons
PMC - Pollutant Mobility Criteria
TPH - Total petroleum hydrocarbons
High Lead - Mass lead > 1090 mg/kg or TCLP lead > 5 mg/L
High PAH - Mass Benzo(a)pyrene (BAP) Equivalents > 1 mg/kg
High TPH - Mass TPH > 2500 mg/kg and not "High Lead"
Asphalt assumed to be 3 inches thick across the Lower Subase.
Assume topsoil will be 6" thick

| | | | | |
|---|---|---|---|---|
| CLIENT: | Naval Submarine Base New London<br>Lower Subase Feasibility Study | | JOB NUMBER: | CTO 0811<br>0265 |
| SUBJECT: | Determine Soil Volumes at Specific Concentrations | | | |
| BASED ON: | Design Drawings | | DRAWING NUMBER: | |
| BY:<br>Date: | SP<br>7/14/2010 | CHECKED BY:<br>Date: | APPROVED BY: | DATE: |

| Chemical | Zones | Isoconcentration | Elevation | Contaminated_Volume ** (cubic feet) | Contaminated_Volume ** (cubic yards) |
|---|---|---|---|---|---|
| **Residential Scenario** | | | | | |
| TPH | 1 | 500 mg/kg | El 8 to El -7 | 1,619,591 | 59,985 |
| TPH | 2 | 500 mg/kg | El 9 to El -6 | 165,111 | 6,115 |
| Lead | 7 | 1090 mg/kg | El 7 to El -8 | 557,898 | 20,663 |
| Lead | 4 | 1090 mg/kg | El 7 to El -8 | 113,448 | 4,202 |
| **Industrial/Commercial Scenario** | | | | | |
| Lead | 7 | 1090 mg/kg | El 7 to El 1 | 154,548 | 5,724 |

** Contaminated Volumes were obtained using the Volumetrics module in the Mining Visualization System (MVS) software package. The data was subset to the specified zones, elevation intervals, and isoconcentration level for each parameter. The Z-scale was set to the same scale that was used to generate the models for each parameter (5.0) so the software could account for this exaggeration and properly adjust the value when calculating the volumes. The Total Soil Volume from the Volumetrics module was used as the Volume of Contaminated Soil and this was confirmed by support staff at CTech. This volume is described as "the total volume of the plume...[including] all regions within your input field which meet the subsetting criteria (isolevel and geologic layer cell sets)".

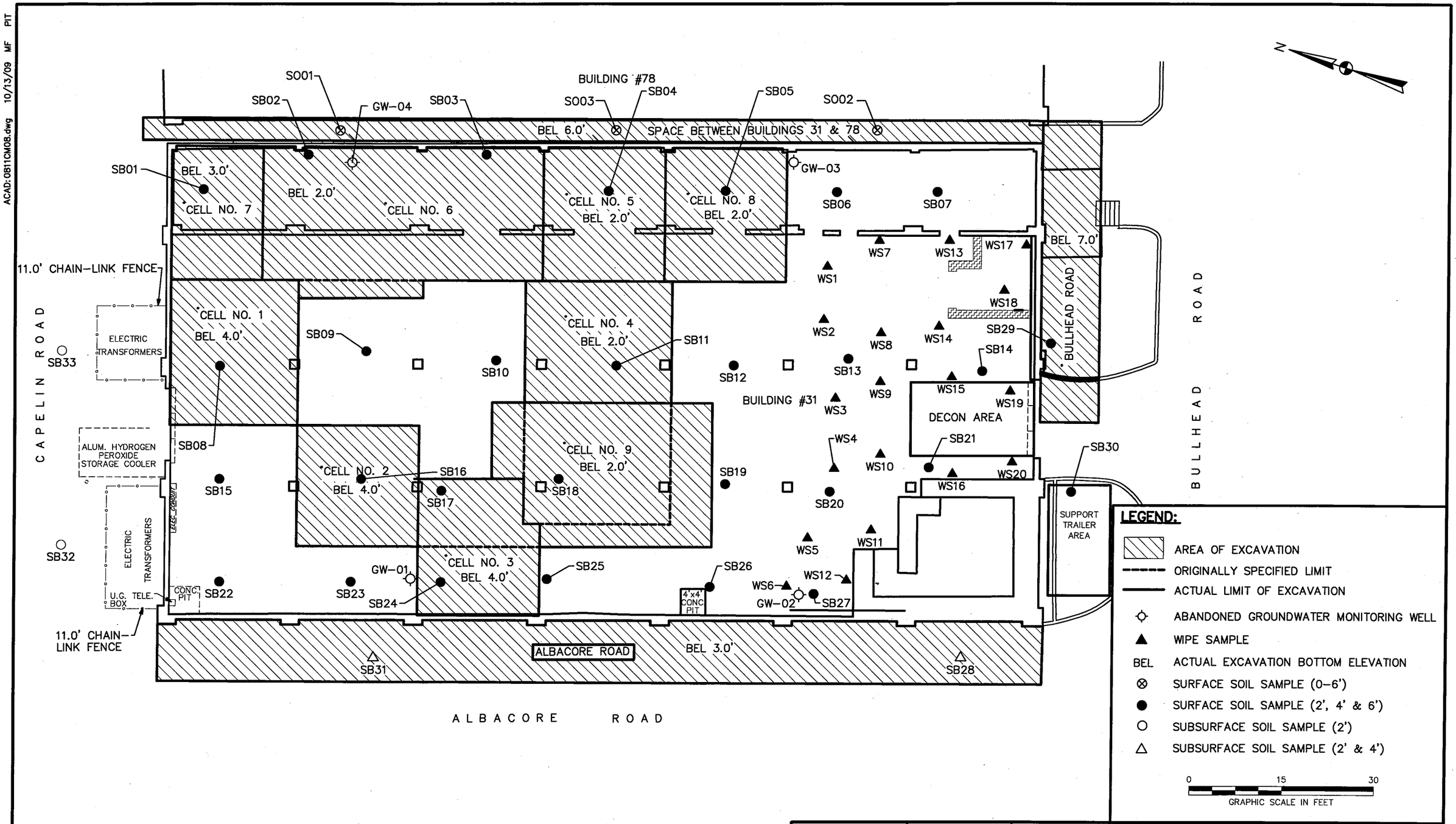
| | | | | |
|---|---|---|---|---|
| CLIENT: | Naval Submarine Base New London<br>Lower Subase Feasibility Study | | JOB NUMBER: | CTO 0811<br>0265 |
| SUBJECT: | Determine Soil Volumes at Specific Concentrations | | | |
| BASED ON: | Design Drawings | | DRAWING NUMBER: | |
| BY:<br>Date: | NJB<br>7/15/2010 | CHECKED BY:<br>Date: | APPROVED B | DATE: |

Determine volumes from El 1 to 15 feet below ground surface, stop at railroad embankment and zone boundaries.

| TPH Concentration (mg/kg) | Total Volume[1] (cubic feet) | Total Volume (cubic yards) |
|---|---|---|
| **Zone 1** | | |
| Location 1: Large area around 13MW18 to 13MW8 to TB8-1RI<br>Assume that none of the tanks or buildings go below El. 1. | | |
| ≥2,500 | 379,485 | 14,055 |
| ≥7,500 | 159,266 | 5,899 |
| ≥22,500 | 43,161 | 1,599 |
| Location 2: Area around GS25L and GS29L | | |
| ≥2,500 | 10,811 | 400 |
| ≥7,500 | 759 | 28 |
| Total: | | |
| ≥2,500 | 390,296 | 14,455 |
| ≥7,500 | 160,025 | 5,927 |
| ≥22,500 | 43,161 | 1,599 |
| **Zone 2** | | |
| Location 1: Area around GS22L | | |
| ≥2,500 | 5,000 | 185 |
| ≥7,500 | 0 | 0 |
| **Zone 3** | | |
| Location 1: Area around 13MW12 | | |
| ≥2,500 | 21 | 1 |
| **Zone 4** | | |
| Location 1: Area around 13TB2A | | |
| ≥2,500 | 5,183 | 192 |
| ≥7,500 | 24 | 1 |
| Location 2: Area around 13TB4A - include depth from ground surface to 15 feet deep, just this well | | |
| ≥2,500 | 10,282 | 381 |
| Location 3: Area around GS-9L | | |
| ≥2,500 | 5,785 | 214 |
| ≥7,500 | 3 | 0 |
| Total: | | |
| ≥2,500 | 21,250 | 787 |
| ≥7,500 | 27 | 1 |
| **Zone 7** | | |
| Location 1: Area around MW5-7RI | | |
| ≥2,500 | 109 | 4 |

(1) Volumes from Appendix C.2.

ACAD:0811CM08.dwg 10/13/09 MF PIT

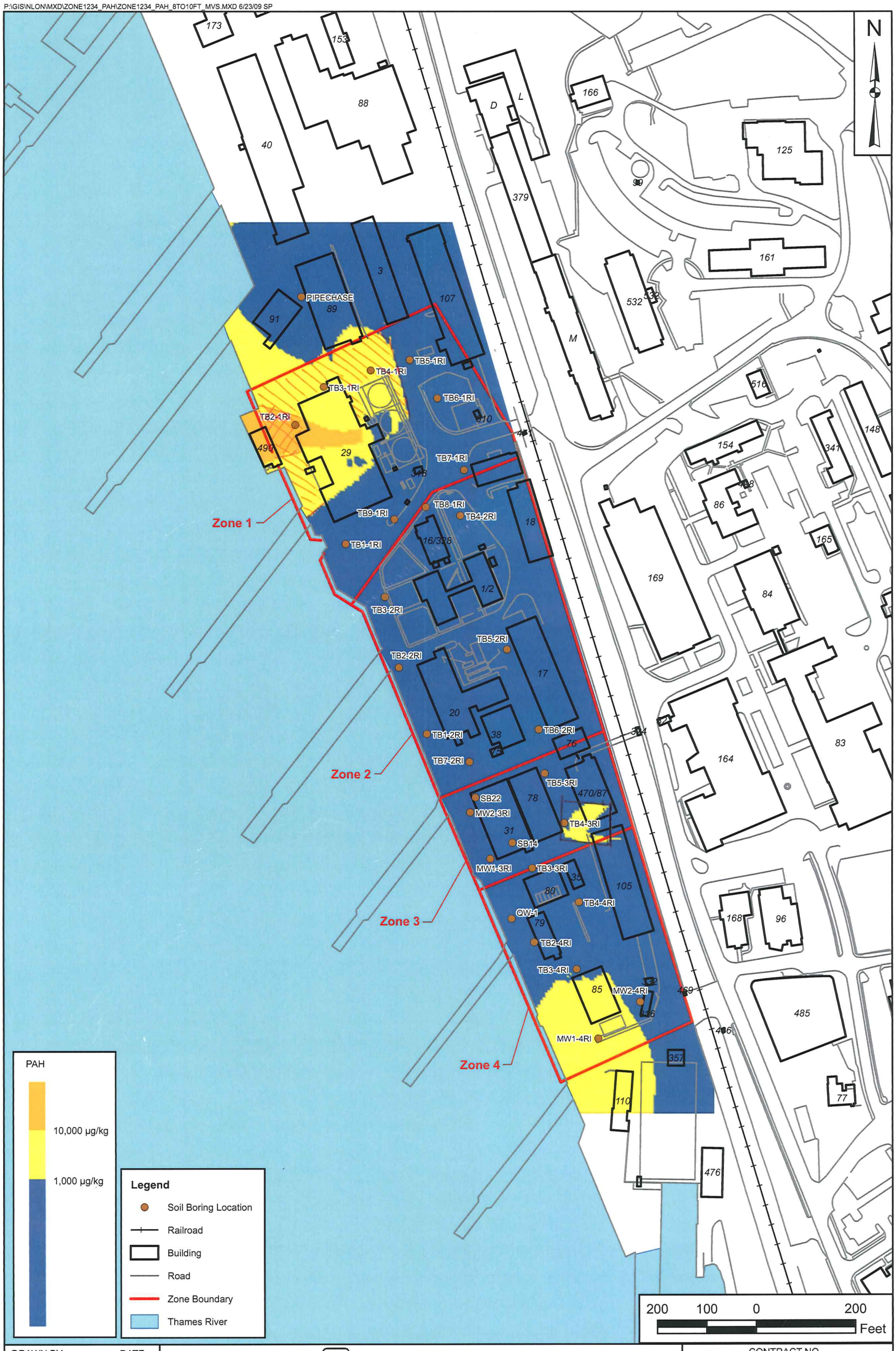



| | | | |
|---|---|---|---|
| DRAWN BY MF | DATE 3/5/08 | Tetra Tech NUS, Inc. | SITE MAP<br>AREAS OF REMEDIATION AT SITE 17<br>LOWER SUBASE FEASIBILITY STUDY<br>NSB-NLON, GROTON, CONNECTICUT |
| CHECKED BY | DATE | | |
| REVISED BY | DATE | | |
| SCALE AS NOTED | | | |

| | |
|---|---|
| CONTRACT NO. 0811 | |
| OWNER NO. 424 | |
| APPROVED BY | DATE |
| DRAWING NO. FIGURE 1-7 | REV. 0 |

FORM CADD NO. TTNUS-BH.DWG - REV 1 - 9/10/98

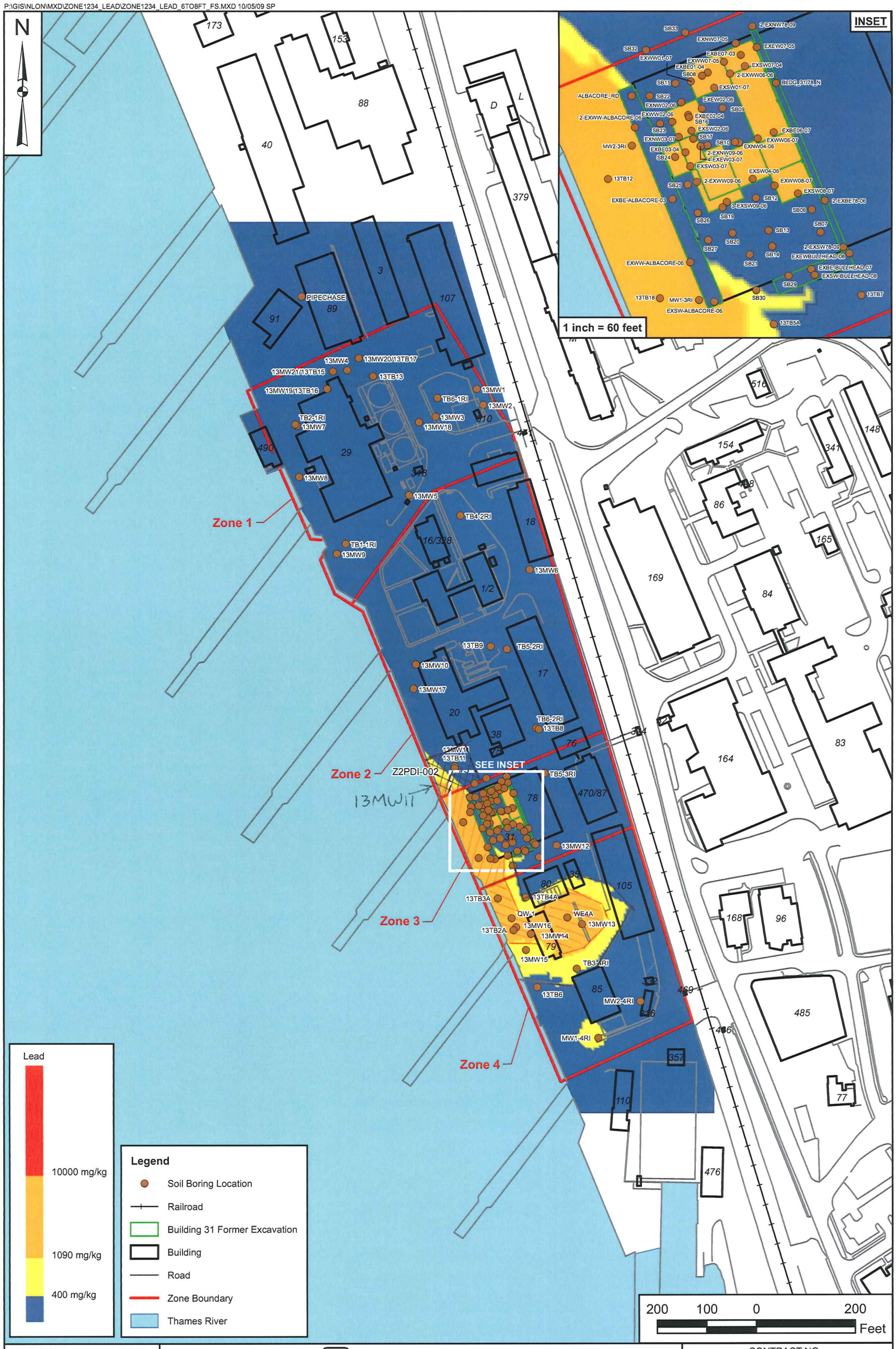
P:\GIS\NLON\MXD\ZONE1234_PAH\ZONE1234_PAH_8TO10FT_MVS.MXD 6/23/09 SP




| | | | |
|---|---|---|---|
| DRAWN BY S. PAXTON | DATE 4/02/09 | Tetra Tech NUS, Inc. | CONTRACT NO. 0811 |
| CHECKED BY N. BALSAMO | DATE 6/23/09 | ESTIMATED PAH CONCENTRATIONS (KRIGING RESULTS)<br>ELEVATION: 8 TO 10 FEET<br>ZONES 1, 2, 3, AND 4<br>NAVAL SUBMARINE BASE - NEW LONDON<br>GROTON, CONNECTICUT | APPROVED BY – / DATE -- |
| COST/SCHED-AREA | | | APPROVED BY -- / DATE -- |
| SCALE AS NOTED | | | FIGURE NO. — / REV. |

Worksheet 1

P:\GIS\NLON\MXD\ZONE1234_LEAD\ZONE1234_LEAD_6TO8FT_FS.MXD 10/05/09 SP




| | | | |
|---|---|---|---|
| DRAWN BY S. PAXTON | DATE 4/02/09 | Tetra Tech NUS, Inc. | CONTRACT NO. 2195 |
| CHECKED BY N. BALSAMO | DATE 10/05/09 | ESTIMATED LEAD CONCENTRATIONS (KRIGING RESULTS)<br>ELEVATION: 6 TO 8 FEET<br>ZONES 1, 2, 3, AND 4<br>NAVAL SUBMARINE BASE - NEW LONDON<br>GROTON, CONNECTICUT | APPROVED BY – DATE -- |
| COST/SCHED-AREA | | | APPROVED BY -- DATE -- |
| SCALE AS NOTED | | | FIGURE NO. — REV. |

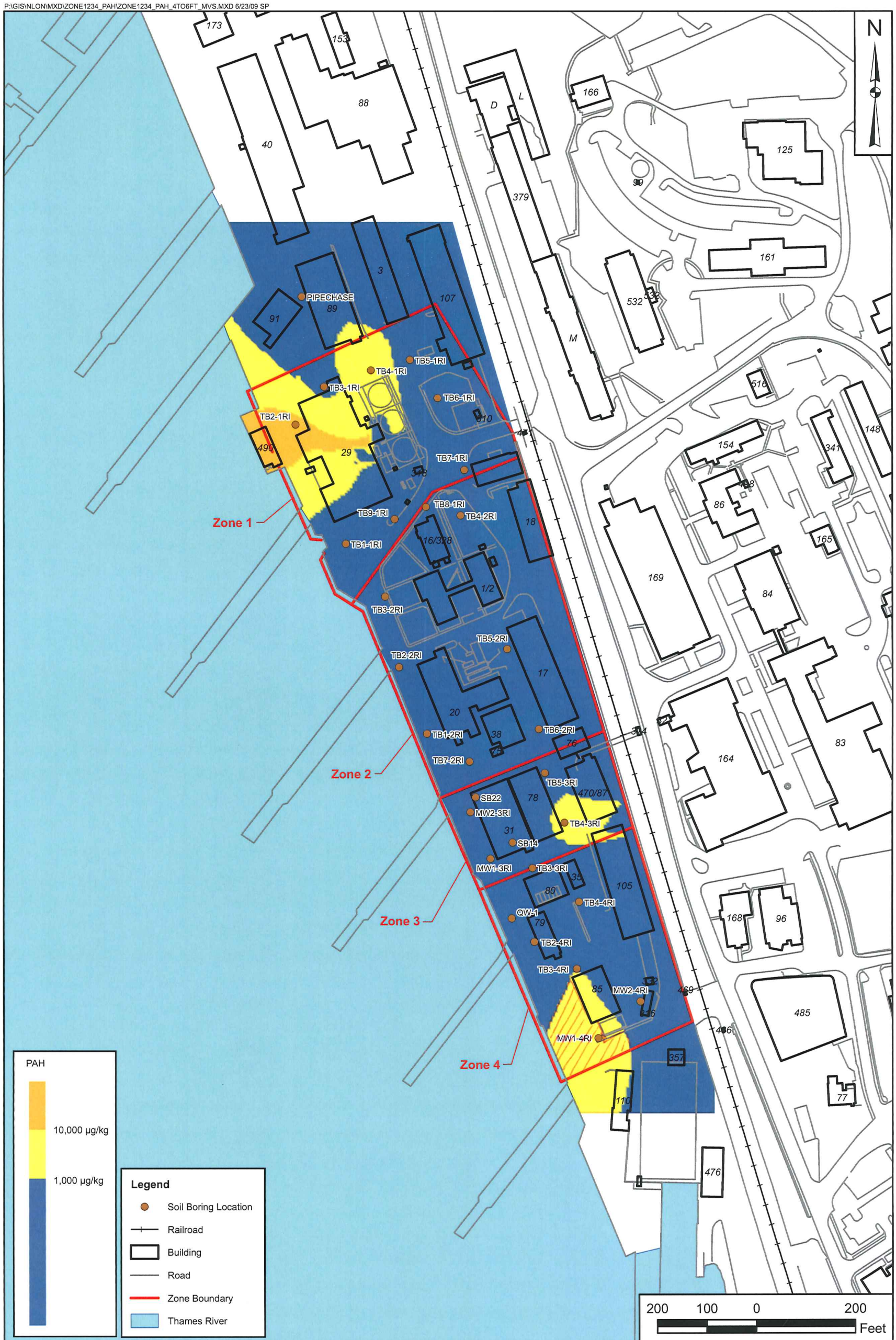
Worksheet 2

P:\GIS\NLON\MXD\ZONE1234_TPH\ZONE1234_TPH_4TO6FT_MVS.MXD 7/08/09 SP

| DRAWN BY | DATE | Tetra Tech NUS, Inc. | CONTRACT NO. 0811 | |
|---|---|---|---|---|
| S. PAXTON | 4/02/09 | | | |
| CHECKED BY | DATE | ESTIMATED TPH CONCENTRATIONS (KRIGING RESULTS)<br>ELEVATION: 4 TO 6 FEET<br>ZONES 1, 2, 3, AND 4<br>NAVAL SUBMARINE BASE - NEW LONDON<br>GROTON, CONNECTICUT | APPROVED BY | DATE |
| N. BALSAMO | 7/08/09 | | _ | -- |
| COST/SCHED-AREA | | | APPROVED BY | DATE |
| | | | -- | -- |
| SCALE | | | FIGURE NO. | REV. |
| AS NOTED | | | — | |

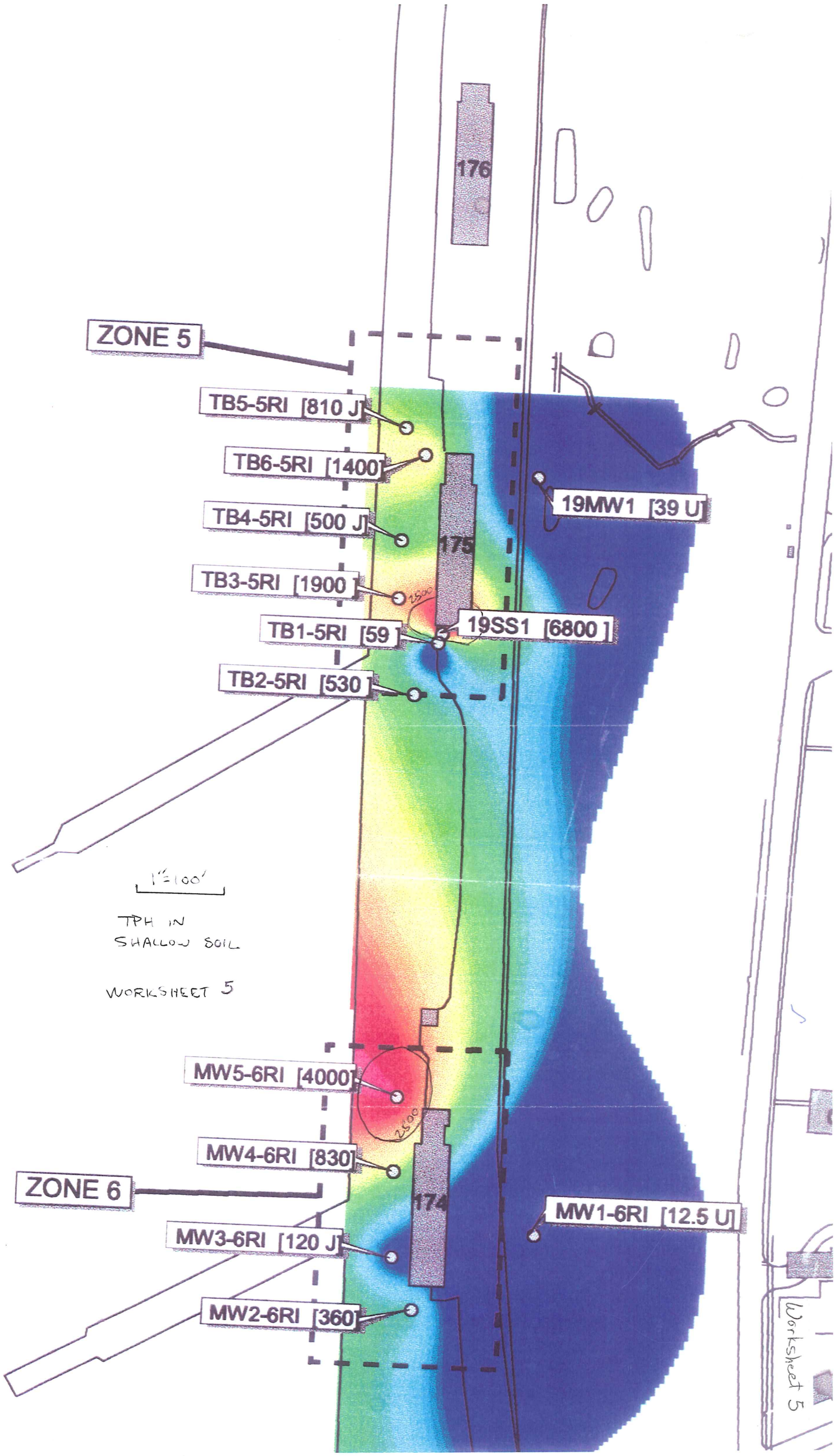
Worksheet 3

P:\GIS\NLON\MXD\ZONE1234_PAH\ZONE1234_PAH_4TO6FT_MVS.MXD 6/23/09 SP

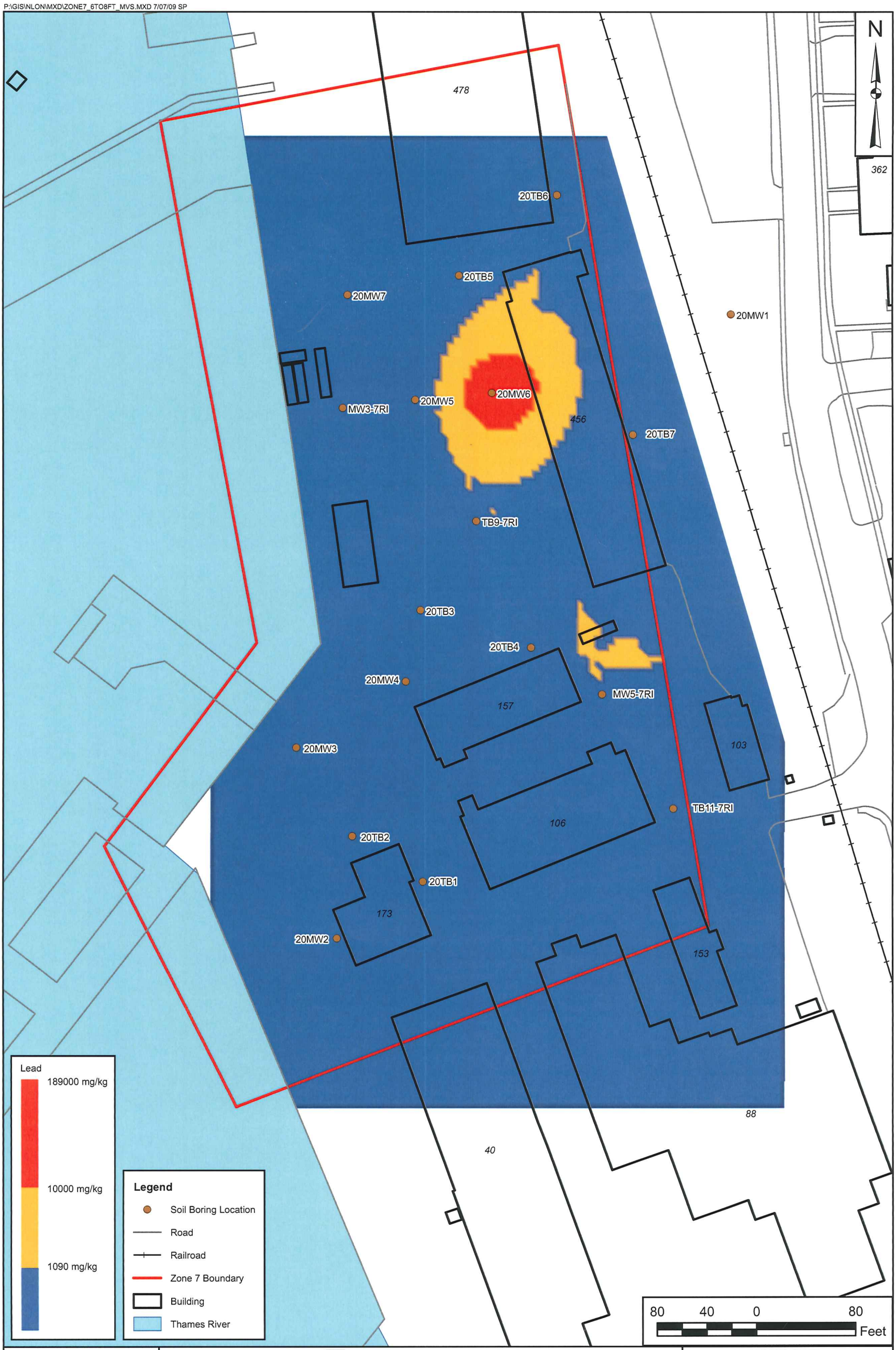



| DRAWN BY | DATE | Tetra Tech NUS, Inc. | CONTRACT NO. 0811 | |
|---|---|---|---|---|
| S. PAXTON | 4/02/09 | | | |
| CHECKED BY | DATE | ESTIMATED PAH CONCENTRATIONS (KRIGING RESULTS)<br>ELEVATION: 4 TO 6 FEET<br>ZONES 1, 2, 3, AND 4<br>NAVAL SUBMARINE BASE - NEW LONDON<br>GROTON, CONNECTICUT | APPROVED BY | DATE |
| N. BALSAMO | 6/23/09 | | – | -- |
| COST/SCHED-AREA | | | APPROVED BY | DATE |
| | | | -- | -- |
| SCALE | | | FIGURE NO. | REV. |
| AS NOTED | | | — | |

Worksheet 4


ZONE 5
TB5-5RI [810 J]
TB6-5RI [1400]
TB4-5RI [500 J]
TB3-5RI [1900]
TB1-5RI [59
TB2-5RI [530
19MW1 [39 U]
19SS1 [6800 ]
176
175
174
1500
2500
1" = 100'
TPH IN
SHALLOW SOIL
WORKSHEET 5
MW5-6RI [4000]
MW4-6RI [830]
ZONE 6
MW3-6RI [120 J]
MW2-6RI [360]
MW1-6RI [12.5 U]
Worksheet 5

P:\GIS\NLON\MXD\ZONE7_6TO8FT_MVS.MXD 7/07/09 SP

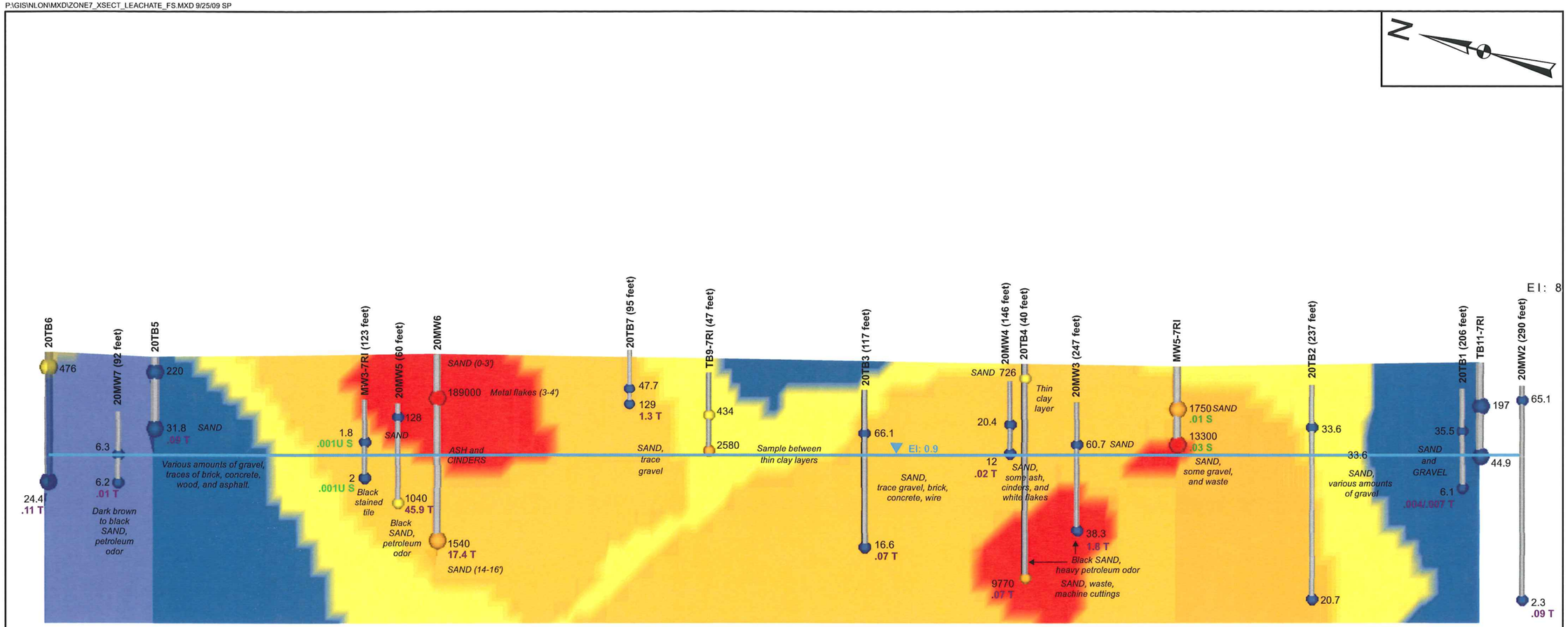



| | | | |
|---|---|---|---|
| DRAWN BY S. PAXTON | DATE 4/02/09 | Tetra Tech NUS, Inc. | CONTRACT NO. 0811 |
| CHECKED BY N. BALSAMO | DATE 7/07/09 | ESTIMATED LEAD CONCENTRATIONS (KRIGING RESULTS)<br>ELEVATION: 6 TO 8 FEET<br>ZONE 7<br>NAVAL SUBMARINE BASE - NEW LONDON<br>GROTON, CONNECTICUT | APPROVED BY – / DATE -- |
| COST/SCHED-AREA | | | APPROVED BY -- / DATE -- |
| SCALE AS NOTED | | | FIGURE NO. 5 / REV. |

Worksheet 6

Worksheet 7

P:\GIS\NLON\MXD\ZONE7_XSECT_LEACHATE_FS.MXD 9/25/09 SP




## LEGEND

Lead

- 189000 mg/kg
- 10000 mg/kg
- 1090 mg/kg
- 400 mg/kg

Boring Offset > 60 feet from Cross-Section

Boring Offset ≤ 60 feet from Cross-Section

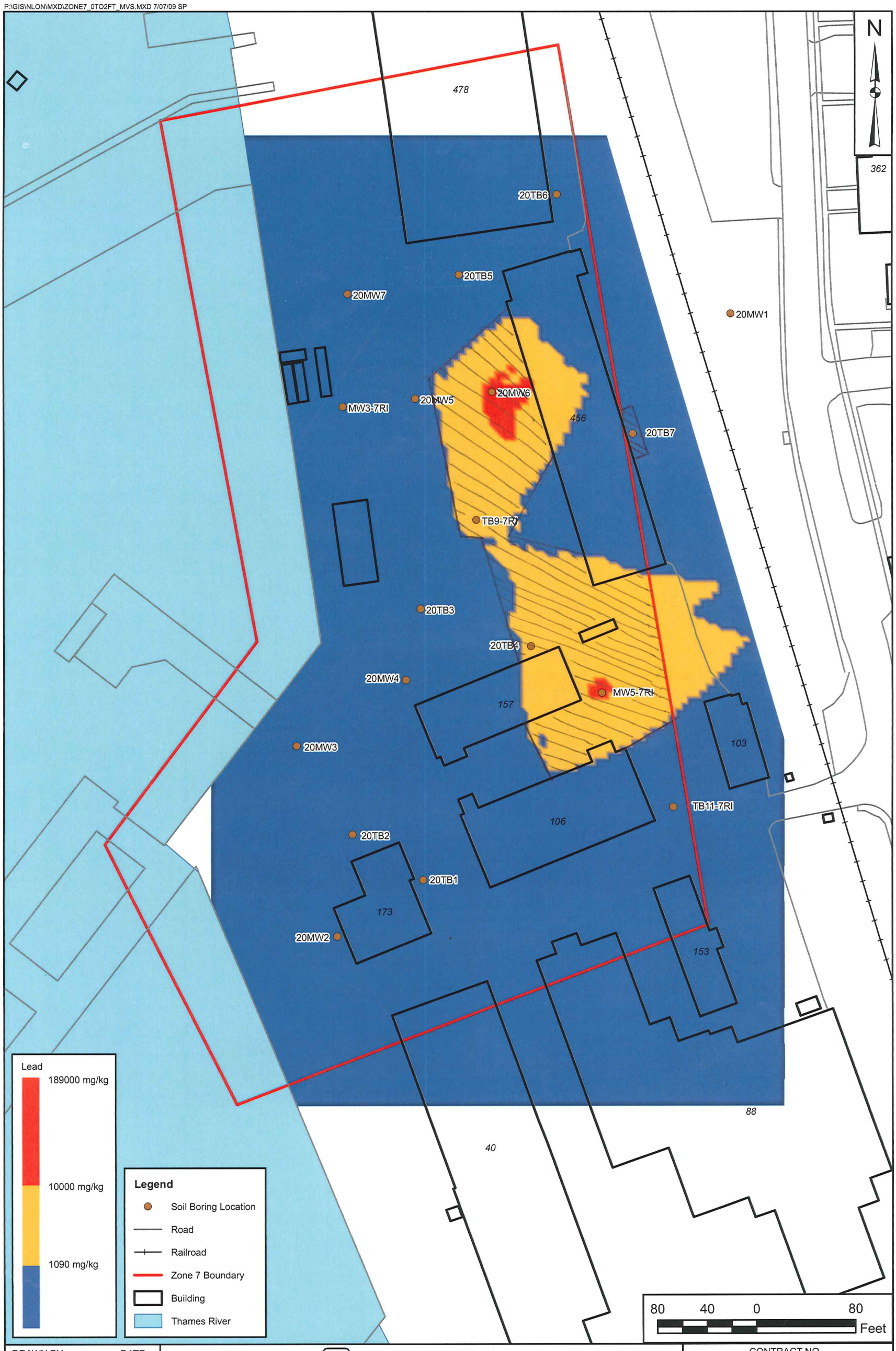
Boring Included in Cross-Section

T TCLP (mg/L)

S SPLP (mg/L)

| | | | | |
|---|---|---|---|---|
| DRAWN BY S. PAXTON | DATE 4/28/09 | Tetra Tech NUS, Inc. | CONTRACT NO. 2195 | OWNER NO. WE24 |
| CHECKED BY N. BALSAMO | DATE 9/25/09 | LEAD CROSS-SECTION WITH LEACHATE RESULTS ZONE 7 NAVAL SUBMARINE BASE - NEW LONDON GROTON, CONNECTICUT | APPROVED BY -- | DATE -- |
| REVISED BY S. PAXTON | DATE 9/25/09 | | APPROVED BY -- | DATE -- |
| SCALE AS NOTED | | | FIGURE NO. — | REV. 0 |

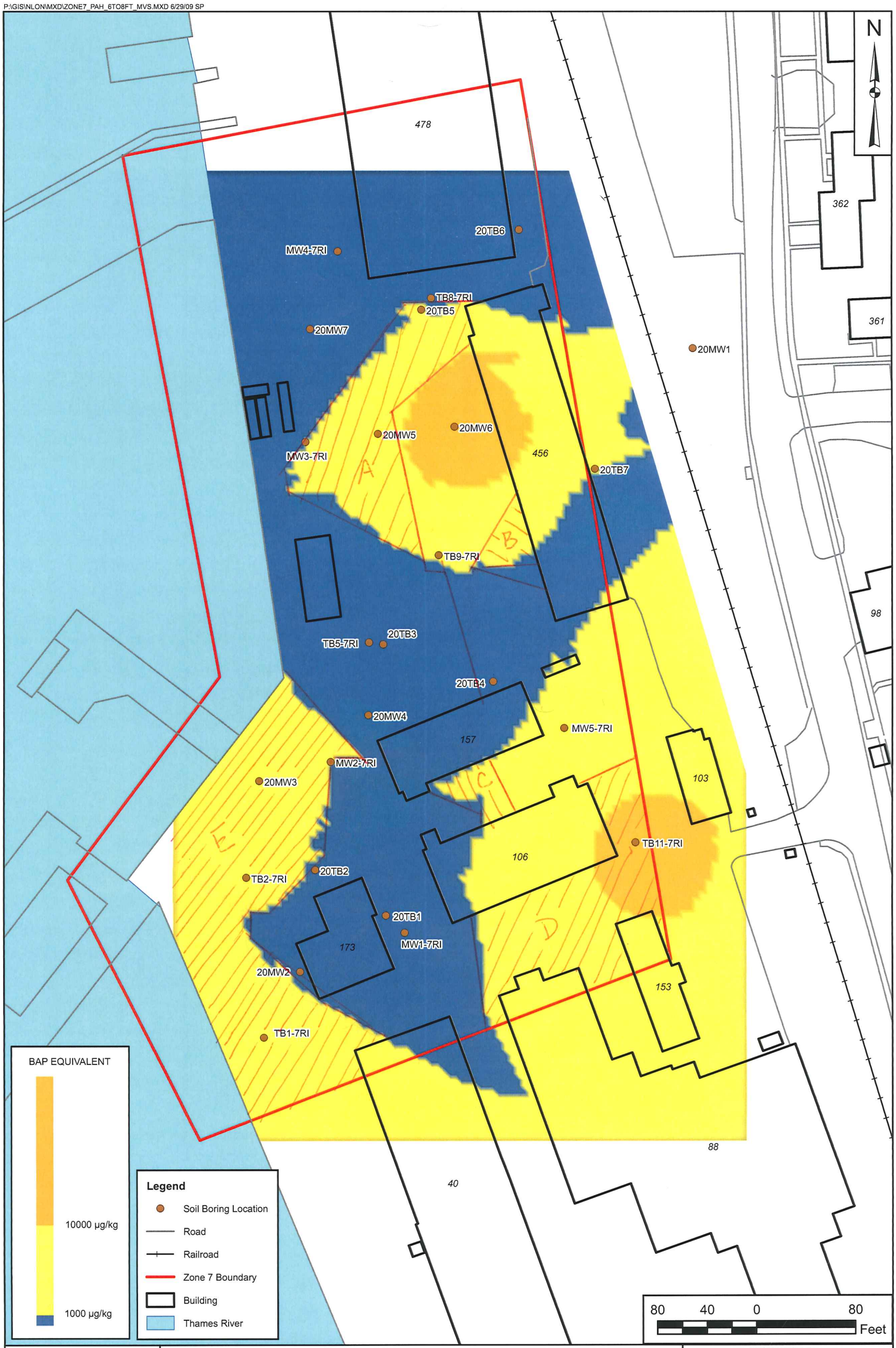
P:\GIS\NLON\MXD\ZONE7_0TO2FT_MVS.MXD 7/07/09 SP




| DRAWN BY | DATE | Tetra Tech NUS, Inc. | CONTRACT NO. 0811 | |
|---|---|---|---|---|
| S. PAXTON | 4/02/09 | | | |
| CHECKED BY | DATE | ESTIMATED LEAD CONCENTRATIONS (KRIGING RESULTS)<br>ELEVATION: 0 TO 2 FEET<br>ZONE 7<br>NAVAL SUBMARINE BASE - NEW LONDON<br>GROTON, CONNECTICUT | APPROVED BY | DATE |
| N. BALSAMO | 7/07/09 | | _ | -- |
| COST/SCHED-AREA | | | APPROVED BY | DATE |
| | | | -- | -- |
| SCALE | | | FIGURE NO. | REV. |
| AS NOTED | | | 5 | |

Worksheet 8

P:\GIS\NLON\MXD\ZONE7_PAH_6TO8FT_MVS.MXD 6/29/09 SP

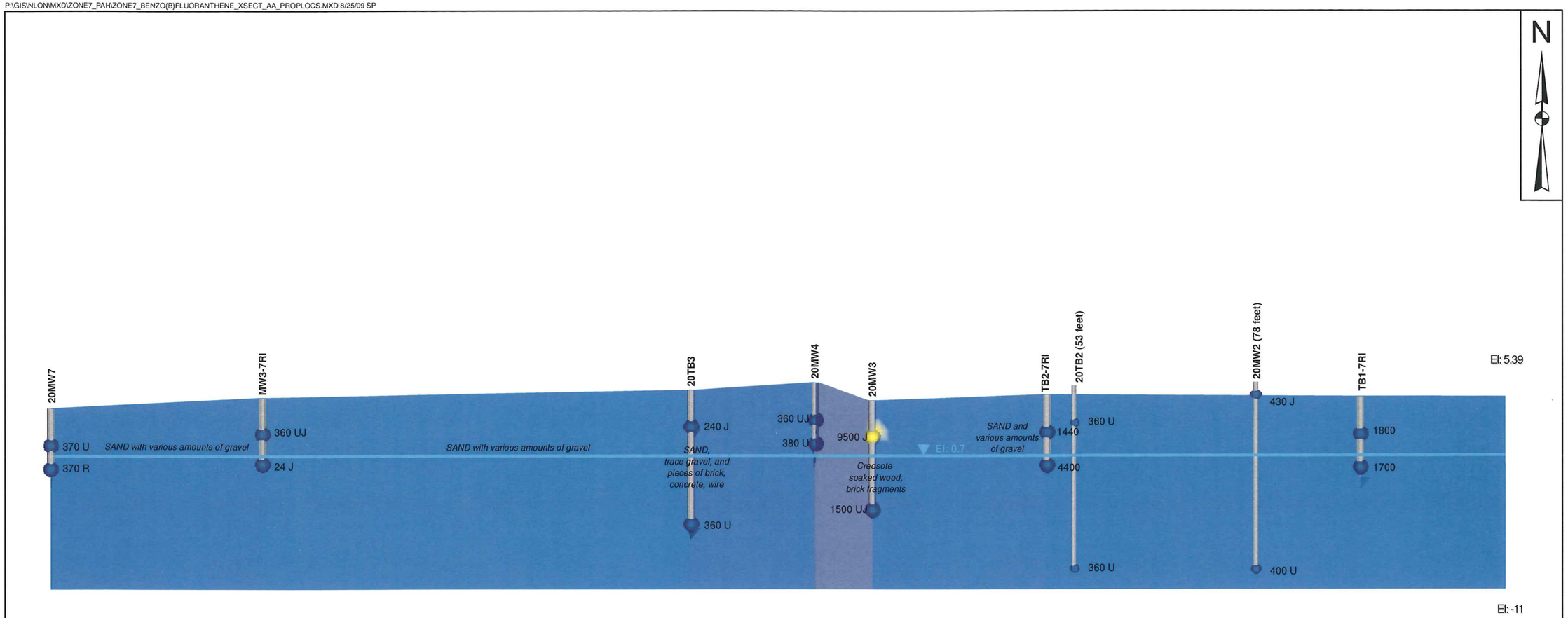



| | | | |
|---|---|---|---|
| DRAWN BY S. PAXTON | DATE 4/02/09 | Tetra Tech NUS, Inc. | CONTRACT NO. 0811 |
| CHECKED BY N. BALSAMO | DATE 6/29/09 | ESTIMATED BAP EQUIVALENT CONCENTRATIONS (KRIGING RESULTS)<br>ELEVATION: 6 TO 8 FEET<br>ZONE 7<br>NAVAL SUBMARINE BASE - NEW LONDON<br>GROTON, CONNECTICUT | APPROVED BY – / DATE -- |
| COST/SCHED-AREA | | | APPROVED BY -- / DATE -- |
| SCALE AS NOTED | | | FIGURE NO. — / REV. |

Worksheet 9

Worksheet 10

P:\GIS\NLON\MXD\ZONE7_PAH\ZONE7_BENZO(B)FLUORANTHENE_XSECT_AA_PROPLOCS.MXD 8/25/09 SP




**LEGEND**

Benzo(B)Fluoranthene

10000 µg/kg
7800 µg/kg

Boring Offset from Cross-Section

Boring Included in Cross-Section

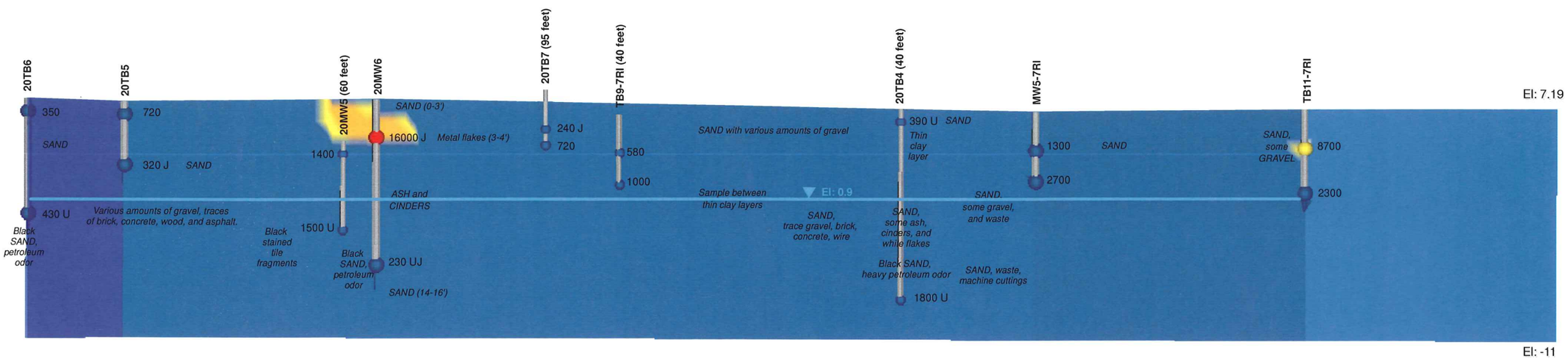
Proposed PDI Boring

Notes:
1) U indicates the result is a non-detect.
2) J indicates the result is an estimated concentration.

| | | | | |
|---|---|---|---|---|
| DRAWN BY S. PAXTON | DATE 8/19/09 | Tetra Tech NUS, Inc. | CONTRACT NO. 2195 | OWNER NO. WE24 |
| CHECKED BY N. BALSAMO | DATE 8/25/09 | BENZO(B)FLUORANTHENE CROSS-SECTION A-A' ~~WITH PDI SAMPLE LOCATIONS~~ ZONE 7 NAVAL SUBMARINE BASE - NEW LONDON GROTON, CONNECTICUT | APPROVED BY -- | DATE -- |
| REVISED BY S. PAXTON | DATE 8/25/09 | | APPROVED BY -- | DATE -- |
| SCALE AS NOTED | | | FIGURE NO. — | REV. 1 |

Worksheet 11

P:\GIS\NLON\MXD\ZONE7_PAH\ZONE7_BENZO(B)FLUORANTHENE_XSECT_BB_FS.MXD 9/25/09 SP




**LEGEND**

Benzo(B)Fluoranthene

10000 µg/kg
7800 µg/kg

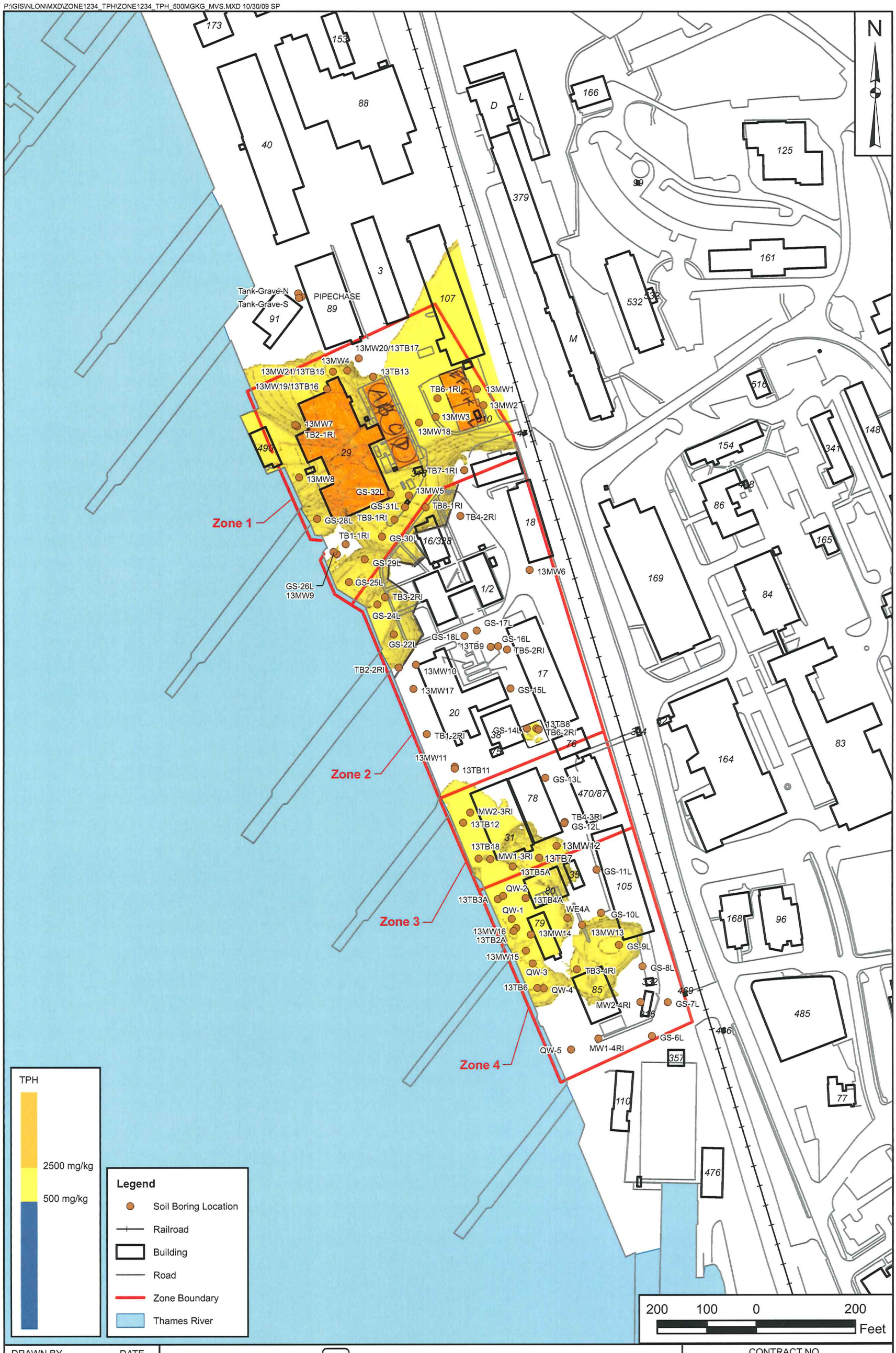
Boring Offset from Cross-Section

Boring Included in Cross-Section

Notes:
1) U indicates the result is a non-detect.
2) J indicates the result is an estimated concentration.

| | | | | |
|---|---|---|---|---|
| DRAWN BY S. PAXTON | DATE 8/19/09 | Tetra Tech NUS, Inc. | CONTRACT NO. 2195 | OWNER NO. WE24 |
| CHECKED BY N. BALSAMO | DATE 9/25/09 | BENZO(B)FLUORANTHENE CROSS-SECTION B-B' ZONE 7 NAVAL SUBMARINE BASE - NEW LONDON GROTON, CONNECTICUT | APPROVED BY -- | DATE -- |
| REVISED BY S. PAXTON | DATE 9/25/09 | | APPROVED BY -- | DATE -- |
| SCALE AS NOTED | | | FIGURE NO. ___ | REV. 0 |

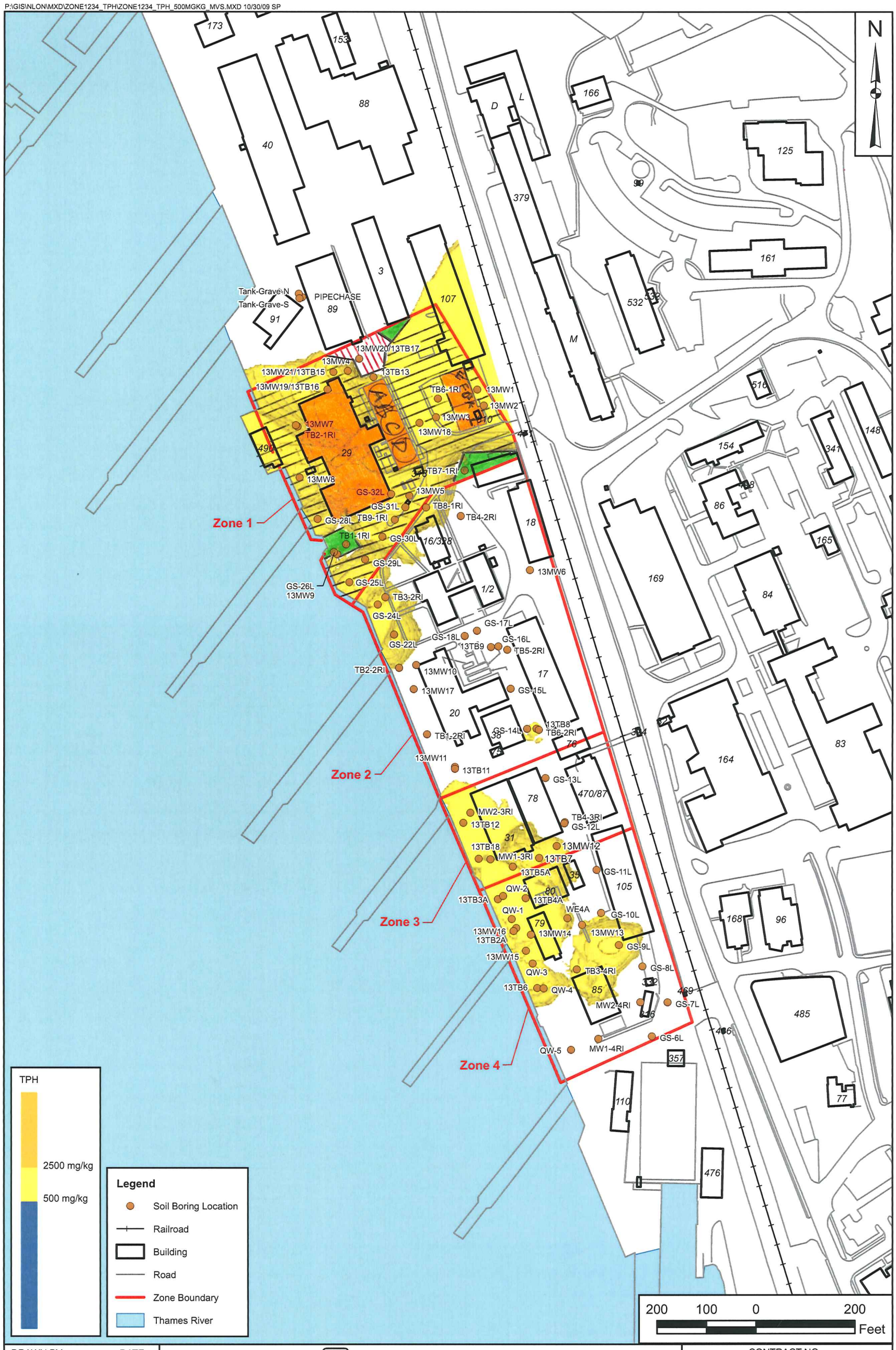
P:\GIS\NLON\MXD\ZONE1234_TPH\ZONE1234_TPH_500MGKG_MVS.MXD 10/30/09 SP




| DRAWN BY | DATE | Tetra Tech NUS, Inc. | CONTRACT NO. |
|---|---|---|---|
| S. PAXTON | 4/02/09 | | 0811 |
| CHECKED BY | DATE | ESTIMATED TPH CONCENTRATIONS (KRIGING RESULTS)<br>ELEVATION: 10 TO -10 FEET<br>ZONES 1, 2, 3, AND 4<br>NAVAL SUBMARINE BASE - NEW LONDON<br>GROTON, CONNECTICUT | APPROVED BY / DATE |
| N. BALSAMO | 10/30/09 | | – / -- |
| COST/SCHED-AREA | | | APPROVED BY / DATE |
| | | | -- / -- |
| SCALE | | | FIGURE NO. / REV. |
| AS NOTED | | | — |

Worksheet 12

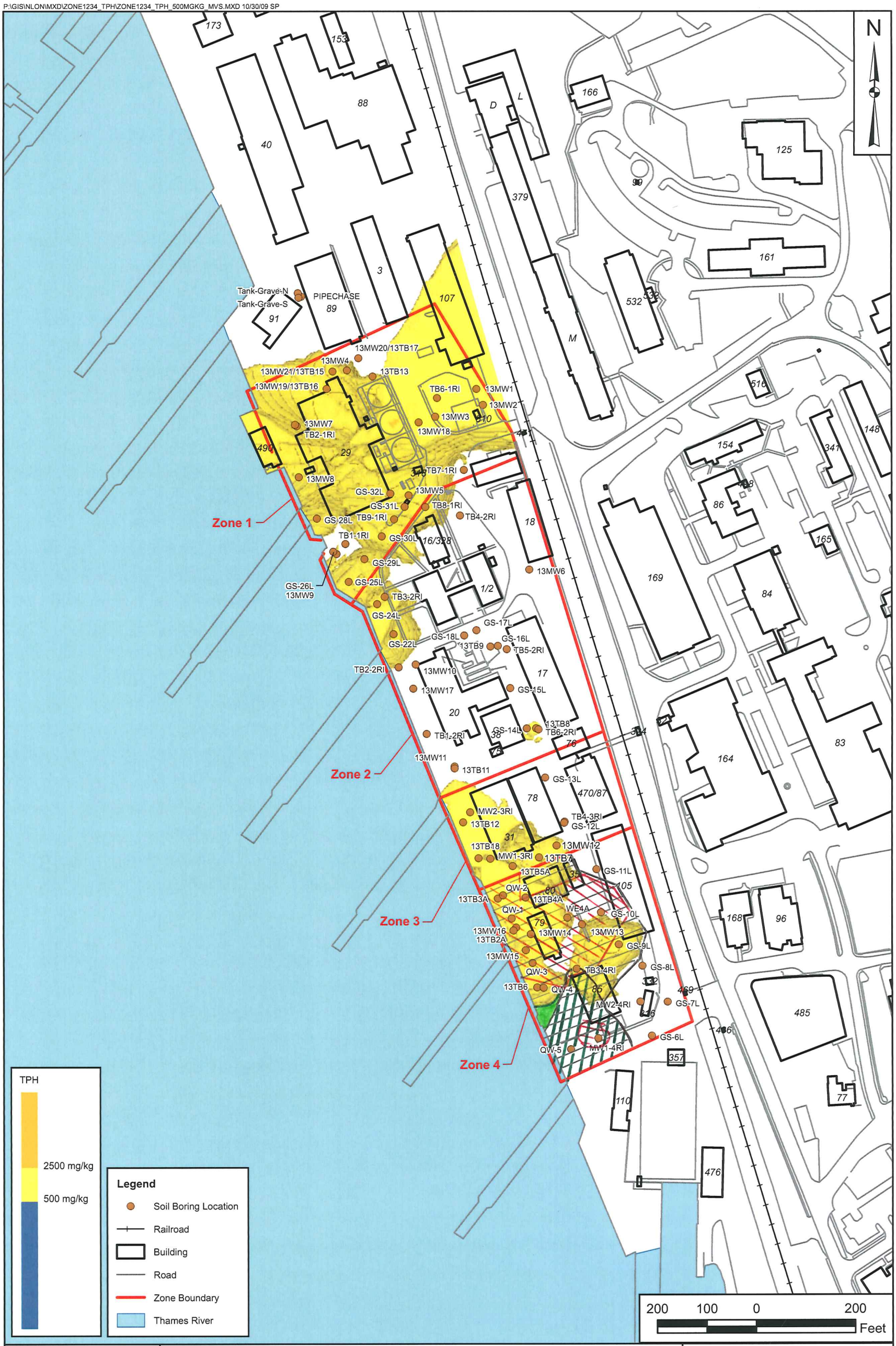
P:\GIS\NLON\MXD\ZONE1234_TPH\ZONE1234_TPH_500MGKG_MVS.MXD 10/30/09 SP




| DRAWN BY | DATE | Tetra Tech NUS, Inc. | CONTRACT NO. |
|---|---|---|---|
| S. PAXTON | 4/02/09 | | 0811 |
| CHECKED BY | DATE | ESTIMATED TPH CONCENTRATIONS (KRIGING RESULTS) | APPROVED BY / DATE |
| N. BALSAMO | 10/30/09 | ELEVATION: 10 TO -10 FEET | – / -- |
| COST/SCHED-AREA | | ZONES 1, 2, 3, AND 4 | APPROVED BY / DATE |
| | | NAVAL SUBMARINE BASE - NEW LONDON | -- / -- |
| SCALE | | GROTON, CONNECTICUT | FIGURE NO. / REV. |
| AS NOTED | | | — |

Worksheet 13

P:\GIS\NLON\MXD\ZONE1234_TPH\ZONE1234_TPH_500MGKG_MVS.MXD 10/30/09 SP




| DRAWN BY | DATE | Tetra Tech NUS, Inc. | CONTRACT NO. |
|---|---|---|---|
| S. PAXTON | 4/02/09 | | 0811 |
| CHECKED BY | DATE | ESTIMATED TPH CONCENTRATIONS (KRIGING RESULTS) | APPROVED BY / DATE |
| N. BALSAMO | 10/30/09 | ELEVATION: 10 TO -10 FEET | – / -- |
| COST/SCHED-AREA | | ZONES 1, 2, 3, AND 4 | APPROVED BY / DATE |
| | | NAVAL SUBMARINE BASE - NEW LONDON | -- / -- |
| SCALE | | GROTON, CONNECTICUT | FIGURE NO. / REV. |
| AS NOTED | | | — |

Lead > 400 mg/kg

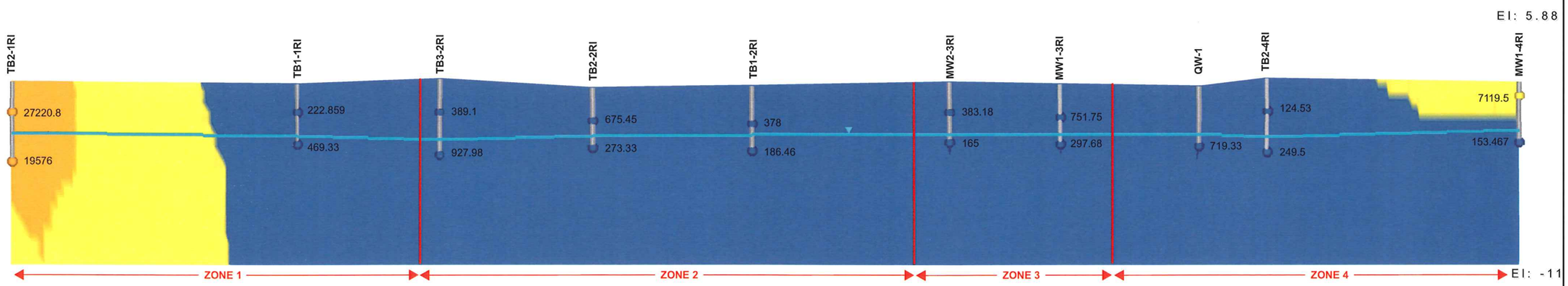
Total Remediation Area

BAP eq. > 1 mg/kg

Worksheet 14

Worksheet 15

P:\GIS\NLON\MXD\ZONE1234_PAH\ZONE1234_PAH_XSECT_AA_FS.MXD 10/13/09 SP




**LEGEND**

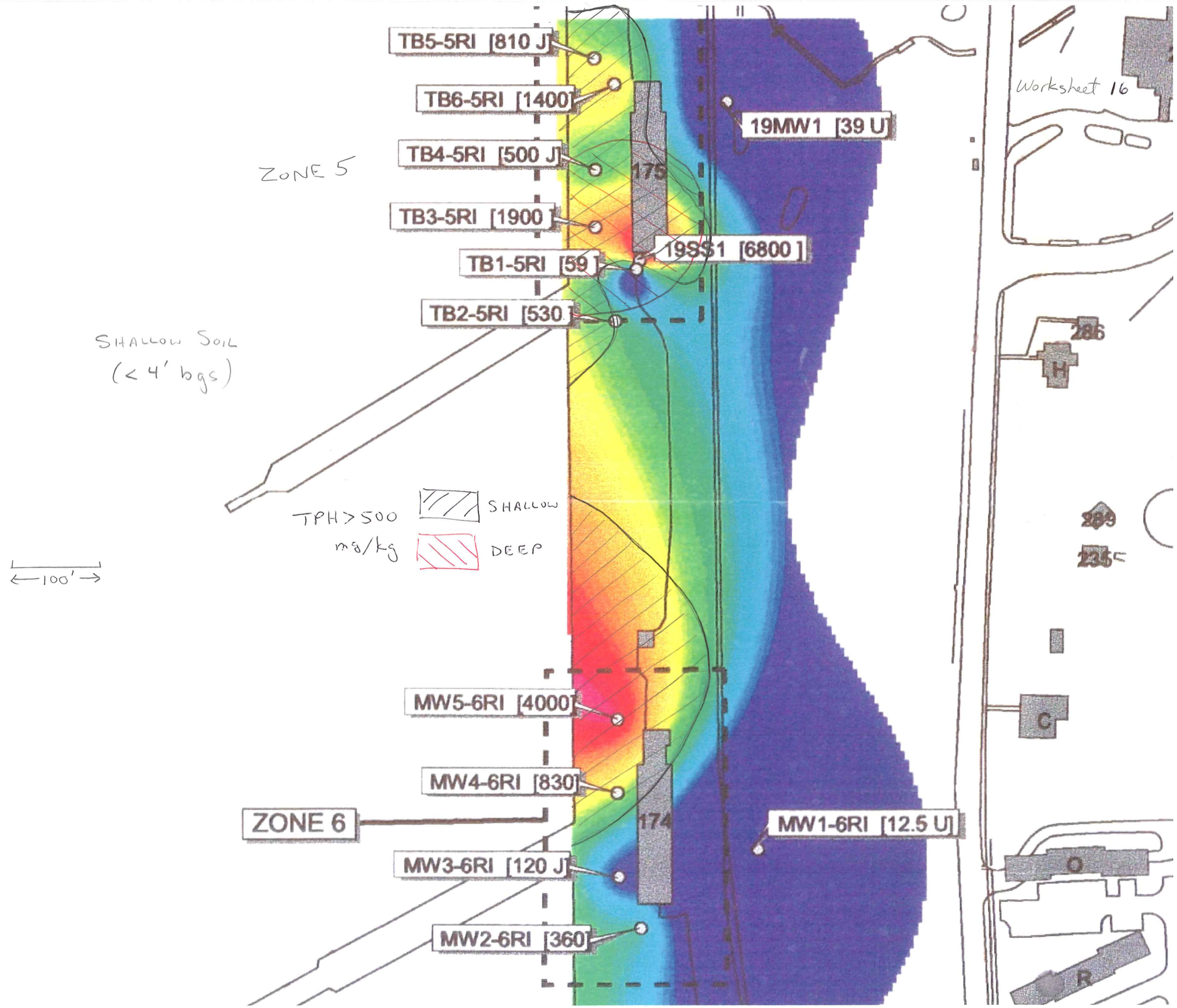
PAH

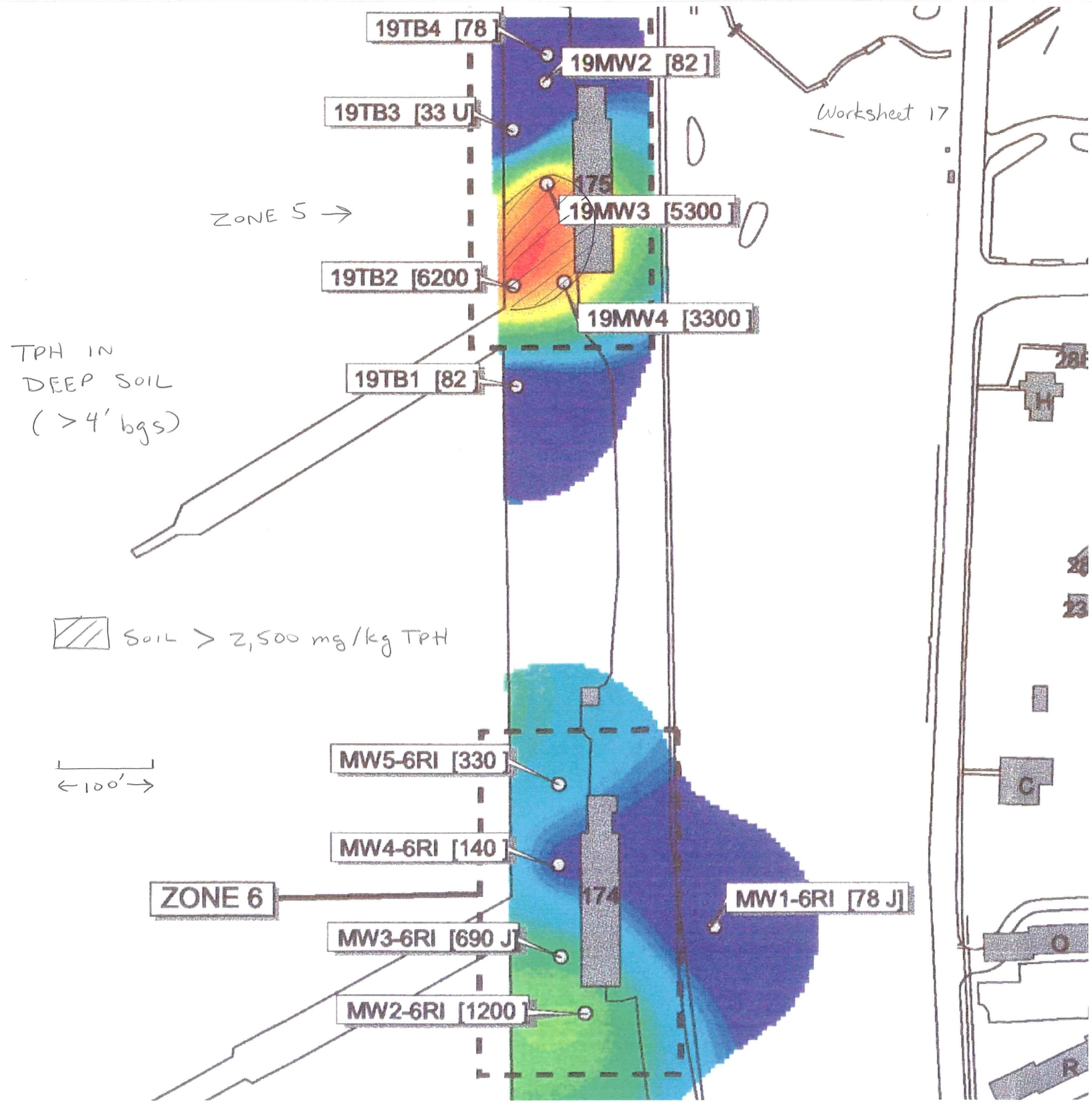
10000 µg/kg

1000 µg/kg

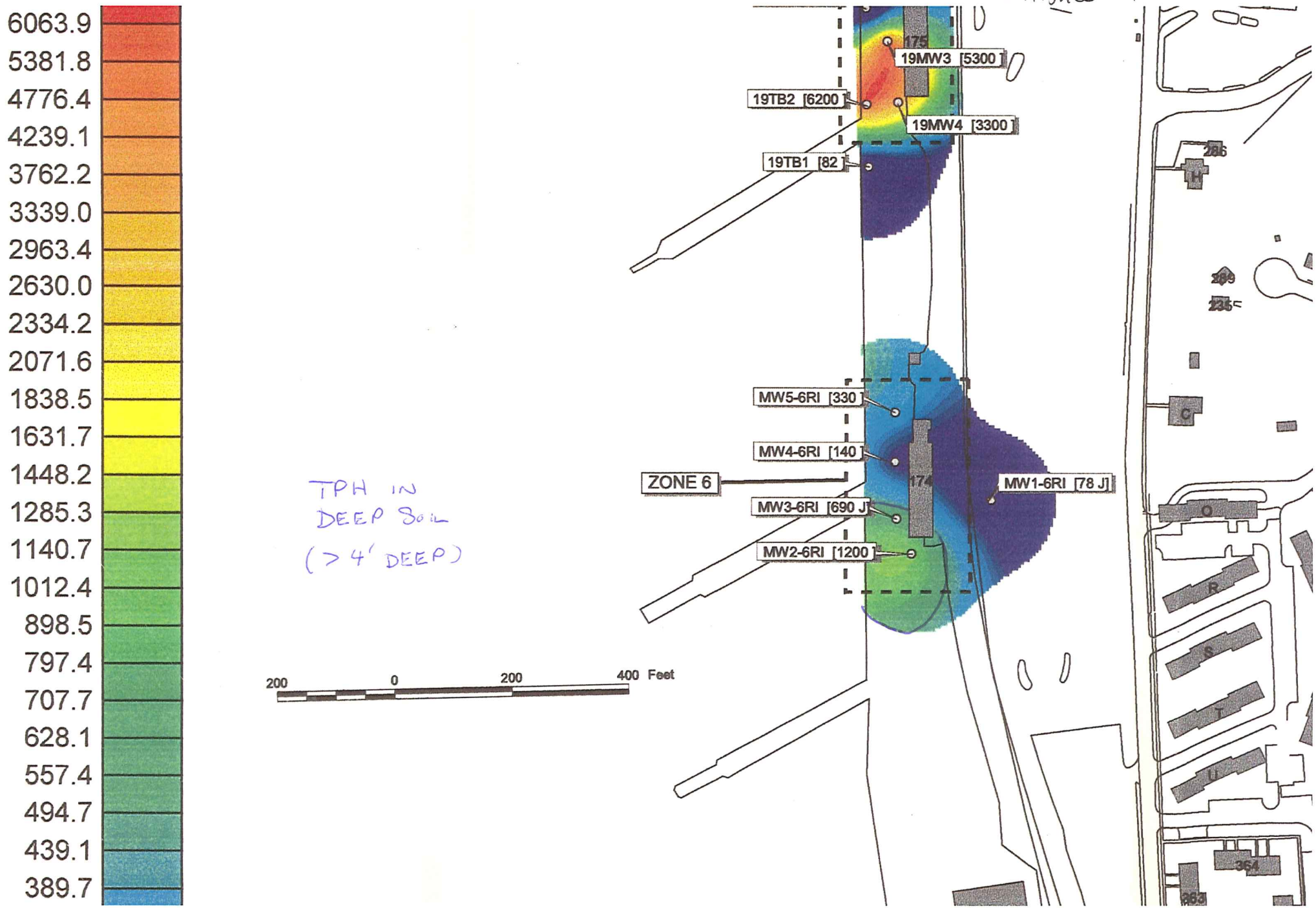
Boring Included in Cross-Section

| | | | | |
|---|---|---|---|---|
| DRAWN BY S. PAXTON | DATE 4/28/09 | Tetra Tech NUS, Inc. | CONTRACT NO. 2195 | OWNER NO. WE24 |
| CHECKED BY N. BALSAMO | DATE 10/13/09 | BAP EQUIVALENT CROSS-SECTION A-A' ZONES 1, 2, 3, AND 4 NAVAL SUBMARINE BASE - NEW LONDON GROTON, CONNECTICUT | APPROVED BY -- | DATE -- |
| REVISED BY S. PAXTON | DATE 10/13/09 | | APPROVED BY -- | DATE -- |
| SCALE AS NOTED | | | FIGURE NO. ___ | REV. 1 |


TB5-5RI [810 J]
TB6-5RI [1400]
TB4-5RI [500 J]
TB3-5RI [1900]
TB1-5RI [59]
TB2-5RI [530]
19MW1 [39 U]
19SS1 [6800]
175
ZONE 5
SHALLOW SOIL
(< 4' bgs)
TPH > 500
mg/kg
SHALLOW
DEEP
100'
MW5-6RI [4000]
MW4-6RI [830]
MW3-6RI [120 J]
MW2-6RI [360]
MW1-6RI [12.5 U]
174
ZONE 6
Worksheet 16
286
H
C
O
R

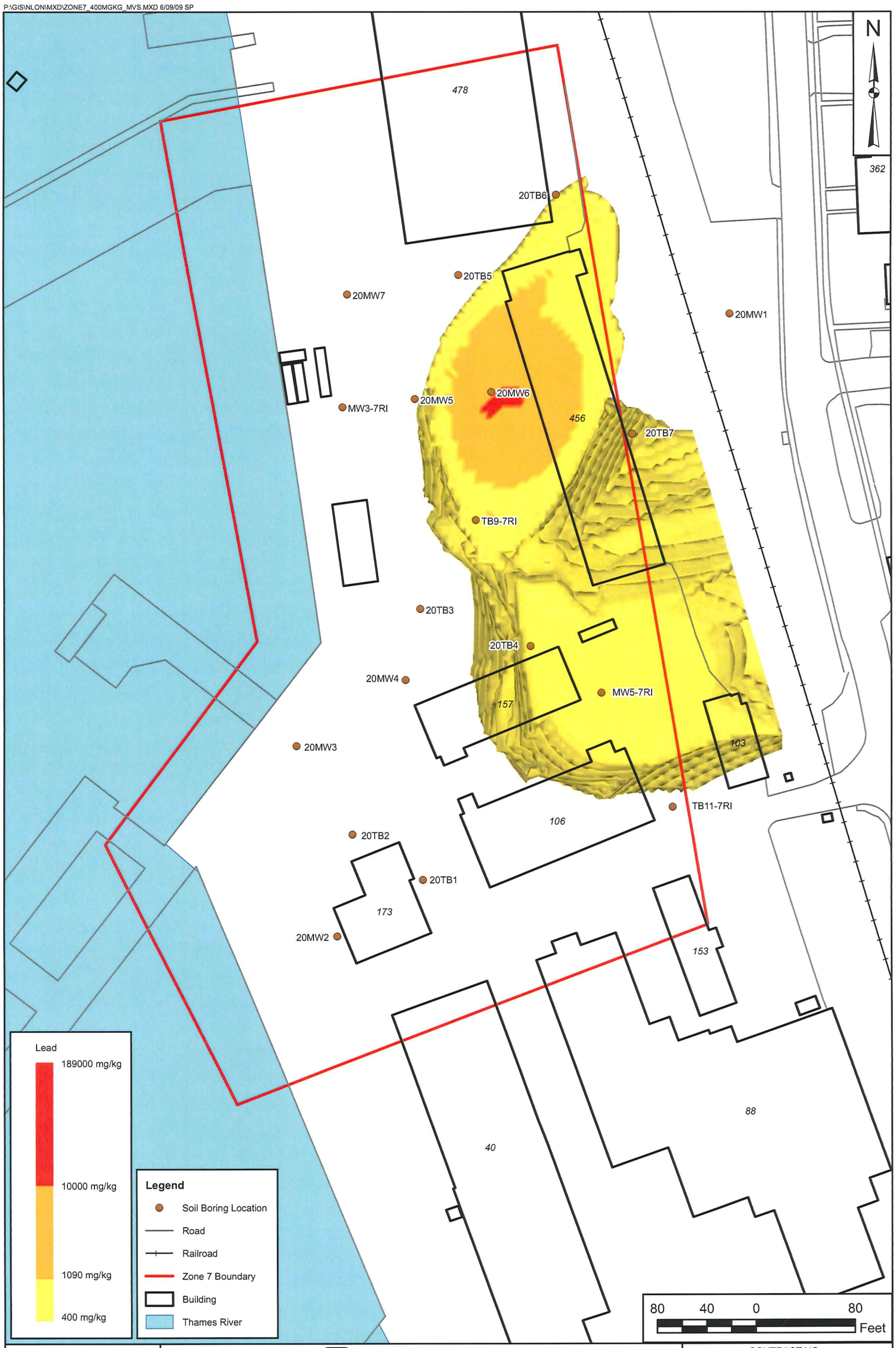

19TB4 [78]
19MW2 [82]
19TB3 [33 U]
Worksheet 17
175
ZONE 5 →
19MW3 [5300]
19TB2 [6200]
19MW4 [3300]
TPH IN
DEEP SOIL
(>4' bgs)
19TB1 [82]
Soil > 2,500 mg/kg TPH
←100'→
MW5-6RI [330]
MW4-6RI [140]
ZONE 6
174
MW1-6RI [78 J]
MW3-6RI [690 J]
MW2-6RI [1200]

Worksheet 17A




TPH IN
DEEP SOIL
(> 4' DEEP)

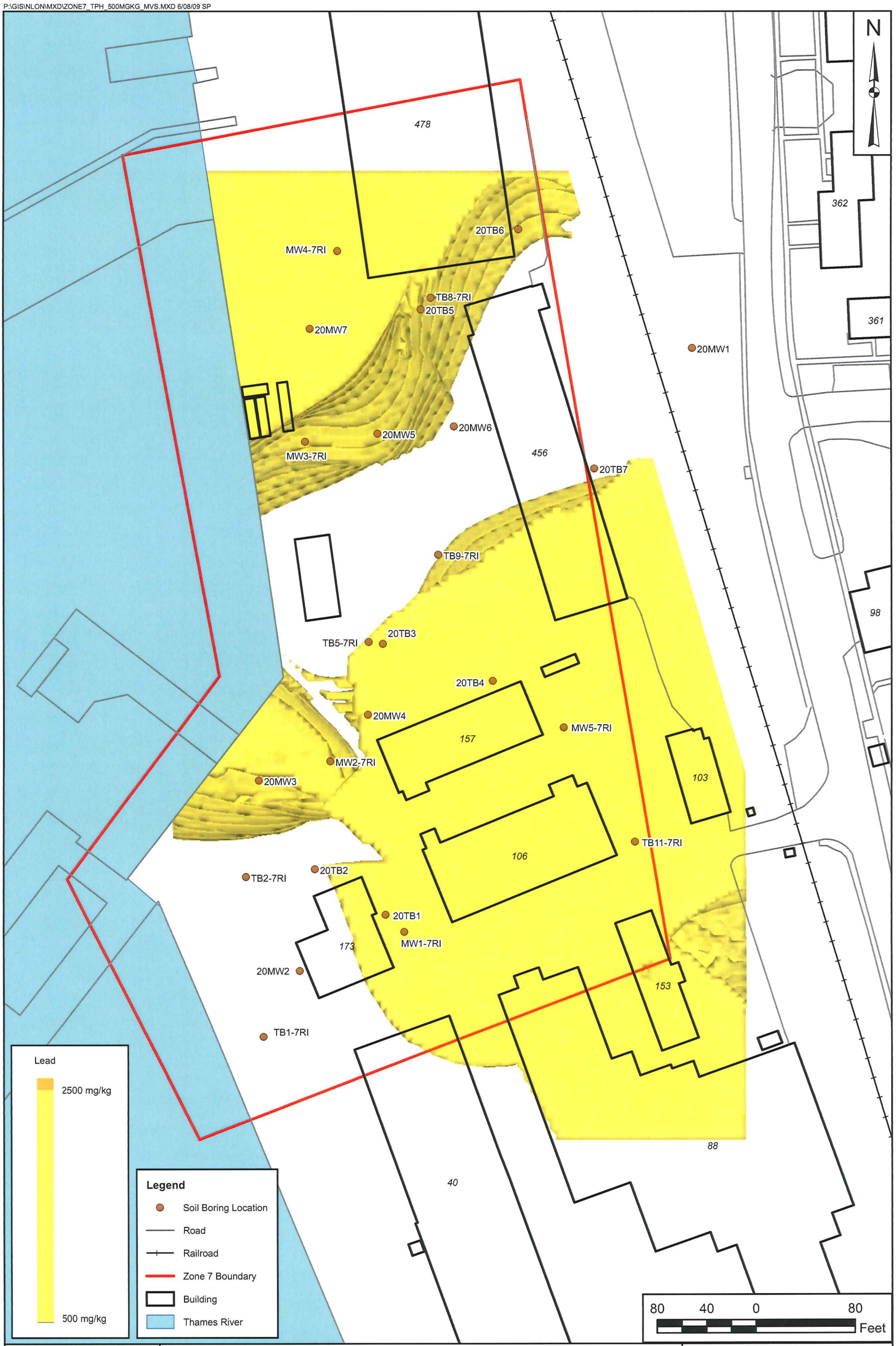
P:\GIS\NLON\MXD\ZONE7_400MGKG_MVS.MXD 6/09/09 SP




| | | | |
|---|---|---|---|
| DRAWN BY S. PAXTON | DATE 4/02/09 | Tetra Tech NUS, Inc. | CONTRACT NO. 0811 |
| CHECKED BY N. BALSAMO | DATE 6/09/09 | ESTIMATED LEAD CONCENTRATIONS (KRIGING RESULTS)<br>ELEVATION: 10 TO -10 FEET<br>ZONE 7<br>NAVAL SUBMARINE BASE - NEW LONDON<br>GROTON, CONNECTICUT | APPROVED BY – / DATE -- |
| COST/SCHED-AREA | | | APPROVED BY -- / DATE -- |
| SCALE AS NOTED | | | FIGURE NO. 5 / REV. |

Worksheet 18

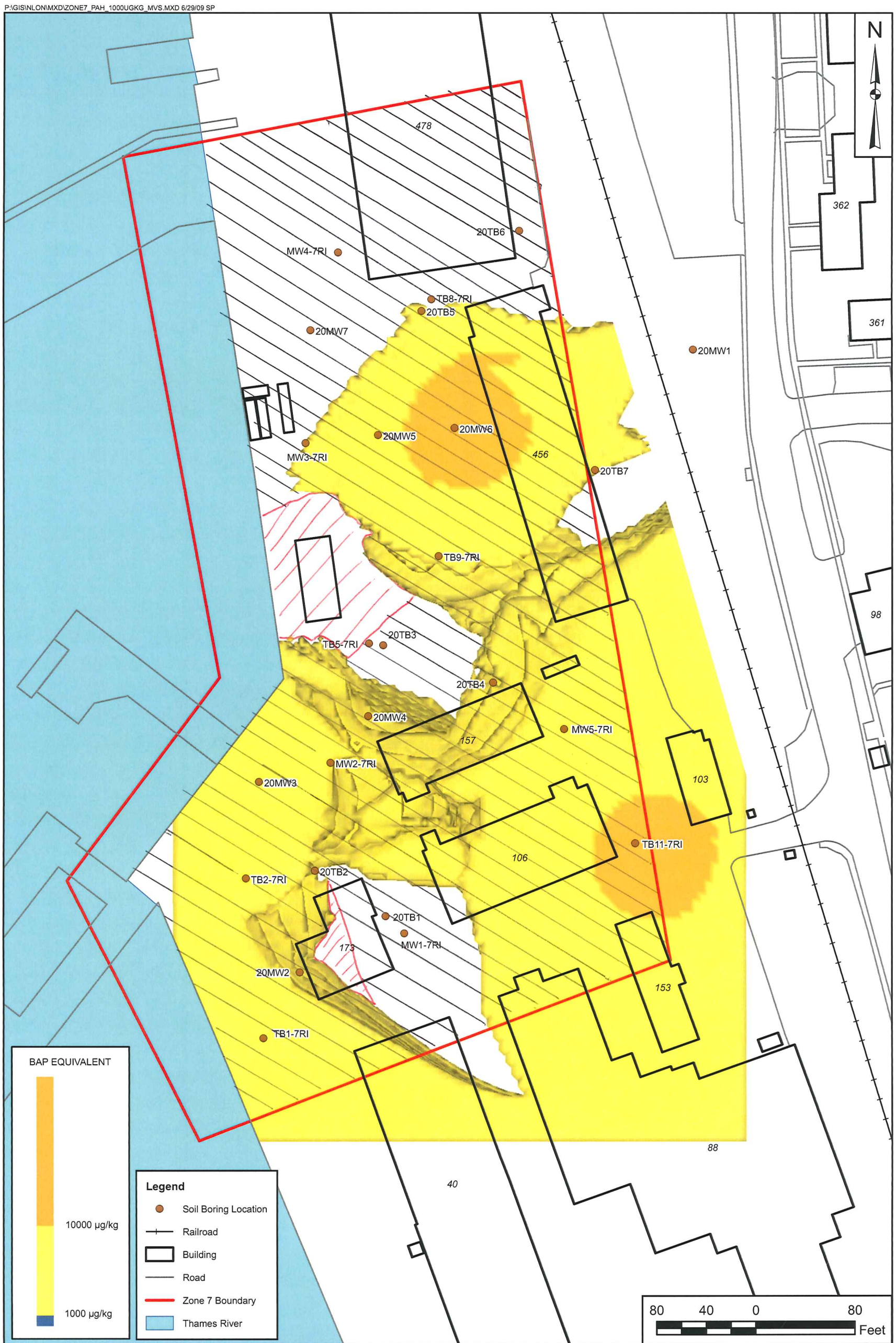
P:\GIS\NLON\MXD\ZONE7_TPH_500MGKG_MVS.MXD 6/08/09 SP




| DRAWN BY | DATE | Tetra Tech NUS, Inc. | CONTRACT NO. |
|---|---|---|---|
| S. PAXTON | 4/02/09 | | 0811 |
| CHECKED BY | DATE | ESTIMATED TPH CONCENTRATIONS (KRIGING RESULTS) | APPROVED BY / DATE |
| N. BALSAMO | 6/08/09 | ELEVATION: 8 TO -10 FEET | – / -- |
| COST/SCHED-AREA | | ZONE 7 | APPROVED BY / DATE |
| | | NAVAL SUBMARINE BASE - NEW LONDON | -- / -- |
| SCALE | | GROTON, CONNECTICUT | FIGURE NO. / REV. |
| AS NOTED | | | — |

Worksheet 19

P:\GIS\NLON\MXD\ZONE7_PAH_1000UGKG_MVS.MXD 6/29/09 SP




| | | | |
|---|---|---|---|
| DRAWN BY S. PAXTON | DATE 4/02/09 | Tetra Tech NUS, Inc. | CONTRACT NO. 0811 |
| CHECKED BY N. BALSAMO | DATE 6/29/09 | ESTIMATED BAP EQUIVALENT CONCENTRATIONS (KRIGING RESULTS)<br>ELEVATION: 8 TO -10 FEET<br>ZONE 7<br>NAVAL SUBMARINE BASE - NEW LONDON<br>GROTON, CONNECTICUT | APPROVED BY – DATE -- |
| COST/SCHED-AREA | | | APPROVED BY -- DATE -- |
| SCALE AS NOTED | | | FIGURE NO. — REV. |

Worksheet 20

SOIL EXCEEDING RESIDENTIAL CRITERIA FOR TPH, PAH OR LEAD

SOIL PASSING RESIDENTIAL CRITERIA FOR TPH, PAH AND LEAD

**TECHNICAL MEMORANDUM**
**KRIGING OF SOIL DATA FOR LOWER SUBASE SOIL PDI SAP**
**NSB-NLON, GROTON, CONNECTICUT**

**By:** S. Paxton

**Date:** July 15, 2010

## INTRODUCTION

In support of the Lower Subase Soil Pre-Design Investigation (PDI) Sampling and Analysis Plan (SAP) and Lower Subase Feasibility Study, three-dimensional modeling was performed using C Tech's Mining Visualization System (MVS) software, Version 9.22. MVS is a state-of-the-art visualization software package with a robust series of modules to assist in the creation of three-dimensional volumetric models for environmental analysis. This software was used to create estimated concentration distribution maps for polynuclear aromatic hydrocarbons (PAHs), total petroleum hydrocarbons (TPH), and lead in soil at Zones 1 through 4 and Zone 7 at the Lower Subase.

## EXTENT OF CONTAMINATION

Kriging is a group of statistical techniques for estimating the value of an attribute at any unsampled location using a number of available data near the unsampled location. The process essentially provides weights for the available data in the local neighborhood and uses linear regression estimators to estimate the data values at unsampled locations. During the interpolation process, the estimation or error variance is minimized. MVS conducts the kriging process automatically. MVS uses the ordinary kriging method for interpolation. Ordinary kriging is a specific type of kriging technique which allows one to account for variations of local means of data.

When conducting kriging using MVS, input data (i.e., analytical results with x-, y-, z- coordinates) need to be provided and kriging parameters need to be specified. This input information is discussed below in detail.

### Input Data

For this project, the soil data from Zones 1 through 4 were assessed together and the data from Zone 7 were assessed separately. Zones 1 through 4 were analyzed together due to the proximity of the zones to each other and the spatial correlation among the data. Zone 7 was assessed separately due to its spatial detachment from Zones 1 through 4. Zones 5 and 6 did not have good data coverage spatially

and the spatial correlation of the data could not be quantified due to a limited number of data, so it was decided that modeling in the two zones would not be beneficial.

The input data provided to MVS for kriging include the following:

- X and Y coordinates for each sample location
- Elevation in feet for each sample location
- Sample result in mg/kg
- Ground Surface Elevation in feet for each sample location

All available data were provided to MVS. For locations where there were duplicate results, the software first calculates an average and then only uses the average as the data point. After the averaging, all data points were assumed to be equally weighted for kriging.

## Kriging Parameters

### Grid

Based on the data density, it was agreed that the grid spacing is five-foot in both x- and y- directions horizontally and two-foot vertically. Provided below are the number of nodes of the kriging domains for the two established zones (i.e., Zone 1 through 4 and Zone 7):

- Zones 1 through 4
  x = 201
  y = 364
  z = 10

- Zone 7
  x = 94
  y = 159
  z = 10

Examples of the calculations to determine the number of nodes in the kriging domains are provided in Attachment A to this memorandum. An example figure (e.g., Figure 17-22) is also included in Attachment A that shows the grid spacing used for kriging Zone 7 data.

The same grid was used for Uncertainty Analysis (discussed in separate memorandum). After kriging, the kriging results were exported into a text format file and imported into the Geostatistical Software Library (GSLIB) for the Uncertainty Analysis. Because GSLIB uses cell data for analysis while MVS uses nodal data, the kriging domain is slightly smaller than the domain for uncertainty analysis; however, these differences were noticed and accounted for in the uncertainty analysis.

**Searching Mechanism**

When kriging, it is important to specify reasonable Reach and Point values. The Reach and Point values together define a searching window that controls how many sample data will be used in kriging at a specific location. The Reach indicates a radial distance from any model node and essentially controls the size of the searching window. Samples outside of the searching window will not be used in interpolation at the specific location. The Point parameter indicates the maximum number of closest sample data that will be used within the searching window during analysis

The Reach value for kriging was generated automatically by the MVS software. By setting zero (default value) for the Reach in MVS, the software automatically calculates a Reach value that is approximately two-thirds of the longest distance between any two data points in the data set. In this way, the Reach value for each zone and parameter is unique. Examination of data values and data density and preliminary contouring suggested that local data variation (i.e., from a contaminated zone to a clean zone) was relatively significant; therefore, the Point value was set to 6 and kept uniform for each model, which means the 6 nearest data points were used for kriging at a specific location within the radius of the Reach.

**Semivariogram**

The MVS software contains an algorithm that can assess the user's dataset and automatically determine the semivariogram based on a best fit of the data. A semivariogram is essentially the quantification of spatial correlation of data, where the quantified spatial correlation will then be used in kriging. A semivariogram model is typically determined as follows: 1) the dataset is evaluated to calculate the differences between all data pairs separated by a series of distances; 2) a graph is then generated to show the calculated variances with distances; 3) a mathematical model (i.e., semivariogram model) is then fit to the graph and usually the model is determined by the best fit with professional judgment. Parameters describing the mathematical model include range, sill, and nugget. The range is the distance at which spatial correlation disappears. The sill is the variance plateau (highest variance) that the semivariogram model reaches at the range. The nugget accounts for the variance among data collected from the same location (if sampling repeats at the same location), and is usually used to represent

possible measurement errors or other sources of variation. For this project, MVS automatically determined the semivariogram model based on the input data and no constraints were placed on its semivariogram modeling algorithm. It is important to note that MVS uses a nugget value of 0 which cannot be changed. CTech explains that "this restriction of the nugget [to only be a value of 0] provides much more representative results than allowing the nugget to be greater than zero, and thus allowing estimated data points to be different than the measured data points when they coincide."

Based on the input data and parameters set, the MVS conducts ordinary kriging automatically. The kriging results of the three-dimensional model were then processed into two-foot slices for presentation purposes. In order to achieve this, the Krig 3D Geology module in MVS was used. This module is generally used to create models of the lithology of a site. Lithology data was not available, but the module still proved useful for this analysis. A geology file was created for each parameter and each modeled area using the coordinates for the sample locations that were used for kriging the analytical data. For each location, two-foot elevation data was entered into the geology file to create the two-foot elevation slices from ground surface to the lowest sampled elevation. Once this data was processed, the three-dimensional model could be subset into the desired two-foot elevation slices. The ultimate goal was to show the resulting slices in plan view figures; therefore, the geology file was designed to display the middle elevation of the each two-foot elevation interval. For example, an elevation interval of 8 to 10 feet would show the data for elevation 9 feet.

The focus of the SAP was to identify the extent of contaminated soil. Both Residential and Industrial criteria were considered to determine the extent. It was deemed more valuable to subset the data based on a color scale as opposed to physically subsetting the three-dimensional model based on the different criterion. As a result, the slices were color coded based on the different criteria to assist engineering staff in their analysis of the data and decisions for future sampling locations.

The two-foot slices were exported as georeferenced image files. These image files were then imported into ArcGIS 9.3 software and displayed along with the New London base map spatial data for the generation of report figures. The resulting figures showing the kriging results for PAHs, TPH, and lead are provided in Appendix B of the Lower Subase Soil PDI SAP.

**CROSS-SECTIONS**

Cross-sections were also generated using C Tech's MVS software to help depict the vertical distribution of soil contamination and determine appropriate sample locations. This software package has modules that allow users to easily create fence diagrams from their three-dimensional models. For this project, fence lines were drawn through all of the sample locations that yielded the highest concentrations. This

provided a good illustration of the vertical extent of the contamination near these locations. A text file was generated and imported into the model to accurately visualize the groundwater table in relation to the estimated concentrations where groundwater level data was available. All cross-section figures displayed sample locations that were used in creating the cross-sections and sample locations that may have potentially influenced the estimated concentration. The two sets of locations were symbolized differently in the resulting cross-section figures and the offset distance was indicated for the potentially influential locations. Images of these cross-sections with the posted sample locations were exported as image files. These images were imported into ArcGIS 9.3 where additional textual information was added to the figures. The resulting cross-section figures are provided and discussed in WS #17 of the Lower Subase Soil PDI SAP.

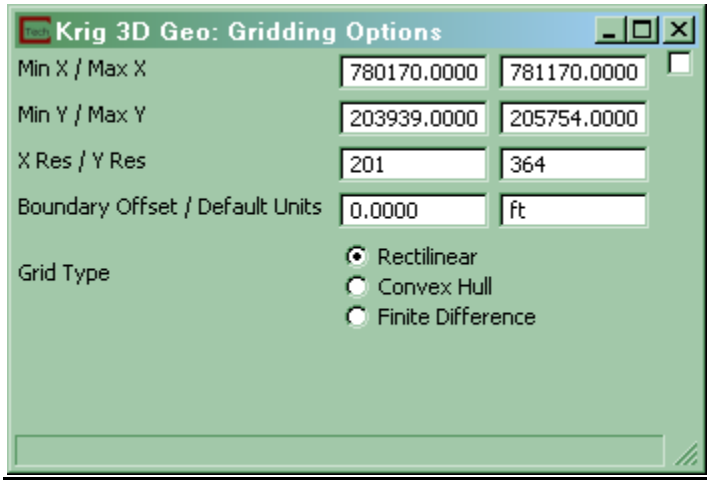
**VOLUMES**

In addition to supporting the preparation of the SAP, the same MVS model was used to support the Feasibility Study for the Lower Subase. The model was used for calculating the volume and mass of soil contaminated by the various constituents. MVS contains a module called Volumetrics that allows users to export these values concerning the modeled data. This module takes into account numerous criteria including the type of media modeled, whether the data were log processed, data units, geologic data, scale of the model, and subsetting based on regulatory criteria values. The goal was to obtain mass and volume values for each zone modeled. This process was streamlined for Zone 7 because this zone was not modeled with other zones. The Volumetrics module was connected to the three-dimensional kriging model. Once connected, the volume and mass data were calculated in the Volumetrics module interface and a text file was exported containing these values. For Zones 1 through 4, the three-dimensional model was cut into individual zones using a module called Area Cut. Once the data was clipped to a singular zone, the Volumetrics module could be connected to the model. At this point a text file, containing only the information for the zone displayed in the model, was generated and exported,. This process was repeated for all four zones to obtain the volume and mass values. This approach will be used to process the new data collected as part of the Soil PDI to develop new volume estimates of the contaminated soil present in the Lower Subase zones.

**ATTACHMENT A**

**NODE CALCULATIONS AND EXAMPLE ZONE 7 GRID SYSTEM**

**Zone 1-4 Extents**




***Number of X nodes for Kriging***

(781170 – 780170)/5 = 200

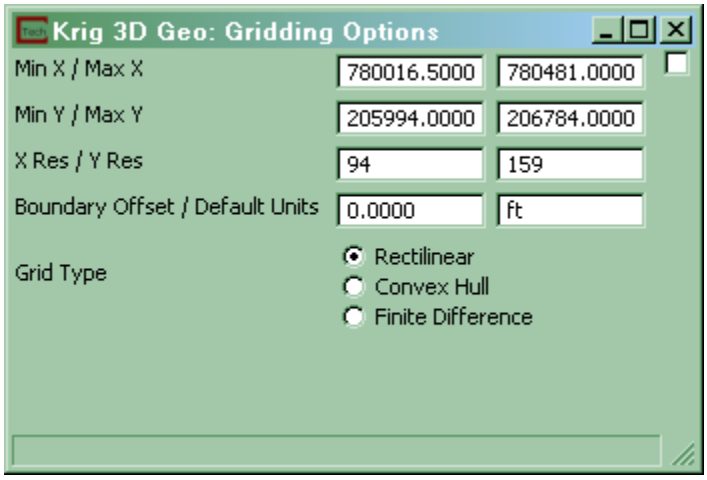
200 + 1 = **201**

***Number of Y nodes for Kriging***

(205754 – 203939)/5 = 363

363 + 1 = **364**

**Zone 7 Extents**




***Number of X nodes for Kriging***

(780481 – 780016.5)/5 = 93.1 (we rounded to 93)

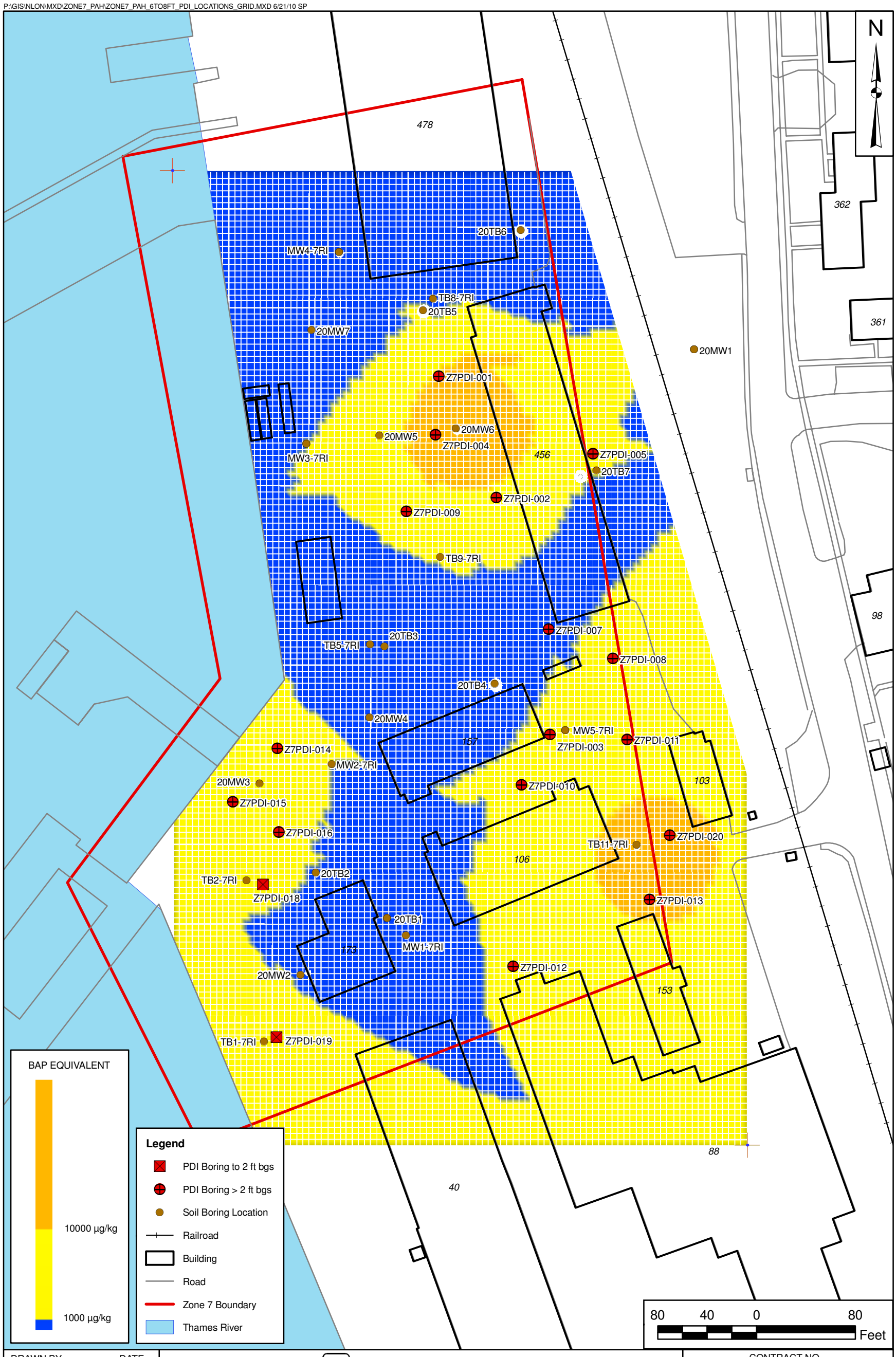
93 + 1 = **94**

***Number of Y nodes for Kriging***

(206784 – 205994)/5 = 158

158 + 1 = **159**

P:\GIS\NLON\MXD\ZONE7_PAH\ZONE7_PAH_6TO8FT_PDI_LOCATIONS_GRID.MXD 6/21/10 SP




| | | | |
|---|---|---|---|
| DRAWN BY S. PAXTON | DATE 4/02/09 | Tetra Tech NUS, Inc. | CONTRACT NO. 2195 |
| CHECKED BY C. RICH | DATE 6/21/10 | ESTIMATED BAP EQUIVALENT CONCENTRATIONS (KRIGING RESULTS) WITH PDI SAMPLE LOCATIONS GROUND SURFACE (ELEVATION: 6 TO 8 FEET) ZONE 7 NAVAL SUBMARINE BASE - NEW LONDON GROTON, CONNECTICUT | APPROVED BY – DATE -- |
| COST/SCHED-AREA | | | APPROVED BY -- DATE -- |
| SCALE AS NOTED | | | FIGURE NO. 17 - 22 REV. |

# APPENDIX C.4

# MASS OF LEAD IN SOIL

# LEAD MASS CALCULATIONS

| Tetra Tech NUS | | | STANDARD CALCULATION SHEET |
|---|---|---|---|
| CLIENT: NSB-New London, Feasibility Study | FILE No: | BY: JWL | PAGE: 1 of 2 |
| SUBJECT: Mass of Lead in areas of soil containing lead in excess of Industrial/commercial or residential PRGs | | CHECKED BY: | DATE: 11/24/09 |

**Introduction**

The mass of lead in excavated soil was calculated for each zone under each scenario (industrial commercial exposure [I/C] or residential). These excavations are only required in Zones 2, 3, 4, and 7. No areas in Zones 1, 5, and 6 must be excavated because of lead contamination, so no lead mass is estimated for these zones.

The extent of lead contamination was estimated using a krigging program. This program provided contours that showed the extent of lead concentrations that are greater than I/C and residential criteria. Nearly all of the lead to be excavated is accounted for by this method.

However, in each zone, there are additional excavations to meet TPH criteria that are out side of the areas contaminated with lead. At a few locations (one each in Zones 2 and 4, and two in Zone 7) within these TPH excavations, the lead concentration was greater than the background concentration, but these lead concentrations were not high enough to require removal. At these locations, an area of contamination was assumed, and a mass of lead that was incidentally removed during the TPH excavation was estimated. This incidental lead was then added to the mass of lead from the lead-contaminated soil excavations.

**Estimate of lead in lead-contaminated soil areas**

The krigging program calculates the mass of lead. The output of the krigging program was used to calculate the mass of lead. These results are included for each zone and scenario.

**Estimate of incidental Lead**

1. For each area with an elevated lead concentration, an area of contamination was assumed. The dimensions of areas are noted on the attached spreadsheets for each zone. The lead contamination was assumed to be localized.

1. For each area with the incidental lead, a geometric average was calculated. Unless there was a large quantity of data, the geometric mean was used in the mass calculation because the contaminated area was assumed to be most likely the result of a localized contamination source. Contaminant concentrations are assumed to decrease rapidly in an outward direction from the source and this is better represented by a geometric average rather than an arithmetic average.

The geometric average is:

Geometric average = $\sqrt[n]{y_1 \times y_2 \times y_3 \ldots \times y_n}$

Where n = number of data points
y = the data points

2. Because each area had only one data point, the background concentration was used as a second value to calculate the averages. For lead, the background concentration in soil is 17.5 mg/kg (for example, see Table 1-3 in the FS).

3. The incidental (often naturally-occurring) low levels of lead are not relevant to the calculation of the mass of COCs. In zones where lead was a COC, but with individual areas where there were no lead analyses or where the lead concentration was less than the background level, no lead mass was calculated. The soil density was assumed to be 113 $lb/ft^3$.

4. Because of the large amount of data for Building 31 (Zone 3 stabilized soil removed for the residential scenario), the average of the results was used. No background sample result needed to be used.

5. The basic calculation for the mass of lead incidentally removed or removed for the Building 31 residential excavation is:

$$M = C \times V \times \rho \times 27\ ft^3/yd^3 / 10^6$$

Where:

M = mass of lead, lb
C = lead concentration in soil, mg/kg (or ppm) (geometric average or arithmetic average)
V = Volume of soil with lead, cubic yards (Asphalt and uncontaminated soil above the contaminated soil is accounted for.)
$\rho$ = density of soil, $lb/ft^3$

BY: _____
CHECKED:_____

NSB-NEW LONDON
FEASIBILITY STUDY
MASS OF LEAD IN EXCAVATIONS
SUMMARY OF AREAS WHERE LEAD IS A COC
12/10/2009

| EXCAVATIONS | Number of areas | |
|---|---|---|
| Zone 1 | | |
| I/C | 0 | |
| Residential | 0 | |
| Zone 2 | | |
| I/C | 1 | |
| Residential | 1 + 1** | ** one area with incidental lead being removed with TPH. |
| Zone 3 | | |
| I/C | 1 | |
| Residential | 1 + 1* | * Stabilized soil at and below Bulding 31. |
| Zone 4 | | |
| I/C | 1 | |
| Residential | 2 + 1 ** | ** one area with incidental lead being removed with TPH. |
| Zone 5 | | |
| I/C | 0 | |
| Residential | 0 | |
| Zone 6 | | |
| I/C | 0 | |
| Residential | 0 | |
| Zone 7 | | |
| I/C | 1 | |
| Residential | 1 + 2** | ** two areas with incidental lead being removed with TPH. |

Note: Lead is not a COC in Zones 1, 5, and 6.

**EXCAVATION DEPTHS**
**FEASIBILITY STUDY**
**NSB NEW LONDON, GROTON, CONNECTICUT**

| Zone | Industrial Scenario (1) | | Residential Scenario(2) | |
|---|---|---|---|---|
| | Top El | Bottom El | Top El | Bottom El |
| 2 | El 6 | El 1 | El 6 | El 1 |
| 3(3) | El 6 | El 1 | El 6 | El -4 |
| 4 | El 6 | El 1 | El 6 | El -6 |
| 7 | El 7 | El 1 | El 7 | El -8 |

(1) Excavate orange and red kriged areas. Do not excavate under buildings. Do not excavate beyond Zone boundaries.
(2) Excavate yellow, orange and red kriged areas. DO excavate under buildings. Do not excavate beyond Zone boundaries.
(3) Zone 3 - do not include orange at Building 31 for Industrial Scenario, DO include for the Residential Scenario
(4) Elevations are in feet.

NSB-NEW LONDON
FEASIBILITY STUDY
MASS OF LEAD IN EXCAVATIONS
SUMMARY OF MASS OF LEAD FROM AREAS
12/10/2009

| EXCAVATIONS | Lead, lb | Lead - I/C, lb | Lead - Res, lb |
|---|---|---|---|
| Zone 1 | | | |
| I/C | 0 | 0 | |
| Residential | 0 | | 0 |
| Zone 2 | | | |
| I/C | 117 | 117 | |
| Residential | 788 | | 788 |
| Zone 3 | | | |
| I/C | 5,412 | 5,412 | |
| Residential | 16,368 | | 16,368 |
| Zone 4 | | | |
| I/C | 15,510 | 15510 | |
| Residential | 29,515 | | 29,515 |
| Zone 5 | | | |
| I/C | 0 | 0 | |
| Residential | 0 | | 0 |
| Zone 6 | | | |
| I/C | 0 | 0 | |
| Residential | 0 | | 0 |
| Zone 7 | | | |
| I/C | 82,060 | 82,060 | |
| Residential | 247,147 | | 247,147 |
| Grand Total | | 103,099 | 293,818 |

NSB NEW LONDON
FEASIBILITY STUDY
SUMMARY OF LEAD EXCAVATION VOLUMES
12/7/2009

Volumes associated with incidental lead are not included.

| EXCAVATIONS | Number of areas | Volume from krigging output, ft3 | Volume from krigging output, yd3 |
|---|---|---|---|
| Zone 1 | | | |
| I/C | 0 | 0 | 0 |
| Residential | 0 | 0 | 0 |
| Zone 2 | | | |
| I/C | 1 | 687 | 25 |
| Residential | 1 + 1** | 10,848 | 402 |
| Zone 3 | | | |
| I/C | 1 | 21,940 | 813 |
| Residential | 1 + 1* | 53,736 | 1,990 |
| Zone 4 | | | |
| I/C | 1 | 54,569 | 2,021 |
| Residential | 2 + 1 ** | 191,076 | 7,077 |
| Zone 5 | | | |
| I/C | 0 | 0 | 0 |
| Residential | 0 | 0 | 0 |
| Zone 6 | | | |
| I/C | 0 | 0 | 0 |
| Residential | 0 | 0 | 0 |
| Zone 7 | | | |
| I/C | 1 | 113,956 | 4,221 |
| Residential | 1 + 2** | 762,621 | 28,245 |

Note: Lead is not a COC in Zones 1, 5, and 6.

Note about volume calculations:

Appendix C.3 and C.4 volumes don't match for the following reasons: Most of the volumes in Appendix C.3 were based on the surface or largest krigged area times the depth of excavation, assuming that excavation walls were vertical and that it would not be practical to separate excavated soil by lead concentration, therefore some low lead soil would be disposed with the higher lead soil. Appendix C.4 lead soil volumes were based on krigged areas of lead concentrations that varied with each depth interval and tapered with depth. In addition, estimated residential lead soil in Appendix C.4 has greater than 400 mg/kg lead, while "high lead soil" identified in Appendix C.3 is that soil estimated at greater than 1090 mg/kg.

ZONE 2

NSB-NEW LONDON
FEASIBILITY STUDY
MASS OF LEAD IN EXCAVATIONS
12/10/2009

**ZONE 2 - I/C SCENARIO (1 area)**
See Fig Z2-1
**Area 1 - From krigging output**

| | |
|---|---|
| Volume of lead-contaminated soil, cy | 25 |
| **Mass of lead, lb** | **117** |
| **Total Lead in Zone, lb** | **117** |

**ZONE 2 - RESIDENTIAL SCENARIO (2 areas)**
See Fig Z2-2

**Area 1 - From krigging output**

| | |
|---|---|
| Volume of lead-contaminated soil, cy | 400 |
| **Mass of lead, lb** | **770** |

**Area 2 - Sample 13TB8**

| Sample | | | Total, mg/kg | Notes |
|---|---|---|---|---|
| 13TB8 | | | 149 | 10' - 12' interval |
| Background | | | 17.5 | |

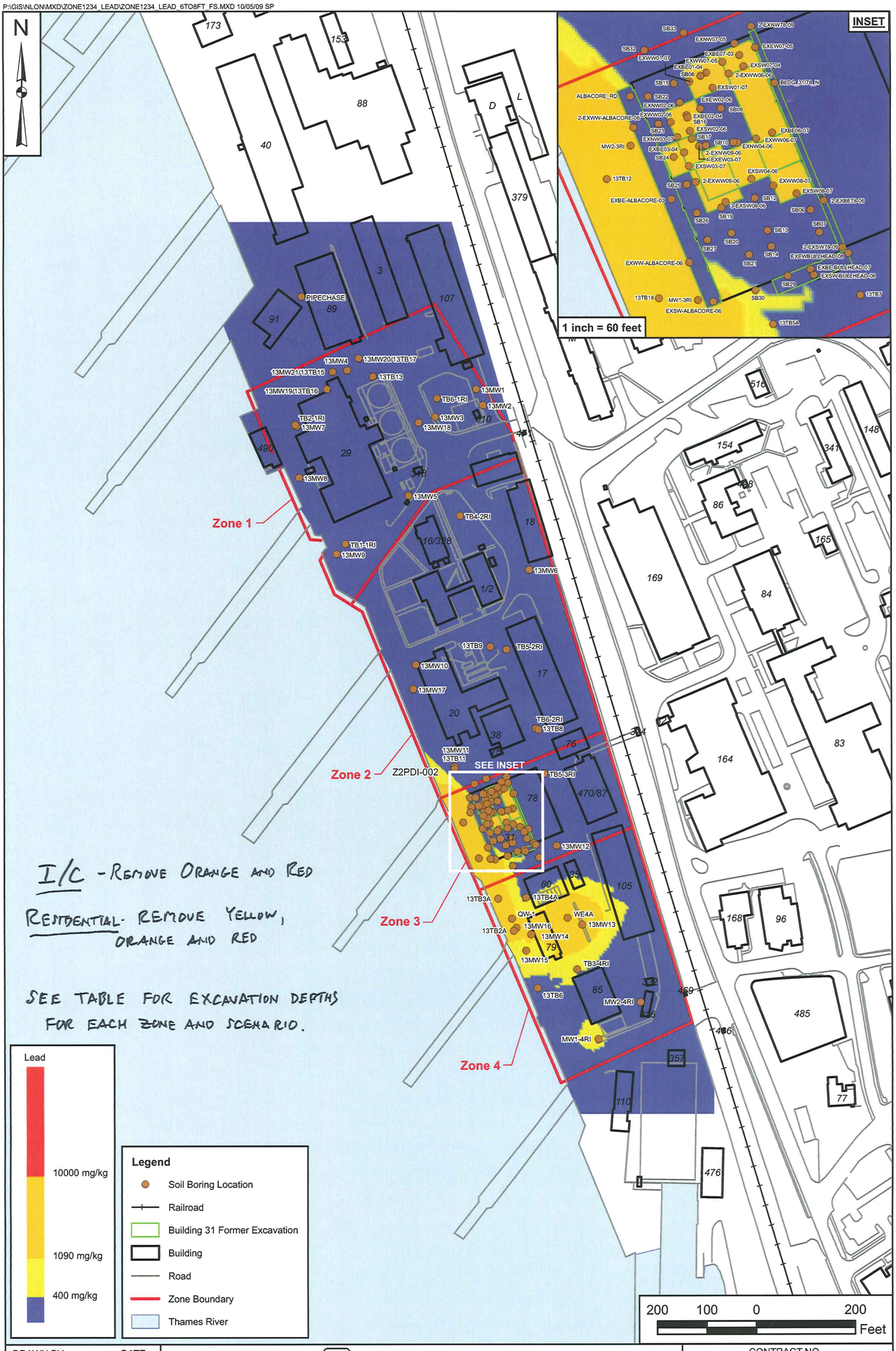
Notes:
Lead (greater than background) is coincidentally removed.

| | |
|---|---|
| Geometric average, mg/kg | 51.1 |

| | |
|---|---|
| Volume of lead-contaminated soil, cy | 115 |
| Soil density, lb/ft$^3$ | 113 |
| **Mass of lead, lb** | **18** |

| | |
|---|---|
| **Total Lead in Zone, lb** | **788** |

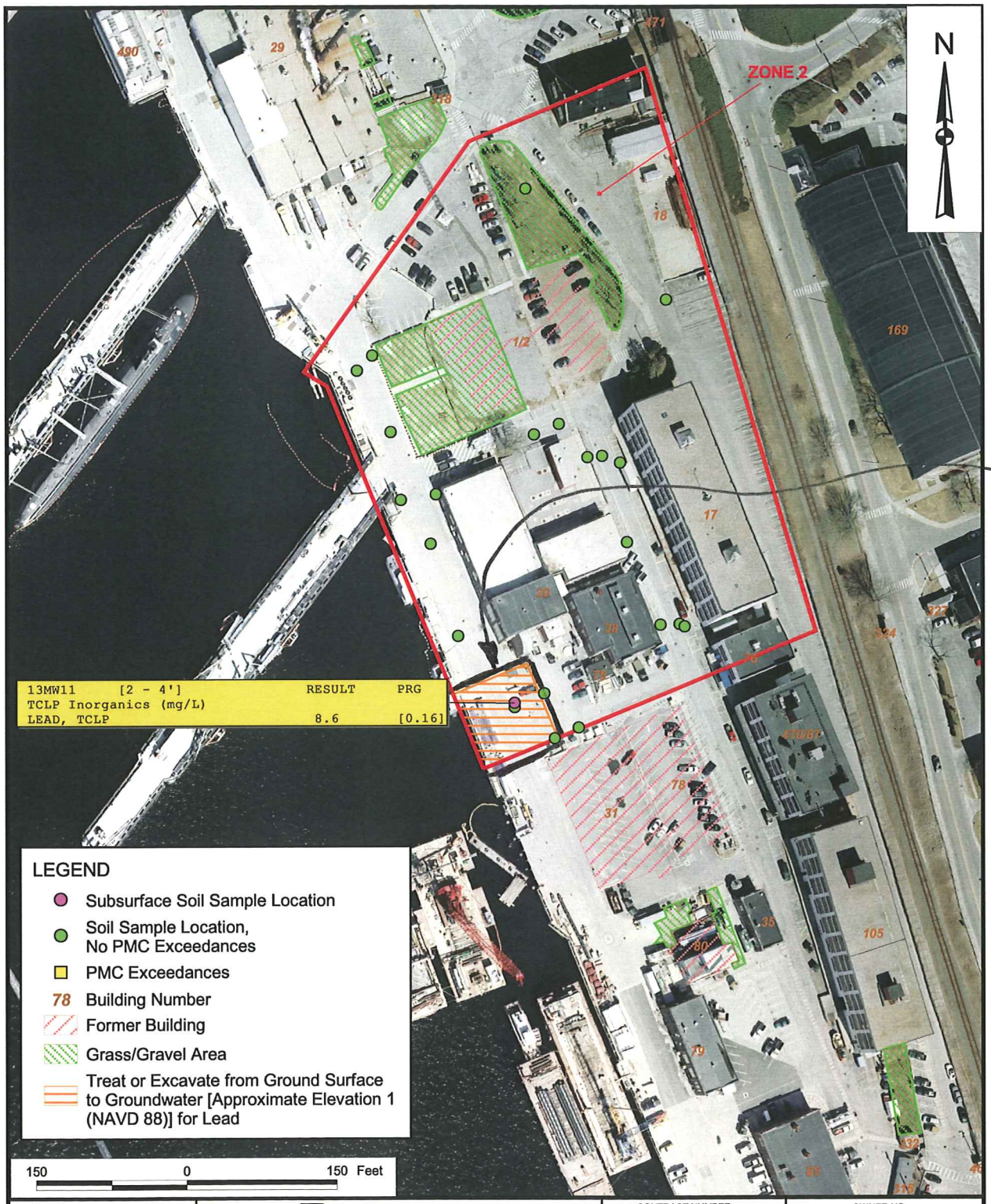
P:\GIS\NLON\MXD\ZONE1234_LEAD\ZONE1234_LEAD_6TO8FT_FS.MXD 10/05/09 SP




| DRAWN BY | DATE | Tetra Tech NUS, Inc. | CONTRACT NO. |
|---|---|---|---|
| S. PAXTON | 4/02/09 | | 2195 |
| CHECKED BY | DATE | ESTIMATED LEAD CONCENTRATIONS (KRIGING RESULTS) | APPROVED BY / DATE |
| N. BALSAMO | 10/05/09 | ELEVATION: 6 TO 8 FEET | – / -- |
| COST/SCHED-AREA | | ZONES 1, 2, 3, AND 4 | APPROVED BY / DATE |
| | | NAVAL SUBMARINE BASE - NEW LONDON | -- / -- |
| SCALE | | GROTON, CONNECTICUT | FIGURE NO. / REV. |
| AS NOTED | | | — |

GENERAL NOTES - SEE FIGURES FOR EACH ZONE.

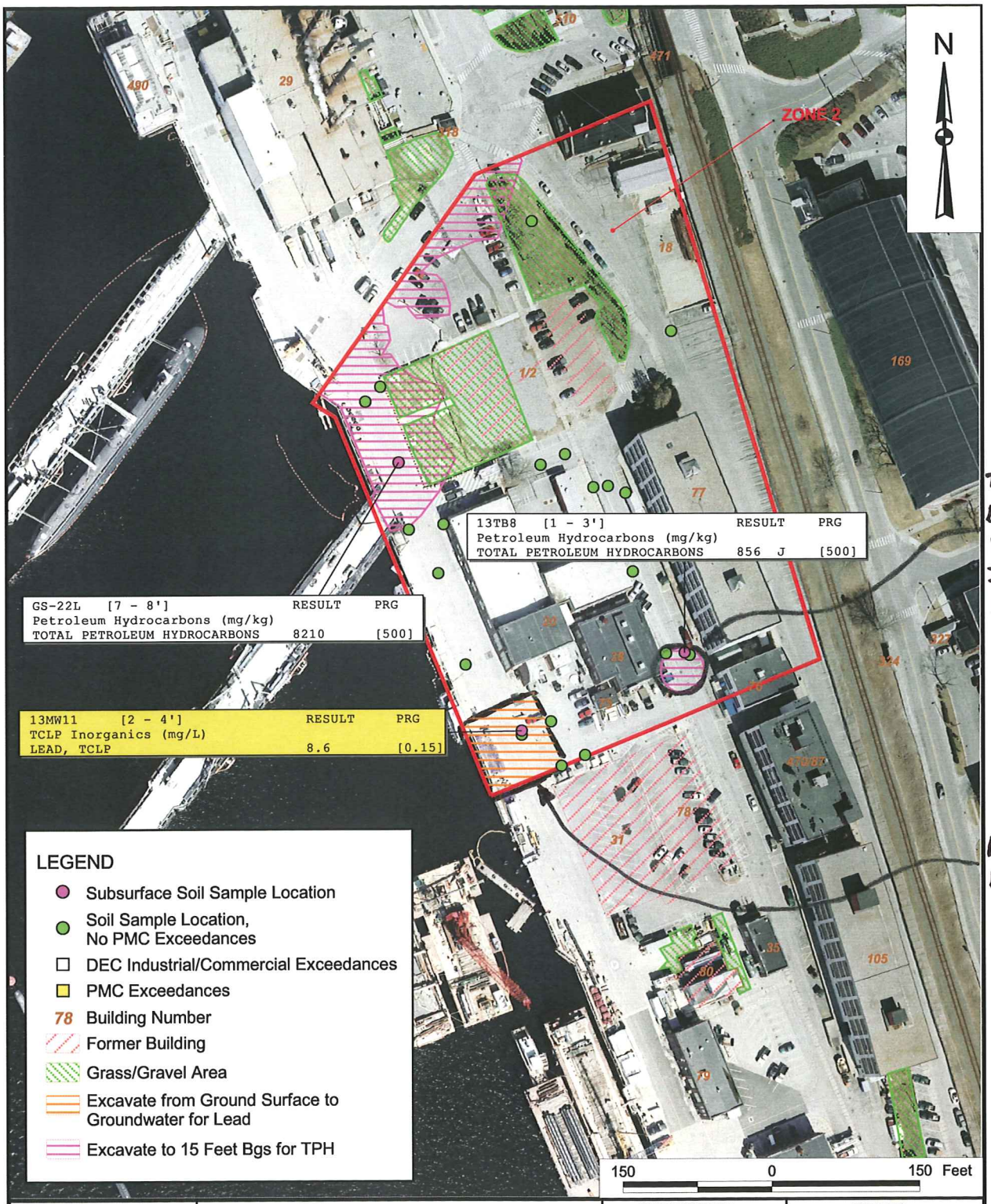
FIG Z1-1




| | | | |
|---|---|---|---|
| DRAWN BY S. STROZ — DATE 11/19/09 | Tetra Tech NUS, Inc. | CONTRACT NUMBER 0424 | OWNER NO. |
| CHECKED BY N. BALSAMO — DATE 11/24/09 | ZONE 2 AREA OF SOIL TO BE IN-SITU TREATED OR EXCAVATED FOR ALTERNATIVES S-2.4 AND S-2.5 LOWER SUBASE FEASIBILITY STUDY NAVAL SUBMARINE BASE - NEW LONDON GROTON, CONNECTICUT | APPROVED BY — DATE — | |
| COST/SCHEDULE-AREA | | APPROVED BY — DATE — | |
| SCALE AS NOTED | | DRAWING NO. FIGURE 4-5 | REV 0 |

P:\GIS\NLON\SUBASE FEASIBILITY STUDY_ZONES.APR ZONE 2 AREA OF SOIL TO BE EXCAVATED LAYOUT 11/24/09 SP

FIG Z2-1
I/C SCENARIO




TPH EXCAVATION WITH INCIDENTAL LEAD

LEAD EXCAVATION

| | | | |
|---|---|---|---|
| DRAWN BY S. STROZ — DATE 11/19/09 | Tetra Tech NUS, Inc. | CONTRACT NUMBER 0424 | OWNER NO. |
| CHECKED BY N. BALSAMO — DATE 11/24/09 | ZONE 2 AREAS TO BE EXCAVATED FOR ALTERNATIVE S-2.6 LOWER SUBASE FEASIBILITY STUDY NAVAL SUBMARINE BASE - NEW LONDON GROTON, CONNECTICUT | APPROVED BY — DATE | |
| COST/SCHEDULE-AREA | | APPROVED BY — DATE | |
| SCALE AS NOTED | | DRAWING NO. FIGURE 4-6 | REV 0 |

P:\GIS\NLON\SUBASE FEASIBILITY STUDY.APR ZONE 2 AREA TO BE EXCAVATED LAYOUT 11/24/09 SS

FIG. Z2-2

RESIDENTIAL SCENARIO

zone2_lead_industrial

| | | | |
|---|---|---|---|
| Soil Case | | | |
| Geologic Layers: All (El 6 to El 1) | | | |
| Isolevel above | 1.090000e+003 | mg/kg (ppm) | |
| Porosity | 0.250000 | | |
| Density | 1.850000 | | |
| Volume Units | Cubic Feet | | |
| Mass Units | Kilograms | | |
| Soil Vol | 6.869671e+002 | | |
| Soil Mass | 3.598656e+004 | | |
| Chem Vol | 1.876744e+000 | | |
| Chem Mass | 5.314198e+001 | | LEAD MASS |
| Average Conc | 1.476717e+003 | mg/kg (ppm) | |
| Volume $ | 4.121802e+004 | | |
| Mass $ | 2.125679e+004 | | |
| Chem Density | 1.000000e+000 | | |
| Vol $ rate | 6.000000e+001 | | |
| Mass $ rate | 4.000000e+002 | | |
| Xcg | 780624.007114 | Feet | |
| Ycg | 204588.975955 | Feet | |
| Zcg | 4.388059 | Feet | |

Krigging program output 11/23/09

zone2_lead_residential

| | | |
|---|---|---|
| Soil Case | | |
| Geologic Layers: All (El 6 to El 1) | | |
| Isolevel above | 4.000000e+002 | mg/kg (ppm) |
| Porosity | 0.250000 | |
| Density | 1.850000 | |
| Volume Units | Cubic Feet | |
| Mass Units | Kilograms | |
| Soil Vol | 1.084828e+004 | |
| Soil Mass | 5.682836e+005 | |
| Chem Vol | 1.236848e+001 | |
| Chem Mass | 3.502265e+002 | LEAD MASS |
| Average Conc | 6.162882e+002 | mg/kg (ppm) |
| Volume $ | 6.508965e+005 | |
| Mass $ | 1.400906e+005 | |
| Chem Density | 1.000000e+000 | |
| Vol $ rate | 6.000000e+001 | |
| Mass $ rate | 4.000000e+002 | |
| Xcg | 780619.574840 | Feet |
| Ycg | 204614.215589 | Feet |
| Zcg | 2.844720 | Feet |

Kriging program output 11/23/09

**ZONE 3**

NSB-NEW LONDON
FEASIBILITY STUDY
MASS OF LEAD IN EXCAVATIONS
12/10/2009

**ZONE 3 - I/C SCENARIO (1 area)**
See Fig Z3-1
**Area 1 - From krigging output**

| | |
|---|---|
| Volume of lead-contaminated soil, cy | 811 |
| **Mass of lead, lb** | **5,412** |
| **Total Lead in Zone, lb** | **5,412** |

**ZONE 3 - RESIDENTIAL SCENARIO (2 areas)**
See Fig Z3-2

**Area 1 - From krigging output**

| | |
|---|---|
| Volume of lead-contaminated soil, cy | 1,989 |
| **Mass of lead, lb** | **8,184** |

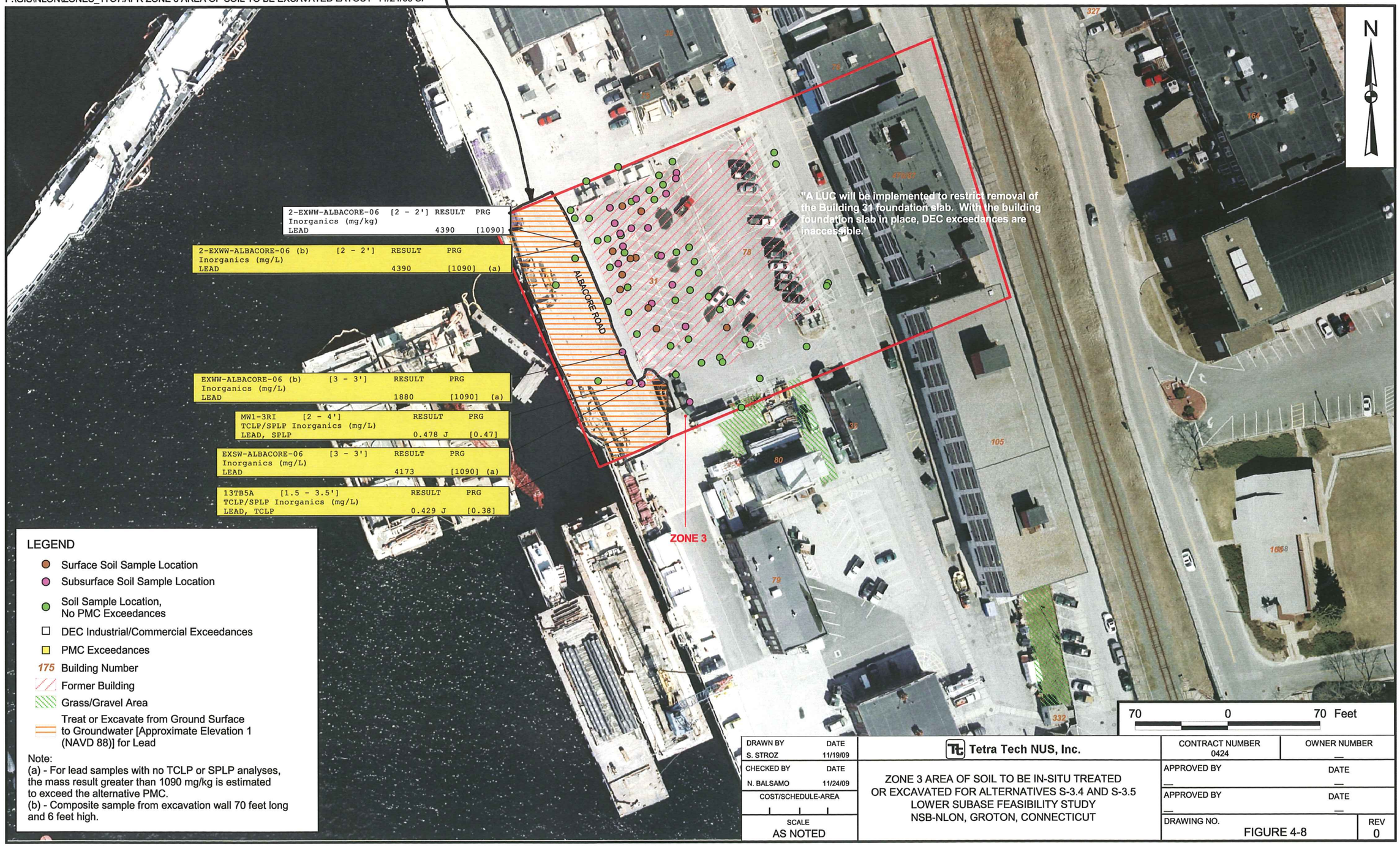
**Area 2 - Building 31**

**See spreadsheet "Bldg 31 rev 12-09" for calculations.**

| | |
|---|---|
| Volume of lead-contaminated soil, cy | 1,728 |
| **Mass of lead, lb** | **8,184** |

| | |
|---|---|
| **Total Lead in Zone, lb** | **16,368** |

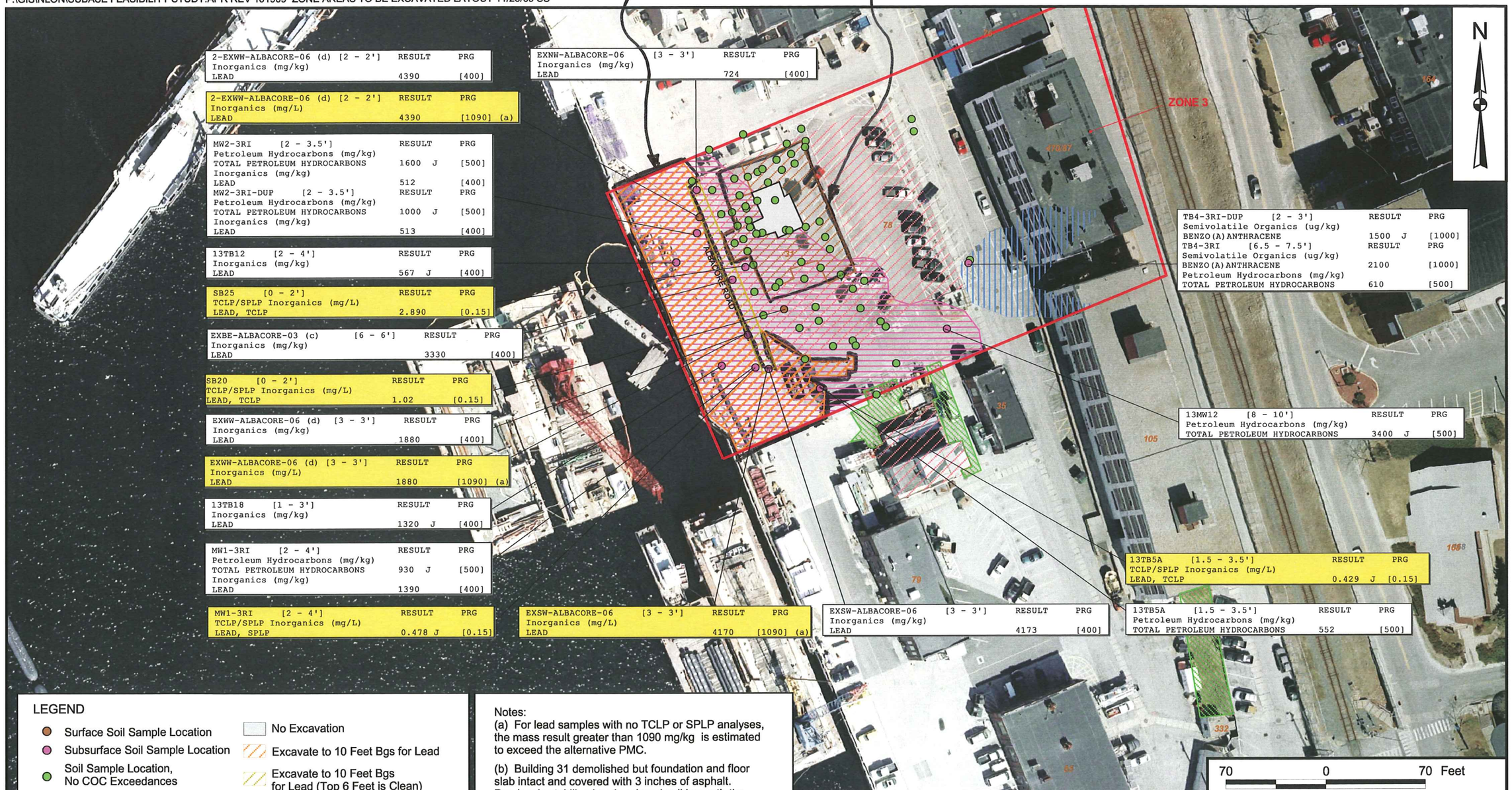
P:\GIS\NLON\ZONES_1TO7.APR ZONE 3 AREA OF SOIL TO BE EXCAVATED LAYOUT 11/24/09 SP




| | | | | |
|---|---|---|---|---|
| DRAWN BY S. STROZ | DATE 11/19/09 | Tetra Tech NUS, Inc. | CONTRACT NUMBER 0424 | OWNER NUMBER — |
| CHECKED BY N. BALSAMO | DATE 11/24/09 | ZONE 3 AREA OF SOIL TO BE IN-SITU TREATED OR EXCAVATED FOR ALTERNATIVES S-3.4 AND S-3.5 LOWER SUBASE FEASIBILITY STUDY NSB-NLON, GROTON, CONNECTICUT | APPROVED BY — | DATE — |
| COST/SCHEDULE-AREA | | | APPROVED BY — | DATE — |
| SCALE AS NOTED | | | DRAWING NO. FIGURE 4-8 | REV 0 |

FIG Z3-1
I/C SCENARIO

P:\GIS\NLON\SUBASE FEASIBILITY STUDY.APR REV 101909 ZONE AREAS TO BE EXCAVATED LAYOUT 11/23/09 SS




LEGEND

- Surface Soil Sample Location
- Subsurface Soil Sample Location
- Soil Sample Location, No COC Exceedances
- DEC Residential Exceedances
- PMC Exceedances
- 105 Building Number
- Former Building
- Grass/Gravel Area
- No Excavation
- Excavate to 10 Feet Bgs for Lead
- Excavate to 10 Feet Bgs for Lead (Top 6 Feet is Clean)
- Excavate to 10 Feet Bgs for Lead (Top 5 to 7 Feet is Cement-Stabilized High-Lead Soil)
- Excavate to 5 Feet Bgs for PAHs
- Excavate to 14 Feet Bgs for TPH Some Upper Soil TPH < 500 mg/kg

Notes:

(a) For lead samples with no TCLP or SPLP analyses, the mass result greater than 1090 mg/kg is estimated to exceed the alternative PMC.

(b) Building 31 demolished but foundation and floor slab intact and covered with 3 inches of asphalt. Previously stabilized and replaced soil beneath the Building 31 floor slab exceeds DEC Residential Criteria.

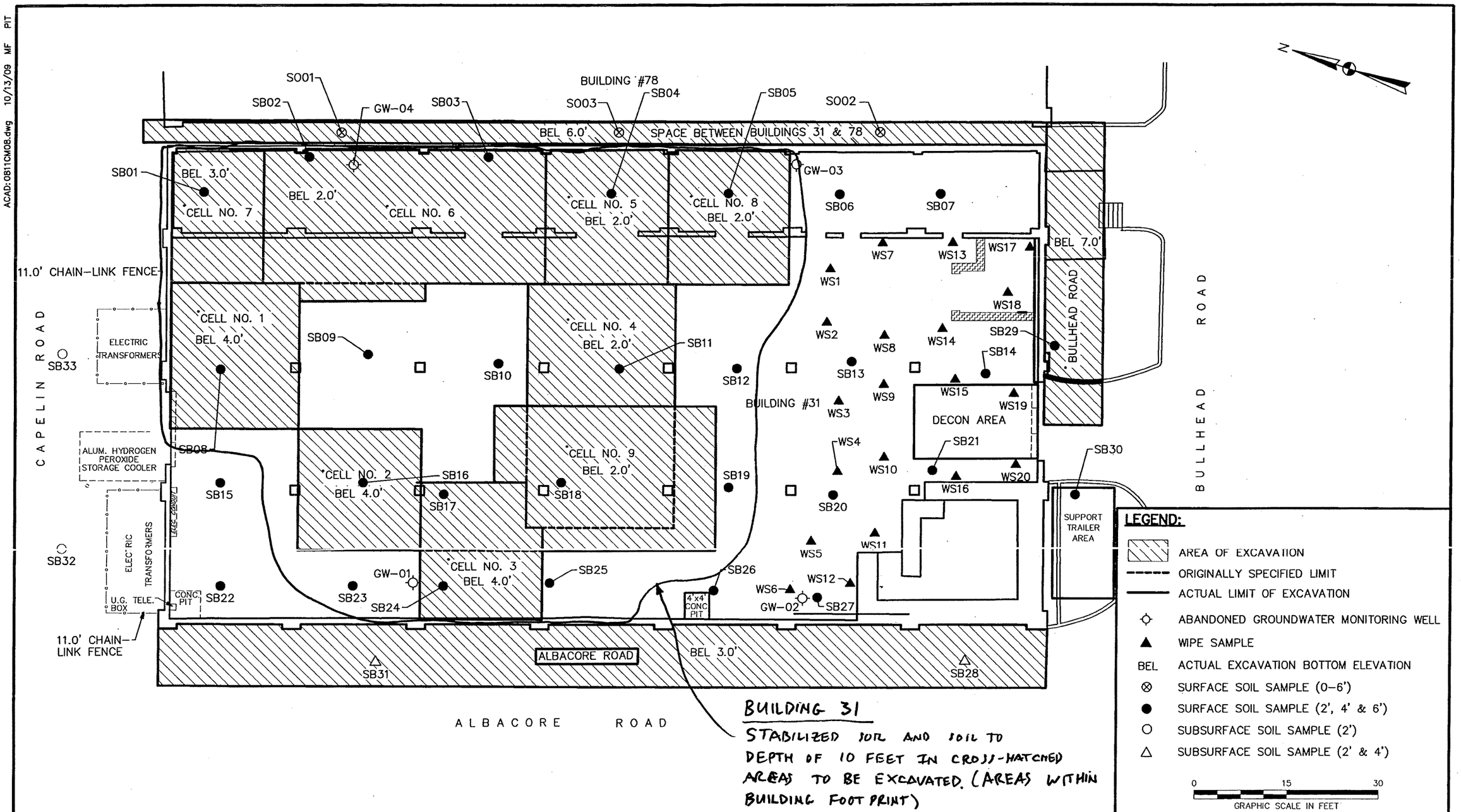
(c) Composite sample from area 10 feet wide along length of Building 31.

(d) Composite sample from excavation wall 70 feet long and 6 feet high.

| | | | |
|---|---|---|---|
| DRAWN BY S. STROZ | DATE 11/20/09 | Tetra Tech NUS, Inc. | CONTRACT NUMBER 0424 / OWNER NUMBER — |
| CHECKED BY N. BALSAMO | DATE 11/23/09 | ZONE 3 AREAS OF SOIL TO BE EXCAVATED FOR ALTERNATIVE S-3.6 LOWER SUBASE FEASIBILITY STUDY NSB-NLON, GROTON, CONNECTICUT | APPROVED BY — / DATE — |
| COST/SCHEDULE-AREA | | | APPROVED BY — / DATE — |
| SCALE AS NOTED | | | DRAWING NO. FIGURE 4-9 / REV 0 |

FIG Z3-2
RESIDENTIAL SCENARIO

ACAD:0811CM08.dwg 10/13/09 MF PIT




BUILDING 31

STABILIZED SOIL AND SOIL TO DEPTH OF 10 FEET IN CROSS-HATCHED AREAS TO BE EXCAVATED. (AREAS WITHIN BUILDING FOOT PRINT)

| | | | | |
|---|---|---|---|---|
| DRAWN BY MF | DATE 3/5/08 | Tetra Tech NUS, Inc. | SITE MAP<br>AREAS OF REMEDIATION AT SITE 17<br>LOWER SUBASE FEASIBILITY STUDY<br>NSB-NLON, GROTON, CONNECTICUT | CONTRACT NO. 0811 |
| CHECKED BY | DATE | | | OWNER NO. 424 |
| REVISED BY | DATE | | | APPROVED BY / DATE |
| SCALE AS NOTED | | | | DRAWING NO. FIGURE 1-7 / REV. 0 |

FORM CADD NO. TTNUS-BH.DWG – REV 1 – 9/10/98

FIG Z3-3
RESIDENTIAL SCENARIO

zone3_lead_industrial

| | | |
|---|---|---|
| Soil Case | | |
| Geologic Layers: All (El 6 to El 1) | | |
| Isolevel above | 1.090000e+003 | mg/kg (ppm) |
| Porosity | 0.250000 | |
| Density | 1.850000 | |
| Volume Units | Cubic Feet | |
| Mass Units | Kilograms | |
| Soil Vol | 2.193966e+004 | |
| Soil Mass | 1.149302e+006 | |
| Chem Vol | 8.701654e+001 | |
| Chem Mass | 2.463965e+003 - | LEAD MASS |
| Average Conc | 2.143879e+003 | mg/kg (ppm) |
| Volume $ | 1.316379e+006 | |
| Mass $ | 9.855860e+005 | |
| Chem Density | 1.000000e+000 | |
| Vol $ rate | 6.000000e+001 | |
| Mass $ rate | 4.000000e+002 | |
| Xcg | 780683.239155 | Feet |
| Ycg | 204483.179493 | Feet |
| Zcg | 4.331767 | Feet |

Kriggsins program output 11/23/09

zone3_lead_residential

Soil Case
Geologic Layers: All (El 6 to El -4)

| | | |
|---|---|---|
| Isolevel above | 4.000000e+002 | mg/kg (ppm) |
| Porosity | 0.250000 | |
| Density | 1.850000 | |
| Volume Units | Cubic Feet | |
| Mass Units | Kilograms | |
| Soil Vol | 5.373606e+004 | |
| Soil Mass | 2.814948e+006 | |
| Chem Vol | 1.313081e+002 | |
| Chem Mass | 3.718127e+003 | LEAD MASS |
| Average Conc | 1.320851e+003 | mg/kg (ppm) |
| Volume $ | 3.224164e+006 | |
| Mass $ | 1.487251e+006 | |
| Chem Density | 1.000000e+000 | |
| Vol $ rate | 6.000000e+001 | |
| Mass $ rate | 4.000000e+002 | |
| Xcg | 780684.552142 | Feet |
| Ycg | 204484.325906 | Feet |
| Zcg | 3.578773 | Feet |

Kriging program output 11/23/09

NSB NEW LONDON
REVISED CALCULATION OF LEAD MASS IN BUILDING 31 STABILIZED SOIL
12/10/2009

**General approach.**
Calculate footprint of shaded area on Figure Z3-3
Calculate average lead for each layer: 0-2', 2-6', and 6'-10'
0-2' average based on table PMC-3A
2-6' based on table PMC-4A
6'-10' based on deep samples of PMC-4A divided by 2 to reflect clean samples at 10 feet.
Assume soil density of 113 lb/ft3

| | |
|---|---|
| Soil density | 113 lb/ft3 |

**Mass of Lead**

| Interval | Thickness, feet | Area, ft2 | Volume, ft3 | Lead, mg/kg | Lead, lb |
|---|---|---|---|---|---|
| 0 - 2 | 2 | 4,667 | 9,333 | 3,473 | 3,663 |
| 2 - 6 | 4 | 4,667 | 18,666 | 1,585 | 3,344 |
| 6 - 10 | 4 | 4,667 | 18,666 | 558 | 1,178 |
| | | | | | |
| Total | | | 46,666 | | 8,184 |
| | | | 1,728 | cy | |

Estimate of average lead concentrations at each depth interval.
Data copied from tables, then TCLP data was deleted

**PMC-3A (0 - 2')**

| | | | | | |
|---|---|---|---|---|---|
| SB01 | 0 | 2 LEAD | M | 1,490 | mg/kg |
| SB02 | 0 | 2 LEAD | M | 3,390 | mg/kg |
| SB02 | 0 | 2 LEAD | M | 5,860 | mg/kg |
| SB03 | 0 | 2 LEAD | M | 4,790 | mg/kg |
| SB04 | 0 | 2 LEAD | M | 492 | mg/kg |
| SB04 | 0 | 2 LEAD | M | 591 | mg/kg |
| SB05 | 0 | 2 LEAD | M | 11,900 | mg/kg |
| SB08 | 0 | 2 LEAD | M | 962 | mg/kg |
| SB11 | 0 | 2 LEAD | M | 10 | mg/kg |
| SB16 | 0 | 2 LEAD | M | 1,060 | mg/kg |
| SB17 | 0 | 2 LEAD | M | 25 | mg/kg |
| SB18 | 0 | 2 LEAD | M | 39 | mg/kg |
| SB24 | 0 | 2 LEAD | M | 16,900 | mg/kg |
| CELL_NO_3 | 2 | 2 LEAD | M | 4,480 | mg/kg |
| CELL_NO_3 | 2 | 2 LEAD | M | 1,950 | mg/kg |
| CELL_NO_3 | 2 | 2 LEAD | M | 1,630 | mg/kg |
| **Average** | | | | 3,473 | mg/kg |

**PMC-4A (2' - 6')**

| | Top | Bottom | | | | |
|---|---|---|---|---|---|---|
| EXBE01-04 | | 5 | 5 LEAD | M | 49.6 | mg/kg |
| EXBE02-04 | | 5 | 5 LEAD | M | 322 | mg/kg |
| EXBE03-04 | | 5 | 5 LEAD | M | 134 | mg/kg |
| EXBE06-07 | | 7 | 7 LEAD | M | 162 | mg/kg |
| EXBE07-03 | | 6 | 6 LEAD | M | 15.2 | mg/kg |
| SB01 | | 2 | 4 LEAD | M | 4,330 | mg/kg |
| SB01 | | 2 | 4 LEAD | M | 1,590 | mg/kg |
| SB02 | | 2 | 4 LEAD | M | 3,160 | mg/kg |
| SB02 | | 2 | 4 LEAD | M | 2,720 | mg/kg |
| SB03 | | 2 | 4 LEAD | M | 5,370 | mg/kg |
| SB04 | | 2 | 4 LEAD | M | 177 | mg/kg |
| SB08 | | 2 | 4 LEAD | M | 8.6 | mg/kg |
| SB11 | | 2 | 4 LEAD | M | 8.4 | mg/kg |
| SB16 | | 2 | 4 LEAD | M | 713 | mg/kg |
| SB17 | | 2 | 4 LEAD | M | 77.3 | mg/kg |
| SB18 | | 2 | 4 LEAD | M | 53.9 | mg/kg |
| SB24 | | 2 | 4 LEAD | M | 4,550 | mg/kg |
| CELL_NO_1 | | 3 | 3 LEAD | M | 1,980 | mg/kg |
| CELL_NO_6N | | 5 | 5 LEAD | M | 1,210 | mg/kg |
| CELL_NO_9 | | 3 | 3 LEAD | M | 1,940 | mg/kg |
| CELL_NO_9 | | 3 | 3 LEAD | M | 7,420 | mg/kg |
| CELL_NO_9 | | 3 | 3 LEAD | M | 1,690 | mg/kg |
| CELL_NO_9 | | 3 | 3 LEAD | M | 1,990 | mg/kg |

| | | | | | | |
|---|---|---|---|---|---|---|
| CELL_NO_9 | 3 | 3 | LEAD | M | 167 | mg/kg |
| SB01 | 4 | 6 | LEAD | M | 1,180 | mg/kg |
| SB02 | 4 | 6 | LEAD | M | 383 | mg/kg |
| SB03 | 4 | 6 | LEAD | M | 106 | mg/kg |
| SB04 | 4 | 6 | LEAD | M | 301 | mg/kg |
| SB05 | 4 ? | | LEAD | M | 2,990 | mg/kg |
| SB11 | 4 | 6 | LEAD | M | 799 | mg/kg |
| SB16 | 4 | 6 | LEAD | M | 339 | mg/kg |
| SB17 | 4 | 6 | LEAD | M | 302 | mg/kg |
| SB18 | 4 | 6 | LEAD | M | 9,470 | mg/kg |
| SB18 | 4 | 6 | LEAD | M | 689 | mg/kg |
| SB24 | 4 | 6 | LEAD | M | 4.9 | mg/kg |
| SB05 | 6 | 6 | LEAD | M | 670 | mg/kg |
| **Average** | | | | | 1,585 | mg/kg |

**From PMC-4A above, but only the deepest samples (6' - 10')**

| | Top | Bottom | | | | |
|---|---|---|---|---|---|---|
| EXBE06-07 | 7 | 7 | LEAD | M | 162 | mg/kg |
| EXBE07-03 | 6 | 6 | LEAD | M | 15.2 | mg/kg |
| CELL_NO_6N | 5 | 5 | LEAD | M | 1,210 | mg/kg |
| SB01 | 4 | 6 | LEAD | M | 1,180 | mg/kg |
| SB02 | 4 | 6 | LEAD | M | 383 | mg/kg |
| SB03 | 4 | 6 | LEAD | M | 106 | mg/kg |
| SB04 | 4 | 6 | LEAD | M | 301 | mg/kg |
| SB11 | 4 | 6 | LEAD | M | 799 | mg/kg |
| SB16 | 4 | 6 | LEAD | M | 339 | mg/kg |
| SB17 | 4 | 6 | LEAD | M | 302 | mg/kg |
| SB18 | 4 | 6 | LEAD | M | 9,470 | mg/kg |
| SB18 | 4 | 6 | LEAD | M | 689 | mg/kg |
| SB24 | 4 | 6 | LEAD | M | 4.9 | mg/kg |
| SB05 | 6 | 6 | LEAD | M | 670 | mg/kg |
| Average | | | | | 1,117 | mg/kg |
| **For 6-10', use half of average** | | | | | 558 | mg/kg |

Building 31
Shaded area
12/9/2009

From Figure 1-7. Scale is 1" = 15'

| Cell | W, in | L, in | area, in2 | Area, ft2 |
|---|---|---|---|---|
| Cells 7, 6, 5, and 8 | 6.65 | 1.42 | 9.443 | 2,125 |
| Cell 1 | 1.55 | 1.35 | 2.0925 | 471 |
| Part next to Cell 1 | 1.35 | 0.2 | 0.27 | 61 |
| Cell 4 | 1.3 | 1.6 | 2.08 | 468 |
| Cell 2 | 1.2 | 1.3 | 1.56 | 351 |
| "SB17" | 0.75 | 0.8 | 0.6 | 135 |
| Cell 9 | 2.4 | 1.55 | 3.72 | 837 |
| Lower Cell 3 | 0.75 | 1.3 | 0.975 | 219 |
| Total | | | | **4,667** |

# ZONE 4

NSB-NEW LONDON
FEASIBILITY STUDY
MASS OF LEAD IN EXCAVATIONS
12/10/2009

**ZONE 4 - I/C SCENARIO (1 area)**
See Fig Z4-1
**Area 1 - From krigging output**

| | |
|---|---|
| Volume of lead-contaminated soil, cy | 2,022 |

| | |
|---|---|
| **Mass of lead, lb** | **15,510** |

| | |
|---|---|
| **Total Lead in Zone, lb** | **15,510** |

**ZONE 4 - RESIDENTIAL SCENARIO (3 areas)**
See Fig Z4-2
**Areas 1 and 2 - From krigging output**

| | | |
|---|---|---|
| Volume of lead-contaminated soil, cy | 7,074 | This is the total of two areas. |

| | |
|---|---|
| **Mass of lead, lb** | **29,480** |

**Area 3 - Sample 13TB6**

| Sample | | | Total, mg/kg | Notes |
|---|---|---|---|---|
| 13TB6 | | | 99 | 5' - 7' interval |
| Background | | | 17.5 | |

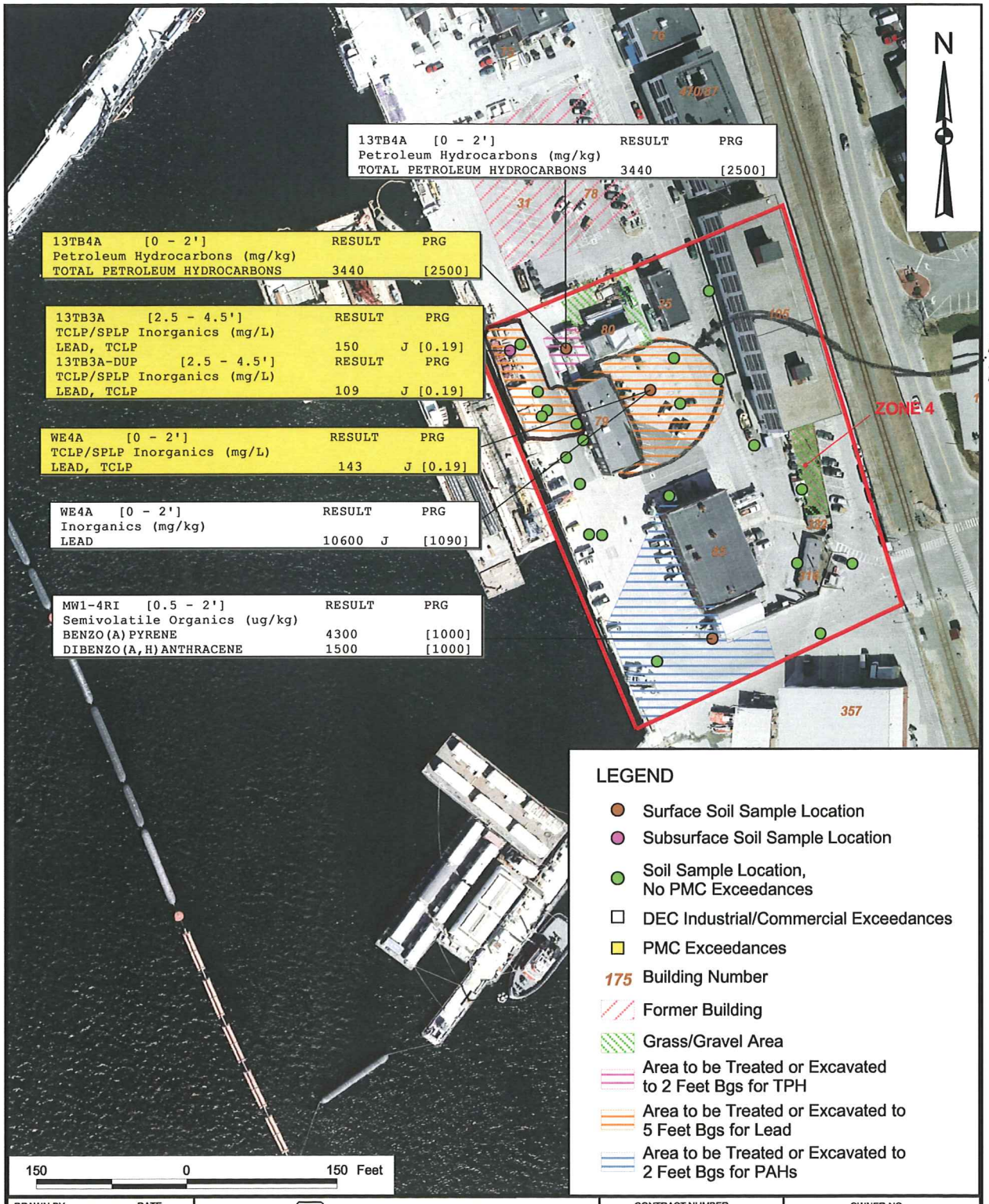
Note:
Lead concentration did not exceed PRG and is incidental.

| | |
|---|---|
| Geometric average, mg/kg | 41.6 |

| | | |
|---|---|---|
| Volume of lead-contaminated soil, cy | 276 | Volume from 2008 was scaled. |
| Soil density, lb/ft$^3$ | 113 | (The 2008 area was 30' x 30' .) |

| | |
|---|---|
| **Mass of lead, lb** | **35** |

| | |
|---|---|
| **Total Lead in Zone, lb** | **29,515** |




| | | | |
|---|---|---|---|
| DRAWN BY S. STROZ DATE 11/19/09 | Tetra Tech NUS, Inc. | CONTRACT NUMBER 0424 | OWNER NO. |
| CHECKED BY N. BALSAMO DATE 11/24/09 | ZONE 4 AREAS TO BE IN-SITU TREATED OR EXCAVATED FOR ALTERNATIVES S-4.4 AND S-4.5 NAVAL SUBMARINE BASE - NEW LONDON GROTON, CONNECTICUT | APPROVED BY — DATE — | |
| COST/SCHEDULE-AREA | | APPROVED BY — DATE — | |
| SCALE AS NOTED | | DRAWING NO. FIGURE 4-11 | REV 0 |

P:\GIS\NLON\ZONES_1TO7.APR ZONE 4 AREAS TO BE EXCAVATED LAYOUT 11/24/09 SP

FIG Z4-1
I/C SCENARIO

TPH EXCAVATION WITH INCIDENTAL LEAD

LEAD EXCAVATIONS

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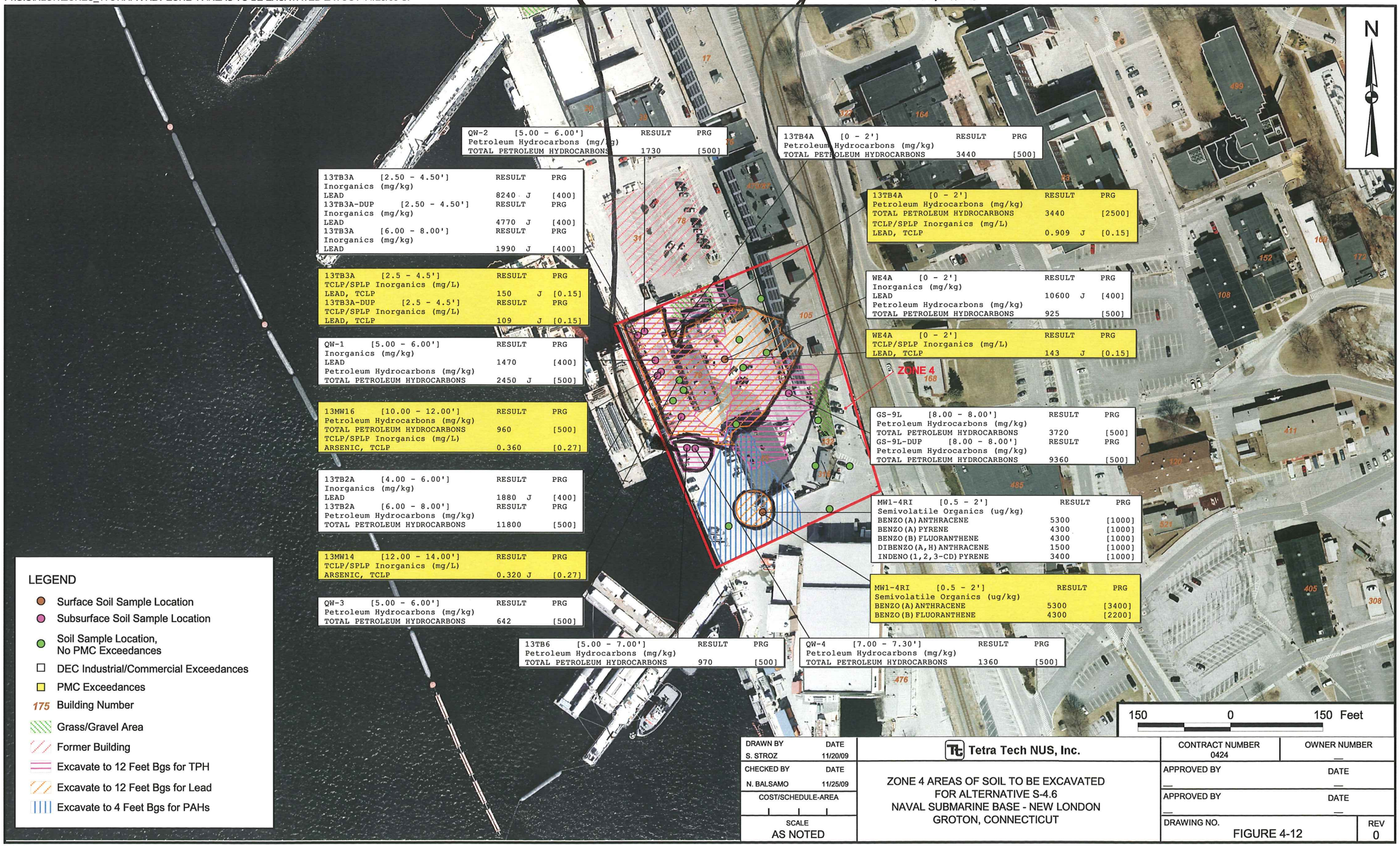



| QW-2 [5.00 - 6.00'] | RESULT | PRG |
|---|---|---|
| Petroleum Hydrocarbons (mg/kg) | | |
| TOTAL PETROLEUM HYDROCARBONS | 1730 | [500] |

| 13TB3A [2.50 - 4.50'] | RESULT | PRG |
|---|---|---|
| Inorganics (mg/kg) | | |
| LEAD | 8240 J | [400] |
| 13TB3A-DUP [2.50 - 4.50'] | RESULT | PRG |
| Inorganics (mg/kg) | | |
| LEAD | 4770 J | [400] |
| 13TB3A [6.00 - 8.00'] | RESULT | PRG |
| Inorganics (mg/kg) | | |
| LEAD | 1990 J | [400] |

| 13TB3A [2.5 - 4.5'] | RESULT | PRG |
|---|---|---|
| TCLP/SPLP Inorganics (mg/L) | | |
| LEAD, TCLP | 150 J | [0.15] |
| 13TB3A-DUP [2.5 - 4.5'] | RESULT | PRG |
| TCLP/SPLP Inorganics (mg/L) | | |
| LEAD, TCLP | 109 J | [0.15] |

| QW-1 [5.00 - 6.00'] | RESULT | PRG |
|---|---|---|
| Inorganics (mg/kg) | | |
| LEAD | 1470 | [400] |
| Petroleum Hydrocarbons (mg/kg) | | |
| TOTAL PETROLEUM HYDROCARBONS | 2450 J | [500] |

| 13MW16 [10.00 - 12.00'] | RESULT | PRG |
|---|---|---|
| Petroleum Hydrocarbons (mg/kg) | | |
| TOTAL PETROLEUM HYDROCARBONS | 960 | [500] |
| TCLP/SPLP Inorganics (mg/L) | | |
| ARSENIC, TCLP | 0.360 | [0.27] |

| 13TB2A [4.00 - 6.00'] | RESULT | PRG |
|---|---|---|
| Inorganics (mg/kg) | | |
| LEAD | 1880 J | [400] |
| 13TB2A [6.00 - 8.00'] | RESULT | PRG |
| Petroleum Hydrocarbons (mg/kg) | | |
| TOTAL PETROLEUM HYDROCARBONS | 11800 | [500] |

| 13MW14 [12.00 - 14.00'] | RESULT | PRG |
|---|---|---|
| TCLP/SPLP Inorganics (mg/L) | | |
| ARSENIC, TCLP | 0.320 J | [0.27] |

| QW-3 [5.00 - 6.00'] | RESULT | PRG |
|---|---|---|
| Petroleum Hydrocarbons (mg/kg) | | |
| TOTAL PETROLEUM HYDROCARBONS | 642 | [500] |

| 13TB6 [5.00 - 7.00'] | RESULT | PRG |
|---|---|---|
| Petroleum Hydrocarbons (mg/kg) | | |
| TOTAL PETROLEUM HYDROCARBONS | 970 | [500] |

| 13TB4A [0 - 2'] | RESULT | PRG |
|---|---|---|
| Petroleum Hydrocarbons (mg/kg) | | |
| TOTAL PETROLEUM HYDROCARBONS | 3440 | [500] |

| 13TB4A [0 - 2'] | RESULT | PRG |
|---|---|---|
| Petroleum Hydrocarbons (mg/kg) | | |
| TOTAL PETROLEUM HYDROCARBONS | 3440 | [2500] |
| TCLP/SPLP Inorganics (mg/L) | | |
| LEAD, TCLP | 0.909 J | [0.15] |

| WE4A [0 - 2'] | RESULT | PRG |
|---|---|---|
| Inorganics (mg/kg) | | |
| LEAD | 10600 J | [400] |
| Petroleum Hydrocarbons (mg/kg) | | |
| TOTAL PETROLEUM HYDROCARBONS | 925 | [500] |

| WE4A [0 - 2'] | RESULT | PRG |
|---|---|---|
| TCLP/SPLP Inorganics (mg/L) | | |
| LEAD, TCLP | 143 J | [0.15] |

| GS-9L [8.00 - 8.00'] | RESULT | PRG |
|---|---|---|
| Petroleum Hydrocarbons (mg/kg) | | |
| TOTAL PETROLEUM HYDROCARBONS | 3720 | [500] |
| GS-9L-DUP [8.00 - 8.00'] | RESULT | PRG |
| Petroleum Hydrocarbons (mg/kg) | | |
| TOTAL PETROLEUM HYDROCARBONS | 9360 | [500] |

| MW1-4RI [0.5 - 2'] | RESULT | PRG |
|---|---|---|
| Semivolatile Organics (ug/kg) | | |
| BENZO(A)ANTHRACENE | 5300 | [1000] |
| BENZO(A)PYRENE | 4300 | [1000] |
| BENZO(B)FLUORANTHENE | 4300 | [1000] |
| DIBENZO(A,H)ANTHRACENE | 1500 | [1000] |
| INDENO(1,2,3-CD)PYRENE | 3400 | [1000] |

| MW1-4RI [0.5 - 2'] | RESULT | PRG |
|---|---|---|
| Semivolatile Organics (ug/kg) | | |
| BENZO(A)ANTHRACENE | 5300 | [3400] |
| BENZO(B)FLUORANTHENE | 4300 | [2200] |

| QW-4 [7.00 - 7.30'] | RESULT | PRG |
|---|---|---|
| Petroleum Hydrocarbons (mg/kg) | | |
| TOTAL PETROLEUM HYDROCARBONS | 1360 | [500] |

| DRAWN BY | DATE |
|---|---|
| S. STROZ | 11/20/09 |
| CHECKED BY | DATE |
| N. BALSAMO | 11/25/09 |
| COST/SCHEDULE-AREA | |
| SCALE | |
| AS NOTED | |

Tetra Tech NUS, Inc.

ZONE 4 AREAS OF SOIL TO BE EXCAVATED
FOR ALTERNATIVE S-4.6
NAVAL SUBMARINE BASE - NEW LONDON
GROTON, CONNECTICUT

| CONTRACT NUMBER | OWNER NUMBER |
|---|---|
| 0424 | — |
| APPROVED BY | DATE |
| — | — |
| APPROVED BY | DATE |
| — | — |
| DRAWING NO. | REV |
| FIGURE 4-12 | 0 |

FIG Z4-2
RESIDENTIAL SCENARIO

zone4_lead_industrial

| | | |
|---|---|---|
| Soil Case | | |
| Geologic Layers: All (El 6 to El 1) | | |
| Isolevel above | 1.090000e+003 | mg/kg (ppm) |
| Porosity | 0.250000 | |
| Density | 1.850000 | |
| Volume Units | Cubic Feet | |
| Mass Units | Kilograms | |
| Soil Vol | 5.456885e+004 | |
| Soil Mass | 2.858573e+006 | |
| Chem Vol | 2.491224e+002 | |
| Chem Mass | 7.054164e+003 | LEAD MASS |
| Average Conc | 2.467722e+003 | mg/kg (ppm) |
| Volume $ | 3.274131e+006 | |
| Mass $ | 2.821665e+006 | |
| Chem Density | 1.000000e+000 | |
| Vol $ rate | 6.000000e+001 | |
| Mass $ rate | 4.000000e+002 | |
| Xcg | 780801.292176 | Feet |
| Ycg | 204342.193074 | Feet |
| Zcg | 3.917151 | Feet |

Kriging program output 11/23/09

zone4_lead_residential (BOTH AREAS)

| | | |
|---|---|---|
| Soil Case | | |
| Geologic Layers: All (El 6 to El -6) | | |
| Isolevel above | 4.000000e+002 | mg/kg (ppm) |
| Porosity | 0.250000 | |
| Density | 1.850000 | |
| Volume Units | Cubic Feet | |
| Mass Units | Kilograms | |
| Soil Vol | 1.910755e+005 | |
| Soil Mass | 1.000944e+007 | |
| Chem Vol | 4.732041e+002 | |
| Chem Mass | 1.339927e+004 | LEAD MASS |
| Average Conc | 1.338664e+003 | mg/kg (ppm) |
| Volume $ | 1.146453e+007 | |
| Mass $ | 5.359709e+006 | |
| Chem Density | 1.000000e+000 | |
| Vol $ rate | 6.000000e+001 | |
| Mass $ rate | 4.000000e+002 | |
| Xcg | 780805.916548 | Feet |
| Ycg | 204337.115682 | Feet |
| Zcg | 3.042862 | Feet |

Kriging program output 11/23/09

ZONE 7

NSB-NEW LONDON
FEASIBILITY STUDY
MASS OF LEAD IN EXCAVATIONS
12/10/2009

**ZONE 7 - I/C SCENARIO (1 area)**
See Fig Z7-1
**Area 1 - From krigging output**

| | |
|---|---|
| Volume of lead-contaminated soil, cy | 4,222 |

| | |
|---|---|
| **Mass of lead, lb** | **82,060** |

| | |
|---|---|
| **Total Lead in Zone, lb** | **82,060** |

**ZONE 7 - RESIDENTIAL SCENARIO (3 areas)**
See Fig Z7-2
**Area 1 - From krigging output**

| | |
|---|---|
| Volume of lead-contaminated soil, cy | 28,222 |

| | |
|---|---|
| **Mass of lead, lb** | **247,060** |

**Area 2 - Sample TB11-7RI**
See Fig Z7-3

| Sample | | | Total, mg/kg | Notes |
|---|---|---|---|---|
| TB11-7RI | | | 197 | 2' - 4' interval |
| TB11-7RI | | | 45 | 6' - 7' interval |
| Background | | | 17.5 | |

Notes:
Lead is incidentally in this area.

| | | |
|---|---|---|
| Geometric average, mg/kg | 53.7 | No change to 2008 estimate. Original area was 30' x 45' |

| | |
|---|---|
| Volume of lead-contaminated soil, cy | 338 |
| Soil density, lb/ft$^3$ | 113 |

| | |
|---|---|
| **Mass of lead, lb** | **55** |

**Area 3 - Sample 20MW3**
See Fig Z7-3

| Sample | | | Total, mg/kg | Notes |
|---|---|---|---|---|
| 20MW3 | | | 61 | 2' - 4' interval |
| 20MW3 | | | 38 | 8' - 10' interval, ave of dups |
| Background | | | 17.5 | |

Notes:

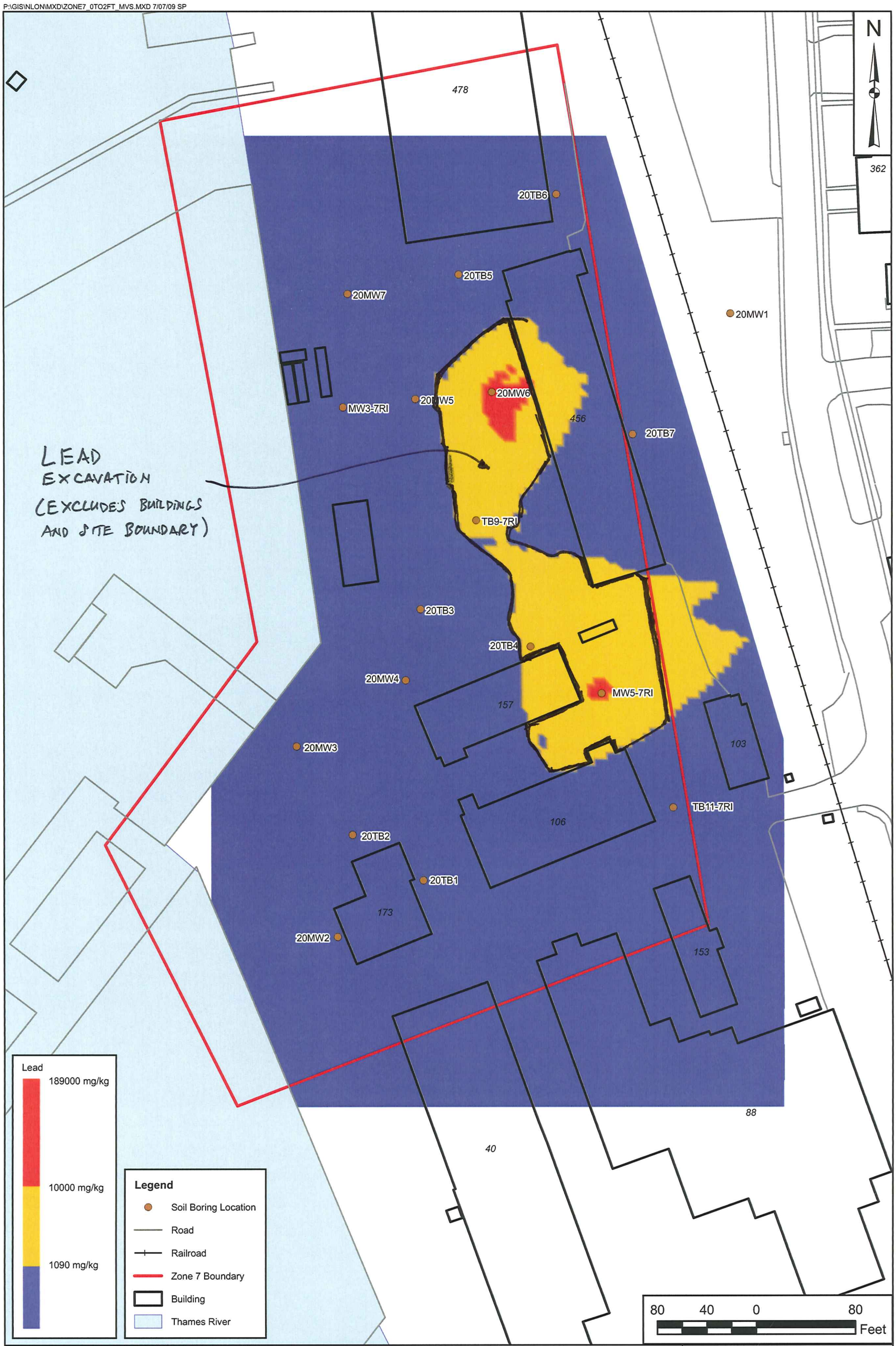
| | | |
|---|---|---|
| Geometric average, mg/kg | 34.4 | No change to 2008 estimate. Original area was 45' x 45' |

| | |
|---|---|
| Volume of lead-contaminated soil, cy | 300 |
| Soil density, lb/ft$^3$ | 113 |

| | |
|---|---|
| **Mass of lead, lb** | **31** |

| | |
|---|---|
| **Total Lead in Zone, lb** | **247,147** |

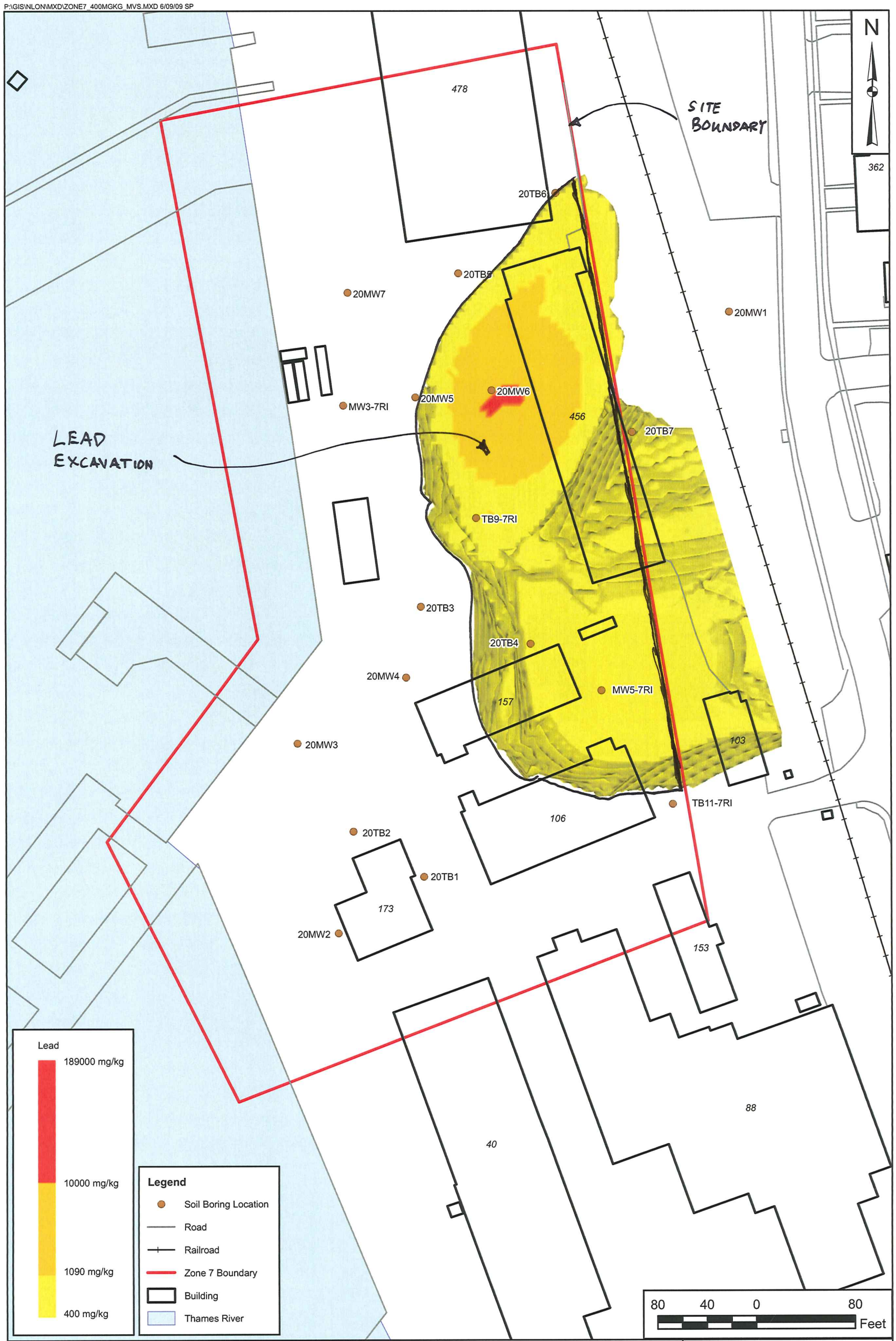
P:\GIS\NLON\MXD\ZONE7_0TO2FT_MVS.MXD 7/07/09 SP




| DRAWN BY | DATE | Tetra Tech NUS, Inc. | CONTRACT NO. |
|---|---|---|---|
| S. PAXTON | 4/02/09 | | 0811 |
| CHECKED BY | DATE | ESTIMATED LEAD CONCENTRATIONS (KRIGING RESULTS)<br>ELEVATION: 0 TO 2 FEET<br>ZONE 7<br>NAVAL SUBMARINE BASE - NEW LONDON<br>GROTON, CONNECTICUT | APPROVED BY / DATE |
| N. BALSAMO | 7/07/09 | | – / – |
| COST/SCHED-AREA | | | APPROVED BY / DATE |
| | | | – / – |
| SCALE | | | FIGURE NO. / REV. |
| AS NOTED | | | 5 / |

FIG Z7-1
I/C SCENARIO

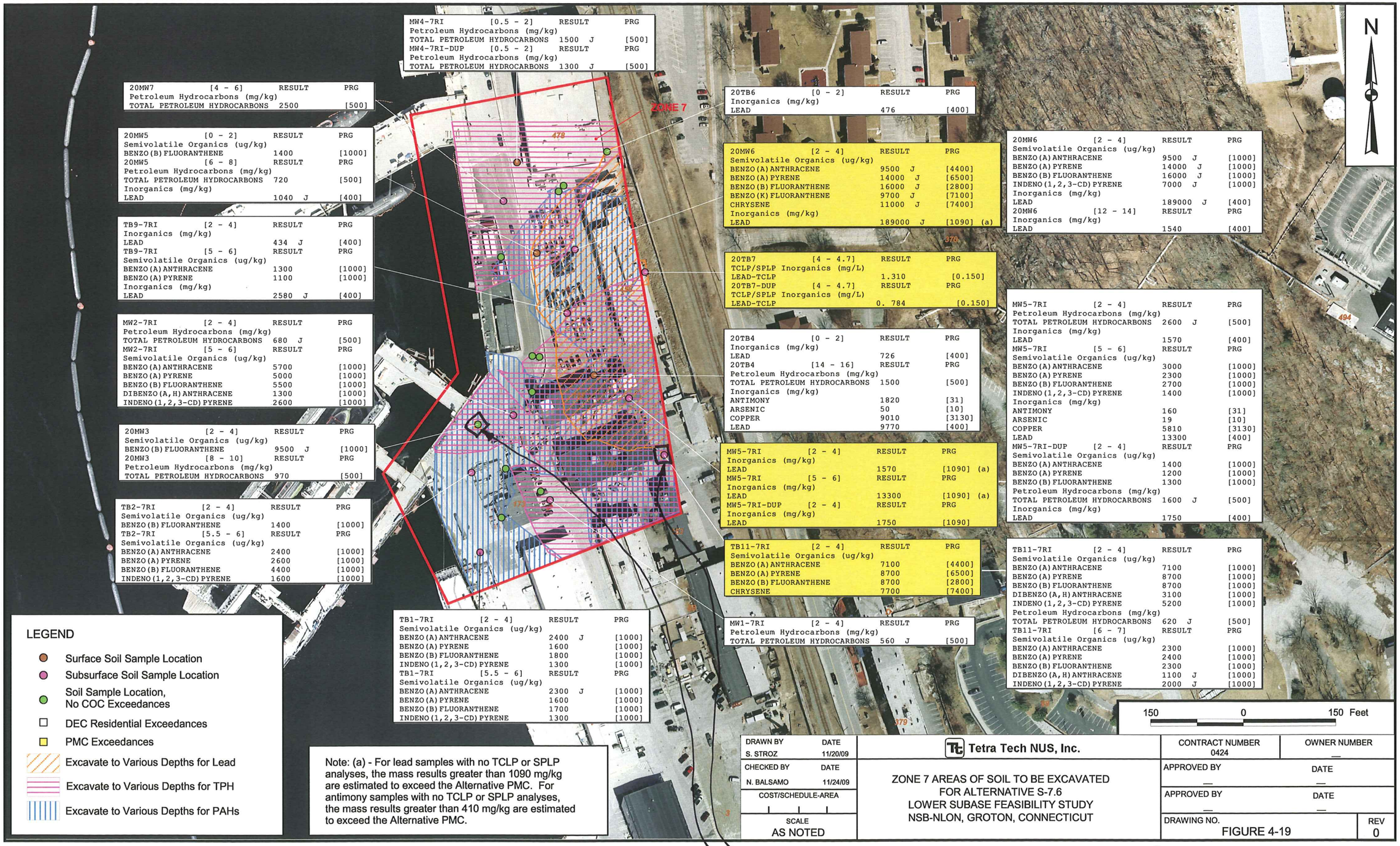
P:\GIS\NLON\MXD\ZONE7_400MGKG_MVS.MXD 6/09/09 SP




| DRAWN BY | DATE | Tetra Tech NUS, Inc. | CONTRACT NO. |
|---|---|---|---|
| S. PAXTON | 4/02/09 | | 0811 |
| CHECKED BY | DATE | ESTIMATED LEAD CONCENTRATIONS (KRIGING RESULTS)<br>ELEVATION: 10 TO -10 FEET<br>ZONE 7<br>NAVAL SUBMARINE BASE - NEW LONDON<br>GROTON, CONNECTICUT | APPROVED BY / DATE |
| N. BALSAMO | 6/09/09 | | – / -- |
| COST/SCHED-AREA | | | APPROVED BY / DATE |
| | | | -- / -- |
| SCALE | | | FIGURE NO. / REV. |
| AS NOTED | | | 5 |

FIG Z7-2
RESIDENTIAL SCENARIO

P:\GIS\NLON\SUBASE FEASIBILITY STUDY.APR ZONE 7 AREAS TO BE EXCAVATED LAYOUT 11/24/09 SS




TPH EXCAVATIONS WITH INCIDENTAL LEAD
(TB11-7RI AND 20MW3)

FIG Z7-3
RESIDENTIAL SCENARIO
(SEE FIG Z7-2 FOR LEAD EXCAVATION

zone7_lead_industrial

Soil Case
Geologic Layers: All (El 7 to El 1)

| | | |
|---|---|---|
| Isolevel above | 1.090000e+003 | mg/kg (ppm) |
| Porosity | 0.250000 | |
| Density | 1.850000 | |
| Volume Units | Cubic Feet | |
| Mass Units | Kilograms | |
| Soil Vol | 1.139565e+005 | |
| Soil Mass | 5.969578e+006 | |
| Chem Vol | 1.315642e+003 | |
| Chem Mass | 3.725378e+004 | LEAD MASS |
| Average Conc | 6.240605e+003 | mg/kg (ppm) |
| Volume $ | 6.837391e+006 | |
| Mass $ | 1.490151e+007 | |
| Chem Density | 1.000000e+000 | |
| Vol $ rate | 6.000000e+001 | |
| Mass $ rate | 4.000000e+002 | |
| Xcg | 780264.687130 | Feet |
| Ycg | 206532.431281 | Feet |
| Zcg | 4.031444 | Feet |

Kriging program output 11/23/09

zone7_lead_residential

| | | |
|---|---|---|
| Soil Case | | |
| Geologic Layers: All (El 7 to El -8) | | |
| Isolevel above | 4.000000e+002 | mg/kg (ppm) |
| Porosity | 0.250000 | |
| Density | 1.850000 | |
| Volume Units | Cubic Feet | |
| Mass Units | Kilograms | |
| Soil Vol | 7.626214e+005 | |
| Soil Mass | 3.994969e+007 | |
| Chem Vol | 3.966317e+003 | |
| Chem Mass | 1.123104e+005 | LEAD MASS |
| Average Conc | 2.811297e+003 | mg/kg (ppm) |
| Volume $ | 4.575729e+007 | |
| Mass $ | 4.492417e+007 | |
| Chem Density | 1.000000e+000 | |
| Vol $ rate | 6.000000e+001 | |
| Mass $ rate | 4.000000e+002 | |
| Xcg | 780289.948505 | Feet |
| Ycg | 206460.512201 | Feet |
| Zcg | -0.414802 | Feet |

Kriging program output 11/23/09

# APPENDIX C.5

# VOLUME OF CONTAMINATED THAMES RIVER SEDIMENT

| CLIENT: NSB-NLON, Groton, CT | | | | JOB NUMBER: 112G00811 |
|---|---|---|---|---|
| SUBJECT: Appendix C.5: Volume of Contaminated Thames River Sediment | | | | |
| BASED ON: Various Reports | | | | DRAWING NUMBER: |
| BY: | CAR | JLG | CHECKED BY: JLG CAR | APPROVED BY: DATE: |
| Date: | 02-20-08 | 12-04-09 | Date: 02-21-08 | |

## 1.0 OBJECTIVE:

Determine the volume of contaminated Thames River sediment in Zone 4, Zone 7, and Outer Pier 1 along the Lower Subase at Naval Submarine Base - New London in Groton, Connecticut. Area of contaminated sediment determined in Baseline Ecological Risk Assessment (Reference 1).

## 2.0 ASSUMPTIONS:

- Based on Reference 1, the sediment that requires remediation under the FS is located in Zone 4 and Outer Pier 1. No sediment in Zone 7 requires remediation.
- The Zone 4 contaminated sediment is located along the Quay Wall from south of Pier 2 to just south of Pier 6 (approximately 520 feet). The sediment in this area slopes from approximately 16 feet below the water surface near the Quay Wall at a 2.5-to-1 slope to approximately 36 feet below the water surface at 50 feet from the Quay Wall. Based on this slope, the length of the slope is approximately 54 feet.
- The Outer Pier 1 sediment to be remediated under the Lower Subase FS only includes the area of contaminated sediment centered around sampling point TRP1-SD-005 at a depth of 4-6 feet. Other areas of Outer Pier 1 (and Inner Pier 1) contaminated sediment were evaluated as part of a separate EE/CA and remediated under a separate non-time-critical removal action.

## 3.0 ZONE 4

### 3.1 Estimated Surface Areas

#### 3.1.1 Actual Surface Areas

As illustrated on attached Figures 1 to 6, the estimated surface areas of contaminated sediment at various depths are as follows for Zone 4:

Based on ERM-Q exceedance: 0-2 feet: 25,930 square feet (sf)
2-4 feet: 61,740 sf
4-6 feet: 48,760 sf

Based on PCB exceedance: 0-2 feet: 1,000 sf
2-4 feet: 0 sf
4-6 feet: 20,200 sf

In the 0-2 feet and 2-4 sediment feet depth intervals, areas of PCB exceedance are included within the areas of ERM-Q exceedance. Therefore, in these two zones, the surface of the areas of ERM-Q exceedance represents the total surface of contaminated sediment. In addition, the footprint of the area of ERM-Q exceedance in the 0-2 feet depth interval is fully contained within the footprint of the area of ERM-Q exceedance in the 2-4 feet depth interval, except for two areas approximately circular in shape. The smaller of these areas is centered on sampling location TRZ4-SD-007 and covers an estimated 2,050 sf and the larger one is centered on sampling location Z4-42 and covers an estimated 5,710 sf.

| CLIENT: NSB-NLON, Groton, CT | | | | JOB NUMBER: 112G00811 |
|---|---|---|---|---|
| SUBJECT: Appendix C.5: Volume of Contaminated Thames River Sediment | | | | |
| BASED ON: Various Reports | | | | DRAWING NUMBER: |
| BY: | CAR | JLG | CHECKED BY: JLG CAR | APPROVED BY: DATE: |
| Date: | 02-20-08 | 12-04-09 | Date: 02-21-08 | |

In the 4-6 feet sediment depth interval, the areas of PCB exceedance around sampling location SD-006 extends approximately 2,280 sf beyond the area of ERM-Q exceedance. Therefore, in that zone the total area of contaminated sediment is 48,760 + 2,280 = 51,040 sf.

### 3.1.2 Adjusted Surface Areas

As per above assumption, only these areas of contaminated sediment located east of the Dredge Buffer Zone are to be considered for remediation.

As illustrated on Figure 1, the only areas of sediment contamination in the 0-2 feet depth interval located within or west of the Dredge Buffer Zone are the two previously mentioned circular areas centered around sampling locations TRZ4-SD-007 and Z4-42 which cover a total of 7,760 sf.

Therefore adjusted estimated surface area of sediment contamination in the 0-2 feet depth interval is:
25,930 sf – 7,760 sf = 18,170 sf

As illustrated on Figure 2, the only area of sediment contamination in the 2-4 feet depth interval located within or west of the Dredge Buffer Zone is that which projects across the Dredge Buffer Zone in the vicinity of sampling location TRZ4-SD-008 and which covers an estimated 3,320 sf.

Therefore adjusted estimated surface area of sediment contamination in the 2-4 feet depth interval is:
61,740 sf – 3,320 sf = 58,420 sf

As illustrated on Figure 3, no areas of sediment contamination in the 4-6 feet depth interval are located within or west of the Dredge Buffer Zone.

Therefore adjusted estimated surface area of sediment contamination in the 4-6 feet depth interval is:
51,040 sf – 0 sf = 51,040 sf

### 3.2 Estimated Volume and Mass

In-situ contaminated sediment:
[(2 ft * 18,170 sf) + (2 ft * 58,420 sf) + (2 ft * 51,040 sf)] = 255,260 cf = 9,454 cy

In-situ mass of dredged contaminated sediment to be treated and disposed:
9,454 cy * 1.19 ton/cy = 11,250 tons

## 4.0 OUTER PIER 1

### 4.1 Estimated Surface Area

As previously noted and as Illustrated on Figure 7, the only area of Outer Pier 1 contaminated sediment to be considered as part of the Lower Subase FS is centered around sampling point TRP1-SD-005 at a depth of 4-6 feet. Other Outer Pier 1 areas of contaminated sediment were evaluated as part of a separate EE/CA and remediated under a separate non-time-critical removal action.

| CLIENT: NSB-NLON, Groton, CT | | | | JOB NUMBER: 112G00811 |
|---|---|---|---|---|
| SUBJECT: Appendix C.5: Volume of Contaminated Thames River Sediment | | | | |
| BASED ON: Various Reports | | | | DRAWING NUMBER: |
| BY: | CAR | JLG | CHECKED BY: JLG CAR | APPROVED BY: DATE: |
| Date: | 02-20-08 | 12-04-09 | Date: 02-21-08 | |

Based on ERM-Q exceedance: 0-2 feet: 0 sf
2-4 feet: 0 sf
4-6 feet: 13,510 sf

Based on PCB exceedance: 0-2 feet: 0 sf
2-4 feet: 0 sf
4-6 feet: 0 sf

### 4.2 Estimated Volume and Mass

In-situ volume of contaminated sediment:
2 ft * 13,510 sf = 27,020 cf = 1,001 cy

In-situ mass of dredged contaminated sediment to be treated and disposed:
1,001 cy * 1.19 ton/cy = 1,192 tons

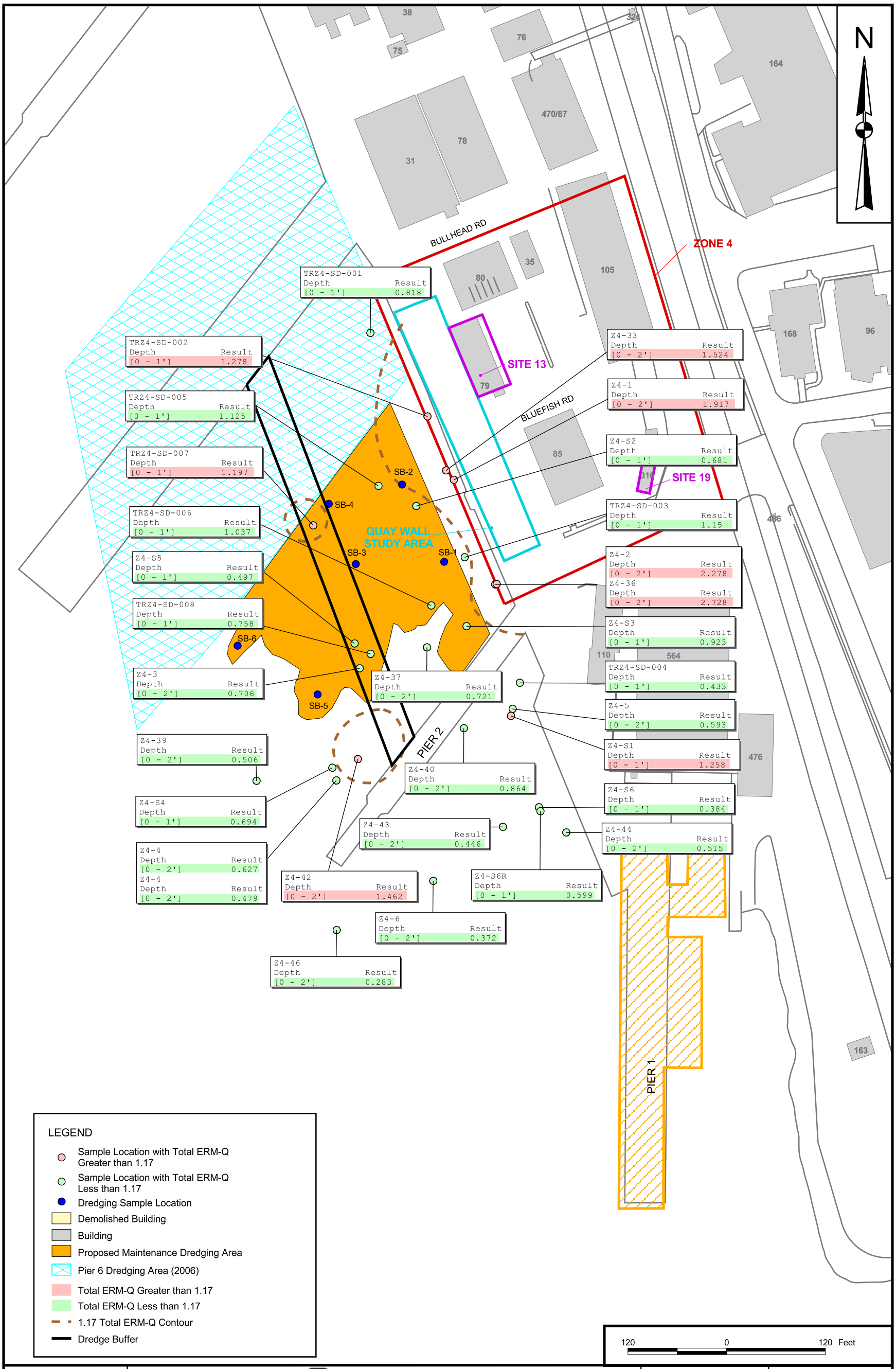
## 5.0 REFERENCE

(1) Battelle and Neptune and Company, Draft Thames River Validation Study Report, Duxbury, Massachusetts and Los Alamos, New Mexico, October 2007 and Responses to Regulator Comments, January 17, 2008.

## ATTACHMENTS

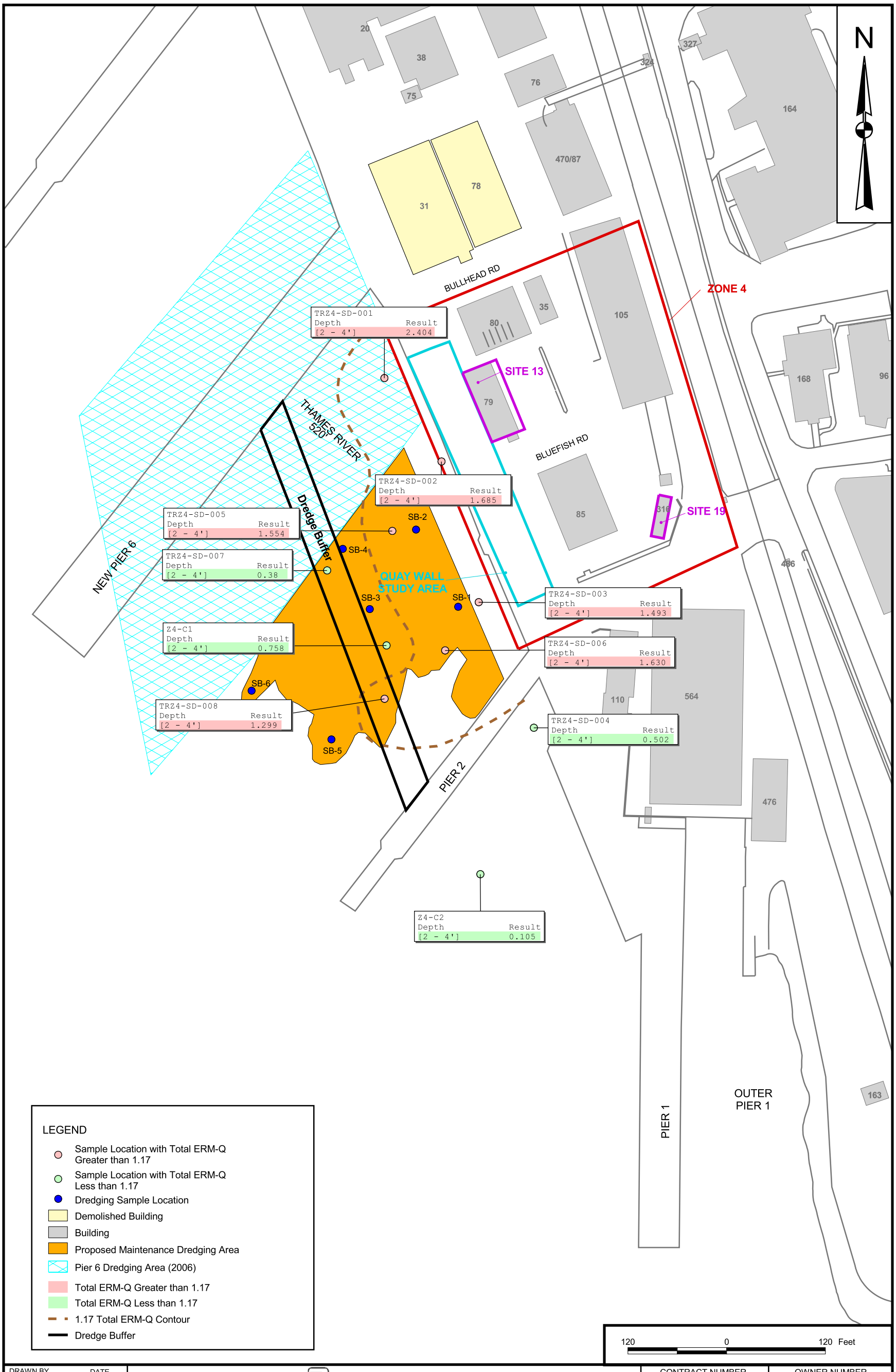
Figure 1.pdf: Zone 4 ERM-Qs Exceedances, 0-2 Ft Contour
Figure 2.pdf: Zone 4 ERM-Qs Exceedances, 2-4 Ft Contour
Figure 3.pdf: Zone 4 ERM-Qs Exceedances, 4-6 Ft Contour
Figure 4.pdf: Zone 4 PCBs Exceedances, 0-2 Ft Contour
Figure 5.pdf: Zone 4 PCBs Exceedances, 2-4 Ft Contour
Figure 6.pdf: Zone 4 PCBs Exceedances, 4-6 Ft Contour
Figure 7.pdf: Outer Pier 1 ERMQs Exceedances, 4-6 Ft Contour

P:\GIS\NLON\MAPDOCS\ZONES_1TO7.APR REV ZONE 4 TOTAL ERM-QS 0-2 FOOT DEPTH LAYOUT 11/25/09 SP



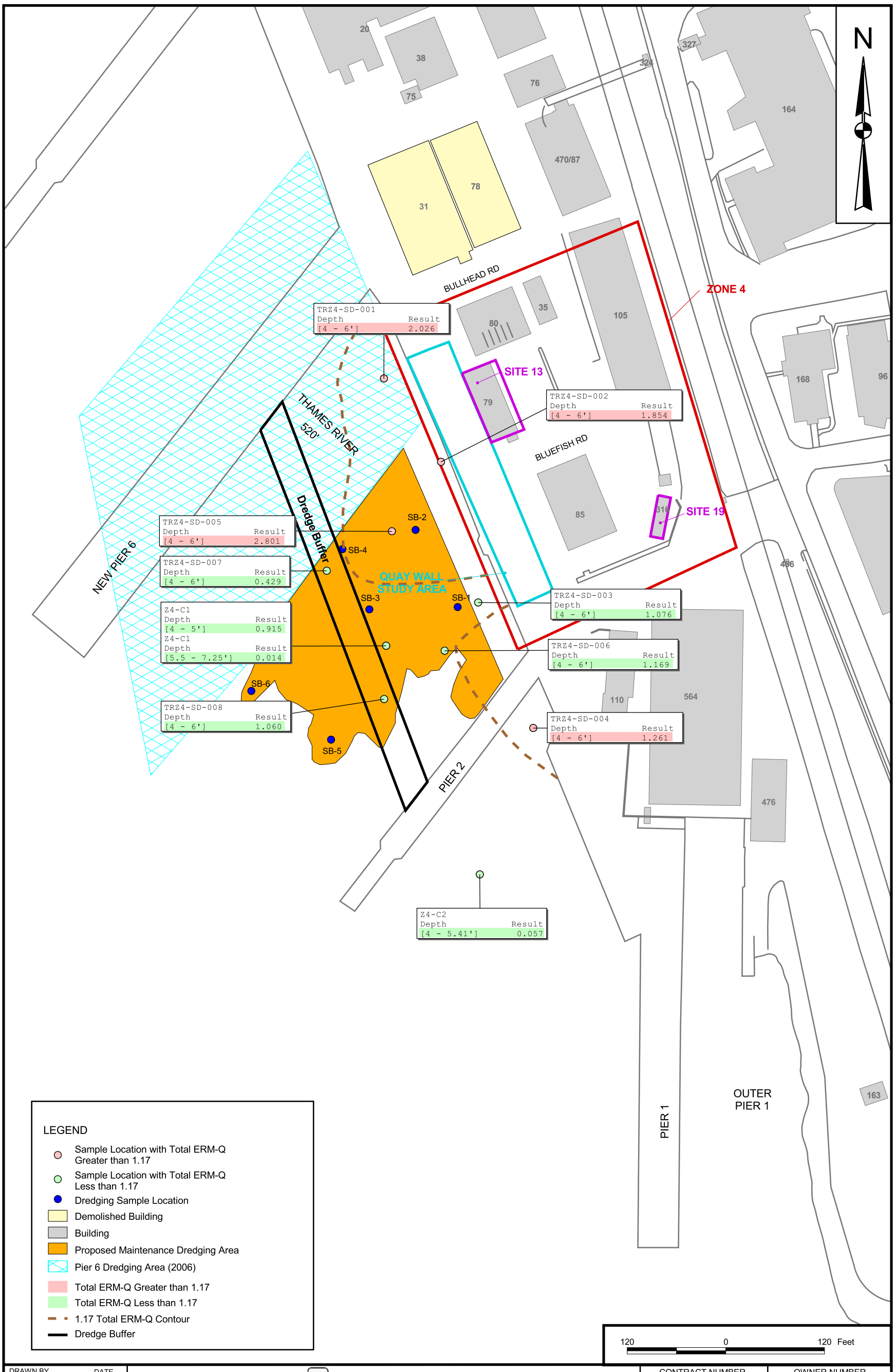

| | | | |
|---|---|---|---|
| DRAWN BY S. STROZ — DATE 04/23/09 | Tetra Tech NUS, Inc. | CONTRACT NUMBER 0424 | OWNER NUMBER 0811 |
| CHECKED BY N. BALSAMO — DATE 11/24/09 | TOTAL ERM-Qs (0 -2 FOOT DEPTH)<br>ZONE 4 AREA<br>LOWER SUBASE<br>NSB - NLON<br>GROTON, CONNECTICUT | APPROVED BY — DATE — | |
| COST/SCHEDULE-AREA | | APPROVED BY — DATE — | |
| SCALE AS NOTED | | DRAWING NO. FIGURE 1 | REV 0 |

P:\GIS\NLON\MAPDOCS\ZONES_1TO7.APR ZONE 4 TOTAL ERM-QS 2 - 4 FOOT DEPTH LAYOUT 11/24/09 SP



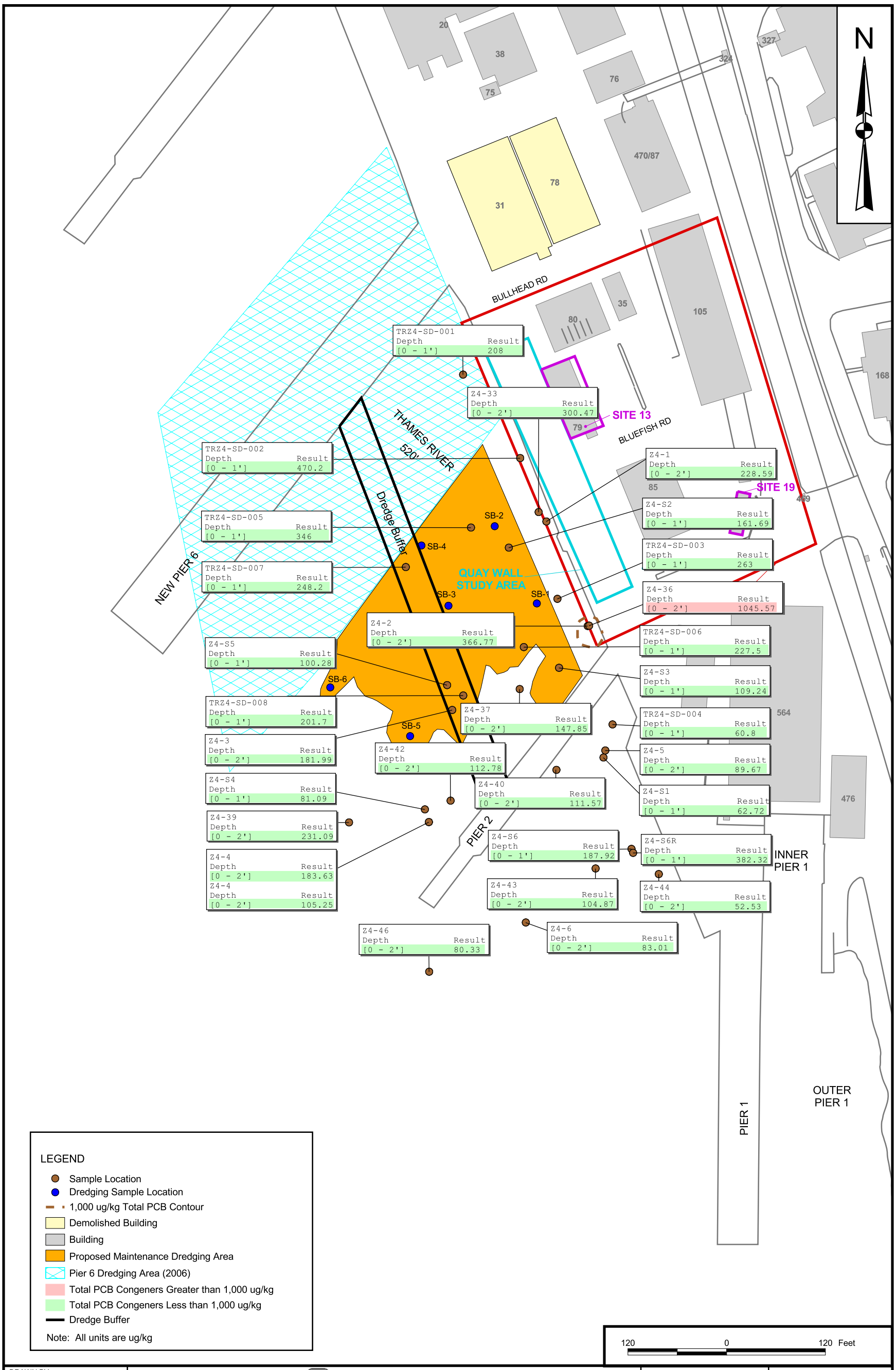

| | | | |
|---|---|---|---|
| DRAWN BY S. STROZ DATE 04/23/09 | Tetra Tech NUS, Inc. | CONTRACT NUMBER 0424 | OWNER NUMBER 0811 |
| CHECKED BY N. BALSAMO DATE 11/24/09 | TOTAL ERM-Qs (2 TO 4 FOOT DEPTH)<br>ZONE 4 AREA<br>LOWER SUBASE<br>NSB - NLON<br>GROTON, CONNECTICUT | APPROVED BY — DATE — | |
| COST/SCHEDULE-AREA | | APPROVED BY — DATE — | |
| SCALE AS NOTED | | DRAWING NO. FIGURE 2 | REV 0 |

P:\GIS\NLON\MAPDOCS\ZONES_1TO7.APR ZONE 4 TOTAL ERM-QS 4-6 FOOT DEPTH LAYOUT 11/24/09 SP




| | | | |
|---|---|---|---|
| DRAWN BY S. STROZ — DATE 04/23/09 | Tetra Tech NUS, Inc. | CONTRACT NUMBER 0424 | OWNER NUMBER 0811 |
| CHECKED BY N. BALSAMO — DATE 11/24/09 | TOTAL ERM-Qs (4 TO 6 FOOT DEPTH)<br>ZONE 4 AREA<br>LOWER SUBASE<br>NSB - NLON<br>GROTON, CONNECTICUT | APPROVED BY — DATE — | |
| COST/SCHEDULE-AREA | | APPROVED BY — DATE — | |
| SCALE AS NOTED | | DRAWING NO. FIGURE 3 | REV 0 |

P:\GIS\NLON\MAPDOCS\ZONES_1TO7.APR ZONE 4 PCB CONGENERS 0-2 FOOT DEPTH LAYOUT 11/24/09 SP




| | | | |
|---|---|---|---|
| DRAWN BY S. STROZ — DATE 04/22/09 | Tetra Tech NUS, Inc. | CONTRACT NUMBER 0424 | OWNER NUMBER 0811 |
| CHECKED BY N. BALSAMO — DATE 11/24/09 | TOTAL PCB CONGENERS (0 -2 FOOT DEPTH)<br>ZONE 4 AREA<br>LOWER SUBASE<br>NSB - NLON<br>GROTON, CONNECTICUT | APPROVED BY CAR — DATE — | |
| COST/SCHEDULE-AREA | | APPROVED BY — — DATE — | |
| SCALE AS NOTED | | DRAWING NO. FIGURE 4 | REV 0 |

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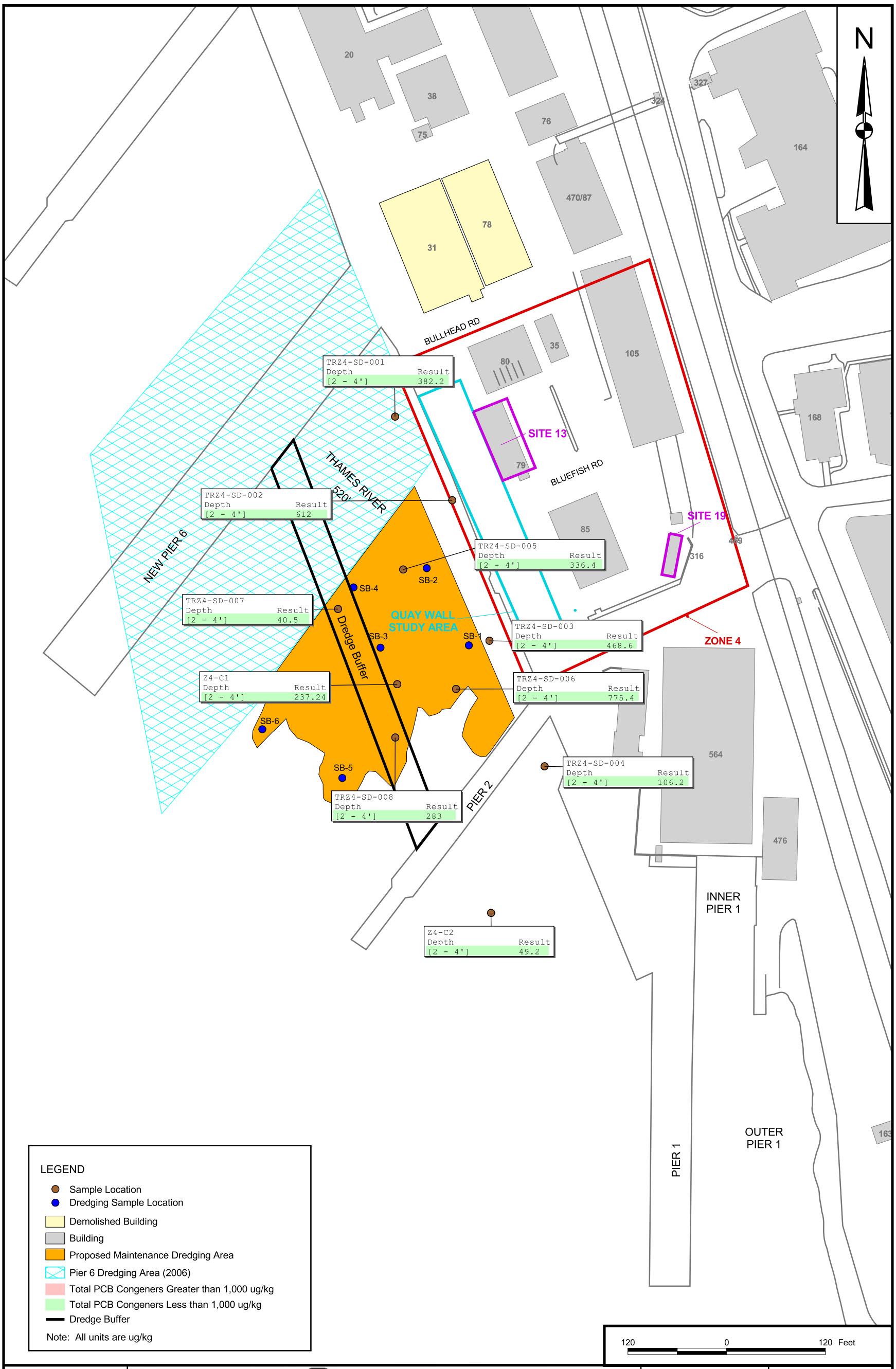


| | | | |
|---|---|---|---|
| DRAWN BY S. STROZ — DATE 04/29/09 | Tetra Tech NUS, Inc. | CONTRACT NUMBER 0424 | OWNER NUMBER 0811 |
| CHECKED BY N. BALSAMO — DATE 11/24/09 | TOTAL PCB CONGENERS (2 -4 FOOT DEPTH)<br>ZONE 4 AREA<br>LOWER SUBASE<br>NSB - NLON<br>GROTON, CONNECTICUT | APPROVED BY CAR — DATE — | |
| COST/SCHEDULE-AREA | | APPROVED BY — — DATE — | |
| SCALE AS NOTED | | DRAWING NO. FIGURE 5 | REV 0 |

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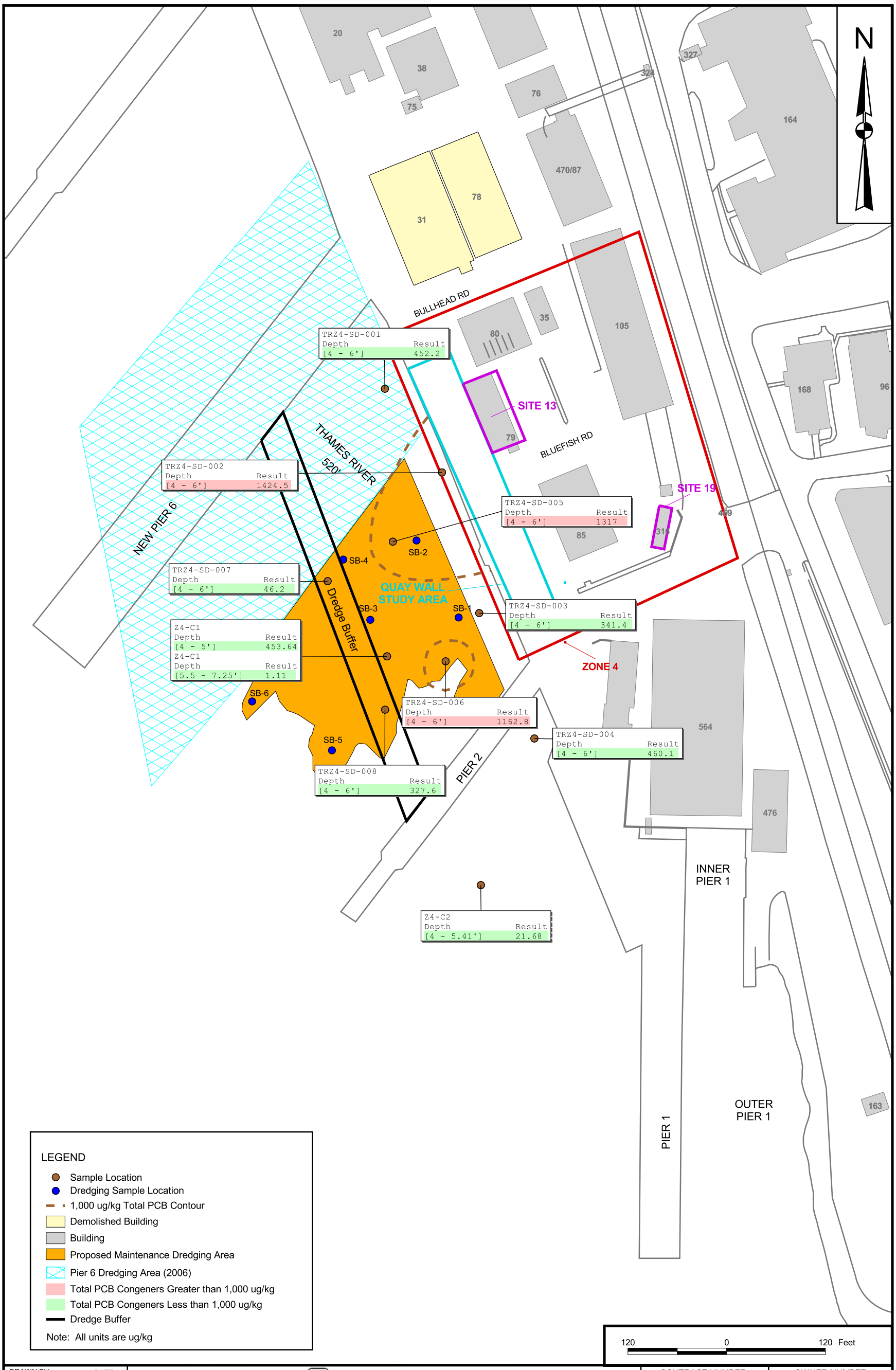
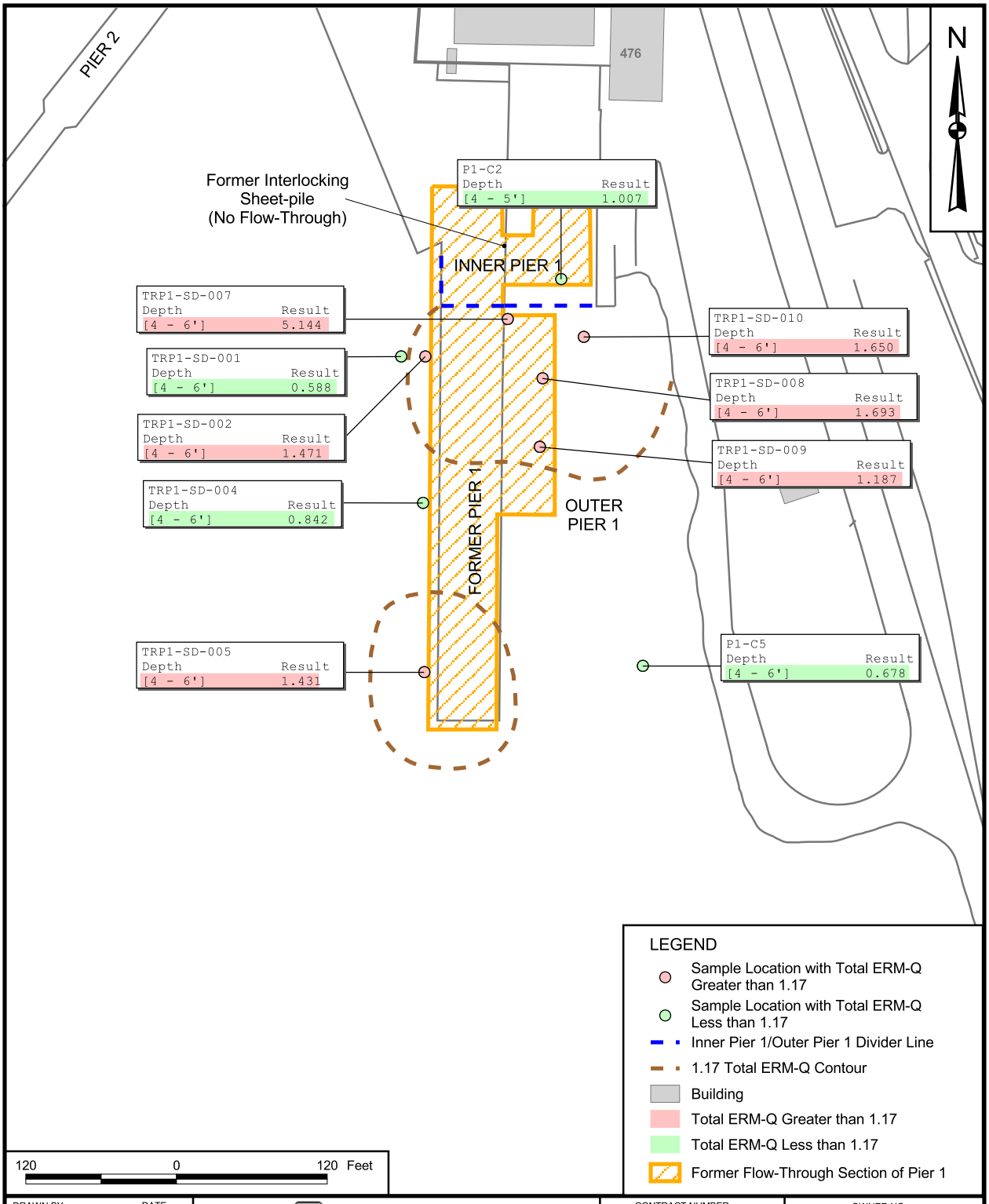



| DRAWN BY S. STROZ | DATE 04/29/09 | Tetra Tech NUS, Inc. | CONTRACT NUMBER 0424 | OWNER NUMBER 0811 |
|---|---|---|---|---|
| CHECKED BY N. BALSAMO | DATE 11/24/09 | TOTAL PCB CONGENERS (4 -6 FOOT DEPTH) ZONE 4 AREA LOWER SUBASE NSB - NLON GROTON, CONNECTICUT | APPROVED BY CAR | DATE — |
| COST/SCHEDULE-AREA | | | APPROVED BY — | DATE — |
| SCALE AS NOTED | | | DRAWING NO. FIGURE 6 | REV 0 |




| DRAWN BY | DATE | Tetra Tech NUS, Inc. | CONTRACT NUMBER | OWNER NO. |
|---|---|---|---|---|
| S. STROZ | 04/22/09 | | 0424 | 0811 |
| CHECKED BY | DATE | TOTAL ERM-Qs (4 - 6 FOOT DEPTH) | APPROVED BY | DATE |
| N. BALSAMO | 11/24/09 | PIER 1 AREA | — | — |
| COST/SCHEDULE-AREA | | LOWER SUBASE | APPROVED BY | DATE |
| | | NSB - NLON | — | — |
| SCALE | | GROTON, CONNECTICUT | DRAWING NO. | REV |
| AS NOTED | | | FIGURE 7 | 0 |

P:\GIS\NLON\ZONES_1TO7.APR PIER 1 TOTAL ERM-Q (4-6 FT) LAYOUT 11/24/09 SP

# APPENDIX C.6

# VOLUME OF CONTAMINATED GROUNDWATER

## 1.0 ASSUMPTIONS

The following assumptions are made based upon results of field investigations:

- As illustrated on attached Figures 2-15, 2-16, and 2-17, there are a total of 5 groups of points of groundwater contamination at the Lower Subase including two in Zones 1 and 4 and one in Zone 7.
- The two groups of Zone 1 points of groundwater contamination include a single copper/TPH point of groundwater contamination centered on monitoring well FOMW14 in the east-central area of the zone and a cluster of arsenic/copper points of groundwater contamination extending around monitoring wells 13MW19, 13MW20, and 13MW21 in the north-central area of the zone.
- The two groups of Zone 4 points of groundwater contamination include a cluster of arsenic/TPH points of groundwater contamination around monitoring wells 13MW13, 13MW15, 13MW16, WE-5 and NESO-10 in the north-west quadrant of the zone and a single lead point of groundwater contamination extending around monitoring well NESO-11 in the central area of the zone.
- The Zone 7 points of groundwater contamination include a cluster of arsenic points of groundwater points of contamination extending around monitoring wells 20MW7 and MW4-7RI in the north-central part of the zone.
- In each point of groundwater contamination, groundwater contamination is assumed to extend within a 50-foot radius (100-foot diameter) from the monitoring wells where exceedances of the groundwater PRGs have been detected.
- The thickness of contaminated groundwater is estimated at approximately 10 feet for all of the points of groundwater contamination.

## 2.0 ZONE 1 POINTS OF GROUNDWATER CONTAMINATION SURFACE AREAS, THICKNESS, VOLUMES, AND COCS QUANTITIES

### 2.1 Surface Areas

As stated in the assumptions and as illustrated on attached Figure 2-15, the Zone 1 points of groundwater contaminaion extend within a 50-foot radius from the monitoring wells where exceedances of the groundwater PRGs have been detected. In accordance with this assumption and as shown on the attached computations, the following surface areas are estimated for the Zone 1 points of groundwater contamination:

- Zone 1 copper/TPH point of groundwater contamination: 7,854 square feet (sf)
- Zone 1 arsenic/copper points of groundwater contamination: 16,761 sf

### 2.2 Thickness

As stated in the assumptions the thickness of contaminated groundwater is estimated at approximately 10 feet throughout the Lower Subase. Groundwater surface elevation ranges from approximately 4 to 7 feet below ground surface (bgs).

### 2.3 Volumes

The Lower Subase aquifer has a typical porosity of 0.3. Therefore, the estimated volumes of contaminated groundwater in the Zone 1 points of groundwater contamination can be computed as follows:

- Zone 1 copper/TPH point of groundwater contamination: 7,854 sf * 10 ft * 0.3 = 23,562 cubic feet (cf) or 176,256 gallons

- Zone 1 arsenic/copper points of groundwater contamination: 16,761 sf * 10 ft * 0.3 = 50,283 cf or 376,142 gallons

## 2.4 COCs Quantities

The quantities of COCs within the points of groundwater contamination can be computed based upon the volume of contaminated groundwater and the average concentrations of these COCs in that area. Average concentrations are assumed to be the mathematical average of the concentrations detected in monitoring wells located within the points of groundwater contamination.

Average concentrations (in µg/L) of COCs in the Zone 1 points of groundwater contamination are as follows:

| COC | 13MW19 | 13MW20 | 13MW21 | FOMW14 | Average |
|---|---|---|---|---|---|
| **Zone 1 Copper/TPH Point of Groundwater Contamination** | | | | | |
| Copper | NA | NA | NA | 77.9[4] | 77.9 |
| TPH | NA | NA | NA | 16,000[4] | 16,000 |
| **Zone 1 Arsenic/Copper Points of Groundwater Contamination** | | | | | |
| Arsenic | 13.9[1] | 12.4[2] | 16.8[3] | NA | 14.4 |
| Copper | 68.4[1] | 156[2] | 53.3[3] | NA | 92.6 |

(1) Unfiltered. Detected during Phase 2-1 (03/05/94)
(2) Unfiltered. Detected during LS RI (11/11/97)
(3) Unfiltered. Detected during Phase 2-1 (03/05/94)
(4) Unfiltered. Detected during LS RI (11/10/97)

Quantities (in pounds) of COCs in the points of groundwater contamination can be calculated according to the following formula:

Quantity of COC in pounds = groundwater volume in gallons * 8.34 lbs/gallon * average COC concentration in µg/L * $10^{-9}$

Accordingly, estimated quantities (in pounds) of COCs in the Zone 1 groundwater points of contamination are as follows:

| COC | Quantity |
|---|---|
| **Zone 1 Copper/TPH** | |
| Copper | 0.114 |
| TPH | 23.52 |
| **Zone 1 Arsenic/Copper** | |
| Arsenic | 0.045 |
| Copper | 0.290 |

TPH in soil of smear zone:

Based on the computations provided in Appendix C for the quantity of TPH contained in the soil of Zone 1 in the vicinity of well 13MW18, which is located near well FOMW14, the average TPH concentration in the soil of the 3-foot thick smear zone of the Zone 1 copper/TPH point of groundwater contamination is estimated at 1,500 mg/kg for 6,654 sf of the 7,854 sf point and at 5,000 mg/kg in the remaining 1,200 sf.

Accordingly, estimated quantity of TPH in soil associated with the Zone 1 copper/TPH point of groundwater contamination is as follows:

[(6,654 sf * 1,500 mg/kg) + (1,200 sf * 5,000 mg/kg)] * 3 ft * 113 lbs/cf * $10^{-6}$ = 5,417 lbs of TPH

**Therefore, although the concentration of TPH actually detected in groundwater is considered to be representative, the amount of TPH derived from this concentration is assumed to be negligible compared to the amount of TPH present in the soil of the smear zone and that might eventually release in the groundwater.**

## 3.0 ZONE 4 POINTS OF GROUNDWATER CONTAMINATION SURFACE AREAS, THICKNESS, VOLUMES, AND COCS QUANTITIES

### 3.1. Surface Areas

As stated in the assumptions and as illustrated on attached Figure 2-16, the Zone 4 points of groundwater contamination extend within a 50-foot radius from the monitoring wells where exceedances of the groundwater PRGs have been detected. In accordance with this assumption and as shown on the attached computations, the following surface areas are estimated for the Zone 4 points of groundwater contamination:

- Zone 4 arsenic/TPH points of groundwater contamination: 29,559 sf
- Zone 4 lead point of groundwater contamination: 7,854 sf

### 3.2 Thickness

As stated in the assumptions the thickness of contaminated groundwater is estimated at approximately 10 feet throughout the Lower Subase. Groundwater surface elevation ranges from approximately 4 to 7 feet bgs.

### 3.3 Volumes

The Lower Subase aquifer has a typical porosity of 0.3. Therefore, the estimated volumes of contaminated groundwater in the Zone 4 points of groundwater contamination can be computed as follows:

Zone 4 arsenic/TPH points of groundwater contamination: 29,559 sf * 10 ft * 0.3 = 88,677 cf or 663,348 gallons
Within these points the estimated volume of arsenic PRG exceedance is:
[(7,854 sf * 4) – 3,511 sf] * 10 ft * 0.3 = 83,715 cf or 626,230 gallons
Within these points the estimated volume of TPH PRG exceedance is:
7,854 sf * 10 ft * 0.3 = 23,562 cf or 176,256 gallons

Zone 4 lead point of groundwater contamination: 7,854 sf * 10 ft * 0.3 = 23,562 cf or 176,256 gallons

### 3.4 COCs Quantities

The quantities of COCs within the points of groundwater contamination can be computed based upon the volume of contaminated groundwater and the average concentrations of these COCs in that area. Average concentrations are assumed to be the mathematical average of the concentrations detected in monitoring wells located within the points of groundwater contamination. Average concentrations (in µg/L) of COCs in the Zone 4 points of groundwater contamination are as follows:

| COC | 13MW13 | NESO-10 | WE-5 | 13MW-15 | 13MW16 | NESO-11 | Average |
|---|---|---|---|---|---|---|---|
| **Zone 4 Arsenic/TPH Points of Groundwater Contamination** | | | | | | | |
| Arsenic | 17.5(1) | 19(2) | 29.6(3) | 11(4) | 2.5 U(5) | NA | 19.3/18.2(7) |
| TPH | NA | 500 U(2) | 500 U(3) | 1,100 U(4) | 5,400(5) | NA | 5,400/1,435(7) |
| **Zone 4 Lead Point of Groundwater Contamination** | | | | | | | |
| Lead | NA | NA | NA | NA | NA | 2,760(6) | 2,760 |

(1) Unfiltered. Average of detection of 13.6 during Phase 2-2 (06/24/94) and 21.4 during LS RI (10/29/97)
(2) Unfiltered. Detected during Phase 2-2 (06/23/94)
(3) Unfiltered. Detected during Phase 2-1 (03/07/94)
(4) Unfiltered. Detected during Phase 2-2 (06/25/94)
(5) Unfiltered. Detected during Phase 1 (01/23/91)
(6) Unfiltered. Detected during Phase 2-1 (03/08/94)
(7) Average concentration for area of exceedance only / Average for entire point fof groundwater contamination
NA Not applicable
U Undetected at indicated analytical detection limit

Using the previous formula, quantities (in pounds) of COCs in the Zone 4 points of groundwater contamination are as follows:

| COC | Quantity(1) |
|---|---|
| **Zone 4 Arsenic/TPH** | |
| Arsenic | 0.1 |
| TPH | 7.94 |
| **Zone 4 Lead** | |
| Lead | 4.06 |

(1) Quantity in area of exceedance only

Quantity of Arsenic in Areas of Non-TPH Exceedance

Well WE-5: [(7,854 – 2,236)sf * 10 ft * 0.3] cf * 7.48 gal/cf * 8.34 lbs/gal * 29.6 µg/L * $10^{-9}$ = 0.031
Wells 13MW15 & NESO-11:
{[(7,854 * 2) – (3,963 + 3,511)] sf * 10 ft * 0.3} cf * 7.48 gal/cf * 8.34 lbs/gal * (11 + 19)/2 µg/L * $10^{-9}$ = 0.023
Well 13 MW13: (7,854 sf * 10 ft * 0.3)cf * 7.48 gal/cf * 8.34 lbs/gal * 17.5 µg/L * $10^{-9}$ = 0.026

Total: 0.031 + 0.023 + 0.026 = 0.08 pounds

TPH in soil of smear zone:

According to the estimates of TPH in soil provided in Appendix C, the average TPH concentration in the 6,200 $ft^2$ area within a 50 ft radius of monitoring well 13MW16 where the highest groundwater TPH concentration in Zone 4 (5,400 µg/L) was detected is 500 mg/kg.

Accordingly, estimated quantity of TPH in soil associated with the Zone 4 arsenic/TPH points of groundwater contamination is as follows:
500 mg/kg * 6,200 sf * 3 ft * 113 lbs/cf * $10^{-6}$ = 1,051 lbs of TPH

**Therefore, although the concentration of TPH actually detected in groundwater is considered to be representative, the amount of TPH derived from this concentration is assumed to be negligible compared to the amount of TPH present in the soil of the smear zone and that might eventually release in the groundwater.**

## 4.0 ZONE 7 POINTS OF GROUNDWATER CONTAMINATION SURFACE AREA, THICKNESS, VOLUME, AND ARSENIC CONTENT

### 4.1 Surface Area

As stated in the assumptions and as illustrated on attached Figure 2-17, the Zone 7 arsenic points of groundwater contamination extend within a 50-foot radius from the monitoring wells where exceedances of the groundwater

PRGs have been detected. In accordance with this assumption and as shown on the attached computations, the combined surface area of the Zone 7 arsenic points of groundwater contamination is estimated at 13,471 $ft^2$.

## 2.2 Thickness

As stated in the assumptions the thickness of contaminated groundwater is estimated at approximately 10 feet throughout the Lower Subase. Groundwater surface elevation ranges from approximately 4 to 7 feet below ground surface (bgs).

## 4.3 Volume

The Lower Subase aquifer has a typical porosity of 0.3. Therefore, the estimated volumes of contaminated groundwater in the Zone 7 points of groundwater contamination can be computed as follows:

- Zone 7 arsenic groundwater points of contamination: 13,471 $ft^2$ * 10 ft * 0.3 = 40,413 $ft^3$ or 302,309 gallons

## 4.4 Arsenic Content

The quantity of arsenic within the Zone 7 arsenic points of groundwater contamination can be computed based upon the volume of contaminated groundwater and the average concentrations of this COC in that area. Average concentrations is assumed to be the mathematical average of the concentrations detected in monitoring wells located within the points of groundwater contamination.

Average concentrations (in µg/L) of arsenic in the Zone 7 arsenic points of groundwater contamination is as follows:

| COC | MW4-7RI | 20MW7 | Average |
|---|---|---|---|
| Arsenic | 11(1) | 18.8(2) | 14.9 |

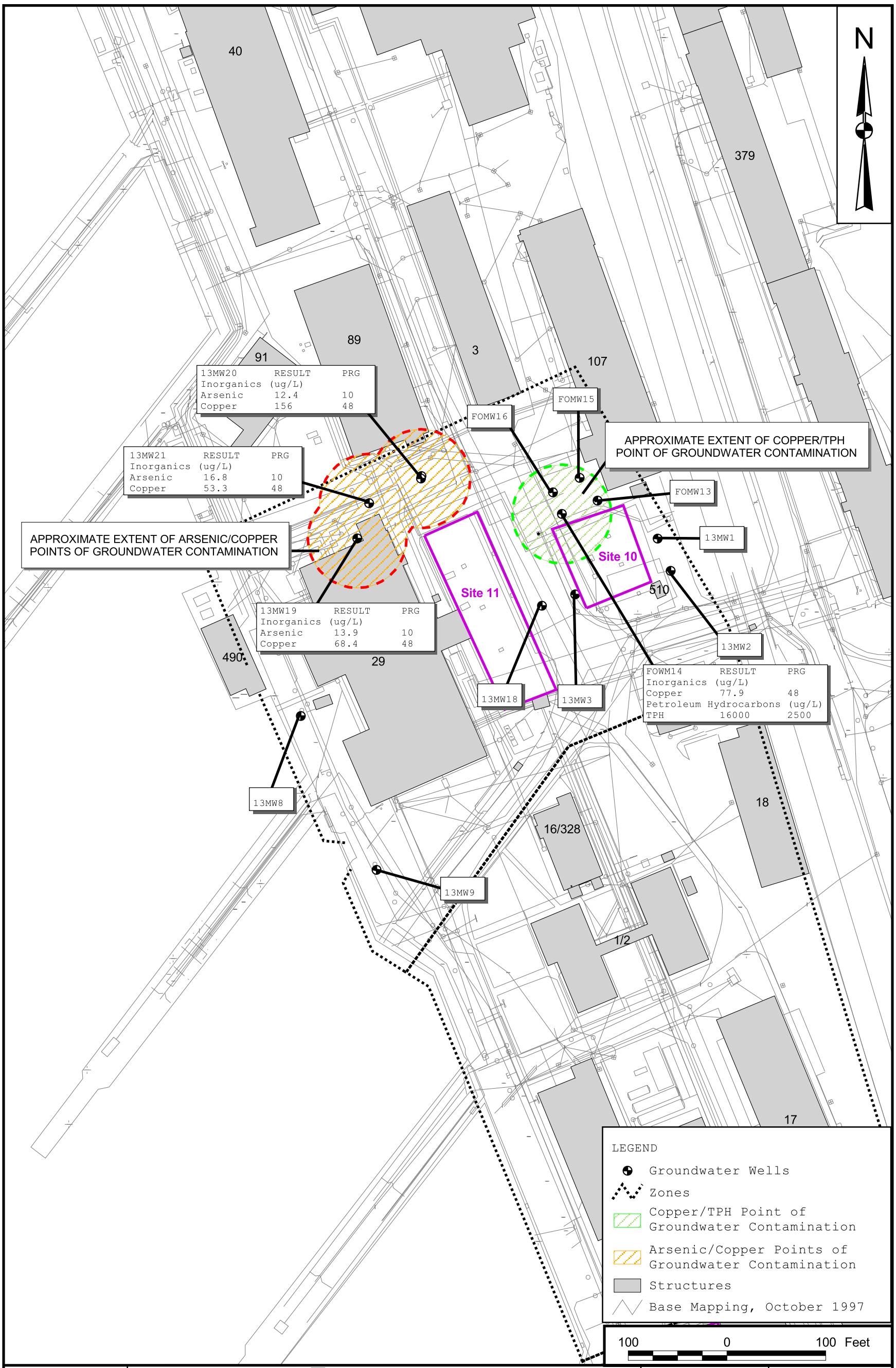
(1) Unfiltered. Detected during LS RI (10/29/97)
(2) Unfiltered. Detected during LS RI (10/31/97)

Quantity of arsenic in the Zone 7 arsenic points of groundwater contamination:
302,309 gallons * 8.34 lbs/gallon * 14.9 µg/L * $10^{-9}$ = 0.037 pounds

**ATTACHMENTS**:

GW Contamination Points Calcs.xls
Figure 4-15.pdf
Figure 4-16.pdf
Figure 4-17.pdf

P:\GIS\NLON\MAPDOCS\APR\NLONTAGS.APR ZONE 1 GW PLUME LAYOUT 01/01/10 SS




| | | | |
|---|---|---|---|
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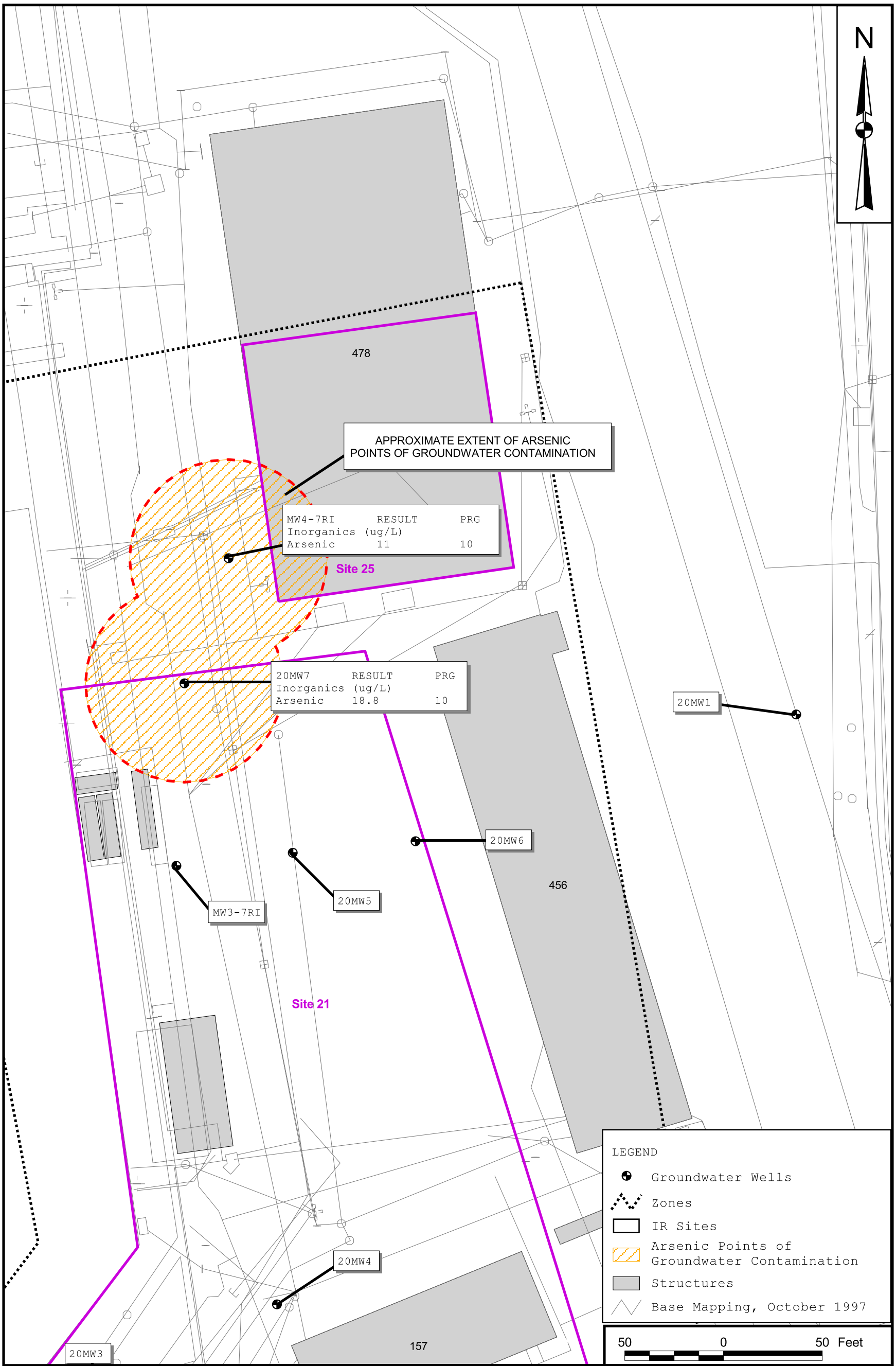
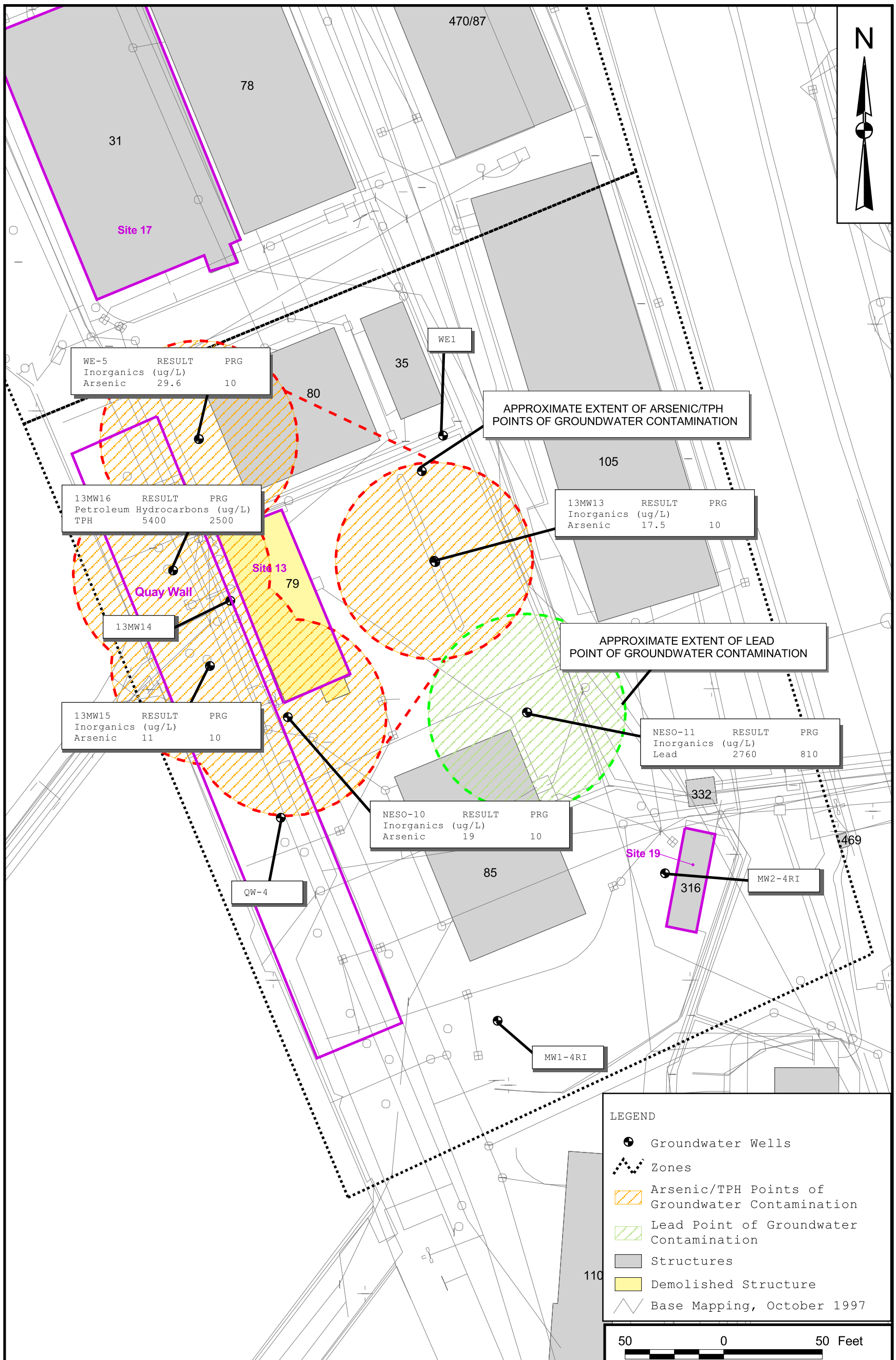
| CHECKED BY N. BALSAMO DATE 01/11/10 | ZONE 1 POINTS OF GROUNDWATER CONTAMINATION<br>LOWER SUBASE FEASIBILITY STUDY<br>NSB-NLON, GROTON, CONNECTICUT | APPROVED BY CAR — DATE 01/12/10 | |
| COST/SCHEDULE-AREA | | APPROVED BY — DATE — | |
| SCALE AS NOTED | | DRAWING NO. FIGURE 2-15 | REV 0 |

P:\GIS\NLON\MAPDOCS\APR\NLONTAGS.APR ZONE 7 GW PLUMES LAYOUT 01/11/10 SS




| | | | |
|---|---|---|---|
| DRAWN BY S.STROZ DATE 11/01/07 | Tetra Tech NUS, Inc. | CONTRACT NUMBER 0424 | OWNER NUMBER — |
| CHECKED BY N. BALSAMO DATE 01/11/10 | ZONE 7 POINTS OF GROUNDWATER CONTAMINATION<br>LOWER SUBASE FEASIBILITY STUDY<br>NSB-NLON, GROTON, CONNECTICUT | APPROVED BY CAR DATE 01/12/10 | |
| COST/SCHEDULE-AREA | | APPROVED BY — DATE — | |
| SCALE AS NOTED | | DRAWING NO. FIGURE 2-17 | REV 0 |

P:\GIS\NLON\MAPDOCS\APR\NLONTAGS.APR ZONE 4 GW PLUMES LAYOUT 01/11/10 SS




| | | | |
|---|---|---|---|
| DRAWN BY S.STROZ DATE 11/01/07 | Tetra Tech NUS, Inc. | CONTRACT NUMBER 0424 | OWNER NUMBER — |
| CHECKED BY N. BALSAMO DATE 01/11/10 | ZONE 4 POINTS OF GROUNDWATER CONTAMINATION<br>LOWER SUBASE FEASIBILITY STUDY<br>NSB-NLON, GROTON, CONNECTICUT | APPROVED BY CAR DATE 01/12/10 | |
| COST/SCHEDULE-AREA | | APPROVED BY — DATE — | |
| SCALE AS NOTED | | DRAWING NO. FIGURE 2-16 | REV 0 |

**CIRCLE OVERLAP CALCULATIONS**
**FOR**
**POINTS OF GROUNDWATER CONTAMINATION COMPUTATIONS**
**LOWER SUBASE FS**
**NASB-NLON - GROTON, CONNECTICUT**

| Points of Groundwater Contamination | Monitoring Wells | Well-to-Well Distance (ft) | Intercept Angle (degree) | Intercept Sector Surface ($ft^2$) | Sub-Cord Triangle Surface ($ft^2$) | Overlap Surface ($ft^2$) | Combined Surface ($ft^2$) |
|---|---|---|---|---|---|---|---|
| Zone 1 Arsenic/Copper | 13MW20 to 13MW21 | 55.8 | 56.08 | 2,447 | 1,158 | 2,579 | 16,761 |
| | 13MW19 to 13MW21 | 37.2 | 68.16 | 2,974 | 863 | 4,222 | |
| Zone 1 Copper/TPH | FOMW14 | | Only one well. No overlap | | | | 7,854 |
| Zone 4 Lead | NESO-11 | | Only one well. No overlap | | | | 7,854 |
| Zone 4 Arsenic/TPH | WE-5 to 13MW16 | 60 | 53.13 | 2,318 | 1,200 | 2,236 | 29,559 |
| | 13MW16 to 13MW15 | 40 | 66.42 | 2,898 | 917 | 3,963 | |
| | 13MW15 to NESO-10 | 45 | 63.26 | 2,760 | 1,005 | 3,511 | |
| | 13MW13 | | Only one well. No overlap | | | | |
| Zone 7 Arsenic | MW4-7RI to 20MW7 | 60 | 53.13 | 2,318 | 1,200 | 2,236 | 13,471 |

# APPENDIX D

## REMEDIAL ALTERNATIVES CONCEPTUAL DESIGN CALCULATIONS

D.1 - SOIL CONCEPTUAL DESIGN CALCULATIONS
D.2 - GROUNDWATER CONCEPTUAL DESIGN CALCULATIONS
D.3 - SEDIMENT CONCEPTUAL DESIGN CALCULATIONS
D.4 - LNAPL CONCEPTUAL DESIGN CALCULATIONS

# APPENDIX D.1

## SOIL CONCEPTUAL DESIGN CALCULATIONS

### D.1.1 - SOIL IN-SITU TREATMENT

### D.1.2 - ON-SITE SOIL DEWATERING

### D.1.3 - ENGINEERING CONTROLS CALCULATIONS

# APPENDIX D.1.1

## D.1.1 - SOIL IN-SITU TREATMENT

## 1.0 DESIGN ASSUMPTIONS

The following design assumptions are made based upon available information and from experience with similar projects for the in-situ enhanced treatment of soil:

- In-situ treatment of the areas of soil exceeding the Zone 1 I/C Direct Exposure Criteria (DECs) or Pollutant Mobility Criteria (PMCs) for polycyclic aromatic hydrocarbons (PAHs) , the Zone 4 I/C DEC for PAHs or TPH, and the Zone 5 and Zone 6 I/C DEC or PMC for TPH would be by enhanced bioremediation.
- In-situ treatment of the areas of soil exceeding the Zone 2 Industrial/Commercial (I/C) Pollutant Mobility Criterion (PMC) for lead, the Zone 3 I/C DEC or PMC for lead, the Zone 4 I/C PMC for total petroleum hydrocarbon (TPH) or lead, and the Zone 7 I/C PMC for antimony or lead would be by chemical stabilization/solidification.
- In-situ enhanced bioremediation would be performed through the subsurface blending of an oxygen release compound (ORC) such as magnesium peroxide ($MgO_2$). For soil up to 3 feet deep, this would be done with a backhoe. For deeper soil, this would be done with a 6-foot large diameter auger (LDA). $MgO_2$ would be blended in the soil as a 10% (wt) solution at the rate of 10 pounds of dry $MgO_2$ per pound of PAHs or TPH to be removed. Only one ORC application would be required.
- In-situ chemical stabilization/solidification would be performed through blending of Portland cement and water into the soil to be treated. For soil up to 3 feet deep, this would be done with a backhoe. For deeper soil, this would be done with the same LDA technology used for in-situ enhanced bioremediation. Portland cement and water would be blended into the soil in a soil:cement:water ratio of approximately 93:5:2.
- In-situ treatment (either enhanced bioremediation or chemical stabilization/solidification) would result in an increase of the volume of treated soil. This increase is estimated at approximately 10%. For enhanced bioremediation, the incremental volume of treated soil would have to be accommodated on site through appropriate site grading to allow sufficient time for completion of the biological degradation process (1 to 3 years). For chemical stabilization/solidification, the incremental volume of treated soil could be disposed off site because the chemical stabilization/solidification process would be complete within a few days.

## 2.0 IN-SITU TREATMENT SYSTEMS

### 2.1 Zone 1 / Alternative S-1.3

Treatment to consist of in-situ enhanced bioremediation to remove PAHs.

Surface area of soil to be treated: Total of 33,200 square feet (sf) in the vicinity of soil sampling point 1TB2-1RI, including 5,600 sf to a depth of 5 ft bgs and the remainder to a depth of 2 ft bgs
Surface area treated by each LDA pass: $(6\ ft)^2 \times \pi \div 4 = 28.3$ sf
Number of 5 feet deep LDA passes: (5,600 sf / 28.3 sf/pass) * 1.1 overlap factor = 218 passes

Volume of contaminated soil to be treated: 2,796 cy
Weight of soil to be treated: 2,796 cy * 27 cf/cy * 113 lbs/cf = 8,530,596 lbs
Concentration of PAHs in soil: 63 mg/kg
Weight of PAHs to be removed: 8,530,596 lbs * 63 mg/kg * $10^{-6}$ = 538 lbs

ORC requirement: 538 lbs PAHs * 10 lbs ORC/lb PAHs = 5,380 lbs dry $MgO_2$ (ORC)

Total blended liquid volume @ 8-percent (wt) $MgO_2$ concentration:
5,380 lbs / (9 lbs/gal * 0.08) = 7,472 gallons

Estimated increase in volume of treated soil: 2,796 cy * 0.1 = 279.6, say 300 cy

### 2.2 Zone 2 / Alternative S-2.4

Treatment to consist of in-situ chemical stabilization/solidification to immobilize lead

Surface area of soil to be treated: Total of 6,400 sf to a depth of 5 ft bgs around sampling location 13MW11
Surface area treated by each LDA pass: $(6\ ft)^2 * \pi / 4$ = 28.3 sf
Required number of LDA passes: (6,400 sf / 28.3 sf/pass) * 1.1 overlap factor = 248.8, say 250 passes

Volume of soil to be treated: 1,126 cy
Weight of soil to be treated: 1,126 cy * 27 cf/cy * 113 lbs/cf = 3,435,426 lbs
Portland cement required: 3,435,426 lbs * (5 / 93) = 184,700 lbs or 92.3 tons
Water required: 3,435,426 lbs * (2 ÷ 93) = 73,880 lbs or 8,858 gal

Estimated increase in volume of treated soil: 1,126 cy * 0.1 = 112.6, say 115 cy

### 2.3 Zone 3 / Alternative S-3.4

Treatment to consist of in-situ chemical stabilization/solidification to immobilize lead

Surface area of soil to be treated: Total of 8,775 sf to a depth of 5 ft bgs on Albacore Road west of former Building 31.
Surface area treated by each LDA pass: $(6\ ft)^2 * \pi / 4$ = 28.3 sf
Required number of LDA passes: (8,775 sf / 28.3 sf/pass) * 1.1 overlap factor = 341 passes

Volume of soil to be treated: 1,544 cy
Weight of soil to be treated: 1,544 cy * 27 cf/cy * 113 lbs/cf = 4,710,744 lbs
Portland cement required: 4,710,744 lbs * (5 / 93) = 253,266 lbs or 126.6 tons
Water required: 4,710,744 lbs * (2 / 93) = 101,306 lbs or 12,147 gal

Estimated increase in volume of treated soil: 1,554 cy * 0.1 = 155.4, say 160 cy

### 2.4 Zone 4 / Alternative S-4.4

Treatment to consist of in-situ enhanced bioremediation to remove BAP equivalents and TPH and in-situ chemical stabilization/solidification to immobilize lead.

#### 2.4.1 In-Situ Enhanced Bioremediation

Surface area of soil to be treated: Total of 16,000 sf to a depth of 2 ft bgs including 14,800 sf of PAHs contaminated soil in the vicinity of soil sampling points MW1-4RI and 1,200 sf of TPH contaminated soil in the vicinity of sampling location 13TB4A.

Volume of PAHs contaminated soil to be treated: 959 cy

Weight of soil to be treated: 959 cy * 27 cf/cy * 113 lbs/cf = 2,925,909 lbs
Concentrations of PAHs in soil: 5,800 µg/kg
Weight of PAHs to be removed: 2,925,909 lbs * 5,800 µg/kg * $10^{-9}$ = 17 lbs

Volume of TPH contaminated soil to be treated: 78 cy
Weight of soil to be treated: 78 cy * 27 cf/cy * 113 lbs/cf = 237,978 lbs
Concentrations of TPH in soil: 3,440 mg/kg
Weight of TPH to be removed: 237,978 lbs * 3,440 mg/kg * $10^{-6}$ = 819 lbs

ORC required to treat PAHs: 17 lbs PAHs * 10 lb ORC/lb PAHs = 170 lbs dry $MgO_2$ (ORC)
Total blended liquid volume @ 8-percent (wt) $MgO_2$ concentration:
170 lbs / (9 lbs/gal * 0.08) = 236.1 say 240 gallons
:
ORC required to treat TPH: 819 lbs TPH * 10 lb ORC/lb TPH = 8,190 lbs dry $MgO_2$ (ORC)
Total blended liquid volume @ 8-percent (wt) $MgO_2$ concentration:
8,190 lbs / (9 lbs/gal * 0.08) = 11,375 gallons

Estimated increase in volume of treated soil: (959 cy + 78 cy) * 0.1 = 103.7, say 105 cy

### 2.4.2 In-Situ Chemical Stabilization/Solidification

Surface area of soil to be treated: Total of 17,400 sf to a depth of 5 ft bgs in the vicinity of soil sampling points 13TB3A (6,200 sf) and WE4A (11,200 sf)
Surface area treated by each LDA pass: $(6\ ft)^2 * \pi / 4$ = 28.3 sf
Required number of LDA passes: (17,400 sf / 28.3 sf/pass) * 1.1 overlap factor = 676 passes

Volume of soil to be treated: 3,061 cy
Weight of soil to be treated: 3,061 cy * 27 cf/cy * 113 lbs/cf = 9,339,111 lbs
Portland cement required: 9,339,111 lbs * (5 / 93) = 502,103 lbs or 251 tons
Water required: 9,339,111 lbs * (2 / 93) = 200,841 lbs or 24,082 gal

Estimated increase in volume of treated soil: 3,061 cy * 0.1 = 306.1, say 310 cy

## 2.5 <u>Zone 5 / Alternative S-5.3</u>

Treatment to consist of in-situ enhanced bioremediation to remove TPH.

Surface area of soil to be treated: Total of 2,200 sf to a depth of 3 ft bgs in the vicinity of soil sampling point 19SS1.

Volume of contaminated soil to be treated: 234 cy
Weight of soil to be treated: 234 cy * 27 cf/cy * 113 lbs/cf = 713,934 lbs
Concentrations of TPH in soil: 6,800 mg/kg
Weight of TPH to be removed: 713,934 lbs * 6,800 mg/kg * $10^{-6}$ = 4,855 lbs

ORC required: 4,855 lbs TPH * 10 lb ORC/lb TPH = 48,550 lbs dry $MgO_2$ (ORC)
Total blended liquid volume @ 8-percent (wt) $MgO_2$ concentration:
48,550 lbs / (9 lbs/gal * 0.08) = 67,431 gallons

Estimated increase in volume of treated soil: 234 cy * 0.1 = 23.4, say 25 cy

## 2.6 Zone 6 / Alternative S-6.2

Treatment to consist of in-situ enhanced bioremediation to remove TPH.

Surface area of soil to be treated: Total of 7,200 sf to a depth of 3 ft bgs in the vicinity of soil sampling point MW5-6RI.

Volume of TPH contaminated soil to be treated: 733 cy
Weight of soil to be treated: 733 cy * 27 cf/cy * 113 lbs/cf = 2,236,400 lbs
Concentrations of TPH in soil: 4,000 mg/kg
Weight of TPH to be removed: 2,236,400 lbs * 4,000 mg/kg * $10^{-6}$ = 8,945 lbs

ORC required: 8,945 lbs TPH * 10 lb ORC/lb TPH = 89,450 lbs dry $MgO_2$ (ORC)
Total blended liquid volume @ 8-percent (wt) $MgO_2$ concentration:
89,450 lbs / (9 lbs/gal * 0.08) = 124,200 gallons

Estimated increase in volume of treated soil: 733 cy * 0.1 = 73.3, say 75 cy

## 2.7 Zone 7 / Alternative S-7.4

Treatment to consist of in-situ bioremediation to remove PAHs and chemical stabilization/solidification to immobilize antimony, and lead

### 2.7.1 In-Situ Enhanced Bioremediation

Surface area of soil to be treated: Total of 59,840 sf to a depth of 2 ft bgs in the central and southern portion of Zone 7.

Volume of PAHs contaminated soil to be treated: 3,892 cy
Weight of soil to be treated: 3,892 cy * 27 cf/cy * 113 lbs/cf = 11,874,492 lbs
Concentrations of PAHs in soil: 11,780 µg/kg
Weight of PAHs to be removed: 11,874,492 lbs * 11,780 µg/kg * $10^{-9}$ = 140 lbs

ORC required to treat PAHs: 140 lbs PAHs * 10 lb ORC/lb PAHs = 1,400 lbs dry $MgO_2$ (ORC)
Total blended liquid volume @ 8-percent (wt) $MgO_2$ concentration:
1,400 lbs / (9 lbs/gal * 0.08) = 1,944.4 say 1,950 gallons

Estimated increase in volume of treated soil: 3,892 cy * 0.1 = 389.2, say 400 cy
:

### 2.7.2 In-Situ Chemical Stabilization/Solidification

Surface area of soil to be treated: Total of 27,536 sf to a depth of 7 ft bgs in the central and southern portion of Zone 7.
Surface area treated by each LDA pass: $(6\ ft)^2 * \pi / 4$ = 28.3 sf
Required number of LDA passes: (27,536 sf / 28.3 sf / pass) * 1.1 overlap factor = 1,070.3, say 1,075

passes

Volume of soil to be treated: 5,573 cy
Weight of soil to be treated: 5,573 cy * 27 cf/cy * 113 lbs/cf = 17,003,223 lbs
Portland cement required: 17,003,223 lbs * (5 / 93) = 914,152 lbs or 457 tons
Water required: 17,003,223 lbs * (2 / 93) = 365,661 lbs or 43,844 gal

Estimated increase in volume of treated soil: 5,573 cy * 0.1 = 557.3, say 560 cy

# APPENDIX D.1.2

## D.1.2.1 - ON-SITE SOIL DEWATERING

## D.1.2.2 - ROSEDALE MULTI-BAG FILTERS

## D.1.2.3 - CARBONAIR PC SERIES ACTIVATED CARBON UNITS

## 1.0 ASSUMPTIONS

The following design assumptions are made based upon available information and from experience with similar projects for the dewatering of soil excavated below the groundwater table:

- The saturated soil to be excavated has an in-situ porosity of 0.3 and the voids within the soil are assumed to be filled with water.
- The solids in the soil to be excavated are mostly sand and gravel with a specific gravity of 2.6 and a density of 162 pounds per cubic foot (lbs/cf).
- The underwater excavation process entrains 0.5 cf of water for each cf of in-situ soil. Therefore, each cf of excavated soil consists of 0.67 cf of in-situ soil and 0.33 cf of free entrained water.
- Static gravity stockpile dewatering of the excavated soil would remove all of the free water entrained by excavation dredging and re-compact the soil to its original volume and characteristics within approximately one day.
- Typical volume of excavated soil in dewatering stockpile is 300 cubic yards (cy) (40 * 40 * 5 ft LWH) and it takes one day to load and one day to unload that stockpile. Therefore, total operating time is 3 days per dewatering stockpile operating sequence.
- Essentially all solids are retained in the dewatering process. However, it is assumed that the water released by the dewatering process would contain approximately 2,000 milligrams per liter (mg/L) suspended solids.

## 2.0 GENERAL CALCULATIONS

### 2.1 <u>In-Situ Soil</u>

Volume composition per cf of in-situ soil based on a porosity of 0.3:
Solids: 1.0 * 0.7 = 0.7 cf
Water: 1.0 * 0.3 = 0.3 cf .

Density of in-situ soil:
(0.7 * 162.2) lbs solids + (0.3 * 63) lbs water = 132.4 lbs/cf or 1.79 tons/cy

Mass composition per cf of in-situ soil:
Solids: 0.7 * 162.2 = 113.5 lbs, or (113.5 / 132.4) * 100 = 85.7% solids by weight
Water: 0.3 * 63 = 18.9 lbs, or (18.9 / 132.4) * 100 = 14.3% water by weight

### 2.2 <u>Excavated Soil</u>

Volume of excavated soil per cf of in-situ soil:
1 cf in-situ soil + 0.5 cf water = 1.5 cf

Volume composition per cf of excavated soil based on above assumptions:
Solids: 0.7 * (1 /1.5) = 0.47 cf
Water: [0.3 * (1 / 1.5)] + [0.5 * (1 / 1.5)] = 0.53 cf
Density of excavated soil:
(0.47 * 162.2) lbs solids + (0.53 * 63) lbs water = 109.6 lbs/cf

Mass composition per cf of excavated soil:
Solids: 0.47 * 162.2 = 76.2 lbs, or (76.2 / 109.6) * 100 = 69.5% solids by weight
Water: 0.53 * 63 = 33.4 lbs, or (33.4 / 109.6) * 100 = 30.5% water by weight

### 2.3 Dewatered Soil

Same characteristics as in-situ soil.

### 2.4 Water Release

Volume of water released by dewatering:
0.5 cf water / 1.5 cf excavated soil = 0.33 cf, or 2.49 gallons per cf, or 67.33 gallons per cy of excavated soil

## 3.0 ZONE-SPECIFIC CALCULATIONS

Zone-specific dewatering volumes and operating parameters can be summarized on the following spreadsheet:

| Zone | In-Situ Soil Volume (cy) | Excavated Soil Volume (cy) | Dewatered Soil Volume (cy) | Water Release Volume (gallons) | Number of Stockpiles | Operating Days |
|---|---|---|---|---|---|---|
| 1 | 44,326 | 66,489 | 44,326 | 4,476,924 | 6 | 111 |
| 2 | 7,190 | 10,785 | 7,190 | 726,190 | 1 | 108 |
| 3 | 5,938 | 8,907 | 5,938 | 599,738 | 1 | 90 |
| 4 | 9,300 | 13,950 | 9,300 | 939,300 | 2 | 70 |
| 5 | 5,513 | 8,270 | 5,513 | 556,813 | 1 | 84 |
| 6 | 4,769 | 7,154 | 4,769 | 481,669 | 1 | 72 |
| 7 | 38,002 | 57,003 | 38,002 | 3,838,200 | 5 | 114 |

## 4.0 WATER TREATMENT

### 4.1 Pre-Filtration

Water released by dewatering would be pre-filtered by drainage pad of dewatering stockpile.

Per Section 2.4 of these calculations, water released per dewatering stockpile operating sequence:
300 cy * 67.33 gal/cy = 20,200 gal
Suspended solids content of released water @ 2,000 mg/L & 95% removal:
20,200 gal * (2,000 * 0.95) mg/L * 8.34 lbs/gal * $10^{-6}$ = 320.1 lbs solids
Dewatering pad solids retention capacity @ 1.5 pounds per square foot (lbs/sf):
40 ft * 40 ft * 1.5 lbs/sf = 2,400 lbs
Expected pad replacement frequency:
2,400 lbs / 320.1 lbs/day = 7.5, say every 7 operating sequences

## 4.2 Modular Water Treatment System Design

### 4.2.1 Flow

Water releasing/treatment rate:
20,200 gal/operating sequence / 1 day dewatering time = 20,200 gal/day (gpd), or 14 gal/min (gpm)

Design modular water treatment system for 15 gpm and 21,600 gpd

### 4.2.2 Water Quality

Suspended solids concentration of water pre-filtered through stockpile drainage pad:
2,000 mg/L * 0.05 = 100 mg/L

Assume that total organic compounds (TOC) of pre-filtered water would be approximately 1,000 mg/L

### 4.2.3 Treatment Scheme

Each modular water treatment system would consist of the two following components:

- A Filtration System to remove residual suspended solids
- A Liquid-Phase Granular Activated Carbon (GAC) Adsorption System to remove soluble TOC

### 4.2.4 Filtration System

Use a bag type filter unit to avoid liquid residual stream from backwashing.

Size bag filter unit for replacement of filter bag element no more frequently than once a day and assume 95% solids removal. Solids accumulation in the bag filter would be:

15 gpm * 1,440 min/day * 8.34 lbs/gal * (100 * 0.95) mg/L * $10^{-6}$ = 17.1 lbs/day solids

Assuming a typical solids capture capacity of approximately 0.5 lbs suspended solids per sf of bag filter element, required surface of bag element is:

17.1 lbs / 0.5 lbs/sf = 34.2, say 35 sf

→ Call for two (in parallel) multi-bag pressurized Bag Filters (BF) with a filter area of 35 sf each (Rosedale Model 30 or equivalent)

Also need a pump to convey released water from dewatering stockpile to treatment system:

→ Call for one horizontal centrifugal 15 gpm Transfer Pump (P) [100 feet total displacement head (TDH), 1 horsepower (hp) motor]

### 4.2.5 Liquid-Phase GAC Adsorption System

Size GAC adsorption units to provide an empty bed contact time (EBCT) of 15 minutes.
Assume GAC usage of 10 pounds per pound of TOC removed and breakthrough after usage of 3/4 of GAC

Required GAC volume:
15 gpm * 15 minutes / 7.48 gal/cf = 30 cf GAC
@ 30 lbs/cf, weight of GAC: 30 cf * 30 lbs/cf = 900 lbs GAC

Check frequency of replacement:
(900 * 0.75) lbs GAC ÷ (15 gpm * 1,440 min/day * 8.34 lbs/gal * 1,000 mg/L TOC * $10^{-6}$ * 10 lbs GAC/lb TOC) = 0.37 operating days **INSUFFICIENT**

**Need to re-size GAC unit for a maximum estimated frequency of replacement of approximately 3 days.**

Required GAC quantity:
(15 gpm * 1,440 min/day * 3 days * 8.34 lbs/gal * 1,000 mg/L TOC * $10^{-6}$ * 10 lbs GAC/lb TOC) / 0.75 = 7,205 lbs

→ Call for a liquid-phase GAC Adsorption System (GAC-1.1) consisting of two (2) adsorption units operating in parallel, each holding 5,000 lbs GAC (Carbonair Model PC28 or equivalent).

Estimated frequency of replacement:
(10,000 * 0.75) lbs GAC ÷ (15 gpm * 1,440 min/day * 8.34 lbs/gal * 1,000 mg/L TOC * $10^{-6}$ * 10 lbs GAC/lb TOC) = 4.2 operating days **OK**

### 4.3 Zone-Specific Water Treatment System(s) Operating Parameters

Based on the water volume computations presented in Section 3.0 of these calculations, the zone-specific operating parameters of the above-described water treatment system(s) can be summarized in the following table:

| Parameters | Zone 1 (S-1.5) | Zone 2 (S-2.6) | Zone 3 (S-3.6) | Zone 4 (S-4.6) | Zone 5 (S-5.5) | Zone 6 (S-6.4) | Zone 7 (S-7.6) |
|---|---|---|---|---|---|---|---|
| Nb. of Modular Systems | 6 | 1 | 1 | 2 | 1 | 1 | 5 |
| Operating Days | 37 | 36 | 30 | 24 | 28 | 24 | 38 |
| Filter Cleanups (1/day) | 222 | 36 | 30 | 48 | 28 | 24 | 190 |
| Filter Bags Used (8/system) | 1,776 | 288 | 240 | 384 | 224 | 192 | 1,520 |
| GAC Replacements (1/4.2days) | 54 | 9 | 7 | 12 | 7 | 6 | 45 |
| GAC Usage (10,000 lbs/system) | 540,000 | 90,000 | 70,000 | 120,000 | 70,000 | 60,000 | 450,000 |

**ATTACHMENTS**

Rosedale bag filters literature
Carbonair liquid-phase GAC adsorption units literature

# Multi-Basket Strainers and Multi-Bag Filters

*These multi-basket strainers and bag filters offer a wide range of flow capacities and contaminant-holding capabilities. They contain from 2 to 23 baskets.*

*To serve as a strainer, a unit is ordered with perforated stainless steel baskets (mesh-lined if desired). When ordered as a filter, it's fitted with perforated stainless steel baskets designed to hold disposable or cleanable filter bags. Industry-standard size bags are used: the standard 30 inch baskets accept bag size 2, the optional 15 inch baskets take size 1.*

*The standard pressure rating for all models is 150 psi. All housings can be supplied with an ASME code stamp, if required.*

## Features

- *Multiple housing styles available (standard, quick access, low profile, hinged)*
- *Permanently piped housings are opened without tools and without disturbing the piping*
- *Machined cover gasket groove provides positive O-ring sealing*
- *Carbon steel, 304 or 316 stainless steel construction housings*
- *Large-area, 30 inch deep, heavy-duty, 9/64 inch perforated baskets*
- *Easy to clean*
- *Low pressure drop*
- *Four cover seal materials: Buna N, Ethylene Propylene, Viton®, and Teflon®*
- *Pressure rating 150 psi*
- *Flanged connections for 2 through 12 inch pipe*
- *Vent, drain and gage connections*

## Options

- *ASME code stamp*
- *Higher pressure ratings*
- *Corrosion allowances*
- *Steam jackets*
- *Special connection locations*
- *Bag hold down assembly (standard on QAC design)*
- *Inner baskets for dual-stage straining or filtering*
- *Cleanable wire mesh lined or perforated strainer baskets*
- *Special alloy materials*
- *Hydraulic cover lifting assembly*
- *Sanitary fittings*
- *Differential pressure indicators*

## Duplex Systems

*All multi-basket models described here are also available as duplex systems. Two units come piped together with valves to permit continuous use of either unit while servicing the other. One lever actuates all valves simultaneously or it can be ordered for automatic service. See page 63.*

Rosedale Quick Access "QAC" Low Maintenance Filter/Strainer
COUNTERBALANCED COVER - Stops In Any Position
COVER SEAL
COVER HINGE MECHANISM
SECONDARY SAFETY RELEASE
POSITIVE BAG RESTRAINT
CLAMP RELEASE BAR
INLET
COVER SUPPORT ASSEMBLY
INLET DRAIN/VENT
PRIMARY RELEASE SAFETY LEVER
OUTLET
LOW PROFILE CLEARANCE
DRAIN

# Choose Baskets That Strain or Filter

## Whatever your needs dictate

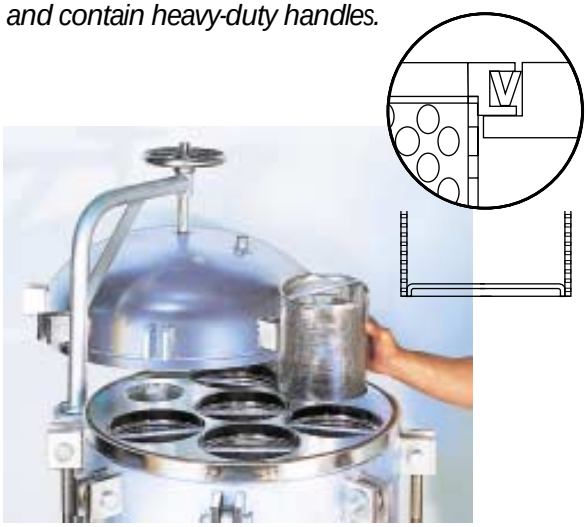
*Strainer baskets are cleanable, reusable.*

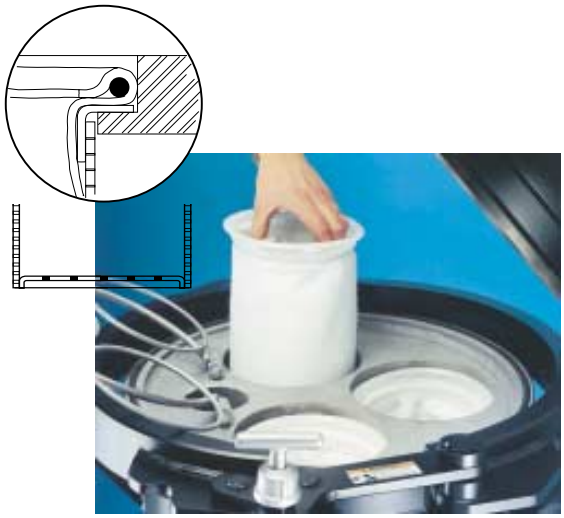
*A seal is supplied on any strainer basket. It forms a seal between basket and housing to prevent dirty fluid bypass. Choose between various perforation sizes or wire mesh. Strainer baskets have flat, non-perforated bottoms and contain heavy-duty handles.*

*Filter bag baskets hold disposable filter bags.*

*Filter bags have an interference fit between the bags top rim and the housing causing a positive seal to prevent fluid bypass. Filter bag baskets have flat perforated bottoms.*

*Filter bags are available in a wide variety of felt, micro-fiber, monofilament and multifilament mesh materials. They are detailed completely on pages 126-128.*





*DUAL-STAGE– Dual-stage action will increase strainer or filter life and reduce servicing needs. This straining/filtering action can be achieved by ordering a second, inner basket. It is supported on the top flange of the outer basket. Both baskets can be utilized as strainers (with or without wire mesh linings), filter bag baskets, or a combination of strainer and bag basket.*

## Basket Data

*Surface area of each 30 in. basket: 4.4 sq. ft. Volume of each 30 in. basket: 0.6 cu. ft.*

## Basket Construction

*For cleanable strainer baskets, choose from the following perforation diameters: 1/4, 3/16, 9/64, 3/32, or 1/16 inch (for other not shown consult factory).*

*Any perforated basket can also be ordered lined with wire mesh. Stainless steel wire is used in mesh sizes 20, 30, 40, 50, 60, 70, 80, 100, 150, or 200.*

*Filter bag baskets, have standard 9/64 inch diameter perforations that are 51% open area. A wire mesh can also be utilized with bag baskets for two advantages:*

1. *Fiber migration is minimized.*
2. *In the unlikely event of bag rupture, the wire mesh better contains the contaminant.*

# Choose Housing Style

## *Designed to suit your requirements*

*The versatility of Rosedale Products provides a choice of several different designs.*

- ***Quick Access Cover (QAC)*** *features a clamp and spring assisted hinged cover that is quick and easy to open and close with no tools required. This will significantly reduce change-out time and lower operating costs. The QAC is rated to 150 PSI and constructed to meet ASME code requirements. Built-in safety features ensure that the cover cannot be opened unless the internal pressure is first released. The QAC is offered with our low profile design making bags more accessible and easy to remove.*

- ***Low Profile Design (SLP) Housings*** *are compact and space saving, allowing for ease of bag change-out. Standard operating height is reduced, resulting in a safe design by eliminating platforms and ladders. The SLP is manufactured in any housing version, including our standard davit arm cover, QAC design, and spring assisted hinged cover.*

- ***Spring Assisted Hinged Cover (HLP)*** *opens and closes without effort. Simply loosen the swing bolts and lift the cover up to open. An automatic cover stop is provided. This design saves time by eliminating the labor intensive handwheel. It is offered standard with our low profile design, or can be ordered in the QAC design.*

- ***Standard Housing Design (STD)*** *is durable and economic. It includes a davit arm and handwheel to facilitate cover removal. It is our most versatile housing design offering a variety of options, including our low profile design.*

*Quick Access Cover*

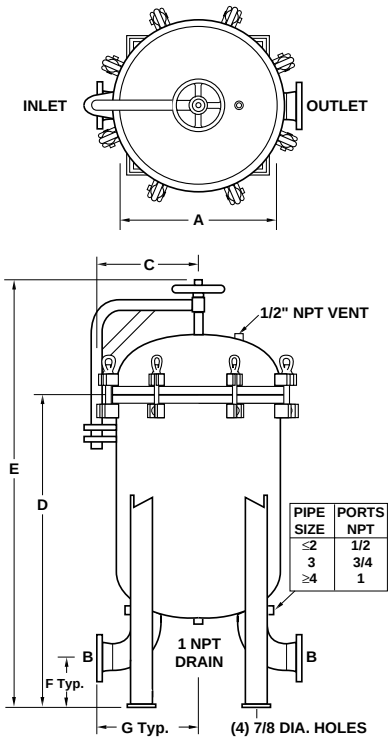
*Low Profile Design*

*Standard Davit Arm*

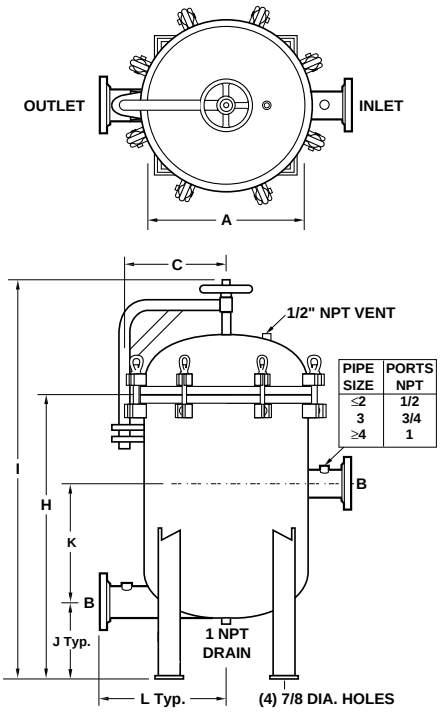
| MODEL NUMBER & Dim. A | Pipe Sizes B | Leg Bolt Circle Dia. | Standard | | | | | | Low Profile | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | C | D | E | F | G | Weight, lb (Approx) | H | I | J | K | L |
| **16** | 2 | 14.0 | 10.9 | 40.1 | 57.1 | 4.50 | 10.5 | 400 | 37.9 | 54.9 | 8.00 | 15.0 | 13.0 |
| | 3 | | | 42.5 | 59.5 | 5.25 | 12.3 | 425 | 38.3 | 55.3 | 9.00 | 17.0 | 14.0 |
| | 4 | | | 44.9 | 61.9 | 6.00 | 14.0 | 450 | N/A | N/A | N/A | N/A | N/A |
| **18** | 2 | 16.0 | 11.9 | 40.5 | 58.0 | 4.50 | 11.1 | 450 | 39.6 | 58.5 | 8.00 | 15.0 | 14.0 |
| | 3 | | | 42.9 | 60.4 | 5.25 | 12.9 | 475 | 40.0 | 58.9 | 9.00 | 17.0 | 15.0 |
| | 4 | | | 45.3 | 62.8 | 6.00 | 14.6 | 500 | N/A | N/A | N/A | N/A | N/A |
| **22** | 2 | 20.0 | 14.0 | 41.4 | 60.0 | 4.50 | 11.9 | 485 | 39.5 | 58.0 | 8.00 | 15.0 | 16.0 |
| | 3 | | | 43.9 | 62.4 | 5.25 | 13.7 | 500 | 40.0 | 58.5 | 9.00 | 17.0 | 17.0 |
| | 4 | | | 46.2 | 64.7 | 6.00 | 15.4 | 515 | 39.5 | 58.0 | 9.00 | 19.0 | 18.0 |
| | 6 | | | 50.4 | 69.0 | 7.00 | 18.9 | 560 | N/A | N/A | N/A | N/A | N/A |
| **24** | 2 | 22.0 | 15.0 | 41.7 | 60.7 | 4.50 | 13.1 | 675 | 41.2 | 61.6 | 8.00 | 15.0 | 17.0 |
| | 3 | | | 44.1 | 63.1 | 5.25 | 14.8 | 700 | 41.6 | 62.0 | 9.00 | 17.0 | 18.0 |
| | 4 | | | 46.5 | 65.5 | 6.00 | 16.6 | 725 | 41.1 | 61.5 | 9.00 | 19.0 | 19.0 |
| | 6 | | | 50.7 | 69.7 | 7.00 | 20.1 | 750 | N/A | N/A | N/A | N/A | N/A |
| **30** | 2 | 28.0 | 18.0 | 42.8 | 63.3 | 4.50 | 15.2 | 635 | 41.3 | 61.9 | 8.00 | 15.0 | 20.5 |
| | 3 | | | 45.2 | 65.7 | 5.25 | 17.0 | 650 | 41.8 | 62.4 | 9.00 | 17.0 | 21.0 |
| | 4 | | | 47.6 | 68.1 | 6.00 | 18.7 | 665 | 41.3 | 61.9 | 9.00 | 19.0 | 22.5 |
| | 6 | | | 51.9 | 72.4 | 7.00 | 22.2 | 705 | 41.2 | 61.8 | 10.0 | 17.0 | 23.0 |
| | 8 | | | 56.4 | 76.8 | 8.25 | 25.7 | 850 | N/A | N/A | N/A | N/A | N/A |
| **36** | 3 | 34.0 | 21.0 | 46.4 | 68.4 | 5.25 | 18.8 | 840 | 43.3 | 64.5 | 9.00 | 17.0 | 24.0 |
| | 4 | | | 48.8 | 70.8 | 6.00 | 20.6 | 860 | 43.2 | 64.5 | 9.50 | 19.0 | 25.0 |
| | 6 | | | 53.1 | 75.1 | 7.00 | 24.1 | 870 | 43.2 | 64.4 | 10.5 | 17.0 | 26.0 |
| | 8 | | | 57.6 | 79.6 | 8.25 | 27.6 | 1010 | 43.2 | 64.4 | 11.5 | 17.0 | 27.0 |
| | 10 | | | 62.1 | 84.1 | 9.50 | 30.6 | 1150 | N/A | N/A | N/A | N/A | N/A |
| **42** | 4 | 40.0 | 24.0 | 50.0 | 73.5 | 6.00 | 22.6 | 1840 | 45.9 | 70.7 | 9.50 | 19.0 | 28.0 |
| | 6 | | | 54.3 | 77.8 | 7.00 | 26.1 | 1870 | 45.9 | 70.6 | 10.5 | 17.0 | 28.0 |
| | 8 | | | 58.8 | 82.3 | 8.25 | 29.6 | 1960 | 45.9 | 70.6 | 11.5 | 17.0 | 29.5 |
| | 10 | | | 63.3 | 86.8 | 9.50 | 32.6 | 2070 | 45.8 | 70.5 | 12.5 | 17.0 | 30.0 |
| | 12 | | | 68.0 | 91.5 | 11.0 | 36.1 | 2200 | N/A | N/A | N/A | N/A | N/A |
| **48** | 4 | 46.0 | 27.0 | 51.0 | 76.0 | 6.00 | 24.8 | 2015 | 46.5 | 71.5 | 9.50 | 19.0 | 32.0 |
| | 6 | | | 55.4 | 80.4 | 7.00 | 28.3 | 2075 | 46.4 | 71.4 | 10.5 | 17.0 | 32.0 |
| | 8 | | | 60.0 | 85.0 | 8.25 | 31.8 | 2200 | 46.4 | 71.4 | 11.5 | 17.0 | 32.5 |
| | 10 | | | 64.4 | 89.4 | 9.50 | 34.8 | 2350 | 46.4 | 71.4 | 12.5 | 17.0 | 33.0 |
| | 12 | | | 69.2 | 94.2 | 11.0 | 38.3 | 2530 | N/A | N/A | N/A | N/A | N/A |

## Dimensions (IN)

(30-inch deep basket)




**Standard**

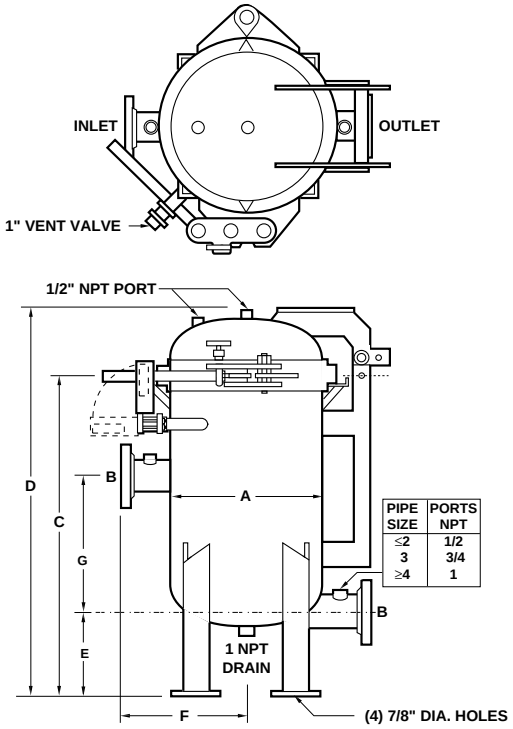



**Low Profile**

## QAC Low Profile

| MODEL NUMBER | A | Pipe Sizes B | Leg Bolt Circle Dia. | C | D | E | F | G |
|---|---|---|---|---|---|---|---|---|
| **16 & 18** | 18 | 2 | 16.0 | 37.6 | 45.4 | 8.00 | 14.0 | 15.0 |
| | | 3 | | 38.1 | 45.9 | 9.00 | 15.0 | 17.0 |
| **22 & 24** | 24 | 2 | 22.0 | 41.2 | 49.9 | 8.00 | 17.0 | 15.0 |
| | | 3 | | 41.6 | 50.3 | 9.00 | 18.0 | 17.0 |
| | | 4 | | 41.1 | 49.8 | 9.00 | 19.0 | 19.0 |

## Dimensions (IN)




**QAC Low Profile**

## Model Selection (For all housings)

| Model No. | Number of Baskets | Straining, Filtering Area, ft2 | Nominal Flow Rate (gpm)** | Inlet/ Outlet Size (in) | Available Housing Styles |
|---|---|---|---|---|---|
| 16 | 2 | 8.8 | 200 | 2,3,4* | Std,SLP,HLP,QAC |
| 18 | 3 | 13.2 | 300 | 2,3,4* | Std,SLP,HLP,QAC |
| 22 | 4 | 17.6 | 400 | 2,3,4,6* | Std,SLP,HLP,QAC |
| 24 | 6 | 26.4 | 600 | 2,3,4,6* | Std,SLP,HLP,QAC |
| 30 | 8 | 35.2 | 800 | 2,3,4,6,8* | Std,SLP,HLP |
| 36 | 12 | 52.8 | 1200 | 2,3,4,6,8,10* | Std,SLP,HLP |
| 42 | 17 | 74.8 | 1700 | 2,3,4,6,8,10,12* | Std,SLP,HLP |
| 48 | 23 | 101.2 | 2300 | 2,3,4,6,8,10,12* | Std,SLP,HLP |

*Not available on SLP, HLP, and QAC styles.

**Nominal flow rate is based on water @ 1 psi ΔP. For optimum filtering effectiveness, a maximum fluid velocity of 10 ft/sec should be maintained.

## Pressure Drop Data

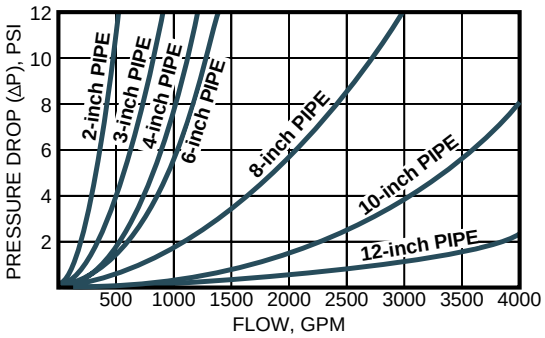
*Basket strainers and bag filters are usually selected so that the pressure drop does not exceed 2 psi, when they are clean. Higher pressure drops may be tolerated when contaminant loading is low.*

### Determining housing pressure drop:

*The pressure drops shown on the graph are reliable for all multi-basket housings, including strainer baskets or bag filter (perforated only or mesh lined). The pressure drop of any housing is governed by the size of the inlet and outlet, not the vessel itself.*

1. *Using the desired pipe size and approximate flow rate, determine the basic pressure drop from the graph.*
2. *Multiply the pressure drop obtained in step 1 by the viscosity correction factor found in the accompanying table.*
3. *You now have the pressure drop for a clean multi-basket unit. If bag filters are to be employed, you must add the pressure drop they incur to get a true pressure drop for the assembly.*

**Note:** *Filter bags are specified separately. See pages 120-130.*




*Recommended flow rates are based on housing only. Fluid viscosity, filter bag used, and expected dirt load should be considered when sizing a filter.*

## Viscosity Factors

| CPS NUMBER | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1 ($H_2O$) | 50 | 100 | 200 | 400 | 600 | 800 | 1000 | 2000 |
| .65 | .85 | 1.00 | 1.10 | 1.20 | 1.40 | 1.50 | 1.60 | 1.80 |

# How To Order

*Build an ordering code as shown in the example*

**Example: SLP-24-30-4F -1-150-C- B -S -M-20- C- 2P 1/16**

Housings — Options — OPTIONAL INNER BASKET

**HOUSING STYLE**
- Standard (std) = **No Symbol**
- Standard Low Profile = **SLP**
- Quick Access Cover (16-24) = **QAC**
- Hinged Low Profile = **HLP**

**MODEL NO.**
- 16 = **16**, 30 = **30**
- 18 = **18**, 36 = **36**
- 22 = **22**, 42 = **42**
- 24 = **24**, 48 = **48**

**BASKET DEPTH**
- 15-in. = **15**
- 30-in. (std) = **30**

**PIPE SIZE (FLANGED[1])**
- 2-in. (Std,SLP,HLP16-48 / QAC 18 & 24) = **2F**
- 3-in.(Std, SLP, HLP 16-48 / QAC 18 & 24) = **3F**
- 4-in. (Std 16-48 / SLP, HLP 22-48 / QAC 24) = **4F**
- 6-in. (Std 22-48 / SLP, HLP 30-48) = **6F**
- 8-in. (Std 30-48 / SLP, HLP 36-48) = **8F**
- 10-in. (Std 36-48 / SLP, HLP 42 & 48) = **10F**
- 12-in. (Std 42, 48) = **12F**

**OUTLET STYLE**
- In-line, bottom (std) = **1**
- Side inlet/outlet (SLP, HLP, QAC) = **2**
- Side inlet/outlet, same side (SLP, HLP, QAC) = **4**

**PRESSURE RATING[2]**
- 150 psi (flanged) = **150**

**HOUSING MATERIAL**
- Carbon steel = **C**
- 304 stainless steel = **S**
- 316 stainless steel = **S316**

***COVER SEAL**
- Buna N = **B**
- Ethylene Propylene = **E**
- Viton® = **V**
- Teflon® Encapsulated Viton® = **TEV**
- Teflon® (solid white) = **TSW**

**BASKET SEAL**
- No seal = **N**
- Seal (only on strainer housings) = **S**

**OPTIONAL INNER BASKET, MEDIA SIZE**
Perforation diameters (for type 2P baskets)
**1/4, 3/16, 9/64, 3/32, 1/16**
Mesh sizes (for type 2M & 2BM baskets)
**20, 30, 40, 50, 60, 70, 80, 100, 150, or 200**

**OPTIONAL INNER BASKET, TYPE**
- **2B** = Filter bag basket, 9/64 perforations
- **2P** = Strainer basket, perforated metal
- **2BM** = Filter basket, mesh lined
- **2M** = Strainer basket, perforated, mesh lined

**ASME CODE STAMP**
- **C** = Code

**BASKET, MEDIA SIZE No symbol if type B basket was selected**
Perforation diameters (for type P baskets)
**1/4, 3/16, 9/64, 3/32, 1/16**
Mesh sizes (for type M & BM baskets)
**20, 30, 40, 50, 60, 70, 80, 100, 150, or 200**

**BASKET, TYPE**
- **PB** = Filter bag basket, 9/64 perforations
- **P** = Strainer basket, perforated metal
- **BM** = Filter bag basket, perforated, mesh lined
- **M** = Strainer basket, perforated, mesh lined
- **HWM** = Filter bag basket, heavy wire mesh

1. Flanges provided with the housing match the pressure rating of the vessel. Housings rated 150 psi have 150 class flanges. Housings rated 300 psi have 300 class flanges. Other styles and classes available. ANSI B16.5 Pressure-Temperature rating tables determine flange class for ASME code housings. Consult factory.
2. Higher pressure ratings available. Consult factory.

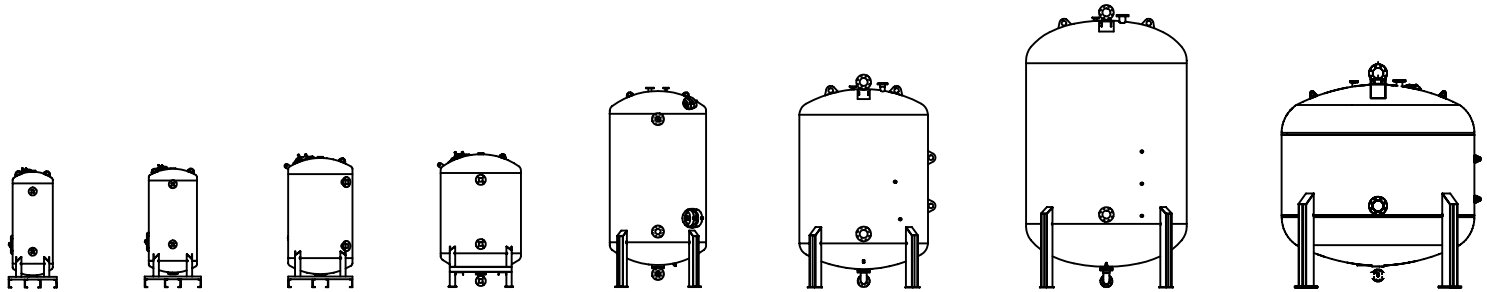
***Note:** The TEV and TSW cover seals are not available on the low profile QAC.

CARBONAIR
www.carbonair.com

# PC Series
# Carbon Vessels

Carbonair's carbon vessels are designed and manufactured in accordance with engineering standards set forth by the American Society of Mechanical Engineers (ASME). The materials used in construction are in accordance with standards established by AWWA, FDA, and EPA.

**Specifications**



| Model | PC 5 | PC 7 | PC 13 | PC 20 | PC 28 | PC 50 | PC 78 | PC 113 |
|---|---|---|---|---|---|---|---|---|
| Flow Range (gpm) | 3 - 35 | 4 - 50 | 6 - 100 | 10 - 130 | 14 - 200 | 25 - 360 | 40 - 550 | 55 - 800 |
| Carbon Capacity (lb) | 500 | 1000 | 1500 | 2500 | 5000 | 10,000 | 20,000 | 20,000 |
| Vessel Diameter | 2'-6" | 3' | 4' | 5' | 6' | 8' | 10' | 12' |
| Vessel Height | **7'-3"** | **7'-7"** | **8'-4"** | **8'-5"** | **12'-5"** | 13'-3" | 17'-7" | **13'-11"** |
| Bed Area (ft²) | 4.9 | 7.1 | 12.6 | 19.6 | 28.3 | 50 | 78 | 113 |
| Empty Weight (lb) | 780 | 980 | 1230 | 1800 | 3150 | 8100 | 10,900 | 16,600 |
| Loaded Weight (lb) | 1280 | 1980 | 2730 | 4300 | 8150 | 18,100 | 30,900 | 36,600 |
| Operating Weight (lb) | 2670 | 3670 | 6150 | 9200 | 17,450 | 40,600 | 75,600 | 82,650 |
| Spent & Drained Weight (lb) | 1900 | 3230 | 4600 | 7400 | 14,400 | 30,520 | 55,750 | 61,450 |
| Design Pressure (psig) | 90 | 90 | 90 | 75 | 75 | 75 | 75 | 75 |
| Influent Connection | 2" | 2" | 2" | 3" | 4" | 6" | 6" | 8" |
| Effluent Connection | 2" | 2" | 2" | 3" | 4" | 6" | 6" | 8" |

Design Features

- **Welded Steel Construction**
- **Corrosion Resistant Acrylic Polyurethane Coated Exterior**
- **Multi-Coated Corrosion Resistant Epoxy Interior**
- **Built to ASME code**
- **PVC and Stainless Steel Internals**
- **Two 12" x 16" Access Ports**

Options

- ☐ Influent/Effluent Sample and Pressure Taps
- ☐ Influent/Effluent Quick-Connect Couplings
- ☐ Flexible Interconnecting Hose
- ☐ External Sample/Gauge Ports
- ☐ Piping Packages
- ☐ Flow Instrumentation
- ☐ ASME Inspected and Stamped Vessels Available
- ☐ Complete line of granular activated carbon and other media

Service Centers

**FLORIDA**
4710 Dignan Street
Jacksonville, FL 32254
800.241.7833
904.387.4465
904.387.5058 Fax

**MINNESOTA**
2731 Nevada Ave. No.
New Hope, MN 55427
800.526.4999
763.544.2154
763.544.2151 Fax

**TEXAS**
4889 Hunter Rd. Bldg 1-C
San Marcos, TX 78666
800.893.5937
512.392.0085
512.392.0066 Fax

**VIRGINIA**
4328 West Main Street
Salem, VA 24153
800.204.0324
540.380.5913
540.380.5920 Fax

Dwg # 217327 PC

# APPENDIX D.1.3

## D.1.3 - ENGINEERING CONTROLS CALCULATIONS

**Appendix D.1.3**

**Initial Evaluation of Adequacy of Engineered Controls**

- **April 12, 2010 Lead Leaching Memorandum**
- **April 28, 2010 CTDEP Comment Email**
- **May 6, 2010 Response to Comment Document**
- **May 12, 2010 CTDEP Rebuttal Email**
- **May 17, 2010 Response to Comment Document**
- **May 18, 2010 CTDEP Rebuttal Email**

**EVALUATION OF LEAD LEACHING IMPACT ON GROUNDWATER**
**LOWER SUBASE FS**
**NSB-NLON, GROTON, CONNECTICUT**

## Approach

Potential impact of lead leaching from contaminated soil to groundwater is estimated by multiplying the zone-specific lead Synthetic Precipitation Leaching Procedure (SPLP) data which represents an empirical estimate of the lead concentrations that could leach from contaminated soil to infiltrating water by a calculated zone-specific dilution factor (DF) that estimates the dilution effect of the aquifer on infiltration water.

Estimated lead concentration in groundwater = Lead SPLP concentration * DF

The estimated lead concentration in groundwater was then compared to the site-specific Alternative Surface Water Protection Criterion (SWPC) developed for lead at the Lower Subase (810 µg/L, see Appendix B.4) and also to the lead SWPC as promulgated in the Connecticut Remediation Standard Regulations (RSRs) (13 µg/L) to determine its acceptability.

## Lead SPLP Data

Attachment 1 presents available lead SPLP analytical data and computes zone-specific mean and maximum values.

## Dilution Factors

The zone-specific DFs are computed in accordance to Equation 11 from EPA Soil Screening Guidance http://www.epa.gov/superfund/health/conmedia/soil/pdfs/ssg496.pdf

DF = 1 + (Kid / IL)

With

K: Aquifer hydraulic conductivity (ft/yr)
i: Hydraulic gradient (ft/ft)
d: Mixing zone depth (ft)
I: Infiltration rate (ft/yr)
L: Source length parallel to groundwater flow (ft)

### Parameter Determination

Hydraulic Conductivity (K)
Hydraulic conductivity was calculated as the geometric mean of all currently available hydraulic conductivity data including the following:

| Zone | 1 | 2 | | | 3 | 4 | |
|---|---|---|---|---|---|---|---|
| Well | 13MW7 | 13MW6 | 13MW10 | 13MW11 | 13MW12 | 13MW13 | 13MW14 |
| K (ft/yr) | 57,670 | 26,280 | 21,535 | 34,310 | 620.5 | 14,600 | 210,240 |

Therefore, a representative K for the Lower Subase soil can be calculated as:

$K = (57{,}670 * 26{,}280 * 21{,}535 * 34{,}310 * 620.5 * 14{,}600 * 210{,}240)^{1/7} = 21{,}513$ ft/yr

Hydraulic Gradients (i)

Hydraulic gradients were determined as follows during the Lower Subase Remedial Investigation based on water level data collected during low tide (TtNUS, 1999):

| Zone | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| I (ft/ft) | 0.00476 | 0.00318 | 0.00792 | 0.00390 | 0.00920 | 0.00920 | 0.00527 |

Mixing Zone Depth (d)

Mixing zone depth is estimated at approximately 15 ft throughout the Lower Subase per CTDEP RSRs.

Infiltration Rate (I)

As summarized in Attachment 2, infiltration rates were calculated as 0.02 ft/year for a fully-paved impervious area, 0.25 ft/year under the current industrial/commercial (I/C) site use scenario, and 1.25 ft/year under a hypothetical future residential site use scenario.

Source Length Parallel to Groundwater Flow (L)

Source length parallel to groundwater flow is estimated to be approximately 175 ft which is half the width of the Lower Subase to take into account the fact that most surfaces are paved or covered by buildings and thus not open to infiltration.

Zone-specific DFs for a fully-paved impervious surface, the current I/C site use scenario, and a hypothetical future residential site use are calculated in Attachment 3

**Groundwater Concentrations**

Computation of lead groundwater concentrations resulting from lead leaching are presented in Attachment 4. The results can be summarized as follows:

- No exceedances of Alternative lead SWPC and promulgated lead SWPC are predicted to occur at any location with either a fully paved impervious surface or under the current I/C site use scenario.

- No exceedances of the Alternative lead SWPC are predicted to occur under a hypothetical future residential site scenario. Under a hypothetical future residential site use scenario, exceedances of the promulgated lead SWPC might occur in Zones 3 and 4.

- Additional soil sampling and analysis will be performed as part of a Soil Pre-Design Investigation. The soil samples will be analyzed for SPLP lead. This calculation will be updated after the results of the Pre-Design Investigation are available.

**ATTACHMENT 1**
**SPLP LEAD ANALYTICAL DATA**
**LOWER SUBASE FEASIBILITY STUDY**
**NSB-NLON, GROTON, CONNECTICUT**

| Zone | Sample Location | Sample Elevation | | Mass Conc. (mg/kg) | SPLP | | |
|---|---|---|---|---|---|---|---|
| | | Top (ft bgs) | Bottom (ft bgs) | | Detected (µg/L) | Mean (µg/L) | Max. (µg/L) |
| 1 | TB1-1RI | 1.5 | 3.5 | 34.3 | 7 U | 3.08 | 3.50 |
| | TB2-1RI | 2 | 3.5 | 98.8 | 5.3 U | | |
| 2 | TB5-2RI | 8 | 11 | 2.1 | 1.3 U | 0.93 | 1.50 |
| | TB6-2RI | 8 | 11 | 14 | 1.3 U | | |
| | TB6-2RI | 8 | 11 | 14.6 | 1.5 J | | |
| 3 | MW2-3RI | 5 | 6 | 207 | 45.8 J | 171.00 | 478.00 |
| | MW2-3RI | 2 | 3.5 | 512 | 120 J | | |
| | MW2-3RI | 2 | 3.5 | 513 | 40.2 J | | |
| | MW1-3RI | 2 | 4 | 1390 | 478 J | | |
| 4 | MW2-4RI | 5 | 7 | 2.2 | 1.3 U | 46.01 | 104.00 |
| | MW1-4RI | 5 | 6 | 2.7 | 2 U | | |
| | MW2-4RI | 1 | 3 | 57.1 | 13.2 U | | |
| | TB3-4RI | 7 | 8 | 214 | 87.2 | | |
| | TB3-4RI | 2 | 4 | 237 | 104 | | |
| | MW1-4RI | 0.5 | 2 | 444 | 76.6 | | |
| 5 | TB1-5RI | 5 | 7 | 3.6 | 1.4 J | 4.22 | 10.10 |
| | TB6-5RI | 5.5 | 6.5 | 7.6 | 1.6 J | | |
| | TB6-5RI | 2 | 4 | 9.6 | 2 J | | |
| | TB1-5RI | 2 | 4 | 73.5 | 6 J | | |
| | TB1-5RI | 2 | 4 | 91.2 | 10.1 | | |
| 6 | MW4-6RI | 5 | 6 | 2 | 1.3 U | 1.44 | 2.90 |
| | MW3-6RI | 5 | 6 | 4.4 | 1.3 U | | |
| | MW4-6RI | 0.5 | 1.5 | 4.8 | 2.9 J | | |
| | MW1-6RI | 6 | 8 | 8.5 | 1.6 U | | |
| | MW3-6RI | 0.5 | 2 | 12.4 | 1.9 U | | |
| | MW1-6RI | 2 | 4 | 18 | 5.4 U | | |
| 7 | MW3-7RI | 2 | 4 | 1.6 | 1.28 U | 8.60 | 30.10 |
| | MW3-7RI | 2 | 4 | 1.8 | 1.28 U | | |
| | MW3-7RI | 5 | 6 | 2 | 1.28 U | | |
| | MW5-7RI | 2 | 4 | 1570 | 7.5 | | |
| | MW5-7RI | 2 | 4 | 1750 | 12.1 | | |
| | MW5-7RI | 5 | 6 | 13300 | 30.1 | | |

U: Undetected at indicated analytical detection limit.
J: Estimated value.
Mean is calculated as the average of all analytical data including half of detection limits.

**ATTACHMENT 2**
**ESTIMATE OF INFILTRATION RATES FOR VARIOUS SITE USE SCENARIOS**
**LOWER SUBASE FEASIBILITY STUDY**
**NSB-NLON, GROTON, CONNECTICUT**

## 1.0 METHODOLOGY

Infiltration I is defined as the difference between precipitation P and runoff Q as follows:

$I = P - Q$

Ia = initial abstraction (in) = all loses after runoff begins...Infiltration would actually be a little less...

Precipitation P is provided through meteorological data for the area under consideration. In the New London area, average yearly precipitation is approximately 44 inches/year.

The runoff Q can be estimated through the Soil Conservation Service (SCS) runoff curve number (CN) method. In accordance with Equation (2-3) of the SCS TR-55 (page 2-1), runoff can be estimated as follows:

$Q = (P - 0.2S)^2 \div (P + 0.8S)$

With:

Q: runoff (inches/year)
P: precipitation (44 inches/year as measured at New London over an 81-year period (NFEC, 1988)
S: potential retention after runoff begins (inches/year)

The potential retention S can be calculated using CN values ranging from 0 to 100 depending on the nature of the terrain for the study area in accordance with Equation (2-4) of the SCS TR-55 (page 2-1) as follows:

$S = (1{,}000 \div CN) - 10$

CN values are presented on Table 2-2a of SCS TR-55 (page 2-5) for 4 hydrologic soil groups (A, B, C, and D) and a selection of cover types and hydrological conditions.

Lower Subase soil can be classified in hydrologic group A which is defined as having low runoff potential and high infiltration rates even when thoroughly wetted. Group A soil consist chiefly of deep, well to excessively drained sand or gravel and have a high rate of water transmission (greater than 0.30 in/hr).

Runoff Q and infiltration I were calculated for the following three cover types and hydrological conditions listed in attached Table 2-2a of the SCS TR-55 (page 2-5):

- Impervious areas (paved parking lots, roofs, driveways, etc.) that would be representative of maximum run-off potential

- Urban industrial district that would be representative of current site conditions at the Lower Subase

- Open space (lawns, parks, golf courses, cemeteries, etc.), good condition (grass cover > 75%) that would be representative of maximum infiltration potential under a hypothetical future residential site use scenario.

## 2.0 INFILTRATION CALCULATIONS

### 2.1 Impervious Areas

As per attached Table 2-2a of the SCS TR-55 (page 2-5), CN = 98 for a Group A soil and this type of cover and hydrologic condition.

Therefore:

$S = (1{,}000 \div 98) - 10 = 0.20$ inches/year

And:

$Q = [44 - (0.2 * 0.20)]^2 \div [44 + (0.8 * 0.20)] = 43.76$ inches/year

And:

$I = (44 - 43.76) = 0.24$ inches/year or 0.02 feet/year

### 2.2 Urban Industrial District

As per attached Table 2-2a of the SCS TR-55 (page 2-5), CN = 81 for a Group A soil and this type of cover and hydrologic condition.

Therefore:

$S = (1{,}000 \div 81) - 10 = 2.35$ inches/year

And:

$Q = [44 - (0.2 * 2.35)]^2 \div [44 + (0.8 * 2.35)] = 41.30$ inches/year

And:

$I = (44 - 41.30) = 2.70$ inches/year or 0.22 feet/year, rounded to 0.25 ft/yr for conservativeness

### 2.3 Open Space, Good Condition

As per attached Table 2-2a of the SCS TR-55 (page 2-5), CN = 39 for a Group A soil and this type of cover and hydrologic condition.

Therefore:

$S = (1{,}000 \div 39) - 10 = 15.64$ inches/year

And:

$Q = [44 - (0.2 * 15.64)]^2 \div [44 + (0.8 * 15.64)] = 29.56$ inches/year

And:

I = (44 – 29.56) = 14.44 inches/year or 1.20 feet/year, rounded to 1.25 feet/year for conservativeness.

## REFERENCE

NFEC (Naval Facilities Engineering Command), 1988. Master Plan for Naval Submarine Base, New London.

United States Department of Agriculture, Natural Resources Conservation Service, Conservation Engineering Division. Technical Release 55, Urban Hydrology for Small Watersheds, TR-55. June 1986.

**ATTACHMENT 3**
**COMPUTATION OF ZONE-SPECIFIC NON-ADJUSTED DFs**
**LOWER SUBASE FEASIBILITY STUDY**
**NSB-NLON, GROTON, CONNECTICUT**

**Fully-Paved Impervious Surface**

| Zone | K (ft/yr) | i (ft/ft) | d (ft) | I (ft/yr) | L (ft) | DF |
|---|---|---|---|---|---|---|
| 1 | 21513 | 0.00476 | 15 | 0.02 | 175 | 439.87 |
| 2 | 21513 | 0.00318 | 15 | 0.02 | 175 | 294.19 |
| 3 | 21513 | 0.00792 | 15 | 0.02 | 175 | 731.21 |
| 4 | 21513 | 0.00390 | 15 | 0.02 | 175 | 360.57 |
| 5 | 21513 | 0.00920 | 15 | 0.02 | 175 | 849.23 |
| 6 | 21513 | 0.00920 | 15 | 0.02 | 175 | 849.23 |
| 7 | 21513 | 0.00527 | 15 | 0.02 | 175 | 486.89 |

**Industrial/Commercial Site Use**

| Zone | K (ft/yr) | i (ft/ft) | d (ft) | I (ft/yr) | L (ft) | DF |
|---|---|---|---|---|---|---|
| 1 | 21513 | 0.00476 | 15 | 0.25 | 175 | 36.11 |
| 2 | 21513 | 0.00318 | 15 | 0.25 | 175 | 24.46 |
| 3 | 21513 | 0.00792 | 15 | 0.25 | 175 | 59.42 |
| 4 | 21513 | 0.00390 | 15 | 0.25 | 175 | 29.77 |
| 5 | 21513 | 0.00920 | 15 | 0.25 | 175 | 68.86 |
| 6 | 21513 | 0.00920 | 15 | 0.25 | 175 | 68.86 |
| 7 | 21513 | 0.00527 | 15 | 0.25 | 175 | 39.87 |

**Residential Site Use**

| Zone | K (ft/yr) | i (ft/ft) | d (ft) | I (ft/yr) | L (ft) | DF |
|---|---|---|---|---|---|---|
| 1 | 21513 | 0.00476 | 15 | 1.25 | 175 | 8.02 |
| 2 | 21513 | 0.00318 | 15 | 1.25 | 175 | 5.69 |
| 3 | 21513 | 0.00792 | 15 | 1.25 | 175 | 12.68 |
| 4 | 21513 | 0.00390 | 15 | 1.25 | 175 | 6.75 |
| 5 | 21513 | 0.00920 | 15 | 1.25 | 175 | 14.57 |
| 6 | 21513 | 0.00920 | 15 | 1.25 | 175 | 14.57 |
| 7 | 21513 | 0.00527 | 15 | 1.25 | 175 | 8.77 |

**ATTACHMENT 4**
**COMPUTATION OF LEAD GROUNDWATER CONCENTRATIONS**
**LOWER SUBASE FEASIBILITY STUDY**
**NSB-NLON, GROTON, CONNECTICUT**

| Zone | SPLP (µg/L) | | Dilution Factor | | | Lead Groundwater Concentration (µg/L) | | |
|---|---|---|---|---|---|---|---|---|
| | | | Paved Impervious | Industrial/ Commercial | Residential | Paved Impervious | Industrial/ Commercial | Residential |
| 1 | 3.08 | Mean | 439.87 | 36.11 | 8.02 | 0.007 | 0.085 | 0.38 |
| | 3.50 | Max | 439.87 | 36.11 | 8.02 | 0.008 | 0.097 | 0.44 |
| | | | | | | | | |
| 2 | 0.93 | Mean | 294.19 | 24.46 | 5.69 | 0.003 | 0.038 | 0.16 |
| | 1.50 | Max | 294.19 | 24.46 | 5.69 | 0.005 | 0.061 | 0.26 |
| | | | | | | | | |
| 3 | 171.00 | Mean | 731.21 | 59.42 | 12.68 | 0.234 | 2.878 | 13.48 |
| | 478.00 | Max | 731.21 | 59.42 | 12.68 | 0.654 | 8.045 | **37.69** |
| | | | | | | | | |
| 4 | 46.01 | Mean | 360.57 | 29.77 | 6.75 | 0.128 | 1.546 | 6.81 |
| | 104.00 | Max | 360.57 | 29.77 | 6.75 | 0.288 | 3.494 | **15.40** |
| | | | | | | | | |
| 5 | 4.22 | Mean | 849.23 | 68.86 | 14.57 | 0.005 | 0.061 | 0.29 |
| | 10.10 | Max | 849.23 | 68.86 | 14.57 | 0.012 | 0.147 | 0.69 |
| | | | | | | | | |
| 6 | 1.44 | Mean | 849.23 | 68.86 | 14.57 | 0.002 | 0.021 | 0.10 |
| | 2.90 | Max | 849.23 | 68.86 | 14.57 | 0.003 | 0.042 | 0.20 |
| | | | | | | | | |
| 7 | 8.60 | Mean | 486.89 | 39.87 | 8.77 | 0.018 | 0.216 | 0.98 |
| | 30.10 | Max | 486.89 | 39.87 | 8.77 | 0.062 | 0.755 | 3.43 |

Highlighting denotes exceedance of the 13 µg/L promulgated SWPC for lead.
There are no exceedances of the 810 µg/L Alternative lead SWPC.

## Rich, Corey

**From:** Hamel, Maurice [Maurice.Hamel@ct.gov]
**Sent:** Wednesday, April 28, 2010 9:04 AM
**To:** Gravette, James CIV NAVFAC; Lewis, Mark
**Cc:** Keckler.Kymberlee@epamail.epa.gov; Conant, Richard CIV NAVFAC MIDLANT; Rich, Corey
**Subject:** RE: New London Soil PDI WP

The Remediation Division of the Bureau of Water Protection and Land Reuse ("Department") has reviewed the document titled "Evaluation of Lead Leaching Impact on Groundwater, Lower Subase FS, NSB-NLON, Groton, Connecticut." That document prepared by Tetra-Tech on behalf of the Navy was received by the Department as part of an e-mail on April 12, 2010.

The document presents an initial round of calculations in support of a site-specific dilution factor for use in Zones 1 through 7 of the Lower Submarine Base as part of a proposed Engineered Control. This Engineered Control would utilize and maintain pavement to minimize infiltration through the contaminated soil remaining above the seasonal high groundwater.

Our review of this document has resulted in the following comments:

1. This initial round of calculations will not be approvable, since the infiltration rate used was calculated not based on the hydraulic conductivity of the asphalt, but on the storm water run-off coefficient of asphalt. The assumptions that go into that coefficient would be questionable since they are conservative for a run-off calculation, but are overly liberal for infiltration rates. The proposed 0.02 ft/yr coefficient, when converted to cm/sec, yields an unrealistically small hydraulic conductivity of 1.9 x 10-8 cm/sec, which is two orders of magnitude lower than the value of a HDPE membrane.

A sensitively analysis of the calculations will be needed utilizing alternative hydraulic conductivities of 1 x 10-6 cm/sec and 5 x 10-5 cm/sec.

2. Due to the fact that saturated soil hydraulic conductivity values were only available for four of the seven zones under consideration for calculations in this approach, representative boring logs must be provided to support the assumption that texture (and so hydraulic conductivity) of soils are similar in each zone. (Note that while the fill present at the site is widespread, it is unlikely to extend deep enough below the watertable to be relevant in this soil permeability evaluation.)

3. While the current calculations are based on existing data for SPLP lead from each zone, supplemental testing will be needed to more adequately characterize the lead distribution.

4. Supplemental information will be needed regarding whether lead is the most sensitive constituent of concern for each zone in relation to its potential mobility.

5. The underground utility mapping provided shows that storm drains are present in various portions of each of the zones that would be subject to these Engineered Controls. Please clarify to what extent the impacted soil within these zones is likely to be either laterally discontinuous or limited to depths that are above the storm drainage piping. For those sections of piping which would not be exempted by such clarifications, the potential for leakage from storm drains through the polluted soil will need to be addressed through methods

other than the proposed engineered control. Once the extent of these areas is better clarified, the potential impact from pipe leakage can be estimated.

Maurice Hamel
Remediation Division
CTDEP
(860) 424-3787

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From: Gravette, James CIV NAVFAC [james.gravette@navy.mil]
Sent: Tuesday, April 27, 2010 1:51 PM
To: Lewis, Mark
Cc: Keckler.Kymberlee@epamail.epa.gov; Hamel, Maurice; Conant, Richard CIV NAVFAC MIDLANT; Rich, Corey
Subject: New London Soil PDI WP

Mark,

Not pushing - just seeing where you are with your review of the Soil PDI WP? It was sent out for review on 19 Mar and comments were due 20 Apr. We have received EPA comments, but still need State comments. Please let us know when you think we will receive your comments. Thanks.

Also - can you check with Maurice to see where he is with providing TTNUS with input on the infiltration cals they provided a few weeks ago? Thanks.

Jim

**RESPONSES TO CTDEP's APRIL 28, 2010 COMMENTS ON THE LEAD LEACHING CALCULATION MEMORANDUM FOR THE LOWER SUBASE FEASIBILITY STUDY NAVAL SUBMARINE BASE – NEW LONDON, GROTON, CONNECTICUT**

**Initial Issue: May 6, 2010**

**Comment 1:**

This initial round of calculations will not be approvable, since the infiltration rate used was calculated not based on the hydraulic conductivity of the asphalt, but on the storm water run-off coefficient of asphalt. The assumptions that go into that coefficient would be questionable since they are conservative for a run-off calculation, but are overly liberal for infiltration rates. The proposed 0.02 ft/yr coefficient, when converted to cm/sec, yields an unrealistically small hydraulic conductivity of $1.9 \times 10^{-8}$ cm/sec, which is two orders of magnitude lower than the value of a HDPE membrane.

A sensitively analysis of the calculations will be needed utilizing alternative hydraulic conductivities of $1 \times 10^{-6}$ cm/sec and $5 \times 10^{-5}$ cm/sec.

**Response:**

The methodology used to estimate infiltration rates for the Evaluation of Lead Leaching Impact on Groundwater Memorandum (April 12, 2010) is one of several suggested by EPA in the following document: *Estimation of Infiltration Rate in the Vadose Zone: Application of Selected Mathematical Models, Volume II, EPA/600/R-97/128b, February 1998.* It should be noted that the proposed definition of infiltration was previously accepted by CTDEP as part of the computation of Alternative Pollutant Mobility Criteria (PMCs), as allowed by the Connecticut RSRs, and as presented in Appendix B.1 of the draft final Lower Subase FS (January 2010).

The infiltration rate, as calculated in Attachment 2 of the memorandum, estimates the annual amount of water that would penetrate the ground based upon site specific conditions such as cover type, annual precipitation, and runoff. The estimated infiltration rate will be slightly higher than the actual rate because factors such evapotranspiration, interception, and storage are not able to be considered in the calculation. Hydraulic conductivity (or permeability) measures the absolute water conductivity of a given surface or medium assuming that this surface/medium is constantly submerged. Therefore, the amount of water that infiltrates to the groundwater table must take into consideration, among other factors, the amount of rainfall, amount of runoff, cover conditions, and underlying soil permeability.

Based on Table 4 of the Hydrologic Evaluation of Landfill Performance (HELP) Model, User's Guide for Version 3, United States Army Corps of Engineers, Waterways Experiment Station, the vertical hydraulic conductivity of High Density Polyethylene (HDPE) is $2.0 \times 10^{-13}$ cm/sec. Therefore, the proposed infiltration rate of $1.9 \times 10^{-8}$ cm/sec is not two orders of magnitude lower than the permeability of a typical HDPE membrane, as indicated in the comment, but rather almost five orders of magnitude greater. The typical vertical conductivity of clay is $1 \times 10^{-6}$ cm/sec. Therefore, the permeability/infiltration rate estimated in the calculation for high quality asphalt with no cracks ($1.9 \times 10^{-8}$ cm/sec) appears to be reasonable. The vertical hydraulic conductivity of the underlying sandy soil [$2 \times 10^{-3}$ cm/sec = 0.1 x horizontal hydraulic conductivity of the soil ($2 \times 10^{-2}$ cm/sec)] would not limit the vertical migration of the infiltration passing through the asphalt.

The current calculations include a sensitivity analysis for infiltration rates based on cover conditions. The resulting infiltration rates ranged from 0.02 feet/year ($1.9 \times 10^{-8}$ cm/sec) for hypothetical fully-paved site conditions, to 0.25 feet/year ($2.4 \times 10^{-7}$ cm/sec) for current mostly paved industrial site conditions, to 1.25 feet/year ($1.2 \times 10^{-6}$ cm/sec) for hypothetical mostly unpaved residential conditions. Given that the total annual rainfall for New London is approximately 3.7 feet/year (44 inches/year), infiltration rates greater than 1.25 feet/year (1.2 x

$10^{-6}$ cm/sec) are unlikely. Additional sensitivity analysis does not appear to be warranted. No changes required in response to this comment.

**Comment 2**:

Due to the fact that saturated soil hydraulic conductivity values were only available for four of the seven zones under consideration for calculations in this approach, representative boring logs must be provided to support the assumption that texture (and so hydraulic conductivity) of soils are similar in each zone. (Note that while the fill present at the site is widespread, it is unlikely to extend deep enough below the water table to be relevant in this soil permeability evaluation.).

**Response**:

The use of a common hydraulic conductivity value for all zones that is equal to the geometric average of existing hydraulic conductivity measurements was approved by EPA and CTDEP during preparation of the draft final Lower Subase FS for the calculation of a dilution factor (DF) to compute Alternative PMCs. Therefore, use of that same hydraulic conductivity to estimate leaching characteristics of soil COCs should be acceptable. No changes required in response to this comment.

**Comment 3**:

While the current calculations are based on existing data for SPLP lead from each zone, supplemental testing will be needed to more adequately characterize the lead distribution.

**Response**:

Agree. Currently available SPLP data is somewhat limited and will be significantly supplemented by the upcoming Soil PDI. However, it should be noted that the current SPLP data, which was collected from a majority of the zones, provides a reasonable estimate of leachability concerns and the new data may show similar information.

**Comment 4**:

Supplemental information will be needed regarding whether lead is the most sensitive constituent of concern for each zone in relation to its potential mobility.

**Response**:

Based on the screening of available soil data in the draft final Lower Subase FS against CTDEP PMC, lead is the primary pollutant mobility contaminant of concern. Other contaminants detected in soil that pose potential mobility concerns include PAHs [benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranethene, benzo(k)fluoranthene, chrysene, indeno(1,2,3-cd)pyrene, and phenanthrene] and antimony. Lead was selected for this initial calculation instead of the other contaminants because it was detected most frequently in Lower Subase zones at concentrations greater than PMC. It is agreed that additional calculations will be performed to assess the leachability of other soil COCs after the results of the upcoming Soil PDI are available. The results of the pollutant mobility screening conducted in the FS can be added to the Memorandum.

**Comment 5**:

The underground utility mapping provided shows that storm drains are present in various portions of each of the zones that would be subject to these Engineered Controls. Please clarify to what extent the impacted soil within these zones is likely to be either laterally discontinuous or limited to depths that are above the storm drainage piping. For those sections of piping which would not be exempted by such clarifications, the potential for leakage from storm drains through the polluted soil will need to be addressed through methods other than the proposed engineered control. Once the extent of these areas is better clarified, the potential impact from pipe leakage can be estimated.

**Response**:

As illustrated on the figures of Section 2.0 of the draft final Lower Subase FS, the extent of areas of soil contamination are localized and laterally discontinuous, particularly under the current I/C site use scenario. In addition, areas of soil with concentrations of COCs greater than their I/C DECs and PMCs may occur above or at the depth of utilities and storm drainage lines. The facility has plans to improve the current storm drainage lines that will minimize future infiltration and migration of contaminants through the lines. Additional zone-specific analyses will have to be conducted to completely assess the storm drain issue.

## Rich, Corey

**From:** Lewis, Mark [Mark.Lewis@ct.gov]
**Sent:** Wednesday, May 12, 2010 3:53 PM
**To:** Rich, Corey
**Cc:** 'Conant, Richard CIV NAVFAC MIDLANT'; Hamel, Maurice; Warzecha, William; 'Gravette, James CIV NAVFAC'; 'Keckler.Kymberlee@epamail.epa.gov'; Glorieux, Jean-Luc; Feathers, Kenneth
**Subject:** RE: Technical Meeting - Lead Leaching Memo, NSB-NLON, Groton, CT
**Attachments:** Sub Base - asphalt permeability references.pdf

Corey-

DEP has reviewed the Navy's May 6, 2010 Responses to Comments on the Lead Leaching Calculation, distributed for the conference call on that date for the Groton Submarine Base, along with the EPA document referenced to support the estimates of infiltration.

The approach being used in the Navy's response does not differentiate between permeability and velocity, both of which have units of cm/sec (distance over time). Because of this, the calculations did not take into account a factor for flow through porous media under Darcy's Law, which resulted in the assertion that infiltration rates in the range of 1.25 feet/year could be expected with a permeability of 10-6 cm/sec.

In the attached documents, the leakage rate is inversely proportional to the thickness of the asphalt and directly proportional to the water depth overlying it for a given permeability. Maurice Hamel can provide further clarification regarding these documents if needed.

Those documents also provide surface permeabilities of asphalt ranging from $10^{-7}$ to $5 \times 10^{-2}$ cm/sec, varying according to the percentage of air voids present, matrix texture and proximity to pavement seams.

Therefore, in the context of the clarifications that were provided regarding limiting the pollutant mobility issue to soils above the seasonal high water table, a revised response will be needed for Item #1 from our April 28, 2010 comments.

As we discussed during our April 6, 2010 conference call, this is only an issue where contaminated soil is present above the seasonal high water table, assuming that any NAPL or other continuing sources of pollution have been removed.

DEP would be happy to discuss this issue in a follow- up conference call. Maurice and I are available tomorrow Thursday May 13 from 3:30 pm to 4:30 pm, Monday May 17 from 1:30 pm to 4:30 pm, or Tue. May 18 in the am.

Regards,

Mark

Mark R. Lewis
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phone (860) 424-3768
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mark.lewis@ct.gov

-----Original Message-----
From: Rich, Corey [mailto:Corey.Rich@tetratech.com]
Sent: Wednesday, May 05, 2010 2:10 PM
To: Gravette, James CIV NAVFAC; Lewis, Mark; Keckler.Kymberlee@epamail.epa.gov; Glorieux, Jean-Luc
Cc: Conant, Richard CIV NAVFAC MIDLANT; Hamel, Maurice; Warzecha, William
Subject: Technical Meeting - Lead Leaching Memo, NSB-NLON, Groton, CT

Mark/Maurice,

The attached file contains responses to CTDEP's comments on the Evaluation of Lead Leaching Impact on Groundwater Memorandum. Hopefully we can discuss and resolve any outstanding issues associated with the responses during tomorrow's call. The goal of the call will be to resolve those issues critical to finalizing the Feasibility Study (use of Engineered Controls is potentially viable based on existing data) and identifying those issues that can be addressed later in the Record of Decision after the soil Pre-Design Investigation is complete (use of Engineered Controls are viable based on all data).

Information for the call was distributed yesterday and is provided below.

Regards,

Corey Rich | Senior Project Manager/Civil Engineer
Direct: 412.921.8984 | Main: 412.921.7090 | Fax: 412.921.4040 Corey.Rich@tetratech.com

Tetra Tech NUS, Inc. | Technical Support Services Group
661 Andersen Drive Foster Plaza 7 | Pittsburgh, PA 15220

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-----Original Message-----
From: Rich, Corey
Sent: Tuesday, May 04, 2010 8:28 AM
To: 'Gravette, James CIV NAVFAC'; Lewis, Mark; Keckler.Kymberlee@epamail.epa.gov; Glorieux, Jean-Luc
Cc: Conant, Richard CIV NAVFAC MIDLANT; Hamel, Maurice; Warzecha, William
Subject: RE: New London Soil PDI WP

All,

Per Jim's request, I set up a conference call for Thursday afternoon. The call in information is provided below.

| | |
|---|---|
| Date/Time: | May 06, 2010 at 01:30 PM America/New_York |
| Length: | 60 |
| Meeting ID: | 8984 |
| Phone Number: | 1-866-270-2016 (US Toll Free) |

Corey
-----Original Message-----
From: Gravette, James CIV NAVFAC [mailto:james.gravette@navy.mil]
Sent: Tuesday, May 04, 2010 8:13 AM
To: Lewis, Mark; Keckler.Kymberlee@epamail.epa.gov; Rich, Corey
Cc: Conant, Richard CIV NAVFAC MIDLANT; Hamel, Maurice; Warzecha, William
Subject: RE: New London Soil PDI WP

**RESPONSES TO CTDEP MAY 12, 2010 REBUTTALS**
**LEAD LEACHING MEMORANDUM**
**LOWER SUBASE FEASIBIILTY STUDY**
**NSB-NLON, GROTON, CT**

**INITIAL ISSUE: May 17, 2010**

**Comment 1:**

The approach being used in the Navy's response does not differentiate between permeability and velocity, both of which have units of cm/sec (distance over time). Because of this, the calculations did not take into account a factor for flow through porous media under Darcy's Law, which resulted in the assertion that infiltration rates in the range of 1.25 feet/year could be expected with a permeability of 10-6 cm/sec.

**Response:**

The infiltration rates provided in the calculation and May 6, 2010 response to comment document are provided in units of inches/year or feet/year. The CTDEP, in their April 28, 2010 comment letter, tried to equate infiltration rates to permeabilities; however, they are not directly related. The infiltration rates are not intended to be velocities. The response document expressed infiltration in units requested by CTDEP (cm/sec).

The SCS Curve Numbers used in the calculation take into account the surface conditions (pavement, mixed pavement and grass, grass). As long as the underlying soil does not impede infiltration, whatever passes through the surface will eventually make it to the water table. The goal of the calculation was not to equate approval to a specific type of asphalt or hydraulic conductivity. That approach is typical for landfill cap designs. The goal of the calculation is to estimate quantities of infiltration for various cover types that will mix with groundwater to determine expected groundwater concentrations for each cover type. The resulting concentrations are then used to show compliance or non-compliance with the CTDEP SWPC or Alternative SWPC. If compliance is shown, then the current cover type is adequate to meet CTDEP PMC concerns.

The 1.25 feet/year infiltration rate is for grass covered areas and is reasonable for that type of cover. The permeability of the underlying sandy soil is sufficient to pass this amount of water. Models are available to estimate vertical migration rates of water and/or contaminants through an unsaturated media (vadose zone), but they are not warranted for this project.

**Comment 2:**

In the attached documents, the leakage rate is inversely proportional to the thickness of the asphalt and directly proportional to the water depth overlying it for a given permeability. Maurice Hamel can provide further clarification regarding these documents if needed.

**Response:**

Comment noted. This information is not required for the calculation. The goal of the calculation is defined in the Response to Comment 1.

**Comment 3:**

Those documents also provide surface permeabilities of asphalt ranging from $10^{-7}$ to $5 \times 10^{-2}$ cm/sec, varying according to the percentage of air voids present, matrix texture and proximity to pavement seams.

**Response:**

Comment noted. Pavement design is not the direct focus of this calculation. The greatest impacts on the amount of water infiltrating through the contaminated soil is the amount of surface area covered by asphalt and buildings and the amount of cracks in the asphalt. The current calculation takes this into account by considering three scenarios, one of which includes current conditions at the Lower Subase (i.e., a combination of asphalt and grass cover).

**Comment 4:**

Therefore, in the context of the clarifications that were provided regarding limiting the pollutant mobility issue to soils above the seasonal high water table, a revised response will be needed for Item #1 from our April 28, 2010 comments.

**Response:**

Disagree. The current approach is adequate. A conference call will be conducted to resolve this issue.

**Comment 5:**

As we discussed during our April 6, 2010 conference call, this is only an issue where contaminated soil is present above the seasonal high water table, assuming that any NAPL or other continuing sources of pollution have been removed.

**Response:**

Comment noted. Further clarification is required regarding NAPL. NAPL has been shown to be present in Zone 1 at the Lower Subase. The Navy intends to address the NAPL, but the Navy's remedial strategy for the remaining contaminated soil in Zone 1 would include leaving some of it in place as long as the LUC alternative is appropriate. Because NAPL is not present in other zones, the LUC alternative should be appropriate for contaminated soil as long the Navy and CTDEP can resolve issues on the leaching calculation.

## Rich, Corey

**From:** Lewis, Mark [Mark.Lewis@ct.gov]
**Sent:** Tuesday, May 18, 2010 4:31 PM
**To:** Rich, Corey
**Cc:** 'Conant, Richard CIV NAVFAC MIDLANT'; Hamel, Maurice; Warzecha, William; 'Gravette, James CIV NAVFAC'; 'Keckler.Kymberlee@epamail.epa.gov'; Feathers, Kenneth; Logan, Joe
**Subject:** RE: Technical Meeting - Lead Leaching Memo, NSB-NLON, Groton, CT

Corey-

The following is DEP's response to your e- mail dated May 17, 2010. I hope this will make tomorrow's conference call more productive.

In light of the continued confusion about what the Department's goal is in relation to the leachability of lead in unsaturated soil in the lower sub base, we would like to clarify what is needed for granting the desired variance under the Remediation Standard Regulations (RSRs).

The use of infiltration rates as presented in the May 6th and 17th responses focuses on calculating an alternative dilution factor to determine the compliance with the surface water protection criteria, stating "If compliance is shown, then the current cover type is adequate to meet CTDEP PMC." However, water quality compliance is only a part of the technical justification needed for the granting of a variance to the pollutant mobility criteria (PMC) exceedances for lead. Since, under section 22a-133k-2 of the RSRs, the context of the regulatory framework of addressing the leachability of residual contamination in the soil must include the concept of an Engineered Control. The use of calculations to show that the various applicable water quality criteria are being met is part of the justification for the use of this engineering alternative, but does not in itself negate the need to have the engineered control minimizing infiltration.

The variance being considered for the site under subsection 22a-133k-2(f)(2)(B)(i) of the RSRs is an Engineered Control Cap "designed and constructed ... to minimize the migration of liquids through soil, to function with minimum maintenance [and] to promote drainage". It would have a permeability as "otherwise specified by the Commissioner in writing."

Therefore, the goal of this exercise is to evaluate the option of achieving compliance with PMC through the use of pavement to limit infiltration through unsaturated soils. This would in fact include specifying a minimum hydraulic conductivity that will be maintained for the asphalt. That conductivity would be evaluated in the context of the default cap permeability is $10^{-6}$ cm/sec.

In the Department's April 28th e-mail, we had specifically requested "A sensitively analysis of the calculations will be needed utilizing alternative hydraulic conductivities of $1 \times 10^{-6}$ cm/sec and $5 \times 10^{-5}$ cm/sec." It is in this context that the mass loading of contaminants on groundwater is to be evaluated and compared to water quality criteria. Existing water quality data would be used to support those calculations.

The use of this approach is based on the assumption that prudent remedial actions have been implemented and that no human or ecological receptors were determined to be at risk downgradient of the release area.

I think it might be helpful also to outline the overall process. The finished product from the Navy's calculations will be an infiltration rate through the pavement based on the pavement's permeability. The Navy will use that infiltration rate to calculate a mass loading of lead using SPLP data. In the calculations the Navy

will use a mixing zone depth of 15 feet or whatever value the geology suggests. The Navy will use this for comparison with the groundwater protection criterion and the surface water protection criterion.

I'm looking forward to tomorrow's call.

Regards,

Mark

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---

**From:** Rich, Corey [mailto:Corey.Rich@tetratech.com]
**Sent:** Monday, May 17, 2010 4:03 PM
**To:** Lewis, Mark
**Cc:** 'Conant, Richard CIV NAVFAC MIDLANT'; Hamel, Maurice; Warzecha, William; 'Gravette, James CIV NAVFAC'; 'Keckler.Kymberlee@epamail.epa.gov'; Feathers, Kenneth; Logan, Joe
**Subject:** RE: Technical Meeting - Lead Leaching Memo, NSB-NLON, Groton, CT

Mark,

Attached is the response-to-comment document mentioned in my previous email.

I talked with Jim and Wednesday (5/19/10) afternoon would work best for him. I am also available that day. Does a 1:30 PM conference call work for everyone?

Regards,
Corey

---

**From:** Lewis, Mark [mailto:Mark.Lewis@ct.gov]
**Sent:** Monday, May 17, 2010 3:03 PM
**To:** Rich, Corey
**Cc:** 'Conant, Richard CIV NAVFAC MIDLANT'; Hamel, Maurice; Warzecha, William; 'Gravette, James CIV NAVFAC'; 'Keckler.Kymberlee@epamail.epa.gov'; Glorieux, Jean-Luc; Feathers, Kenneth
**Subject:** RE: Technical Meeting - Lead Leaching Memo, NSB-NLON, Groton, CT

Corey-

A call tomorrow won't give us enough time to digest your response. Maurice and I are available Wednesday afternoon or Thursday morning to do a conference call. DEP appreciates that the Navy wants to resolve this issue ASAP. However, we need some time to give your response due consideration.

Regards,

Mark

# APPENDIX D.2

# GROUNDWATER CONCEPTUAL DESIGN CALCULATIONS

## D.2.1 - IN-SITU BIOREMEDIATION

## D.2.2 - IN-SITU CHEMICAL PRECIPITATION

## D.2.3 - EXTRACTION AND TREATMENT

# APPENDIX D.2.1

## IN-SITU BIOREMEDIATION

D.2.1.1 - GROUNDWATER IN-SITU BIOREMEDIATION
D.2.1.2 - ETEC LITERATURE
D.2.1.3 - ETEC PROPOSAL FOR ZONE 1 TPH
D.2.1.4 - ETEC PROPOSAL FOR ZONE 4 TPH

## 1.0 DESIGN ASSUMPTIONS

The following design assumptions are made based upon available site characterization and information for other similar projects for the in-situ enhanced bioremediation of total petroleum hydrocarbons (TPH) in groundwater:

- The estimated surface areas and volumes of the Lower Subase points of groundwater contamination and the estimated quantities of TPH contained in these points are computed in Appendix C.6.
- The TPH in the Lower Subase roundwater can be effectively biodegraded under aerobic conditions with the help of injection of dissolved and gaseous oxygen and specialized bacterial cultures into these points of groundwater contamination by means of a groundwater recycle stream (extraction/re-injection).
- The Dissolved Oxygen In situ Treatment (DO-IT™) technology marketed by ETEC, LLC has been tentatively selected as the process of choice. Attached technical literature provides more information about this process.
- the DO-IT™ technology would also result in the oxidation, precipitation, and immobilization of the arsenic and copper .

## 2.0 TPH QUANTITY TO BE REMOVED

### 2.1 Zone 1 Copper/TPH Point of Groundwater Contamination (Alternative GW-1.3)

As per the computations presented in Appendix C.6, it is estimated that the Zone 1 copper/TPH point of groundwater contamination contains 23.5 pounds of TPH dissolved in the groundwater and 5,274 pounds of TPH in the soil of the smear zone for a total of 5,300 pounds of TPH.

### 2.2 Zone 4 Arsenic/TPH Points of Groundwater Contamination (Alternative GW-4.3)

As per the computations presented in Appendix C.6, it is estimated that the area of TPH PRG exceedance in the Zone 4 arsenic/TPH points of groundwater contamination contains 7.9 pounds of TPH dissolved in the groundwater and approximately 1,023 pounds of TPH in the soil of the smear zone for a total of 1,030 pounds of TPH.

## 3.0 DO-IT™ SYSTEMS (see attached ETEC proposals)

### 3.1 Zone 1 Copper/TPH Point of Groundwater Contamination (Alternative GW-1.3)

Oxygen requirement:
5,300 lbs TPH * 3.0 lbs $O_2$/lb TPH = 15,900 lbs $O_2$

As per attached ETEC proposal, the proposed SuperOx™ Model 20A system can deliver approximately 325 lbs/month of dissolved $O_2$, 1,584 lbs/month of supplemental gaseous $O_2$, and 500 lbs/month of CBN™ nutrient blend with an electron acceptor/oxygen equivalency of 61%.

Total proposed oxygen/electron acceptor delivery:
325 + 1,584 + (500 * 0.61) = 2,214 lbs/month

Anticipated remediation time:
15,900 lbs / 2,214 lbs/month = 7.2 months, say 8 months

### 3.2 Zone 4 Arsenic/TPH Points of Groundwater Contamination (Alternative GW-4.3)

Oxygen requirement:
1,030 lbs TPH * 3.0 lbs $O_2$/lb TPH = 3,090 lbs $O_2$

As per attached ETEC proposal, the proposed SuperOx™ Model 20A system can deliver approximately 325 lbs/month of dissolved $O_2$, 1,584 lbs/month of supplemental gaseous $O_2$, and 300 lbs/month of CBN™ nutrient blend with an electron acceptor/oxygen equivalency of 61%.

Total proposed oxygen/electron acceptor delivery:
325 + 1,584 + (300 * 0.61) = 2,092 lbs/month

Anticipated remediation time:
3,090 lbs / 2,092 lbs/month = 1.5 months, say 2 months

## 4.0 ADDITIONAL EQUIPMENT

In addition to the SuperOx™ units, each DO-IT™ system would require the following:

- Four (4) 4-inch diameter extraction wells installed along the downgradient edge of the points of groundwater contamination and screened in the capillary zone (9 to 12 ft bgs in Zone 1, 4 to 6 ft bgs in Zone 4).
- Four (4) 5 gpm submersible pumps installed in the extraction wells.
- Eight (8) 4-inch diameter re-injection wells installed along the upgradient edge of the points of groundwater contamination and screened in the vadose zone (5 ft bgs in Zone 1, 2 ft bgs in Zone 4).
- Interconnecting piping (1½-inch PVC or PE) between the extraction wells, the SuperOx™ units, and the re-injection wells (approximately 400 ft)

**Attachments**:

ETEC, LLC technical literature
ETEC, LLC proposals

Environmental Technologies

# Key Aspects of the DO-IT™ Process



***The DO-IT™ process addresses the critical governing principles that control the success or failure of any in situ soil and groundwater remediation effort. These principles are discussed below in greater detail.***

## Mass Balance

All remediation processes come down to mass balance. How many pounds or kilograms of a contaminant exists in the subsurface, and how much of this mass can be removed by the proposed remediation system? With aerobic bioremediation, the mass balance is a function of the stoichiometry of the oxidation-reduction reactions that govern the biological utilization of a particular compound. For example, oxidation-reduction reactions for the aerobic utilization of benzene are as follows:

- Oxidation Reaction: $C_6H_6 + 12\ H_2O \rightarrow 6\ CO_2 + 30\ H^+ + 30\ e^-$
- Reduction Reaction: $7.5\ O_2 + 30\ H^+ + 30\ e^- \rightarrow 15\ H_2O$
- *Overall Reaction: $C_6H_6 + 7.5\ O_2 \rightarrow 6\ CO_2 + 3\ H_2O$*

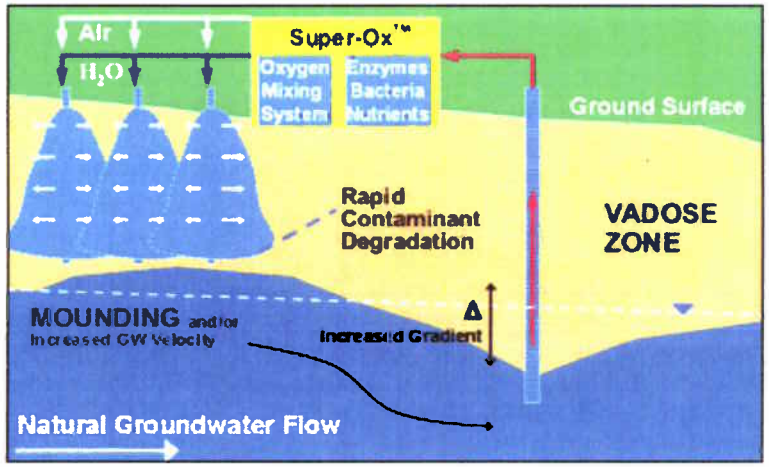
The $O_2$ requirement for this reaction is that 1 mole of $C_6H_6$ requires 7.5 moles of $O_2$. Converting to the appropriate mass ratio results in the following:

- 1 unit $C_6H_6$ : 7.5 x (32/78) units of $O_2$, or *1 unit $C_6H_6$ requires 3 units of $O_2$*

Therefore, aerobic biological degradation requires 3 pounds of dissolved oxygen to degrade 1 pound of benzene in the subsurface. Our Super-Ox™ systems fully address this need for large masses of dissolved oxygen. For example, by oxygenating a 10-gpm flow of water with 45 mg/L of dissolved oxygen, a Super-Ox™ unit will deliver approximately *6 pounds of dissolved oxygen* to the subsurface *per day*, or close to *200 lbs. of dissolved oxygen per month!!* On an annual basis, this would support aerobic biological degradation of over 750 lbs. of benzene.

## Hydraulic Influence

By utilizing our Super-Ox™ equipment in combination with localized injection and extraction wells, *artificial groundwater gradients can be produced within the plume area to induce circulation of biologically-active treatment water through the groundwater and smear-zone soil.* By

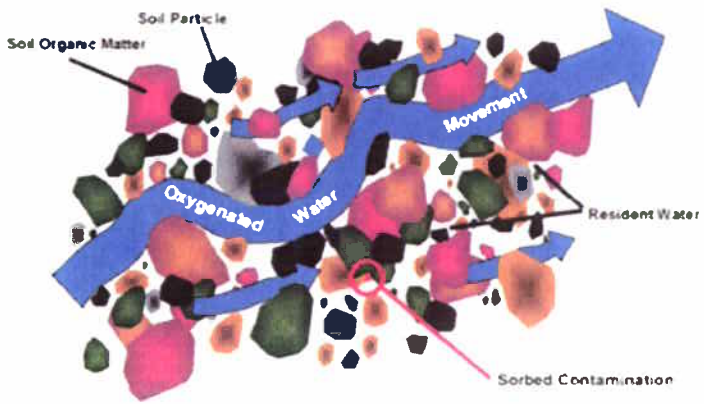



placing injection and extraction wells at specific locations, individual "circulation cells" can be created throughout a plume zone (i.e. source area, sidegradient, downgradient, etc.), resulting in:

- Optimized dissolved oxygen transfer
- Hydraulic plume control
- Induced groundwater gradients via GW mounding/drawdown

The importance of hydraulic influence as part of a groundwater remediation process cannot be overstated...groundwater management results in long-term flexibility, accelerated cleanup, and shorter remediation timeframes.

## Dissolution & Desorption



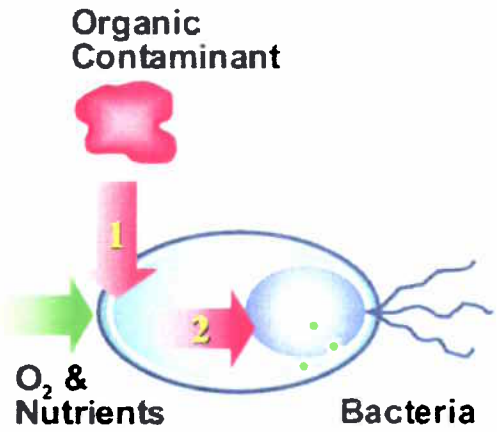

Redrawn from Suthersan & Payne 2005

Contaminants in the subsurface partition into various phases depending upon their specific physical/chemical characteristics. However, contaminants in the adsorbed phase (i.e. the constituents that are bound to the organic soil fraction) usually represents over 70% of the total subsurface mass. *Successful in situ bioremediation must address the adsorbed-phase mass in conjunction with the dissolved-phase constituents to achieve site closure.* By constantly replacing and recirculating groundwater within the soil matrix, the DO-IT™ process accelerates dissolution of sorbed constituents via:

- Maximized and continuous smear-zone soil contact
- Enhanced delivery of biological products

By forcing sorbed constituents into solution, they are rendered bio-available and susceptible to subsequent biological degradation. *This hydraulically-assisted dissolution process ensures treatment of both sorbed- and dissolved-phase contaminant mass.*

## Complete Biological Process




At a minimum, successful bioremediation requires:

- Bacterial species that are capable of metabolizing the contaminant of concern
- Availability of specific nutrients (N, P, K, etc.) to support growth of these bacterial species
- Abundance of electron acceptors (i.e. dissolved oxygen and secondary electron acceptors)

If any one of these requirements is not fulfilled, bioremediation will inhibited, either partially or completely.

The DO-IT™ process addresses each of these governing principles by providing proven microbial species (PetroZyme™ bundle), macro- and micro-nutrients for ongoing microbial growth (CBN™), and large masses of dissolved oxygen (Super-Ox™) throughout a plume zone.

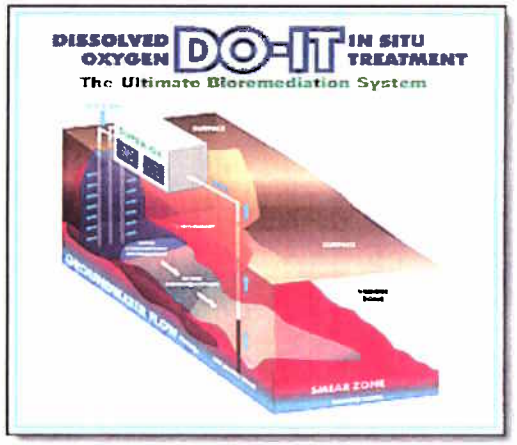
Environmental Technologies

# Aerobic Bioremedation

## Processes & Products

ETEC Home
In Situ Technologies
Aerobic Bioremediation »
Anaerobic Dechlorination »
Chemical Oxidation »
Ex Situ Landfarming
Services
Case Studies
Knowledge Center
Partners

## Dissolved Oxygen In situ Treatment (DO-IT™) Process




The DO-IT™ process is a revolutionary groundwater recirculation system that combines our specialized Super-Ox™ oxygenation platform with powerful biological enhancements.

Super Ox™ — Super-Ox™ Oxygenation Equipment

BioPro™ BIOLOGICAL PRODUCTS — Advanced Biological Enhancements

## Advanced Biological Enhancements

BioPro™ BIOLOGICAL PRODUCTS

ETEC manufactures a series of specific biological enhancements that dramatically accelerate the degradation of petroleum, chlorinated, and other organic compounds. These products have been successfully used in conjunction with traditional remediation systems (AS/SVE) and as a stand-alone treatment solution.

*Our biological products are also very effective for cleanup of residual contaminants when applied to excavation cavities. Click here for an emergency response excavation case study.*

## Custom Equipment Systems

ETEC produces a small number of customized biovent, biosparge, and automated injection systems to meet our clients' site-specific remediation needs.

Environmental Technologies

# Super-Ox™

## In Situ Oxygenation Equipment

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Click here for Super-Ox ™ models and specifications

Super Ox™

Oxygen is the primary limiting factor for most aerobic bioremediation efforts. For example, petroleum compounds typically require a 3:1 stoichiometric ratio of oxygen:petroleum for aerobic biological degradation. Therefore, aerobic biological contaminant removal requires the delivery of large masses of oxygen to the subsurface. Unfortunately, when dealing with groundwater contamination, the aqueous solubility of oxygen is fairly limited, and most conventional remediation systems (i.e. air or oxygen sparging) cannot deliver enough dissolved oxygen to allow significant biological degradation to occur.

It is for these reasons that ETEC developed the Super-Ox™ system, the most effective subsurface oxgyenation equipment available today. These automated units consistently process and *infuse extracted groundwater with 40-ppm concentrations of dissolved oxygen,* then amend this oxygenated water with necessary biological enhancements prior to subsurface re-injection. This approach provides incredibly fast and cost-effective site-wide remediation.

| Technology | Max. DO Conc. (ppm) | DO Mass Delivery (lb./day) | Cost ($/lb. DO) |
|---|---|---|---|
| Super-Ox™ | 45+ | 2.5-20 | $10-$35 |

For example, at a 10-gpm flowrate, the Super-Ox™

system will deliver approximately 6 lbs. of dissolved oxygen in a single day. This adds up to over 180 lbs. of dissolved oxygen per month, or over 2,000 lbs. per year!

At a 20-gpm rate, this mass will be doubled, with an annual delivery of over 4,000 lbs. of dissolved oxygen!

| | | | |
|---|---|---|---|
| Biosparge | 8-10 | 0.001-0.1 | $350 |
| $O_2$ Sparge | 15-20 | 0.003-0.3 | $170 |
| iSOC | 50-100 | 0.3 | $185 |
| Iso-Gen | 15-25 | 0.5 | $100 |
| $O_2$ Release Compounds | 15-25 | 0.05-0.5 | $120 |

(1) Assumes 10 sparging points, med. sand ($10^2$ gal./day/$ft^2$), GW gradient of 0.001-0.01

(2) Assumes 1,000 lbs. at $10/lb.

(3) Assumes 2-year treatment timeframe

## *Use the Super-Ox™ equipment to deliver...*

- Large masses of oxygen
- Hydrocarbon-degrading bacteria
- Enzymes
- Nutrients
- Biosurfactants

The Super-Ox™ systems are automated, programmable equipment platforms that include an integrated oxygen generator and patented thermodynamic mixing system to produce 40-ppm concentrations of stable dissolved oxygen. Click here to learn more about the principles of aqueous-phase dissolved oxygen transfer.

The Super-Ox™ equipment is an integral component of our aerobic DO-IT™ bioremediation process. Click here to learn more about the unique DO-IT™ process for groundwater remediation.

Environmental Technologies

# Biological Enhancements

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## BioPro™ Biological Enhancement Products

***ETEC's biological enhancements are formulated for the degradation of petroleum compounds and chlorinated solvents. Click on the descriptions below for more information.***

### Products for Petroleum Degradation

| | |
|---|---|
| PetroZyme™ Bundle | This unique formulation of bacteria, enzyme enhancements, and micro-nutrients is ideal for accelerated degradation of MTBE and other gasoline-range contaminants. |
| PetroBac™ Bundle | We recommend PetroBac™ for petroleum hydrocarbon bioremediation projects impacted by contaminants ranging from gasoline to heating oil. Also recommended for bio-augmentation of existing air sparge or biosparge systems. |
| CBN™/ NutriMax™ | CBN™/NutriMax™ is a balanced blend of macro- and micro-nutrients that are necessary for optimal microbial growth and activity. |
| PetroSolv™ | PetroSolv™ is a completely biodegradable non-ionic sufactant specially-formulated for soil flushing and enhanced free product recovery. |
| BioStimulator™ | BioStimulator™ is a specialized formulation of bacteria, nutrients, and biosurfactant for one-step biological enhancement. Intended primarily as a spray-on application for surface spills or for small-scale application to the subsurface. |

# Products for Anaerobic Reductive Dechlorination

**CarBstrate-12™**

CarBstrate-12™ is a soluble, nutrient-amended electron donor that is easily transported through groundwater formations to maximize plume-wide dechlorination at an ultra-competitive price.

**NutriChlor™**

NutriChlor™ is a blend of inorganic compounds and trace metals that are critical for growth of sensitive anaerobic microbial species, especially those that play important roles in the reductive dechlorination process. Intended for use with any electron donor substrate (i.e. lactate, edible oils, etc.).

***IMPORTANT - Please note that even the best biological products can only be successful if they are applied correctly and under the right conditions. Our trained staff works directly with you to determine the most appropriate biological treatment scenario for your projects.***

6635 N.E. 59th Place
Portland, Oregon 97218
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www.etecllc.com

October 30, 2009

Mr. Jean-Luc Glorieux
Tetra Tech NUS, Inc.
Pittsburgh, PA

**RE: PROPOSAL FOR DISSOLVED OXYGEN IN SITU TREATMENT (DO-IT™)**
**SUB-BASE ZONE #1 – GROTON, CONNECTICUT**

Dear Jean-Luc,

This quote includes budgetary costs for biological product enhancement and recommendations for application to impacted soil/groundwater. Based on the information provided by Tetra Tech, our understanding of the site includes the following:

- A diesel and #2 fuel oil leak from an UST/AST impact the soil and groundwater onsite
- No free-product is present in the area, but smear-zone soil contamination is estimated at 5,200 lbs. TPH
- Soil at 13MW2 contained 14,000 mg/kg TPH historically
- Soil at 13MW3 is contained 11,000 mg/kg TPH historically
- Groundwater from FOMW14 contained 16,000 ug/L TPH historically
- The proposed treatment area is approximately 100 feet in diameter, or 7,850 square feet
- DTW is approximately 4-7 feet bgs
- The soil onsite is primarily gravel and sand
- The treatment area is influenced by tidal action
- A consistent 20+ gpm extraction rate is assumed
- This proposal is based on the use of a 20-gpm DO-IT™ system for treatment of the GW and smear-zone soils

This data and the associated assumptions were used to determine appropriate biological product and equipment requirements, and to provide recommendations for site-specific application.

## DO-IT™ Process Description

Our DO-IT™ process is a complete bioremediation system that uses proprietary biological products in combination with a specialized in situ oxygenation equipment platform to obtain rapid reduction of diesel, fuel oil, and gasoline contaminants. It is our philosophy to add all of the components necessary for successful bioremediation, including enzymes, bacteria, nutrients, and an abundant supply of dissolved oxygen. To maximize oxygen supply, we utilize an oxygenation approach that differs from standard methods (air sparging, $O_2$ sparging, etc.). Our Super-Ox™ oxygenation units process water through a specialized pure-oxygen mixing system to generate greater than 40 ppm dissolved oxygen concentrations in a water stream. This oxygenated water stream is then injected into the subsurface to support high rates of microbial activity.

The DO-IT™ process works best in a closed-loop system, where groundwater is extracted, oxygenated, biologically-amended, and then re-injected into the subsurface. The recirculation of oxygenated water allows us to deliver daily DO masses ranging from 1 lb. per day to as much as 20 lbs. per day – this is order-of-magnitude higher masses of DO than any other oxygenation system available. For example, with a 10-gpm recirculation rate, the DO-IT™ system will deliver approximately ***5 pounds of dissolved oxygen*** to the subsurface ***per day***, or close to ***200 lbs. of dissolved oxygen per month***!!

**Equipment Recommendations**

For equipment, we recommend the Super-Ox™ Model 20-Automatic (20-A) for this site. This system will receive water (from the extraction system), oxygenate it to >40 ppm of dissolved oxygen, amend it with nutrients and bacteria, then re-inject into the subsurface. The 20-A system will be equipped with a 6-station injection manifold; each station will connect to one or more of the installed injection wells. The 20-A system is capable of a maximum process rate of 20 gallons per minute (gpm) that can be adjusted to match the extraction rate, if desired. These systems generate stable, high concentrations of dissolved oxygen (>40 ppm) in the process water using our unique pure oxygen mixing system. The 20-A equipment enclosure has an 8' x 12' (typically, varies upon unit availability) footprint, is fully weatherproof, contains double doors for walk-in access to all equipment, and includes a heating and fan system to control internal temperatures. The Model 20-A is an automated, programmable, turnkey bioremediation system requiring 1-phase, 220 Volt (4-wire), 80 Amp power service for operation.

Additional info and specifications for this system is available at www.etecllc.com. ***Since we rent the Super-Ox™ equipment, we supply replacement parts (at no cost) for damaged equipment (pumps, valves, etc.) on the Super-Ox™ system throughout the rental period.***

**Product Recommendations**

For biological products at this site, we recommend our TPH Bacterial Consortium (EZT-A2™) and PetroSolv™ biosurfactant. Our CBN™ nutrient blend will be also be needed. These products work together to effectively degrade diesel and fuel oil.

The application of the biological products will perform three critical functions, including:

1. Supply of a large population of pre-acclimated bacteria to optimize initial growth of a healthy, in situ, hydrocarbon-degrading microbial population.
2. Maximizing contact between the contaminants and the bacteria. Bioremediation is a contact technology – the bacteria must physically contact the diesel and fuel oil food source and the electron acceptors (oxygen, nitrate, sulfate) to biochemically oxidize the petroleum to $CO_2$ and water.
3. Supplying critical nutrients like nitrogen, phosphorus, and potassium to support ongoing biological growth. The nitrogen compounds will also act as a secondary electron acceptor to ensure continuous in situ contaminant degradation during temporary absences of dissolved oxygen.

**Site Application**

The DO-IT™ technology is a very effective soil and groundwater treatment system, especially when utilized in a closed-loop remediation process. Advantages to this approach include hydraulic control of the leading plume edge, treatment of both dissolved and adsorbed contamination, and maximized contact between the treatment water and the contaminants. Biological enhancements are efficiently distributed, allowing for smaller mixing volumes, and therefore less onsite time and labor than slug injections.

By utilizing a series of injection points/wells in combination with extraction wells, artificial groundwater gradients can be produced within the on-site plume to induce cycling of biologically-active treatment water through the plume zone. The general approach includes the following:

1. Install a series of 4-inch extraction wells (4-6 wells) along the downgradient edge of the proposed treatment area. These wells will provide process water for the DO-IT™ system. Installation of the wells in this area will provide hydraulic capture of migrating groundwater, collect any

possible free-product, and encourage movement of the oxygenated treatment water throughout the site. The biosurfactant product applied will enhance diesel/fuel oil de-sorption and mobilization. If free-product is present, top-loading pneumatic pumps should be utilized to capture free-product. Otherwise, electric submersible pumps can be used to collect impacted groundwater.

2. Following extraction, the groundwater can be processed through a oil/water separator to collect free-product, if present. Additional treatment of groundwater prior to re-injection can be achieved by activated carbon.
3. Install a series of 4-inch vertical injection wells (8-10) throughout the upgradient portion of the treatment area. These wells should be screened above the groundwater interface to allow for application to the upper smear-zone soils. The trenching connecting the DO-IT™ system to the injection wells can also have a horizontal injection piping installed in the same trench. Oxygenated treatment water applied to this trench will percolate through the vadose soils into the upper impacted smear-zone soils.

**Electron Acceptor Mass Balance**

Tetra Tech estimates that 5,200 lbs. of TPH resides in the soil within the Zone #1 treatment area. This estimated TPH mass is significant, and a large supply of electron acceptor mass will be necessary to biologically degrade enough of the TPH mass to achieve regulatory groundwater goals of 2.5 mg/L. Using a solely biological degradation approach, the ability to deliver the necessary electron acceptor mass become the limiting factor. ETEC has designed the DO-IT™ system to deliver as much dissolved oxygen and secondary electron acceptors as possible to overcome this limitation.

Utilizing a 3:1 ratio of 3 lbs. of oxygen necessary to degrade 1 lb. of TPH, the required oxygen mass is:

3 lbs. oxygen * 5,200 lbs. TPH = **15,600 lbs. oxygen**

**Electron Acceptor Delivery**

Oxygen delivery at the site will be dependent upon the extraction/injection rate achievable at the site. With a consistent extraction/injection rate, the Super-Ox™ Model 20-A should inject more than 28,800 gallons of oxygenated water each day (~20-gpm), or more than 864,000 gallons per month. The calculation below outlines the dissolved oxygen delivery of the Super-Ox™ equipment per month.

864,000 gal./month * 3.79 L/gal. = 3,275,000 L/month

3,275,000 L/month * >45 mg/L DO / 454,000 mg/1 lb. = **>325 lbs. DO/month**

As part of the dissolved oxygen mixing process, more oxygen gas must be supplied than can be dissolved into the water stream. This oxygen gas is carried with the water stream to the injection wells where it is transferred to the groundwater.

$\frac{PV}{RT}$ = moles $O_2$ P = 2.72 atm V = 283 L $O_2$/hour
R = 0.08206 L*atm/mol*K T = 298 K

(2.72 atm * 283 L $O_2$) / (0.08206 L*atm/mol*K * 298 K) = 31.5 moles $O_2$ / hour

31.5 moles $O_2$/hour * 32 g/mol $O_2$ = 1,008 g $O_2$/hour

1,008 g $O_2$/hour / 454 g/lb. = 2.2 lbs. $O_2$/hour * 24 hours/day = 52.8 lbs. $O_2$/day

52.8 lbs. $O_2$/day * 30 days/month = **1,584 lbs. $O_2$/month**

In addition to the oxygen mass delivered by the DO-IT™ system, a large mass of secondary electron acceptors will also need to be supplied to overcome the electron acceptor limiting conditions. Our

CBN™ nutrient blend contains ~60% electron acceptors. For this site we would recommend 2,000 lbs. be applied initially (1,200 lbs. of electron acceptors) and approximately 1,000 lbs. per month (600 lbs. of electron acceptors). This combination application of oxygen and secondary electron acceptors will maximize the electron acceptor delivery to the site. In a 24-month treatment, the DO-IT™ system will have applied more than 51,400 lbs. of electron acceptors to the site.

In comparison to a chemical based oxygen-release product which contains at most 17% oxygen, in order to deliver the same 51,400 lbs. of electron acceptors, over 300,000 lbs. would need to be applied to the site. At $8/lb, this represents a cost of $2,400,000. Also, the application of a solely oxygen releasing product would not address nitrogen, phosphorus, and micro-nutrient limiting conditions that will certainly inhibit the microbial activity at the site.

With either application, to rely solely on biological degradation to remediate the mass of TPH onsite will be difficult. That is why incorporating physical removal of any available free-product and contaminated groundwater into the treatment will be important. The DO-IT™ system is designed to work with a pump & treat system to enhance contaminant recovery using groundwater recirculation and biosurfactants to increase contaminant mobility.

## Monitoring Discussion

For the treatment, we recommend Tetra Tech collect field data as well as nutrient and plate count data. Tetra Tech can collect the field data (temperature, pH, DO, ORP, etc.) with their in-house meters, and analysis costs for a limited-nutrient suite and a hydrocarbon-degrading plate count are $140.00 per GW sample. Samples should be collected from the most impacted wells (FOMW-14, FOMW-13, and a downgradient extraction well). This data will be used to evaluate the effectiveness of the treatment activities, and will provide information on how to maximize efficiency.

**Cost Estimate (System Rental)**

The table below summarizes biological product, equipment rental, analytical, and shipping costs.

| Item | Cost |
|---|---|
| ***Initial Costs*** | |
| A2™ Bacterial Consortium – Initial Supply (25 gallons) | $2,500.00 |
| PetroSolv™ Biosurfactant – Initial Supply (50 gallons) | $5,000.00 |
| CBN™ Nutrients – Initial Supply (2,000 lbs.) | $5,000.00 |
| Super-Ox™ 20-A – Monthly Rental | $5,000.00 |
| Nutrient & Plate Count Analysis (3 samples @ $140 per sample) | $420.00 |
| Installation, Set-up, and Training (5-days) | $5,000.00 |
| Shipping (estimated) | $5,500.00 |
| **INITIAL COST** | **$28,420.00** |
| ***Monthly Costs*** | |
| A2™ Bacterial Consortium – Initial Supply (15 gallons) | $1,500.00 |
| PetroSolv™ Biosurfactant – Initial Supply (30 gallons) | $3,000.00 |
| CBN™ Nutrients – Total Supply (1,000 lbs.) | $2,500.00 |
| Super-Ox™ 20-A – Monthly Rental | $5,000.00 |
| Nutrient & Plate Count Analysis (3 samples @ $140 per sample) | $420.00 |
| Shipping (estimated) | $750.00 |
| **MONTHLY COST** | **$13,170.00** |
| **24-MONTH TREATMENT TOTAL** | **$331,330.00** |
| ***Final Costs*** | |
| Return Shipment | **$3,500.00** |
| | |
| ***Out-of-Scope Costs*** | |
| Well Installation | **???** |
| Trenching, piping | **???** |
| Pneumatic pumps, compressor, panel | **???** |
| Oil/water separator, activated carbon | **???** |
| Electrical | **???** |

We believe that a 24-month biological enhancement program will reduce free-product and contaminant concentrations in the groundwater onsite. Due to the large mass of adsorbed contaminants, additional ongoing treatment may be necessary. After a 24-month treatment, it may be more cost-effective to purchase the unit rather than continue leasing the system. The cost table below contains an option for purchase of the 20-A equipment system. Ongoing biological product application will be necessary to achieve the desired results.

**Cost Estimate (System Purchase)**

The table below summarizes biological product, equipment purchase, analytical, and shipping costs.

| Item | Cost |
|---|---|
| ***Initial Costs*** | |
| A2™ Bacterial Consortium – Initial Supply (25 gallons) | $2,500.00 |
| PetroSolv™ Biosurfactant – Initial Supply (50 gallons) | $5,000.00 |
| CBN™ Nutrients – Total Supply (2,000 lbs.) | $5,000.00 |
| Super-Ox™ 20-A – Purchase | $150,000.00 |
| Nutrient & Plate Count Analysis (3 samples @ $140 per sample) | $420.00 |
| Installation, Set-up, and Training (5-days) | $5,000.00 |
| Onsite Maintenance Visits (4 in 2 years) | $20,000.00 |
| Data Interpretation / Support (2 years) | $5,000.00 |
| Shipping (estimated) | $5,500.00 |
| **INITIAL COST** | **$198,420.00** |
| ***Monthly Costs*** | |
| A2™ Bacterial Consortium – Initial Supply (15 gallons) | $1,500.00 |
| PetroSolv™ Biosurfactant – Initial Supply (30 gallons) | $3,000.00 |
| CBN™ Nutrients – Total Supply (1,000 lbs.) | $2,500.00 |
| Nutrient & Plate Count Analysis (3 samples @ $140 per sample) | $420.00 |
| Shipping (estimated) | $750.00 |
| **MONTHLY COST** | **$8,170.00** |
| **24-MONTH TREATMENT TOTAL** | **$386,330.00** |
| ***Ongoing Yearly Support*** | |
| 2 Onsite Maintenance Visits | **$10,000.00** |
| Data Interpretation / Support | **$2,500.00** |
| **ONGOING YEARLY COSTS** | **$110,540.00** |
| | |
| ***Out-of-Scope Costs*** | |
| Well Installation | **???** |
| Trenching, piping | **???** |
| Pneumatic pumps, compressor, panel | **???** |
| Oil/water separator, activated carbon | **???** |
| Electrical | **???** |

This is a budgetary proposal, and is for use in determining the feasibility of treatment at the site. This proposal will need to be revisited during the writing of the RAP when more data is available. Payment terms and conditions will need to be agreed upon at that time. Please review the summarized costs and call me at 971-222-3680 with any questions or comments. Thank you for the opportunity, and we look forward to further discussion with you on this project.

Respectfully,

**ETEC, LLC**

_____

Eric Bueltel
Project Manager

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Portland, Oregon 97218
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www.etecllc.com

October 30th, 2009

Mr. Jean-Luc Glorieux
Tetra Tech NUS, Inc.
Pittsburgh, PA

**RE: PROPOSAL FOR DISSOLVED OXYGEN IN SITU TREATMENT (DO-IT™)**
**SUB-BASE ZONE #4 – GROTON, CONNECTICUT**

Dear Jean-Luc,

This quote includes budgetary costs for biological product enhancement and recommendations for application to impacted soil/groundwater. Based on the information provided by Tetra Tech, our understanding of the site includes the following:

- A diesel and #2 fuel oil leak from an UST/AST impact the soil and groundwater onsite
- No free-product is present in the area, but smear-zone soil contamination is estimated at ~1,000 lbs. TPH
- Soil at 13TB4A contained 3,400 mg/kg TPH historically
- Groundwater from 13MW16 contained 5,400 ug/L TPH historically
- The proposed treatment area is 6,200 square feet
- DTW is approximately 4-7 feet bgs
- The soil onsite is primarily gravel and sand
- The treatment area is influenced by tidal action
- A consistent 20+ gpm extraction rate is assumed
- This proposal is based on the use of a 20-gpm DO-IT™ system for treatment of the GW and smear-zone soils

This data and the associated assumptions were used to determine appropriate biological product and equipment requirements, and to provide recommendations for site-specific application.

## DO-IT™ Process Description

Our DO-IT™ process is a complete bioremediation system that uses proprietary biological products in combination with a specialized in situ oxygenation equipment platform to obtain rapid reduction of diesel, fuel oil, and gasoline contaminants. It is our philosophy to add all of the components necessary for successful bioremediation, including enzymes, bacteria, nutrients, and an abundant supply of dissolved oxygen. To maximize oxygen supply, we utilize an oxygenation approach that differs from standard methods (air sparging, $O_2$ sparging, etc.). Our Super-Ox™ oxygenation units process water through a specialized pure-oxygen mixing system to generate greater than 40 ppm dissolved oxygen concentrations in a water stream. This oxygenated water stream is then injected into the subsurface to support high rates of microbial activity.

The DO-IT™ process works best in a closed-loop system, where groundwater is extracted, oxygenated, biologically-amended, and then re-injected into the subsurface. The recirculation of oxygenated water allows us to deliver daily DO masses ranging from 1 lb. per day to as much as 20 lbs. per day – this is order-of-magnitude higher masses of DO than any other oxygenation system available. For example, with a 10-gpm recirculation rate, the DO-IT™ system will deliver approximately ***5 pounds of dissolved oxygen*** to the subsurface ***per day***, or close to ***200 lbs. of dissolved oxygen per month***!!

**Equipment Recommendations**

For equipment, we recommend the Super-Ox™ Model 20-Automatic (20-A) for this site. This system will receive water (from the extraction system), oxygenate it to >40 ppm of dissolved oxygen, amend it with nutrients and bacteria, then re-inject into the subsurface. The 20-A system will be equipped with a 6-station injection manifold; each station will connect to one or more of the installed injection wells. The 20-A system is capable of a maximum process rate of 20 gallons per minute (gpm) that can be adjusted to match the extraction rate, if desired. These systems generate stable, high concentrations of dissolved oxygen (>40 ppm) in the process water using our unique pure oxygen mixing system. The 20-A equipment enclosure has an 8' x 12' (typically, varies upon unit availability) footprint, is fully weatherproof, contains double doors for walk-in access to all equipment, and includes a heating and fan system to control internal temperatures. The Model 20-A is an automated, programmable, turnkey bioremediation system requiring 1-phase, 220 Volt (4-wire), 80 Amp power service for operation.

Additional info and specifications for this system is available at www.etecllc.com. ***Since we rent the Super-Ox™ equipment, we supply replacement parts (at no cost) for damaged equipment (pumps, valves, etc.) on the Super-Ox™ system throughout the rental period.***

**Product Recommendations**

For biological products at this site, we recommend our TPH Bacterial Consortium (EZT-A2™) and PetroSolv™ biosurfactant. Our CBN™ nutrient blend will be also be needed. These products work together to effectively degrade diesel and fuel oil.

The application of the biological products will perform three critical functions, including:

1. Supply of a large population of pre-acclimated bacteria to optimize initial growth of a healthy, in situ, hydrocarbon-degrading microbial population.
2. Maximizing contact between the contaminants and the bacteria. Bioremediation is a contact technology – the bacteria must physically contact the diesel and fuel oil food source and the electron acceptors (oxygen, nitrate, sulfate) to biochemically oxidize the petroleum to $CO_2$ and water.
3. Supplying critical nutrients like nitrogen, phosphorus, and potassium to support ongoing biological growth. The nitrogen compounds will also act as a secondary electron acceptor to ensure continuous in situ contaminant degradation during temporary absences of dissolved oxygen.

**Site Application**

The DO-IT™ technology is a very effective soil and groundwater treatment system, especially when utilized in a closed-loop remediation process. Advantages to this approach include hydraulic control of the leading plume edge, treatment of both dissolved and adsorbed contamination, and maximized contact between the treatment water and the contaminants. Biological enhancements are efficiently distributed, allowing for smaller mixing volumes, and therefore less onsite time and labor than slug injections.

By utilizing a series of injection points/wells in combination with extraction wells, artificial groundwater gradients can be produced within the on-site plume to induce cycling of biologically-active treatment water through the plume zone. The general approach includes the following:

1. Install a series of 4-inch extraction wells (4-6 wells) along the downgradient edge of the proposed treatment area along the river edge. These wells will provide process water for the DO-IT™ system. Installation of the wells in this area will provide hydraulic capture of migrating

groundwater and encourage movement of the oxygenated treatment water throughout the site. The biosurfactant product applied will enhance diesel/fuel oil de-sorption and mobilization. Electric submersible pumps can be used to collect impacted groundwater.

2. Following extraction, the groundwater can be processed through activated carbon to remove dissolved-phase contamination prior to re-injection.
3. Install a series of 4-inch vertical injection wells (8-10) throughout the upgradient portion of the treatment area. These wells should be screened above the groundwater interface to allow for application to the upper smear-zone soils. The trenching connecting the DO-IT™ system to the injection wells can also have a horizontal injection piping installed in the same trench. Oxygenated treatment water applied to this trench will percolate through the vadose soils into the upper impacted smear-zone soils.

**Electron Acceptor Mass Balance**

Tetra Tech estimates that 1,000 lbs. of TPH resides in the soil within the Zone #4 treatment area. This estimated TPH mass is significant, and a large supply of electron acceptor mass will be necessary to biologically degrade enough of the TPH mass to achieve regulatory groundwater goals of 2.5 mg/L. Using a solely biological degradation approach, the ability to deliver the necessary electron acceptor mass become the limiting factor. ETEC has designed the DO-IT™ system to deliver as much dissolved oxygen and secondary electron acceptors as possible to overcome this limitation.

Utilizing a 3:1 ratio of 3 lbs. of oxygen necessary to degrade 1 lb. of TPH, the required oxygen mass is:

3 lbs. oxygen * 1,000 lbs. TPH = **3,000 lbs. oxygen**

**Electron Acceptor Delivery**

Oxygen delivery at the site will be dependent upon the extraction/injection rate achievable at the site. With a consistent extraction/injection rate, the Super-Ox™ Model 20-A should inject more than 28,800 gallons of oxygenated water each day (~20-gpm), or more than 864,000 gallons per month. The calculation below outlines the dissolved oxygen delivery of the Super-Ox™ equipment per month.

864,000 gal./month * 3.79 L/gal. = 3,275,000 L/month

3,275,000 L/month * >45 mg/L DO / 454,000 mg/1 lb. = **>325 lbs. DO/month**

As part of the dissolved oxygen mixing process, more oxygen gas must be supplied than can be dissolved into the water stream. This oxygen gas is carried with the water stream to the injection wells where it is transferred to the groundwater.

$\frac{PV}{RT}$ = moles $O_2$ P = 2.72 atm V = 283 L $O_2$/hour
R = 0.08206 L*atm/mol*K T = 298 K

(2.72 atm * 283 L $O_2$) / (0.08206 L*atm/mol*K * 298 K) = 31.5 moles $O_2$ / hour

31.5 moles $O_2$/hour * 32 g/mol $O_2$ = 1,008 g $O_2$/hour

1,008 g $O_2$/hour / 454 g/lb. = 2.2 lbs. $O_2$/hour * 24 hours/day = 52.8 lbs. $O_2$/day

52.8 lbs. $O_2$/day * 30 days/month = **1,584 lbs. $O_2$/month**

In addition to the oxygen mass delivered by the DO-IT™ system, a large mass of secondary electron acceptors will also need to be supplied to overcome the electron acceptor limiting conditions. Our CBN™ nutrient blend contains ~60% electron acceptors. For this site we would recommend 1,000 lbs. be applied initially (600 lbs. of electron acceptors) and approximately 300 lbs. per month (180 lbs. of

electron acceptors). This combination application of oxygen and secondary electron acceptors will maximize the electron acceptor delivery to the site. In a 24-month treatment, the DO-IT™ system will have applied more than 42,750 lbs. of electron acceptors to the site.

In comparison to a chemical based oxygen-release product which contains at most 17% oxygen, in order to deliver the same 42,750 lbs. of electron acceptors, over 251,000 lbs. would need to be applied to the site. At $8/lb, this represents a cost of $2,000,000. Also, the application of a solely oxygen releasing product would not address nitrogen, phosphorus, and micro-nutrient limiting conditions that will certainly inhibit the microbial activity at the site.

With either application, to rely solely on biological degradation to remediate the mass of TPH onsite will be difficult. That is why incorporating physical removal of contaminated groundwater into the treatment will be important. The DO-IT™ system is designed to work with a pump & treat system to enhance contaminant recovery using groundwater recirculation and biosurfactants to increase contaminant mobility.

## Monitoring Discussion

For the treatment, we recommend Tetra Tech collect field data as well as nutrient and plate count data. Tetra Tech can collect the field data (temperature, pH, DO, ORP, etc.) with their in-house meters, and analysis costs for a limited-nutrient suite and a hydrocarbon-degrading plate count are $140.00 per GW sample. Samples should be collected from the most impacted wells (13MW16, 13MW15, and a downgradient extraction well). This data will be used to evaluate the effectiveness of the treatment activities, and will provide information on how to maximize efficiency.

### Cost Estimate (System Rental)

The table below summarizes biological product, equipment rental, analytical, and shipping costs.

| Item | Cost |
|---|---|
| ***Initial Costs*** | |
| A2™ Bacterial Consortium – Initial Supply (20 gallons) | $2,000.00 |
| PetroSolv™ Biosurfactant – Initial Supply (20 gallons) | $2,000.00 |
| CBN™ Nutrients – Initial Supply (1,000 lbs.) | $2,500.00 |
| Super-Ox™ 20-A – Monthly Rental | $5,000.00 |
| Nutrient & Plate Count Analysis (3 samples @ $140 per sample) | $420.00 |
| Installation, Set-up, and Training (5-days) | $5,000.00 |
| Shipping (estimated) | $4,500.00 |
| **INITIAL COST** | **$21,420.00** |
| ***Monthly Costs*** | |
| A2™ Bacterial Consortium – Monthly Supply (10 gallons) | $1,000.00 |
| PetroSolv™ Biosurfactant – Monthly Supply (10 gallons) | $1,000.00 |
| CBN™ Nutrients – Monthly Supply (300 lbs.) | $750.00 |
| Super-Ox™ 20-A – Monthly Rental | $5,000.00 |
| Nutrient & Plate Count Analysis (3 samples @ $140 per sample) | $420.00 |
| Shipping (estimated) | $500.00 |
| **MONTHLY COST** | **$8,670.00** |
| **24-MONTH TREATMENT TOTAL** | **$222,830.00** |

| | |
|---|---|
| ***Final Costs*** | |
| Return Shipment | **$3,500.00** |
| ***Out-of-Scope Costs*** | |
| Well Installation | **???** |
| Trenching, piping | **???** |
| Pneumatic pumps, compressor, panel | **???** |
| Oil/water separator, activated carbon | **???** |
| Electrical | **???** |

We believe that a 24-month biological enhancement program will reduce dissolved-phase contaminant concentrations in the groundwater onsite. This is a budgetary proposal, and is for use in determining the feasibility of treatment at the site. This proposal will need to be revisited during the writing of the RAP when more data is available. Payment terms and conditions will need to be agreed upon at that time. Please review the summarized costs and call me at 971-222-3680 with any questions or comments. Thank you for the opportunity, and we look forward to further discussion with you on this project.

Respectfully,

**ETEC, LLC**

_____

Eric Bueltel
Project Manager

# APPENDIX D.2.2

# IN-SITU CHEMICAL PRECIPITATION

## D.2.2 – GROUNDWATER IN-SITU CHEMICAL PRECIPITATION

## 1.0 DESIGN BASIS

### 1.1 Design Assumptions

The following design assumptions are made based upon information for other similar in-situ chemical treatment projects:

- The estimated surface areas and volumes of the Lower Subase points of groundwater contamination and the estimated quantities of metals COCs contained in these points are computed in Appendix C.6.
- The arsenic and copper in the Lower Subase groundwater can be effectively precipitated and immobilized through the combined subsurface injection of a ferric iron salt such as ferric chloride ($Fe\ Cl_3$) and an oxygen release compound (ORC) such as magnesium peroxide ($MgO_2$).
- No treatment would be required in the areas where exceedances of arsenic or copper coincides with exceedances of TPH because the DO-IT™ technology tentatively selected for the in-situ treatment of TPH in these areas would also result in the oxidation, precipitation, and immobilization of arsenic and copper.
- The lead in the Lower Subase groundwater can be effectively precipitated and immobilized through the subsurface injection of a phosphate compound such as ammonium phosphate [$(NH_4)_3PO_4$].
- Chemical injection will be performed with the use of multiple direct push technology (DPT) injection wells.
- The average radius of influence (ROI) of each DPT injection well is approximately 8 ft.
- Only one chemical injection event will be required.
- In-situ chemical oxidation and precipitation will be completed within approximately one year.

## 2.0 DPT INJECTION SYSTEMS

ROI of each DPT injection well: $(8\ ft)^2 * \pi = 201$ square feet (sf)

### 2.1 Zone 1 Arsenic/Copper Points of Groundwater Contamination (Alternative GW-1.3)

As per the computation provided in Appendix C.6, the estimated combined surface area of the Zone 1 arsenic/copper points of groundwater contamination is 16,761 square feet (sf)

Number of DPT injection wells: (16,761 sf / 201 sf/injection well) * 1.1 overlap factor = 91.7, say 92 wells

DPT injection wells would be installed to a depth of 15 feet below ground surface (bgs).

### 2.2 Zone 4 Arsenic/TPH Points of Groundwater Contamination (Alternative GW-4.3)

As per the computation provided in Appendix C.6, the estimated combined surface area of the Zone 4 arsenic/TPH points of groundwater contamination is 29,559 sf including an area of TPH PRG exceedance of 7,854 sf. Therefore, as per the above assumption, injection treatment is only required for 29,559 – 7,854 = 21,705 sf

Number of DPT injection wells: (21,705 sf / 201 sf/injection well) * 1.1 overlap factor = 118.8, say 119 wells

DPT injection wells will be installed to a depth of 15 feet bgs.

## 2.3 Zone 4 Lead Point of Groundwater Contamination (Alternative GW-4.3)

As per the computation provided in Appendix C.6, the estimated surface area of the Zone 4 lead point of groundwater contamination is 7,854 sf

Number of DPT injection wells: (7,854 sf / 201 sf/injection well) * 1.1 overlap factor = 43 wells

DPT injection wells will be installed to a depth of 15 feet bgs.

## 2.4 Zone 7 Arsenic Points of Groundwater Contamination (Alternative GW-7.3)

As per the computation provided in Appendix C.6, the estimated combined surface area of the Zone 7 arsenic points of groundwater contamination is 13,471 sf

Number of DPT injection wells: (13,471 sf / 201 sf/injection well) * 1.1 overlap factor = 73.7, say 74 wells

DPT injection wells will be installed to a depth of 15 feet bgs.

## 3.0 IRON SALT INJECTION

Iron co-precipitation requires approximately a 20:1 ratio of ferric iron to arsenic and copper.

## 3.1 Zone 1 Arsenic/Copper Points of Groundwater Contamination (Alternative GW-1.3)

Based on the computations provided in Appendix C.6, the Zone 1 arsenic/copper points of groundwater contamination is estimated to contain approximately 0.045 pounds of arsenic and 0.29 pounds of copper.

Required quantity of ferric iron: (0.045 + 0.29) * 20 = 6.7 pounds
Required quantity of ferric chloride: 6.7 pounds * (162.5/56) = 19.4 pounds of $FeCl_3$
Increase this quantity by an order of magnitude to counterbalance inefficiencies in the injection process
Ferric chloride is typically available commercially as a 40% (wt) solution with a specific gravity of 11.7 lbs/gal
Required quantity of commercial ferric chloride solution:
(19.4 pounds * 10) / (0.4 x 11.7 lbs/gal) = 41.4 gal 40% $FeCL_3$ solution

Assume that the commercial 40% $FeCl_3$ will be diluted 100 to 1 for injection:

Volume injected per DPT well: 41.4 gal * 100 / 92 wells = 45 gal/well

## 3.2 Zone 4 Arsenic/TPH Points of Groundwater Contamination (Alternative GW-4.3)

Based on the computations provided in Appendix C.6, the area of arsenic-only PRG exceedance of the Zone 4 arsenic/TPH points of groundwater contamination is estimated to contain approximately 0.1 pounds of arsenic.

Required quantity of ferric iron: 0.1 * 20 = 2 pounds
Required quantity of ferric chloride: 2 pounds * (162.5/56) = 5.8 pounds of $FeCl_3$
Increase this quantity by an order of magnitude to counterbalance inefficiencies in the injection process
Required quantity of commercial ferric chloride solution:
(5.8 pounds * 10) / (0.4 x 11.7 lbs/gal) = 12.4 gal 40% $FeCL_3$ solution

Assume that the commercial 40% $FeCl_3$ will be diluted 100 to 1 for injection:
Volume injected per DPT well: 12.4 gal * 100 / 119 wells = 10.4 gal/well

### 3.3 Zone 7 Arsenic Points of Groundwater Contamination (Alternative GW-7.3)

Based on the computations provided in Appendix C.6, the Zone 7 arsenic points of groundwater contamination is estimated to contain approximately 0.037 pounds of arsenic.

Required quantity of ferric iron: 0.037 * 20 = 0.74 pounds
Required quantity of ferric chloride: 0.74 pounds * (162.5/56) = 2.15 pounds of $FeCl_3$
Increase this quantity by an order of magnitude to counterbalance inefficiencies in the injection process
Required quantity of commercial ferric chloride solution:
(2.15 pounds * 10) / (0.4 x 11.7 lbs/gal) = 4.6 gal 40% $FeCL_3$ solution

Assume that the commercial 40% $FeCl_3$ will be diluted 100 to 1 for injection:

Volume injected per DPT well: 4.6 gal * 100 / 74 wells = 6.2 gal/well

## 4.0 ORC INJECTION (ALTERNATIVES GW-1.3, GW-4.3, and GW-7.3)

Typical ORC injection rate for this type of application is 4 pounds per foot of aquifer depth or 4 lbs/ft * 10 ft = 40 lbs per DPT well

ORC use for the Zone 1 arsenic/copper points of groundwater contamination: 40 lbs/DPT well * 92 DPT wells = 3,680 pounds ORC
ORC use for the Zone 4 arsenic/TPH points of groundwater contamination: 40 lbs/DPT well * 119 DPT wells = 4,760 pounds ORC
ORC use for the Zone 7 arsenic points of groundwater contamination: 40 lbs/DPT well * 74 DPT wells = 2,960 pounds ORC

## 5.0 AMMONIUM PHOSPHATE INJECTION (ALTERNATIVE GW-4.3)

Ammonium phosphate would be injected to precipitate lead in the Zone 4 lead point of groundwater contamination as lead phosphate in accordance with the following chemical reaction:

$$2\ (NH_4)_3PO_4 + 3\ PbCl_2\ \text{(typical)} \rightarrow Pb_3(PO_4)_2 + 6\ NH_4Cl$$

Therefore, stoichiometric requirement of ammonium phosphate is:
(149 * 2) / (207 * 3) = 0.48 pounds ammonium phosphate per pound of lead
Increase this quantity by an order of magnitude to counterbalance inefficiencies in the injection process:
0.48 * 10 = 4.8 pounds ammonium phosphate per pound of lead

Based on the computations provided in Appendix C.6, the area of lead PRG exceedance of the Zone 4 lead point of groundwater contamination is estimated to contain approximately 4.06 pounds of lead.

Ammonium phosphate required for in-situ chemical precipitation of the lead in the Zone 4 lead point of groundwater contamination:
4.06 pounds lead * 4.8 pounds ammonium phosphate per pound of lead = 19.5 pounds

Assume that ammonium phosphate would be injected as a 1% solution by weight.
Required volume of ammonium phosphate solution:
(19.5 pounds * 100) / 8.5 pounds per gal = 229 gallons

Volume injected per DPT well: 229 gal / 43 DPT wells = 5.3 gal/well

# APPENDIX D.2.3

## EXTRACTION AND TREATMENT

D.2.3.1 – GROUNDWATER EXTRACTION AND TREATMENT
D.2.3.2 - GROUNDWATER EXTRACTION SYSTEM DESIGN – ZONE 1
D.2.3.3 - GROUNDWATER EXTRACTION SYSTEM DESIGN – ZONE 4
D.2.3.4- GROUNDWATER EXTRACTION SYSTEM DESIGN – ZONE 7
D.2.3.5 - QED AP3T AUTOPUMP
D.2.3.6 - ROSEDALE MULTI-BAG FILTERS (SEE APPENDIX D.1.2.2)
D.2.3.7 - CARBONAIR PC SERIES ACTIVATED CARBON UNITS (SEE APPENDIX D.1.2.3)
D.2.3.8 - SIEMENS GFH OXIDATIVE FILTRATION MEDIUM LITERATURE

## 1.0 GROUNDWATER QUALITY AND TREATMENT CRITERIA

### 1.1 Groundwater Quality

| Chemicals | Zone 1 Copper/ TPH | Zone 1 Arsenic/ Copper | Zone 4 Arsenic/ TPH | Zone 4 Lead | Zone 7 Arsenic | Discharge Standard |
|---|---|---|---|---|---|---|
| **COCs** (µg/L) | | | | | | |
| Arsenic | NA | 14.4(2) | 18.2(3) | NA | 14.9(5) | 10(6) |
| Copper | 77.9(1) | 92.6(2) | NA | NA | NA | 84(7) |
| Lead | NA | NA | NA | 2,760(4) | NA | 810(7) |
| TPH | 16,000(1) | NA | 1.435(3) | NA | NA | 2,500(8) |
| **Water Chemistry** | (mg/L) | | | | | |
| Suspended Solids (mg/L) | 10(9) | 10(9) | 10(9) | 10(9) | 10(9) | 1(9) |

**NOTES**:

NA Not applicable
(1) Maximum detected concentration at FOMW14
(2) Average of maximum concentrations detected at 13MW19, 13MW20, and 13MW21
(3) Average of concentrations in areas of exccedance ( WE-5, 13MW13, 13MW15, and NESO-10 for arsenic, 13MW16 for TPH) (see Appendix C.6).
(4) Maximum detected concentration at NESO-11
(5) Average of maximum concentrations detected at MW4-7RI and 20MW7
(6) Connecticut site-specific Surface Water Protection Criterion (SWPC)
(7) Connecticut Remediation Standard Regulations (RSR) SWPCs
(8) NSB-NLON General Permit for the Discharge of Stormwater with Industrial Activity, Bureau of Water Management, DEP-PERD-GP-014, modified July 15, 2003
(9) Assumed values

### 1.2 Estimated Volumes of Contaminated Groundwater and Quantities of COCs

Estimated volumes of contaminated groundwater and quantities of COCs are computed in Appendix C.6 and summarized as follows:

| Points of Groundwater Contamination | Total Volume (gal) | Arsenic | | Copper | | Lead | | TPH | |
|---|---|---|---|---|---|---|---|---|---|
| | | Volume (gal) | Quantity (pounds) | Volume (gal) | Quantity (pounds) | Volume (gal) | Quantity (pounds) | Volume (gal) | Quantity (pounds) |
| **Zone 1** | | | | | | | | | |
| Copper/TPH | 176,256 | NA | NA | 176,256 | 0.114 | NA | NA | 176,256 | 23.52 |
| Arsenic/Copper | 376,142 | 376,142 | 0.045 | 376,142 | 0.290 | NA | NA | NA | NA |
| Total | 552,398 | 376,142 | 0.045 | 552,398 | 0.404 | NA | NA | 176,256 | 23.52 |
| **Zone 4** | | | | | | | | | |
| Arsenic/TPH | 663,349 | 626,230 | 0.100 | NA | NA | NA | NA | 176,256 | 7.94 |
| Lead | 176,256 | NA | NA | NA | NA | 176,256 | 4.06 | NA | NA |
| Total | 839,605 | 626,230 | 0.100 | NA | NA | 176,256 | 4.06 | 176,256 | 7.94 |
| **Zone 7** | | | | | | | | | |
| Arsenic | 302,309 | 302,309 | 0.037 | NA | NA | NA | NA | NA | NA |

**NOTE**:

NA Not applicable

## 2.0 ALTERNATIVES DESCRIPTION

Alternatives GW-1.4, GW-4.4, and GW-7.4 would consist of extraction systems to capture groundwater from the Zone 1 (copper/TPH and arsenic/copper), Zone 4 (arsenic/TPH and lead), and Zone 7 (arsenic) points of groundwater contamination, respectively. The extracted groundwater would then be discharged to the Lower Subase sanitary sewer system for eventual treatment and disposal at the City of Groton publicly owned treatment works (POTW).

Alternatives GW-1.5, GW-4.5, and GW-7.5 would consist of the same extraction systems as Alternatives GW-1.4, GW-4.4, and GW-7.4, but the extracted groundwater would be treated by on-site systems prior to discharge to the Thames River. The on-site treatment systems would include the following subsystems:

**Alternative GW-1.5**:

Zone 1 Copper/TPH Point of Groundwater Contamination:

- Filtration System to remove insoluble total petroleum hydrocarbon (TPH) and control suspended solids
- Liquid-Phase granular activated carbon (GAC) Adsorption System to remove soluble TPH
- Oxidative Filtration System to remove soluble copper

Zone 1 Arsenic/Copper Points of groundwater Contamination:

- Filtration System to control suspended solids
- Oxidative Filtration System to remove soluble arsenic and copper

**Alternative GW-4.5**:

Zone 4 Arsenic/TPH Points of Groundwater Contamination:

- Equalization to blend extracted groundwater and control extraction pumps
- Filtration System to remove insoluble TPH and control suspended solids
- Liquid-Phase GAC Adsorption System to remove soluble TPH
- Oxidative Filtration System to remove soluble arsenic

Zone 4 Lead Point of Groundwater Contamination:

- Phosphate Precipitation System to remove soluble lead
- Filtration System to remove suspended solids

**Alternative GW-7.5**:

Zone 7 Arsenic Points of Groundwater Contamination:

- Filtration System to control suspended solids
- Oxidative Filtration System to remove soluble arsenic and control suspended solids

The groundwater extraction and treatment systems would be operated and maintained for the following estimated durations:

Zone 1 Copper/TPH Point of Groundwater Contamination: 11 years
Zone 1 Arsenic/Copper Points of Groundwater Contamination: 26 years
Zone 4 Arsenic/TPH Points of Groundwater Contamination: 11 years
Zone 4 Lead Point of Groundwater Contamination: 27 years

Zone 7 Arsenic Point of Groundwater Contamination: 18 years

## 3.0 GROUNDWATER EXTRACTION SYSTEMS

### 3.1 Zone 1 (Alternatives GW-1.4 and GW-1.5)

As per attached summary of groundwater modeling, The Zone 1 groundwater extraction systems would consist of the following:

| Points of Groundwater Contamination | Well Numbers | Well Diameter (in) | Screened Depth (ft) | Total Pumping Rate (gpm) |
|---|---|---|---|---|
| Zone 1 Copper/TPH | EW-1.1 | 6 | 5-30 | 16 |
| Zone 1 Arsenic/Copper | EW-1.2, EW-1.3 | 6 | 5-30 | 40 |

A submersible centrifugal pump would be installed in these wells as follows:

| Points of Groundwater Contamination | Pump Number | Pump Design | | |
|---|---|---|---|---|
| | | Flow Rate (gpm) | Total Discharge Head (ft) | Motor Size (HP) |
| Zone 1 Copper/TPH | P-1.1 | 20 | 100 | 1.0 |
| Zone 1 Arsenic/Copper | P-1.2, P-1.3 | 20 | 100 | 1.0 |

### 3.2 Zone 4 (Alternatives GW-4.4 and GW-4.5)

As per attached summary of groundwater modeling, the Zone 4 groundwater extraction systems would consist of the following:

| Points of Groundwater Contamination | Well Numbers | Well Diameter (in) | Screened Depth (ft) | Total Pumping Rate (gpm) |
|---|---|---|---|---|
| Zone 4 Arsenic/TPH | EW-4.1 to EW-4.3 | 6 | 5-30 | 30 |
| Zone 4 Lead | EW-4.4 to EW-4.6 | 6 | 5-30 | 120 |

A submersible centrifugal pump would be installed in these wells as follows:

| Points of Groundwater Contamination | Pump Number | Pump Design | | |
|---|---|---|---|---|
| | | Flow Rate (gpm) | Total Discharge Head (ft) | Motor Size (HP) |
| Zone 4 Arsenic/TPH | P-4.1 to P-4.3 | 10 | 100 | 0.5 |
| Zone 4 Lead | P-4.4 to P-4.6 | 40 | 100 | 0.75 |

### 3.3 Zone 7 (Alternatives GW-7.4 and GW-7.5)

As per attached summary of groundwater modeling, The Zone 7 groundwater extraction system would consist of the following:

| Points of Groundwater Contamination | Well Numbers | Well Diameter (in) | Screened Depth (ft) | Total Pumping Rate (gpm) |
|---|---|---|---|---|
| Zone 7 Arsenic | EW-7.1, EW-7.2 | 6 | 5-30 | 28 |

A submersible centrifugal pump would be installed in these wells as follows:

| Points of Groundwater Contamination | Pump Number | Pump Design | | |
|---|---|---|---|---|
| | | Flow Rate (gpm) | Total Discharge Head (ft) | Motor Size (HP) |
| Zone 7 Arsenic | P-7.1, P-7.2 | 15 | 100 | 0.75 |

## 4.0 EQUALIZATION (Alternative GW-4.5 only)

Groundwater equalization is only required for the Zone 4 arsenic/TPH points of groundwater contamination because these points are the only ones in the Lower Subase that would require more than two extraction wells and the blending of a groundwater stream containing relatively high concentrations of TPH with another containing very low concentrations of metallic chemicals of concern (COCs).

Equalization Tank would be sized to provide approximately 30 minutes detention under design flow conditions.

Equalization Tank volume: 30 gpm * 30 minutes = 900 gallons

→ Call for an Equalization Tank (T-4.1). Tank to have a working capacity of 1,000 gallons. Tank to be 5 feet diameter by 8 feet high, closed-top with vent, and manufactured of fiberglass or painted steel. Tank to be equipped with pressure switches to control operation of Groundwater Extraction Pumps.

A mixer is required to blend incoming groundwater streams. Typical mixer horsepower requirement for this kind of application is 1.5 horsepower (hp) per 1,000 cubic feet (cf) of tank capacity.

Mixer horsepower: 1,000 gal * 1.5 hp/1,000 cf / (7.48 gal/cf * 1,000) = 0.2 hp

→ Call for one top-mounted turbine-type 0.5 hp Equalization Tank Mixer (M-4.1)

A pump would be provided to transfer groundwater from the Equalization Tank to downstream treatment processes. Pump operation (start/stop) would be controlled by the pressure in the Equalization Tank.

→ Call for one (1) Equalization Transfer Pump (P-4.7). Pump to be horizontal centrifugal type, rated for 30 gallons per minute (gpm) @100 feet total displacement head (TDH) with a 1.5 hp motor.

## 5.0 OXIDATIVE FILTRATION SYSTEMS

Oxidative filtration would be used to remove arsenic and copper from the Zone 1 groundwater and arsenic from the Zones 4 and 7 groundwater. Oxidative filtration would use common pressure filtration equipment loaded with a ferric oxide oxidation/filtration medium [Siemens/US Filter Granular Ferric Hydroxide (GFH®) or equivalent].

Per vendor recommendation, oxidative filtration systems should consist of twin units operating in parallel and sized to provide an overall maximum percolation rate of 5 gpm per square foot (gpm/sf) and minimum

empty bed contact time (EBCT) of 5 minutes.

## 5.1 Zone 1 (Alternative GW-1.5)

### 5.1.1 Zone 1 Copper/TPH Point of Groundwater Contamination

Required oxidative filter unit surface area: 16 gpm / 5 gpm/sf = 3.2 sf minimum, or 1.6 sf per unit
Required medium volume: (16 gpm * 5 min) / 7.48 gal/cf = 10.7 cf minimum, or 5.35 cf per unit
EBCT is the governing parameter
With a typical medium depth of 2.5 feet, filter unit surface area: 5.35 cf / 2.5 ft = 2.14 sf
Filter unit diameter: $(4 * 2.14 \text{ sf} / \text{pi})^{1/2}$ = 1.65 ft, or 19.8, say 20-inch diameter
Actual surface area: $[(20 / 12)^2 * \text{pi}] / 4$ = 2.18 sf per unit, 4.36 sf total
Actual medium volume: 2.18 sf * 2.5 ft = 5.45 cf per unit, 10.9 cf total
Actual EBCT: (10.9 cf * 7.48 gal/cf) / 16 gpm = 5.1 minute total

→ Call for an Oxidative Filter System (OFS-1.1) consisting of twin 20-inch diameter units operating in parallel, each holding a minimum of 5.45 cf of granulated ferric hydroxide medium (Siemens/US Filter GFH® EFAX020 or equivalent).

Anticipated copper hydroxide accumulation in reactive medium:
16 gpm * 1,440 min/day * 8.34 lbs/gal * [77.9 * (97.5 / 63.5)] µg/L $Cu(OH)_2$ * $10^{-9}$ = 0.023 lbs/day
Anticipated Oxidative Filter backwash frequency @ 1 lbs $Cu(OH)_2$/sf holding capacity:
4.36 sf * 1 lb $Cu(OH)_2$/sf / 0.023 lbs $Cu(OH)_2$/day = 190 days, say once a month to be conservative
Backwash requirements: 16 gpm for 15 minutes per unit
Dirty backwash volume: 16 gpm * 15 min/month * 2 units = 480 gal/month

Assume that dirty backwash wastewater would be collected in a tanker truck for off-site disposal.

### 5.1.2 Zone 1 Arsenic/Copper Points of Groundwater Contamination

Required oxidative filter unit surface area: 40 gpm / 5 gpm/sf = 8 sf minimum, or 4 sf per unit
Required medium volume: (40 gpm * 5 min) / 7.48 gal/cf = 26.7 cf minimum, or 13.35 cf per unit
EBCT is the governing parameter
With a typical medium depth of 2.75 feet, filter unit surface area: 13.35 cf / 2.75 ft = 4.85 sf
Filter unit diameter: $(4 * 4.85 \text{ sf} / \text{pi})^{1/2}$ = 2.48 ft, or 29.8, say 30-inch diameter
Actual surface area: $[(30 / 12)^2 * \text{pi}] / 4$ = 4.91 sf per unit, 9.82 sf total
Actual medium volume: 4.91 sf * 2.75 ft = 13.5 cf per unit, 27 cf total
Actual EBCT: (27 cf * 7.48 gal/cf) / 40 gpm = 5.05 minute total

→ Call for an Oxidative Filter System (OFS-1.2) consisting of twin 30-inch diameter units operating in parallel, each holding a minimum of 13.5 cf of granulated ferric hydroxide medium (Siemens/US Filter GFH® EFAX040 or equivalent).

Anticipated arsenic oxide ($H_2AsO_4$) and copper hydroxide [$Cu(OH)_2$] accumulation in reactive medium:
40 gpm * 1,440 min/day * 8.34 lbs/gal * {[92.6 * (97.5 / 63.5)] + [14.4 * (141/75)]} µg/L oxides * $10^{-9}$ = 0.081 lbs/day
Anticipated Oxidative Filter backwash frequency @ 1 lbs oxides/sf holding capacity:
9.82 sf * 1 lb oxides/sf / 0.081 lbs oxides/day = 121 days, say once a month to be conservative
Backwash requirements: 40 gpm for 15 minutes per unit
Dirty backwash volume: 40 gpm * 15 min/month * 2 units = 1,200 gal/month

Assume that dirty backwash wastewater would be collected in a tanker truck for off-site disposal.

## 5.2 Zone 4 Arsenic/TPH Points of Groundwater Contamination (Alternative GW-4.5)

Required oxidative filter unit surface area: 30 gpm / 5 gpm/sf = 6 sf minimum, or 3 sf per unit
Required medium volume: (30 gpm * 5 min) / 7.48 gal/cf = 20 cf minimum, or 10 cf per unit
EBCT is the governing parameter
With a typical medium depth of 3.18 feet, filter unit surface area: 10 cf / 3.18 ft = 3.14 sf
Filter unit diameter: $(4 * 3.14 \text{ sf} / \text{pi})^{1/2}$ = 2 ft , or 24-inch diameter

→ Call for an Oxidative Filter System (OFS-4.1) consisting of twin 24-inch diameter units operating in parallel, each holding a minimum of 10 cf of granulated ferric hydroxide medium (Siemens/US Filter GFH® EFAX030 or equivalent).

Anticipated arsenic oxide accumulation in reactive medium:
30 gpm * 1,440 min/day * 8.34 lbs/gal * [18.2 * (141/75)] µg/L $H_2AsO_4$ * $10^{-9}$ = 0.012 lbs/day
Anticipated Oxidative Filter backwash frequency @ 1 lbs $H_2AsO_4$/sf holding capacity:
(3.14 sf * 2 units * 1 lb $As_2O_5$/sf) / 0.012 lbs $H_2AsO_4$/day = 523 days, say once a month to be conservative
Backwash requirements: 30 gpm for 15 minutes.
Dirty backwash volume: 30 gpm * 15 min/month * 2 units = 900 gal/month

Assume that dirty backwash wastewater would be collected in a tanker truck for off-site disposal.

## 5.3 Zone 7 Arsenic Points of Groundwater Contamination (Alternative GW-7.5)

Treated groundwater flow is 28 gpm which is almost identical to the 30 gpm treated for the Zone 4 arsenic/TPH points of groundwater contamination. Therefore, for the purpose of this FS, it assumed that the oxidative filter system for the Zone 7 arsenic points of groundwater contamination would have the same design as that for the Zone 4 arsenic/TPH points of groundwater contamination.

→ Call for an Oxidative Filter System (OFS-7.1) consisting of twin 24-inch diameter units operating in parallel, each holding a minimum of 10 cf of granulated ferric hydroxide medium (Siemens/US Filter GFH® EFAX030 or equivalent).

Anticipated arsenic oxide accumulation in reactive medium:
28 gpm * 1,440 min/day * 8.34 lbs/gal * [14.9 * (141/75)] µg/L $H_2AsO_4$ * $10^{-9}$ = 0.0094 lbs/day
Anticipated Oxidative Filter backwash frequency @ 1 lbs $H_2AsO_4$/sf holding capacity:
3.14 sf * 2 units * 1 lb $H_2AsO_4$/sf / 0.0094 lbs $H_2AsO_4$/day = 668 days, say once a month to be conservative
Backwash requirements: 30 gpm for 15 minutes.
Dirty backwash volume: 30 gpm * 15 min/month * 2 units = 900 gal/month

Assume that dirty backwash wastewater would be collected in a tanker truck for off-site disposal.

## 6.0 FILTRATION SYTEMS

Use bag type filter unit to avoid liquid residual stream from backwashing.

Size bag filter unit for replacement of filter bag element no more frequently than once a week.

Assume that total suspened solids present in the untreated groundwater include the 10 mg/L of naturally-occurring material listed in Section 1.1, plus approximately one third of any TPH, plus whatever chemical precipitate is generated by the above-described processes. Also assume that 95 percent of the insoluble

TPH and suspended solids are removed by the bag filter.

## 6.1 Zone 1 (Alternative GW-1.5)

Weekly dry solids accumulation in the bag filter would be:

For Zone 1 copper/TPH point of groundwater contamination:
16 gpm * 1,440 min/day * 7 days/week * 8.34 lbs/gal * [10 + (16/3)] * 0.95 mg/L suspended solids * $10^{-6}$ = 19.6 lbs /week

For Zone 1 arsenic/copper points of groundwater contamination:
40 gpm * 1,440 min/day * 7 days/week * 8.34 lbs/gal * (10 * 0.95) mg/L suspended solids * $10^{-6}$ = 31.9 lbs /week

Assuming a typical solids capture capacity of approximately 0.5 lbs dry suspended solids per square foot of bag filter element, required surface of bag element is:

For Zone 1 copper/TPH point of groundwater contamination:
19.6 lbs / 0.5 lbs/sf = 39.2, say 40 sf

→ Call for one multi-bag pressurized Bag Filter (BF-1.1) with a filter area of 53 sf (Rosedale Model 36 or equivalent)

For Zone 1 arsenic/copper points of groundwater contamination:
31.9 lbs / 0.5 lbs/sf = 63.8, say 65 sf

→ Call for one multi-bag pressurized Bag Filter (BF-1.2) with a filter area of 75 sf (Rosedale Model 42 or equivalent)

## 6.2 Zone 4 (Alternative GW-4.5)

Weekly solids accumulation in the bag filter would be:

For Zone 4 arsenic/TPH points of groundwater contamination:
30 gpm * 1,440 min/day * 7 days/week * 8.34 lbs/gal * [10 + (5.4 / 3)] * 0.95 mg/L * $10^{-6}$ = 28.3 lbs/week

For Zone 4 lead point of groundwater contamination:
120 gpm * 1,440 min/day * 7 days/week * 8.34 lbs/gal * (10 + 3.6) * 0.95 mg/L * $10^{-6}$ = 130.2 lbs/week

Assuming a typical solids capture capacity of approximately 0.5 lbs dry suspended solids per square foot of bag filter element, required surface of bag element is:

For Zone 4 arsenic/TPH points of groundwater contamination:
28.3 lbs / 0.5 lbs/sf = 56.6 sf

→ Call for one multi-bag pressurized Bag Filter (BF-4.1) with a filter area of 75 sf (Rosedale Model 42 or equivalent)

For Zone 4 lead point of groundwater contamination:
130.2 lbs / 0.5 lbs/sf = 260.4 sf

→ Call for three multi-bag pressurized Bag Filters (BF-4.2 to BF-4.4), each with a filter area of 101 sf (Rosedale Model 48 or equivalent)

### 6.3 Zone 7 (Alternative GW-7.5)

Weekly solids accumulation in the bag filter would be:

For Zone 7 arsenic points of groundwater contamination:
28 gpm * 1,440 min/day * 7 days/week * 8.34 lbs/gal * (10 * 0.95) mg/L * $10^{-6}$ = 22.4 lbs /week

Assuming a typical solids capture capacity of approximately 0.5 lbs dry suspended solids per square foot of bag filter element, required surface of bag element is:

For Zone 7 arsenic points of groundwater contamination:
22.4 lbs ÷ 0.5 lbs/sf = 44.8 sf

→ Call for one multi-bag pressurized Bag Filter (BF-7.1) with a filter area of 53 sf (Rosedale Model 36 or equivalent)

## 7.0 CHEMICAL PRECIPITATION SYSTEM (Alternative GW-4.5 only)

Ammonium phosphate would be used to precipitate lead as lead phosphate in accordance with the following chemical reaction:

$2\ (NH_4)_3PO_4 + 3\ PbCl_2$ (typical) → $Pb_3(PO_4)_2 \downarrow + 6\ NH_4Cl$

Therefore, stoichiometric requirement of ammonium phosphate is:
(149 * 2) / (207 * 3) = 0.48 pound ammonium phosphate per pound of lead
Double the stoichiometric requirement to counterbalance inefficiencies in the precipitation process:
0.48 * 2 = 0.96, say one pound ammonium phosphate per pound of lead

Ammonium phosphate required to precipitate lead in the groundwater extracted from the lead exceedance area of the Zone 4 lead point of groundwater contamination:
120 gpm * 1,440 min/day * 8.34 lbs/gal * 2,760 µg/L Pb * $10^{-9}$ * 1 = 3.98 pounds/day
Volume of ammonium phosphate solution required at 1 % (wt) strength:
3.98 lbs/day / (0.01 * 8.5 lbs/gal) = 46.8 gal/day (gpd)

→ Call for a skid-mounted packaged-type Chemical Feed System (CSF-4.1) including one 400-gal capacity storage/feed container (1 week storage), one (1) rim-mounted 1 hp mixer to put ammonium phosphate in solution and one diaphragm-type manually-adjustable stroke 1-5 gallons per hour (gph) feed pump.

Lead phosphate precipitate quantity:
120 gpm * 1,440 min/day * 8.34 lbs/gal * 2,760 µg/L Pb * $10^{-9}$ * (811 / 621) = 5.19 pounds/day
Lead phosphate precipitate concentration:
5.19 pounds * $10^{9}$ / (120 gpm * 1,440 min/day * 8.34 lbs/gal) = 3,604 µg/L or 3.6 mg/L

Chemical precipitation would take place in a Reaction Tank sized to provide one hour detention under design flow conditions.

Reaction Tank Volume: 120 gpm * 60 minutes = 7,200 gallons

→ Call for a 10-foot diameter 14 feet high Reaction Tank (T-4.2) with a working capacity of 7,500 gallons. Tank to be of cylindrical vertical configuration and manufactured of coated steel. Tank to be of closed-top design with vent.

Mixer size @ 3 hp/1,000 cf: (7,500 gal / 7.48 gal/cf) cf * 3 hp / 1,000 cf = 3 hp

→ Call for a top-mounted 3 hp low-speed turbine-type mixer.

Pumps would be provided to transfer precipitated groundwater to downstream processes (i.e., bag filtration).

→ Call for one horizontal-centrifugal 120 gpm Transfer Pump (P-4.8) with 7.5 hp motor.

## 8.0 LIQUID-PHASE GAC ADSORPTION SYSTEMS

Liquid-phase GAC adsorption would be used to remove soluble TPH from the filtered groundwater.

Size GAC adsorption units to provide an EBCT of 15 minutes.
Assume GAC usage of 20 pounds per pound of soluble TPH removed and breakthrough after usage of 3/4 of GAC.

### 8.1 Zone 1 Copper/TPH Point of Groundwater Contamination (Alternative GW-1.5)

Required GAC volume:
16 gpm * 15 minutes / 7.48 gal/ cf = 32 cf GAC
@ 30 lbs/cf, weight of GAC: 32 cf * 30 lbs/cf = 962 lbs GAC

→ Call for one liquid-phase GAC Adsorption Unit (GAC-1.1) and holding 1,000 lbs GAC (Carbonair Model PC7 or equivalent).

Estimated frequency of replacement of the liquid-phase GAC adsorption unit would be:

Based upon initial design concentration of TPH:
(1,000 * 0.75) lbs GAC / (16 gpm * 1,440 min/day * 8.34 lbs/gal * 16 mg/L TPH * 2/3 * $10^{-6}$ x 20 lbs GAC/lb TPH) = 18.3 days, say once a month **TOO LOW**

→ Call for one liquid-phase GAC Adsorption Unit (GAC-1.1) and holding 1,500 lbs GAC (Carbonair Model PC13 or equivalent).

Estimated frequency of replacement of the liquid-phase GAC adsorption unit would be 1.5 times less frequent of 18.3 * 1.5 = 27.4 days **OK**

### 8.2 Zone 4 Arsenic/TPH Points of Groundwater Contamination (Alternative GW-4.5)

Required GAC volume:
30 gpm * 15 minutes / 7.48 gal/ cf = 60 cf GAC
@ 30 lbs/cf, weight of GAC: 60 cf x 30 lbs/cf = 1,800 lbs GAC

→ Call for one liquid-phase GAC Adsorption Unit (GAC-4.1) and holding 2,500 lbs GAC (Carbonair Model PC20 or equivalent).

Estimated frequency of replacement of the liquid-phase GAC adsorption unit would be:

Based upon initial design concentration of TPH:
(2,500 * 0.75) lbs GAC / (30 gpm * 1,440 min/day * 8.34 lbs/gal * 1.435 mg/L TPH * 2/3 * $10^{-6}$ * 20 lbs GAC/lb TPH) = 272 days, say once every 9 months **OK**

**Attachments**

QED groundwater extraction pumps literature
GFH® oxidative filtration medium literature
Rosedale bag filters literature
Carbonair liquid-phase GAC adsorption units literature

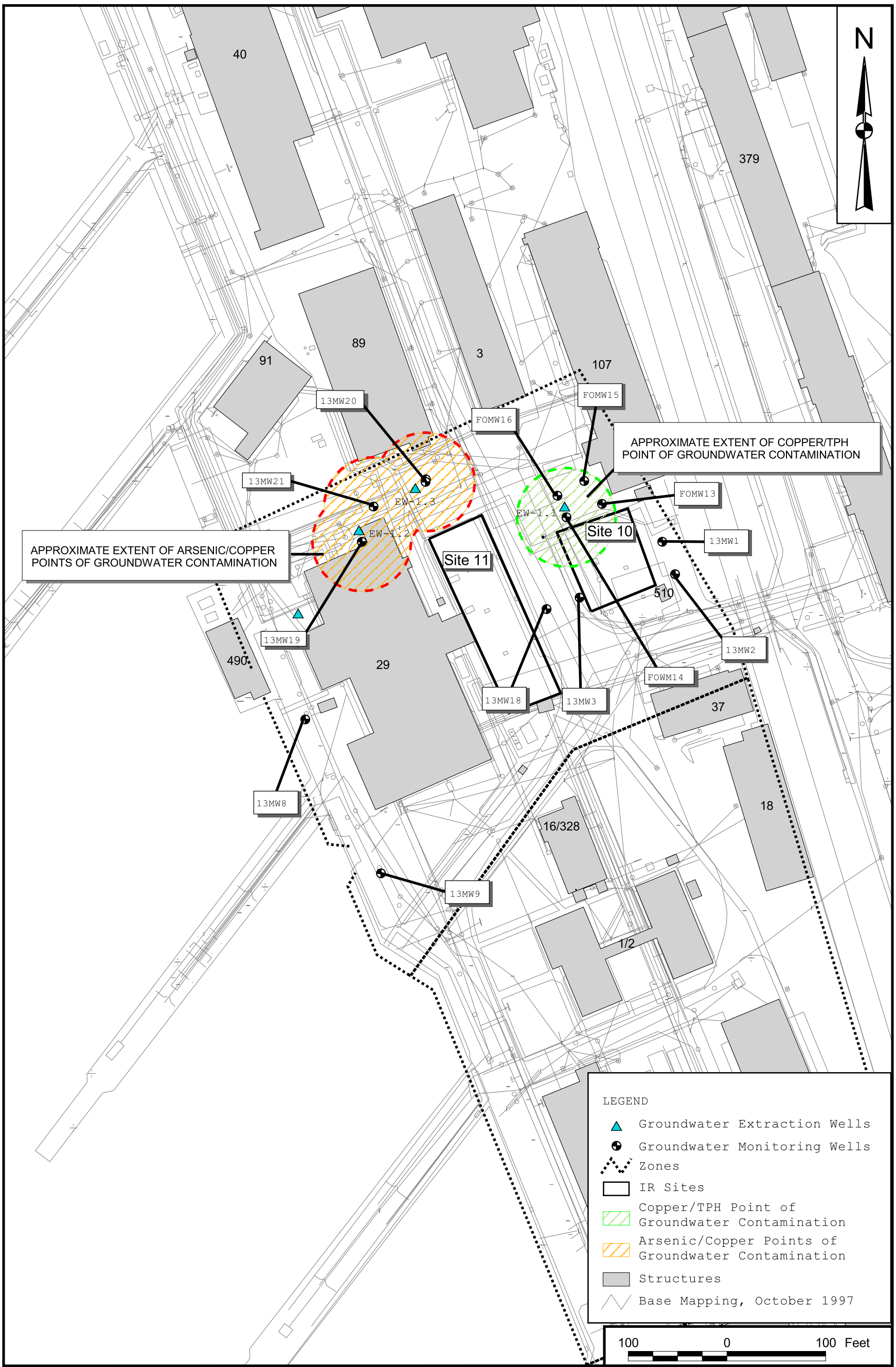
**Contaminant Characteristics**
**NSB New London**

| Site | COC | PRG, ug/l | Max Conc., ug/l | Kd | Koc | Foc |
|---|---|---|---|---|---|---|
| Zone 1 | arsenic | 10 | 16.8 | 29 | | |
| | copper | 48 | 156 | 35 | | |
| | TPH (blended) | 2500 | 16000 | | 1650000 | 0.006 |
| | | | | | | |
| Zone 4 | arsenic | 10 | 29.6 | 29 | | |
| | lead | 810 | 2760 | 270 | | |
| | TPH (blended) | 2500 | 5400 | | 1650000 | 0.006 |
| | | | | | | |
| Zone 7 | arsenic | 10 | 18.8 | 29 | | |

**Lower Subase FS Remediation Scenarios**

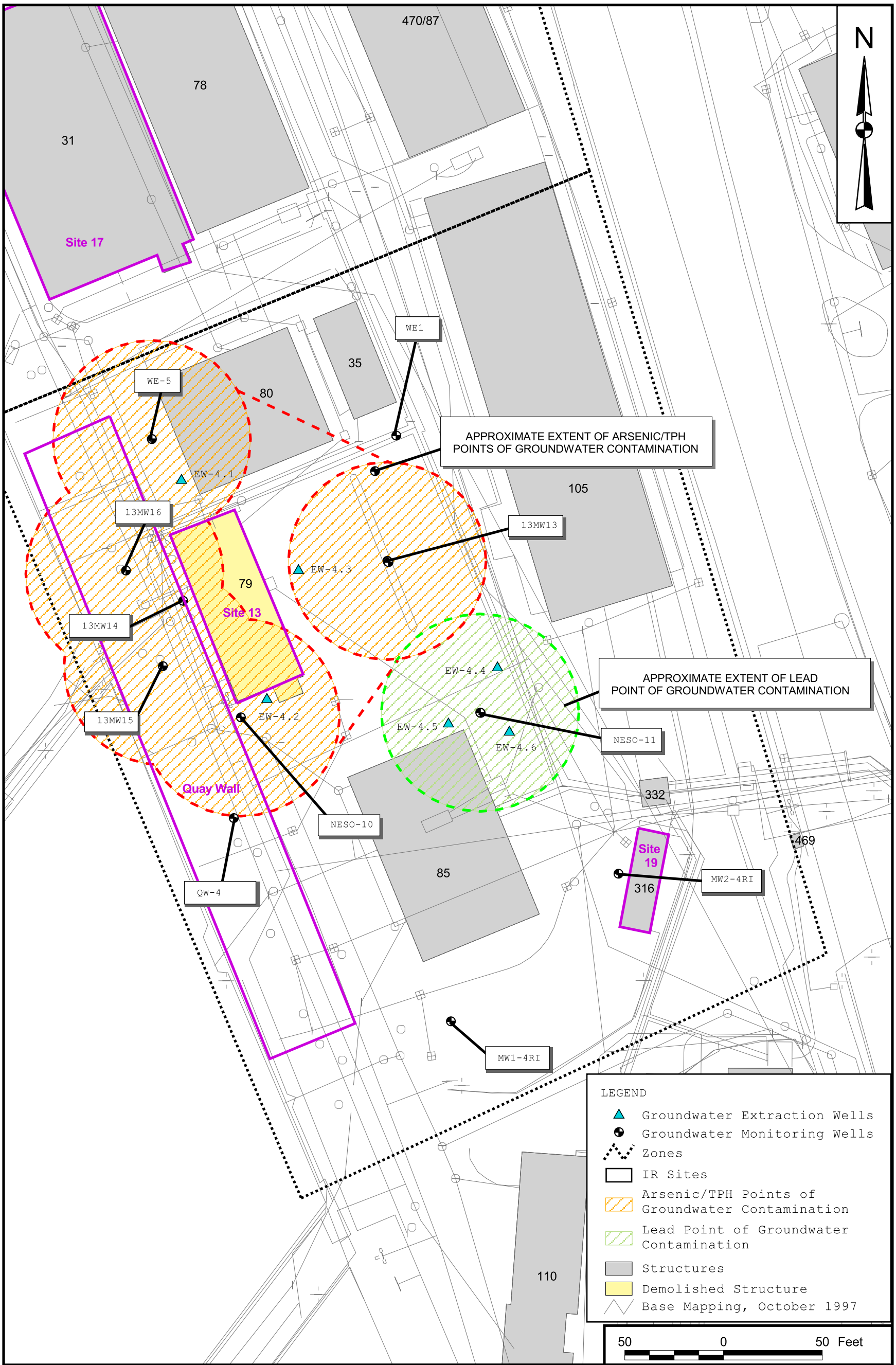
| Points of GW Contamination | COC | Max Conc., ug/l | PRG, ug/l | No. of wells | Total pumping rate, gpm | Time to reach PRG, years | Notes |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| Zone 1 Arsenic/Copper | Arsenic | 16.8 | 10 | 2 | 40 | 9 | NA in 80 years |
| | Copper | 156 | 48 | | | 26 | NA in 219 years |
| Zone 1 Copper/TPH | Copper | 77.9 | 48 | 1 | 16 | 11 | NA in 42 years, 21 years @ 8gpm |
| | TPH (blended) | 16000 | 2500 | | | 27 | Pumping ineffective due to high retardation, biodegradation will reduce TPH over time |
| | | | | | | | |
| Zone 4 Arsenic/TPH | Arsenic | 29.6 | 10 | 3 | 30 | 11 | NA in 22 years |
| | TPH (blended) | 5400 | 2500 | | | 11 | Pumping ineffective due to high retardation, biodegradation will reduce TPH over time |
| Zone 4 Lead | Lead | 2760 | 810 | 3 | 40 | 27 | NA in 548 years |
| | | | | | | | |
| Zone 7 Arsenic | Arsenic | 18.8 | 10 | 2 | 28 | 18 | NA in 34 years |

P:\GIS\NLON\MAPDOCS\APR\NLONTAGS.APR ZONE 1 PROPOSED GW EXTRACTION WELL LOCATIONS LAYOUT 01/11/10 SS




| | | | |
|---|---|---|---|
| DRAWN BY S.STROZ DATE 11/18/09 | Tetra Tech NUS, Inc. | CONTRACT NUMBER 0424 | OWNER NUMBER — |
| CHECKED BY N. BALSAMO DATE 01/11/10 | ZONE 1 TPH/COPPER AND ARSENIC/COPPER POINTS OF GROUNDWATER CONTAMINATION<br>PROPOSED GROUNDWATER EXTRACTION WELL LOCATIONS<br>ALTERNATIVES GW-1.4 AND GW-1.5<br>LOWER SUBASE FEASIBILITY STUDY<br>NSB-NLON, GROTON, CONNECTICUT | APPROVED BY — DATE — | |
| COST/SCHEDULE-AREA | | APPROVED BY — DATE — | |
| SCALE AS NOTED | | DRAWING NO. FIGURE 4-23 | REV 0 |

P:\GIS\NLON\MAPDOCS\APR\NLONTAGS.APR ZONE 4 PROPOSED GW EXTRACTION WELL LOCATIONS LAYOUT 01/11/10 SS

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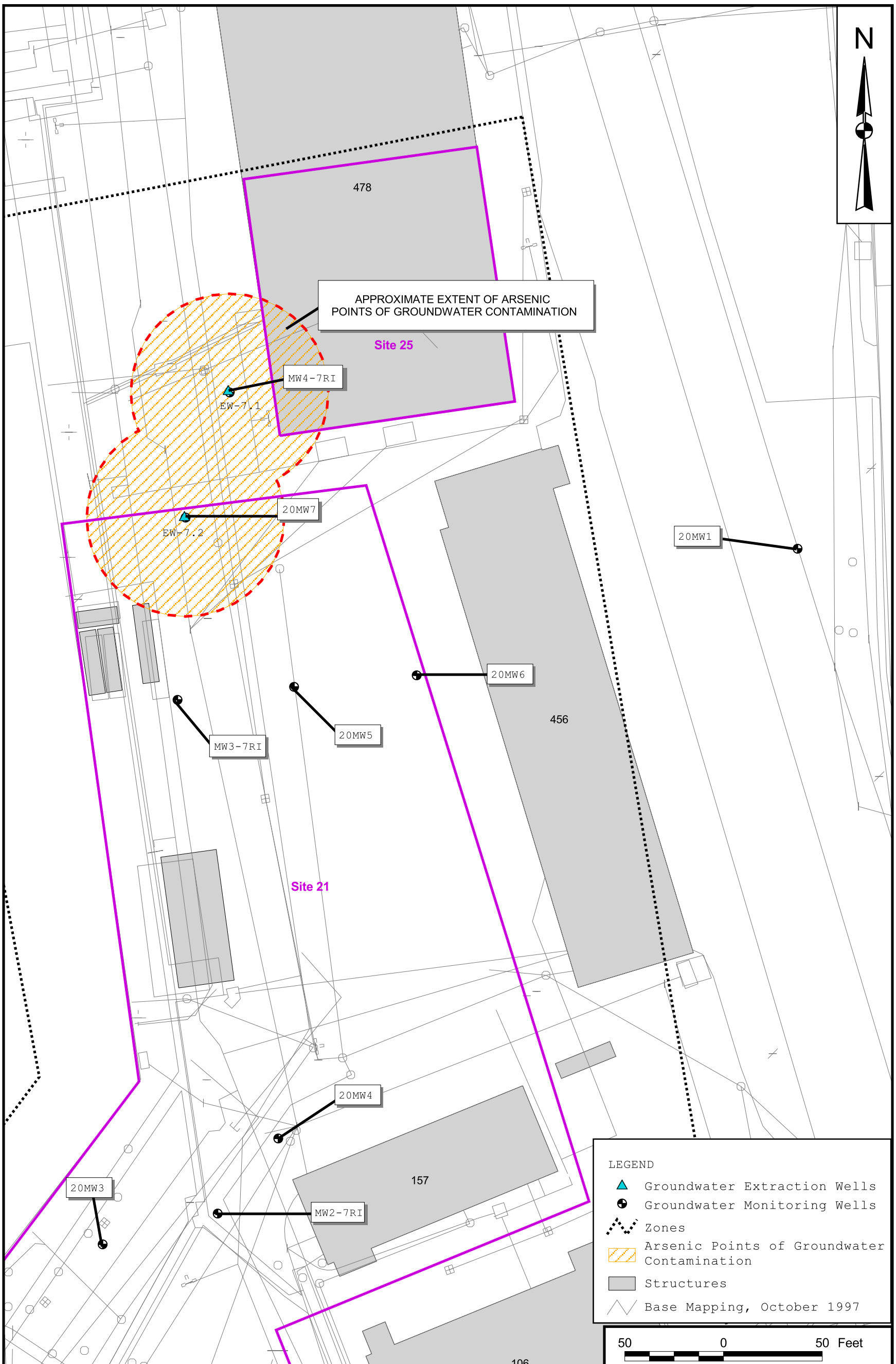
|---|---|---|---|
| DRAWN BY S.STROZ — DATE 11/18/09 | Tetra Tech NUS, Inc. | CONTRACT NUMBER 0424 | OWNER NUMBER — |
| CHECKED BY N. BALSAMO — DATE 01/11/10 | ZONE 4 ARSENIC/TPH AND LEAD POINTS OF GROUNDWATER CONTAMINATION<br>PROPOSED GROUNDWATER EXTRACTION WELLS LOCATION<br>ALTERNATIVES GW-4.4 AND GW-4.5<br>LOWER SUBASE FEASIBILITY STUDY<br>NSB-NLON, GROTON, CONNECTICUT | APPROVED BY — | DATE — |
| COST/SCHEDULE-AREA | | APPROVED BY — | DATE — |
| SCALE AS NOTED | | DRAWING NO. FIGURE 4-28 | REV 0 |

P:\GIS\NLON\MAPDOCS\APR\NLONTAGS.APR ZONE 7 PROPOSED GW EXTRACTION WELL LOCATIONS LAYOUT 01/11/10 SS




| | | | |
|---|---|---|---|
| DRAWN BY S.STROZ DATE 11/18/09 | Tetra Tech NUS, Inc. | CONTRACT NUMBER 0424 | OWNER NUMBER — |
| CHECKED BY N. BALSAMO DATE 01/11/10 | ZONE 7 ARSENIC POINTS OF GROUNDWATER CONTAMINATION<br>PROPOSED GROUNDWATER EXTRACTION WELL LOCATIONS<br>ALTERNATIVES GW-7.4 AND GW-7.5<br>LOWER SUBASE FEASIBILITY STUDY<br>NSB-NLON, GROTON, CONNECTICUT | APPROVED BY — DATE — | |
| COST/SCHEDULE-AREA | | APPROVED BY — DATE — | |
| SCALE AS NOTED | | DRAWING NO. FIGURE 4-32 | REV 0 |

| Project: | NSB New London Zone 1 | Project No.: | 112G00811 |
|---|---|---|---|
| Subject: | Groundwater Extraction System CMS Design | | |
| By: | J. Orient | Date: | 1/12/2010 |
| Checked: | | Date: | |

**Project/Design Objective:**

Design a groundwater extraction system for containment/cleanup of the copper/TPH point of groundwater contamination centered around FOMW14 in the shallow portion of the unconsolidated groundwater flow system. Project cleanup rates/times assuming that the residual source (free product from Tank H-54) been removed or otherwise isolated from groundwater. The final design should be capable of remediating contaminated groundwater to target cleanup levels within a reasonable time frame (30 years or less), and should offer significant advantages over natural processes in terms of cleanup rate and/or protection of receptors. This design should be considered as conceptual only - additional data, i.e., aquifer characteristics, contaminant distributions are needed for a final design.

**Basis of Design Data:** (Input cells yellow, blue automatically calculated)

**Groundwater Plume Information**

| | | |
|---|---|---|
| Plume Width (W): | 100 | ft. |
| Plume Thickness: | 50 | ft. |
| Plume Area: | 7,854 | $ft^2$ |
| Volume of Groundwater in Plume: | 129591 | $ft^3$ |
| Avg Hydraulic Conductivity, Plume Area: | 59 | ft/day |

**Aquifer Characteristics**

| | | |
|---|---|---|
| Thickness (B): | 50 | ft. |
| Avg. Hydraulic Conductivity (K): | 59 | ft/day |
| Transmissivity (T): | 2950 | $ft^2$/day |
| Porosity (n): | 0.33 | |
| Storativity (S): | 0.15 | |
| Fractional Organic Carbon Content (foc): | 0.006 | |
| Flow Gradient (i): | 0.0026 | |

**Contaminant Characteristics**

| | | | |
|---|---|---|---|
| Contaminant A Representative gw conc.: | TPH (pyrene surrogate) | 16000 | ug/L |
| Contaminant B Representative gw conc.: | copper | 78 | |
| Koc, Contaminant A: | | 1,650,000 | l/kg |
| Koc, Contaminant B: | | 5834 | l/kg |
| Kd, Contaminant A: | | 9900 | l/kg |
| Kd, Contaminant B: | | 35.004 | l/kg |
| Half-life, Contaminant A: | | 10 | years |
| Half-life, Contaminant B: | | | years |
| Target Cleanup Level, Contaminant A: | | 2500 | ug/L |
| Target Cleanup Level, Contaminant B: | | 48 | ug/L |

**Remedial System Information**

| | | |
|---|---|---|
| Extraction Well Radius, (r) : | 0.25 | ft. |
| Time to Reach Steady-State Drawdown (t): | 30 | days |
| Allowable Drawdown, Single Well, (s): | 5 | ft. |

**Technical Approach:**

Using aquifer characteristics, contaminated groundwater volume, Kd, half-life, and representative groundwater concentration data, calculate the number of pore volume flushes and times required to reach the target groundwater concentration (performed using the attached spreadsheets). Use standard equations to calculate the minimum required pumping rate for containment, per-well achievable pumping rates, and well spacings. Develop a preliminary extraction system design based on the calculations, adjusting the design as appropriate based on data limitation considerations and best scientific judgement. Base cleanup rate calculation on TPH, also check copper.

**Required Pumping Rate (Qt) for Total Plume Capture**

Qt = TiW x 2 (2x the natural groundwater flow-thru rate for entire aquifer)

Qt = 767.00 $ft^3$/day x 2, or 3.98 gpm x 2

Qt = 1534.00 $ft^3$/day, or 7.97 gpm

**Maximum Achievable Pumping Rate in a Single Well (Qa)**

Qa = $[4\pi Ts/2.3] / \log [2.25Tt/r^2S]$

Qa = 10998.66 $ft^3$/day, or 57.13 gpm

**Minimum Number of Extraction Wells Required**

= Qt/Qa

= 0.14 wells

**Plume Cleanup Rate Projections (From Spreadsheet Program or Other Source)**

| | | | | |
|---|---|---|---|---|
| At | 8.0 | gpm, | 27 | years |
| At | 16.0 | gpm, | 27 | years |
| At | 32.0 | gpm, | 27 | years |
| At natural GW flow rate: (plume area only) | 3.98 | gpm, | 27 | years |

Contaminant that cleanup rate is based on: TPH (blended)

**Based on the limiting conditions calculated above, projections regarding cleanup times at various pumping rates (see accompanying spreadsheets), a suitable safety factor based on the degree of confidence in the design data, and best scientific judgement, the following are the number of extraction wells and pumping rates selected for the design:**

| | | | |
|---|---|---|---|
| **Number of Wells:** | 1 | | |
| **Per-well Pumping Rate (Qw):** | 8 | gpm, or | 1540.08 $ft^3$/day |
| **Total System Pumping Rate (Qes):** | 8 | gpm, or | 1540.08 $ft^3$/day |

**Extraction Well Spacings, (WSp), ft Perpendicular to Groundwater Flow Direction**

WSp = $Qw/\pi Ti$, for a 2-well extraction system

WSp = 63.91 ft

or

WSp = $1.26(Qw)/\pi Ti$, for a 3-well extraction system

WSp = 80.53 ft

or

WSp = $1.2(Qw)/\pi Ti$, for an extraction system with 4+ wells

WSp = 76.70 ft

**Downgradient Stagnation Point (SPd) Approximation**

SPd = $Qes/2\pi Ti$, Qes = total extraction system pumping rate, $ft^3$/day

SPd = 31.96 ft

**Alternate Layout of Extraction Well System (I.e., parallel to GW flow direction):**

Position well within hot spot area, within 25-30 ft of downgradient limit of where remediation is reqiured.

**Final Configuration, Groundwater Extraction System:**

No pumping recommended for the TPH-impacted groundwater. Residual TPH likely has extremely high soil/water partition coefficient/low mobility and as a result pumping will not accelerate cleanup to any noticeable degree. Long term biodegradation will reduce TPH levels over time to the 2500 ug/l cleanup level within an estimated 27 years, assuming a conservative 10-year half life for TPH. Copper cleanup timeframe under non-pumping conditions is projected to be similar (42 years), so overall benefit from pumping would be minimal (27 versus 42 year cleanup timeframe).

# Heterogeneous Aquifer Flushing Rate Calculations

| | | | |
|---|---|---|---|
| **Project:** | NSB New London Zone 1 | **Proj. No.:** | 112G00811 |
| **Chemical :** | TPH | **$K_{OC}$ ($K_d$*) :** | 1650000 |
| **Concentration units, water & soil (pick 1):** | mg/L & mg/Kg: | ug/L & ug/Kg: | x |

**This spreadsheet calculates flushing rates and cleanup times for a groundwater flow system that consists of up to 3 groundwater "flow units". Flow units are discrete portions of the aquifer that have unique properties, i.e., higher or lower average hydraulic conductivity, porosity, or specific gravity relative to other portions of the aquifer, higher/lower contaminant concentrations, and/or different organic carbon contents. The spreadsheet factors in different flushing rates for discrete portions of the aquifer based on the differences in the physical/chemical characteristics of the flow units. First-order contaminant decay/degradation processes can also be factored into the cleanup rate prediction through the optional use of contaminant half-life data.**

**NOTE:** Input cells are shaded yellow; cells automatically calculated are shaded blue; the remaining cells are fixed.

All groundwater/soil contaminant concentrations are in consistent units, i.e., mg/L & mg/Kg, or ug/L & ug/Kg.

*** for contaminants that partition between soil and water thru mechanisms other than adsoption onto organic carbon, i.e., metals, the compound's $K_d$ is input directly into the $K_{OC}$ entry cell, with $f_{OC}$ then set to 1. For fractured bedrock, reduce the $f_{OC}$ by 1-2 orders of magnitude to adjust for typical low fracture porosity and resulting high model-perceived mass of aquifer sediments in contact with water.**

### Groundwater Flow Unit Physical/Chemical Data

| Flow Unit 1 (U1) | | Flow Unit 2 (U2) | | Flow Unit 3 (U3) | |
|---|---|---|---|---|---|
| $Cw_{01}$ | 16000.00 | $Cw_{02}$ | 16000.00 | $Cw_{03}$ | 16000.00 |
| n | 0.33 | n | 0.33 | n | 0.33 |
| $S_G$ | 2.65 | $S_G$ | 2.65 | $S_G$ | 2.65 |
| $f_{OC}$* | 0.0060 | $f_{OC}$* | 0.0060 | $f_{OC}$* | 0.0060 |
| $K_d$ | 9900.00 | $K_d$ | 9900.00 | $K_d$ | 9900.00 |
| $M_W$ | 5280.00 | $M_W$ | 5280.00 | $M_W$ | 5280.00 |
| $C_S$ | 158400000.00 | $C_S$ | 158400000.00 | $C_S$ | 158400000.00 |
| $M_S$ | 281239200.00 | $M_S$ | 281239200.00 | $M_S$ | 281239200.00 |
| $M_T$ | 281244480.00 | $M_T$ | 281244480.00 | $M_T$ | 281244480.00 |
| $M_S/M_T$ | 1.000 | $M_S/M_T$ | 1.000 | $M_S/M_T$ | 1.000 |

**$Cw_{0N}$ = Initial contaminant concentration in groundwater flow unit N**

### Groundwater Flow Unit Hydrogeologic Characteristics

| Avg. K, ft/d highest to lowest | Relative average K, $K_U$ | Fraction of aquifer volume, $FV_U$ | Fraction of total flow, $FQ_U$ | Flow unit number, U |
|---|---|---|---|---|
| 59 | 1.000 | 0.33 | 0.331 | 1 |
| 59 | 1.000 | 0.34 | 0.338 | 2 |
| 59 | 1.000 | 0.33 | 0.331 | 3 |

### Pore Volumes and Pore Volume Removal Rates

| Groundwater discharge rate, gpm | Groundwater discharge rate, $ft^3$/day, $Q_T$ | Total volume occupied by plume, $ft^3$, $PV_T$ |
|---|---|---|
| 4 | 770.05 | 392,700 |

| Discharge rate, Unit 1 $ft^3$/day, $Q_1$ | Discharge rate, Unit 2 $ft^3$/day, $Q_2$ | Discharge rate, Unit 3 $ft^3$/day, $Q_3$ | Plume pore Vol., Unit 1 $ft^3$, $PV_1$ | Plume pore Vol., Unit 2 $ft^3$, $PV_2$ | Plume pore Vol., Unit 3 $ft^3$, $PV_3$ | Time for 1 PV flush, Unit 1, days, $t_1$ | Time for 1 PV flush, Unit 2, days, $t_2$ | Time for 1 PV flush, Unit 3, days, $t_3$ |
|---|---|---|---|---|---|---|---|---|
| 254.98 | 260.10 | 254.98 | 42765.03 | 44060.94 | 42765.03 | 167.72 | 169.40 | 167.72 |

### Contaminant Half-Life Data

| | | | |
|---|---|---|---|
| **Does contaminant have a decay half-life (yes/no):** | yes | **If yes, half-life (days):** | 3650 |
| **1st order decay coefficient (k):** | 0.000190 | | |

### Average Pumped/Discharged and Residual Plume Concentrations Over Time

| Target Cleanup Concentration : | | | 2500 | ug/L |
|---|---|---|---|---|
| Time period | Time span, days, t | Avg pumped GW conc. | Avg residual GW conc. | Time span, years |
| 0 | 0 | 0 | **16000** | 0 |
| 1 | 167.72 | 15498.282 | **15498.282** | 0.46 |
| 1.5 | 251.58 | 15253.353 | **15253.353** | 0.69 |
| 2 | 335.44 | 15012.296 | **15012.296** | 0.92 |
| 3 | 503.17 | 14541.549 | **14541.549** | 1.38 |
| 4 | 670.89 | 14085.564 | **14085.564** | 1.84 |
| 5 | 838.61 | 13643.877 | **13643.877** | 2.30 |
| 7 | 1174.05 | 12801.620 | **12801.620** | 3.21 |
| 9 | 1509.50 | 12011.357 | **12011.357** | 4.13 |
| 12 | 2012.66 | 10916.484 | **10916.484** | 5.51 |
| 15 | 2515.83 | 9921.411 | **9921.412** | 6.89 |
| 18 | 3018.99 | 9017.043 | **9017.043** | 8.27 |
| 21 | 3522.16 | 8195.111 | **8195.111** | 9.64 |
| 25 | 4193.04 | 7214.548 | **7214.548** | 11.48 |
| 30 | 5031.65 | 6152.150 | **6152.150** | 13.78 |
| 35 | 5870.26 | 5246.199 | **5246.199** | 16.07 |
| 40 | 6708.87 | 4473.656 | **4473.656** | 18.37 |
| 50 | 8386.09 | 3253.106 | **3253.106** | 22.96 |
| 60 | 10063.31 | 2365.560 | **2365.560** | 27.55 |
| 80 | 13417.74 | 1250.850 | **1250.850** | 36.74 |
| 100 | 16772.18 | 661.419 | **661.419** | 45.92 |
| 52 | 8721.53 | 3052.287 | **3052.287** | 23.88 |
| 54 | 9056.98 | 2863.865 | **2863.865** | 24.80 |
| 56 | 9392.42 | 2687.074 | **2687.074** | 25.72 |
| 58 | 9727.86 | 2521.197 | **2521.197** | 26.63 |
| 59 | 9895.58 | 2442.139 | **2442.139** | 27.09 |

Adjust the initial time period to auto-adjust the following 19 time periods and obtain the desired range in concentrations.

The last 5 time periods can be modified to more precisely determine the time required to meet a specific residual concentration.

# Heterogeneous Aquifer Flushing Rate Calculations

| | | | |
|---|---|---|---|
| **Project:** | NSB New London Zone 1 | **Proj. No.:** | 112G00811 |
| **Chemical :** | TPH | **$K_{OC}$ ($K_d$*) :** | 1650000 |
| **Concentration units, water & soil (pick 1):** | mg/L & mg/Kg: | ug/L & ug/Kg: | x |

**This spreadsheet calculates flushing rates and cleanup times for a groundwater flow system that consists of up to 3 groundwater "flow units". Flow units are discrete portions of the aquifer that have unique properties, i.e., higher or lower average hydraulic conductivity, porosity, or specific gravity relative to other portions of the aquifer, higher/lower contaminant concentrations, and/or different organic carbon contents. The spreadsheet factors in different flushing rates for discrete portions of the aquifer based on the differences in the physical/chemical characteristics of the flow units. First-order contaminant decay/degradation processes can also be factored into the cleanup rate prediction through the optional use of contaminant half-life data.**

**NOTE:** Input cells are shaded yellow; cells automatically calculated are shaded blue; the remaining cells are fixed.

All groundwater/soil contaminant concentrations are in consistent units, i.e., mg/L & mg/Kg, or ug/L & ug/Kg.

*** for contaminants that partition between soil and water thru mechanisms other than adsoption onto organic carbon, i.e., metals, the compound's $K_d$ is input directly into the $K_{OC}$ entry cell, with $f_{OC}$ then set to 1. For fractured bedrock, reduce the $f_{OC}$ by 1-2 orders of magnitude to adjust for typical low fracture porosity and resulting high model-perceived mass of aquifer sediments in contact with water.**

### Groundwater Flow Unit Physical/Chemical Data

| Flow Unit 1 (U1) | | Flow Unit 2 (U2) | | Flow Unit 3 (U3) | |
|---|---|---|---|---|---|
| $Cw_{01}$ | 16000.00 | $Cw_{02}$ | 16000.00 | $Cw_{03}$ | 16000.00 |
| n | 0.33 | n | 0.33 | n | 0.33 |
| $S_G$ | 2.65 | $S_G$ | 2.65 | $S_G$ | 2.65 |
| $f_{OC}$* | 0.0060 | $f_{OC}$* | 0.0060 | $f_{OC}$* | 0.0060 |
| $K_d$ | 9900.00 | $K_d$ | 9900.00 | $K_d$ | 9900.00 |
| $M_W$ | 5280.00 | $M_W$ | 5280.00 | $M_W$ | 5280.00 |
| $C_S$ | 158400000.00 | $C_S$ | 158400000.00 | $C_S$ | 158400000.00 |
| $M_S$ | 281239200.00 | $M_S$ | 281239200.00 | $M_S$ | 281239200.00 |
| $M_T$ | 281244480.00 | $M_T$ | 281244480.00 | $M_T$ | 281244480.00 |
| $M_S/M_T$ | 1.000 | $M_S/M_T$ | 1.000 | $M_S/M_T$ | 1.000 |

**$Cw_{0N}$ = Initial contaminant concentration in groundwater flow unit N**

### Groundwater Flow Unit Hydrogeologic Characteristics

| Avg. K, ft/d highest to lowest | Relative average K, $K_U$ | Fraction of aquifer volume, $FV_U$ | Fraction of total flow, $FQ_U$ | Flow unit number, U |
|---|---|---|---|---|
| 59 | 1.000 | 0.33 | 0.331 | 1 |
| 59 | 1.000 | 0.34 | 0.338 | 2 |
| 59 | 1.000 | 0.33 | 0.331 | 3 |

### Pore Volumes and Pore Volume Removal Rates

| Groundwater discharge rate, gpm | Groundwater discharge rate, $ft^3$/day, $Q_T$ | Total volume occupied by plume, $ft^3$, $PV_T$ |
|---|---|---|
| 8 | 1540.11 | 392,700 |

| Discharge rate, Unit 1 $ft^3$/day, $Q_1$ | Discharge rate, Unit 2 $ft^3$/day, $Q_2$ | Discharge rate, Unit 3 $ft^3$/day, $Q_3$ | Plume pore Vol., Unit 1 $ft^3$, $PV_1$ | Plume pore Vol., Unit 2 $ft^3$, $PV_2$ | Plume pore Vol., Unit 3 $ft^3$, $PV_3$ | Time for 1 PV flush, Unit 1, days, $t_1$ | Time for 1 PV flush, Unit 2, days, $t_2$ | Time for 1 PV flush, Unit 3, days, $t_3$ |
|---|---|---|---|---|---|---|---|---|
| 509.95 | 520.20 | 509.95 | 42765.03 | 44060.94 | 42765.03 | 83.86 | 84.70 | 83.86 |

### Contaminant Half-Life Data

| | | | |
|---|---|---|---|
| **Does contaminant have a decay half-life (yes/no):** | yes | **If yes, half-life (days):** | 3650 |
| **1st order decay coefficient (k):** | 0.000190 | | |

### Average Pumped/Discharged and Residual Plume Concentrations Over Time

| Target Cleanup Concentration : | | | 2500 | ug/L |
|---|---|---|---|---|
| Time period | Time span, days, t | Avg pumped GW conc. | Avg residual GW conc. | Time span, years |
| 0 | 0 | 0 | **16000** | 0 |
| 2 | 167.72 | 15497.992 | **15497.992** | 0.46 |
| 3 | 251.58 | 15252.925 | **15252.925** | 0.69 |
| 4 | 335.44 | 15011.734 | **15011.734** | 0.92 |
| 6 | 503.17 | 14540.733 | **14540.733** | 1.38 |
| 8 | 670.89 | 14084.510 | **14084.510** | 1.84 |
| 10 | 838.61 | 13642.601 | **13642.601** | 2.30 |
| 14 | 1174.05 | 12799.944 | **12799.944** | 3.21 |
| 18 | 1509.50 | 12009.334 | **12009.334** | 4.13 |
| 24 | 2012.66 | 10914.033 | **10914.033** | 5.51 |
| 30 | 2515.83 | 9918.627 | **9918.627** | 6.89 |
| 36 | 3018.99 | 9014.007 | **9014.007** | 8.27 |
| 42 | 3522.16 | 8191.892 | **8191.892** | 9.64 |
| 50 | 4193.04 | 7211.174 | **7211.174** | 11.48 |
| 60 | 5031.65 | 6148.698 | **6148.698** | 13.78 |
| 70 | 5870.26 | 5242.765 | **5242.765** | 16.07 |
| 80 | 6708.87 | 4470.309 | **4470.309** | 18.37 |
| 100 | 8386.09 | 3250.064 | **3250.064** | 22.96 |
| 120 | 10063.31 | 2362.905 | **2362.906** | 27.55 |
| 160 | 13417.74 | 1248.979 | **1248.979** | 36.74 |
| 200 | 16772.18 | 660.182 | **660.182** | 45.92 |
| 105 | 8805.39 | 3001.101 | **3001.101** | 24.11 |
| 110 | 9224.70 | 2771.208 | **2771.208** | 25.26 |
| 115 | 9644.00 | 2558.926 | **2558.926** | 26.40 |
| 116 | 9727.86 | 2518.462 | **2518.462** | 26.63 |
| 117 | 9811.72 | 2478.638 | **2478.639** | 26.86 |

Adjust the initial time period to auto-adjust the following 19 time periods and obtain the desired range in concentrations.

The last 5 time periods can be modified to more precisely determine the time required to meet a specific residual concentration.

# Heterogeneous Aquifer Flushing Rate Calculations

| Project: | NSB New London Zone 1 | Proj. No.: | 112G00811 |
|---|---|---|---|
| Chemical : | TPH | $K_{OC}$ ($K_d$*) : | 1650000 |
| Concentration units, water & soil (pick 1): | mg/L & mg/Kg: | ug/L & ug/Kg: | x |

**This spreadsheet calculates flushing rates and cleanup times for a groundwater flow system that consists of up to 3 groundwater "flow units". Flow units are discrete portions of the aquifer that have unique properties, i.e., higher or lower average hydraulic conductivity, porosity, or specific gravity relative to other portions of the aquifer, higher/lower contaminant concentrations, and/or different organic carbon contents. The spreadsheet factors in different flushing rates for discrete portions of the aquifer based on the differences in the physical/chemical characteristics of the flow units. First-order contaminant decay/degradation processes can also be factored into the cleanup rate prediction through the optional use of contaminant half-life data.**

NOTE: Input cells are shaded yellow; cells automatically calculated are shaded blue; the remaining cells are fixed.

All groundwater/soil contaminant concentrations are in consistent units, i.e., mg/L & mg/Kg, or ug/L & ug/Kg.

*** for contaminants that partition between soil and water thru mechanisms other than adsoption onto organic carbon, i.e., metals, the compound's $K_d$ is input directly into the $K_{OC}$ entry cell, with $f_{OC}$ then set to 1. For fractured bedrock, reduce the $f_{OC}$ by 1-2 orders of magnitude to adjust for typical low fracture porosity and resulting high model-perceived mass of aquifer sediments in contact with water.**

## Groundwater Flow Unit Physical/Chemical Data

| Flow Unit 1 (U1) | | Flow Unit 2 (U2) | | Flow Unit 3 (U3) | |
|---|---|---|---|---|---|
| $Cw_{01}$ | 16000.00 | $Cw_{02}$ | 16000.00 | $Cw_{03}$ | 16000.00 |
| n | 0.33 | n | 0.33 | n | 0.33 |
| $S_G$ | 2.65 | $S_G$ | 2.65 | $S_G$ | 2.65 |
| $f_{OC}$* | 0.0060 | $f_{OC}$* | 0.0060 | $f_{OC}$* | 0.0060 |
| $K_d$ | 9900.00 | $K_d$ | 9900.00 | $K_d$ | 9900.00 |
| $M_W$ | 5280.00 | $M_W$ | 5280.00 | $M_W$ | 5280.00 |
| $C_S$ | 158400000.00 | $C_S$ | 158400000.00 | $C_S$ | 158400000.00 |
| $M_S$ | 281239200.00 | $M_S$ | 281239200.00 | $M_S$ | 281239200.00 |
| $M_T$ | 281244480.00 | $M_T$ | 281244480.00 | $M_T$ | 281244480.00 |
| $M_S/M_T$ | 1.000 | $M_S/M_T$ | 1.000 | $M_S/M_T$ | 1.000 |

$Cw_{0N}$ = Initial contaminant concentration in groundwater flow unit N

## Groundwater Flow Unit Hydrogeologic Characteristics

| Avg. K, ft/d highest to lowest | Relative average K, $K_U$ | Fraction of aquifer volume, $FV_U$ | Fraction of total flow, $FQ_U$ | Flow unit number, U |
|---|---|---|---|---|
| 59 | 1.000 | 0.33 | 0.331 | 1 |
| 59 | 1.000 | 0.34 | 0.338 | 2 |
| 59 | 1.000 | 0.33 | 0.331 | 3 |

## Pore Volumes and Pore Volume Removal Rates

| Groundwater discharge rate, gpm | Groundwater discharge rate, $ft^3$/day, $Q_T$ | Total volume occupied by plume, $ft^3$, $PV_T$ |
|---|---|---|
| 16 | 3080.21 | 392,700 |

| Discharge rate, Unit 1 $ft^3$/day, $Q_1$ | Discharge rate, Unit 2 $ft^3$/day, $Q_2$ | Discharge rate, Unit 3 $ft^3$/day, $Q_3$ | Plume pore Vol., Unit 1 $ft^3$, $PV_1$ | Plume pore Vol., Unit 2 $ft^3$, $PV_2$ | Plume pore Vol., Unit 3 $ft^3$, $PV_3$ | Time for 1 PV flush, Unit 1, days, $t_1$ | Time for 1 PV flush, Unit 2, days, $t_2$ | Time for 1 PV flush, Unit 3, days, $t_3$ |
|---|---|---|---|---|---|---|---|---|
| 1019.90 | 1040.41 | 1019.90 | 42765.03 | 44060.94 | 42765.03 | 41.93 | 42.35 | 41.93 |

## Contaminant Half-Life Data

| Does contaminant have a decay half-life (yes/no): | yes | If yes, half-life (days): | 3650 |
|---|---|---|---|
| 1st order decay coefficient (k): | 0.000190 | | |

## Average Pumped/Discharged and Residual Plume Concentrations Over Time

| Target Cleanup Concentration : | | | 2500 | ug/L |
|---|---|---|---|---|
| Time period | Time span, days, t | Avg pumped GW conc. | Avg residual GW conc. | Time span, years |
| 0 | 0 | 0 | 16000 | 0 |
| 3 | 125.79 | 15621.559 | **15621.559** | 0.34 |
| 4.5 | 188.69 | 15435.708 | **15435.709** | 0.52 |
| 6 | 251.58 | 15252.069 | **15252.069** | 0.69 |
| 9 | 377.37 | 14891.319 | **14891.319** | 1.03 |
| 12 | 503.17 | 14539.101 | **14539.101** | 1.38 |
| 15 | 628.96 | 14195.214 | **14195.214** | 1.72 |
| 21 | 880.54 | 13531.649 | **13531.649** | 2.41 |
| 27 | 1132.12 | 12899.103 | **12899.103** | 3.10 |
| 36 | 1509.50 | 12005.290 | **12005.290** | 4.13 |
| 45 | 1886.87 | 11173.413 | **11173.413** | 5.17 |
| 54 | 2264.24 | 10399.178 | **10399.178** | 6.20 |
| 63 | 2641.62 | 9678.592 | **9678.592** | 7.23 |
| 75 | 3144.78 | 8794.876 | **8794.877** | 8.61 |
| 90 | 3773.74 | 7802.822 | **7802.822** | 10.33 |
| 105 | 4402.70 | 6922.670 | **6922.670** | 12.05 |
| 120 | 5031.65 | 6141.799 | **6141.799** | 13.78 |
| 150 | 6289.57 | 4834.366 | **4834.366** | 17.22 |
| 180 | 7547.48 | 3805.252 | **3805.252** | 20.66 |
| 240 | 10063.31 | 2357.606 | **2357.606** | 27.55 |
| 300 | 12579.13 | 1460.693 | **1460.693** | 34.44 |
| 200 | 8386.09 | 3243.989 | **3243.989** | 22.96 |
| 220 | 9224.70 | 2765.510 | **2765.510** | 25.26 |
| 230 | 9644.00 | 2553.426 | **2553.426** | 26.40 |
| 232 | 9727.86 | 2513.002 | **2513.002** | 26.63 |
| 233 | 9769.79 | 2493.031 | **2493.031** | 26.75 |

Adjust the initial time period to auto-adjust the following 19 time periods and obtain the desired range in concentrations.

The last 5 time periods can be modified to more precisely determine the time required to meet a specific residual concentration.

# Heterogeneous Aquifer Flushing Rate Calculations

| | | | |
|---|---|---|---|
| **Project:** | NSB New London Zone 1 | **Proj. No.:** | 112G00811 |
| **Chemical :** | TPH | $K_{OC}$ ($K_d$*) : | 1650000 |
| **Concentration units, water & soil (pick 1):** | mg/L & mg/Kg: | ug/L & ug/Kg: | x |

**This spreadsheet calculates flushing rates and cleanup times for a groundwater flow system that consists of up to 3 groundwater "flow units". Flow units are discrete portions of the aquifer that have unique properties, i.e., higher or lower average hydraulic conductivity, porosity, or specific gravity relative to other portions of the aquifer, higher/lower contaminant concentrations, and/or different organic carbon contents. The spreadsheet factors in different flushing rates for discrete portions of the aquifer based on the differences in the physical/chemical characteristics of the flow units. First-order contaminant decay/degradation processes can also be factored into the cleanup rate prediction through the optional use of contaminant half-life data.**

**NOTE:** Input cells are shaded yellow; cells automatically calculated are shaded blue; the remaining cells are fixed.

All groundwater/soil contaminant concentrations are in consistent units, i.e., mg/L & mg/Kg, or ug/L & ug/Kg.

*** for contaminants that partition between soil and water thru mechanisms other than adsoption onto organic carbon, i.e., metals, the compound's $K_d$ is input directly into the $K_{OC}$ entry cell, with $f_{OC}$ then set to 1. For fractured bedrock, reduce the $f_{OC}$ by 1-2 orders of magnitude to adjust for typical low fracture porosity and resulting high model-perceived mass of aquifer sediments in contact with water.**

## Groundwater Flow Unit Physical/Chemical Data

| Flow Unit 1 (U1) | | Flow Unit 2 (U2) | | Flow Unit 3 (U3) | |
|---|---|---|---|---|---|
| $Cw_{01}$ | 16000.00 | $Cw_{02}$ | 16000.00 | $Cw_{03}$ | 16000.00 |
| n | 0.33 | : n | 0.33 | n | 0.33 |
| $S_G$ | 2.65 | $S_G$ | 2.65 | $S_G$ | 2.65 |
| $f_{OC}$* | 0.0060 | $f_{OC}$* | 0.0060 | $f_{OC}$* | 0.0060 |
| $K_d$ | 9900.00 | $K_d$ | 9900.00 | $K_d$ | 9900.00 |
| $M_W$ | 5280.00 | $M_W$ | 5280.00 | $M_W$ | 5280.00 |
| $C_S$ | 158400000.00 | $C_S$ | 158400000.00 | $C_S$ | 158400000.00 |
| $M_S$ | 281239200.00 | $M_S$ | 281239200.00 | $M_S$ | 281239200.00 |
| $M_T$ | 281244480.00 | $M_T$ | 281244480.00 | $M_T$ | 281244480.00 |
| $M_S/M_T$ | 1.000 | $M_S/M_T$ | 1.000 | $M_S/M_T$ | 1.000 |

**$Cw_{0N}$ = Initial contaminant concentration in groundwater flow unit N**

## Groundwater Flow Unit Hydrogeologic Characteristics

| Avg. K, ft/d highest to lowest | Relative average K, $K_U$ | Fraction of aquifer volume, $FV_U$ | Fraction of total flow, $FQ_U$ | Flow unit number, U |
|---|---|---|---|---|
| 59 | 1.000 | 0.33 | 0.331 | 1 |
| 59 | 1.000 | 0.34 | 0.338 | 2 |
| 59 | 1.000 | 0.33 | 0.331 | 3 |

## Pore Volumes and Pore Volume Removal Rates

| Groundwater discharge rate, gpm | Groundwater discharge rate, $ft^3$/day, $Q_T$ | Total volume occupied by plume, $ft^3$, $PV_T$ |
|---|---|---|
| 32 | 6160.43 | 392,700 |

| Discharge rate, Unit 1 $ft^3$/day, $Q_1$ | Discharge rate, Unit 2 $ft^3$/day, $Q_2$ | Discharge rate, Unit 3 $ft^3$/day, $Q_3$ | Plume pore Vol., Unit 1 $ft^3$, $PV_1$ | Plume pore Vol., Unit 2 $ft^3$, $PV_2$ | Plume pore Vol., Unit 3 $ft^3$, $PV_3$ | Time for 1 PV flush, Unit 1, days, $t_1$ | Time for 1 PV flush, Unit 2, days, $t_2$ | Time for 1 PV flush, Unit 3, days, $t_3$ |
|---|---|---|---|---|---|---|---|---|
| 2039.81 | 2080.81 | 2039.81 | 42765.03 | 44060.94 | 42765.03 | 20.97 | 21.17 | 20.97 |

## Contaminant Half-Life Data

| | | | |
|---|---|---|---|
| **Does contaminant have a decay half-life (yes/no):** | yes | **If yes, half-life (days):** | 3650 |
| **1st order decay coefficient (k):** | 0.000190 | | |

## Average Pumped/Discharged and Residual Plume Concentrations Over Time

| Target Cleanup Concentration : | | | 2500 | ug/L |
|---|---|---|---|---|
| Time period | Time span, days, t | Avg pumped GW conc. | Avg residual GW conc. | Time span, years |
| 0 | 0 | 0 | **16000** | 0 |
| 5 | 104.83 | 15683.271 | **15683.271** | 0.29 |
| 7.5 | 157.24 | 15527.266 | **15527.266** | 0.43 |
| 10 | 209.65 | 15372.813 | **15372.813** | 0.57 |
| 15 | 314.48 | 15068.500 | **15068.500** | 0.86 |
| 20 | 419.30 | 14770.211 | **14770.211** | 1.15 |
| 25 | 524.13 | 14477.826 | **14477.827** | 1.43 |
| 35 | 733.78 | 13910.307 | **13910.307** | 2.01 |
| 45 | 943.43 | 13365.034 | **13365.034** | 2.58 |
| 60 | 1257.91 | 12586.938 | **12586.939** | 3.44 |
| 75 | 1572.39 | 11854.142 | **11854.143** | 4.30 |
| 90 | 1886.87 | 11164.009 | **11164.009** | 5.17 |
| 105 | 2201.35 | 10514.054 | **10514.054** | 6.03 |
| 125 | 2620.65 | 9705.924 | **9705.925** | 7.17 |
| 150 | 3144.78 | 8782.543 | **8782.543** | 8.61 |
| 175 | 3668.91 | 7947.008 | **7947.009** | 10.04 |
| 200 | 4193.04 | 7190.963 | **7190.963** | 11.48 |
| 250 | 5241.31 | 5887.810 | **5887.811** | 14.35 |
| 300 | 6289.57 | 4820.816 | **4820.817** | 17.22 |
| 400 | 8386.09 | 3231.872 | **3231.872** | 22.96 |
| 500 | 10482.61 | 2166.644 | **2166.645** | 28.70 |
| 440 | 9224.70 | 2754.150 | **2754.150** | 25.26 |
| 450 | 9434.35 | 2646.189 | **2646.190** | 25.83 |
| 460 | 9644.00 | 2542.461 | **2542.461** | 26.40 |
| 464 | 9727.86 | 2502.117 | **2502.117** | 26.63 |
| 465 | 9748.83 | 2492.131 | **2492.132** | 26.69 |

Adjust the initial time period to auto-adjust the following 19 time periods and obtain the desired range in concentrations.

The last 5 time periods can be modified to more precisely determine the time required to meet a specific residual concentration.

# Heterogeneous Aquifer Flushing Rate Calculations

| | | | |
|---|---|---|---|
| Project: | NSB New London Zone 1 | Proj. No.: | 112G00811 |
| Chemical : | Copper | $K_{OC}$ ($K_d$*) : | 35 |
| Concentration units, water & soil (pick 1): | mg/L & mg/Kg: | ug/L & ug/Kg: | x |

**This spreadsheet calculates flushing rates and cleanup times for a groundwater flow system that consists of up to 3 groundwater "flow units". Flow units are discrete portions of the aquifer that have unique properties, i.e., higher or lower average hydraulic conductivity, porosity, or specific gravity relative to other portions of the aquifer, higher/lower contaminant concentrations, and/or different organic carbon contents. The spreadsheet factors in different flushing rates for discrete portions of the aquifer based on the differences in the physical/chemical characteristics of the flow units. First-order contaminant decay/degradation processes can also be factored into the cleanup rate prediction through the optional use of contaminant half-life data.**

**NOTE:** Input cells are shaded yellow; cells automatically calculated are shaded blue; the remaining cells are fixed.

All groundwater/soil contaminant concentrations are in consistent units, i.e., mg/L & mg/Kg, or ug/L & ug/Kg.

*** for contaminants that partition between soil and water thru mechanisms other than adsoption onto organic carbon, i.e., metals, the compound's $K_d$ is input directly into the $K_{OC}$ entry cell, with $f_{OC}$ then set to 1. For fractured bedrock, reduce the $f_{OC}$ by 1-2 orders of magnitude to adjust for typical low fracture porosity and resulting high model-perceived mass of aquifer sediments in contact with water.**

## Groundwater Flow Unit Physical/Chemical Data

| Flow Unit 1 (U1) | | Flow Unit 2 (U2) | | Flow Unit 3 (U3) | |
|---|---|---|---|---|---|
| $Cw_{01}$ | 78.00 | $Cw_{02}$ | 78.00 | $Cw_{03}$ | 78.00 |
| n | 0.33 | n | 0.33 | n | 0.33 |
| $S_G$ | 2.65 | $S_G$ | 2.65 | $S_G$ | 2.65 |
| $f_{OC}$* | 1.0000 | $f_{OC}$* | 1.0000 | $f_{OC}$* | 1.0000 |
| $K_d$ | 35.00 | $K_d$ | 35.00 | $K_d$ | 35.00 |
| $M_W$ | 25.74 | $M_W$ | 25.74 | $M_W$ | 25.74 |
| $C_S$ | 2730.00 | $C_S$ | 2730.00 | $C_S$ | 2730.00 |
| $M_S$ | 4847.12 | $M_S$ | 4847.12 | $M_S$ | 4847.12 |
| $M_T$ | 4872.86 | $M_T$ | 4872.86 | $M_T$ | 4872.86 |
| $M_S/M_T$ | 0.995 | $M_S/M_T$ | 0.995 | $M_S/M_T$ | 0.995 |

**$Cw_{0N}$ = Initial contaminant concentration in groundwater flow unit N**

## Groundwater Flow Unit Hydrogeologic Characteristics

| Avg. K, ft/d highest to lowest | Relative average K, $K_U$ | Fraction of aquifer volume, $FV_U$ | Fraction of total flow, $FQ_U$ | Flow unit number, U |
|---|---|---|---|---|
| 59 | 1.000 | 0.33 | 0.331 | 1 |
| 59 | 1.000 | 0.34 | 0.338 | 2 |
| 59 | 1.000 | 0.33 | 0.331 | 3 |

## Pore Volumes and Pore Volume Removal Rates

| Groundwater discharge rate, gpm | Groundwater discharge rate, $ft^3$/day, $Q_T$ | Total volume occupied by plume, $ft^3$, $PV_T$ |
|---|---|---|
| 4 | 770.05 | 392,700 |

| Discharge rate, Unit 1 $ft^3$/day, $Q_1$ | Discharge rate, Unit 2 $ft^3$/day, $Q_2$ | Discharge rate, Unit 3 $ft^3$/day, $Q_3$ | Plume pore Vol., Unit 1 $ft^3$, $PV_1$ | Plume pore Vol., Unit 2 $ft^3$, $PV_2$ | Plume pore Vol., Unit 3 $ft^3$, $PV_3$ | Time for 1 PV flush, Unit 1, days, $t_1$ | Time for 1 PV flush, Unit 2, days, $t_2$ | Time for 1 PV flush, Unit 3, days, $t_3$ |
|---|---|---|---|---|---|---|---|---|
| 254.98 | 260.10 | 254.98 | 42765.03 | 44060.94 | 42765.03 | 167.72 | 169.40 | 167.72 |

## Contaminant Half-Life Data

| | | | |
|---|---|---|---|
| Does contaminant have a decay half-life (yes/no): | no | If yes, half-life (days): | 3650 |
| 1st order decay coefficient (k): | 0.000190 | | |

## Average Pumped/Discharged and Residual Plume Concentrations Over Time

| Target Cleanup Concentration : | | | 48 | ug/L |
|---|---|---|---|---|
| Time period | Time span, days, t | Avg pumped GW conc. | Avg residual GW conc. | Time span, years |
| 0 | 0 | 0 | **78** | 0 |
| 1 | 167.72 | 77.589 | **77.589** | 0.46 |
| 1.5 | 251.58 | 77.385 | **77.385** | 0.69 |
| 2 | 335.44 | 77.181 | **77.181** | 0.92 |
| 3 | 503.17 | 76.775 | **76.775** | 1.38 |
| 4 | 670.89 | 76.370 | **76.370** | 1.84 |
| 5 | 838.61 | 75.968 | **75.968** | 2.30 |
| 7 | 1174.05 | 75.170 | **75.171** | 3.21 |
| 9 | 1509.50 | 74.381 | **74.381** | 4.13 |
| 12 | 2012.66 | 73.212 | **73.213** | 5.51 |
| 15 | 2515.83 | 72.062 | **72.062** | 6.89 |
| 18 | 3018.99 | 70.930 | **70.930** | 8.27 |
| 21 | 3522.16 | 69.816 | **69.816** | 9.64 |
| 25 | 4193.04 | 68.357 | **68.357** | 11.48 |
| 30 | 5031.65 | 66.576 | **66.577** | 13.78 |
| 35 | 5870.26 | 64.842 | **64.843** | 16.07 |
| 40 | 6708.87 | 63.153 | **63.154** | 18.37 |
| 50 | 8386.09 | 59.906 | **59.906** | 22.96 |
| 60 | 10063.31 | 56.826 | **56.826** | 27.55 |
| 80 | 13417.74 | 51.133 | **51.133** | 36.74 |
| 100 | 16772.18 | 46.010 | **46.010** | 45.92 |
| 88 | 14759.51 | 49.018 | **49.019** | 40.41 |
| 89 | 14927.24 | 48.760 | **48.761** | 40.87 |
| 90 | 15094.96 | 48.504 | **48.504** | 41.33 |
| 91 | 15262.68 | 48.248 | **48.249** | 41.79 |
| 92 | 15430.40 | 47.994 | **47.995** | 42.25 |

Adjust the initial time period to auto-adjust the following 19 time periods and obtain the desired range in concentrations.

The last 5 time periods can be modified to more precisely determine the time required to meet a specific residual concentration.

# Heterogeneous Aquifer Flushing Rate Calculations

| | | | |
|---|---|---|---|
| Project: | NSB New London Zone 1 | Proj. No.: | 112G00811 |
| Chemical : | Copper | $K_{OC}$ ($K_d$*) : | 35 |
| Concentration units, water & soil (pick 1): | mg/L & mg/Kg: | ug/L & ug/Kg: | x |

**This spreadsheet calculates flushing rates and cleanup times for a groundwater flow system that consists of up to 3 groundwater "flow units". Flow units are discrete portions of the aquifer that have unique properties, i.e., higher or lower average hydraulic conductivity, porosity, or specific gravity relative to other portions of the aquifer, higher/lower contaminant concentrations, and/or different organic carbon contents. The spreadsheet factors in different flushing rates for discrete portions of the aquifer based on the differences in the physical/chemical characteristics of the flow units. First-order contaminant decay/degradation processes can also be factored into the cleanup rate prediction through the optional use of contaminant half-life data.**

NOTE: Input cells are shaded yellow; cells automatically calculated are shaded blue; the remaining cells are fixed.

All groundwater/soil contaminant concentrations are in consistent units, i.e., mg/L & mg/Kg, or ug/L & ug/Kg.

*** for contaminants that partition between soil and water thru mechanisms other than adsoption onto organic carbon, i.e., metals, the compound's $K_d$ is input directly into the $K_{OC}$ entry cell, with $f_{OC}$ then set to 1. For fractured bedrock, reduce the $f_{OC}$ by 1-2 orders of magnitude to adjust for typical low fracture porosity and resulting high model-perceived mass of aquifer sediments in contact with water.**

## Groundwater Flow Unit Physical/Chemical Data

| Flow Unit 1 (U1) | | Flow Unit 2 (U2) | | Flow Unit 3 (U3) | |
|---|---|---|---|---|---|
| $Cw_{01}$ | 78.00 | $Cw_{02}$ | 78.00 | $Cw_{03}$ | 78.00 |
| n | 0.33 | n | 0.33 | n | 0.33 |
| $S_G$ | 2.65 | $S_G$ | 2.65 | $S_G$ | 2.65 |
| $f_{OC}$* | 1.0000 | $f_{OC}$* | 1.0000 | $f_{OC}$* | 1.0000 |
| $K_d$ | 35.00 | $K_d$ | 35.00 | $K_d$ | 35.00 |
| $M_W$ | 25.74 | $M_W$ | 25.74 | $M_W$ | 25.74 |
| $C_S$ | 2730.00 | $C_S$ | 2730.00 | $C_S$ | 2730.00 |
| $M_S$ | 4847.12 | $M_S$ | 4847.12 | $M_S$ | 4847.12 |
| $M_T$ | 4872.86 | $M_T$ | 4872.86 | $M_T$ | 4872.86 |
| $M_S/M_T$ | 0.995 | $M_S/M_T$ | 0.995 | $M_S/M_T$ | 0.995 |

$Cw_{0N}$ = Initial contaminant concentration in groundwater flow unit N

## Groundwater Flow Unit Hydrogeologic Characteristics

| Avg. K, ft/d highest to lowest | Relative average K, $K_U$ | Fraction of aquifer volume, $FV_U$ | Fraction of total flow, $FQ_U$ | Flow unit number, U |
|---|---|---|---|---|
| 59 | 1.000 | 0.33 | 0.331 | 1 |
| 59 | 1.000 | 0.34 | 0.338 | 2 |
| 59 | 1.000 | 0.33 | 0.331 | 3 |

## Pore Volumes and Pore Volume Removal Rates

| Groundwater discharge rate, gpm | Groundwater discharge rate, $ft^3$/day, $Q_T$ | Total volume occupied by plume, $ft^3$, $PV_T$ |
|---|---|---|
| 8 | 1540.11 | 392,700 |

| Discharge rate, Unit 1 $ft^3$/day, $Q_1$ | Discharge rate, Unit 2 $ft^3$/day, $Q_2$ | Discharge rate, Unit 3 $ft^3$/day, $Q_3$ | Plume pore Vol., Unit 1 $ft^3$, $PV_1$ | Plume pore Vol., Unit 2 $ft^3$, $PV_2$ | Plume pore Vol., Unit 3 $ft^3$, $PV_3$ | Time for 1 PV flush, Unit 1, days, $t_1$ | Time for 1 PV flush, Unit 2, days, $t_2$ | Time for 1 PV flush, Unit 3, days, $t_3$ |
|---|---|---|---|---|---|---|---|---|
| 509.95 | 520.20 | 509.95 | 42765.03 | 44060.94 | 42765.03 | 83.86 | 84.70 | 83.86 |

## Contaminant Half-Life Data

| | | | |
|---|---|---|---|
| Does contaminant have a decay half-life (yes/no): | no | If yes, half-life (days): | 3650 |
| 1st order decay coefficient (k): | 0.000190 | | |

## Average Pumped/Discharged and Residual Plume Concentrations Over Time

| Target Cleanup Concentration : | | | 48 | ug/L |
|---|---|---|---|---|
| Time period | Time span, days, t | Avg pumped GW conc. | Avg residual GW conc. | Time span, years |
| 0 | 0 | 0 | **78** | 0 |
| 1 | 83.86 | 77.589 | **77.589** | 0.23 |
| 1.5 | 125.79 | 77.385 | **77.385** | 0.34 |
| 2 | 167.72 | 77.181 | **77.181** | 0.46 |
| 3 | 251.58 | 76.775 | **76.775** | 0.69 |
| 4 | 335.44 | 76.370 | **76.370** | 0.92 |
| 5 | 419.30 | 75.968 | **75.968** | 1.15 |
| 7 | 587.03 | 75.170 | **75.171** | 1.61 |
| 9 | 754.75 | 74.381 | **74.381** | 2.07 |
| 12 | 1006.33 | 73.212 | **73.213** | 2.76 |
| 15 | 1257.91 | 72.062 | **72.062** | 3.44 |
| 18 | 1509.50 | 70.930 | **70.930** | 4.13 |
| 21 | 1761.08 | 69.816 | **69.816** | 4.82 |
| 25 | 2096.52 | 68.357 | **68.357** | 5.74 |
| 30 | 2515.83 | 66.576 | **66.577** | 6.89 |
| 35 | 2935.13 | 64.842 | **64.843** | 8.04 |
| 40 | 3354.44 | 63.153 | **63.154** | 9.18 |
| 50 | 4193.04 | 59.906 | **59.906** | 11.48 |
| 60 | 5031.65 | 56.826 | **56.826** | 13.78 |
| 80 | 6708.87 | 51.133 | **51.133** | 18.37 |
| 100 | 8386.09 | 46.010 | **46.010** | 22.96 |
| 88 | 7379.76 | 49.018 | **49.019** | 20.20 |
| 89 | 7463.62 | 48.760 | **48.761** | 20.43 |
| 90 | 7547.48 | 48.504 | **48.504** | 20.66 |
| 91 | 7631.34 | 48.248 | **48.249** | 20.89 |
| 92 | 7715.20 | 47.994 | **47.995** | 21.12 |

Adjust the initial time period to auto-adjust the following 19 time periods and obtain the desired range in concentrations.

The last 5 time periods can be modified to more precisely determine the time required to meet a specific residual concentration.

# Heterogeneous Aquifer Flushing Rate Calculations

| | | | |
|---|---|---|---|
| Project: | NSB New London Zone 1 | Proj. No.: | 112G00811 |
| Chemical : | Copper | $K_{OC}$ ($K_d$*) : | 35 |
| Concentration units, water & soil (pick 1): | mg/L & mg/Kg: | ug/L & ug/Kg: | x |

NOTE: Input cells are shaded yellow; cells automatically calculated are shaded blue; the remaining cells are fixed.

**This spreadsheet calculates flushing rates and cleanup times for a groundwater flow system that consists of up to 3 groundwater "flow units". Flow units are discrete portions of the aquifer that have unique properties, i.e., higher or lower average hydraulic conductivity, porosity, or specific gravity relative to other portions of the aquifer, higher/lower contaminant concentrations, and/or different organic carbon contents. The spreadsheet factors in different flushing rates for discrete portions of the aquifer based on the differences in the physical/chemical characteristics of the flow units. First-order contaminant decay/degradation processes can also be factored into the cleanup rate prediction through the optional use of contaminant half-life data.**

All groundwater/soil contaminant concentrations are in consistent units, i.e., mg/L & mg/Kg, or ug/L & ug/Kg.

*** for contaminants that partition between soil and water thru mechanisms other than adsoption onto organic carbon, i.e., metals, the compound's $K_d$ is input directly into the $K_{OC}$ entry cell, with $f_{OC}$ then set to 1. For fractured bedrock, reduce the $f_{OC}$ by 1-2 orders of magnitude to adjust for typical low fracture porosity and resulting high model-perceived mass of aquifer sediments in contact with water.**

## Groundwater Flow Unit Physical/Chemical Data

| Flow Unit 1 (U1) | | Flow Unit 2 (U2) | | Flow Unit 3 (U3) | |
|---|---|---|---|---|---|
| $Cw_{01}$ | 78.00 | $Cw_{02}$ | 78.00 | $Cw_{03}$ | 78.00 |
| n | 0.33 | n | 0.33 | n | 0.33 |
| $S_G$ | 2.65 | $S_G$ | 2.65 | $S_G$ | 2.65 |
| $f_{OC}$* | 1.0000 | $f_{OC}$* | 1.0000 | $f_{OC}$* | 1.0000 |
| $K_d$ | 35.00 | $K_d$ | 35.00 | $K_d$ | 35.00 |
| $M_W$ | 25.74 | $M_W$ | 25.74 | $M_W$ | 25.74 |
| $C_S$ | 2730.00 | $C_S$ | 2730.00 | $C_S$ | 2730.00 |
| $M_S$ | 4847.12 | $M_S$ | 4847.12 | $M_S$ | 4847.12 |
| $M_T$ | 4872.86 | $M_T$ | 4872.86 | $M_T$ | 4872.86 |
| $M_S/M_T$ | 0.995 | $M_S/M_T$ | 0.995 | $M_S/M_T$ | 0.995 |

$Cw_{0N}$ = Initial contaminant concentration in groundwater flow unit N

## Groundwater Flow Unit Hydrogeologic Characteristics

| Avg. K, ft/d highest to lowest | Relative average K, $K_U$ | Fraction of aquifer volume, $FV_U$ | Fraction of total flow, $FQ_U$ | Flow unit number, U |
|---|---|---|---|---|
| 59 | 1.000 | 0.33 | 0.331 | 1 |
| 59 | 1.000 | 0.34 | 0.338 | 2 |
| 59 | 1.000 | 0.33 | 0.331 | 3 |

## Pore Volumes and Pore Volume Removal Rates

| Groundwater discharge rate, gpm | Groundwater discharge rate, $ft^3$/day, $Q_T$ | Total volume occupied by plume, $ft^3$, $PV_T$ |
|---|---|---|
| 16 | 3080.21 | 392,700 |

| Discharge rate, Unit 1 $ft^3$/day, $Q_1$ | Discharge rate, Unit 2 $ft^3$/day, $Q_2$ | Discharge rate, Unit 3 $ft^3$/day, $Q_3$ | Plume pore Vol., Unit 1 $ft^3$, $PV_1$ | Plume pore Vol., Unit 2 $ft^3$, $PV_2$ | Plume pore Vol., Unit 3 $ft^3$, $PV_3$ | Time for 1 PV flush, Unit 1, days, $t_1$ | Time for 1 PV flush, Unit 2, days, $t_2$ | Time for 1 PV flush, Unit 3, days, $t_3$ |
|---|---|---|---|---|---|---|---|---|
| 1019.90 | 1040.41 | 1019.90 | 42765.03 | 44060.94 | 42765.03 | 41.93 | 42.35 | 41.93 |

## Contaminant Half-Life Data

| | | | |
|---|---|---|---|
| Does contaminant have a decay half-life (yes/no): | no | If yes, half-life (days): | 3650 |
| 1st order decay coefficient (k): | 0.000190 | | |

## Average Pumped/Discharged and Residual Plume Concentrations Over Time

| Target Cleanup Concentration : | | | 48 | ug/L |
|---|---|---|---|---|
| Time period | Time span, days, t | Avg pumped GW conc. | Avg residual GW conc. | Time span, years |
| 0 | 0 | 0 | **78** | 0 |
| 1 | 41.93 | 77.589 | **77.589** | 0.11 |
| 1.5 | 62.90 | 77.385 | **77.385** | 0.17 |
| 2 | 83.86 | 77.181 | **77.181** | 0.23 |
| 3 | 125.79 | 76.775 | **76.775** | 0.34 |
| 4 | 167.72 | 76.370 | **76.370** | 0.46 |
| 5 | 209.65 | 75.968 | **75.968** | 0.57 |
| 7 | 293.51 | 75.170 | **75.171** | 0.80 |
| 9 | 377.37 | 74.381 | **74.381** | 1.03 |
| 12 | 503.17 | 73.212 | **73.213** | 1.38 |
| 15 | 628.96 | 72.062 | **72.062** | 1.72 |
| 18 | 754.75 | 70.930 | **70.930** | 2.07 |
| 21 | 880.54 | 69.816 | **69.816** | 2.41 |
| 25 | 1048.26 | 68.357 | **68.357** | 2.87 |
| 30 | 1257.91 | 66.576 | **66.577** | 3.44 |
| 35 | 1467.57 | 64.842 | **64.843** | 4.02 |
| 40 | 1677.22 | 63.153 | **63.154** | 4.59 |
| 50 | 2096.52 | 59.906 | **59.906** | 5.74 |
| 60 | 2515.83 | 56.826 | **56.826** | 6.89 |
| 80 | 3354.44 | 51.133 | **51.133** | 9.18 |
| 100 | 4193.04 | 46.010 | **46.010** | 11.48 |
| 88 | 3689.88 | 49.018 | **49.019** | 10.10 |
| 89 | 3731.81 | 48.760 | **48.761** | 10.22 |
| 90 | 3773.74 | 48.504 | **48.504** | 10.33 |
| 91 | 3815.67 | 48.248 | **48.249** | 10.45 |
| 92 | 3857.60 | 47.994 | **47.995** | 10.56 |

Adjust the initial time period to auto-adjust the following 19 time periods and obtain the desired range in concentrations.

The last 5 time periods can be modified to more precisely determine the time required to meet a specific residual concentration.

| | | | |
|---|---|---|---|
| **Project:** | **NSB New London Zone 1/Plume 2** | **Project No.:** | **112G00811** |
| **Subject:** | **Groundwater Extraction System CMS Design** | | |
| **By:** | J. Orient | **Date:** | 1/12/2010 |
| **Checked:** | | **Date:** | |

**Project/Design Objective:**

Design a groundwater extraction system for containment/cleanup of the arsenic/copper point of groundwater contamination in the shallow portion of the unconsolidated groundwater flow system. Project cleanup rates/times assuming that the residual source has been removed or otherwise isolated from groundwater. The final design should be capable of remediating contaminated groundwater to target cleanup levels within a reasonable time frame (30 years or less), and should offer significant advantages over natural processes in terms of cleanup rate and/or protection of receptors. This design should be considered as conceptual only - additional data, i.e., aquifer characteristics, contaminant distributions are needed for a final design.

**Basis of Design Data:** (Input cells yellow, blue automatically calculated)

**Groundwater Plume Information**

| | | |
|---|---|---|
| Plume Width (W): | 120 | ft. |
| Plume Thickness: | 50 | ft. |
| Plume Area: | 20,000 | $ft^2$ |
| Volume of Groundwater in Plume: | 330000 | $ft^3$ |
| Avg Hydraulic Conductivity, Plume Area: | 59 | ft/day |

**Aquifer Characteristics**

| | | |
|---|---|---|
| Thickness (B): | 50 | ft. |
| Avg. Hydraulic Conductivity (K): | 59 | ft/day |
| Transmissivity (T): | 2950 | $ft^2$/day |
| Porosity (n): | 0.33 | |
| Storativity (S): | 0.15 | |
| Fractional Organic Carbon Content (foc): | 1 | |
| Flow Gradient (i): | 0.0026 | |

**Contaminant Characteristics**

| | | | |
|---|---|---|---|
| Contaminant A Representative gw conc.: | arsenic | 16.8 | ug/L |
| Contaminant B Representative gw conc.: | copper | 156 | |
| Koc, Contaminant A: | | 29 | l/kg |
| Koc, Contaminant B: | | 35 | l/kg |
| Kd, Contaminant A: | | 29 | l/kg |
| Kd, Contaminant B: | | 35 | l/kg |
| Half-life, Contaminant A: | | | years |
| Half-life, Contaminant B: | | | years |
| Target Cleanup Level, Contaminant A: | | 10 | ug/L |
| Target Cleanup Level, Contaminant B: | | 48 | ug/L |

**Remedial System Information**

| | | |
|---|---|---|
| Extraction Well Radius, (r) : | 0.25 | ft. |
| Time to Reach Steady-State Drawdown (t): | 30 | days |
| Allowable Drawdown, Single Well, (s): | 5 | ft. |

**Technical Approach:**

Using aquifer characteristics, contaminated groundwater volume, Kd, half-life, and representative groundwater concentration data, calculate the number of pore volume flushes and times required to reach the target groundwater concentration (performed using the attached spreadsheets). Use standard equations to calculate the minimum required pumping rate for containment, per-well achievable pumping rates, and well spacings. Develop a preliminary extraction system design based on the calculations, adjusting the design as appropriate based on data limitation considerations and best scientific judgement. Base initial cleanup rate calculation on copper (longer cleanup timeframe than arsenic).

**Required Pumping Rate (Qt) for Total Plume Capture**

Qt = TiW x 2 (2x the natural groundwater flow-thru rate for entire aquifer)

Qt = 920.40 $ft^3$/day x 2, or 4.78 gpm x 2

Qt = 1840.80 $ft^3$/day, or 9.56 gpm

**Maximum Achievable Pumping Rate in a Single Well (Qa)**

Qa = $[4\pi Ts/2.3] / \log [2.25Tt/r^2S]$

Qa = 10998.66 $ft^3$/day, or 57.13 gpm

**Minimum Number of Extraction Wells Required**

= Qt/Qa

= 0.17 wells

**Plume Cleanup Rate Projections (From Spreadsheet Program or Other Source)**

| | | | | |
|---|---|---|---|---|
| At | 10.0 | gpm, | 104 | years |
| At | 20.0 | gpm, | 52 | years |
| At | 40.0 | gpm, | 26 | years |
| At natural GW flow rate: (plume area only) | 4.78 | gpm, | 219 | years |

Contaminant that cleanup rate is based on: copper

**Based on the limiting conditions calculated above, projections regarding cleanup times at various pumping rates (see accompanying spreadsheets), a suitable safety factor based on the degree of confidence in the design data, and best scientific judgement, the following are the number of extraction wells and pumping rates selected for the design:**

| | | | |
|---|---|---|---|
| **Number of Wells:** | 2 | | |
| **Per-well Pumping Rate (Qw):** | 20 | gpm, or | 3850.20 $ft^3$/day |
| **Total System Pumping Rate (Qes):** | 40 | gpm, or | 7700.40 $ft^3$/day |

**Extraction Well Spacings, (WSp), ft Perpendicular to Groundwater Flow Direction**

WSp = $Qw/\pi Ti$, for a 2-well extraction system

WSp = 159.79 ft

or

WSp = $1.26(Qw)/\pi Ti$, for a 3-well extraction system

WSp = 201.33 ft

or

WSp = $1.2(Qw)/\pi Ti$, for an extraction system with 4+ wells

WSp = 191.74 ft

**Downgradient Stagnation Point (SPd) Approximation**

SPd = $Qes/2\pi Ti$, Qes = total extraction system pumping rate, $ft^3$/day

SPd = 159.79 ft

**Alternate Layout of Extraction Well System (I.e., parallel to GW flow direction):**

Position two wells within the hot spot area, aligned along the direction of groundwater flow.

**Final Configuration, Groundwater Extraction System:**

Install two wells within hot spot area, aligned along centerline of area of impacted groundwater in the direction of groundwater flow. One well should be centered at location of highest copper concentrations. Pump wells at 20 gpm each, for combined flow rate of 40 gpm. Copper projected to reach MCL within a 26 year timeframe; arsenic will reach cleanup gal sooner.

# Heterogeneous Aquifer Flushing Rate Calculations

| | | | |
|---|---|---|---|
| Project: | NSB New London Zone 1/Plume 2 | Proj. No.: | 112G00811 |
| Chemical : | Copper | $K_{OC}$ ($K_d$*) : | 35 |
| Concentration units, water & soil (pick 1): | mg/L & mg/Kg: | ug/L & ug/Kg: | x |

**This spreadsheet calculates flushing rates and cleanup times for a groundwater flow system that consists of up to 3 groundwater "flow units". Flow units are discrete portions of the aquifer that have unique properties, i.e., higher or lower average hydraulic conductivity, porosity, or specific gravity relative to other portions of the aquifer, higher/lower contaminant concentrations, and/or different organic carbon contents. The spreadsheet factors in different flushing rates for discrete portions of the aquifer based on the differences in the physical/chemical characteristics of the flow units. First-order contaminant decay/degradation processes can also be factored into the cleanup rate prediction through the optional use of contaminant half-life data.**

NOTE: Input cells are shaded yellow; cells automatically calculated are shaded blue; the remaining cells are fixed.

All groundwater/soil contaminant concentrations are in consistent units, i.e., mg/L & mg/Kg, or ug/L & ug/Kg.

*** for contaminants that partition between soil and water thru mechanisms other than adsoption onto organic carbon, i.e., metals, the compound's $K_d$ is input directly into the $K_{OC}$ entry cell, with $f_{OC}$ then set to 1. For fractured bedrock, reduce the $f_{OC}$ by 1-2 orders of magnitude to adjust for typical low fracture porosity and resulting high model-perceived mass of aquifer sediments in contact with water.**

## Groundwater Flow Unit Physical/Chemical Data

| Flow Unit 1 (U1) | | Flow Unit 2 (U2) | | Flow Unit 3 (U3) | |
|---|---|---|---|---|---|
| $Cw_{01}$ | 156.00 | $Cw_{02}$ | 156.00 | $Cw_{03}$ | 156.00 |
| n | 0.33 | n | 0.33 | n | 0.33 |
| $S_G$ | 2.65 | $S_G$ | 2.65 | $S_G$ | 2.65 |
| $f_{OC}$* | 1.0000 | $f_{OC}$* | 1.0000 | $f_{OC}$* | 1.0000 |
| $K_d$ | 35.00 | $K_d$ | 35.00 | $K_d$ | 35.00 |
| $M_W$ | 51.48 | $M_W$ | 51.48 | $M_W$ | 51.48 |
| $C_S$ | 5460.00 | $C_S$ | 5460.00 | $C_S$ | 5460.00 |
| $M_S$ | 9694.23 | $M_S$ | 9694.23 | $M_S$ | 9694.23 |
| $M_T$ | 9745.71 | $M_T$ | 9745.71 | $M_T$ | 9745.71 |
| $M_S/M_T$ | 0.995 | $M_S/M_T$ | 0.995 | $M_S/M_T$ | 0.995 |

$Cw_{0N}$ = Initial contaminant concentration in groundwater flow unit N

## Groundwater Flow Unit Hydrogeologic Characteristics

| Avg. K, ft/d highest to lowest | Relative average K, $K_U$ | Fraction of aquifer volume, $FV_U$ | Fraction of total flow, $FQ_U$ | Flow unit number, U |
|---|---|---|---|---|
| 59 | 1.000 | 0.33 | 0.331 | 1 |
| 59 | 1.000 | 0.34 | 0.338 | 2 |
| 59 | 1.000 | 0.33 | 0.331 | 3 |

## Pore Volumes and Pore Volume Removal Rates

| Groundwater discharge rate, gpm | Groundwater discharge rate, $ft^3$/day, $Q_T$ | Total volume occupied by plume, $ft^3$, $PV_T$ |
|---|---|---|
| 4.78 | 920.21 | 1,000,000 |

| Discharge rate, Unit 1 $ft^3$/day, $Q_1$ | Discharge rate, Unit 2 $ft^3$/day, $Q_2$ | Discharge rate, Unit 3 $ft^3$/day, $Q_3$ | Plume pore Vol., Unit 1 $ft^3$, $PV_1$ | Plume pore Vol., Unit 2 $ft^3$, $PV_2$ | Plume pore Vol., Unit 3 $ft^3$, $PV_3$ | Time for 1 PV flush, Unit 1, days, $t_1$ | Time for 1 PV flush, Unit 2, days, $t_2$ | Time for 1 PV flush, Unit 3, days, $t_3$ |
|---|---|---|---|---|---|---|---|---|
| 304.70 | 310.82 | 304.70 | 108900 | 112200 | 108900 | 357.40 | 360.98 | 357.40 |

## Contaminant Half-Life Data

| | | | |
|---|---|---|---|
| Does contaminant have a decay half-life (yes/no): | no | If yes, half-life (days): | 3650 |
| 1st order decay coefficient (k): | 0.000190 | | |

## Average Pumped/Discharged and Residual Plume Concentrations Over Time

| Target Cleanup Concentration : | | | 48 | ug/L |
|---|---|---|---|---|
| Time period | Time span, days, t | Avg pumped GW conc. | Avg residual GW conc. | Time span, years |
| 0 | 0 | 0 | **156** | 0 |
| 2 | 714.81 | 154.362 | **154.362** | 1.96 |
| 3 | 1072.21 | 153.549 | **153.549** | 2.94 |
| 4 | 1429.62 | 152.741 | **152.741** | 3.91 |
| 6 | 2144.43 | 151.137 | **151.137** | 5.87 |
| 8 | 2859.24 | 149.549 | **149.550** | 7.83 |
| 10 | 3574.05 | 147.979 | **147.979** | 9.79 |
| 14 | 5003.67 | 144.887 | **144.887** | 13.70 |
| 18 | 6433.29 | 141.860 | **141.860** | 17.61 |
| 24 | 8577.72 | 137.438 | **137.438** | 23.48 |
| 30 | 10722.15 | 133.153 | **133.153** | 29.36 |
| 36 | 12866.58 | 129.002 | **129.002** | 35.23 |
| 42 | 15011.01 | 124.980 | **124.981** | 41.10 |
| 50 | 17870.25 | 119.812 | **119.813** | 48.93 |
| 60 | 21444.30 | 113.652 | **113.653** | 58.71 |
| 70 | 25018.35 | 107.808 | **107.809** | 68.50 |
| 80 | 28592.40 | 102.265 | **102.266** | 78.28 |
| 100 | 35740.50 | 92.019 | **92.020** | 97.85 |
| 120 | 42888.60 | 82.800 | **82.801** | 117.42 |
| 160 | 57184.80 | 67.040 | **67.041** | 156.56 |
| 200 | 71481.00 | 54.279 | **54.281** | 195.70 |
| 210 | 75055.05 | 51.489 | **51.490** | 205.49 |
| 215 | 76842.07 | 50.148 | **50.149** | 210.38 |
| 220 | 78629.10 | 48.841 | **48.843** | 215.27 |
| 223 | 79701.31 | 48.074 | **48.075** | 218.21 |
| 224 | 80058.72 | 47.821 | **47.822** | 219.19 |

Adjust the initial time period to auto-adjust the following 19 time periods and obtain the desired range in concentrations.

The last 5 time periods can be modified to more precisely determine the time required to meet a specific residual concentration.

# Heterogeneous Aquifer Flushing Rate Calculations

| | | | |
|---|---|---|---|
| Project: | NSB New London Zone 1/Plume 2 | Proj. No.: | 112G00811 |
| Chemical : | Copper | $K_{OC}$ ($K_d$*) : | 35 |
| Concentration units, water & soil (pick 1): | mg/L & mg/Kg: | ug/L & ug/Kg: | x |

**This spreadsheet calculates flushing rates and cleanup times for a groundwater flow system that consists of up to 3 groundwater "flow units". Flow units are discrete portions of the aquifer that have unique properties, i.e., higher or lower average hydraulic conductivity, porosity, or specific gravity relative to other portions of the aquifer, higher/lower contaminant concentrations, and/or different organic carbon contents. The spreadsheet factors in different flushing rates for discrete portions of the aquifer based on the differences in the physical/chemical characteristics of the flow units. First-order contaminant decay/degradation processes can also be factored into the cleanup rate prediction through the optional use of contaminant half-life data.**

NOTE: Input cells are shaded yellow; cells automatically calculated are shaded blue; the remaining cells are fixed.

All groundwater/soil contaminant concentrations are in consistent units, i.e., mg/L & mg/Kg, or ug/L & ug/Kg.

*** for contaminants that partition between soil and water thru mechanisms other than adsoption onto organic carbon, i.e., metals, the compound's $K_d$ is input directly into the $K_{OC}$ entry cell, with $f_{OC}$ then set to 1. For fractured bedrock, reduce the $f_{OC}$ by 1-2 orders of magnitude to adjust for typical low fracture porosity and resulting high model-perceived mass of aquifer sediments in contact with water.**

## Groundwater Flow Unit Physical/Chemical Data

| Flow Unit 1 (U1) | | Flow Unit 2 (U2) | | Flow Unit 3 (U3) | |
|---|---|---|---|---|---|
| $Cw_{01}$ | 156.00 | $Cw_{02}$ | 156.00 | $Cw_{03}$ | 156.00 |
| n | 0.33 | n | 0.33 | n | 0.33 |
| $S_G$ | 2.65 | $S_G$ | 2.65 | $S_G$ | 2.65 |
| $f_{OC}$* | 1.0000 | $f_{OC}$* | 1.0000 | $f_{OC}$* | 1.0000 |
| $K_d$ | 35.00 | $K_d$ | 35.00 | $K_d$ | 35.00 |
| $M_W$ | 51.48 | $M_W$ | 51.48 | $M_W$ | 51.48 |
| $C_S$ | 5460.00 | $C_S$ | 5460.00 | $C_S$ | 5460.00 |
| $M_S$ | 9694.23 | $M_S$ | 9694.23 | $M_S$ | 9694.23 |
| $M_T$ | 9745.71 | $M_T$ | 9745.71 | $M_T$ | 9745.71 |
| $M_S/M_T$ | 0.995 | $M_S/M_T$ | 0.995 | $M_S/M_T$ | 0.995 |

$Cw_{0N}$ = Initial contaminant concentration in groundwater flow unit N

## Groundwater Flow Unit Hydrogeologic Characteristics

| Avg. K, ft/d highest to lowest | Relative average K, $K_U$ | Fraction of aquifer volume, $FV_U$ | Fraction of total flow, $FQ_U$ | Flow unit number, U |
|---|---|---|---|---|
| 59 | 1.000 | 0.33 | 0.331 | 1 |
| 59 | 1.000 | 0.34 | 0.338 | 2 |
| 59 | 1.000 | 0.33 | 0.331 | 3 |

## Pore Volumes and Pore Volume Removal Rates

| Groundwater discharge rate, gpm | Groundwater discharge rate, $ft^3$/day, $Q_T$ | Total volume occupied by plume, $ft^3$, $PV_T$ |
|---|---|---|
| 10 | 1925.13 | 1,000,000 |

| Discharge rate, Unit 1 $ft^3$/day, $Q_1$ | Discharge rate, Unit 2 $ft^3$/day, $Q_2$ | Discharge rate, Unit 3 $ft^3$/day, $Q_3$ | Plume pore Vol., Unit 1 $ft^3$, $PV_1$ | Plume pore Vol., Unit 2 $ft^3$, $PV_2$ | Plume pore Vol., Unit 3 $ft^3$, $PV_3$ | Time for 1 PV flush, Unit 1, days, $t_1$ | Time for 1 PV flush, Unit 2, days, $t_2$ | Time for 1 PV flush, Unit 3, days, $t_3$ |
|---|---|---|---|---|---|---|---|---|
| 637.44 | 650.25 | 637.44 | 108900 | 112200 | 108900 | 170.84 | 172.55 | 170.84 |

## Contaminant Half-Life Data

| | | | |
|---|---|---|---|
| Does contaminant have a decay half-life (yes/no): | no | If yes, half-life (days): | 3650 |
| 1st order decay coefficient (k): | 0.000190 | | |

## Average Pumped/Discharged and Residual Plume Concentrations Over Time

| Target Cleanup Concentration : | | | 48 | ug/L |
|---|---|---|---|---|
| Time period | Time span, days, t | Avg pumped GW conc. | Avg residual GW conc. | Time span, years |
| 0 | 0 | 0 | 156 | 0 |
| 2 | 341.68 | 154.362 | **154.362** | 0.94 |
| 3 | 512.52 | 153.549 | **153.549** | 1.40 |
| 4 | 683.36 | 152.741 | **152.741** | 1.87 |
| 6 | 1025.04 | 151.137 | **151.137** | 2.81 |
| 8 | 1366.72 | 149.549 | **149.550** | 3.74 |
| 10 | 1708.40 | 147.979 | **147.979** | 4.68 |
| 14 | 2391.75 | 144.887 | **144.887** | 6.55 |
| 18 | 3075.11 | 141.860 | **141.860** | 8.42 |
| 24 | 4100.15 | 137.438 | **137.438** | 11.23 |
| 30 | 5125.19 | 133.153 | **133.153** | 14.03 |
| 36 | 6150.22 | 129.002 | **129.002** | 16.84 |
| 42 | 7175.26 | 124.980 | **124.981** | 19.64 |
| 50 | 8541.98 | 119.812 | **119.813** | 23.39 |
| 60 | 10250.37 | 113.652 | **113.653** | 28.06 |
| 70 | 11958.77 | 107.808 | **107.809** | 32.74 |
| 80 | 13667.17 | 102.265 | **102.266** | 37.42 |
| 100 | 17083.96 | 92.019 | **92.020** | 46.77 |
| 120 | 20500.75 | 82.800 | **82.801** | 56.13 |
| 160 | 27334.33 | 67.040 | **67.041** | 74.84 |
| 200 | 34167.92 | 54.279 | **54.281** | 93.55 |
| 210 | 35876.31 | 51.489 | **51.490** | 98.22 |
| 215 | 36730.51 | 50.148 | **50.149** | 100.56 |
| 220 | 37584.71 | 48.841 | **48.843** | 102.90 |
| 223 | 38097.23 | 48.074 | **48.075** | 104.30 |
| 224 | 38268.07 | 47.821 | **47.822** | 104.77 |

Adjust the initial time period to auto-adjust the following 19 time periods and obtain the desired range in concentrations.

The last 5 time periods can be modified to more precisely determine the time required to meet a specific residual concentration.

# Heterogeneous Aquifer Flushing Rate Calculations

| | | | |
|---|---|---|---|
| Project: | NSB New London Zone 1/Plume 2 | Proj. No.: | 112G00811 |
| Chemical : | Copper | $K_{OC}$ ($K_d$*) : | 35 |
| Concentration units, water & soil (pick 1): | mg/L & mg/Kg: | ug/L & ug/Kg: | x |

**This spreadsheet calculates flushing rates and cleanup times for a groundwater flow system that consists of up to 3 groundwater "flow units". Flow units are discrete portions of the aquifer that have unique properties, i.e., higher or lower average hydraulic conductivity, porosity, or specific gravity relative to other portions of the aquifer, higher/lower contaminant concentrations, and/or different organic carbon contents. The spreadsheet factors in different flushing rates for discrete portions of the aquifer based on the differences in the physical/chemical characteristics of the flow units. First-order contaminant decay/degradation processes can also be factored into the cleanup rate prediction through the optional use of contaminant half-life data.**

NOTE: Input cells are shaded yellow; cells automatically calculated are shaded blue; the remaining cells are fixed.

All groundwater/soil contaminant concentrations are in consistent units, i.e., mg/L & mg/Kg, or ug/L & ug/Kg.

*** for contaminants that partition between soil and water thru mechanisms other than adsoption onto organic carbon, i.e., metals, the compound's $K_d$ is input directly into the $K_{OC}$ entry cell, with $f_{OC}$ then set to 1. For fractured bedrock, reduce the $f_{OC}$ by 1-2 orders of magnitude to adjust for typical low fracture porosity and resulting high model-perceived mass of aquifer sediments in contact with water.**

## Groundwater Flow Unit Physical/Chemical Data

| Flow Unit 1 (U1) | | Flow Unit 2 (U2) | | Flow Unit 3 (U3) | |
|---|---|---|---|---|---|
| $Cw_{01}$ | 156.00 | $Cw_{02}$ | 156.00 | $Cw_{03}$ | 156.00 |
| n | 0.33 | n | 0.33 | n | 0.33 |
| $S_G$ | 2.65 | $S_G$ | 2.65 | $S_G$ | 2.65 |
| $f_{OC}$* | 1.0000 | $f_{OC}$* | 1.0000 | $f_{OC}$* | 1.0000 |
| $K_d$ | 35.00 | $K_d$ | 35.00 | $K_d$ | 35.00 |
| $M_W$ | 51.48 | $M_W$ | 51.48 | $M_W$ | 51.48 |
| $C_S$ | 5460.00 | $C_S$ | 5460.00 | $C_S$ | 5460.00 |
| $M_S$ | 9694.23 | $M_S$ | 9694.23 | $M_S$ | 9694.23 |
| $M_T$ | 9745.71 | $M_T$ | 9745.71 | $M_T$ | 9745.71 |
| $M_S/M_T$ | 0.995 | $M_S/M_T$ | 0.995 | $M_S/M_T$ | 0.995 |

**$Cw_{0N}$ = Initial contaminant concentration in groundwater flow unit N**

## Groundwater Flow Unit Hydrogeologic Characteristics

| Avg. K, ft/d highest to lowest | Relative average K, $K_U$ | Fraction of aquifer volume, $FV_U$ | Fraction of total flow, $FQ_U$ | Flow unit number, U |
|---|---|---|---|---|
| 59 | 1.000 | 0.33 | 0.331 | 1 |
| 59 | 1.000 | 0.34 | 0.338 | 2 |
| 59 | 1.000 | 0.33 | 0.331 | 3 |

## Pore Volumes and Pore Volume Removal Rates

| Groundwater discharge rate, gpm | Groundwater discharge rate, $ft^3$/day, $Q_T$ | Total volume occupied by plume, $ft^3$, $PV_T$ |
|---|---|---|
| 20 | 3850.27 | 1,000,000 |

| Discharge rate, Unit 1 $ft^3$/day, $Q_1$ | Discharge rate, Unit 2 $ft^3$/day, $Q_2$ | Discharge rate, Unit 3 $ft^3$/day, $Q_3$ | Plume pore Vol., Unit 1 $ft^3$, $PV_1$ | Plume pore Vol., Unit 2 $ft^3$, $PV_2$ | Plume pore Vol., Unit 3 $ft^3$, $PV_3$ | Time for 1 PV flush, Unit 1, days, $t_1$ | Time for 1 PV flush, Unit 2, days, $t_2$ | Time for 1 PV flush, Unit 3, days, $t_3$ |
|---|---|---|---|---|---|---|---|---|
| 1274.88 | 1300.51 | 1274.88 | 108900 | 112200 | 108900 | 85.42 | 86.27 | 85.42 |

## Contaminant Half-Life Data

| | | | |
|---|---|---|---|
| Does contaminant have a decay half-life (yes/no): | no | If yes, half-life (days): | 3650 |
| 1st order decay coefficient (k): | 0.000190 | | |

## Average Pumped/Discharged and Residual Plume Concentrations Over Time

| Target Cleanup Concentration : | | | 48 | ug/L |
|---|---|---|---|---|
| Time period | Time span, days, t | Avg pumped GW conc. | Avg residual GW conc. | Time span, years |
| 0 | 0 | 0 | **156** | 0 |
| 2 | 170.84 | 154.362 | **154.362** | 0.47 |
| 3 | 256.26 | 153.549 | **153.549** | 0.70 |
| 4 | 341.68 | 152.741 | **152.741** | 0.94 |
| 6 | 512.52 | 151.137 | **151.137** | 1.40 |
| 8 | 683.36 | 149.549 | **149.550** | 1.87 |
| 10 | 854.20 | 147.979 | **147.979** | 2.34 |
| 14 | 1195.88 | 144.887 | **144.887** | 3.27 |
| 18 | 1537.56 | 141.860 | **141.860** | 4.21 |
| 24 | 2050.07 | 137.438 | **137.438** | 5.61 |
| 30 | 2562.59 | 133.153 | **133.153** | 7.02 |
| 36 | 3075.11 | 129.002 | **129.002** | 8.42 |
| 42 | 3587.63 | 124.980 | **124.981** | 9.82 |
| 50 | 4270.99 | 119.812 | **119.813** | 11.69 |
| 60 | 5125.19 | 113.652 | **113.653** | 14.03 |
| 70 | 5979.39 | 107.808 | **107.809** | 16.37 |
| 80 | 6833.58 | 102.265 | **102.266** | 18.71 |
| 100 | 8541.98 | 92.019 | **92.020** | 23.39 |
| 120 | 10250.37 | 82.800 | **82.801** | 28.06 |
| 160 | 13667.17 | 67.040 | **67.041** | 37.42 |
| 200 | 17083.96 | 54.279 | **54.281** | 46.77 |
| 210 | 17938.16 | 51.489 | **51.490** | 49.11 |
| 215 | 18365.26 | 50.148 | **50.149** | 50.28 |
| 220 | 18792.35 | 48.841 | **48.843** | 51.45 |
| 223 | 19048.61 | 48.074 | **48.075** | 52.15 |
| 224 | 19134.03 | 47.821 | **47.822** | 52.39 |

Adjust the initial time period to auto-adjust the following 19 time periods and obtain the desired range in concentrations.

The last 5 time periods can be modified to more precisely determine the time required to meet a specific residual concentration.

# Heterogeneous Aquifer Flushing Rate Calculations

| | | | |
|---|---|---|---|
| Project: | NSB New London Zone 1/Plume 2 | Proj. No.: | 112G00811 |
| Chemical : | Copper | $K_{OC}$ ($K_d$*) : | 35 |
| Concentration units, water & soil (pick 1): | mg/L & mg/Kg: | ug/L & ug/Kg: | x |

NOTE: Input cells are shaded yellow; cells automatically calculated are shaded blue; the remaining cells are fixed.

**This spreadsheet calculates flushing rates and cleanup times for a groundwater flow system that consists of up to 3 groundwater "flow units". Flow units are discrete portions of the aquifer that have unique properties, i.e., higher or lower average hydraulic conductivity, porosity, or specific gravity relative to other portions of the aquifer, higher/lower contaminant concentrations, and/or different organic carbon contents. The spreadsheet factors in different flushing rates for discrete portions of the aquifer based on the differences in the physical/chemical characteristics of the flow units. First-order contaminant decay/degradation processes can also be factored into the cleanup rate prediction through the optional use of contaminant half-life data.**

All groundwater/soil contaminant concentrations are in consistent units, i.e., mg/L & mg/Kg, or ug/L & ug/Kg.

*** for contaminants that partition between soil and water thru mechanisms other than adsoption onto organic carbon, i.e., metals, the compound's $K_d$ is input directly into the $K_{OC}$ entry cell, with $f_{OC}$ then set to 1. For fractured bedrock, reduce the $f_{OC}$ by 1-2 orders of magnitude to adjust for typical low fracture porosity and resulting high model-perceived mass of aquifer sediments in contact with water.**

## Groundwater Flow Unit Physical/Chemical Data

| Flow Unit 1 (U1) | | Flow Unit 2 (U2) | | Flow Unit 3 (U3) | |
|---|---|---|---|---|---|
| $Cw_{01}$ | 156.00 | $Cw_{02}$ | 156.00 | $Cw_{03}$ | 156.00 |
| n | 0.33 | n | 0.33 | n | 0.33 |
| $S_G$ | 2.65 | $S_G$ | 2.65 | $S_G$ | 2.65 |
| $f_{OC}$* | 1.0000 | $f_{OC}$* | 1.0000 | $f_{OC}$* | 1.0000 |
| $K_d$ | 35.00 | $K_d$ | 35.00 | $K_d$ | 35.00 |
| $M_W$ | 51.48 | $M_W$ | 51.48 | $M_W$ | 51.48 |
| $C_S$ | 5460.00 | $C_S$ | 5460.00 | $C_S$ | 5460.00 |
| $M_S$ | 9694.23 | $M_S$ | 9694.23 | $M_S$ | 9694.23 |
| $M_T$ | 9745.71 | $M_T$ | 9745.71 | $M_T$ | 9745.71 |
| $M_S/M_T$ | 0.995 | $M_S/M_T$ | 0.995 | $M_S/M_T$ | 0.995 |

$Cw_{0N}$ = Initial contaminant concentration in groundwater flow unit N

## Groundwater Flow Unit Hydrogeologic Characteristics

| Avg. K, ft/d highest to lowest | Relative average K, $K_U$ | Fraction of aquifer volume, $FV_U$ | Fraction of total flow, $FQ_U$ | Flow unit number, U |
|---|---|---|---|---|
| 59 | 1.000 | 0.33 | 0.331 | 1 |
| 59 | 1.000 | 0.34 | 0.338 | 2 |
| 59 | 1.000 | 0.33 | 0.331 | 3 |

## Pore Volumes and Pore Volume Removal Rates

| Groundwater discharge rate, gpm | Groundwater discharge rate, $ft^3$/day, $Q_T$ | Total volume occupied by plume, $ft^3$, $PV_T$ |
|---|---|---|
| 40 | 7700.53 | 1,000,000 |

| Discharge rate, Unit 1 $ft^3$/day, $Q_1$ | Discharge rate, Unit 2 $ft^3$/day, $Q_2$ | Discharge rate, Unit 3 $ft^3$/day, $Q_3$ | Plume pore Vol., Unit 1 $ft^3$, $PV_1$ | Plume pore Vol., Unit 2 $ft^3$, $PV_2$ | Plume pore Vol., Unit 3 $ft^3$, $PV_3$ | Time for 1 PV flush, Unit 1, days, $t_1$ | Time for 1 PV flush, Unit 2, days, $t_2$ | Time for 1 PV flush, Unit 3, days, $t_3$ |
|---|---|---|---|---|---|---|---|---|
| 2549.76 | 2601.01 | 2549.76 | 108900 | 112200 | 108900 | 42.71 | 43.14 | 42.71 |

## Contaminant Half-Life Data

| | | | |
|---|---|---|---|
| Does contaminant have a decay half-life (yes/no): | no | If yes, half-life (days): | 3650 |
| 1st order decay coefficient (k): | 0.000190 | | |

## Average Pumped/Discharged and Residual Plume Concentrations Over Time

| Target Cleanup Concentration : | | | 48 | ug/L |
|---|---|---|---|---|
| Time period | Time span, days, t | Avg pumped GW conc. | Avg residual GW conc. | Time span, years |
| 0 | 0 | 0 | **156** | 0 |
| 2 | 85.42 | 154.362 | **154.362** | 0.23 |
| 3 | 128.13 | 153.549 | **153.549** | 0.35 |
| 4 | 170.84 | 152.741 | **152.741** | 0.47 |
| 6 | 256.26 | 151.137 | **151.137** | 0.70 |
| 8 | 341.68 | 149.549 | **149.550** | 0.94 |
| 10 | 427.10 | 147.979 | **147.979** | 1.17 |
| 14 | 597.94 | 144.887 | **144.887** | 1.64 |
| 18 | 768.78 | 141.860 | **141.860** | 2.10 |
| 24 | 1025.04 | 137.438 | **137.438** | 2.81 |
| 30 | 1281.30 | 133.153 | **133.153** | 3.51 |
| 36 | 1537.56 | 129.002 | **129.002** | 4.21 |
| 42 | 1793.82 | 124.980 | **124.981** | 4.91 |
| 50 | 2135.49 | 119.812 | **119.813** | 5.85 |
| 60 | 2562.59 | 113.652 | **113.653** | 7.02 |
| 70 | 2989.69 | 107.808 | **107.809** | 8.19 |
| 80 | 3416.79 | 102.265 | **102.266** | 9.35 |
| 100 | 4270.99 | 92.019 | **92.020** | 11.69 |
| 120 | 5125.19 | 82.800 | **82.801** | 14.03 |
| 160 | 6833.58 | 67.040 | **67.041** | 18.71 |
| 200 | 8541.98 | 54.279 | **54.281** | 23.39 |
| 210 | 8969.08 | 51.489 | **51.490** | 24.56 |
| 215 | 9182.63 | 50.148 | **50.149** | 25.14 |
| 220 | 9396.18 | 48.841 | **48.843** | 25.73 |
| 223 | 9524.31 | 48.074 | **48.075** | 26.08 |
| 224 | 9567.02 | 47.821 | **47.822** | 26.19 |

Adjust the initial time period to auto-adjust the following 19 time periods and obtain the desired range in concentrations.

The last 5 time periods can be modified to more precisely determine the time required to meet a specific residual concentration.

# Heterogeneous Aquifer Flushing Rate Calculations

| | | | |
|---|---|---|---|
| Project: | NSB New London Zone 1/Plume 2 | Proj. No.: | 112G00811 |
| Chemical : | Arsenic | $K_{OC}$ ($K_d$*) : | 29 |
| Concentration units, water & soil (pick 1): | mg/L & mg/Kg: | ug/L & ug/Kg: | x |

**This spreadsheet calculates flushing rates and cleanup times for a groundwater flow system that consists of up to 3 groundwater "flow units". Flow units are discrete portions of the aquifer that have unique properties, i.e., higher or lower average hydraulic conductivity, porosity, or specific gravity relative to other portions of the aquifer, higher/lower contaminant concentrations, and/or different organic carbon contents. The spreadsheet factors in different flushing rates for discrete portions of the aquifer based on the differences in the physical/chemical characteristics of the flow units. First-order contaminant decay/degradation processes can also be factored into the cleanup rate prediction through the optional use of contaminant half-life data.**

NOTE: Input cells are shaded yellow; cells automatically calculated are shaded blue; the remaining cells are fixed.

All groundwater/soil contaminant concentrations are in consistent units, i.e., mg/L & mg/Kg, or ug/L & ug/Kg.

*** for contaminants that partition between soil and water thru mechanisms other than adsoption onto organic carbon, i.e., metals, the compound's $K_d$ is input directly into the $K_{OC}$ entry cell, with $f_{OC}$ then set to 1. For fractured bedrock, reduce the $f_{OC}$ by 1-2 orders of magnitude to adjust for typical low fracture porosity and resulting high model-perceived mass of aquifer sediments in contact with water.**

### Groundwater Flow Unit Physical/Chemical Data

| Flow Unit 1 (U1) | | Flow Unit 2 (U2) | | Flow Unit 3 (U3) | |
|---|---|---|---|---|---|
| $Cw_{01}$ | 16.80 | $Cw_{02}$ | 16.80 | $Cw_{03}$ | 16.80 |
| n | 0.33 | n | 0.33 | n | 0.33 |
| $S_G$ | 2.65 | $S_G$ | 2.65 | $S_G$ | 2.65 |
| $f_{OC}$* | 1.0000 | $f_{OC}$* | 1.0000 | $f_{OC}$* | 1.0000 |
| $K_d$ | 29.00 | $K_d$ | 29.00 | $K_d$ | 29.00 |
| $M_W$ | 5.54 | $M_W$ | 5.54 | $M_W$ | 5.54 |
| $C_S$ | 487.20 | $C_S$ | 487.20 | $C_S$ | 487.20 |
| $M_S$ | 865.02 | $M_S$ | 865.02 | $M_S$ | 865.02 |
| $M_T$ | 870.57 | $M_T$ | 870.57 | $M_T$ | 870.57 |
| $M_S/M_T$ | 0.994 | $M_S/M_T$ | 0.994 | $M_S/M_T$ | 0.994 |

$Cw_{0N}$ = Initial contaminant concentration in groundwater flow unit N

### Groundwater Flow Unit Hydrogeologic Characteristics

| Avg. K, ft/d highest to lowest | Relative average K, $K_U$ | Fraction of aquifer volume, $FV_U$ | Fraction of total flow, $FQ_U$ | Flow unit number, U |
|---|---|---|---|---|
| 59 | 1.000 | 0.33 | 0.331 | 1 |
| 59 | 1.000 | 0.34 | 0.338 | 2 |
| 59 | 1.000 | 0.33 | 0.331 | 3 |

### Pore Volumes and Pore Volume Removal Rates

| Groundwater discharge rate, gpm | Groundwater discharge rate, $ft^3$/day, $Q_T$ | Total volume occupied by plume, $ft^3$, $PV_T$ |
|---|---|---|
| 4.78 | 920.21 | 1,000,000 |

| Discharge rate, Unit 1 $ft^3$/day, $Q_1$ | Discharge rate, Unit 2 $ft^3$/day, $Q_2$ | Discharge rate, Unit 3 $ft^3$/day, $Q_3$ | Plume pore Vol., Unit 1 $ft^3$, $PV_1$ | Plume pore Vol., Unit 2 $ft^3$, $PV_2$ | Plume pore Vol., Unit 3 $ft^3$, $PV_3$ | Time for 1 PV flush, Unit 1, days, $t_1$ | Time for 1 PV flush, Unit 2, days, $t_2$ | Time for 1 PV flush, Unit 3, days, $t_3$ |
|---|---|---|---|---|---|---|---|---|
| 304.70 | 310.82 | 304.70 | 108900 | 112200 | 108900 | 357.40 | 360.98 | 357.40 |

### Contaminant Half-Life Data

| | | | |
|---|---|---|---|
| Does contaminant have a decay half-life (yes/no): | no | If yes, half-life (days): | 3650 |
| 1st order decay coefficient (k): | 0.000190 | | |

### Average Pumped/Discharged and Residual Plume Concentrations Over Time

| Target Cleanup Concentration : | | | 10 | ug/L |
|---|---|---|---|---|
| Time period | Time span, days, t | Avg pumped GW conc. | Avg residual GW conc. | Time span, years |
| 0 | 0 | 0 | **16.8** | 0 |
| 1 | 357.40 | 16.693 | **16.693** | 0.98 |
| 1.5 | 536.11 | 16.640 | **16.640** | 1.47 |
| 2 | 714.81 | 16.587 | **16.587** | 1.96 |
| 3 | 1072.21 | 16.482 | **16.482** | 2.94 |
| 4 | 1429.62 | 16.378 | **16.378** | 3.91 |
| 5 | 1787.02 | 16.274 | **16.274** | 4.89 |
| 7 | 2501.83 | 16.068 | **16.068** | 6.85 |
| 9 | 3216.64 | 15.864 | **15.864** | 8.81 |
| 12 | 4288.86 | 15.564 | **15.564** | 11.74 |
| 15 | 5361.07 | 15.270 | **15.270** | 14.68 |
| 18 | 6433.29 | 14.981 | **14.981** | 17.61 |
| 21 | 7505.50 | 14.697 | **14.697** | 20.55 |
| 25 | 8935.12 | 14.328 | **14.328** | 24.46 |
| 30 | 10722.15 | 13.879 | **13.879** | 29.36 |
| 35 | 12509.17 | 13.444 | **13.444** | 34.25 |
| 40 | 14296.20 | 13.023 | **13.023** | 39.14 |
| 50 | 17870.25 | 12.219 | **12.219** | 48.93 |
| 60 | 21444.30 | 11.466 | **11.466** | 58.71 |
| 80 | 28592.40 | 10.095 | **10.095** | 78.28 |
| 100 | 35740.50 | 8.888 | **8.888** | 97.85 |
| 81 | 28949.80 | 10.031 | **10.031** | 79.26 |
| 82 | 29307.21 | 9.967 | **9.967** | 80.24 |
| 83 | 29664.61 | 9.904 | **9.904** | 81.22 |
| 84 | 30022.02 | 9.841 | **9.841** | 82.20 |
| 85 | 30379.42 | 9.778 | **9.778** | 83.17 |

Adjust the initial time period to auto-adjust the following 19 time periods and obtain the desired range in concentrations.

The last 5 time periods can be modified to more precisely determine the time required to meet a specific residual concentration.

# Heterogeneous Aquifer Flushing Rate Calculations

| | | | |
|---|---|---|---|
| **Project:** | NSB New London Zone 1/Plume 2 | **Proj. No.:** | 112G00811 |
| **Chemical :** | Arsenic | $K_{OC}$ ($K_d$*) : | 29 |
| **Concentration units, water & soil (pick 1):** | mg/L & mg/Kg: | ug/L & ug/Kg: | x |

**This spreadsheet calculates flushing rates and cleanup times for a groundwater flow system that consists of up to 3 groundwater "flow units". Flow units are discrete portions of the aquifer that have unique properties, i.e., higher or lower average hydraulic conductivity, porosity, or specific gravity relative to other portions of the aquifer, higher/lower contaminant concentrations, and/or different organic carbon contents. The spreadsheet factors in different flushing rates for discrete portions of the aquifer based on the differences in the physical/chemical characteristics of the flow units. First-order contaminant decay/degradation processes can also be factored into the cleanup rate prediction through the optional use of contaminant half-life data.**

**NOTE:** Input cells are shaded yellow; cells automatically calculated are shaded blue; the remaining cells are fixed.

All groundwater/soil contaminant concentrations are in consistent units, i.e., mg/L & mg/Kg, or ug/L & ug/Kg.

*** for contaminants that partition between soil and water thru mechanisms other than adsoption onto organic carbon, i.e., metals, the compound's $K_d$ is input directly into the $K_{OC}$ entry cell, with $f_{OC}$ then set to 1. For fractured bedrock, reduce the $f_{OC}$ by 1-2 orders of magnitude to adjust for typical low fracture porosity and resulting high model-perceived mass of aquifer sediments in contact with water.**

## Groundwater Flow Unit Physical/Chemical Data

| Flow Unit 1 (U1) | | Flow Unit 2 (U2) | | Flow Unit 3 (U3) | |
|---|---|---|---|---|---|
| $Cw_{01}$ | 16.80 | $Cw_{02}$ | 16.80 | $Cw_{03}$ | 16.80 |
| n | 0.33 | n | 0.33 | n | 0.33 |
| $S_G$ | 2.65 | $S_G$ | 2.65 | $S_G$ | 2.65 |
| $f_{OC}$* | 1.0000 | $f_{OC}$* | 1.0000 | $f_{OC}$* | 1.0000 |
| $K_d$ | 29.00 | $K_d$ | 29.00 | $K_d$ | 29.00 |
| $M_W$ | 5.54 | $M_W$ | 5.54 | $M_W$ | 5.54 |
| $C_S$ | 487.20 | $C_S$ | 487.20 | $C_S$ | 487.20 |
| $M_S$ | 865.02 | $M_S$ | 865.02 | $M_S$ | 865.02 |
| $M_T$ | 870.57 | $M_T$ | 870.57 | $M_T$ | 870.57 |
| $M_S/M_T$ | 0.994 | $M_S/M_T$ | 0.994 | $M_S/M_T$ | 0.994 |

**$Cw_{0N}$ = Initial contaminant concentration in groundwater flow unit N**

## Groundwater Flow Unit Hydrogeologic Characteristics

| Avg. K, ft/d highest to lowest | Relative average K, $K_U$ | Fraction of aquifer volume, $FV_U$ | Fraction of total flow, $FQ_U$ | Flow unit number, U |
|---|---|---|---|---|
| 59 | 1.000 | 0.33 | 0.331 | 1 |
| 59 | 1.000 | 0.34 | 0.338 | 2 |
| 59 | 1.000 | 0.33 | 0.331 | 3 |

## Pore Volumes and Pore Volume Removal Rates

| Groundwater discharge rate, gpm | Groundwater discharge rate, $ft^3$/day, $Q_T$ | Total volume occupied by plume, $ft^3$, $PV_T$ |
|---|---|---|
| 40 | 7700.53 | 1,000,000 |

| Discharge rate, Unit 1 $ft^3$/day, $Q_1$ | Discharge rate, Unit 2 $ft^3$/day, $Q_2$ | Discharge rate, Unit 3 $ft^3$/day, $Q_3$ | Plume pore Vol., Unit 1 $ft^3$, $PV_1$ | Plume pore Vol., Unit 2 $ft^3$, $PV_2$ | Plume pore Vol., Unit 3 $ft^3$, $PV_3$ | Time for 1 PV flush, Unit 1, days, $t_1$ | Time for 1 PV flush, Unit 2, days, $t_2$ | Time for 1 PV flush, Unit 3, days, $t_3$ |
|---|---|---|---|---|---|---|---|---|
| 2549.76 | 2601.01 | 2549.76 | 108900 | 112200 | 108900 | 42.71 | 43.14 | 42.71 |

## Contaminant Half-Life Data

| | | | |
|---|---|---|---|
| **Does contaminant have a decay half-life (yes/no):** | no | **If yes, half-life (days):** | 3650 |
| **1st order decay coefficient (k):** | 0.000190 | | |

## Average Pumped/Discharged and Residual Plume Concentrations Over Time

| Target Cleanup Concentration : | | | 10 | ug/L |
|---|---|---|---|---|
| Time period | Time span, days, t | Avg pumped GW conc. | Avg residual GW conc. | Time span, years |
| 0 | 0 | 0 | **16.8** | 0 |
| 1 | 42.71 | 16.693 | **16.693** | 0.12 |
| 1.5 | 64.06 | 16.640 | **16.640** | 0.18 |
| 2 | 85.42 | 16.587 | **16.587** | 0.23 |
| 3 | 128.13 | 16.482 | **16.482** | 0.35 |
| 4 | 170.84 | 16.378 | **16.378** | 0.47 |
| 5 | 213.55 | 16.274 | **16.274** | 0.58 |
| 7 | 298.97 | 16.068 | **16.068** | 0.82 |
| 9 | 384.39 | 15.864 | **15.864** | 1.05 |
| 12 | 512.52 | 15.564 | **15.564** | 1.40 |
| 15 | 640.65 | 15.270 | **15.270** | 1.75 |
| 18 | 768.78 | 14.981 | **14.981** | 2.10 |
| 21 | 896.91 | 14.697 | **14.697** | 2.46 |
| 25 | 1067.75 | 14.328 | **14.328** | 2.92 |
| 30 | 1281.30 | 13.879 | **13.879** | 3.51 |
| 35 | 1494.85 | 13.444 | **13.444** | 4.09 |
| 40 | 1708.40 | 13.023 | **13.023** | 4.68 |
| 50 | 2135.49 | 12.219 | **12.219** | 5.85 |
| 60 | 2562.59 | 11.466 | **11.466** | 7.02 |
| 80 | 3416.79 | 10.095 | **10.095** | 9.35 |
| 100 | 4270.99 | 8.888 | **8.888** | 11.69 |
| 81 | 3459.50 | 10.031 | **10.031** | 9.47 |
| 82 | 3502.21 | 9.967 | **9.967** | 9.59 |
| 83 | 3544.92 | 9.904 | **9.904** | 9.71 |
| 84 | 3587.63 | 9.841 | **9.841** | 9.82 |
| 85 | 3630.34 | 9.778 | **9.778** | 9.94 |

Adjust the initial time period to auto-adjust the following 19 time periods and obtain the desired range in concentrations.

The last 5 time periods can be modified to more precisely determine the time required to meet a specific residual concentration.

| Project: | NSB New London Zone 4 | Project No.: | 112G00811 |
|---|---|---|---|
| Subject: | Groundwater Extraction System CMS Design | | |
| By: | J. Orient | Date: | 1/12/2010 |
| Checked: | | Date: | |

**Project/Design Objective:**

Design a groundwater extraction system for containment/cleanup of the arsenic point of groundwater contamination in the shallow portion of the unconsolidated groundwater flow system. Project cleanup rates/times assuming that the residual source been removed or otherwise isolated from groundwater. The final design should be capable of remediating contaminated groundwater to target cleanup levels within a reasonable time frame (30 years or less), and should offer significant advantages over natural processes in terms of cleanup rate and/or protection of receptors. This design should be considered as conceptual only - additional data, i.e., aquifer characteristics, contaminant distributions are needed for a final design.

**Basis of Design Data:** (Input cells yellow, blue automatically calculated)

**Groundwater Plume Information**

| | | |
|---|---|---|
| Plume Width (W): | 240 | ft. |
| Plume Thickness: | 50 | ft. |
| Plume Area: | 45,240 | $ft^2$ |
| Volume of Groundwater in Plume: | 746460 | $ft^3$ |
| Avg Hydraulic Conductivity, Plume Area: | 59 | ft/day |

**Aquifer Characteristics**

| | | |
|---|---|---|
| Thickness (B): | 50 | ft. |
| Avg. Hydraulic Conductivity (K): | 59 | ft/day |
| Transmissivity (T): | 2950 | $ft^2$/day |
| Porosity (n): | 0.33 | |
| Storativity (S): | 0.15 | |
| Fractional Organic Carbon Content (foc): | 1 | |
| Flow Gradient (i): | 0.0039 | |

**Contaminant Characteristics**

| | | | |
|---|---|---|---|
| Contaminant A Representative gw conc.: | arsenic | 29.6 | ug/L |
| Contaminant B Representative gw conc.: | | | |
| Koc, Contaminant A: | | 29 | l/kg |
| Koc, Contaminant B: | | | l/kg |
| Kd, Contaminant A: | | 29 | l/kg |
| Kd, Contaminant B: | | 0 | l/kg |
| Half-life, Contaminant A: | | | years |
| Half-life, Contaminant B: | | | years |
| Target Cleanup Level, Contaminant A: | | 10 | ug/L |
| Target Cleanup Level, Contaminant B: | | | ug/L |

**Remedial System Information**

| | | |
|---|---|---|
| Extraction Well Radius, (r) : | 0.25 | ft. |
| Time to Reach Steady-State Drawdown (t): | 30 | days |
| Allowable Drawdown, Single Well, (s): | 5 | ft. |

**Technical Approach:**

Using aquifer characteristics, contaminated groundwater volume, Kd, half-life, and representative groundwater concentration data, calculate the number of pore volume flushes and times required to reach the target groundwater concentration (performed using the attached spreadsheets). Use standard equations to calculate the minimum required pumping rate for containment, per-well achievable pumping rates, and well spacings. Develop a preliminary extraction system design based on the calculations, adjusting the design as appropriate based on data limitation considerations and best scientific judgement.

**Required Pumping Rate (Qt) for Total Plume Capture**

Qt = TiW x 2 (2x the natural groundwater flow-thru rate for entire aquifer)

Qt = 2761.20 $ft^3$/day x 2, or 14.34 gpm x 2

Qt = 5522.40 $ft^3$/day, or 28.69 gpm

**Maximum Achievable Pumping Rate in a Single Well (Qa)**

Qa = $[4\pi Ts/2.3] / \log [2.25Tt/r^2S]$

Qa = 10998.66 $ft^3$/day, or 57.13 gpm

**Minimum Number of Extraction Wells Required**

= Qt/Qa

= 0.50 wells

**Plume Cleanup Rate Projections (From Spreadsheet Program or Other Source)**

| | | | | |
|---|---|---|---|---|
| At | 28.0 | gpm, | 11 | years |
| At | 42.0 | gpm, | 7.5 | years |
| At | | gpm, | | years |
| At natural GW flow rate: (plume area only) | 14.34 | gpm, | 22 | years |

Contaminant that cleanup rate is based on: arsenic

**Based on the limiting conditions calculated above, projections regarding cleanup times at various pumping rates (see accompanying spreadsheets), a suitable safety factor based on the degree of confidence in the design data, and best scientific judgement, the following are the number of extraction wells and pumping rates selected for the design:**

| | | | |
|---|---|---|---|
| **Number of Wells:** | 3 | | |
| **Per-well Pumping Rate (Qw):** | 10 | gpm, or | 1925.10 $ft^3$/day |
| **Total System Pumping Rate (Qes):** | 30 | gpm, or | 5775.30 $ft^3$/day |

**Extraction Well Spacings, (WSp), ft Perpendicular to Groundwater Flow Direction**

WSp = $Qw/\pi Ti$, for a 2-well extraction system

WSp = 53.26 ft

or

WSp = $1.26(Qw)/\pi Ti$, for a 3-well extraction system

WSp = 67.11 ft

or

WSp = $1.2(Qw)/\pi Ti$, for an extraction system with 4+ wells

WSp = 63.91 ft

**Downgradient Stagnation Point (SPd) Approximation**

SPd = $Qes/2\pi Ti$, Qes = total extraction system pumping rate, $ft^3$/day

SPd = 79.89 ft

**Alternate Layout of Extraction Well System (I.e., parallel to GW flow direction):**

Position well within impacted areas, within 25-30 ft of downgradient limit of where remediation is reqiured but no closer than 60 ft to the river, to minimize pulling in river water via induced infiltration.

**Final Configuration, Groundwater Extraction System:**

Install three extraction wells within the area of arsenic-impacted groundwater, targeted at points of highest concentration. Pump 10 gpm from each well for a total pumping rate of 30 gpm. Position wells to minimize drawing of water from the river. Cleanup timeframe is approximately 11 years.

# Heterogeneous Aquifer Flushing Rate Calculations

| | | | |
|---|---|---|---|
| Project: | NSB New London Zone 4 | Proj. No.: | 112G00811 |
| Chemical : | Arsenic | $K_{OC}$ ($K_d$*) : | 29 |
| Concentration units, water & soil (pick 1): | mg/L & mg/Kg: | ug/L & ug/Kg: | x |

**NOTE:** Input cells are shaded yellow; cells automatically calculated are shaded blue; the remaining cells are fixed.

All groundwater/soil contaminant concentrations are in consistent units, i.e., mg/L & mg/Kg, or ug/L & ug/Kg.

*** for contaminants that partition between soil and water thru mechanisms other than adsoption onto organic carbon, i.e., metals, the compound's $K_d$ is input directly into the $K_{OC}$ entry cell, with $f_{OC}$ then set to 1. For fractured bedrock, reduce the $f_{OC}$ by 1-2 orders of magnitude to adjust for typical low fracture porosity and resulting high model-perceived mass of aquifer sediments in contact with water.**

**This spreadsheet calculates flushing rates and cleanup times for a groundwater flow system that consists of up to 3 groundwater "flow units". Flow units are discrete portions of the aquifer that have unique properties, i.e., higher or lower average hydraulic conductivity, porosity, or specific gravity relative to other portions of the aquifer, higher/lower contaminant concentrations, and/or different organic carbon contents. The spreadsheet factors in different flushing rates for discrete portions of the aquifer based on the differences in the physical/chemical characteristics of the flow units. First-order contaminant decay/degradation processes can also be factored into the cleanup rate prediction through the optional use of contaminant half-life data.**

## Groundwater Flow Unit Physical/Chemical Data

| Flow Unit 1 (U1) | | Flow Unit 2 (U2) | | Flow Unit 3 (U3) | |
|---|---|---|---|---|---|
| $Cw_{01}$ | 29.60 | $Cw_{02}$ | 29.60 | $Cw_{03}$ | 29.60 |
| n | 0.33 | n | 0.33 | n | 0.33 |
| $S_G$ | 2.65 | $S_G$ | 2.65 | $S_G$ | 2.65 |
| $f_{OC}$* | 1.0000 | $f_{OC}$* | 1.0000 | $f_{OC}$* | 1.0000 |
| $K_d$ | 29.00 | $K_d$ | 29.00 | $K_d$ | 29.00 |
| $M_W$ | 9.77 | $M_W$ | 9.77 | $M_W$ | 9.77 |
| $C_S$ | 858.40 | $C_S$ | 858.40 | $C_S$ | 858.40 |
| $M_S$ | 1524.09 | $M_S$ | 1524.09 | $M_S$ | 1524.09 |
| $M_T$ | 1533.86 | $M_T$ | 1533.86 | $M_T$ | 1533.86 |
| $M_S/M_T$ | 0.9936 | $M_S/M_T$ | 0.9936 | $M_S/M_T$ | 0.9936 |

**$Cw_{0N}$ = Initial contaminant concentration in groundwater flow unit N**

## Groundwater Flow Unit Hydrogeologic Characteristics

| Avg. K, ft/d highest to lowest | Relative average K, $K_U$ | Fraction of aquifer volume, $FV_U$ | Fraction of total flow, $FQ_U$ | Flow unit number, U |
|---|---|---|---|---|
| 59 | 1.000 | 0.33 | 0.331 | 1 |
| 59 | 1.000 | 0.34 | 0.338 | 2 |
| 59 | 1.000 | 0.33 | 0.331 | 3 |

## Pore Volumes and Pore Volume Removal Rates

| Groundwater discharge rate, gpm | Groundwater discharge rate, $ft^3$/day, $Q_T$ | Total volume occupied by plume, $ft^3$, $PV_T$ |
|---|---|---|
| 14.3 | 2752.94 | 392,700 |

| Discharge rate, Unit 1 $ft^3$/day, $Q_1$ | Discharge rate, Unit 2 $ft^3$/day, $Q_2$ | Discharge rate, Unit 3 $ft^3$/day, $Q_3$ | Plume pore Vol., Unit 1 $ft^3$, $PV_1$ | Plume pore Vol., Unit 2 $ft^3$, $PV_2$ | Plume pore Vol., Unit 3 $ft^3$, $PV_3$ | Time for 1 PV flush, Unit 1, days, $t_1$ | Time for 1 PV flush, Unit 2, days, $t_2$ | Time for 1 PV flush, Unit 3, days, $t_3$ |
|---|---|---|---|---|---|---|---|---|
| 911.54 | 929.86 | 911.54 | 42765.03 | 44060.94 | 42765.03 | 46.92 | 47.38 | 46.92 |

## Contaminant Half-Life Data

| | | | |
|---|---|---|---|
| Does contaminant have a decay half-life (yes/no): | no | If yes, half-life (days): | 3650 |
| 1st order decay coefficient (k): | 0.000190 | | |

## Average Pumped/Discharged and Residual Plume Concentrations Over Time

| Target Cleanup Concentration : | | | 10 | ug/L |
|---|---|---|---|---|
| Time period | Time span, days, t | Avg pumped GW conc. | Avg residual GW conc. | Time span, years |
| 0 | 0 | 0 | **29.6** | 0 |
| 2 | 93.83 | 29.225 | **29.225** | 0.26 |
| 3 | 140.75 | 29.040 | **29.040** | 0.39 |
| 4 | 187.66 | 28.856 | **28.856** | 0.51 |
| 6 | 281.49 | 28.491 | **28.491** | 0.77 |
| 8 | 375.32 | 28.130 | **28.130** | 1.03 |
| 10 | 469.15 | 27.774 | **27.774** | 1.28 |
| 14 | 656.81 | 27.076 | **27.076** | 1.80 |
| 18 | 844.47 | 26.395 | **26.395** | 2.31 |
| 24 | 1125.96 | 25.405 | **25.405** | 3.08 |
| 30 | 1407.46 | 24.453 | **24.453** | 3.85 |
| 36 | 1688.95 | 23.537 | **23.537** | 4.62 |
| 42 | 1970.44 | 22.654 | **22.654** | 5.39 |
| 50 | 2345.76 | 21.529 | **21.529** | 6.42 |
| 60 | 2814.91 | 20.201 | **20.201** | 7.71 |
| 70 | 3284.06 | 18.955 | **18.955** | 8.99 |
| 80 | 3753.21 | 17.786 | **17.786** | 10.28 |
| 100 | 4691.52 | 15.659 | **15.659** | 12.84 |
| 120 | 5629.82 | 13.787 | **13.787** | 15.41 |
| 160 | 7506.43 | 10.687 | **10.687** | 20.55 |
| 200 | 9383.04 | 8.284 | **8.284** | 25.69 |
| 164 | 7694.09 | 10.418 | **10.418** | 21.07 |
| 168 | 7881.75 | 10.156 | **10.156** | 21.58 |
| 170 | 7975.58 | 10.028 | **10.028** | 21.84 |
| 171 | 8022.50 | 9.964 | **9.964** | 21.96 |
| 172 | 8069.41 | 9.901 | **9.901** | 22.09 |

Adjust the initial time period to auto-adjust the following 19 time periods and obtain the desired range in concentrations.

The last 5 time periods can be modified to more precisely determine the time required to meet a specific residual concentration.

# Heterogeneous Aquifer Flushing Rate Calculations

| Project: | NSB New London Zone 4 | Proj. No.: | 112G00811 |
|---|---|---|---|
| Chemical : | Arsenic | $K_{OC}$ ($K_d$*) : | 29 |
| Concentration units, water & soil (pick 1): | mg/L & mg/Kg: | ug/L & ug/Kg: | x |

**This spreadsheet calculates flushing rates and cleanup times for a groundwater flow system that consists of up to 3 groundwater "flow units". Flow units are discrete portions of the aquifer that have unique properties, i.e., higher or lower average hydraulic conductivity, porosity, or specific gravity relative to other portions of the aquifer, higher/lower contaminant concentrations, and/or different organic carbon contents. The spreadsheet factors in different flushing rates for discrete portions of the aquifer based on the differences in the physical/chemical characteristics of the flow units. First-order contaminant decay/degradation processes can also be factored into the cleanup rate prediction through the optional use of contaminant half-life data.**

**NOTE:** Input cells are shaded yellow; cells automatically calculated are shaded blue; the remaining cells are fixed.

All groundwater/soil contaminant concentrations are in consistent units, i.e., mg/L & mg/Kg, or ug/L & ug/Kg.

*** for contaminants that partition between soil and water thru mechanisms other than adsoption onto organic carbon, i.e., metals, the compound's $K_d$ is input directly into the $K_{OC}$ entry cell, with $f_{OC}$ then set to 1. For fractured bedrock, reduce the $f_{OC}$ by 1-2 orders of magnitude to adjust for typical low fracture porosity and resulting high model-perceived mass of aquifer sediments in contact with water.**

## Groundwater Flow Unit Physical/Chemical Data

| Flow Unit 1 (U1) | | Flow Unit 2 (U2) | | Flow Unit 3 (U3) | |
|---|---|---|---|---|---|
| $Cw_{01}$ | 29.60 | $Cw_{02}$ | 29.60 | $Cw_{03}$ | 29.60 |
| n | 0.33 | n | 0.33 | n | 0.33 |
| $S_G$ | 2.65 | $S_G$ | 2.65 | $S_G$ | 2.65 |
| $f_{OC}$* | 1.0000 | $f_{OC}$* | 1.0000 | $f_{OC}$* | 1.0000 |
| $K_d$ | 29.00 | $K_d$ | 29.00 | $K_d$ | 29.00 |
| $M_W$ | 9.77 | $M_W$ | 9.77 | $M_W$ | 9.77 |
| $C_S$ | 858.40 | $C_S$ | 858.40 | $C_S$ | 858.40 |
| $M_S$ | 1524.09 | $M_S$ | 1524.09 | $M_S$ | 1524.09 |
| $M_T$ | 1533.86 | $M_T$ | 1533.86 | $M_T$ | 1533.86 |
| $M_S/M_T$ | 0.9936 | $M_S/M_T$ | 0.9936 | $M_S/M_T$ | 0.9936 |

$Cw_{0N}$ = Initial contaminant concentration in groundwater flow unit N

## Groundwater Flow Unit Hydrogeologic Characteristics

| Avg. K, ft/d highest to lowest | Relative average K, $K_U$ | Fraction of aquifer volume, $FV_U$ | Fraction of total flow, $FQ_U$ | Flow unit number, U |
|---|---|---|---|---|
| 59 | 1.000 | 0.33 | 0.331 | 1 |
| 59 | 1.000 | 0.34 | 0.338 | 2 |
| 59 | 1.000 | 0.33 | 0.331 | 3 |

## Pore Volumes and Pore Volume Removal Rates

| Groundwater discharge rate, gpm | Groundwater discharge rate, $ft^3$/day, $Q_T$ | Total volume occupied by plume, $ft^3$, $PV_T$ |
|---|---|---|
| 28 | 5390.37 | 392,700 |

| Discharge rate, Unit 1 $ft^3$/day, $Q_1$ | Discharge rate, Unit 2 $ft^3$/day, $Q_2$ | Discharge rate, Unit 3 $ft^3$/day, $Q_3$ | Plume pore Vol., Unit 1 $ft^3$, $PV_1$ | Plume pore Vol., Unit 2 $ft^3$, $PV_2$ | Plume pore Vol., Unit 3 $ft^3$, $PV_3$ | Time for 1 PV flush, Unit 1, days, $t_1$ | Time for 1 PV flush, Unit 2, days, $t_2$ | Time for 1 PV flush, Unit 3, days, $t_3$ |
|---|---|---|---|---|---|---|---|---|
| 1784.83 | 1820.71 | 1784.83 | 42765.03 | 44060.94 | 42765.03 | 23.96 | 24.20 | 23.96 |

## Contaminant Half-Life Data

| Does contaminant have a decay half-life (yes/no): | no | If yes, half-life (days): | 3650 |
|---|---|---|---|
| 1st order decay coefficient (k): | 0.000190 | | |

## Average Pumped/Discharged and Residual Plume Concentrations Over Time

| Target Cleanup Concentration : | | | 10 | ug/L |
|---|---|---|---|---|
| Time period | Time span, days, t | Avg pumped GW conc. | Avg residual GW conc. | Time span, years |
| 0 | 0 | 0 | **29.6** | 0 |
| 2 | 47.92 | 29.225 | **29.225** | 0.13 |
| 3 | 71.88 | 29.040 | **29.040** | 0.20 |
| 4 | 95.84 | 28.856 | **28.856** | 0.26 |
| 6 | 143.76 | 28.491 | **28.491** | 0.39 |
| 8 | 191.68 | 28.130 | **28.130** | 0.52 |
| 10 | 239.60 | 27.774 | **27.774** | 0.66 |
| 14 | 335.44 | 27.076 | **27.076** | 0.92 |
| 18 | 431.28 | 26.395 | **26.395** | 1.18 |
| 24 | 575.05 | 25.405 | **25.405** | 1.57 |
| 30 | 718.81 | 24.453 | **24.453** | 1.97 |
| 36 | 862.57 | 23.537 | **23.537** | 2.36 |
| 42 | 1006.33 | 22.654 | **22.654** | 2.76 |
| 50 | 1198.01 | 21.529 | **21.529** | 3.28 |
| 60 | 1437.62 | 20.201 | **20.201** | 3.94 |
| 70 | 1677.22 | 18.955 | **18.955** | 4.59 |
| 80 | 1916.82 | 17.786 | **17.786** | 5.25 |
| 100 | 2396.03 | 15.659 | **15.659** | 6.56 |
| 120 | 2875.23 | 13.787 | **13.787** | 7.87 |
| 160 | 3833.64 | 10.687 | **10.687** | 10.50 |
| 200 | 4792.05 | 8.284 | **8.284** | 13.12 |
| 164 | 3929.48 | 10.418 | **10.418** | 10.76 |
| 168 | 4025.32 | 10.156 | **10.156** | 11.02 |
| 170 | 4073.24 | 10.028 | **10.028** | 11.15 |
| 171 | 4097.20 | 9.964 | **9.964** | 11.22 |
| 172 | 4121.16 | 9.901 | **9.901** | 11.28 |

Adjust the initial time period to auto-adjust the following 19 time periods and obtain the desired range in concentrations.

The last 5 time periods can be modified to more precisely determine the time required to meet a specific residual concentration.

# Heterogeneous Aquifer Flushing Rate Calculations

| | | | |
|---|---|---|---|
| **Project:** | NSB New London Zone 4 | **Proj. No.:** | 112G00811 |
| **Chemical :** | Arsenic | **$K_{OC}$ ($K_d$*) :** | 29 |
| **Concentration units, water & soil (pick 1):** | mg/L & mg/Kg: | ug/L & ug/Kg: | x |

**NOTE:** Input cells are shaded yellow; cells automatically calculated are shaded blue; the remaining cells are fixed.

All groundwater/soil contaminant concentrations are in consistent units, i.e., mg/L & mg/Kg, or ug/L & ug/Kg.

*** for contaminants that partition between soil and water thru mechanisms other than adsoption onto organic carbon, i.e., metals, the compound's $K_d$ is input directly into the $K_{OC}$ entry cell, with $f_{OC}$ then set to 1. For fractured bedrock, reduce the $f_{OC}$ by 1-2 orders of magnitude to adjust for typical low fracture porosity and resulting high model-perceived mass of aquifer sediments in contact with water.**

**This spreadsheet calculates flushing rates and cleanup times for a groundwater flow system that consists of up to 3 groundwater "flow units". Flow units are discrete portions of the aquifer that have unique properties, i.e., higher or lower average hydraulic conductivity, porosity, or specific gravity relative to other portions of the aquifer, higher/lower contaminant concentrations, and/or different organic carbon contents. The spreadsheet factors in different flushing rates for discrete portions of the aquifer based on the differences in the physical/chemical characteristics of the flow units. First-order contaminant decay/degradation processes can also be factored into the cleanup rate prediction through the optional use of contaminant half-life data.**

### Groundwater Flow Unit Physical/Chemical Data

| Flow Unit 1 (U1) | | Flow Unit 2 (U2) | | Flow Unit 3 (U3) | |
|---|---|---|---|---|---|
| $Cw_{01}$ | 29.60 | $Cw_{02}$ | 29.60 | $Cw_{03}$ | 29.60 |
| n | 0.33 | n | 0.33 | n | 0.33 |
| $S_G$ | 2.65 | $S_G$ | 2.65 | $S_G$ | 2.65 |
| $f_{OC}$* | 1.0000 | $f_{OC}$* | 1.0000 | $f_{OC}$* | 1.0000 |
| $K_d$ | 29.00 | $K_d$ | 29.00 | $K_d$ | 29.00 |
| $M_W$ | 9.77 | $M_W$ | 9.77 | $M_W$ | 9.77 |
| $C_S$ | 858.40 | $C_S$ | 858.40 | $C_S$ | 858.40 |
| $M_S$ | 1524.09 | $M_S$ | 1524.09 | $M_S$ | 1524.09 |
| $M_T$ | 1533.86 | $M_T$ | 1533.86 | $M_T$ | 1533.86 |
| $M_S/M_T$ | 0.9936 | $M_S/M_T$ | 0.9936 | $M_S/M_T$ | 0.9936 |

**$Cw_{0N}$ = Initial contaminant concentration in groundwater flow unit N**

### Groundwater Flow Unit Hydrogeologic Characteristics

| Avg. K, ft/d highest to lowest | Relative average K, $K_U$ | Fraction of aquifer volume, $FV_U$ | Fraction of total flow, $FQ_U$ | Flow unit number, U |
|---|---|---|---|---|
| 59 | 1.000 | 0.33 | 0.331 | 1 |
| 59 | 1.000 | 0.34 | 0.338 | 2 |
| 59 | 1.000 | 0.33 | 0.331 | 3 |

### Pore Volumes and Pore Volume Removal Rates

| Groundwater discharge rate, gpm | Groundwater discharge rate, $ft^3$/day, $Q_T$ | Total volume occupied by plume, $ft^3$, $PV_T$ |
|---|---|---|
| 42 | 8085.56 | 392,700 |

| Discharge rate, Unit 1 $ft^3$/day, $Q_1$ | Discharge rate, Unit 2 $ft^3$/day, $Q_2$ | Discharge rate, Unit 3 $ft^3$/day, $Q_3$ | Plume pore Vol., Unit 1 $ft^3$, $PV_1$ | Plume pore Vol., Unit 2 $ft^3$, $PV_2$ | Plume pore Vol., Unit 3 $ft^3$, $PV_3$ | Time for 1 PV flush, Unit 1, days, $t_1$ | Time for 1 PV flush, Unit 2, days, $t_2$ | Time for 1 PV flush, Unit 3, days, $t_3$ |
|---|---|---|---|---|---|---|---|---|
| 2677.25 | 2731.06 | 2677.25 | 42765.03 | 44060.94 | 42765.03 | 15.97 | 16.13 | 15.97 |

### Contaminant Half-Life Data

| | | | |
|---|---|---|---|
| **Does contaminant have a decay half-life (yes/no):** | no | **If yes, half-life (days):** | 3650 |
| **1st order decay coefficient (k):** | 0.000190 | | |

### Average Pumped/Discharged and Residual Plume Concentrations Over Time

| Target Cleanup Concentration : | | | 10 | ug/L |
|---|---|---|---|---|
| Time period | Time span, days, t | Avg pumped GW conc. | Avg residual GW conc. | Time span, years |
| 0 | 0 | 0 | **29.6** | 0 |
| 2 | 31.95 | 29.225 | **29.225** | 0.09 |
| 3 | 47.92 | 29.040 | **29.040** | 0.13 |
| 4 | 63.89 | 28.856 | **28.856** | 0.17 |
| 6 | 95.84 | 28.491 | **28.491** | 0.26 |
| 8 | 127.79 | 28.130 | **28.130** | 0.35 |
| 10 | 159.74 | 27.774 | **27.774** | 0.44 |
| 14 | 223.63 | 27.076 | **27.076** | 0.61 |
| 18 | 287.52 | 26.395 | **26.395** | 0.79 |
| 24 | 383.36 | 25.405 | **25.405** | 1.05 |
| 30 | 479.21 | 24.453 | **24.453** | 1.31 |
| 36 | 575.05 | 23.537 | **23.537** | 1.57 |
| 42 | 670.89 | 22.654 | **22.654** | 1.84 |
| 50 | 798.68 | 21.529 | **21.529** | 2.19 |
| 60 | 958.41 | 20.201 | **20.201** | 2.62 |
| 70 | 1118.15 | 18.955 | **18.955** | 3.06 |
| 80 | 1277.88 | 17.786 | **17.786** | 3.50 |
| 100 | 1597.35 | 15.659 | **15.659** | 4.37 |
| 120 | 1916.82 | 13.787 | **13.787** | 5.25 |
| 160 | 2555.76 | 10.687 | **10.687** | 7.00 |
| 200 | 3194.70 | 8.284 | **8.284** | 8.75 |
| 164 | 2619.65 | 10.418 | **10.418** | 7.17 |
| 168 | 2683.55 | 10.156 | **10.156** | 7.35 |
| 170 | 2715.50 | 10.028 | **10.028** | 7.43 |
| 171 | 2731.47 | 9.964 | **9.964** | 7.48 |
| 172 | 2747.44 | 9.901 | **9.901** | 7.52 |

Adjust the initial time period to auto-adjust the following 19 time periods and obtain the desired range in concentrations.

The last 5 time periods can be modified to more precisely determine the time required to meet a specific residual concentration.

| Project: | NSB New London Zone 4 | Project No.: | 112G00811 |
|---|---|---|---|
| Subject: | Groundwater Extraction System CMS Design | | |
| By: | J. Orient | Date: | 1/12/2010 |
| Checked: | | Date: | |

**Project/Design Objective:**

Design a groundwater extraction system for containment/cleanup of the lead point of groundwater contamination in the shallow portion of the unconsolidated groundwater flow system. Project cleanup rates/times assuming that the residual source been removed or otherwise isolated from groundwater. The final design should be capable of remediating contaminated groundwater to target cleanup levels within a reasonable time frame (30 years or less), and should offer significant advantages over natural processes in terms of cleanup rate and/or protection of receptors. This design should be considered as conceptual only - additional data, i.e., aquifer characteristics, contaminant distributions are needed for a final design.

**Basis of Design Data:** (Input cells yellow, blue automatically calculated)

**Groundwater Plume Information**

| | | |
|---|---|---|
| Plume Width (W): | 100 | ft. |
| Plume Thickness: | 50 | ft. |
| Plume Area: | 7,854 | $ft^2$ |
| Volume of Groundwater in Plume: | 129591 | $ft^3$ |
| Avg Hydraulic Conductivity, Plume Area: | 59 | ft/day |

**Aquifer Characteristics**

| | | |
|---|---|---|
| Thickness (B): | 50 | ft. |
| Avg. Hydraulic Conductivity (K): | 59 | ft/day |
| Transmissivity (T): | 2950 | $ft^2$/day |
| Porosity (n): | 0.33 | |
| Storativity (S): | 0.15 | |
| Fractional Organic Carbon Content (foc): | 1 | |
| Flow Gradient (i): | 0.0039 | |

**Contaminant Characteristics**

| | | | |
|---|---|---|---|
| Contaminant A Representative gw conc.: | lead | 2760 | ug/L |
| Contaminant B Representative gw conc.: | | | |
| Koc, Contaminant A: | | 270 | l/kg |
| Koc, Contaminant B: | | | l/kg |
| Kd, Contaminant A: | | 270 | l/kg |
| Kd, Contaminant B: | | 0 | l/kg |
| Half-life, Contaminant A: | | | years |
| Half-life, Contaminant B: | | | years |
| Target Cleanup Level, Contaminant A: | | 810 | ug/L |
| Target Cleanup Level, Contaminant B: | | | ug/L |

**Remedial System Information**

| | | |
|---|---|---|
| Extraction Well Radius, (r) : | 0.25 | ft. |
| Time to Reach Steady-State Drawdown (t): | 30 | days |
| Allowable Drawdown, Single Well, (s): | 5 | ft. |

**Technical Approach:**

Using aquifer characteristics, impacted groundwater volume, Kd, half-life, and representative groundwater concentration data, calculate the number of pore volume flushes and times required to reach the target groundwater concentration (performed using the attached spreadsheets). Use standard equations to calculate the minimum required pumping rate for containment, per-well achievable pumping rates, and well spacings. Develop a preliminary extraction system design based on the calculations, adjusting the design as appropriate based on data limitation considerations and best scientific judgement.

**Required Pumping Rate (Qt) for Total Plume Capture**

Qt = TiW x 2 (2x the natural groundwater flow-thru rate for entire aquifer)

Qt = 1150.50 $ft^3$/day x 2, or 5.98 gpm x 2

Qt = 2301.00 $ft^3$/day, or 11.95 gpm

**Maximum Achievable Pumping Rate in a Single Well (Qa)**

Qa = $[4\pi Ts/2.3] / \log [2.25Tt/r^2S]$

Qa = 10998.66 $ft^3$/day, or 57.13 gpm

**Minimum Number of Extraction Wells Required**

= Qt/Qa

= 0.21 wells

**Plume Cleanup Rate Projections (From Spreadsheet Program or Other Source)**

| | | | | |
|---|---|---|---|---|
| At | 36.0 | gpm, | 91 | years |
| At | 80.0 | gpm, | 41 | years |
| At | 120.0 | gpm, | 27 | years |
| At natural GW flow rate: (plume area only) | 5.98 | gpm, | 548 | years |

Contaminant that cleanup rate is based on: lead

**Based on the limiting conditions calculated above, projections regarding cleanup times at various pumping rates (see accompanying spreadsheets), a suitable safety factor based on the degree of confidence in the design data, and best scientific judgement, the following are the number of extraction wells and pumping rates selected for the design:**

| | | | |
|---|---|---|---|
| **Number of Wells:** | 3 | | |
| **Per-well Pumping Rate (Qw):** | 40 | gpm, or | 7700.40 $ft^3$/day |
| **Total System Pumping Rate (Qes):** | 120 | gpm, or | 23101.20 $ft^3$/day |

**Extraction Well Spacings, (WSp), ft Perpendicular to Groundwater Flow Direction**

WSp = $Qw/\pi Ti$, for a 2-well extraction system

WSp = 213.05 ft

or

WSp = $1.26(Qw)/\pi Ti$, for a 3-well extraction system

WSp = 268.44 ft

or

WSp = $1.2(Qw)/\pi Ti$, for an extraction system with 4+ wells

WSp = 255.66 ft

**Downgradient Stagnation Point (SPd) Approximation**

SPd = $Qes/2\pi Ti$, Qes = total extraction system pumping rate, $ft^3$/day

SPd = 319.57 ft

**Alternate Layout of Extraction Well System (I.e., parallel to GW flow direction):**

Position one well near the downgradient edge of the impacted area, other two more centrally located.

**Final Configuration, Groundwater Extraction System:**

Install three extraction wells within the area of lead-impacted groundwater. Pump 40 gpm from each well for a total pumping rate of 120 gpm. Cleanup timeframe is approximately 27 years.

# Heterogeneous Aquifer Flushing Rate Calculations

| | | | |
|---|---|---|---|
| **Project:** | NSB New London Zone 4 | **Proj. No.:** | 112G00811 |
| **Chemical :** | Lead | $K_{OC}$ ($K_d$*) : | 270 |
| **Concentration units, water & soil (pick 1):** | mg/L & mg/Kg: | ug/L & ug/Kg: | x |

**NOTE:** Input cells are shaded yellow; cells automatically calculated are shaded blue; the remaining cells are fixed.

All groundwater/soil contaminant concentrations are in consistent units, i.e., mg/L & mg/Kg, or ug/L & ug/Kg.

*** for contaminants that partition between soil and water thru mechanisms other than adsoption onto organic carbon, i.e., metals, the compound's $K_d$ is input directly into the $K_{OC}$ entry cell, with $f_{OC}$ then set to 1. For fractured bedrock, reduce the $f_{OC}$ by 1-2 orders of magnitude to adjust for typical low fracture porosity and resulting high model-perceived mass of aquifer sediments in contact with water.**

**This spreadsheet calculates flushing rates and cleanup times for a groundwater flow system that consists of up to 3 groundwater "flow units". Flow units are discrete portions of the aquifer that have unique properties, i.e., higher or lower average hydraulic conductivity, porosity, or specific gravity relative to other portions of the aquifer, higher/lower contaminant concentrations, and/or different organic carbon contents. The spreadsheet factors in different flushing rates for discrete portions of the aquifer based on the differences in the physical/chemical characteristics of the flow units. First-order contaminant decay/degradation processes can also be factored into the cleanup rate prediction through the optional use of contaminant half-life data.**

## Groundwater Flow Unit Physical/Chemical Data

| Flow Unit 1 (U1) | | Flow Unit 2 (U2) | | Flow Unit 3 (U3) | |
|---|---|---|---|---|---|
| $Cw_{01}$ | 2760.00 | $Cw_{02}$ | 2760.00 | $Cw_{03}$ | 2760.00 |
| n | 0.33 | n | 0.33 | n | 0.33 |
| $S_G$ | 2.65 | $S_G$ | 2.65 | $S_G$ | 2.65 |
| $f_{OC}$* | 1.0000 | $f_{OC}$* | 1.0000 | $f_{OC}$* | 1.0000 |
| $K_d$ | 270.00 | $K_d$ | 270.00 | $K_d$ | 270.00 |
| $M_W$ | 910.80 | $M_W$ | 910.80 | $M_W$ | 910.80 |
| $C_S$ | 745200.00 | $C_S$ | 745200.00 | $C_S$ | 745200.00 |
| $M_S$ | 1323102.60 | $M_S$ | 1323102.60 | $M_S$ | 1323102.60 |
| $M_T$ | 1324013.40 | $M_T$ | 1324013.40 | $M_T$ | 1324013.40 |
| $M_S/M_T$ | 0.9993 | $M_S/M_T$ | 0.9993 | $M_S/M_T$ | 0.9993 |

**$Cw_{0N}$ = Initial contaminant concentration in groundwater flow unit N**

## Groundwater Flow Unit Hydrogeologic Characteristics

| Avg. K, ft/d highest to lowest | Relative average K, $K_U$ | Fraction of aquifer volume, $FV_U$ | Fraction of total flow, $FQ_U$ | Flow unit number, U |
|---|---|---|---|---|
| 59 | 1.000 | 0.33 | 0.331 | 1 |
| 59 | 1.000 | 0.34 | 0.338 | 2 |
| 59 | 1.000 | 0.33 | 0.331 | 3 |

## Pore Volumes and Pore Volume Removal Rates

| Groundwater discharge rate, gpm | Groundwater discharge rate, $ft^3$/day, $Q_T$ | Total volume occupied by plume, $ft^3$, $PV_T$ |
|---|---|---|
| 6 | 1155.08 | 392,700 |

| Discharge rate, Unit 1 $ft^3$/day, $Q_1$ | Discharge rate, Unit 2 $ft^3$/day, $Q_2$ | Discharge rate, Unit 3 $ft^3$/day, $Q_3$ | Plume pore Vol., Unit 1 $ft^3$, $PV_1$ | Plume pore Vol., Unit 2 $ft^3$, $PV_2$ | Plume pore Vol., Unit 3 $ft^3$, $PV_3$ | Time for 1 PV flush, Unit 1, days, $t_1$ | Time for 1 PV flush, Unit 2, days, $t_2$ | Time for 1 PV flush, Unit 3, days, $t_3$ |
|---|---|---|---|---|---|---|---|---|
| 382.46 | 390.15 | 382.46 | 42765.03 | 44060.94 | 42765.03 | 111.81 | 112.93 | 111.81 |

## Contaminant Half-Life Data

| | | | |
|---|---|---|---|
| Does contaminant have a decay half-life (yes/no): | no | If yes, half-life (days): | 3650 |
| 1st order decay coefficient (k): | 0.000190 | | |

## Average Pumped/Discharged and Residual Plume Concentrations Over Time

| Target Cleanup Concentration : | | | 810 | ug/L |
|---|---|---|---|---|
| Time period | Time span, days, t | Avg pumped GW conc. | Avg residual GW conc. | Time span, years |
| 0 | 0 | 0 | **2760** | 0 |
| 20 | 2236.29 | 2722.400 | **2722.401** | 6.12 |
| 30 | 3354.44 | 2703.792 | **2703.794** | 9.18 |
| 40 | 4472.58 | 2685.312 | **2685.314** | 12.25 |
| 60 | 6708.87 | 2648.729 | **2648.732** | 18.37 |
| 80 | 8945.16 | 2612.645 | **2612.648** | 24.49 |
| 100 | 11181.45 | 2577.053 | **2577.057** | 30.61 |
| 140 | 15654.03 | 2507.316 | **2507.321** | 42.86 |
| 180 | 20126.61 | 2439.466 | **2439.472** | 55.10 |
| 240 | 26835.48 | 2341.118 | **2341.126** | 73.47 |
| 300 | 33544.35 | 2246.735 | **2246.745** | 91.84 |
| 360 | 40253.22 | 2156.157 | **2156.169** | 110.21 |
| 420 | 46962.09 | 2069.231 | **2069.245** | 128.58 |
| 500 | 55907.25 | 1958.757 | **1958.772** | 153.07 |
| 600 | 67088.70 | 1828.921 | **1828.938** | 183.68 |
| 700 | 78270.15 | 1707.692 | **1707.710** | 214.29 |
| 800 | 89451.61 | 1594.498 | **1594.518** | 244.91 |
| 1000 | 111814.51 | 1390.123 | **1390.144** | 306.13 |
| 1200 | 134177.41 | 1211.944 | **1211.966** | 367.36 |
| 1600 | 178903.21 | 921.174 | **921.197** | 489.81 |
| 2000 | 223629.01 | 700.167 | **700.189** | 612.26 |
| 1700 | 190084.66 | 860.116 | **860.138** | 520.42 |
| 1800 | 201266.11 | 803.104 | **803.126** | 551.04 |
| 1770 | 197911.68 | 819.799 | **819.821** | 541.85 |
| 1780 | 199029.82 | 814.196 | **814.218** | 544.91 |
| 1790 | 200147.97 | 808.631 | **808.653** | 547.98 |

Adjust the initial time period to auto-adjust the following 19 time periods and obtain the desired range in concentrations.

The last 5 time periods can be modified to more precisely determine the time required to meet a specific residual concentration.

# Heterogeneous Aquifer Flushing Rate Calculations

| | | | |
|---|---|---|---|
| **Project:** | NSB New London Zone 4 | **Proj. No.:** | 112G00811 |
| **Chemical :** | Lead | **$K_{OC}$ ($K_d$*) :** | 270 |
| **Concentration units, water & soil (pick 1):** | mg/L & mg/Kg: | ug/L & ug/Kg: | x |

**NOTE:** Input cells are shaded yellow; cells automatically calculated are shaded blue; the remaining cells are fixed.

All groundwater/soil contaminant concentrations are in consistent units, i.e., mg/L & mg/Kg, or ug/L & ug/Kg.

*** for contaminants that partition between soil and water thru mechanisms other than adsoption onto organic carbon, i.e., metals, the compound's $K_d$ is input directly into the $K_{OC}$ entry cell, with $f_{OC}$ then set to 1. For fractured bedrock, reduce the $f_{OC}$ by 1-2 orders of magnitude to adjust for typical low fracture porosity and resulting high model-perceived mass of aquifer sediments in contact with water.**

**This spreadsheet calculates flushing rates and cleanup times for a groundwater flow system that consists of up to 3 groundwater "flow units". Flow units are discrete portions of the aquifer that have unique properties, i.e., higher or lower average hydraulic conductivity, porosity, or specific gravity relative to other portions of the aquifer, higher/lower contaminant concentrations, and/or different organic carbon contents. The spreadsheet factors in different flushing rates for discrete portions of the aquifer based on the differences in the physical/chemical characteristics of the flow units. First-order contaminant decay/degradation processes can also be factored into the cleanup rate prediction through the optional use of contaminant half-life data.**

### Groundwater Flow Unit Physical/Chemical Data

| Flow Unit 1 (U1) | | Flow Unit 2 (U2) | | Flow Unit 3 (U3) | |
|---|---|---|---|---|---|
| $Cw_{01}$ | 2760.00 | $Cw_{02}$ | 2760.00 | $Cw_{03}$ | 2760.00 |
| n | 0.33 | n | 0.33 | n | 0.33 |
| $S_G$ | 2.65 | $S_G$ | 2.65 | $S_G$ | 2.65 |
| $f_{OC}$* | 1.0000 | $f_{OC}$* | 1.0000 | $f_{OC}$* | 1.0000 |
| $K_d$ | 270.00 | $K_d$ | 270.00 | $K_d$ | 270.00 |
| $M_W$ | 910.80 | $M_W$ | 910.80 | $M_W$ | 910.80 |
| $C_S$ | 745200.00 | $C_S$ | 745200.00 | $C_S$ | 745200.00 |
| $M_S$ | 1323102.60 | $M_S$ | 1323102.60 | $M_S$ | 1323102.60 |
| $M_T$ | 1324013.40 | $M_T$ | 1324013.40 | $M_T$ | 1324013.40 |
| $M_S/M_T$ | 0.9993 | $M_S/M_T$ | 0.9993 | $M_S/M_T$ | 0.9993 |

**$Cw_{0N}$ = Initial contaminant concentration in groundwater flow unit N**

### Groundwater Flow Unit Hydrogeologic Characteristics

| Avg. K, ft/d highest to lowest | Relative average K, $K_U$ | Fraction of aquifer volume, $FV_U$ | Fraction of total flow, $FQ_U$ | Flow unit number, U |
|---|---|---|---|---|
| 59 | 1.000 | 0.33 | 0.331 | 1 |
| 59 | 1.000 | 0.34 | 0.338 | 2 |
| 59 | 1.000 | 0.33 | 0.331 | 3 |

### Pore Volumes and Pore Volume Removal Rates

| Groundwater discharge rate, gpm | Groundwater discharge rate, $ft^3$/day, $Q_T$ | Total volume occupied by plume, $ft^3$, $PV_T$ |
|---|---|---|
| 36 | 6930.48 | 392,700 |

| Discharge rate, Unit 1 $ft^3$/day, $Q_1$ | Discharge rate, Unit 2 $ft^3$/day, $Q_2$ | Discharge rate, Unit 3 $ft^3$/day, $Q_3$ | Plume pore Vol., Unit 1 $ft^3$, $PV_1$ | Plume pore Vol., Unit 2 $ft^3$, $PV_2$ | Plume pore Vol., Unit 3 $ft^3$, $PV_3$ | Time for 1 PV flush, Unit 1, days, $t_1$ | Time for 1 PV flush, Unit 2, days, $t_2$ | Time for 1 PV flush, Unit 3, days, $t_3$ |
|---|---|---|---|---|---|---|---|---|
| 2294.78 | 2340.91 | 2294.78 | 42765.03 | 44060.94 | 42765.03 | 18.64 | 18.82 | 18.64 |

### Contaminant Half-Life Data

| | | | |
|---|---|---|---|
| **Does contaminant have a decay half-life (yes/no):** | no | **If yes, half-life (days):** | 3650 |
| **1st order decay coefficient (k):** | 0.000190 | | |

### Average Pumped/Discharged and Residual Plume Concentrations Over Time

| Target Cleanup Concentration : | | | 810 | ug/L |
|---|---|---|---|---|
| Time period | Time span, days, t | Avg pumped GW conc. | Avg residual GW conc. | Time span, years |
| 0 | 0 | 0 | **2760** | 0 |
| 20 | 372.72 | 2722.400 | **2722.401** | 1.02 |
| 30 | 559.07 | 2703.792 | **2703.794** | 1.53 |
| 40 | 745.43 | 2685.312 | **2685.314** | 2.04 |
| 60 | 1118.15 | 2648.729 | **2648.732** | 3.06 |
| 80 | 1490.86 | 2612.645 | **2612.648** | 4.08 |
| 100 | 1863.58 | 2577.053 | **2577.057** | 5.10 |
| 140 | 2609.01 | 2507.316 | **2507.321** | 7.14 |
| 180 | 3354.44 | 2439.466 | **2439.472** | 9.18 |
| 240 | 4472.58 | 2341.118 | **2341.126** | 12.25 |
| 300 | 5590.73 | 2246.735 | **2246.745** | 15.31 |
| 360 | 6708.87 | 2156.157 | **2156.169** | 18.37 |
| 420 | 7827.02 | 2069.231 | **2069.245** | 21.43 |
| 500 | 9317.88 | 1958.757 | **1958.772** | 25.51 |
| 600 | 11181.45 | 1828.921 | **1828.938** | 30.61 |
| 700 | 13045.03 | 1707.692 | **1707.710** | 35.72 |
| 800 | 14908.60 | 1594.498 | **1594.518** | 40.82 |
| 1000 | 18635.75 | 1390.123 | **1390.144** | 51.02 |
| 1200 | 22362.90 | 1211.944 | **1211.966** | 61.23 |
| 1600 | 29817.20 | 921.174 | **921.197** | 81.64 |
| 2000 | 37271.50 | 700.167 | **700.189** | 102.04 |
| 1700 | 31680.78 | 860.116 | **860.138** | 86.74 |
| 1800 | 33544.35 | 803.104 | **803.126** | 91.84 |
| 1770 | 32985.28 | 819.799 | **819.821** | 90.31 |
| 1780 | 33171.64 | 814.196 | **814.218** | 90.82 |
| 1790 | 33357.99 | 808.631 | **808.653** | 91.33 |

Adjust the initial time period to auto-adjust the following 19 time periods and obtain the desired range in concentrations.

The last 5 time periods can be modified to more precisely determine the time required to meet a specific residual concentration.

# Heterogeneous Aquifer Flushing Rate Calculations

| Project: | NSB New London Zone 4 | Proj. No.: | 112G00811 |
|---|---|---|---|
| Chemical : | Lead | $K_{OC}$ ($K_d$*) : | 270 |
| Concentration units, water & soil (pick 1): | mg/L & mg/Kg: | ug/L & ug/Kg: | x |

**This spreadsheet calculates flushing rates and cleanup times for a groundwater flow system that consists of up to 3 groundwater "flow units". Flow units are discrete portions of the aquifer that have unique properties, i.e., higher or lower average hydraulic conductivity, porosity, or specific gravity relative to other portions of the aquifer, higher/lower contaminant concentrations, and/or different organic carbon contents. The spreadsheet factors in different flushing rates for discrete portions of the aquifer based on the differences in the physical/chemical characteristics of the flow units. First-order contaminant decay/degradation processes can also be factored into the cleanup rate prediction through the optional use of contaminant half-life data.**

NOTE: Input cells are shaded yellow; cells automatically calculated are shaded blue; the remaining cells are fixed.

All groundwater/soil contaminant concentrations are in consistent units, i.e., mg/L & mg/Kg, or ug/L & ug/Kg.

*** for contaminants that partition between soil and water thru mechanisms other than adsoption onto organic carbon, i.e., metals, the compound's $K_d$ is input directly into the $K_{OC}$ entry cell, with $f_{OC}$ then set to 1. For fractured bedrock, reduce the $f_{OC}$ by 1-2 orders of magnitude to adjust for typical low fracture porosity and resulting high model-perceived mass of aquifer sediments in contact with water.**

## Groundwater Flow Unit Physical/Chemical Data

| Flow Unit 1 (U1) | | Flow Unit 2 (U2) | | Flow Unit 3 (U3) | |
|---|---|---|---|---|---|
| $Cw_{01}$ | 2760.00 | $Cw_{02}$ | 2760.00 | $Cw_{03}$ | 2760.00 |
| n | 0.33 | n | 0.33 | n | 0.33 |
| $S_G$ | 2.65 | $S_G$ | 2.65 | $S_G$ | 2.65 |
| $f_{OC}$* | 1.0000 | $f_{OC}$* | 1.0000 | $f_{OC}$* | 1.0000 |
| $K_d$ | 270.00 | $K_d$ | 270.00 | $K_d$ | 270.00 |
| $M_W$ | 910.80 | $M_W$ | 910.80 | $M_W$ | 910.80 |
| $C_S$ | 745200.00 | $C_S$ | 745200.00 | $C_S$ | 745200.00 |
| $M_S$ | 1323102.60 | $M_S$ | 1323102.60 | $M_S$ | 1323102.60 |
| $M_T$ | 1324013.40 | $M_T$ | 1324013.40 | $M_T$ | 1324013.40 |
| $M_S/M_T$ | 0.9993 | $M_S/M_T$ | 0.9993 | $M_S/M_T$ | 0.9993 |

**$Cw_{0N}$ = Initial contaminant concentration in groundwater flow unit N**

## Groundwater Flow Unit Hydrogeologic Characteristics

| Avg. K, ft/d highest to lowest | Relative average K, $K_U$ | Fraction of aquifer volume, $FV_U$ | Fraction of total flow, $FQ_U$ | Flow unit number, U |
|---|---|---|---|---|
| 59 | 1.000 | 0.33 | 0.331 | 1 |
| 59 | 1.000 | 0.34 | 0.338 | 2 |
| 59 | 1.000 | 0.33 | 0.331 | 3 |

## Pore Volumes and Pore Volume Removal Rates

| Groundwater discharge rate, gpm | Groundwater discharge rate, $ft^3$/day, $Q_T$ | Total volume occupied by plume, $ft^3$, $PV_T$ |
|---|---|---|
| 80 | 15401.07 | 392,700 |

| Discharge rate, Unit 1 $ft^3$/day, $Q_1$ | Discharge rate, Unit 2 $ft^3$/day, $Q_2$ | Discharge rate, Unit 3 $ft^3$/day, $Q_3$ | Plume pore Vol., Unit 1 $ft^3$, $PV_1$ | Plume pore Vol., Unit 2 $ft^3$, $PV_2$ | Plume pore Vol., Unit 3 $ft^3$, $PV_3$ | Time for 1 PV flush, Unit 1, days, $t_1$ | Time for 1 PV flush, Unit 2, days, $t_2$ | Time for 1 PV flush, Unit 3, days, $t_3$ |
|---|---|---|---|---|---|---|---|---|
| 5099.52 | 5202.03 | 5099.52 | 42765.03 | 44060.94 | 42765.03 | 8.39 | 8.47 | 8.39 |

## Contaminant Half-Life Data

| Does contaminant have a decay half-life (yes/no): | no | If yes, half-life (days): | 3650 |
|---|---|---|---|
| 1st order decay coefficient (k): | 0.000190 | | |

## Average Pumped/Discharged and Residual Plume Concentrations Over Time

| Target Cleanup Concentration : | | | 810 | ug/L |
|---|---|---|---|---|
| Time period | Time span, days, t | Avg pumped GW conc. | Avg residual GW conc. | Time span, years |
| 0 | 0 | 0 | **2760** | 0 |
| 20 | 167.72 | 2722.400 | **2722.401** | 0.46 |
| 30 | 251.58 | 2703.792 | **2703.794** | 0.69 |
| 40 | 335.44 | 2685.312 | **2685.314** | 0.92 |
| 60 | 503.17 | 2648.729 | **2648.732** | 1.38 |
| 80 | 670.89 | 2612.645 | **2612.648** | 1.84 |
| 100 | 838.61 | 2577.053 | **2577.057** | 2.30 |
| 140 | 1174.05 | 2507.316 | **2507.321** | 3.21 |
| 180 | 1509.50 | 2439.466 | **2439.472** | 4.13 |
| 240 | 2012.66 | 2341.118 | **2341.126** | 5.51 |
| 300 | 2515.83 | 2246.735 | **2246.745** | 6.89 |
| 360 | 3018.99 | 2156.157 | **2156.169** | 8.27 |
| 420 | 3522.16 | 2069.231 | **2069.245** | 9.64 |
| 500 | 4193.04 | 1958.757 | **1958.772** | 11.48 |
| 600 | 5031.65 | 1828.921 | **1828.938** | 13.78 |
| 700 | 5870.26 | 1707.692 | **1707.710** | 16.07 |
| 800 | 6708.87 | 1594.498 | **1594.518** | 18.37 |
| 1000 | 8386.09 | 1390.123 | **1390.144** | 22.96 |
| 1200 | 10063.31 | 1211.944 | **1211.966** | 27.55 |
| 1600 | 13417.74 | 921.174 | **921.197** | 36.74 |
| 2000 | 16772.18 | 700.167 | **700.189** | 45.92 |
| 1700 | 14256.35 | 860.116 | **860.138** | 39.03 |
| 1800 | 15094.96 | 803.104 | **803.126** | 41.33 |
| 1770 | 14843.38 | 819.799 | **819.821** | 40.64 |
| 1780 | 14927.24 | 814.196 | **814.218** | 40.87 |
| 1790 | 15011.10 | 808.631 | **808.653** | 41.10 |

Adjust the initial time period to auto-adjust the following 19 time periods and obtain the desired range in concentrations.

The last 5 time periods can be modified to more precisely determine the time required to meet a specific residual concentration.

# Heterogeneous Aquifer Flushing Rate Calculations

| | | | |
|---|---|---|---|
| Project: | NSB New London Zone 4 | Proj. No.: | 112G00811 |
| Chemical : | Lead | $K_{OC}$ ($K_d$*) : | 270 |
| Concentration units, water & soil (pick 1): | mg/L & mg/Kg: | ug/L & ug/Kg: | x |

NOTE: Input cells are shaded yellow; cells automatically calculated are shaded blue; the remaining cells are fixed.

**This spreadsheet calculates flushing rates and cleanup times for a groundwater flow system that consists of up to 3 groundwater "flow units". Flow units are discrete portions of the aquifer that have unique properties, i.e., higher or lower average hydraulic conductivity, porosity, or specific gravity relative to other portions of the aquifer, higher/lower contaminant concentrations, and/or different organic carbon contents. The spreadsheet factors in different flushing rates for discrete portions of the aquifer based on the differences in the physical/chemical characteristics of the flow units. First-order contaminant decay/degradation processes can also be factored into the cleanup rate prediction through the optional use of contaminant half-life data.**

All groundwater/soil contaminant concentrations are in consistent units, i.e., mg/L & mg/Kg, or ug/L & ug/Kg.

*** for contaminants that partition between soil and water thru mechanisms other than adsoption onto organic carbon, i.e., metals, the compound's $K_d$ is input directly into the $K_{OC}$ entry cell, with $f_{OC}$ then set to 1. For fractured bedrock, reduce the $f_{OC}$ by 1-2 orders of magnitude to adjust for typical low fracture porosity and resulting high model-perceived mass of aquifer sediments in contact with water.**

## Groundwater Flow Unit Physical/Chemical Data

| Flow Unit 1 (U1) | | Flow Unit 2 (U2) | | Flow Unit 3 (U3) | |
|---|---|---|---|---|---|
| $Cw_{01}$ | 2760.00 | $Cw_{02}$ | 2760.00 | $Cw_{03}$ | 2760.00 |
| n | 0.33 | n | 0.33 | n | 0.33 |
| $S_G$ | 2.65 | $S_G$ | 2.65 | $S_G$ | 2.65 |
| $f_{OC}$* | 1.0000 | $f_{OC}$* | 1.0000 | $f_{OC}$* | 1.0000 |
| $K_d$ | 270.00 | $K_d$ | 270.00 | $K_d$ | 270.00 |
| $M_W$ | 910.80 | $M_W$ | 910.80 | $M_W$ | 910.80 |
| $C_S$ | 745200.00 | $C_S$ | 745200.00 | $C_S$ | 745200.00 |
| $M_S$ | 1323102.60 | $M_S$ | 1323102.60 | $M_S$ | 1323102.60 |
| $M_T$ | 1324013.40 | $M_T$ | 1324013.40 | $M_T$ | 1324013.40 |
| $M_S/M_T$ | 0.9993 | $M_S/M_T$ | 0.9993 | $M_S/M_T$ | 0.9993 |

**$Cw_{0N}$ = Initial contaminant concentration in groundwater flow unit N**

## Groundwater Flow Unit Hydrogeologic Characteristics

| Avg. K, ft/d highest to lowest | Relative average K, $K_U$ | Fraction of aquifer volume, $FV_U$ | Fraction of total flow, $FQ_U$ | Flow unit number, U |
|---|---|---|---|---|
| 59 | 1.000 | 0.33 | 0.331 | 1 |
| 59 | 1.000 | 0.34 | 0.338 | 2 |
| 59 | 1.000 | 0.33 | 0.331 | 3 |

## Pore Volumes and Pore Volume Removal Rates

| Groundwater discharge rate, gpm | Groundwater discharge rate, $ft^3$/day, $Q_T$ | Total volume occupied by plume, $ft^3$, $PV_T$ |
|---|---|---|
| 120 | 23101.60 | 392,700 |

| Discharge rate, Unit 1 $ft^3$/day, $Q_1$ | Discharge rate, Unit 2 $ft^3$/day, $Q_2$ | Discharge rate, Unit 3 $ft^3$/day, $Q_3$ | Plume pore Vol., Unit 1 $ft^3$, $PV_1$ | Plume pore Vol., Unit 2 $ft^3$, $PV_2$ | Plume pore Vol., Unit 3 $ft^3$, $PV_3$ | Time for 1 PV flush, Unit 1, days, $t_1$ | Time for 1 PV flush, Unit 2, days, $t_2$ | Time for 1 PV flush, Unit 3, days, $t_3$ |
|---|---|---|---|---|---|---|---|---|
| 7649.28 | 7803.04 | 7649.28 | 42765.03 | 44060.94 | 42765.03 | 5.59 | 5.65 | 5.59 |

## Contaminant Half-Life Data

| | | | |
|---|---|---|---|
| Does contaminant have a decay half-life (yes/no): | no | If yes, half-life (days): | 3650 |
| 1st order decay coefficient (k): | 0.000190 | | |

## Average Pumped/Discharged and Residual Plume Concentrations Over Time

| Target Cleanup Concentration : | | | 810 | ug/L |
|---|---|---|---|---|
| Time period | Time span, days, t | Avg pumped GW conc. | Avg residual GW conc. | Time span, years |
| 0 | 0 | 0 | **2760** | 0 |
| 20 | 111.81 | 2722.400 | **2722.401** | 0.31 |
| 30 | 167.72 | 2703.792 | **2703.794** | 0.46 |
| 40 | 223.63 | 2685.312 | **2685.314** | 0.61 |
| 60 | 335.44 | 2648.729 | **2648.732** | 0.92 |
| 80 | 447.26 | 2612.645 | **2612.648** | 1.22 |
| 100 | 559.07 | 2577.053 | **2577.057** | 1.53 |
| 140 | 782.70 | 2507.316 | **2507.321** | 2.14 |
| 180 | 1006.33 | 2439.466 | **2439.472** | 2.76 |
| 240 | 1341.77 | 2341.118 | **2341.126** | 3.67 |
| 300 | 1677.22 | 2246.735 | **2246.745** | 4.59 |
| 360 | 2012.66 | 2156.157 | **2156.169** | 5.51 |
| 420 | 2348.10 | 2069.231 | **2069.245** | 6.43 |
| 500 | 2795.36 | 1958.757 | **1958.772** | 7.65 |
| 600 | 3354.44 | 1828.921 | **1828.938** | 9.18 |
| 700 | 3913.51 | 1707.692 | **1707.710** | 10.71 |
| 800 | 4472.58 | 1594.498 | **1594.518** | 12.25 |
| 1000 | 5590.73 | 1390.123 | **1390.144** | 15.31 |
| 1200 | 6708.87 | 1211.944 | **1211.966** | 18.37 |
| 1600 | 8945.16 | 921.174 | **921.197** | 24.49 |
| 2000 | 11181.45 | 700.167 | **700.189** | 30.61 |
| 1700 | 9504.23 | 860.116 | **860.138** | 26.02 |
| 1800 | 10063.31 | 803.104 | **803.126** | 27.55 |
| 1770 | 9895.58 | 819.799 | **819.821** | 27.09 |
| 1780 | 9951.49 | 814.196 | **814.218** | 27.25 |
| 1790 | 10007.40 | 808.631 | **808.653** | 27.40 |

Adjust the initial time period to auto-adjust the following 19 time periods and obtain the desired range in concentrations.

The last 5 time periods can be modified to more precisely determine the time required to meet a specific residual concentration.

| Project: | NSB New London Zone 4 | Project No.: | 112G00811 |
|---|---|---|---|
| Subject: | Groundwater Extraction System CMS Design | | |
| By: | J. Orient | Date: | 1/12/2010 |
| Checked: | | Date: | |

**Project/Design Objective:**

Design a groundwater extraction system for containment/cleanup of the TPH point of groundwater contamination centered around 13MW16 in the shallow portion of the unconsolidated groundwater flow system. Project cleanup rates/times assuming that the residual source been removed or otherwise isolated from groundwater. The final design should be capable of remediating contaminated groundwater to target cleanup levels within a reasonable time frame (30 years or less), and should offer significant advantages over natural processes in terms of cleanup rate and/or protection of receptors. This design should be considered as conceptual only - additional data, i.e., aquifer characteristics, contaminant distributions are needed for a final design.

**Basis of Design Data:** (Input cells yellow, blue automatically calculated)

**Groundwater Plume Information**

| | | |
|---|---|---|
| Plume Width (W): | 100 | ft. |
| Plume Thickness: | 50 | ft. |
| Plume Area: | 7,854 | $ft^2$ |
| Volume of Groundwater in Plume: | 129591 | $ft^3$ |
| Avg Hydraulic Conductivity, Plume Area: | 59 | ft/day |

**Aquifer Characteristics**

| | | |
|---|---|---|
| Thickness (B): | 50 | ft. |
| Avg. Hydraulic Conductivity (K): | 59 | ft/day |
| Transmissivity (T): | 2950 | $ft^2$/day |
| Porosity (n): | 0.33 | |
| Storativity (S): | 0.15 | |
| Fractional Organic Carbon Content (foc): | 0.006 | |
| Flow Gradient (i): | 0.0039 | |

**Contaminant Characteristics**

| | | | |
|---|---|---|---|
| Contaminant A Representative gw conc.: | TPH (blended) | 5400 | ug/L |
| Contaminant B Representative gw conc.: | | | |
| Koc, Contaminant A: | | 1,650,000 | l/kg |
| Koc, Contaminant B: | | | l/kg |
| Kd, Contaminant A: | | 9900 | l/kg |
| Kd, Contaminant B: | | 0 | l/kg |
| Half-life, Contaminant A: | | | years |
| Half-life, Contaminant B: | | | years |
| Target Cleanup Level, Contaminant A: | | 2500 | ug/L |
| Target Cleanup Level, Contaminant B: | | | ug/L |

**Remedial System Information**

| | | |
|---|---|---|
| Extraction Well Radius, (r) : | 0.25 | ft. |
| Time to Reach Steady-State Drawdown (t): | 30 | days |
| Allowable Drawdown, Single Well, (s): | 5 | ft. |

**Technical Approach:**

Using aquifer characteristics, impacted groundwater volume, Kd, half-life, and representative groundwater concentration data, calculate the number of pore volume flushes and times required to reach the target groundwater concentration (performed using the attached spreadsheets). Use standard equations to calculate the minimum required pumping rate for containment, per-well achievable pumping rates, and well spacings. Develop a preliminary extraction system design based on the calculations, adjusting the design as appropriate based on data limitation considerations and best scientific judgement.

**Required Pumping Rate (Qt) for Total Plume Capture**

Qt = TiW x 2 (2x the natural groundwater flow-thru rate for entire aquifer)

Qt = 1150.50 $ft^3$/day x 2, or 5.98 gpm x 2

Qt = 2301.00 $ft^3$/day, or 11.95 gpm

**Maximum Achievable Pumping Rate in a Single Well (Qa)**

Qa = $[4\pi Ts/2.3] / \log [2.25Tt/r^2S]$

Qa = 10998.66 $ft^3$/day, or 57.13 gpm

**Minimum Number of Extraction Wells Required**

= Qt/Qa

= 0.21 wells

**Plume Cleanup Rate Projections (From Spreadsheet Program or Other Source)**

| | | | | |
|---|---|---|---|---|
| At | 12.0 | gpm, | 11 | years |
| At | 24.0 | gpm, | 11 | years |
| At | | gpm, | | years |
| At natural GW flow rate: (plume area only) | 5.98 | gpm, | 11 | years |

Contaminant that cleanup rate is based on: TPH (blended)

**Based on the limiting conditions calculated above, projections regarding cleanup times at various pumping rates (see accompanying spreadsheets), a suitable safety factor based on the degree of confidence in the design data, and best scientific judgement, the following are the number of extraction wells and pumping rates selected for the design:**

| | | | |
|---|---|---|---|
| **Number of Wells:** | 1 | | |
| **Per-well Pumping Rate (Qw):** | 12 | gpm, or | 2310.12 $ft^3$/day |
| **Total System Pumping Rate (Qes):** | 12 | gpm, or | 2310.12 $ft^3$/day |

**Extraction Well Spacings, (WSp), ft Perpendicular to Groundwater Flow Direction**

WSp = $Qw/\pi Ti$, for a 2-well extraction system

WSp = 63.91 ft

or

WSp = $1.26(Qw)/\pi Ti$, for a 3-well extraction system

WSp = 80.53 ft

or

WSp = $1.2(Qw)/\pi Ti$, for an extraction system with 4+ wells

WSp = 76.70 ft

**Downgradient Stagnation Point (SPd) Approximation**

SPd = $Qes/2\pi Ti$, Qes = total extraction system pumping rate, $ft^3$/day

SPd = 31.96 ft

**Alternate Layout of Extraction Well System (I.e., parallel to GW flow direction):**

Position well within hot spot area, within 25-30 ft of downgradient limit of where remediation is required but no closer than 30 ft to the river, to avoid pulling in an excessive amount of river water.

**Final Configuration, Groundwater Extraction System:**

No pumping recommended for the TPH-impacted groundwater. Residual TPH likely has extremely high soil/water partition coefficient/low mobility and as a result pumping will not accelerate cleanup to any noticeable degree. Long term biodegradation will reduce TPH levels over time to the 2500 ug/l cleanup level within an estimated 11 years, assuming a conservative 10-year half life for TPH.

# Heterogeneous Aquifer Flushing Rate Calculations

| | | | |
|---|---|---|---|
| **Project:** | NSB New London Zone 4 | **Proj. No.:** | 112G00811 |
| **Chemical :** | TPH | **$K_{OC}$ ($K_d$*) :** | 1650000 |
| **Concentration units, water & soil (pick 1):** | mg/L & mg/Kg: | ug/L & ug/Kg: | x |

**NOTE:** Input cells are shaded yellow; cells automatically calculated are shaded blue; the remaining cells are fixed.

**This spreadsheet calculates flushing rates and cleanup times for a groundwater flow system that consists of up to 3 groundwater "flow units". Flow units are discrete portions of the aquifer that have unique properties, i.e., higher or lower average hydraulic conductivity, porosity, or specific gravity relative to other portions of the aquifer, higher/lower contaminant concentrations, and/or different organic carbon contents. The spreadsheet factors in different flushing rates for discrete portions of the aquifer based on the differences in the physical/chemical characteristics of the flow units. First-order contaminant decay/degradation processes can also be factored into the cleanup rate prediction through the optional use of contaminant half-life data.**

All groundwater/soil contaminant concentrations are in consistent units, i.e., mg/L & mg/Kg, or ug/L & ug/Kg.

*** for contaminants that partition between soil and water thru mechanisms other than adsoption onto organic carbon, i.e., metals, the compound's $K_d$ is input directly into the $K_{OC}$ entry cell, with $f_{OC}$ then set to 1. For fractured bedrock, reduce the $f_{OC}$ by 1-2 orders of magnitude to adjust for typical low fracture porosity and resulting high model-perceived mass of aquifer sediments in contact with water.**

## Groundwater Flow Unit Physical/Chemical Data

| Flow Unit 1 (U1) | | Flow Unit 2 (U2) | | Flow Unit 3 (U3) | |
|---|---|---|---|---|---|
| $Cw_{01}$ | 5400.00 | $Cw_{02}$ | 5400.00 | $Cw_{03}$ | 5400.00 |
| n | 0.33 | n | 0.33 | n | 0.33 |
| $S_G$ | 2.65 | $S_G$ | 2.65 | $S_G$ | 2.65 |
| $f_{OC}$* | 0.0060 | $f_{OC}$* | 0.0060 | $f_{OC}$* | 0.0060 |
| $K_d$ | 9900.00 | $K_d$ | 9900.00 | $K_d$ | 9900.00 |
| $M_W$ | 1782.00 | $M_W$ | 1782.00 | $M_W$ | 1782.00 |
| $C_S$ | 53460000.00 | $C_S$ | 53460000.00 | $C_S$ | 53460000.00 |
| $M_S$ | 94918230.00 | $M_S$ | 94918230.00 | $M_S$ | 94918230.00 |
| $M_T$ | 94920012.00 | $M_T$ | 94920012.00 | $M_T$ | 94920012.00 |
| $M_S/M_T$ | 1.0000 | $M_S/M_T$ | 1.0000 | $M_S/M_T$ | 1.0000 |

**$Cw_{0N}$ = Initial contaminant concentration in groundwater flow unit N**

## Groundwater Flow Unit Hydrogeologic Characteristics

| Avg. K, ft/d highest to lowest | Relative average K, $K_U$ | Fraction of aquifer volume, $FV_U$ | Fraction of total flow, $FQ_U$ | Flow unit number, U |
|---|---|---|---|---|
| 59 | 1.000 | 0.33 | 0.331 | 1 |
| 59 | 1.000 | 0.34 | 0.338 | 2 |
| 59 | 1.000 | 0.33 | 0.331 | 3 |

## Pore Volumes and Pore Volume Removal Rates

| Groundwater discharge rate, gpm | Groundwater discharge rate, $ft^3$/day, $Q_T$ | Total volume occupied by plume, $ft^3$, $PV_T$ |
|---|---|---|
| 6 | 1155.08 | 392,700 |

| Discharge rate, Unit 1 $ft^3$/day, $Q_1$ | Discharge rate, Unit 2 $ft^3$/day, $Q_2$ | Discharge rate, Unit 3 $ft^3$/day, $Q_3$ | Plume pore Vol., Unit 1 $ft^3$, $PV_1$ | Plume pore Vol., Unit 2 $ft^3$, $PV_2$ | Plume pore Vol., Unit 3 $ft^3$, $PV_3$ | Time for 1 PV flush, Unit 1, days, $t_1$ | Time for 1 PV flush, Unit 2, days, $t_2$ | Time for 1 PV flush, Unit 3, days, $t_3$ |
|---|---|---|---|---|---|---|---|---|
| 382.46 | 390.15 | 382.46 | 42765.03 | 44060.94 | 42765.03 | 111.81 | 112.93 | 111.81 |

## Contaminant Half-Life Data

| | | | |
|---|---|---|---|
| **Does contaminant have a decay half-life (yes/no):** | yes | **If yes, half-life (days):** | 3650 |
| **1st order decay coefficient (k):** | 0.000190 | | |

## Average Pumped/Discharged and Residual Plume Concentrations Over Time

| Target Cleanup Concentration : | | | 2500 | ug/L |
|---|---|---|---|---|
| Time period | Time span, days, t | Avg pumped GW conc. | Avg residual GW conc. | Time span, years |
| 0 | 0 | 0 | **5400** | 0 |
| 0.5 | 55.91 | 5342.940 | **5342.940** | 0.15 |
| 0.75 | 83.86 | 5314.636 | **5314.636** | 0.23 |
| 1 | 111.81 | 5286.482 | **5286.482** | 0.31 |
| 1.5 | 167.72 | 5230.621 | **5230.621** | 0.46 |
| 2 | 223.63 | 5175.350 | **5175.350** | 0.61 |
| 2.5 | 279.54 | 5120.664 | **5120.664** | 0.77 |
| 3.5 | 391.35 | 5013.018 | **5013.018** | 1.07 |
| 4.5 | 503.17 | 4907.635 | **4907.635** | 1.38 |
| 6 | 670.89 | 4753.700 | **4753.700** | 1.84 |
| 7.5 | 838.61 | 4604.593 | **4604.593** | 2.30 |
| 9 | 1006.33 | 4460.163 | **4460.163** | 2.76 |
| 10.5 | 1174.05 | 4320.264 | **4320.264** | 3.21 |
| 12.5 | 1397.68 | 4140.533 | **4140.533** | 3.83 |
| 15 | 1677.22 | 3926.348 | **3926.348** | 4.59 |
| 17.5 | 1956.75 | 3723.242 | **3723.242** | 5.36 |
| 20 | 2236.29 | 3530.643 | **3530.643** | 6.12 |
| 25 | 2795.36 | 3174.818 | **3174.818** | 7.65 |
| 30 | 3354.44 | 2854.853 | **2854.853** | 9.18 |
| 40 | 4472.58 | 2308.415 | **2308.415** | 12.25 |
| 50 | 5590.73 | 1866.568 | **1866.568** | 15.31 |
| 32 | 3578.06 | 2736.086 | **2736.086** | 9.80 |
| 34 | 3801.69 | 2622.260 | **2622.260** | 10.41 |
| 36 | 4025.32 | 2513.170 | **2513.170** | 11.02 |
| 37 | 4137.14 | 2460.338 | **2460.338** | 11.33 |
| 38 | 4248.95 | 2408.617 | **2408.617** | 11.63 |

Adjust the initial time period to auto-adjust the following 19 time periods and obtain the desired range in concentrations.

The last 5 time periods can be modified to more precisely determine the time required to meet a specific residual concentration.

# Heterogeneous Aquifer Flushing Rate Calculations

| | | | |
|---|---|---|---|
| **Project:** | NSB New London Zone 4 | **Proj. No.:** | 112G00811 |
| **Chemical :** | TPH | **$K_{OC}$ ($K_d$*) :** | 1650000 |
| **Concentration units, water & soil (pick 1):** | mg/L & mg/Kg: | ug/L & ug/Kg: | x |

**NOTE:** Input cells are shaded yellow; cells automatically calculated are shaded blue; the remaining cells are fixed.

All groundwater/soil contaminant concentrations are in consistent units, i.e., mg/L & mg/Kg, or ug/L & ug/Kg.

*** for contaminants that partition between soil and water thru mechanisms other than adsoption onto organic carbon, i.e., metals, the compound's $K_d$ is input directly into the $K_{OC}$ entry cell, with $f_{OC}$ then set to 1. For fractured bedrock, reduce the $f_{OC}$ by 1-2 orders of magnitude to adjust for typical low fracture porosity and resulting high model-perceived mass of aquifer sediments in contact with water.**

**This spreadsheet calculates flushing rates and cleanup times for a groundwater flow system that consists of up to 3 groundwater "flow units". Flow units are discrete portions of the aquifer that have unique properties, i.e., higher or lower average hydraulic conductivity, porosity, or specific gravity relative to other portions of the aquifer, higher/lower contaminant concentrations, and/or different organic carbon contents. The spreadsheet factors in different flushing rates for discrete portions of the aquifer based on the differences in the physical/chemical characteristics of the flow units. First-order contaminant decay/degradation processes can also be factored into the cleanup rate prediction through the optional use of contaminant half-life data.**

### Groundwater Flow Unit Physical/Chemical Data

| Flow Unit 1 (U1) | | Flow Unit 2 (U2) | | Flow Unit 3 (U3) | |
|---|---|---|---|---|---|
| $Cw_{01}$ | 5400.00 | $Cw_{02}$ | 5400.00 | $Cw_{03}$ | 5400.00 |
| n | 0.33 | n | 0.33 | n | 0.33 |
| $S_G$ | 2.65 | $S_G$ | 2.65 | $S_G$ | 2.65 |
| $f_{OC}$* | 0.0060 | $f_{OC}$* | 0.0060 | $f_{OC}$* | 0.0060 |
| $K_d$ | 9900.00 | $K_d$ | 9900.00 | $K_d$ | 9900.00 |
| $M_W$ | 1782.00 | $M_W$ | 1782.00 | $M_W$ | 1782.00 |
| $C_S$ | 53460000.00 | $C_S$ | 53460000.00 | $C_S$ | 53460000.00 |
| $M_S$ | 94918230.00 | $M_S$ | 94918230.00 | $M_S$ | 94918230.00 |
| $M_T$ | 94920012.00 | $M_T$ | 94920012.00 | $M_T$ | 94920012.00 |
| $M_S/M_T$ | 1.0000 | $M_S/M_T$ | 1.0000 | $M_S/M_T$ | 1.0000 |

**$Cw_{0N}$ = Initial contaminant concentration in groundwater flow unit N**

### Groundwater Flow Unit Hydrogeologic Characteristics

| Avg. K, ft/d highest to lowest | Relative average K, $K_U$ | Fraction of aquifer volume, $FV_U$ | Fraction of total flow, $FQ_U$ | Flow unit number, U |
|---|---|---|---|---|
| 59 | 1.000 | 0.33 | 0.331 | 1 |
| 59 | 1.000 | 0.34 | 0.338 | 2 |
| 59 | 1.000 | 0.33 | 0.331 | 3 |

### Pore Volumes and Pore Volume Removal Rates

| Groundwater discharge rate, gpm | Groundwater discharge rate, $ft^3$/day, $Q_T$ | Total volume occupied by plume, $ft^3$, $PV_T$ |
|---|---|---|
| 12 | 2310.16 | 392,700 |

| Discharge rate, Unit 1 $ft^3$/day, $Q_1$ | Discharge rate, Unit 2 $ft^3$/day, $Q_2$ | Discharge rate, Unit 3 $ft^3$/day, $Q_3$ | Plume pore Vol., Unit 1 $ft^3$, $PV_1$ | Plume pore Vol., Unit 2 $ft^3$, $PV_2$ | Plume pore Vol., Unit 3 $ft^3$, $PV_3$ | Time for 1 PV flush, Unit 1, days, $t_1$ | Time for 1 PV flush, Unit 2, days, $t_2$ | Time for 1 PV flush, Unit 3, days, $t_3$ |
|---|---|---|---|---|---|---|---|---|
| 764.93 | 780.30 | 764.93 | 42765.03 | 44060.94 | 42765.03 | 55.91 | 56.47 | 55.91 |

### Contaminant Half-Life Data

| | | | |
|---|---|---|---|
| **Does contaminant have a decay half-life (yes/no):** | yes | **If yes, half-life (days):** | 3650 |
| **1st order decay coefficient (k):** | 0.000190 | | |

### Average Pumped/Discharged and Residual Plume Concentrations Over Time

| Target Cleanup Concentration : | | | 2500 | ug/L |
|---|---|---|---|---|
| Time period | Time span, days, t | Avg pumped GW conc. | Avg residual GW conc. | Time span, years |
| 0 | 0 | 0 | **5400** | 0 |
| 1 | 55.91 | 5342.890 | **5342.890** | 0.15 |
| 1.5 | 83.86 | 5314.561 | **5314.561** | 0.23 |
| 2 | 111.81 | 5286.383 | **5286.383** | 0.31 |
| 3 | 167.72 | 5230.474 | **5230.474** | 0.46 |
| 4 | 223.63 | 5175.157 | **5175.157** | 0.61 |
| 5 | 279.54 | 5120.424 | **5120.424** | 0.77 |
| 7 | 391.35 | 5012.690 | **5012.690** | 1.07 |
| 9 | 503.17 | 4907.222 | **4907.222** | 1.38 |
| 12 | 670.89 | 4753.166 | **4753.166** | 1.84 |
| 15 | 838.61 | 4603.947 | **4603.947** | 2.30 |
| 18 | 1006.33 | 4459.412 | **4459.412** | 2.76 |
| 21 | 1174.05 | 4319.415 | **4319.415** | 3.21 |
| 25 | 1397.68 | 4139.565 | **4139.565** | 3.83 |
| 30 | 1677.22 | 3925.246 | **3925.246** | 4.59 |
| 35 | 1956.75 | 3722.023 | **3722.023** | 5.36 |
| 40 | 2236.29 | 3529.322 | **3529.322** | 6.12 |
| 50 | 2795.36 | 3173.333 | **3173.333** | 7.65 |
| 60 | 3354.44 | 2853.251 | **2853.251** | 9.18 |
| 80 | 4472.58 | 2306.688 | **2306.688** | 12.25 |
| 100 | 5590.73 | 1864.823 | **1864.823** | 15.31 |
| 65 | 3633.97 | 2705.529 | **2705.529** | 9.95 |
| 70 | 3913.51 | 2565.455 | **2565.455** | 10.71 |
| 72 | 4025.32 | 2511.477 | **2511.477** | 11.02 |
| 73 | 4081.23 | 2484.916 | **2484.916** | 11.17 |
| 74 | 4137.14 | 2458.636 | **2458.636** | 11.33 |

Adjust the initial time period to auto-adjust the following 19 time periods and obtain the desired range in concentrations.

The last 5 time periods can be modified to more precisely determine the time required to meet a specific residual concentration.

# Heterogeneous Aquifer Flushing Rate Calculations

| | | | |
|---|---|---|---|
| Project: | NSB New London Zone 4 | Proj. No.: | 112G00811 |
| Chemical : | TPH | $K_{OC}$ ($K_d$*) : | 1650000 |
| Concentration units, water & soil (pick 1): | mg/L & mg/Kg: | ug/L & ug/Kg: | x |

**This spreadsheet calculates flushing rates and cleanup times for a groundwater flow system that consists of up to 3 groundwater "flow units". Flow units are discrete portions of the aquifer that have unique properties, i.e., higher or lower average hydraulic conductivity, porosity, or specific gravity relative to other portions of the aquifer, higher/lower contaminant concentrations, and/or different organic carbon contents. The spreadsheet factors in different flushing rates for discrete portions of the aquifer based on the differences in the physical/chemical characteristics of the flow units. First-order contaminant decay/degradation processes can also be factored into the cleanup rate prediction through the optional use of contaminant half-life data.**

NOTE: Input cells are shaded yellow; cells automatically calculated are shaded blue; the remaining cells are fixed.

All groundwater/soil contaminant concentrations are in consistent units, i.e., mg/L & mg/Kg, or ug/L & ug/Kg.

*** for contaminants that partition between soil and water thru mechanisms other than adsoption onto organic carbon, i.e., metals, the compound's $K_d$ is input directly into the $K_{OC}$ entry cell, with $f_{OC}$ then set to 1. For fractured bedrock, reduce the $f_{OC}$ by 1-2 orders of magnitude to adjust for typical low fracture porosity and resulting high model-perceived mass of aquifer sediments in contact with water.**

## Groundwater Flow Unit Physical/Chemical Data

| Flow Unit 1 (U1) | | Flow Unit 2 (U2) | | Flow Unit 3 (U3) | |
|---|---|---|---|---|---|
| $Cw_{01}$ | 5400.00 | $Cw_{02}$ | 5400.00 | $Cw_{03}$ | 5400.00 |
| n | 0.33 | n | 0.33 | n | 0.33 |
| $S_G$ | 2.65 | $S_G$ | 2.65 | $S_G$ | 2.65 |
| $f_{OC}$* | 0.0060 | $f_{OC}$* | 0.0060 | $f_{OC}$* | 0.0060 |
| $K_d$ | 9900.00 | $K_d$ | 9900.00 | $K_d$ | 9900.00 |
| $M_W$ | 1782.00 | $M_W$ | 1782.00 | $M_W$ | 1782.00 |
| $C_S$ | 53460000.00 | $C_S$ | 53460000.00 | $C_S$ | 53460000.00 |
| $M_S$ | 94918230.00 | $M_S$ | 94918230.00 | $M_S$ | 94918230.00 |
| $M_T$ | 94920012.00 | $M_T$ | 94920012.00 | $M_T$ | 94920012.00 |
| $M_S/M_T$ | 1.0000 | $M_S/M_T$ | 1.0000 | $M_S/M_T$ | 1.0000 |

$Cw_{0N}$ = Initial contaminant concentration in groundwater flow unit N

## Groundwater Flow Unit Hydrogeologic Characteristics

| Avg. K, ft/d highest to lowest | Relative average K, $K_U$ | Fraction of aquifer volume, $FV_U$ | Fraction of total flow, $FQ_U$ | Flow unit number, U |
|---|---|---|---|---|
| 59 | 1.000 | 0.33 | 0.331 | 1 |
| 59 | 1.000 | 0.34 | 0.338 | 2 |
| 59 | 1.000 | 0.33 | 0.331 | 3 |

## Pore Volumes and Pore Volume Removal Rates

| Groundwater discharge rate, gpm | Groundwater discharge rate, $ft^3$/day, $Q_T$ | Total volume occupied by plume, $ft^3$, $PV_T$ |
|---|---|---|
| 24 | 4620.32 | 392,700 |

| Discharge rate, Unit 1 $ft^3$/day, $Q_1$ | Discharge rate, Unit 2 $ft^3$/day, $Q_2$ | Discharge rate, Unit 3 $ft^3$/day, $Q_3$ | Plume pore Vol., Unit 1 $ft^3$, $PV_1$ | Plume pore Vol., Unit 2 $ft^3$, $PV_2$ | Plume pore Vol., Unit 3 $ft^3$, $PV_3$ | Time for 1 PV flush, Unit 1, days, $t_1$ | Time for 1 PV flush, Unit 2, days, $t_2$ | Time for 1 PV flush, Unit 3, days, $t_3$ |
|---|---|---|---|---|---|---|---|---|
| 1529.86 | 1560.61 | 1529.86 | 42765.03 | 44060.94 | 42765.03 | 27.95 | 28.23 | 27.95 |

## Contaminant Half-Life Data

| | | | |
|---|---|---|---|
| Does contaminant have a decay half-life (yes/no): | yes | If yes, half-life (days): | 3650 |
| 1st order decay coefficient (k): | 0.000190 | | |

## Average Pumped/Discharged and Residual Plume Concentrations Over Time

| Target Cleanup Concentration : | | | 2500 | ug/L |
|---|---|---|---|---|
| Time period | Time span, days, t | Avg pumped GW conc. | Avg residual GW conc. | Time span, years |
| 0 | 0 | 0 | **5400** | 0 |
| 2 | 55.91 | 5342.790 | **5342.790** | 0.15 |
| 3 | 83.86 | 5314.412 | **5314.412** | 0.23 |
| 4 | 111.81 | 5286.185 | **5286.185** | 0.31 |
| 6 | 167.72 | 5230.181 | **5230.181** | 0.46 |
| 8 | 223.63 | 5174.769 | **5174.769** | 0.61 |
| 10 | 279.54 | 5119.945 | **5119.945** | 0.77 |
| 14 | 391.35 | 5012.033 | **5012.033** | 1.07 |
| 18 | 503.17 | 4906.396 | **4906.396** | 1.38 |
| 24 | 670.89 | 4752.099 | **4752.099** | 1.84 |
| 30 | 838.61 | 4602.655 | **4602.655** | 2.30 |
| 36 | 1006.33 | 4457.911 | **4457.911** | 2.76 |
| 42 | 1174.05 | 4317.718 | **4317.718** | 3.21 |
| 50 | 1397.68 | 4137.629 | **4137.629** | 3.83 |
| 60 | 1677.22 | 3923.043 | **3923.043** | 4.59 |
| 70 | 1956.75 | 3719.587 | **3719.587** | 5.36 |
| 80 | 2236.29 | 3526.681 | **3526.681** | 6.12 |
| 100 | 2795.36 | 3170.366 | **3170.366** | 7.65 |
| 120 | 3354.44 | 2850.050 | **2850.050** | 9.18 |
| 160 | 4472.58 | 2303.237 | **2303.237** | 12.25 |
| 200 | 5590.73 | 1861.337 | **1861.337** | 15.31 |
| 130 | 3633.97 | 2702.241 | **2702.241** | 9.95 |
| 140 | 3913.51 | 2562.097 | **2562.097** | 10.71 |
| 145 | 4053.28 | 2494.775 | **2494.775** | 11.10 |
| 144 | 4025.32 | 2508.096 | **2508.096** | 11.02 |
| 143 | 3997.37 | 2521.489 | **2521.489** | 10.94 |

Adjust the initial time period to auto-adjust the following 19 time periods and obtain the desired range in concentrations.

The last 5 time periods can be modified to more precisely determine the time required to meet a specific residual concentration.

| Project: | NSB New London Zone 7 | Project No.: | 112G00811 |
|---|---|---|---|
| Subject: | Groundwater Extraction System CMS Design | | |
| By: | J. Orient | Date: | 1/12/2010 |
| Checked: | | Date: | |

**Project/Design Objective:**

Design a groundwater extraction system for containment/cleanup of the arsenic points of groundwater contamination in the shallow portion of the unconsolidated groundwater flow system. Project cleanup rates/times assuming that the residual source has been removed or otherwise isolated from groundwater. The final design should be capable of remediating contaminated groundwater to target cleanup levels within a reasonable time frame (30 years or less), and should offer significant advantages over natural processes in terms of cleanup rate and/or protection of receptors. This design should be considered as conceptual only - additional data, i.e., aquifer characteristics, contaminant distributions are needed for a final design.

**Basis of Design Data:** (Input cells yellow, blue automatically calculated)

**Groundwater Plume Information**

| | | |
|---|---|---|
| Plume Width (W): | 180 | ft. |
| Plume Thickness: | 50 | ft. |
| Plume Area: | 21,600 | $ft^2$ |
| Volume of Groundwater in Plume: | 356400 | $ft^3$ |
| Avg Hydraulic Conductivity, Plume Area: | 59 | ft/day |

**Aquifer Characteristics**

| | | |
|---|---|---|
| Thickness (B): | 50 | ft. |
| Avg. Hydraulic Conductivity (K): | 59 | ft/day |
| Transmissivity (T): | 2950 | $ft^2$/day |
| Porosity (n): | 0.33 | |
| Storativity (S): | 0.15 | |
| Fractional Organic Carbon Content (foc): | 1 | |
| Flow Gradient (i): | 0.00527 | |

**Contaminant Characteristics**

| | | | |
|---|---|---|---|
| Contaminant A Representative gw conc.: | arsenic | 18.8 | ug/L |
| Contaminant B Representative gw conc.: | | | |
| Koc, Contaminant A: | | 29 | l/kg |
| Koc, Contaminant B: | | | l/kg |
| Kd, Contaminant A: | | 29 | l/kg |
| Kd, Contaminant B: | | 0 | l/kg |
| Half-life, Contaminant A: | | | years |
| Half-life, Contaminant B: | | | years |
| Target Cleanup Level, Contaminant A: | | 10 | ug/L |
| Target Cleanup Level, Contaminant B: | | | ug/L |

**Remedial System Information**

| | | |
|---|---|---|
| Extraction Well Radius, (r) : | 0.25 | ft. |
| Time to Reach Steady-State Drawdown (t): | 30 | days |
| Allowable Drawdown, Single Well, (s): | 5 | ft. |

**Technical Approach:**

Using aquifer characteristics, contaminated groundwater volume, Kd, half-life, and representative groundwater concentration data, calculate the number of pore volume flushes and times required to reach the target groundwater concentration (performed using the attached spreadsheets). Use standard equations to calculate the minimum required pumping rate for containment, per-well achievable pumping rates, and well spacings. Develop a preliminary extraction system design based on the calculations, adjusting the design as appropriate based on data limitation considerations and best scientific judgement.

**Required Pumping Rate (Qt) for Total Plume Capture**

Qt = TiW x 2 (2x the natural groundwater flow-thru rate for entire aquifer)

Qt = 2798.37 $ft^3$/day x 2, or 14.54 gpm x 2

Qt = 5596.74 $ft^3$/day, or 29.07 gpm

**Maximum Achievable Pumping Rate in a Single Well (Qa)**

Qa = $[4\pi Ts/2.3] / \log [2.25Tt/r^2S]$

Qa = 10998.66 $ft^3$/day, or 57.13 gpm

**Minimum Number of Extraction Wells Required**

= Qt/Qa

= 0.51 wells

**Plume Cleanup Rate Projections (From Spreadsheet Program or Other Source)**

| | | | | |
|---|---|---|---|---|
| At | 28.0 | gpm, | 18 | years |
| At | 42.0 | gpm, | 12 | years |
| At | | gpm, | | years |
| At natural GW flow rate: (plume area only) | 14.54 | gpm, | 34 | years |

Contaminant that cleanup rate is based on: arsenic

**Based on the limiting conditions calculated above, projections regarding cleanup times at various pumping rates (see accompanying spreadsheets), a suitable safety factor based on the degree of confidence in the design data, and best scientific judgement, the following are the number of extraction wells and pumping rates selected for the design:**

| | | | |
|---|---|---|---|
| **Number of Wells:** | 2 | | |
| **Per-well Pumping Rate (Qw):** | 14 | gpm, or | 2695.14 $ft^3$/day |
| **Total System Pumping Rate (Qes):** | 28 | gpm, or | 5390.28 $ft^3$/day |

**Extraction Well Spacings, (WSp), ft Perpendicular to Groundwater Flow Direction**

WSp = $Qw/\pi Ti$, for a 2-well extraction system

WSp = 55.18 ft

or

WSp = $1.26(Qw)/\pi Ti$, for a 3-well extraction system

WSp = 69.53 ft

or

WSp = $1.2(Qw)/\pi Ti$, for an extraction system with 4+ wells

WSp = 66.22 ft

**Downgradient Stagnation Point (SPd) Approximation**

SPd = $Qes/2\pi Ti$, Qes = total extraction system pumping rate, $ft^3$/day

SPd = 55.18 ft

**Alternate Layout of Extraction Well System (I.e., parallel to GW flow direction):**

Position two wells within the impacted area, aligned across (perpendicular to) the direction of groundwater flow, since the impacted area appears to be wider than it is long.

**Final Configuration, Groundwater Extraction System:**

Install two wells within the impacted area, aligned along centerline across the direction of groundwater flow. One well should be centered at location of highest copper concentrations. Pump wells at 14 gpm each, for combined flow rate of 28 gpm. Arsenic projected to reach target cleanup goal within an 18 year timeframe.

# Heterogeneous Aquifer Flushing Rate Calculations

| | | | |
|---|---|---|---|
| Project: | NSB New London Zone 7 | Proj. No.: | 112G00811 |
| Chemical : | Arsenic | $K_{OC}$ ($K_d$*) : | 29 |
| Concentration units, water & soil (pick 1): | mg/L & mg/Kg: | ug/L & ug/Kg: | x |

NOTE: Input cells are shaded yellow; cells automatically calculated are shaded blue; the remaining cells are fixed.

All groundwater/soil contaminant concentrations are in consistent units, i.e., mg/L & mg/Kg, or ug/L & ug/Kg.

*** for contaminants that partition between soil and water thru mechanisms other than adsoption onto organic carbon, i.e., metals, the compound's $K_d$ is input directly into the $K_{OC}$ entry cell, with $f_{OC}$ then set to 1. For fractured bedrock, reduce the $f_{OC}$ by 1-2 orders of magnitude to adjust for typical low fracture porosity and resulting high model-perceived mass of aquifer sediments in contact with water.**

**This spreadsheet calculates flushing rates and cleanup times for a groundwater flow system that consists of up to 3 groundwater "flow units". Flow units are discrete portions of the aquifer that have unique properties, i.e., higher or lower average hydraulic conductivity, porosity, or specific gravity relative to other portions of the aquifer, higher/lower contaminant concentrations, and/or different organic carbon contents. The spreadsheet factors in different flushing rates for discrete portions of the aquifer based on the differences in the physical/chemical characteristics of the flow units. First-order contaminant decay/degradation processes can also be factored into the cleanup rate prediction through the optional use of contaminant half-life data.**

## Groundwater Flow Unit Physical/Chemical Data

| Flow Unit 1 (U1) | | Flow Unit 2 (U2) | | Flow Unit 3 (U3) | |
|---|---|---|---|---|---|
| $Cw_{01}$ | 18.80 | $Cw_{02}$ | 18.80 | $Cw_{03}$ | 18.80 |
| n | 0.33 | n | 0.33 | n | 0.33 |
| $S_G$ | 2.65 | $S_G$ | 2.65 | $S_G$ | 2.65 |
| $f_{OC}$* | 1.0000 | $f_{OC}$* | 1.0000 | $f_{OC}$* | 1.0000 |
| $K_d$ | 29.00 | $K_d$ | 29.00 | $K_d$ | 29.00 |
| $M_W$ | 6.20 | $M_W$ | 6.20 | $M_W$ | 6.20 |
| $C_S$ | 545.20 | $C_S$ | 545.20 | $C_S$ | 545.20 |
| $M_S$ | 968.00 | $M_S$ | 968.00 | $M_S$ | 968.00 |
| $M_T$ | 974.21 | $M_T$ | 974.21 | $M_T$ | 974.21 |
| $M_S/M_T$ | 0.994 | $M_S/M_T$ | 0.994 | $M_S/M_T$ | 0.994 |

**$Cw_{0N}$ = Initial contaminant concentration in groundwater flow unit N**

## Groundwater Flow Unit Hydrogeologic Characteristics

| Avg. K, ft/d highest to lowest | Relative average K, $K_U$ | Fraction of aquifer volume, $FV_U$ | Fraction of total flow, $FQ_U$ | Flow unit number, U |
|---|---|---|---|---|
| 59 | 1.000 | 0.33 | 0.331 | 1 |
| 59 | 1.000 | 0.34 | 0.338 | 2 |
| 59 | 1.000 | 0.33 | 0.331 | 3 |

## Pore Volumes and Pore Volume Removal Rates

| Groundwater discharge rate, gpm | Groundwater discharge rate, $ft^3$/day, $Q_T$ | Total volume occupied by plume, $ft^3$, $PV_T$ |
|---|---|---|
| 14.54 | 2799.14 | 1,080,000 |

| Discharge rate, Unit 1 $ft^3$/day, $Q_1$ | Discharge rate, Unit 2 $ft^3$/day, $Q_2$ | Discharge rate, Unit 3 $ft^3$/day, $Q_3$ | Plume pore Vol., Unit 1 $ft^3$, $PV_1$ | Plume pore Vol., Unit 2 $ft^3$, $PV_2$ | Plume pore Vol., Unit 3 $ft^3$, $PV_3$ | Time for 1 PV flush, Unit 1, days, $t_1$ | Time for 1 PV flush, Unit 2, days, $t_2$ | Time for 1 PV flush, Unit 3, days, $t_3$ |
|---|---|---|---|---|---|---|---|---|
| 926.84 | 945.47 | 926.84 | 117612 | 121176 | 117612 | 126.90 | 128.17 | 126.90 |

## Contaminant Half-Life Data

| | | | |
|---|---|---|---|
| Does contaminant have a decay half-life (yes/no): | no | If yes, half-life (days): | 3650 |
| 1st order decay coefficient (k): | 0.000190 | | |

## Average Pumped/Discharged and Residual Plume Concentrations Over Time

| Target Cleanup Concentration : | | | 48 | ug/L |
|---|---|---|---|---|
| Time period | Time span, days, t | Avg pumped GW conc. | Avg residual GW conc. | Time span, years |
| 0 | 0 | 0 | **18.8** | 0 |
| 1 | 126.90 | 18.681 | **18.681** | 0.35 |
| 1.5 | 190.34 | 18.621 | **18.621** | 0.52 |
| 2 | 253.79 | 18.562 | **18.562** | 0.69 |
| 3 | 380.69 | 18.444 | **18.444** | 1.04 |
| 4 | 507.58 | 18.327 | **18.327** | 1.39 |
| 5 | 634.48 | 18.211 | **18.211** | 1.74 |
| 7 | 888.27 | 17.980 | **17.980** | 2.43 |
| 9 | 1142.06 | 17.753 | **17.753** | 3.13 |
| 12 | 1522.75 | 17.417 | **17.417** | 4.17 |
| 15 | 1903.44 | 17.088 | **17.088** | 5.21 |
| 18 | 2284.13 | 16.764 | **16.764** | 6.25 |
| 21 | 2664.82 | 16.447 | **16.447** | 7.30 |
| 25 | 3172.40 | 16.033 | **16.033** | 8.69 |
| 30 | 3806.88 | 15.531 | **15.531** | 10.42 |
| 35 | 4441.36 | 15.044 | **15.044** | 12.16 |
| 40 | 5075.84 | 14.573 | **14.573** | 13.90 |
| 50 | 6344.80 | 13.674 | **13.674** | 17.37 |
| 60 | 7613.76 | 12.830 | **12.831** | 20.85 |
| 80 | 10151.68 | 11.296 | **11.296** | 27.79 |
| 100 | 12689.60 | 9.946 | **9.946** | 34.74 |
| 84 | 10659.26 | 11.012 | **11.012** | 29.18 |
| 88 | 11166.85 | 10.735 | **10.735** | 30.57 |
| 92 | 11674.43 | 10.465 | **10.466** | 31.96 |
| 96 | 12182.01 | 10.202 | **10.202** | 33.35 |
| 99 | 12562.70 | 10.009 | **10.009** | 34.39 |

Adjust the initial time period to auto-adjust the following 19 time periods and obtain the desired range in concentrations.

The last 5 time periods can be modified to more precisely determine the time required to meet a specific residual concentration.

# Heterogeneous Aquifer Flushing Rate Calculations

| | | | |
|---|---|---|---|
| Project: | NSB New London Zone 7 | Proj. No.: | 112G00811 |
| Chemical : | Arsenic | $K_{OC}$ ($K_d$*) : | 29 |
| Concentration units, water & soil (pick 1): | mg/L & mg/Kg: | ug/L & ug/Kg: | x |

**This spreadsheet calculates flushing rates and cleanup times for a groundwater flow system that consists of up to 3 groundwater "flow units". Flow units are discrete portions of the aquifer that have unique properties, i.e., higher or lower average hydraulic conductivity, porosity, or specific gravity relative to other portions of the aquifer, higher/lower contaminant concentrations, and/or different organic carbon contents. The spreadsheet factors in different flushing rates for discrete portions of the aquifer based on the differences in the physical/chemical characteristics of the flow units. First-order contaminant decay/degradation processes can also be factored into the cleanup rate prediction through the optional use of contaminant half-life data.**

NOTE: Input cells are shaded yellow; cells automatically calculated are shaded blue; the remaining cells are fixed.

All groundwater/soil contaminant concentrations are in consistent units, i.e., mg/L & mg/Kg, or ug/L & ug/Kg.

*** for contaminants that partition between soil and water thru mechanisms other than adsoption onto organic carbon, i.e., metals, the compound's $K_d$ is input directly into the $K_{OC}$ entry cell, with $f_{OC}$ then set to 1. For fractured bedrock, reduce the $f_{OC}$ by 1-2 orders of magnitude to adjust for typical low fracture porosity and resulting high model-perceived mass of aquifer sediments in contact with water.**

## Groundwater Flow Unit Physical/Chemical Data

| Flow Unit 1 (U1) | | Flow Unit 2 (U2) | | Flow Unit 3 (U3) | |
|---|---|---|---|---|---|
| $Cw_{01}$ | 18.80 | $Cw_{02}$ | 18.80 | $Cw_{03}$ | 18.80 |
| n | 0.33 | n | 0.33 | n | 0.33 |
| $S_G$ | 2.65 | $S_G$ | 2.65 | $S_G$ | 2.65 |
| $f_{OC}$* | 1.0000 | $f_{OC}$* | 1.0000 | $f_{OC}$* | 1.0000 |
| $K_d$ | 29.00 | $K_d$ | 29.00 | $K_d$ | 29.00 |
| $M_W$ | 6.20 | $M_W$ | 6.20 | $M_W$ | 6.20 |
| $C_S$ | 545.20 | $C_S$ | 545.20 | $C_S$ | 545.20 |
| $M_S$ | 968.00 | $M_S$ | 968.00 | $M_S$ | 968.00 |
| $M_T$ | 974.21 | $M_T$ | 974.21 | $M_T$ | 974.21 |
| $M_S/M_T$ | 0.994 | $M_S/M_T$ | 0.994 | $M_S/M_T$ | 0.994 |

$Cw_{0N}$ = Initial contaminant concentration in groundwater flow unit N

## Groundwater Flow Unit Hydrogeologic Characteristics

| Avg. K, ft/d highest to lowest | Relative average K, $K_U$ | Fraction of aquifer volume, $FV_U$ | Fraction of total flow, $FQ_U$ | Flow unit number, U |
|---|---|---|---|---|
| 59 | 1.000 | 0.33 | 0.331 | 1 |
| 59 | 1.000 | 0.34 | 0.338 | 2 |
| 59 | 1.000 | 0.33 | 0.331 | 3 |

## Pore Volumes and Pore Volume Removal Rates

| Groundwater discharge rate, gpm | Groundwater discharge rate, $ft^3$/day, $Q_T$ | Total volume occupied by plume, $ft^3$, $PV_T$ |
|---|---|---|
| 28 | 5390.37 | 1,080,000 |

| Discharge rate, Unit 1 $ft^3$/day, $Q_1$ | Discharge rate, Unit 2 $ft^3$/day, $Q_2$ | Discharge rate, Unit 3 $ft^3$/day, $Q_3$ | Plume pore Vol., Unit 1 $ft^3$, $PV_1$ | Plume pore Vol., Unit 2 $ft^3$, $PV_2$ | Plume pore Vol., Unit 3 $ft^3$, $PV_3$ | Time for 1 PV flush, Unit 1, days, $t_1$ | Time for 1 PV flush, Unit 2, days, $t_2$ | Time for 1 PV flush, Unit 3, days, $t_3$ |
|---|---|---|---|---|---|---|---|---|
| 1784.83 | 1820.71 | 1784.83 | 117612 | 121176 | 117612 | 65.90 | 66.55 | 65.90 |

## Contaminant Half-Life Data

| | | | |
|---|---|---|---|
| Does contaminant have a decay half-life (yes/no): | no | If yes, half-life (days): | 3650 |
| 1st order decay coefficient (k): | 0.000190 | | |

## Average Pumped/Discharged and Residual Plume Concentrations Over Time

| Target Cleanup Concentration : | | | 48 | ug/L |
|---|---|---|---|---|
| Time period | Time span, days, t | Avg pumped GW conc. | Avg residual GW conc. | Time span, years |
| 0 | 0 | 0 | **18.8** | 0 |
| 1 | 65.90 | 18.681 | **18.681** | 0.18 |
| 1.5 | 98.84 | 18.621 | **18.621** | 0.27 |
| 2 | 131.79 | 18.562 | **18.562** | 0.36 |
| 3 | 197.69 | 18.444 | **18.444** | 0.54 |
| 4 | 263.58 | 18.327 | **18.327** | 0.72 |
| 5 | 329.48 | 18.211 | **18.211** | 0.90 |
| 7 | 461.27 | 17.980 | **17.980** | 1.26 |
| 9 | 593.06 | 17.753 | **17.753** | 1.62 |
| 12 | 790.74 | 17.417 | **17.417** | 2.16 |
| 15 | 988.43 | 17.088 | **17.088** | 2.71 |
| 18 | 1186.11 | 16.764 | **16.764** | 3.25 |
| 21 | 1383.80 | 16.447 | **16.447** | 3.79 |
| 25 | 1647.38 | 16.033 | **16.033** | 4.51 |
| 30 | 1976.86 | 15.531 | **15.531** | 5.41 |
| 35 | 2306.33 | 15.044 | **15.044** | 6.31 |
| 40 | 2635.81 | 14.573 | **14.573** | 7.22 |
| 50 | 3294.76 | 13.674 | **13.674** | 9.02 |
| 60 | 3953.72 | 12.830 | **12.831** | 10.82 |
| 80 | 5271.62 | 11.296 | **11.296** | 14.43 |
| 100 | 6589.53 | 9.946 | **9.946** | 18.04 |
| 84 | 5535.20 | 11.012 | **11.012** | 15.15 |
| 88 | 5798.78 | 10.735 | **10.735** | 15.88 |
| 92 | 6062.36 | 10.465 | **10.466** | 16.60 |
| 96 | 6325.95 | 10.202 | **10.202** | 17.32 |
| 99 | 6523.63 | 10.009 | **10.009** | 17.86 |

Adjust the initial time period to auto-adjust the following 19 time periods and obtain the desired range in concentrations.

The last 5 time periods can be modified to more precisely determine the time required to meet a specific residual concentration.

# Heterogeneous Aquifer Flushing Rate Calculations

| | | | |
|---|---|---|---|
| Project: | NSB New London Zone 7 | Proj. No.: | 112G00811 |
| Chemical : | Arsenic | $K_{OC}$ ($K_d$*) : | 29 |
| Concentration units, water & soil (pick 1): | mg/L & mg/Kg: | ug/L & ug/Kg: | x |

This spreadsheet calculates flushing rates and cleanup times for a groundwater flow system that consists of up to 3 groundwater "flow units". Flow units are discrete portions of the aquifer that have unique properties, i.e., higher or lower average hydraulic conductivity, porosity, or specific gravity relative to other portions of the aquifer, higher/lower contaminant concentrations, and/or different organic carbon contents. The spreadsheet factors in different flushing rates for discrete portions of the aquifer based on the differences in the physical/chemical characteristics of the flow units. First-order contaminant decay/degradation processes can also be factored into the cleanup rate prediction through the optional use of contaminant half-life data.

NOTE: Input cells are shaded yellow; cells automatically calculated are shaded blue; the remaining cells are fixed.

All groundwater/soil contaminant concentrations are in consistent units, i.e., mg/L & mg/Kg, or ug/L & ug/Kg.

*** for contaminants that partition between soil and water thru mechanisms other than adsoption onto organic carbon, i.e., metals, the compound's $K_d$ is input directly into the $K_{OC}$ entry cell, with $f_{OC}$ then set to 1. For fractured bedrock, reduce the $f_{OC}$ by 1-2 orders of magnitude to adjust for typical low fracture porosity and resulting high model-perceived mass of aquifer sediments in contact with water.**

## Groundwater Flow Unit Physical/Chemical Data

| Flow Unit 1 (U1) | | Flow Unit 2 (U2) | | Flow Unit 3 (U3) | |
|---|---|---|---|---|---|
| $Cw_{01}$ | 18.80 | $Cw_{02}$ | 18.80 | $Cw_{03}$ | 18.80 |
| n | 0.33 | n | 0.33 | n | 0.33 |
| $S_G$ | 2.65 | $S_G$ | 2.65 | $S_G$ | 2.65 |
| $f_{OC}$* | 1.0000 | $f_{OC}$* | 1.0000 | $f_{OC}$* | 1.0000 |
| $K_d$ | 29.00 | $K_d$ | 29.00 | $K_d$ | 29.00 |
| $M_W$ | 6.20 | $M_W$ | 6.20 | $M_W$ | 6.20 |
| $C_S$ | 545.20 | $C_S$ | 545.20 | $C_S$ | 545.20 |
| $M_S$ | 968.00 | $M_S$ | 968.00 | $M_S$ | 968.00 |
| $M_T$ | 974.21 | $M_T$ | 974.21 | $M_T$ | 974.21 |
| $M_S/M_T$ | 0.994 | $M_S/M_T$ | 0.994 | $M_S/M_T$ | 0.994 |

$Cw_{0N}$ = Initial contaminant concentration in groundwater flow unit N

## Groundwater Flow Unit Hydrogeologic Characteristics

| Avg. K, ft/d highest to lowest | Relative average K, $K_U$ | Fraction of aquifer volume, $FV_U$ | Fraction of total flow, $FQ_U$ | Flow unit number, U |
|---|---|---|---|---|
| 59 | 1.000 | 0.33 | 0.331 | 1 |
| 59 | 1.000 | 0.34 | 0.338 | 2 |
| 59 | 1.000 | 0.33 | 0.331 | 3 |

## Pore Volumes and Pore Volume Removal Rates

| Groundwater discharge rate, gpm | Groundwater discharge rate, $ft^3$/day, $Q_T$ | Total volume occupied by plume, $ft^3$, $PV_T$ |
|---|---|---|
| 42 | 8085.56 | 1,080,000 |

| Discharge rate, Unit 1 $ft^3$/day, $Q_1$ | Discharge rate, Unit 2 $ft^3$/day, $Q_2$ | Discharge rate, Unit 3 $ft^3$/day, $Q_3$ | Plume pore Vol., Unit 1 $ft^3$, $PV_1$ | Plume pore Vol., Unit 2 $ft^3$, $PV_2$ | Plume pore Vol., Unit 3 $ft^3$, $PV_3$ | Time for 1 PV flush, Unit 1, days, $t_1$ | Time for 1 PV flush, Unit 2, days, $t_2$ | Time for 1 PV flush, Unit 3, days, $t_3$ |
|---|---|---|---|---|---|---|---|---|
| 2677.25 | 2731.06 | 2677.25 | 117612 | 121176 | 117612 | 43.93 | 44.37 | 43.93 |

## Contaminant Half-Life Data

| | | | |
|---|---|---|---|
| Does contaminant have a decay half-life (yes/no): | no | If yes, half-life (days): | 3650 |
| 1st order decay coefficient (k): | 0.000190 | | |

## Average Pumped/Discharged and Residual Plume Concentrations Over Time

| Target Cleanup Concentration : | | | 48 | ug/L |
|---|---|---|---|---|
| Time period | Time span, days, t | Avg pumped GW conc. | Avg residual GW conc. | Time span, years |
| 0 | 0 | 0 | **18.8** | 0 |
| 1 | 43.93 | 18.681 | **18.681** | 0.12 |
| 1.5 | 65.90 | 18.621 | **18.621** | 0.18 |
| 2 | 87.86 | 18.562 | **18.562** | 0.24 |
| 3 | 131.79 | 18.444 | **18.444** | 0.36 |
| 4 | 175.72 | 18.327 | **18.327** | 0.48 |
| 5 | 219.65 | 18.211 | **18.211** | 0.60 |
| 7 | 307.51 | 17.980 | **17.980** | 0.84 |
| 9 | 395.37 | 17.753 | **17.753** | 1.08 |
| 12 | 527.16 | 17.417 | **17.417** | 1.44 |
| 15 | 658.95 | 17.088 | **17.088** | 1.80 |
| 18 | 790.74 | 16.764 | **16.764** | 2.16 |
| 21 | 922.53 | 16.447 | **16.447** | 2.53 |
| 25 | 1098.25 | 16.033 | **16.033** | 3.01 |
| 30 | 1317.91 | 15.531 | **15.531** | 3.61 |
| 35 | 1537.56 | 15.044 | **15.044** | 4.21 |
| 40 | 1757.21 | 14.573 | **14.573** | 4.81 |
| 50 | 2196.51 | 13.674 | **13.674** | 6.01 |
| 60 | 2635.81 | 12.830 | **12.831** | 7.22 |
| 80 | 3514.41 | 11.296 | **11.296** | 9.62 |
| 100 | 4393.02 | 9.946 | **9.946** | 12.03 |
| 84 | 3690.13 | 11.012 | **11.012** | 10.10 |
| 88 | 3865.86 | 10.735 | **10.735** | 10.58 |
| 92 | 4041.58 | 10.465 | **10.466** | 11.07 |
| 96 | 4217.30 | 10.202 | **10.202** | 11.55 |
| 99 | 4349.09 | 10.009 | **10.009** | 11.91 |

Adjust the initial time period to auto-adjust the following 19 time periods and obtain the desired range in concentrations.

The last 5 time periods can be modified to more precisely determine the time required to meet a specific residual concentration.

# AP3T

## Top Inlet, Short

| | |
|---|---|
| **Max. Flow** | **4.8 gpm (18.1 lpm)** |
| **O.D.** | **3.4 in (8.64 cm)** |
| **Length** | **47 in. (119 cm)** |

### Description

The AP3T Top Inlet Short AutoPump is designed for moderate-duty remediation pumping applications with well casings 3" (7.62 cm) diameter and larger using available 2.63 inch (6.68 cm) inlet. It is designed for applications requiring an elevated inlet, such as pumping total fluids from wells contaminated with LNAPLs. Call QED for prompt, no-obligation assistance on your pumping project needs.

### The AutoPump Heritage

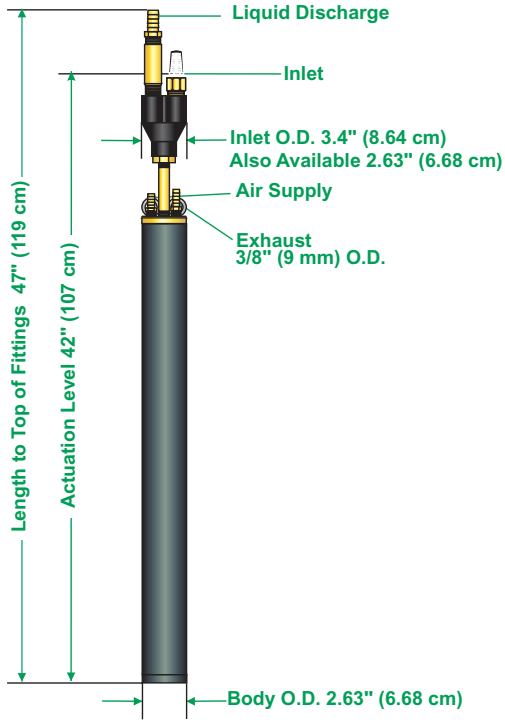
The AP3T Top Inlet Short AutoPump is part of the famous AutoPump family of original automatic air-powered pumps, developed in the mid 1980s specifically to handle unique pumping needs at remediation and landfill sites. Over the years they've proven their durability at thousands of sites worldwide. AutoPumps are designed to handle difficult pumping challenges that other pumps can't, such as solvents, suspended solids, corrosives, temperature extremes, viscous fluids and frequent start/stop cycles. Beyond just the pump, AutoPump systems offer the most complete range of tubing, hose, connectors, caps and accessories to help your installation go smoothly. This superior pumping heritage, application experience and support back up every AutoPump you put to work on your project.

### Advantages

1. **Based on the original automatic air-powered well pump, proven worldwide over 18 years**
2. **Competitive flow rates and pumping capabilities**
3. **Patented, proven design for superior reliability and durability**
4. **Handles solids, some solvents, hydrocarbons and corrosive conditions beyond the limits of electric pumps**
5. **Two-year warranty**

# Top Inlet, Short AP3T

## Pump Dimensions




## Specifications & Operating Requirements

| | |
|---|---|
| **Model** | **3" - Short AP3 Top Inlet** |
| **Liquid Inlet Location** | Top |
| **OD** | 3.4 in. (8.64 cm) (2.63 in. Available) |
| **Length Overall (pump & fittings)** | 47 in. (119 cm) |
| **Weight** | 10 lbs. (4.5 kg) |
| **Max. Flow Rate** | 4.8 gpm (18.1 lpm) - See Flow Rate Chart |
| **Pump Volume / Cycle** | 0.08 - 0.15 gal (.30 - 0.57L ) |
| **Max. Depth** | 175 ft. (53.3 m) |
| **Air Pressure Range** | 5 -80 psi (0.4 - 5.6 kg/cm2) |
| **Min. Actuation Level** | 42 in. (107 cm) |
| **Air Usage** | 0.43 -1.6 scf / gal.(3.2 - 12.0 liter of air / fluid liter) - See Air Usage Chart |
| | |
| **Min. Liquid Density** | 0.7 SpG (0.7 g/cm3) |
| | |
| **Standard Construction Materials** | |
| **Pump Body** | Fiberglass or Stainless Steel |
| **Pump Ends** | Stainless Steel, Acetal, HDPE, Brass |
| **Internal Components** | Stainless Steel, Viton, Acetal, Nylon |
| **Tube & Hose Fittings** | Brass or Stainless Steel |
| **Fitting Type** | Barbs or Quick Connects |
| | |
| **Tube Options** | |
| **Tubing Material** | Nylon |
| **Sizes[1] - Liquid Discharge** | 3/4 in. (19 mm) or 1 in. (25 mm) OD |
| **Pump Air Supply** | 1/2 in. (13 mm) OD |
| **Air Exhaust** | 5/8 in. (16 mm) OD |

[1] Applies to QED supplied tubing; other tubing sources may not conform to QED fittings.

## Application Limits

AP3 AutoPumps are designed to handle the application ranges described below. For applications outside this range, consider the AP4, AP2, and HammerHead Pro models.

Maximum Temperature: 120°F (49°C)
pH Range: 4-9
Solvents and Fuels: gasoline, diesel fuel, BTEX, MTBE

AP-3 AutoPumps are warranted for two (2) years: 100% materials and workmanship.



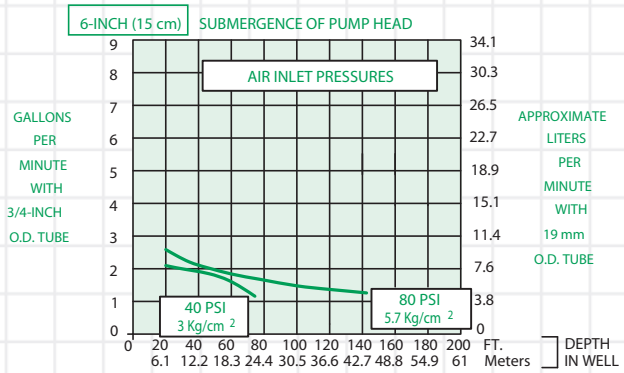
P.O. Box 3726 Ann Arbor, MI 48106-3726 USA **1.800.624.2026** **F 1.734.995.1170** info@qedenv.com www.qedenv.com

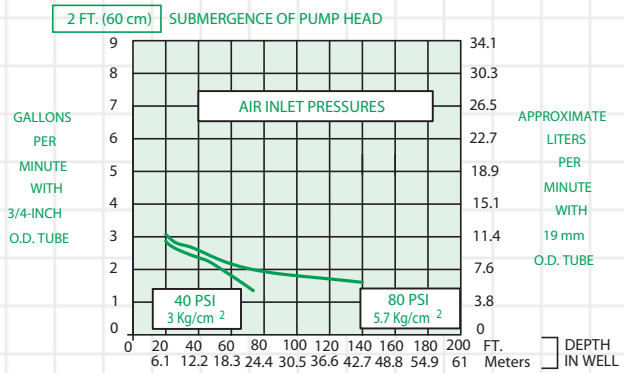
# AP3T

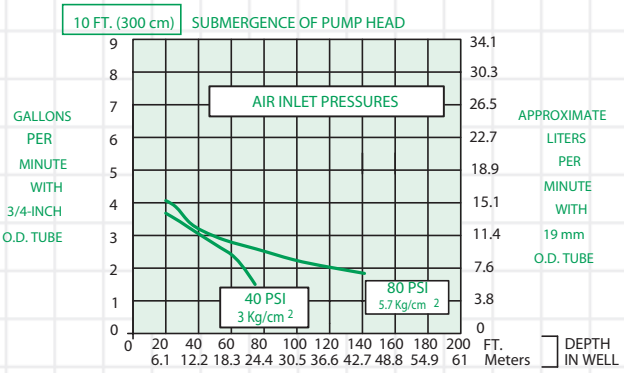
## Top Inlet, Short

## Flow Rates[1]

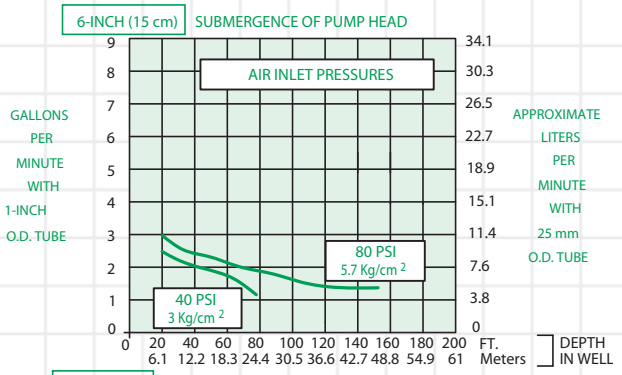
### .75 inch (19 mm) O.D. Fluid Discharge Tubing

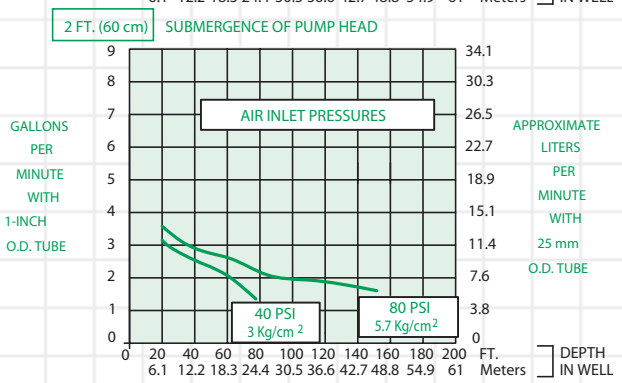


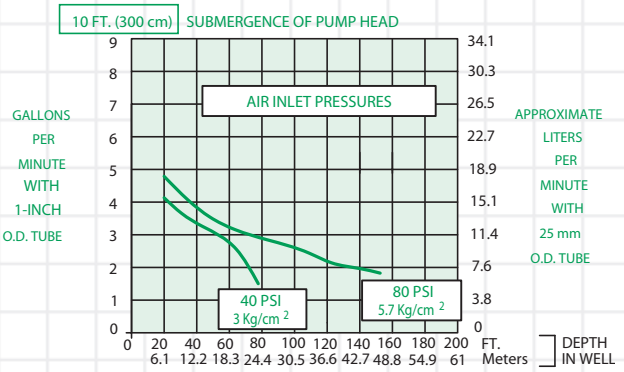




### 1.00 inch (25 mm) O.D. Fluid Discharge Tubing



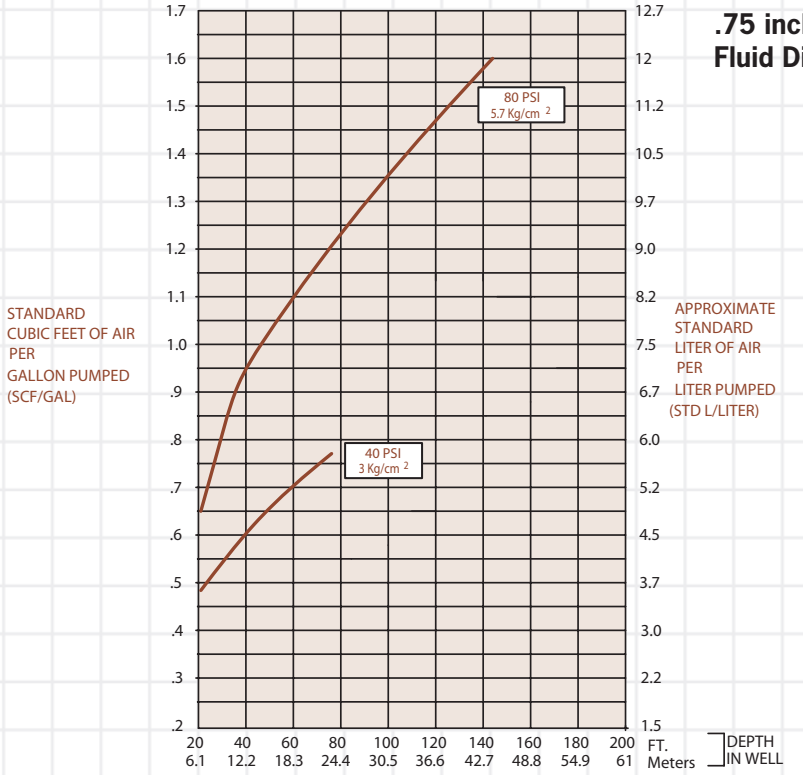



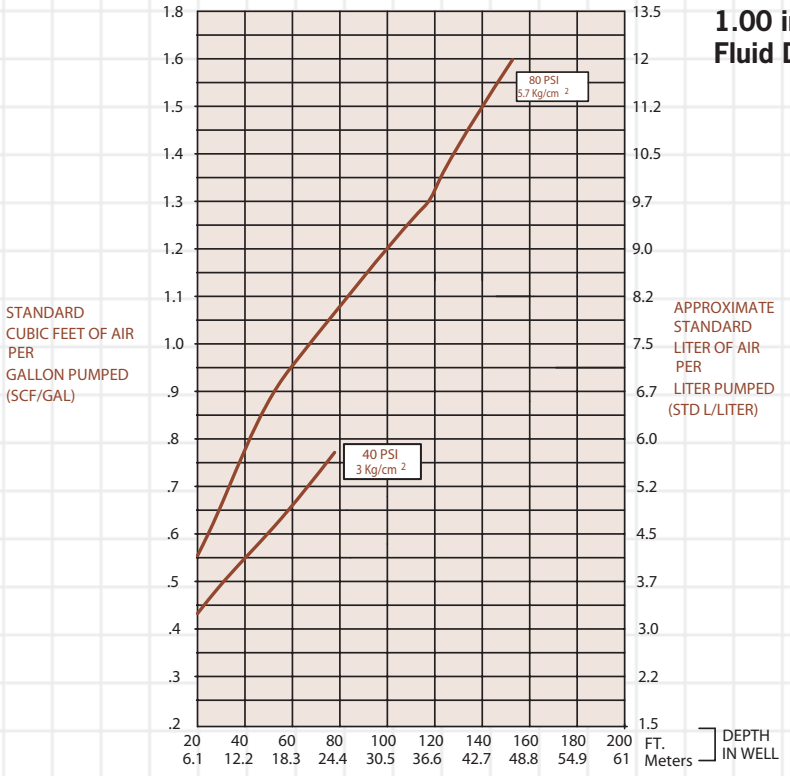

[1] FLOW RATES MAY VARY WITH SITE CONDITIONS. CALL QED FOR TECHNICAL ASSISTANCE.

## Air Consumption

### .75 inch (19 mm) O.D. Fluid Discharge Tubing




### 1.00 inch (25 mm) O.D. Fluid Discharge Tubing





P.O. Box 3726 Ann Arbor, MI 48106-3726 USA **1.800.624.2026** **F 1.734.995.1170** info@qedenv.com www.qedenv.com

# Multi-Basket Strainers and Multi-Bag Filters

*These multi-basket strainers and bag filters offer a wide range of flow capacities and contaminant-holding capabilities. They contain from 2 to 23 baskets.*

*To serve as a strainer, a unit is ordered with perforated stainless steel baskets (mesh-lined if desired). When ordered as a filter, it's fitted with perforated stainless steel baskets designed to hold disposable or cleanable filter bags. Industry-standard size bags are used: the standard 30 inch baskets accept bag size 2, the optional 15 inch baskets take size 1.*

*The standard pressure rating for all models is 150 psi. All housings can be supplied with an ASME code stamp, if required.*

## Features

- *Multiple housing styles available (standard, quick access, low profile, hinged)*
- *Permanently piped housings are opened without tools and without disturbing the piping*
- *Machined cover gasket groove provides positive O-ring sealing*
- *Carbon steel, 304 or 316 stainless steel construction housings*
- *Large-area, 30 inch deep, heavy-duty, 9/64 inch perforated baskets*
- *Easy to clean*
- *Low pressure drop*
- *Four cover seal materials: Buna N, Ethylene Propylene, Viton®, and Teflon®*
- *Pressure rating 150 psi*
- *Flanged connections for 2 through 12 inch pipe*
- *Vent, drain and gage connections*

## Options

- *ASME code stamp*
- *Higher pressure ratings*
- *Corrosion allowances*
- *Steam jackets*
- *Special connection locations*
- *Bag hold down assembly (standard on QAC design)*
- *Inner baskets for dual-stage straining or filtering*
- *Cleanable wire mesh lined or perforated strainer baskets*
- *Special alloy materials*
- *Hydraulic cover lifting assembly*
- *Sanitary fittings*
- *Differential pressure indicators*

## Duplex Systems

*All multi-basket models described here are also available as duplex systems. Two units come piped together with valves to permit continuous use of either unit while servicing the other. One lever actuates all valves simultaneously or it can be ordered for automatic service. See page 63.*

Rosedale Quick Access "QAC" Low Maintenance Filter/Strainer
COUNTERBALANCED COVER - Stops In Any Position
COVER SEAL
COVER HINGE MECHANISM
SECONDARY SAFETY RELEASE
POSITIVE BAG RESTRAINT
CLAMP RELEASE BAR
INLET
COVER SUPPORT ASSEMBLY
INLET DRAIN/VENT
PRIMARY RELEASE SAFETY LEVER
OUTLET
LOW PROFILE CLEARANCE
DRAIN

# Choose Baskets That Strain or Filter

## Whatever your needs dictate

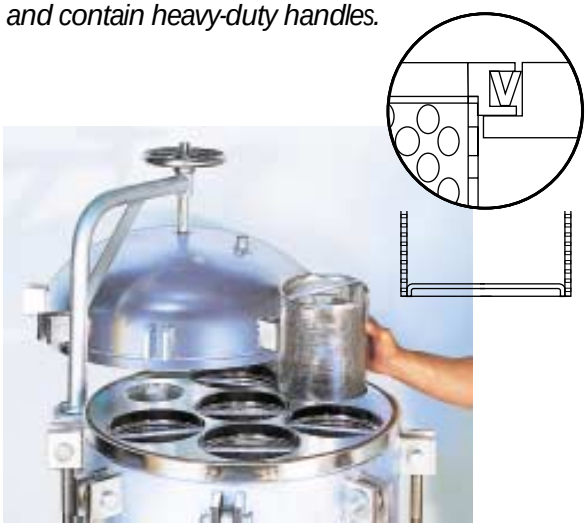
*Strainer baskets are cleanable, reusable.*

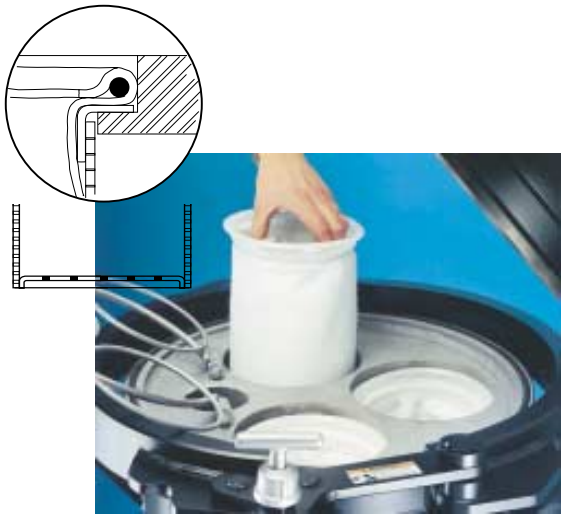
*A seal is supplied on any strainer basket. It forms a seal between basket and housing to prevent dirty fluid bypass. Choose between various perforation sizes or wire mesh. Strainer baskets have flat, non-perforated bottoms and contain heavy-duty handles.*

*Filter bag baskets hold disposable filter bags.*

*Filter bags have an interference fit between the bags top rim and the housing causing a positive seal to prevent fluid bypass. Filter bag baskets have flat perforated bottoms.*

*Filter bags are available in a wide variety of felt, micro-fiber, monofilament and multifilament mesh materials. They are detailed completely on pages 126-128.*





*DUAL-STAGE– Dual-stage action will increase strainer or filter life and reduce servicing needs. This straining/filtering action can be achieved by ordering a second, inner basket. It is supported on the top flange of the outer basket. Both baskets can be utilized as strainers (with or without wire mesh linings), filter bag baskets, or a combination of strainer and bag basket.*

## Basket Data

*Surface area of each 30 in. basket: 4.4 sq. ft. Volume of each 30 in. basket: 0.6 cu. ft.*

## Basket Construction

*For cleanable strainer baskets, choose from the following perforation diameters: 1/4, 3/16, 9/64, 3/32, or 1/16 inch (for other not shown consult factory).*

*Any perforated basket can also be ordered lined with wire mesh. Stainless steel wire is used in mesh sizes 20, 30, 40, 50, 60, 70, 80, 100, 150, or 200.*

*Filter bag baskets, have standard 9/64 inch diameter perforations that are 51% open area. A wire mesh can also be utilized with bag baskets for two advantages:*

1. *Fiber migration is minimized.*
2. *In the unlikely event of bag rupture, the wire mesh better contains the contaminant.*

# Choose Housing Style

## *Designed to suit your requirements*

*The versatility of Rosedale Products provides a choice of several different designs.*

- ***Quick Access Cover (QAC)*** *features a clamp and spring assisted hinged cover that is quick and easy to open and close with no tools required. This will significantly reduce change-out time and lower operating costs. The QAC is rated to 150 PSI and constructed to meet ASME code requirements. Built-in safety features ensure that the cover cannot be opened unless the internal pressure is first released. The QAC is offered with our low profile design making bags more accessible and easy to remove.*

- ***Low Profile Design (SLP) Housings*** *are compact and space saving, allowing for ease of bag change-out. Standard operating height is reduced, resulting in a safe design by eliminating platforms and ladders. The SLP is manufactured in any housing version, including our standard davit arm cover, QAC design, and spring assisted hinged cover.*

- ***Spring Assisted Hinged Cover (HLP)*** *opens and closes without effort. Simply loosen the swing bolts and lift the cover up to open. An automatic cover stop is provided. This design saves time by eliminating the labor intensive handwheel. It is offered standard with our low profile design, or can be ordered in the QAC design.*

- ***Standard Housing Design (STD)*** *is durable and economic. It includes a davit arm and handwheel to facilitate cover removal. It is our most versatile housing design offering a variety of options, including our low profile design.*

*Quick Access Cover*

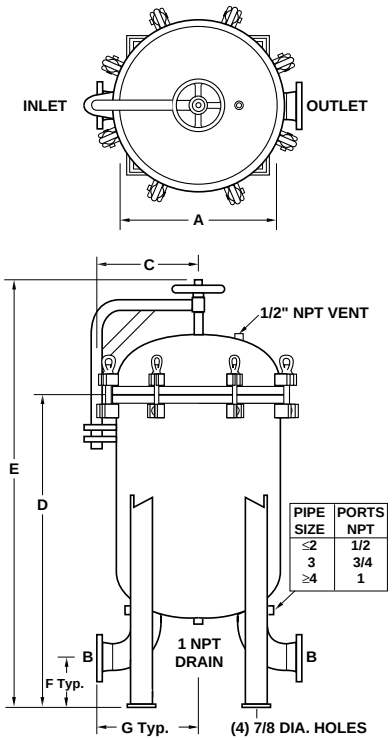
*Low Profile Design*

*Standard Davit Arm*

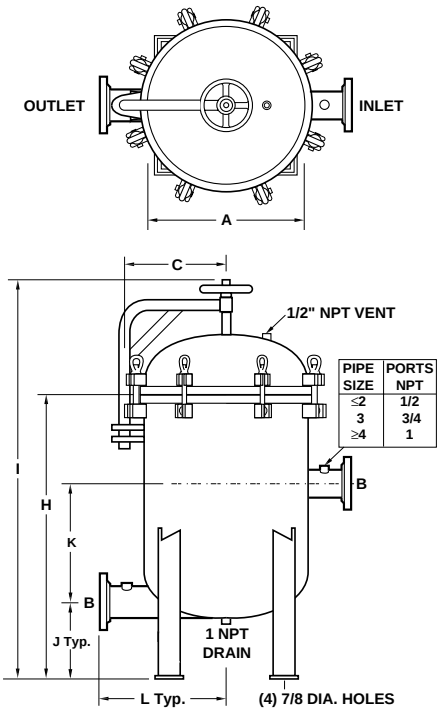
| MODEL NUMBER & Dim. A | Pipe Sizes B | Leg Bolt Circle Dia. | Standard | | | | | | Low Profile | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | C | D | E | F | G | Weight, lb (Approx) | H | I | J | K | L |
| **16** | 2 | 14.0 | 10.9 | 40.1 | 57.1 | 4.50 | 10.5 | 400 | 37.9 | 54.9 | 8.00 | 15.0 | 13.0 |
| | 3 | | | 42.5 | 59.5 | 5.25 | 12.3 | 425 | 38.3 | 55.3 | 9.00 | 17.0 | 14.0 |
| | 4 | | | 44.9 | 61.9 | 6.00 | 14.0 | 450 | N/A | N/A | N/A | N/A | N/A |
| **18** | 2 | 16.0 | 11.9 | 40.5 | 58.0 | 4.50 | 11.1 | 450 | 39.6 | 58.5 | 8.00 | 15.0 | 14.0 |
| | 3 | | | 42.9 | 60.4 | 5.25 | 12.9 | 475 | 40.0 | 58.9 | 9.00 | 17.0 | 15.0 |
| | 4 | | | 45.3 | 62.8 | 6.00 | 14.6 | 500 | N/A | N/A | N/A | N/A | N/A |
| **22** | 2 | 20.0 | 14.0 | 41.4 | 60.0 | 4.50 | 11.9 | 485 | 39.5 | 58.0 | 8.00 | 15.0 | 16.0 |
| | 3 | | | 43.9 | 62.4 | 5.25 | 13.7 | 500 | 40.0 | 58.5 | 9.00 | 17.0 | 17.0 |
| | 4 | | | 46.2 | 64.7 | 6.00 | 15.4 | 515 | 39.5 | 58.0 | 9.00 | 19.0 | 18.0 |
| | 6 | | | 50.4 | 69.0 | 7.00 | 18.9 | 560 | N/A | N/A | N/A | N/A | N/A |
| **24** | 2 | 22.0 | 15.0 | 41.7 | 60.7 | 4.50 | 13.1 | 675 | 41.2 | 61.6 | 8.00 | 15.0 | 17.0 |
| | 3 | | | 44.1 | 63.1 | 5.25 | 14.8 | 700 | 41.6 | 62.0 | 9.00 | 17.0 | 18.0 |
| | 4 | | | 46.5 | 65.5 | 6.00 | 16.6 | 725 | 41.1 | 61.5 | 9.00 | 19.0 | 19.0 |
| | 6 | | | 50.7 | 69.7 | 7.00 | 20.1 | 750 | N/A | N/A | N/A | N/A | N/A |
| **30** | 2 | 28.0 | 18.0 | 42.8 | 63.3 | 4.50 | 15.2 | 635 | 41.3 | 61.9 | 8.00 | 15.0 | 20.5 |
| | 3 | | | 45.2 | 65.7 | 5.25 | 17.0 | 650 | 41.8 | 62.4 | 9.00 | 17.0 | 21.0 |
| | 4 | | | 47.6 | 68.1 | 6.00 | 18.7 | 665 | 41.3 | 61.9 | 9.00 | 19.0 | 22.5 |
| | 6 | | | 51.9 | 72.4 | 7.00 | 22.2 | 705 | 41.2 | 61.8 | 10.0 | 17.0 | 23.0 |
| | 8 | | | 56.4 | 76.8 | 8.25 | 25.7 | 850 | N/A | N/A | N/A | N/A | N/A |
| **36** | 3 | 34.0 | 21.0 | 46.4 | 68.4 | 5.25 | 18.8 | 840 | 43.3 | 64.5 | 9.00 | 17.0 | 24.0 |
| | 4 | | | 48.8 | 70.8 | 6.00 | 20.6 | 860 | 43.2 | 64.5 | 9.50 | 19.0 | 25.0 |
| | 6 | | | 53.1 | 75.1 | 7.00 | 24.1 | 870 | 43.2 | 64.4 | 10.5 | 17.0 | 26.0 |
| | 8 | | | 57.6 | 79.6 | 8.25 | 27.6 | 1010 | 43.2 | 64.4 | 11.5 | 17.0 | 27.0 |
| | 10 | | | 62.1 | 84.1 | 9.50 | 30.6 | 1150 | N/A | N/A | N/A | N/A | N/A |
| **42** | 4 | 40.0 | 24.0 | 50.0 | 73.5 | 6.00 | 22.6 | 1840 | 45.9 | 70.7 | 9.50 | 19.0 | 28.0 |
| | 6 | | | 54.3 | 77.8 | 7.00 | 26.1 | 1870 | 45.9 | 70.6 | 10.5 | 17.0 | 28.0 |
| | 8 | | | 58.8 | 82.3 | 8.25 | 29.6 | 1960 | 45.9 | 70.6 | 11.5 | 17.0 | 29.5 |
| | 10 | | | 63.3 | 86.8 | 9.50 | 32.6 | 2070 | 45.8 | 70.5 | 12.5 | 17.0 | 30.0 |
| | 12 | | | 68.0 | 91.5 | 11.0 | 36.1 | 2200 | N/A | N/A | N/A | N/A | N/A |
| **48** | 4 | 46.0 | 27.0 | 51.0 | 76.0 | 6.00 | 24.8 | 2015 | 46.5 | 71.5 | 9.50 | 19.0 | 32.0 |
| | 6 | | | 55.4 | 80.4 | 7.00 | 28.3 | 2075 | 46.4 | 71.4 | 10.5 | 17.0 | 32.0 |
| | 8 | | | 60.0 | 85.0 | 8.25 | 31.8 | 2200 | 46.4 | 71.4 | 11.5 | 17.0 | 32.5 |
| | 10 | | | 64.4 | 89.4 | 9.50 | 34.8 | 2350 | 46.4 | 71.4 | 12.5 | 17.0 | 33.0 |
| | 12 | | | 69.2 | 94.2 | 11.0 | 38.3 | 2530 | N/A | N/A | N/A | N/A | N/A |

## Dimensions (IN)

(30-inch deep basket)




**Standard**

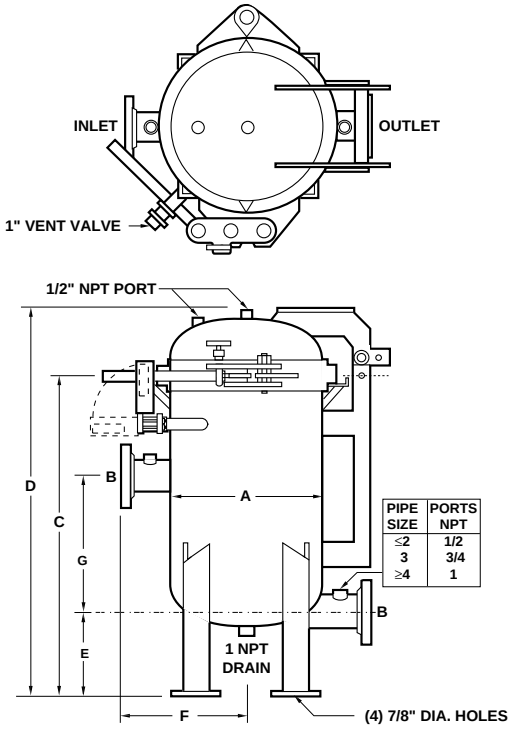



**Low Profile**

## QAC Low Profile

| MODEL NUMBER | A | Pipe Sizes B | Leg Bolt Circle Dia. | C | D | E | F | G |
|---|---|---|---|---|---|---|---|---|
| **16 & 18** | 18 | 2 | 16.0 | 37.6 | 45.4 | 8.00 | 14.0 | 15.0 |
| | | 3 | | 38.1 | 45.9 | 9.00 | 15.0 | 17.0 |
| **22 & 24** | 24 | 2 | 22.0 | 41.2 | 49.9 | 8.00 | 17.0 | 15.0 |
| | | 3 | | 41.6 | 50.3 | 9.00 | 18.0 | 17.0 |
| | | 4 | | 41.1 | 49.8 | 9.00 | 19.0 | 19.0 |

## Dimensions (IN)




**QAC Low Profile**

## Model Selection (For all housings)

| Model No. | Number of Baskets | Straining, Filtering Area, ft2 | Nominal Flow Rate (gpm)** | Inlet/ Outlet Size (in) | Available Housing Styles |
|---|---|---|---|---|---|
| 16 | 2 | 8.8 | 200 | 2,3,4* | Std,SLP,HLP,QAC |
| 18 | 3 | 13.2 | 300 | 2,3,4* | Std,SLP,HLP,QAC |
| 22 | 4 | 17.6 | 400 | 2,3,4,6* | Std,SLP,HLP,QAC |
| 24 | 6 | 26.4 | 600 | 2,3,4,6* | Std,SLP,HLP,QAC |
| 30 | 8 | 35.2 | 800 | 2,3,4,6,8* | Std,SLP,HLP |
| 36 | 12 | 52.8 | 1200 | 2,3,4,6,8,10* | Std,SLP,HLP |
| 42 | 17 | 74.8 | 1700 | 2,3,4,6,8,10,12* | Std,SLP,HLP |
| 48 | 23 | 101.2 | 2300 | 2,3,4,6,8,10,12* | Std,SLP,HLP |

*Not available on SLP, HLP, and QAC styles.

**Nominal flow rate is based on water @ 1 psi ΔP. For optimum filtering effectiveness, a maximum fluid velocity of 10 ft/sec should be maintained.

## Pressure Drop Data

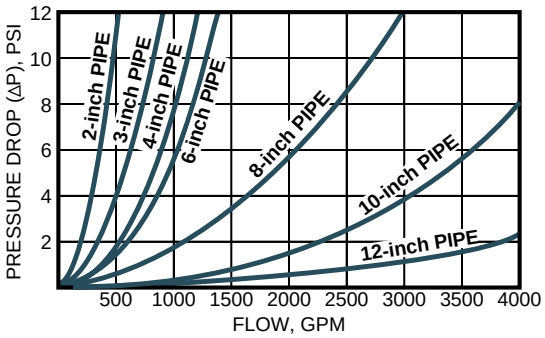
*Basket strainers and bag filters are usually selected so that the pressure drop does not exceed 2 psi, when they are clean. Higher pressure drops may be tolerated when contaminant loading is low.*

### Determining housing pressure drop:

*The pressure drops shown on the graph are reliable for all multi-basket housings, including strainer baskets or bag filter (perforated only or mesh lined). The pressure drop of any housing is governed by the size of the inlet and outlet, not the vessel itself.*

1. *Using the desired pipe size and approximate flow rate, determine the basic pressure drop from the graph.*
2. *Multiply the pressure drop obtained in step 1 by the viscosity correction factor found in the accompanying table.*
3. *You now have the pressure drop for a clean multi-basket unit. If bag filters are to be employed, you must add the pressure drop they incur to get a true pressure drop for the assembly.*

**Note:** *Filter bags are specified separately. See pages 120-130.*




*Recommended flow rates are based on housing only. Fluid viscosity, filter bag used, and expected dirt load should be considered when sizing a filter.*

## Viscosity Factors

| CPS NUMBER | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1 ($H_2O$) | 50 | 100 | 200 | 400 | 600 | 800 | 1000 | 2000 |
| .65 | .85 | 1.00 | 1.10 | 1.20 | 1.40 | 1.50 | 1.60 | 1.80 |

# How To Order

*Build an ordering code as shown in the example*

**Example: SLP-24-30-4F -1-150-C- B -S -M-20- C- 2P 1/16**

Housings — Options — OPTIONAL INNER BASKET

**HOUSING STYLE**
- Standard (std) = **No Symbol**
- Standard Low Profile = **SLP**
- Quick Access Cover (16-24) = **QAC**
- Hinged Low Profile = **HLP**

**MODEL NO.**
- 16 = **16**, 30 = **30**
- 18 = **18**, 36 = **36**
- 22 = **22**, 42 = **42**
- 24 = **24**, 48 = **48**

**BASKET DEPTH**
- 15-in. = **15**
- 30-in. (std) = **30**

**PIPE SIZE (FLANGED[1])**
- 2-in. (Std,SLP,HLP16-48 / QAC 18 & 24) = **2F**
- 3-in.(Std, SLP, HLP 16-48 / QAC 18 & 24) = **3F**
- 4-in. (Std 16-48 / SLP, HLP 22-48 / QAC 24) = **4F**
- 6-in. (Std 22-48 / SLP, HLP 30-48) = **6F**
- 8-in. (Std 30-48 / SLP, HLP 36-48) = **8F**
- 10-in. (Std 36-48 / SLP, HLP 42 & 48) = **10F**
- 12-in. (Std 42, 48) = **12F**

**OUTLET STYLE**
- In-line, bottom (std) = **1**
- Side inlet/outlet (SLP, HLP, QAC) = **2**
- Side inlet/outlet, same side (SLP, HLP, QAC) = **4**

**PRESSURE RATING[2]**
- 150 psi (flanged) = **150**

**HOUSING MATERIAL**
- Carbon steel = **C**
- 304 stainless steel = **S**
- 316 stainless steel = **S316**

***COVER SEAL**
- Buna N = **B**
- Ethylene Propylene = **E**
- Viton® = **V**
- Teflon® Encapsulated Viton® = **TEV**
- Teflon® (solid white) = **TSW**

**BASKET SEAL**
- No seal = **N**
- Seal (only on strainer housings) = **S**

**OPTIONAL INNER BASKET, MEDIA SIZE**
Perforation diameters (for type 2P baskets)
**1/4, 3/16, 9/64, 3/32, 1/16**
Mesh sizes (for type 2M & 2BM baskets)
**20, 30, 40, 50, 60, 70, 80, 100, 150, or 200**

**OPTIONAL INNER BASKET, TYPE**
- **2B** = Filter bag basket, 9/64 perforations
- **2P** = Strainer basket, perforated metal
- **2BM** = Filter basket, mesh lined
- **2M** = Strainer basket, perforated, mesh lined

**ASME CODE STAMP**
- **C** = Code

**BASKET, MEDIA SIZE No symbol if type B basket was selected**
Perforation diameters (for type P baskets)
**1/4, 3/16, 9/64, 3/32, 1/16**
Mesh sizes (for type M & BM baskets)
**20, 30, 40, 50, 60, 70, 80, 100, 150, or 200**

**BASKET, TYPE**
- **PB** = Filter bag basket, 9/64 perforations
- **P** = Strainer basket, perforated metal
- **BM** = Filter bag basket, perforated, mesh lined
- **M** = Strainer basket, perforated, mesh lined
- **HWM** = Filter bag basket, heavy wire mesh

1. Flanges provided with the housing match the pressure rating of the vessel. Housings rated 150 psi have 150 class flanges. Housings rated 300 psi have 300 class flanges. Other styles and classes available. ANSI B16.5 Pressure-Temperature rating tables determine flange class for ASME code housings. Consult factory.
2. Higher pressure ratings available. Consult factory.

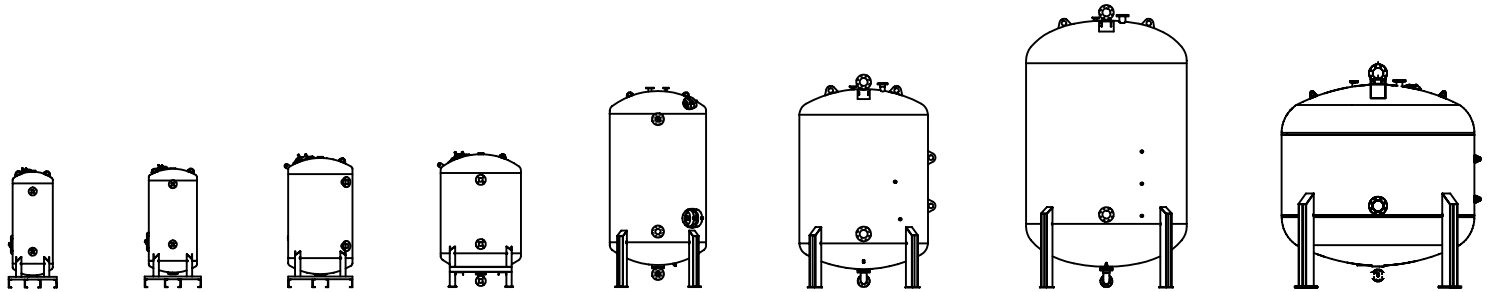
***Note:** The TEV and TSW cover seals are not available on the low profile QAC.

CARBONAIR
www.carbonair.com

# PC Series
# Carbon Vessels

Carbonair's carbon vessels are designed and manufactured in accordance with engineering standards set forth by the American Society of Mechanical Engineers (ASME). The materials used in construction are in accordance with standards established by AWWA, FDA, and EPA.

**Specifications**



| Model | PC 5 | PC 7 | PC 13 | PC 20 | PC 28 | PC 50 | PC 78 | PC 113 |
|---|---|---|---|---|---|---|---|---|
| Flow Range (gpm) | 3 - 35 | 4 - 50 | 6 - 100 | 10 - 130 | 14 - 200 | 25 - 360 | 40 - 550 | 55 - 800 |
| Carbon Capacity (lb) | 500 | 1000 | 1500 | 2500 | 5000 | 10,000 | 20,000 | 20,000 |
| Vessel Diameter | 2'-6" | 3' | 4' | 5' | 6' | 8' | 10' | 12' |
| Vessel Height | **7'-3"** | **7'-7"** | **8'-4"** | **8'-5"** | **12'-5"** | 13'-3" | 17'-7" | **13'-11"** |
| Bed Area (ft²) | 4.9 | 7.1 | 12.6 | 19.6 | 28.3 | 50 | 78 | 113 |
| Empty Weight (lb) | 780 | 980 | 1230 | 1800 | 3150 | 8100 | 10,900 | 16,600 |
| Loaded Weight (lb) | 1280 | 1980 | 2730 | 4300 | 8150 | 18,100 | 30,900 | 36,600 |
| Operating Weight (lb) | 2670 | 3670 | 6150 | 9200 | 17,450 | 40,600 | 75,600 | 82,650 |
| Spent & Drained Weight (lb) | 1900 | 3230 | 4600 | 7400 | 14,400 | 30,520 | 55,750 | 61,450 |
| Design Pressure (psig) | 90 | 90 | 90 | 75 | 75 | 75 | 75 | 75 |
| Influent Connection | 2" | 2" | 2" | 3" | 4" | 6" | 6" | 8" |
| Effluent Connection | 2" | 2" | 2" | 3" | 4" | 6" | 6" | 8" |

Design Features

- **Welded Steel Construction**
- **Corrosion Resistant Acrylic Polyurethane Coated Exterior**
- **Multi-Coated Corrosion Resistant Epoxy Interior**
- **Built to ASME code**
- **PVC and Stainless Steel Internals**
- **Two 12" x 16" Access Ports**

Options

- ☐ Influent/Effluent Sample and Pressure Taps
- ☐ Influent/Effluent Quick-Connect Couplings
- ☐ Flexible Interconnecting Hose
- ☐ External Sample/Gauge Ports
- ☐ Piping Packages
- ☐ Flow Instrumentation
- ☐ ASME Inspected and Stamped Vessels Available
- ☐ Complete line of granular activated carbon and other media

Service Centers

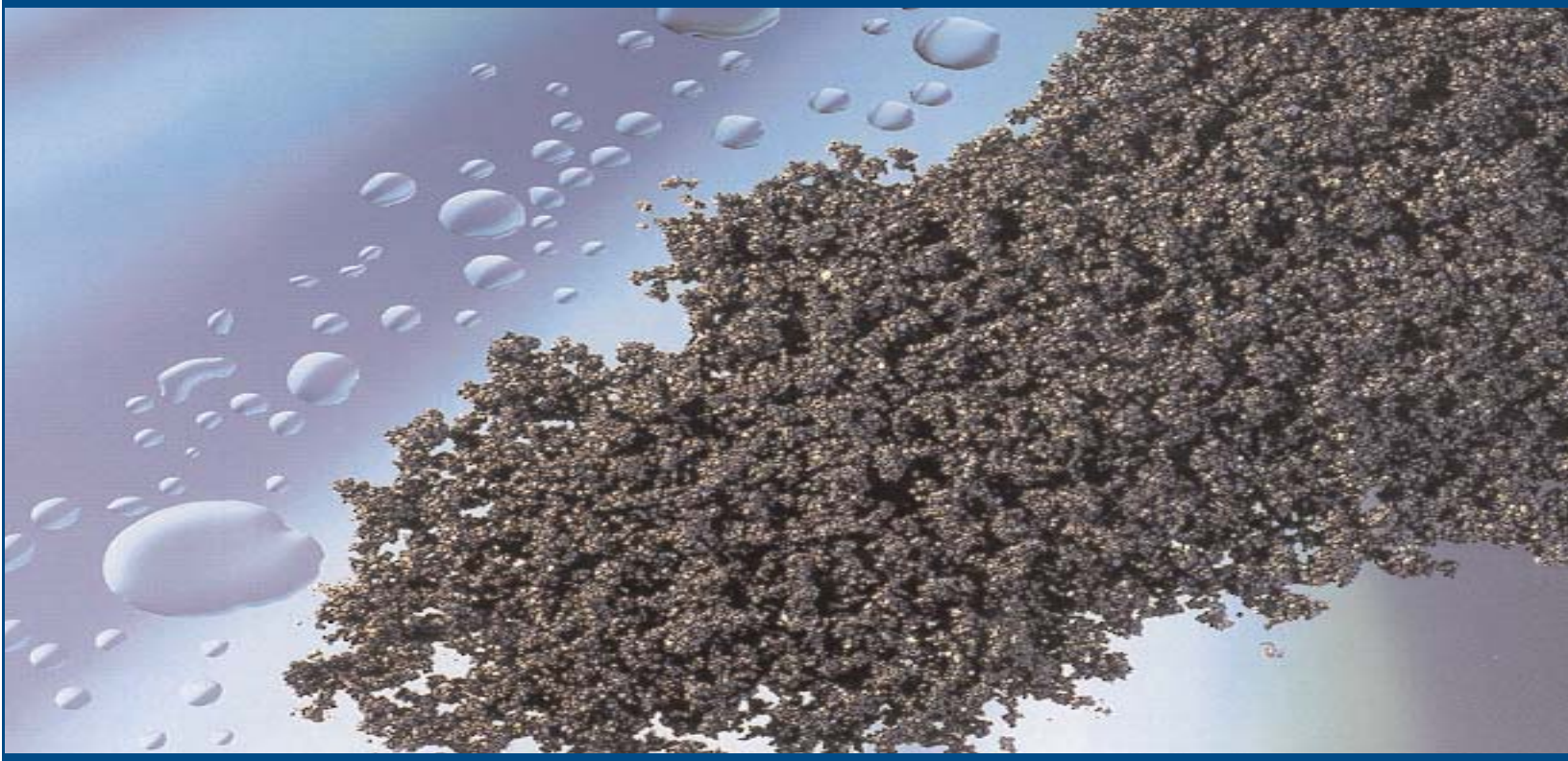
**FLORIDA**
4710 Dignan Street
Jacksonville, FL 32254
800.241.7833
904.387.4465
904.387.5058 Fax

**MINNESOTA**
2731 Nevada Ave. No.
New Hope, MN 55427
800.526.4999
763.544.2154
763.544.2151 Fax

**TEXAS**
4889 Hunter Rd. Bldg 1-C
San Marcos, TX 78666
800.893.5937
512.392.0085
512.392.0066 Fax

**VIRGINIA**
4328 West Main Street
Salem, VA 24153
800.204.0324
540.380.5913
540.380.5920 Fax

Dwg # 217327 PC

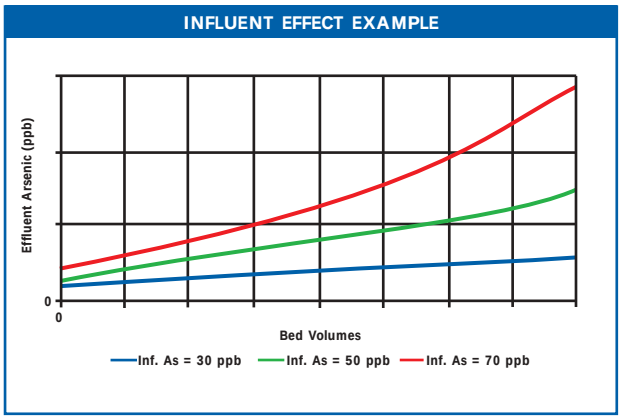


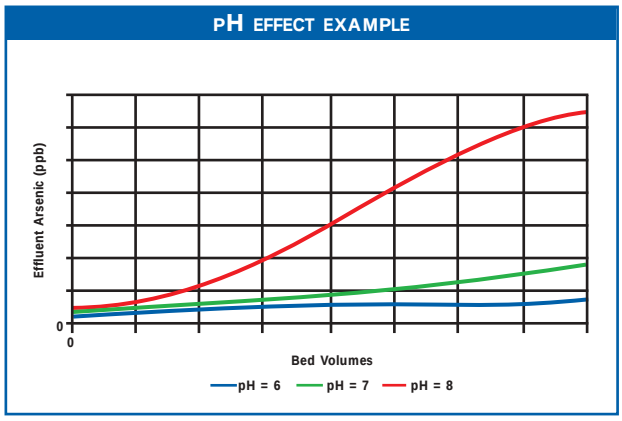
USFilter

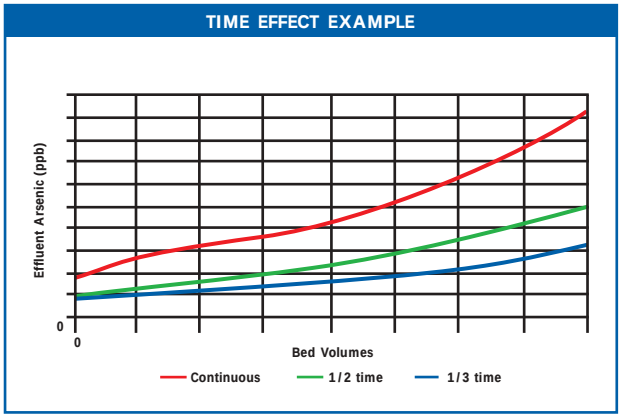
# GFH™ MEDIA

## FOR ARSENIC REMOVAL

*Municipalities concerned with arsenic in the drinking water can employ USFilter's Granular Ferric Hydroxide (GFH) to comply with the new Arsenic Rule. The GFH system is an adsorption process capable of removing arsenic and other heavy metals from raw water supplies. Arsenic is common in ground-water sources and the health effects associated with high concentrations in drinking water include skin lesions, skin cancer, and several internal organ cancers. USFilter realizes the importance of arsenic removal and the GFH system is one of our solutions to meet the standards of today, as well as tomorrow.*



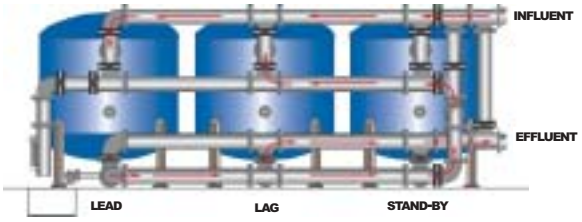

The above graphs show the effect of influent arsenic concentration, pH and duty cycle on GFH systems. As expected, lower influent concentrations lead to a longer media life. Lower raw water pH also has a positive impact on media life. In many cases, pH may not require adjustment. For higher influent pH, a correction step can be included to extend media life. The most interesting operating parameter is the duty cycle. As shown in the graph, systems that allow the media a “rest” period will see an increase in effective media life in terms of bed volumes treated. The rest period allows for an inter-particulate diffusion of arsenic to expose fresh adsorption sites, thus extending the media’s useful life.

The GFH media can be placed into parallel or series pressure vessel systems depending on your required removal concentrations. If a consistent 90% reduction is needed across the system, the series design is used. However, if the percentage is less than 90%, then the parallel design is typically applied. Consult USFilter for special conditions that may define the use of the series design, particularly if higher removal rates are required.

## PARALLEL SYSTEMS

The three, in-service vertical pressure vessels in a parallel system are each designed to treat 1/3 of the incoming flow at a hydraulic loading rate of 5 gpm/sq. ft. (12.2 m/hr). A five minute Empty Bed Contact Time (EBCT) is provided through the parallel system, plus backwash water is supplied solely from the in-service vessels where they are backwashed during the same event. During the initial start-up of the plant, one vessel is placed on-line where it begins the exhaustion curve. Subsequently, the second vessel is started and later the third one is activated. This process causes all the vessels to operate at varying degrees of exhaustion, and the blended effluent concentration is below the desired level. The blended effluent concentration eventually approaches the acceptable limit, however, and when the media in the longest running vessel is replaced, the overall blended effluent is reduced. Overall media life is extended when operated in this fashion.

PARALLEL FLOW – SERVICE MODE
ALL VESSELS IN–SERVICE




SERIES FLOW – SERVICE MODE
TWO VESSELS IN SERIES – ONE IN STAND–BY

## SERIES SYSTEMS

In a series system two vessels are operated in a lead/lag mode with a third vessel in stand-by. The hydraulic loading rate is 8 gpm/sq. ft. (19.6 m/hr) and, similar to the parallel system, provides an EBCT of five minutes total or 2.5-minute EBCT per vessel. Backwash water is supplied from the raw water source, or returned from the system. Again, as in the parallel system in-service vessels are backwashed during the same event. When the lead vessel media is exhausted, it is isolated and the lag vessel shifts to the lead vessel. At that time, the stand-by vessel progresses to the lag sequence. Following this process, the exhausted media is replaced in this vessel and it becomes the stand-by vessel. The series flow systems include a by-pass line in order to blend raw water with the treated water until the desired effluent is achieved. In a series design, the lag unit receives a lower concentration of contaminants, which creates a more consistent removal throughout the system. The series system, however, treats a lower flow rate than the same size vessels in a parallel unit.

For specific applications, contact USFilter for an estimate of water produced between media replacement. We also offer on-site verification pilot units to confirm process design and equipment selection. The pilot units are provided with the tank, controller and media for an efficient study.

*The arsenic standard implemented by the Environmental Protection Agency (EPA) of 10 parts per billion (ppb) in drinking water has prompted municipalities to comply with strict and increased guidelines when considering arsenic removal options. The GFH system can meet the standards set by the EPA with a simple design process that requires minimal operator attention and produces a low liquid waste volume.*

## HOW GFH™ CAN WORK FOR YOU

*GFH Pilot unit*

The GFH system utilizes an NSF® Standard 61-approved, ferric-based, non-regenerative media to adsorb arsenic, selenium, phosphate, chromium and other heavy metals from drinking water. Like other adsorption processes, the water is simply passed through the media to remove the contaminants. Once the media has depleted its adsorption capacity, it is removed from the vessel and replacement media is installed. In many cases, the exhausted media can be discarded in landfills and classified as non-hazardous waste after passing a TCLP test. On-site storage of regeneration chemicals and concentrated waste disposal issues are eliminated with the single use media.

The adsorption life of the media relies on raw water pH, arsenic concentration levels, and operating cycles per day. GFH media does not require preconditioning or pre-oxidation procedures in most cases, and the use of non-regenerative media are design features that are ideal for small and wellhead applications, particularly where no treatment currently exists.

**Typical raw water quality:**

| | |
|---|---|
| pH | 5.5 – 9.0 |
| Oxygen | > 0.5 ppm |
| Ferrous Iron | < 0.2 ppm |
| Manganese | < 0.05 ppm |
| Aluminum | < 0.2 ppm |
| Silica | < 20 ppm |
| Phosphate | < 0.05 ppm |

While these are the general requirements, we recommend providing a complete analysis for specific system performance and evaluation. The water supply should be free of suspended material and precipitated iron and manganese as these may affect the adsorption process.

**Typical contaminants removed:**

- Arsenic (III & V)
- Phosphate
- Chromium
- Selenium
- Antimony
- Copper

The standard GFH system consists of three vertical pressure vessels with factory installed internals for distribution and collection of influent and backwash flows. The vessels include fully finished, painted interiors for superior corrosion protection. GFH media is field placed on a gravel support bed. All face piping and valves are included in the standard system to streamline installation. A backwash process flow rate of 10-12 gpm/sq. ft. (24-29 m/hr) is typically required once every 2-6 weeks to prevent compaction of the bed and remove captured particulate. GFH systems are ideal for plants that have limited waste handling facilities since the unit produces unusually low volumes of liquid waste and on an infrequent basis. When media replacement is required, USFilter service crews are available to remove the exhausted media and safely dispose of it, and fill the vessel with new media. Our highly-trained service personnel routinely provide these services on media filters and granular activated carbon systems.

## CONTACT INFORMATION

*If it's in the water, our engineered processes and equipment can take it out, economically and dependably. Our comprehensive line includes solutions to simple and complex water treatment and conditioning needs, all backed by working installations and years of experience. Our line includes:*

- Adsorption Clarifiers®
- CONTRAFLO® solids contact clarifiers
- SPIRACONE™ sludge blanket clarifiers
- Sludge Sucker™ sludge removal system
- ACTIFLOC™ packaged water treatment
- Vertical and horizontal pressure filters
- Aerators
- AERALATER® packaged treatment
- Microfloc® Trident® packaged water treatment
- MULTIWASH® filtration process
- Gravity filtration equipment
- MULTICRETE II™ monolithic underdrain system
- MULTIBLOCK™ underdrain system
- Memcor® CMF microfiltration system

*Memcor CMF microfiltration system*

*CONTRAFLO clarifiers*

*Microfloc Trident system*

*SPIRACONE clarifiers*

To find out how to put USFilter to work for you, contact us at:

USFilter


Memcor, Microfloc and
General Filter Products

600 Arrasmith Trail
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515.232.4121 *phone*
515.232.2571 *fax*

441 Main Street
P.O. Box 36
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508.347.7344 *phone*
508.347.7049 *fax*

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410.307.6540 *phone*
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1728 Paonia Street
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For more information, visit our website at: www.usfilter.com


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GF-GFH-BR-0203

# APPENDIX D.3

# SEDIMENT CONCEPTUAL DESIGN CALCULATIONS

## D.3.1 - SEDIMENT REMEDIATION

## D.3.2 - ON-SITE DEWATERING FLUID TREATMENT

# APPENDIX D.3.1

# SEDIMENT REMEDIATION

## D.3.1 – SEDIMENT REMEDIATION CONCEPTUAL DESIGN

| CLIENT: NSB-NLON, Groton, CT | | | | JOB NUMBER: 112G02630 | |
|---|---|---|---|---|---|
| SUBJECT: Appendix D.3.1: Sediment Remediation Conceptual Design | | | | | |
| BASED ON: Various Reports | | | | DRAWING NUMBER: | |
| BY: | CAR | JLG | CHECKED BY: JL | APPROVED BY: | DATE: |
| Date: | 05-25-10 | 04-27-10 | Date: 05-26-10 | CAR | 05/27/10 |

## 1.0 OBJECTIVE:

Develop conceptual design and volume estimates for the remediation of contaminated sediment in Zone 4 and Outer Pier 1 along the Lower Subase at Naval Submarine Base - New London in Groton, Connecticut. Consider operation, maintenance, and stability concerns of the Navy's during the process. Area of contaminated sediment determined in Appendix C.5. Use other information available in References 1 through 6.

## 2.0 ASSUMPTIONS:

- Two scenarios are considered for sediment remediation. Scenario 1 would be two-tiered, involving first pre-dredging followed by capping. Pre-dredging would remove sediment contamination from the 0-2 feet depth interval and establish a minimum operational water depth of 36 feet. Capping would cover areas of sediment contamination exposed by the pre-dredging. Scenario 2 would involve only dredging. This dredging would remove all sediment contamination and establish a minimum operational water depth of 36 feet.

- For Scenario 1 pre-dredging depth would range from 2 to 12 feet and capping thickness would be 3 feet. Areas with sufficient operational water depth and where sediment is contaminated in the 2-4 feet interval and/or in the 4-6 feet interval, but not in the 0-2 feet interval would remain untreated as it is assumed that the natural layer of uncontaminated sediment would act as a cap.

- For Scenario 2, dredging depth would range from 2 to 12 feet.

- The Zone 4 contaminated sediment is located along the Quay Wall from south of Pier 2 to just south of Pier 6 (approximately 580 feet). The sediment in this area slopes from approximately 16 feet below the water surface near the Quay Wall at a 2.5-to-1 slope to approximately 36 feet below the water surface at 50 feet from the Quay Wall. Based on this slope, the length of the slope is approximately 54 feet.

- The Zone 4 sediment slope must be maintained to ensure the stability of the Quay Wall. However, it is assumed that short-term removal and replacement of up to 6 feet of sediment would not affect the stability of the Quay Wall. Additional calculations are required during the design to confirm this assumption.

- The sediment to be dredged is 100% saturated and has an in-situ solids content of 50% by weight.

- The sediment to be dredged is comprised of fines and sands with high total organic carbon (TOC) and has an average in-situ density of 88.1 pounds per cubic foot (lb/cf), or 1.19 tons per cubic yard (ton/cy). Salt water has a density of 64 lb/cf, or 0.86 ton/cy.

  Therefore, the volume of solids per cf of in-situ sediment is:
  1 - (88.1 * 0.5 / 64) = 1 - 0.69 = 0.31 cf
  And the density of the solids in the sediment is:
  (88.1 * 0.5) / 0.31 = 142.1 lb/cf, or 1.92 ton/cy

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- The actual in-situ volume of dredged sediment would be 10% higher than the estimated in-situ volume of sediment to be dredged to account for over-dredging. In addition a 1:1 cut-back would be assumed for slope stability along the perimeter of dredged areas, except along the Zone 4 quay wall and in the Dredge Buffer Zone. Along the Zone 4 quay wall there would no dredging cut back. In the Dredge Buffer Zone the dredging slope would be 1:5 decreasing from a dredging depth of 6 feet at its eastern boundary to no dredging at the western boundary to merge with the previous maintenance dredging.

- Uncontaminated sediment dredged to uncover contaminated sediment or to maintain slope stability in dredged areas shall be considered as contaminated.

- The mechanical dredging process entrains water in the amount of 1 cf per in-situ cf of sediment to be not significantly impact the results of this calculation. Therefore, bulking will not be considered.

## 3.0 ZONE 4

### 3.1 Scenario 1 - Dredging followed by Capping (Alternatives SD-3 and SD-4)

#### 3.1.1 Pre-Dredging

As per attached Figure 4-34, five distinct areas of Zone 4 sediment would be pre-dredged under Scenario 1, including:

1 - An estimated 18,000 square feet (sf) area of the 50-foot-wide slope along the quay wall would be dredged to a depth of 2 feet to remove contaminated sediment at the surface.
2 - An estimated 16,200 sf area extending in the central part of Zone 4 between the Dredge Buffer Zone and the quay wall slope would be dredged to an average depth of 9 feet (6 to 12), primarily to establish the required operational water depth. All contaminated sediment would be removed by the dredging.
3 - An estimated 19,800 sf area extending north of Pier 2 between the Dredge Buffer Zone and the quay wall slope would be dredged to an average depth of 4 feet over approximately 75% of the area, primarily to establish the required operational water depth, and to an average depth of 6 feet over 25% of the area to establish the required operational depth and to remove the 2 feet of remaining contaminated sediment exposed by the dredging. This sediment would have been removed to allow installation of the cap; however, because it will be removed, a cap is no longer required.
4 - An estimated 4,050 sf of the Dredge Buffer Zone in the central part of Zone 4 would be dredged to a depth of 0 to 9 feet to establish the required operational water depth. Contaminated sediment would be included in the dredging.
5 - An estimated 4,950 sf of the Dredge Buffer Zone north of Pier 2 would be dredged to a depth of 0 to 4 feet to establish the required operational water depth. Contaminated sediment would be included in the dredging.

In-situ volume of contaminated sediment to be pre-dredged:
[(18,000 sf * 2 ft) + (16,200 sf * 9 ft) + [(19,800 sf * 4ft * 0.75) + (19,800 sf * 6 ft * 0.25)] + (4,050 sf * 9/2 ft) + (4,950 sf * 4/2 ft)] * 1.1 = 328,927 cf = 12,182 cy

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In-situ mass of dredged sediment: 12,182 cy * 1.19 ton/cy = 14,497 tons

Using the assumption that the in-situ sediment contains 50% solids by weight:

In-situ mass of dry solids in dredged sediment: 0.5 * 14,497 tons = 7,248 tons
In-situ mass of water in dredged sediment: 7,248 tons

The mechanical dredging of 1 in-situ cf of sediment would yield 2 cf of dredged material including 1 cf of sediment and 1 cf of entrained water. The 1 cf of sediment would weigh 88.1 lb and the 1 cf of salt water would weigh 64 lb. Therefore, the density of the dredged material is 152.1 lb/2 cf = 76 lb/cf. Each 2 cf of dredged material would include 88.1 lb / 2 = 44 lb of dry sediment and 44 lb + 64 lb = 108 lb of salt water. The overall solids concentration would be 44 lb / 152.1 lb = 29% by weight.

Volume of dredged material:
12,182 cy * 2 = 24,364 cy including 12,182 cy of sediment and 12,182 cy of free water.
Mass of dredged material:
14,497 tons + [(12,182 cy * 27 cf/cy * 64 lb/cf) / 2,000 lb/ton] = 14,497 tons + 10,525 tons = 25,022 tons

### 3.1.2 On-Site Dewatering and Off-Site Disposal

Assume on-site dewatering would proceed in two steps: gravity drainage followed by the addition of fly ash. Gravity drainage would be conducted in the spoil barges and fly ash would be added either on shore prior to off-site transportation or at an off-site disposal facility.

Gravity drainage would remove approximately 100% of the free water entrained by dredging and re-compact the sediment to its original volume:

Volume of drained sediment: 12,182 cy re-compacted sediment
Mass of drained sediment: 14,497 tons
Concentration of drained sediment: 50% solids by weight
Volume of water released by gravity drainage: 12,182 cy * 202 gal/cy = 2,460,764 gal

Assume that approximately 10% of drainage water, or 246,076 gal would be contaminated and would have to be collected either for off-site disposal or for on-site treatment and discharge.

Assume 8 percent (by weight) of fly ash added to drained sediment: 14,497 tons * 0.08 = 1,160 tons

Mass of treated sediment for off-site disposal: 14,497 + 1,160 = 15,657 tons

Bulk density of fly ash is approximately 100 lb/cf.

Volume of fly ash added: (1,160 tons * 2,000 lb/ton) / (100 lb/cf * 27 cf/cy) = 859 cy

Assume approximately 10 % bulking occurs from addition of fly ash and processing; therefore, the total volume of treated sediment for disposal is 12,182 cy * 1.1 = 13,400 cy.

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### 3.1.3 Capping

As shown on Figure 4-34, an estimated 18,000 sf would be capped to cover contaminated sediment exposed by pre-dredging. As assumed above, final cap thickness would be 3 feet and with a compaction factor of 20%.

Volume of cap material: (18,000 sf * 3 ft * 1.20) / (27 cf/cy) = 2,400 cy

Assume the sand has a bulk density of 100 lb/cf.

Mass of cap material: (2,400 cy * 27 cf/cy * 100 lb/cf) / 2000 lb/ton = 3,240 tons

## 3.2 Scenario 2 - Dredging of All Contaminated Sediment (Alternatives SD-6 and SD-7)

As per attached Figure 4-38, seven distinct areas of Zone 4 sediment would be pre-dredged under Scenario 1, including:

1 - An estimated 29,400 sf area covering approximately 2/3 of the northern part of Zone 4 between the Dredge Buffer Zone and the quay wall as well as the central section of the 50-foot-wide slope along the quay wall would be dredged to a depth of 6 feet to remove sediment contamination.
2 - An estimated 16,200 sf area extending in the central part of Zone 4 between the Dredge Buffer Zone and the quay wall slope would be dredged to an average depth of 9 feet, to remove sediment contamination and establish the required operational water depth.
3 - An estimated 18,875 sf area extending north of Pier 2 between the Dredge Buffer Zone and the quay wall slope (except in the southeast corner) would be dredged to an average depth of 4 feet to remove sediment contamination and establish the required operational water depth.
4 - An estimated 6,180 sf area extending north of Pier 2 in the southeast corner between the pier and the quay wall would be dredged to a depth of 6 feet to remove sediment contamination.
5 - An estimated 4,050 sf of the Dredge Buffer Zone in the central part of Zone 4 would be dredged to a depth of 0 to 9 feet to remove remaining sediment contamination and establish the required operational water depth.
6 - An estimated 4,950 sf of the Dredge Buffer Zone north of Pier 2 would be dredged to a depth of 0 to 4 feet to remove remaining sediment contamination and establish the required operational water depth.
7 - An estimated 4,135 sf area extending south of Pier 2 between that pier and the quay wall would be dredged to a depth of 6 feet to remove sediment contamination.

It is assumed that short-term removal and replacement of sediment would not affect the stability of the quay wall. Additional calculations are required during the design to confirm this assumption.

Total in-situ volume of sediment to be dredged:
[(29,400 sf * 6 ft) + (16,200 sf * 9 ft) + (18,875 sf * 4 ft) + (6,180 ft * 6 ft) + (4,050 sf * 9/2 ft) + (4,950 sf * 4/2 ft) + (4,135 sf * 6 ft)] * 1.1 = 536,486 cf = 19,870 cy

In-situ mass of sediment to be dredged:
19,870 cy * 1.19 ton/cy = 23,645 tons

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Using the assumption that the in-situ sediment contains 50% solids by weight:

Mass of dry solids in in-situ sediment to be dredged: 0.5 * 23,645 tons = 11,822 tons
Mass of water in in-situ sediment to be dredged: 11,822 tons

The mechanical dredging of 1 in-situ cf of sediment would yield 2 cf of dredged material including 1 cf of sediment and 1 cf of entrained water. The 1 cf of sediment would weigh 88.1 lb and the 1 cf of salt water would weigh 64 lb. Therefore, the density of the dredged material is 152.1 lb/2 cf = 76 lb/cf. Each 2 cf of dredged material would include 88.1 lb / 2 = 44 lb of dry sediment and 44 lb + 64 lb = 108 lb of salt water. The overall solids concentration would be 44 lb / 152.1 lb = 29% by weight.

Volume of dredged material to be treated and disposed:
19,870 cy * 2 = 39,740 cy including 19,870 cy of sediment and 19,870 cy of free water.
Mass of dredged material to be treated and disposed:
23,645 tons + [(19,870 cy * 27 cf/cy * 64 lb/cf) / 2,000 lb/ton] = 23,645 tons + 17,168 tons =40,813 tons

### 3.2.1 On-Site Dewatering and Off-Site Disposal

Assume on-site dewatering would proceed in two steps: gravity drainage followed by addition of fly ash. Gravity drainage would be performed on the spoil barges and fly ash would be added either on shore prior to off-site transportation or at an off-site disposal facility.

Gravity drainage would remove approximately 100% of the free water entrained by dredging and re-compact the sediment to its original volume:

Volume of drained sediment: 19,870 cy re-compacted sediment
Mass of drained sediment: 23,645 tons
Concentration of drained sediment: 50% solids by weight
Volume of water released by gravity drainage: 19,870 cy * 202 gal/cy = 4,013,740 gal

Assume that approximately 10% of drainage water, or 401,370 gal would be contaminated and would have to be collected either for off-site disposal or for on-site treatment and discharge.

Assume 8 percent (by weight) of fly ash added to drained sediment: 23,645 tons * 0.08 = 1,892 tons

Mass of treated sediment for off-site disposal = 23,645 tons sediment + 1,892 tons fly ash = 25,537 tons

Bulk density of fly ash is approximately 100 lb/cf.

Volume of fly ash added: (1,892 tons * 2,000 lb/ton) / (100 lb/cf * 27 cf/cy) = 1,401 cy

Assume approximately 10 % bulking occurs from addition of fly ash and processing; therefore, the total volume of sediment for disposal is 19,870 cy * 1.1 = 21,857 cy.

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### 3.2.3 Backfilling of Dredged Areas

A total of 7.5 feet of clean sand or sandy sediment would be placed to restore the required slope along the Zone 4 quay wall. The extra material is required to account for over dredge, compaction, and slope stability.

The 50-foot wide (and 54 feet long) slope along 582 linear feet [450 ft + 120 ft + (2 * 6 ft)] of the Zone 4 quay wall would be backfilled to restore structural support to that wall.

Assume that the fill thickness would be 7.5 feet to account for a 20% compaction/settling factor and that a slope of 1:2.5 must be provided for stability along the western edge of the backfilled area.

Volume of fill material: (582 ft * 54 ft * 7.5 ft) + (582 ft * 18.75 ft * 7.5 ft / 2) = 276,631 cf = 10,246 cy

Assume the sand has a bulk density of 100 lb/cf.

Mass of fill material: (10,246 cy * 27 cf/cy * 100 lb/cf) / 2000 lb/ton = 13,832 tons

## 4.0 OUTER PIER 1

### 4.1 Scenario 1 - Capping (Alternatives SD-3 and SD-4)

This scenario would require no active remediation because sediment is uncontaminated to a depth of 4 feet and it is assumed that this layer of uncontaminated sediment will act as a natural cap.

### 4.2 Scenario 2 - Dredging of All Contaminated Sediment (Alternatives SD-6 and SD-7)

#### 4.2.1 Dredging

For Scenario 2, dredging would be performed to a depth of 6 feet to remove all contaminated sediment. No backfilling of the dredged area would be required.

As per attached Figure 4-39, surface area of contaminated sediment to be dredged is estimated at 13,510 sf. Perimeter of this area is estimated at 215 feet

Total in-situ volume of sediment to be dredged:
[(13,510 sf * 6 ft) + (215 ft * 6 ft * 6 ft / 2)] * 1.1 = 93,423 cf = 3,460 cy

In-situ mass of dredged contaminated sediment to be treated and disposed:
3,460 cy * 1.19 ton/cy = 4,118 tons

Using the assumption that the in-situ sediment contains 50% solids by weight:

In-situ mass of dry solids in sediment to be treated and disposed: 0.5 * 4,118 tons = 2,059 tons
In-situ mass of water in sediment to be treated and disposed: 2,059 tons

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The mechanical dredging of 1 in-situ cf of sediment would yield 2 cf of dredged material including 1 cf of sediment and 1 cf of entrained water. The 1 cf of sediment would weigh 88.1 lb and the 1 cf of salt water would weigh 64 lb. Therefore, the density of the dredged material is 152.1 lb/2 cf = 76 lb/cf. Each 2 cf of dredged material would include 88.1 lb / 2 = 44 lb of dry sediment and 44 lb + 64 lb = 108 lb of salt water. The overall solids concentration would be 44 lb / 152.1 lb = 29% by weight.

Volume of dredged material to be treated and disposed:
3,460 cy * 2 = 6,920 cy including 3,460 cy of sediment and 3,460 cy of free water.
Mass of dredged material to be treated and disposed:
4,118 tons + [(3,460 cy * 27 cf/cy * 64 lb/cf) / 2,000 lb/ton] = 4,118 tons + 2,989 tons = 7,107 tons

### 4.2.2 On-Site Dewatering and Off-Site Disposal

Assume on-site dewatering would proceed in two steps: gravity drainage followed by addition of fly ash. Gravity drainage would be conducted in the spoil barges and fly ash would be added either on shore prior to off-site transportation or at an off-site disposal facility.

Gravity drainage would remove approximately 100% of the free water entrained by dredging and re-compact the sediment to its original volume:

Volume of drained sediment: 3,460 cy re-compacted sediment
Mass of drained sediment: 4,118 tons
Concentration of drained sediment: 50% solids by weight
Volume of water released by gravity drainage: 3,460 cy * 202 gal/cy = 698,920 gal

Assume that approximately 10% of drainage water, or 69,900 gal would be contaminated and would have to be collected either for off-site disposal or for on-site treatment and discharge.

Assume 8 percent (by weight) of fly ash added to sediment: 4,118 tons * 0.08 = 330 tons

Mass of treated sediment for off-site disposal: 4,118 tons sediment + 330 tons fly ash = 4,448 tons

Bulk density of fly ash is approximately 100 lb/cf.

Volume of fly ash added: (330 tons * 2,000 lb/ton) / (100 lb/cf * 27 cf/cy) = 244 cy

Assume approximately 10 % bulking occurs from addition of fly ash and processing; therefore, the total volume of sediment for disposal is 3,460 cy * 1.1 = 3,806 cy.

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## 5.0 SUMMARY

| Alternative | In-Situ Sediment (cy/tons) | As-Dredged Sediment (cy/tons) | Dewatering Effluent (gal) | Dewatered Sediment (cy/tons) | Fly Ash (cy/tons) | Sediment to Off-Site Disposal (cy/tons) | Cap or Backfill Material (cy/tons) |
|---|---|---|---|---|---|---|---|
| ZONE 4 | | | | | | | |
| SD-3 & SD-4 | 12,182/14,497 | 24,364/25,022 | 246,076 | 12,182/14,497 | 859/1,160 | 13,400/15,657 | 2,400/3,240 |
| SD-6 & SD-7 | 19,870/23,645 | 39,740/40,813 | 401,370 | 19,870/23,645 | 1,401/1,892 | 21,857/25,537 | 10,246/13,832 |
| OUTER PIER 1 | | | | | | | |
| SD-3 & SD-4 | No Remedial Action (Natural Cap) | | | | | | |
| SD-6 & SD-7 | 3,460/4,118 | 6,920/7,107 | 69,900 | 3,460/4,118 | 244/330 | 3,806/4,448 | 0/0 |
| TOTAL | | | | | | | |
| SD-3 & SD-4 | 12,182/14,497 | 24,364/25,022 | 246,076 | 12,182/14,497 | 859/1,160 | 13,400/15,657 | 2,400/3,240 |
| SD-6 & SD-7 | 23,330/27,763 | 46,660/47,920 | 471,270 | 23,330/27,763 | 1,645/2,222 | 25,663/29,985 | 10,246/13,832 |

## 6.0 REFERENCES

(1) U.S. Army Corps of Engineers, New England District, Public Notice for Dredging Permit for Piers 6, 10, 12, and 31, Naval Submarine Base New London, February 1, 2005.

(2) U.S. Army Corps of Engineers, New England District, Dredging Permit No. NAE-2004-3047 for Demolition and Dredging at Piers 6, 10, 12, and 31 and Thames River CAD Cell, Naval Submarine Base New London, Expiration December 1, 2008.

(3) Environmental Assessment, Pier 6 Replacement, SUBASE, NLON, Maguire Group, February 2004.

(4) Dredge Material Disposal Alternatives Analysis for Replacement of Pier 6 at Naval Submarine Base New London, Groton, Connecticut, Maguire Group, December 2004.

(5) Tetra Tech NUS, Inc., Lower Subase Remedial Investigation for Naval Submarine Base - New London, Groton, Connecticut, King of Prussia, Pennsylvania, January 1999.

(6) State of Connecticut Department of Environmental Protection, Water Quality Certificate No. 200402905-SG, Susan Gradante (CTDEP) to Nancy Kuntzleman (EFANE), April 5, 2005.

## ATTACHMENTS

Figure 4-34.pdf: Zone 4 Area of Sediment to be Pre-Dredged and Capped, Alternatives SD-3 and SD-4
Figure 4-38.pdf: Zone 4 Areas of Sediment to be Dredged, Alternatives SD-6 and SD-7
Figure 4-39.pdf: Outer Pier 1 Area of Sediment to be Dredged, Alternatives SD-6 and SD-7

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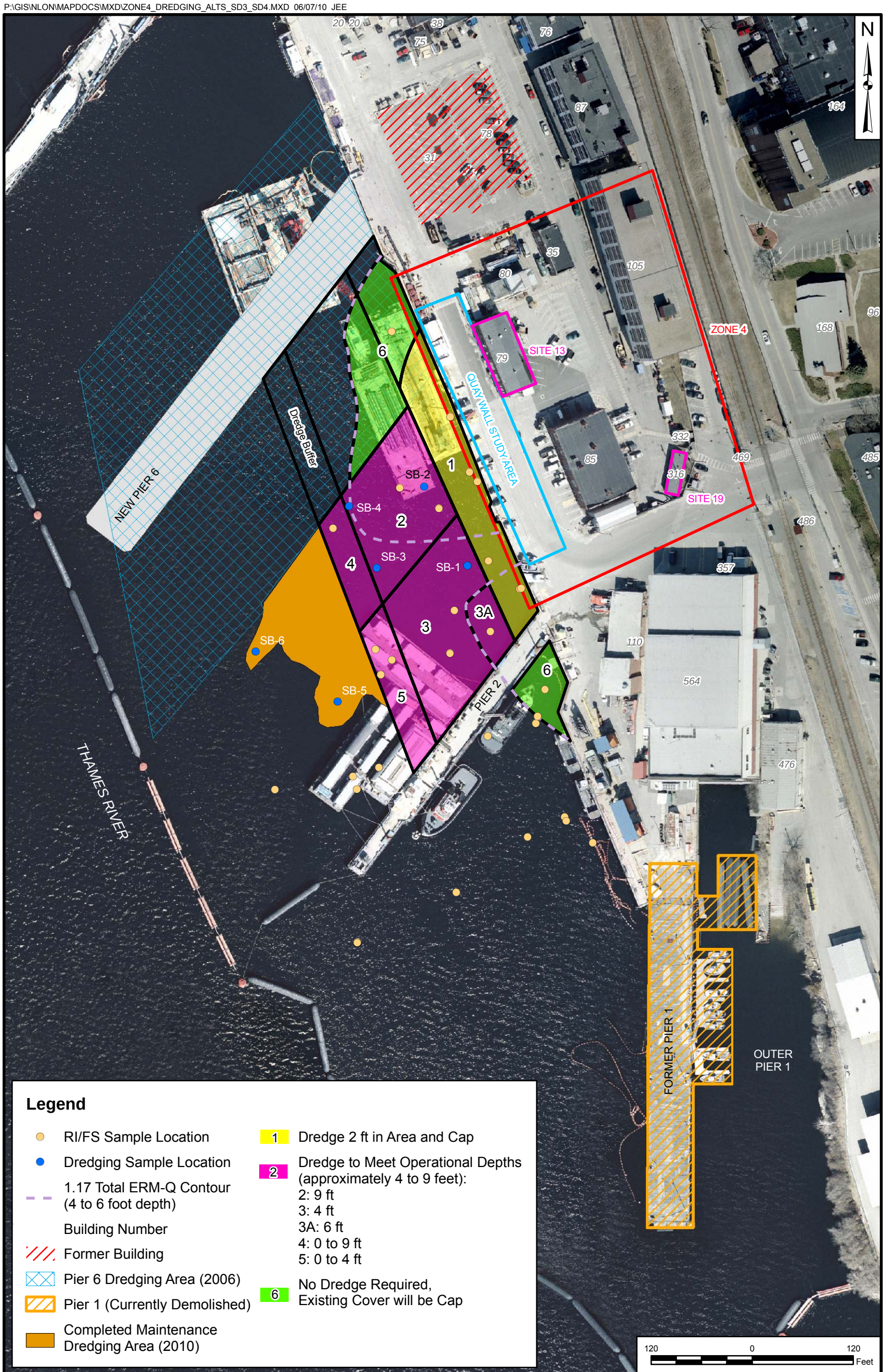


## Legend

- RI/FS Sample Location
- Dredging Sample Location
- 1.17 Total ERM-Q Contour (4 to 6 foot depth)
- Building Number
- Former Building
- Pier 6 Dredging Area (2006)
- Pier 1 (Currently Demolished)
- Completed Maintenance Dredging Area (2010)
- 1 Dredge 2 ft in Area and Cap
- 2 Dredge to Meet Operational Depths (approximately 4 to 9 feet):
  2: 9 ft
  3: 4 ft
  3A: 6 ft
  4: 0 to 9 ft
  5: 0 to 4 ft
- 6 No Dredge Required, Existing Cover will be Cap

| | | | |
|---|---|---|---|
| DRAWN BY J. ENGLISH | DATE 06/04/10 | Tetra Tech NUS, Inc. | CONTRACT NUMBER CTO WE57 / OWNER NUMBER 2630 |
| CHECKED BY C. RICH | DATE 06/04/10 | ZONE 4 AREAS OF SEDIMENT TO BE DREDGED AND CAPPED<br>ALTERNATIVES SD-3 AND SD-4<br>LOWER SUBASE<br>NSB - NLON, GROTON, CONNECTICUT | APPROVED BY CAR / DATE 06/05/10 |
| COST/SCHEDULE-AREA | | | ACAR — / 01/12/10 — |
| SCALE AS NOTED | | | DRAWING NO. FIGURE 4-34 / REV 0 |

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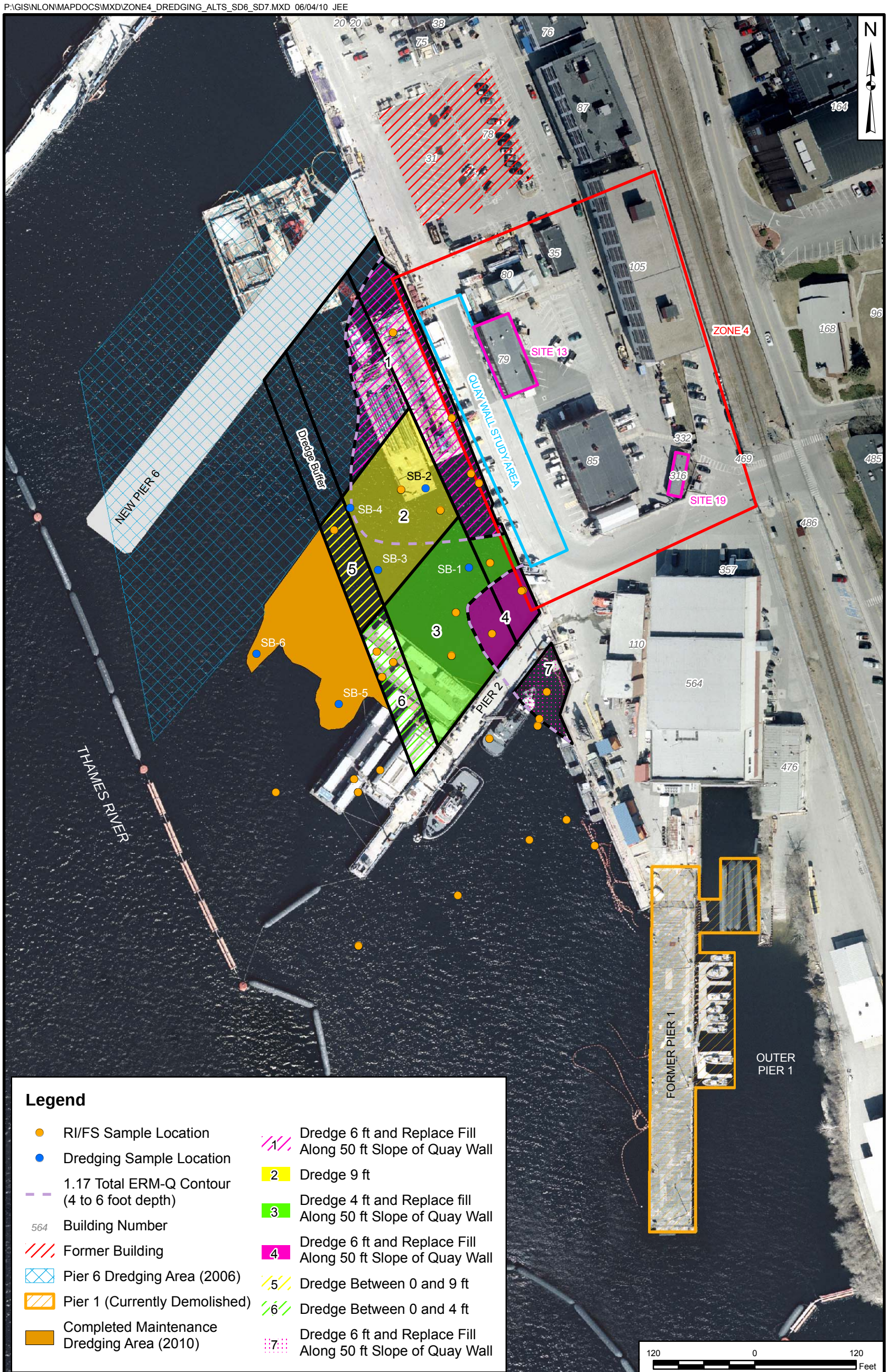
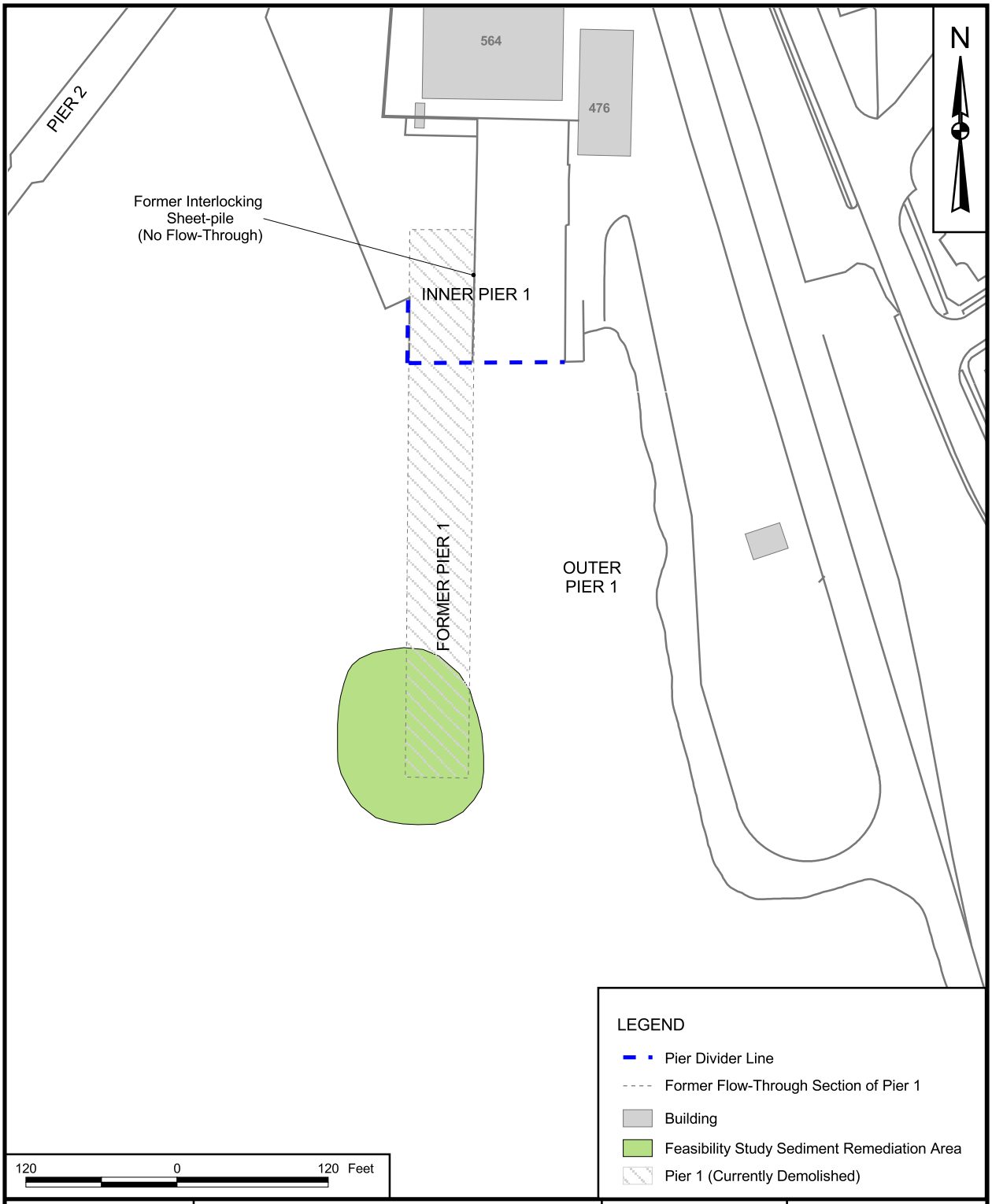



| | | | |
|---|---|---|---|
| DRAWN BY J. ENGLISH — DATE 06/04/10 | Tetra Tech NUS, Inc. | CONTRACT NUMBER CTO WE57 | OWNER NUMBER 2630 |
| CHECKED BY C. RICH — DATE 06/07/10 | ZONE 4 AREAS OF SEDIMENT TO BE DREDGED<br>ALTERNATIVES SD-6 AND SD-7<br>LOWER SUBASE<br>NSB - NLON, GROTON, CONNECTICUT | APPROVED BY CAR — DATE 06/05/10 | |
| COST/SCHEDULE-AREA | | APPROVED BY CAR — DATE 01/12/10 | |
| SCALE AS NOTED | | DRAWING NO. FIGURE 4-38 | REV 0 |




| | | | |
|---|---|---|---|
| DRAWN BY S. STROZ | DATE 04/22/09 | Tetra Tech NUS, Inc. | CONTRACT NUMBER 0424 / OWNER NO. 0811 |
| CHECKED BY N. BALSAMO | DATE 12/06/10 | OUTER PIER 1 AREA OF SEDIMENT TO BE DREDGED<br>ALTERNATIVES SD-6 AND SD-7<br>LOWER SUBASE FEASIBILITY STUDY<br>NSB - NLON<br>GROTON, CONNECTICUT | APPROVED BY CAR / DATE 12/06/10 |
| COST/SCHEDULE-AREA | | | APPROVED BY — / DATE — |
| SCALE AS NOTED | | | DRAWING NO. FIGURE 4-39 / REV 0 |

P:\GIS\NLON\SUBASE FEASIBILITY STUDY.APR OUTER PIER 1 AREA OF SD TO BE CAPPED LAYOUT 12/08/09 SS

# APPENDIX D.3.2

## ON-SITE DEWATERING FLUID TREATMENT

**D.3.2.1 - ON-SITE DEWATERING FLUID TREATMENT AND DISCHARGE SYSTEM**

**D.3.2.2 - ROSEDALE MULTI-BAG FILTERS (SEE APPENDIX D.1.2.2)**

**D.3.2.3 - CARBONAIR PC SERIES ACTIVATED CARBON UNITS (SEE APPENDIX D.1.2.3)**

## 1.0 ASSUMPTIONS

The following design assumptions are made based upon available information and from experience with similar projects:

- The estimated volumes of dewatering fluid for Alternatives SD-3 and SD-6 are provided in Appendix D.3.1.
- The dewatering fluid for Alternatives SD-3 and SD-6 would have an estimated total suspended solids (TSS) concentration of 100 milligrams per liter (mg/L) and an estimated total organic carbon (TOC) concentration of 1,000 mg/L.

## 2.0 WATER TREATMENT

### 2.1 Design Basis

#### 2.1.1 Flow

From the above design assumptions, the design flow of the dewatering fluid treatment system can be summarized as follows:

| Alternative | Total Volume of Dewatering Fluid (gallons) | Treatment System Operating Time(2) (days) | Treatment System Design Flow(3) (gpd/gpm) |
|---|---|---|---|
| SD-3 | 246,076(1) | 31 | 10,000/8 |
| SD-6 | 471,270(1) | 58 | 10,000/8 |

**NOTES**:

(1) As computed in Appendix D.3.1.
(2) Operating times are based on an estimated dredging rate of 400 in-situ cy/day (2 excavators) for Alternatives SD-3 & SD-4 and Alternatives SD-6 & SD-7.
(3) Design flow is equal to total volume divided by operating time and rounded up to the next higher commercially available unit.

#### 2.1.2 Treatment Scheme

The treatment system would consist of the following components:

- Filtration System to remove TSS
- Liquid-Phase Granular Activated Carbon (GAC) Adsorption System to remove soluble TOC
- Discharge to Thames River

Only the first two components require conceptual design at this time.

## 2.2 Filtration System

Use a bag type filter unit to avoid liquid residual stream from backwashing.

Size bag filter unit for replacement of filter bag element every 3 days (to accommodate week-end operation without changeover) and assume 95% TSS removal.

### 2.2.1 Alternatives SD-3 and SD-6

TSS accumulation in the bag filter would be:

10,000 gpd * 3 days * 8.34 lb/gal * (100 * 0.95) mg/L TSS * $10^{-6}$ = 23.8, say 24 lb TSS

Assuming a typical solids capture capacity of approximately 0.5 lbs TSS per sf of bag filter element, required surface of bag element is:

24 lb / 0.5 lb/sf = 48 sf

→ Call for two (2) multi-bag pressurized Bag Filters (BF-1, BF-2) operating in parallel (1 operating, 1 spare) with an individual filter area of 53 sf (Rosedale Model 36 or equivalent)

Also need a pump to convey released water from barge to treatment system:

→ Call for one 8 gpm submersible centrifugal Transfer Pump (P-1) (100 feet TDH, 0.5 HP motor)

## 2.3 Liquid-Phase GAC Adsorption System

Size GAC adsorption unit for the same 3-day cycle as the filter unit.
Assume GAC usage of 10 pounds per pound of TOC removed and breakthrough after usage of 3/4 of GAC

### 2.3.1 Alternatives SD-3 and SD-6

Required GAC quantity:
[(10,000 gpd * 3 days * 8.34 lb/gal * 1,000 mg/L TOC * $10^{-6}$) * 10 lb GAC/lb TOC] / 0.75 = 3,336 lb GAC

→ Call for a liquid-phase GAC Adsorption System (GAC-1) consisting of two (2) adsorption units operating in parallel (1 operating, 1 spare), each holding 5,000 lb GAC (Carbonair Model PC 28 or equivalent).

Actual frequency of GAC unit changeover would be:
(5,000 lb / 3,336 lb) * 3 days = 4.5, say 4 days

## 2.4 Operating Parameters

Based on the dewatering fluid volumes presented in Section 2.1.1 of these calculations, the alternative-specific operating parameters of the above treatment systems can be summarized in the following table:

| Parameters | Alternative SD-3[(1)] | Alternative SD-6[(1)] |
|---|---|---|
| Operating Days | 31 | 58 |
| Filter Cleanups (1 / 3 days) | 11 | 20 |
| Filter Bags Used | 132 | 240 |
| GAC Replacements (1 / 4 days) | 8 | 15 |
| GAC Usage (pounds) | 40,000 | 75,000 |

(1) Filter bags usage based on 12 bags per unit. GAC usage based on 5,000 lbs per unit.

## Attachments

Rosedale bag filter literature.
Carbonair liquid-phase GAC adsorption unit literature.

# APPENDIX D.4

# LNAPL CONCEPTUAL DESIGN CALCULATIONS

## D.4.1 - PASSIVE SKIMMING

## D.4.2 - IN-SITU BIOREMEDIATION

# APPENDIX D.4.1

# PASSIVE SKIMMING

D.4.1.1 - PASSIVE LNAPL SKIMMING
D.4.1.2 - QED PASSIVE SKIMMERS
D.4.1.3 - SOS- 4P SKIMMER

## 1.0 DESIGN ASSUMPTIONS

The following design assumptions are made based upon the computations of TPH volumes provided in Appendix C and on the information for other similar projects for the skimming of light non-aqueous product layer (LNAPL):

- The Zone 1 area of LNAPL accumulation is located in the vicinity of monitoring well 13MW18 and covers an estimated surface area of 9,920 square feet (sf) with a thickness of 3 feet (9 to 12 ft bgs) and a volume of 29,760 cubic feet (cf).
- The area of LNAPL accumulation holds an estimated 29,588 lbs (or 3,938 gallons) of LNAPL.
- The LNAPL can be effectively removed over time by passive skimmers installed in strategically located wells.
- The average radius of influence (ROI) of each skimming well is approximately 10 feet.

## 2.0 SKIMMING WELLS SYSTEM (ALTERNATIVE LN-1)

Area of influence of each skimming well: $(10\ ft)^2 * \pi = 314$ sf

The Zone 1 area of LNAPL accumulation has a surface area of 9,920 $ft^2$ (see Appendix C)

Number of skimming wells: (9,920 sf / 314 sf/skimming well) * 1.15 overlap factor = 36.3, say 37 wells

However, 9 of these wells fall within the footprint of a large UST (see attached Figure 4-41). Therefore, the operational number of skimming wells would be 28.

6-inch diameter skimming wells would be installed to a depth of 15 ft bgs and screened from 5 to 15 ft bgs.

Passive skimmers as described in attached literature would be installed in each well. Use 4-inch QED Model SOS-4P/3000

Assume each passive skimmer can collect approximately 2/3 of a gallon of LNAPL.

Assume frequency of LNAPL collection from skimmers is weekly during Year 1, semi-monthly for Years 2 to 5, and monthly thereafter.

Year 1 LNAPL collection: 28 skimmers * 2/3 gal LNAPL/skimmer * 52 weeks/yr = 971 gal
Years 2 to 5 LNAPL collection: 28 * 2/3 * 24 = 448 gal/yr * 4 = 1,792 gal
Year 6 and after LNAPL collection: 28 * 2/3 * 12 = 224 gal/yr

Estimated timeframe for complete LNAPL removal:

5 years + {[3,938 - (971 + 1,792)] remaining gal of LNAPL / 224 gal/yr} = 5 + 5.2 = 10.2 say 10 yrs

Starting Year 11 assume collection of residual LNAPL at the rate of 10 gal/month or 120 gal/yr

**Attachments**

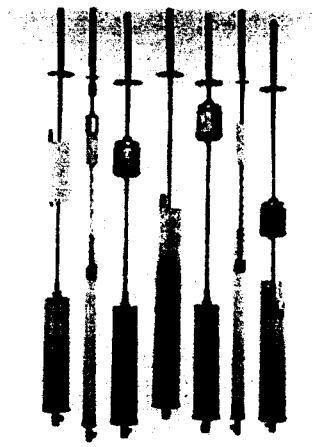
Figure 4-41: Zone 1 Area of LNAPL Accumulation & Skimming Wells Locations
QED passive skimmers literature

QED
Environmental Systems
Global (734) 995-2547
Toll-Free (800) 624-2026
Fax (734) 995-1170



# Passive Skimmers

*Recover The Free-Phase Hydrocarbon (LNAPL) Without Pumps*



The QED family of Passive Skimmers has been designed for product only (LNAPL) recovery applications in sites where active pumping systems are not applicable due to existing conditions or extreme low permeable formations. The Passive Skimmers collect and store the hydrocarbon in a built-in reservoir for further manual transfer to a tank.

Passive Skimmers are available for 2" (50mm) and 4" (100mm) extraction wells, with different reservoir capacities.

Passive Skimmers are available in two different models: **SOS-P** (Passive Selective Oil Skimmer), and **SPG-P** (Passive Specific Gravity Skimmer).

The Floating Intake Head follows the groundwater fluctuations in the recovery well, allowing only the free-floating phase (LNAPL) to be captured, without taking water, and stored in the built-in reservoir.

## Choosing the Right Passive Skimmer

Specific Gravity and Viscosity are two of the most important properties of the hydrocarbons (LNAPL) as far as their mobility in the subsurface. At the same time that these parameters affect the migration of the plume, they also play a very important role in the selection of the right skimmer for the cleanup application.

| | **SOS Skimmers** | **SPG Skimmers** |
|---|---|---|
| Inlet Type | Hydrophobic-Oileophilic Selective Membrane | Intake screen on top floating head |
| Models | SOS-2 for 2" (50mm) ID wells or larger<br>SOS-4 for 4"(100mm) ID wells or larger | SPG-2 for 2" (50mm) ID wells or larger<br>SPG-4 for 4"(100mm) ID wells or larger |
| LNAPL Specific Gravity (SG) | < 1.0 g/cm3 | ≤ 0.85 g/cm3 |
| Kinematic Viscosity @ 50°F (10°C) | 1 - 200 cSt | 1 - 1000 cSt |
| LNAPL Lens Thickness after skimming | ≤ 0.01 in (0.25mm) | 0.8 - 3.0 in (20 - 75mm) |
| Recommended Lens Thickness prior to Skimming | > 0.01 in (0.25mm) | > 3 in (75mm) |

## How the SOS Passive Skimmers Work

The SOS Selective Oil Skimmer is lowered into the recovery well until the midpoint of the skimmer's travel is located at the fluid level in the well and then the skimmer's support rope is secured at the surface.

The skimmer has a floating intake head that follows the groundwater fluctuations. The LNAPL first enters the skimmer through the floating intake's outer debris screen and then an inner oileophilic hydrophobic screen, down through a flexible tube to the product reservoir at the bottom of the skimmer.

## SOS-P Specifications

| **SOS-2P Model for 2" (50mm) ID Wells or Larger** | **SOS-2P/300** | **SOS-2P/450** | **SOS-2P/600** | **SOS-2P/900** |
|---|---|---|---|---|
| Part Number | **301077** | **301076** | **301079** | **301080** |

| | | | | |
|---|---|---|---|---|
| Minimum Fluid Depth Required | 25.5in (65cm) | 31.5in (80cm) | 38.5in (98cm) | 50.5in (128cm) |
| Effective Skimming Travel | 13.5in (34cm) | 13.5in (34cm) | 13.5in (34cm) | 13.5in (34cm) |
| ,ister Capacity | 10 fl.oz (300ml) | 15 fl.oz (450ml) | 20 fl.oz (600ml) | 30 fl.oz (900ml) |
| Total Length | 51.5in (131cm) | 58.5in (149cm) | 65in (165cm) | 76.5in (194cm) |
| Outside Diameter | 1.9in (48.2mm) | 1.9in (48.2mm) | 1.9in (48.2mm) | 1.9in (48.2mm) |
| Weight | 7 lb (3.2Kg) | 7 lb (3.2Kg) | 8 lb (3.6Kg) | 10 lb (4.5Kg) |

SOS-2P CAD drawings

| **SOS-4P Model for 4" (100mm) ID Wells or Larger** | **SOS-4P/1400** | **SOS-4P/2000** | **SOS-4P/3000** | **SOS-4P/6000** |
|---|---|---|---|---|
| Part Number | **301030** | **301031** | **301032** | **301033** |
| Minimum Fluid Depth Required | 24.5in (63cm) | 28.5in (73cm) | 37.3in (95cm) | 54in (138cm) |
| Effective Skimming Travel | 18in (46cm) | 18in (46cm) | 18in (46cm) | 18in (46cm) |
| Canister Capacity | 47 fl.oz (1400ml) | 65 fl.oz (2000ml) | 100 fl.oz (3000ml) | 200 fl.oz (6000ml) |
| Total Length | 56in (142cm) | 60in (152cm) | 69.5in (177cm) | 85.5in (217cm) |
| Outside Diameter | 3.8in (96.5mm) | 3.8in (96.5mm) | 3.8in (96.5mm) | 3.8in (96.5mm) |
| Weight | 8 lb (3.6Kg) | 9 lb (4.0Kg) | 10 lb (4.5Kg) | 16 lb (7.2Kg) |

SOS-4P CAD drawings

**Materials of Construction:**

,inless Steel, Viton, Closed Cell Foam, Brass, Delrin, PVC and other engineering plastics.

# How the SPG Passive Skimmers Work

The SPG Specific Gravity Skimmer is lowered into the recovery well until the midpoint of the skimmer's travel is located at the fluid level in the well and then the skimmer's support rope is secured at the surface.

The skimmer has a floating intake head that follows the groundwater fluctuations. Hydrocarbon first enters the skimmer through the floating intake head's product intake, down through a flexible tube to the product reservoir at the bottom of the skimmer.

# SPG-P Specifications

| **SPG-2P Model for 2" (50mm) ID Wells or Larger** | **SPG-2P/300** | **SPG-2P/450** | **SPG-2P/600** | **SPG-2P/900** |
|---|---|---|---|---|
| Part Number | **301073** | **301074** | **301075** | **307076** |
| Minimum Fluid Depth Required | 25in (64cm) | 31in (79cm) | 38.3in (98cm) | 50.3in (128cm) |
| Effective Skimming Travel | 15in (38cm) | 15in (38cm) | 15in (38cm) | 15in (38cm) |
| Canister Capacity | 10 fl.oz (300ml) | 15 fl.oz (450ml) | 20 fl.oz (600ml) | 30 fl.oz (900ml) |
| Total Length | 49.5in (126cm) | 55.5in (141cm) | 62.5in (159cm) | 74.5in (189cm) |
| Outside Diameter | 1.9in (48.2mm) | 1.9in (48.2mm) | 1.9in (48.2mm) | 1.9in (48.2mm) |
| Weight | 7 lb (3.2Kg) | 7 lb (3.2Kg) | 8 lb (3.6Kg) | 10 lb (4.5Kg) |

SPG-2P CAD drawings

| **SPG-4P Model for 4" (100mm) ID Wells or Larger** | **SPG-4P/1400** | **SPG-4P/2000** | **SPG-4P/3000** | **SPG-4P/6000** |
|---|---|---|---|---|

| Part Number | **301000** | **301031** | **301032** | **301033** |
|---|---|---|---|---|
| Minimum Fluid Depth Required | 24.5in (63cm) | 33.3in (85cm) | 42.8in (109cm) | 59.5in (151cm) |
| Effective Skimming Travel | 15in (38cm) | 15in (38cm) | 15in (38cm) | 15in (38cm) |
| Canister Capacity | 47 fl.oz (1400ml) | 65 fl.oz (2000ml) | 100 fl.oz (3000ml) | 200 fl.oz (6000ml) |
| Total Length | 56in (142cm) | 59in (150cm) | 69in (176cm) | 85in (216cm) |
| Outside Diameter | 3.8in (96.5mm) | 3.8in (96.5mm) | 3.8in (96.5mm) | 3.8in (96.5mm) |
| Weight | 8 lb (3.6Kg) | 9 lb (4.0Kg) | 11 lb (5.0Kg) | 15 lb (6.8Kg) |

SPG-4P CAD drawings

**Materials of Construction:**

Stainless Steel, Viton, Polypropylene, Brass, Delrin, PTFE, PVC and other engineering plastics.

Print Friendly Version

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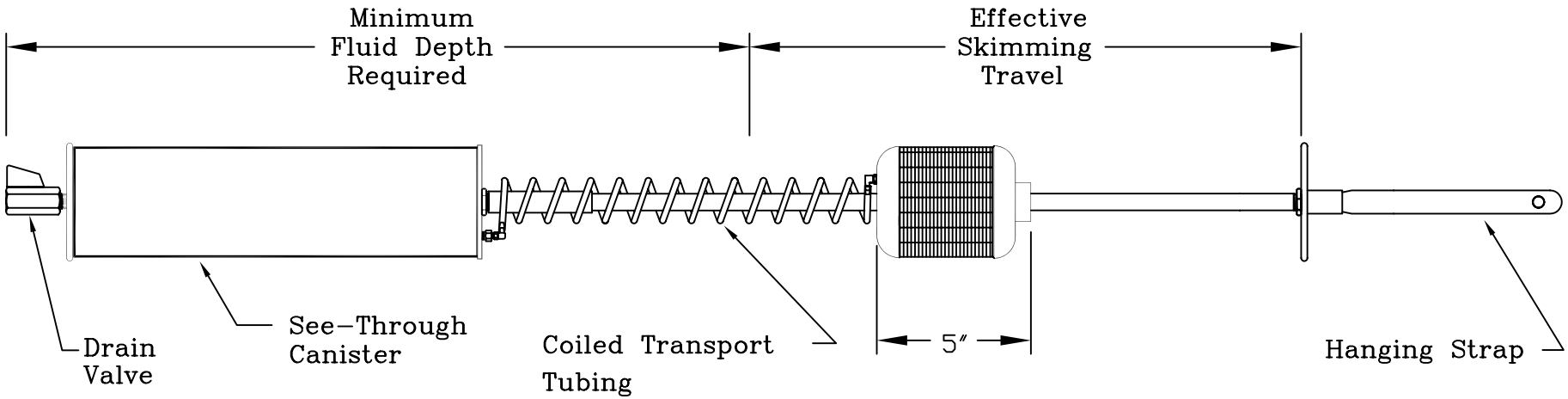


| PART # | 301030 | 301031 | 301032 | 301033 |
|---|---|---|---|---|
| SPECIFICATIONS | SOS–4P/1400 | SOS–4P/2000 | SOS–4P/3000 | SOS–4P/6000 * |
| Minimum Fluid Depth Required | 24.5” (63 cm) | 28.5 ” (73 cm) | 37.3” (95 cm) | 54” (138 cm) |
| Effective Skimming Travel | 18” (46 cm) | 18” (46 cm) | 18” (46 cm) | 18” (46 cm) |
| Canister Capacity | 1400 cc (47 fl oz) | 2000 cc (65 fl oz) | 3000 cc (100 fl oz) | 6000 cc (200 fl oz) |
| Canister Length | 14.5” (37 cm) | 18” (46 cm) | 27” (69 cm) | 44” (112 cm) |
| Total Length | 56” (142 cm) | 60” (152 cm) | 69.5” (177 cm) | 85.5” (217 cm) |
| Outside Diameter | 3.8” (10 cm) | 3.8” (10 cm) | 3.8” (10 cm) | 3.8” (10 cm) |
| Weight | 8 lbs (3.6 kg) | 9 lbs (4 kg) | 10 lbs (4.5 kg) | 16 lbs (7.2 kg) |

**NOTE:**

- Optional canister lengths and float ranges available.
- Hand Pump Upgrade Option available. (Adaptor part No. 300756)
- Active Upgrade Option Available which allows for fully automatic hydrocarbon recovery. (Adaptor part No. 300031)

* All Canisters are clear PVC except model 6000, which is 304 S.S.


Clean Environment Equipment
EQUIPMENT FOR GROUNDWATER REMEDIATION
AND LEACHATE EXTRACTION
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OAKLAND, CA 94607
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| TOLERANCES UNLESS OTHERWISE SPECIFIED ANGULAR ± .30° FRAC ± .XX ±.01 .XXX ± .005 .XXXX ±.0005 | APPROVALS | DATE | TITLE SOS-4P |
|---|---|---|---|
| | DRAWN TONY RAMIREZ | 4-15-93 | |
| | DATA COLLECTED A. L. / T. R. | 3-28-96 | DWG No. 600019 REV 06 |
| MATERIAL | CHECKED R. WEBB/MLF/RL | 4-4-96 | |
| FINISH | APPROVED MIKE K. BRESLIN | 4-5-96 | SCALE NONE SHT OF |

4–Inch Passive Selective Oil Skimmer

SOS–4P

# APPENDIX D.4.2

# IN-SITU BIOREMEDIATION

D.4.2.1 - LNAPL IN-SITU BIOREMEDIATION
D.4.2.2 - ETEC PROPOSAL FOR ZONE 1 LNAPL
D.4.2.3 - ECOLOGIX OIL WATER SEPARATORS

## 1.0 DESIGN ASSUMPTIONS

The following design assumptions are made based upon the computations of TPH volumes provided in Appendix C and on the information for other similar projects for the in-situ enhanced bioremediation of total petroleum hydrocarbons (TPH) in soil and groundwater:

- The Zone 1 area of light non-aqueous product layer (LNAPL) accumulation is located in the vicinity of monitoring well 13MW18 and covers a surface area of approximately 9,920 square feet (sf) with a thickness of 3 feet (9 to 12 ft bgs) and a volume of 29,760 cubic feet (cf).
- The area of LNAPL accumulation holds an estimated 29,588 lbs (or 3,938 gallons) of LNAPL and 91,699 lbs of soil-bound TPH.
- The TPH in the LNAPL and the soil-bound TPH can be effectively biodegraded under aerobic conditions with the help of injection of dissolved and gaseous oxygen and specialized bacterial cultures into these contaminant plumes by means of a groundwater recycle stream (extraction/re-injection).
- The Dissolved Oxygen In situ Treatment (DO-IT™) technology marketed by ETEC, LLC has been tentatively selected as the process of choice. Attached technical literature provides more information about this process.
- The 3,938 gallons of LNAPL would be mechanically removed from the subsurface by the groundwater recirculation process and separated in an oil/water separator installed in the recirculation loop.

## 2.0 DO-IT™ SYSTEM (ALTERNATIVE LN-2) (see attached ETEC proposal)

Oxygen requirement:
91,699 lbs TPH * 3.0 lbs $O_2$/lb TPH = 275,097 lbs $O_2$

As per attached ETEC proposal, the proposed SuperOx™ Model 20A system can deliver approximately 325 lbs/month of dissolved $O_2$, 1,584 lbs/month of supplemental gaseous $O_2$, and 1,000 lbs/month of CBN™ nutrient blend with an electron acceptor/oxygen equivalency of 61%.

Total proposed oxygen/electron acceptor delivery:
325 + 1,584 + (1,000 x 0.61) = 2,519 lbs/month

Anticipated remediation time:
275,097 lbs / 2,519 lbs/month = 109.2 months, say 9 years

## 3.0 ADDITIONAL EQUIPMENT

In addition to the SuperOx™ units, each DO-IT™ system would require the following:

- Six (6) 4-inch diameter extraction wells installed along the downgradient edge of the area of LNAPL accumulation and screened in the capillary zone (9 to 12 ft bgs).
- Six (6) 5 gpm submersible pumps installed in the extraction wells.
- One (1) 20 gpm Oil/Water Separator
- Twelve (12) 4-inch diameter re-injection wells installed along the upgradient edge of the area of LNAPL accumulation and screened in the vadose zone (5 ft bgs).

- Interconnecrting piping (1½-inch PVC or PE) between the extraction wells, the SuperOx™ unit, and the re-injection wells (approximately 600 ft).

**Attachments**:

ETEC, LLC technical literature
ETEC, LLC proposal
Ecologix Oil/Water Separators literature

6635 N.E. 59th Place
Portland, Oregon 97218
(971) 222-3580 • (971) 222-3903 Fax
www.etecllc.com

October 30th, 2009

Mr. Jean-Luc Glorieux
Tetra Tech NUS, Inc.
Pittsburgh, PA

**RE: PROPOSAL FOR DISSOLVED OXYGEN IN SITU TREATMENT (DO-IT™) SUB-BASE LNAPL ZONE – GROTON, CONNECTICUT**

Dear Jean-Luc,

This quote includes budgetary costs for biological product enhancement and recommendations for application to impacted soil/groundwater. Based on the information provided by Tetra Tech, our understanding of the site includes the following:

- A diesel and #2 fuel oil leak from an UST/AST impact the soil and groundwater onsite
- Significant free product exists onsite (~3,938 gallons), as well as smear-zone soil contamination (~91,000 lbs. TPH)
- Soil at 13MW18 contained 51,600 mg/kg TPH (6 inches free-product) historically
- Soil at GS-32L contained 26,800 mg/kg TPH historically
- Soil at 13MW3 is contained 11,000 mg/kg TPH historically
- Soil at GS-29L is contained 14,900 mg/kg TPH historically
- Soil at 13MW8 is contained 4,900 mg/kg TPH historically
- The proposed treatment area is approximately 9,920 square feet
- DTW is approximately 6-9 feet bgs
- The soil onsite is primarily gravel and sand
- The treatment area is influenced by tidal action
- A consistent 20+ gpm extraction rate is assumed
- This proposal is based on the use of a 20-gpm DO-IT™ system for treatment of the GW and smear-zone soils

This data and the associated assumptions were used to determine appropriate biological product and equipment requirements, and to provide recommendations for site-specific application.

## DO-IT™ Process Description

Our DO-IT™ process is a complete bioremediation system that uses proprietary biological products in combination with a specialized in situ oxygenation equipment platform to obtain rapid reduction of diesel, fuel oil, and gasoline contaminants. It is our philosophy to add all of the components necessary for successful bioremediation, including enzymes, bacteria, nutrients, and an abundant supply of dissolved oxygen. To maximize oxygen supply, we utilize an oxygenation approach that differs from standard methods (air sparging, $O_2$ sparging, etc.). Our Super-Ox™ oxygenation units process water through a specialized pure-oxygen mixing system to generate greater than 40 ppm dissolved oxygen concentrations in a water stream. This oxygenated water stream is then injected into the subsurface to support high rates of microbial activity.

The DO-IT™ process works best in a closed-loop system, where groundwater is extracted, oxygenated, biologically-amended, and then re-injected into the subsurface. The recirculation of oxygenated water allows us to deliver daily DO masses ranging from 1 lb. per day to as much as 20 lbs. per day – this is order-of-magnitude higher masses of DO than any other oxygenation system available. For example, with a 10-gpm recirculation rate, the DO-IT™ system will deliver approximately ***5 pounds of dissolved oxygen*** to the subsurface ***per day***, or close to ***200 lbs. of dissolved oxygen per month***!!

**Equipment Recommendations**

For equipment, we recommend the Super-Ox™ Model 20-Automatic (20-A) for this site. This system will receive water (from the extraction system), oxygenate it to >40 ppm of dissolved oxygen, amend it with nutrients and bacteria, then re-inject into the subsurface. The 20-A system will be equipped with a 6-station injection manifold; each station will connect to one or more of the installed injection wells. The 20-A system is capable of a maximum process rate of 20 gallons per minute (gpm) that can be adjusted to match the extraction rate, if desired. These systems generate stable, high concentrations of dissolved oxygen (>40 ppm) in the process water using our unique pure oxygen mixing system. The 20-A equipment enclosure has an 8' x 12' (typically, varies upon unit availability) footprint, is fully weatherproof, contains double doors for walk-in access to all equipment, and includes a heating and fan system to control internal temperatures. The Model 20-A is an automated, programmable, turnkey bioremediation system requiring 1-phase, 220 Volt (4-wire), 80 Amp power service for operation.

Additional info and specifications for this system is available at www.etecllc.com. ***Since we rent the Super-Ox™ equipment, we supply replacement parts (at no cost) for damaged equipment (pumps, valves, etc.) on the Super-Ox™ system throughout the rental period.***

**Product Recommendations**

For biological products at this site, we recommend our TPH Bacterial Consortium (EZT-A2™) and PetroSolv™ biosurfactant. Our CBN™ nutrient blend will be also be needed. These products work together to effectively degrade diesel and fuel oil.

The application of the biological products will perform three critical functions, including:

1. Supply of a large population of pre-acclimated bacteria to optimize initial growth of a healthy, in situ, hydrocarbon-degrading microbial population.
2. Maximizing contact between the contaminants and the bacteria. Bioremediation is a contact technology – the bacteria must physically contact the diesel and fuel oil food source and the electron acceptors (oxygen, nitrate, sulfate) to biochemically oxidize the petroleum to $CO_2$ and water.
3. Supplying critical nutrients like nitrogen, phosphorus, and potassium to support ongoing biological growth. The nitrogen compounds will also act as a secondary electron acceptor to ensure continuous in situ contaminant degradation during temporary absences of dissolved oxygen.

**Site Application**

The DO-IT™ technology is a very effective soil and groundwater treatment system, especially when utilized in a closed-loop remediation process. Advantages to this approach include hydraulic control of the leading plume edge, treatment of both dissolved and adsorbed contamination, and maximized contact between the treatment water and the contaminants. Biological enhancements are efficiently distributed, allowing for smaller mixing volumes, and therefore less onsite time and labor than slug injections.

By utilizing a series of injection points/wells in combination with extraction wells, artificial groundwater gradients can be produced within the on-site plume to induce cycling of biologically-active treatment water through the plume zone. The general approach includes the following:

1. Install a series of 4-inch extraction wells (6-8 wells) along the northeast and southeast edge of Building #29. These wells will provide process water for the DO-IT™ system. Installation of the wells in this area will provide hydraulic capture of migrating groundwater, collect free-product,

and encourage movement of the oxygenated treatment water throughout the site. The biosurfactant product applied will enhance diesel/fuel oil dissolution and mobilization. Top-loading pneumatic pumps should be utilized to capture migrating free-product.

2. Following extraction, the groundwater should be processed through a oil/water separator to collect free-product. Additional treatment of groundwater prior to re-injection can be achieved by activated carbon.
3. Install a series of 4-inch vertical injection wells (10-15) throughout the upgradient area of the site. These wells should be screened above the groundwater interface to allow for application to the upper smear-zone soils. The trenching connecting the DO-IT™ system to the injection wells can also have a horizontal injection piping installed in the same trench. Oxygenated treatment water applied to this trench will percolate through the vadose soils into the upper impacted smear-zone soils.

**Electron Acceptor Mass Balance**

Tetra Tech estimates that 91,000 lbs. of TPH resides in the soil within the LNAPL treatment area, and another 3,900 gallons of free-product is present. This estimated TPH mass is significant, and a large supply of electron acceptor mass will be necessary to biologically degrade enough of the TPH mass to achieve regulatory groundwater goals of 2.5 mg/L. Using a solely biological degradation approach, the ability to deliver the necessary electron acceptor mass become the limiting factor. ETEC has designed the DO-IT™ system to deliver as much dissolved oxygen and secondary electron acceptors as possible to overcome this limitation.

91,000 lbs. TPH (soil) + 3,900 gallons product * ~7 lb./gallon = 118,000 lbs. of TPH present

Utilizing a 3:1 ratio of 3 lbs. of oxygen necessary to degrade 1 lb. of TPH, the required oxygen mass is:

3 lbs. oxygen * 118,000 lbs. TPH = **354,000 lbs. oxygen**

**Electron Acceptor Delivery**

Oxygen delivery at the site will be dependent upon the extraction/injection rate achievable at the site. With a consistent extraction/injection rate, the Super-Ox™ Model 20-A should inject more than 28,800 gallons of oxygenated water each day (~20-gpm), or more than 864,000 gallons per month. The calculation below outlines the dissolved oxygen delivery of the Super-Ox™ equipment per month.

864,000 gal./month * 3.79 L/gal. = 3,275,000 L/month

3,275,000 L/month * >45 mg/L DO / 454,000 mg/1 lb. = **>325 lbs. DO/month**

As part of the dissolved oxygen mixing process, more oxygen gas must be supplied than can be dissolved into the water stream. This oxygen gas is carried with the water stream to the injection wells where it is transferred to the groundwater.

$\frac{PV}{RT}$ = moles $O_2$ P = 2.72 atm V = 283 L $O_2$/hour
R = 0.08206 L*atm/mol*K T = 298 K

(2.72 atm * 283 L $O_2$) / (0.08206 L*atm/mol*K * 298 K) = 31.5 moles $O_2$ / hour

31.5 moles $O_2$/hour * 32 g/mol $O_2$ = 1,008 g $O_2$/hour

1,008 g $O_2$/hour / 454 g/lb. = 2.2 lbs. $O_2$/hour * 24 hours/day = 52.8 lbs. $O_2$/day

52.8 lbs. $O_2$/day * 30 days/month = **1,584 lbs. $O_2$/month**

In addition to the oxygen mass delivered by the DO-IT™ system, a large mass of secondary electron acceptors will also need to be supplied to overcome the electron acceptor limiting conditions. Our CBN™ nutrient blend contains ~60% electron acceptors. For this site we would recommend 2,000 lbs. be applied initially (1,200 lbs. of electron acceptors) and approximately 1,000 lbs. per month (600 lbs. of electron acceptors). This combination application of oxygen and secondary electron acceptors will maximize the electron acceptor delivery to the site. In a 24-month treatment, the DO-IT™ system will have applied more than 51,400 lbs. of electron acceptors to the site.

In comparison to a chemical based oxygen-release product which contains at most 17% oxygen, in order to deliver the same 51,400 lbs. of electron acceptors, over 300,000 lbs. would need to be applied to the site. At $8/lb, this represents a cost of $2,400,000. Also, the application of a solely oxygen releasing product would not address nitrogen, phosphorus, and micro-nutrient limiting conditions that will certainly inhibit the microbial activity at the site.

With either application, to rely solely on biological degradation to remediate the mass of TPH onsite will be difficult. That is why incorporating physical removal of the free-product and contaminated groundwater into the treatment will be important. The DO-IT™ system is designed to work with a pump & treat system to enhance free-product recovery using groundwater recirculation and biosurfactants to increase contaminant mobility. We have been successful at sites with significant free-product using this method (see attached case study).

## Monitoring Discussion

For the treatment, we recommend Tetra Tech collect field data as well as nutrient and plate count data. Tetra Tech can collect the field data (temperature, pH, DO, ORP, etc.) with their in-house meters, and analysis costs for a limited-nutrient suite and a hydrocarbon-degrading plate count are $140.00 per GW sample. Samples should be collected from the most impacted wells (13MW18, GS-32L, and GS-29L). This data will be used to evaluate the effectiveness of the treatment activities, and will provide information on how to maximize efficiency.

**Cost Estimate (System Rental)**

The table below summarizes biological product, equipment rental, analytical, and shipping costs.

| Item | Cost |
|---|---|
| ***Initial Costs*** | |
| A2™ Bacterial Consortium – Initial Supply (50 gallons) | $5,000.00 |
| PetroSolv™ Biosurfactant – Initial Supply (100 gallons) | $10,000.00 |
| CBN™ Nutrients – Initial Supply (2,000 lbs.) | $5,000.00 |
| Super-Ox™ 20-A – Monthly Rental | $5,000.00 |
| Nutrient & Plate Count Analysis (3 samples @ $140 per sample) | $420.00 |
| Installation, Set-up, and Training (5-days) | $5,000.00 |
| Shipping (estimated) | $6,000.00 |
| **INITIAL COST** | **$36,420.00** |
| ***Monthly Costs*** | |
| A2™ Bacterial Consortium – Initial Supply (25 gallons) | $2,500.00 |
| PetroSolv™ Biosurfactant – Initial Supply (50 gallons) | $5,000.00 |
| CBN™ Nutrients – Total Supply (1,000 lbs.) | $2,500.00 |
| Super-Ox™ 20-A – Monthly Rental | $5,000.00 |
| Nutrient & Plate Count Analysis (3 samples @ $140 per sample) | $420.00 |
| Shipping (estimated) | $900.00 |
| **MONTHLY COST** | **$16,320.00** |
| **24-MONTH TREATMENT TOTAL** | **$411,780.00** |
| ***Final Costs*** | |
| Return Shipment | **$3,500.00** |
| | |
| ***Out-of-Scope Costs*** | |
| Well Installation | **???** |
| Trenching, piping | **???** |
| Pneumatic pumps, compressor, panel | **???** |
| Oil/water separator, activated carbon | **???** |
| Electrical | **???** |

We believe that a 24-month biological enhancement program will reduce free-product and contaminant concentrations in the groundwater onsite. Due to the large mass of free-product and adsorbed contaminants, additional ongoing treatment may be necessary. After a 24-month treatment, it may be more cost-effective to purchase the unit rather than continue leasing the system. The cost table below contains an option for purchase of the 20-A equipment system. Ongoing biological product application will be necessary to achieve the desired results.

**Cost Estimate (System Purchase)**

The table below summarizes biological product, equipment purchase, analytical, and shipping costs.

| Item | Cost |
|---|---|
| ***Initial Costs*** | |
| A2™ Bacterial Consortium – Initial Supply (50 gallons) | $5,000.00 |
| PetroSolv™ Biosurfactant – Initial Supply (100 gallons) | $10,000.00 |
| CBN™ Nutrients – Total Supply (2,000 lbs.) | $5,000.00 |
| Super-Ox™ 20-A – Purchase | $150,000.00 |
| Nutrient & Plate Count Analysis (3 samples @ $140 per sample) | $420.00 |
| Installation, Set-up, and Training (5-days) | $5,000.00 |
| Onsite Maintenance Visits (4 in 2 years) | $20,000.00 |
| Data Interpretation / Support (2 years) | $5,000.00 |
| Shipping (estimated) | $6,000.00 |
| **INITIAL COST** | **$206,420.00** |
| ***Monthly Costs*** | |
| A2™ Bacterial Consortium – Initial Supply (25 gallons) | $2,500.00 |
| PetroSolv™ Biosurfactant – Initial Supply (50 gallons) | $5,000.00 |
| CBN™ Nutrients – Total Supply (1,000 lbs.) | $2,500.00 |
| Nutrient & Plate Count Analysis (3 samples @ $140 per sample) | $420.00 |
| Shipping (estimated) | $900.00 |
| **MONTHLY COST** | **$11,320.00** |
| **24-MONTH TREATMENT TOTAL** | **$466,780.00** |
| ***Ongoing Yearly Support*** | |
| 2 Onsite Maintenance Visits | **$10,000.00** |
| Data Interpretation / Support | **$2,500.00** |
| **ONGOING YEARLY COSTS** | **$148,340.00** |
| | |
| ***Out-of-Scope Costs*** | |
| Well Installation | **???** |
| Trenching, piping | **???** |
| Pneumatic pumps, compressor, panel | **???** |
| Oil/water separator, activated carbon | **???** |
| Electrical | **???** |

This is a budgetary proposal, and is for use in determining the feasibility of treatment at the site. This proposal will need to be revisited during the writing of the RAP when more data is available. Payment terms and conditions will need to be agreed upon at that time. Please review the summarized costs and call me at 971-222-3680 with any questions or comments. Thank you for the opportunity, and we look forward to further discussion with you on this project.

Respectfully,

**ETEC, LLC**

_____

Eric Bueltel
Project Manager

# Ecologix Environmental Systems

Air & Water Treatment Solutions • (888) 326-2020 / (678) 514-2100

**Oil Water Separators** > Above Ground Oil Water Separators (ECOS)

Oil water separators are systems used as an efficient method to separate oils and some solids from a variety of wastewater discharges. They are typically installed in industrial and maintenance areas and receive oily wastewater. Our line of above ground oil water separators will assist in the removal of large quantities of free oil from your wastewater before any further treatment step you may have in your process. We have above ground oil water separators with flow rates ranging from 2 to 70 gallons per minute and capacities up to over 1000 gallons

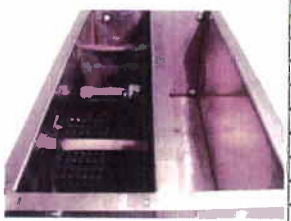
**Related product links**

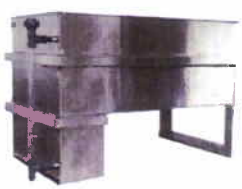
AFD-55 | AHP-55 Series | BORS Marine Grade | HQB Below Ground Separator| MCM830 | MCM830P | OWS General Specs | Clarifier/Separator | Inclined Plate Clarifiers | Hopper Separator | ECOS O & M Manual (all models) | OilFree Polymeric Filtering | HD-Q Pac Media | COD - OrganoClay to the rescue.PDF | Example Photos

**Best of Class - Just 1ppm Oil Effluent**

**Features & Benefits**

- Stainless Steel construction
- No chemicals, absorbent, or filter cartridges to remove, replace, or dispose of.
- Compact size
- Solids storage
- Optional integral oil storage
- Low maintenance cost
- Easily cleaned through the removable vapor tight cover(s)
- No moving parts
- No power consumption
- No consumable wearing elements
- Meets EPA Method 413.2 and European Standard EN 858-1
- Self cleaning and anti-plugging properties
- Very high surface area - 132 ft² per 1ft³
- 99.99% removal of free and dispersed oil, 40 micron size or larger
- High flow rates





ECOS - Oil Water Separators (Flow rates based on oil at 0.9 specific gravity)

| Model Number | Description | Flow Rate GPM | Dimensions | Capacity Gallons |
|---|---|---|---|---|
| AGS-1SS | Flat Bottom | 2 - 5 | 16"W X 28"H X 52"L | 60 |
| AGS-1SS-30V | W / Sump | 2 - 5 | 16"W X48"H X 52"L | 75 |
| AGS-1SS-HP | W / Sludge Hopper | 2 - 5 | 16"W X 48"H X 52"L | 75 |
| AGS-1SS-30V-HP | W / Sump & Sludge Hopper | 2 - 5 | 16"W X 48"H X 52"L | 82 |
| AGS-2SS | Flat Bottom | 3 - 10 | 28"W X 28"H X 52"L | 120 |
| AGS-2SS-60V | W / Sump | 3 - 10 | 28"W X 48"H X 52"L | 174 |
| AGS-2SS-HP | W / Sludge Hopper | 3 - 10 | 28"W X 48"H X 52"L | 134 |
| AGS-2SS-60V-HP | W / Sump & Sludge Hopper | 3 - 10 | 28"W X 48"H X 52"L | 188 |
| AGS-3SS | Flat Bottom | 5 - 15 | 40"W X 28"H X 52"L | 180 |
| AGS-3SS-90V | W / Sump | 5 - 15 | 40"W X 28"H X 52"L | 270 |
| AGS-3SS-HP | W/ Sludge Hopper | 5 - 15 | 40"W X 48"H X 52"L | 200 |
| AGS-3SS-90V-HP | W / Sump & Sludge Hopper | 5 - 15 | 40"W X 48"H X 52"L | 360 |
| AGM-1SS | Flat Bottom | 3 - 10 | 16"W X 28"H X 64"L | 75 |
| AGM-1SS-30V | W / Sump | 3 - 10 | 16"W X 48"H X 64"L | 105 |
| AGM-1SS-HP | W / Sludge Hopper | 3 - 10 | 16"W X 48"H X 64"L | 89 |
| AGM-1SS-30V-HP | W / Sump & Sludge Hopper | 3 - 10 | 16"W X 48"H X 64"L | 119 |
| AGM-2SS | Flat Bottom | 6 - 20 | 28"W X 28"H X 64"L | 150 |
| AGM-2SS-60V | W / Sump | 6 - 20 | 28"W X 48"H X 64"L | 195 |
| AGM-2SS-HP | W/ Sludge Hopper | 6 - 20 | 28"W X 48"H X 64"L | 178 |
| AGM-2SS-60V-HP | W / Sump & Sludge Hopper | 6 - 20 | 28"W X 48"H X 64"L | 223 |
| AGM-3SS | Flat Bottom | 9 - 30 | 40"W X 28"H X 64"L | 225 |
| AGM-3SS-90V | W / Sump | 9 - 30 | 40"W X 48"H X 64"L | 279 |
| AGM-3SS-HP | W / Sludge Hopper | 9 - 30 | 40"W X 48"H X 64"L | 267 |
| AGM-3SS-90V-HP | W / Sump & Sludge Hopper | 9 - 30 | 40"W X 48"H X 64"L | 321 |
| AGM-1SS-1H | Flat Bottom | 6 - 20 | 16"W X 40"H X 64"L | 86 |
| AGM-1SS-36V-1H | W / Sump | 6 - 20 | 16"W X 60"H X 64"L | 142 |
| AGM-1SS-HP-1H | W / Sludge Hopper | 6 - 20 | 16"W X 60"H X 64"L | 96 |
| AGM-1SS-36V-HP-1H | W / Sump & Sludge Hopper | 6 - 20 | 16"W X 60"H X 64"L | 152 |
| AGM-2SS-1H | Flat Bottom | 12 - 40 | 28"W X 40"H X 64"L | 172 |
| AGM-2SS-73V-1H | W / Sump | 12 - 40 | 28"W X 60"H X 64"L | 217 |
| AGM-2SS-HP-1H | W / Sludge Hopper | 12 - 40 | 28"W X 48"H X 64"L | 194 |
| AGM-2SS-73V-HP-1H | W / Sump & Sludge Hopper | 12 - 40 | 24"W X 58"H X 64"L | 239 |
| AGM-3SS1H | Flat Bottom | 18 - 60 | 40"W X 40"H X 64"L | 258 |
| AGM-3SS-118V-1H | W / Sump | 18 - 60 | 40"W X 60"H X 64"L | 325 |
| AGM-3SS-HP-1H | W / Sludge Hopper | 18 - 60 | 40"W X 60"H X 64"L | 290 |
| AGM-3SS-118V-HP-1H | W / Sump & Sludge Hopper | 18 - 60 | 40"W X 60"H X 64"L | 357 |
| AG-1SS | Flat Bottom | 9 - 30 | 16"W X 40"H X 88"L | 157 |
| AG-1SS-38V | W / Sump | 9 - 30 | 16"W X 60"H X 88"L | 172 |
| AG-1SS-HP | W / Sludge Hopper | 9 - 30 | 16"W X 60"H X 88"L | 185 |
| AG-1SS-38V-HP | W / Sump & Sludge Hopper | 9 - 30 | 16"W X 60"H X 88"L | 200 |
| AG-2SS | Flat Bottom | 18 - 60 | 28"W X 40"H X 88"L | 314 |
| AG-2SS-75V | W / Sump | 18 - 60 | 28"W X 60"H X 88"L | 340 |
| AG-2SS-HP | W / Sludge Hopper | 18 - 60 | 28"W X 60"H X 88"L | 343 |
| AG-2SS-75V-HP | W / Sump & Sludge Hopper | 18 - 60 | 28"W X 60"H X 88"L | 369 |
| AG-3SS | Flat Bottom | 27 - 90 | 40"W X 40"H X 88"L | 471 |
| AG-3SS-113V | W / Sump | 27 - 90 | 40"W X 60"H X 88"L | 540 |
| AG-3SS-HP | W / Sludge Hopper | 27 - 90 | 40"W X 60"H X 88"L | 550 |
| AG-3SS-113V-HP | W / Sump & Sludge Hopper | 27 - 90 | 40"W X 60"H X 88"L | 619 |

| | | | | |
|---|---|---|---|---|
| AG-4SS | Flat Bottom | 36 - 120 | 52"W X 40"H X 88"L | 628 |
| AG-4SS-150V | W / Sump | 36 - 120 | 52"W X 60"H X 88"L | 680 |
| AG-4SS-HP | W / Sludge Hopper | 36 - 120 | 52"W X 60"H X 88"L | 750 |
| AG-4SS-150V-HP | W / Sump & Sludge Hopper | 36 - 120 | 52"W X 60"H X 88"L | 802 |
| AG-4SS-1H | Flat Bottom | 60 - 170 | 52"W X 52"H X 88"L | 840 |
| AG-4SS-240V-1H | W / Sump | 60 - 170 | 52"W X 72"H X 88"L | 900 |
| AG-4SS-1H-HP | W / Sludge Hopper | 60 - 170 | 52"W X 72"H X 88"L | 960 |
| AG-4SS-240V-HP-1H | W / Sump & Sludge Hopper | 60 - 170 | 64"W X 72"H X 88"L | 1010 |

**Design**
The Ecologix Oil Separators (ECOS) are designed to exceed your expectations. We start off by collecting the best possible information concerning the wastewater influent characteristics, operation and maintenance of the equipment, and the effluent requirements to be met. We take into consideration the flow rate (pumped or gravity), fluid temperature range, density and viscosity, oil droplet size and distribution, and the specified discharge requirements. Our design meets or exceeds the guidelines of API-421 and ASTM-D19.31 11 4

Ecologix oil/water separators use parallel corrugated plate technology that causes oil droplets to increase in size, thereby speeding the gravity separation process according to Stokes' Law. We offer a unique inclined plate design design, called HD Q-PAC, with an internal structure of interconnecting plates having many crossing points between adjacent plates; as the oil water mixture flows through the separator, new droplets coalesce with retained droplets to form larger droplets. The enlarged droplets are released, and they rise to the surface where they decant from the separator. Since the Stokes' Law calculations presume a zero velocity flow through the HD Q-PAC Plates, a Reynold's Number less than 500 will ensure optimum separation in the oil water separator.Ecologix offers Oil/Water Separators for separation treatment of groundwater from free phase LNAPL and DNAPL contaminants.

## Operation Specifications

**Fabrication**
The oil water separator is a special purpose prefabricated parallel corrugated plate, rectangular, gravity displacement, type oil water separator. The separator shall be comprised of a tank containing an inlet compartment, separation chamber, sludge chamber, and clean water outlet chamber.

**Tank**
The tank shall be a single wall construction conforming to ASTM A240, type 304 stainless steel. Welding will be in accordance with AWS D1.1 to provide a watertight tank that will not warp or deform under load. Pipe connections to the exterior shall be as follows:

**Pipe Connections**
All connections 3" and smaller are FNPT couplings. All connections 4" and larger are flat face flanges with ANSI 150 pound standard bolt circle. Use flanged piping connections that conform to ANSI B16.5.

**Separator Corrosion Protection (for carbon steel only)**
After shop hydrostatic test has been successfully completed, a coating system will be applied to the interior and exterior surfaces of the separator. Interior and exterior shall be sandblasted to SSPC-SP10 & SSPC-SP6; Interior lined with Tnemec Series 61 liner to 9 mils MDFT; Exterior coated with polyamide epoxy to 6 mils MDFT.

**Lifting Lugs**
The tank shall be provided with properly sized lifting lugs for handling and installation.

**Covers**
The tank will be provided with a vapor tight covers for vapor control. Gas vents and suitable access openings to each compartment will be provided. The covers shall be constructed of the same material as the tank and will be fastened in place. A gasket shall be provided for vapor tightness. 304 SS Latches will be provided for cover attachment

**Inlet Compartment**
The inlet chamber shall be comprised of a non-clog diffuser to distribute the flow across the width of the separation chamber. The inlet compartment shall be of sufficient volume to effectively reduce influent suspended solids, dissipate energy and begin separation. The media will sit elevated on top of a sludge baffle. The sludge baffle will be provided to retain settleble solids and sediment from entering the separation chamber.

**Separation Chamber**
The oil separation chamber shall contain HD Q-PAC Coalescing Media containing a minimum of 132 square feet per cubic foot of effective coalescing surface area. The medias needle like elements (plates) shall be at 90 degrees to the horizontal or longitudinal axis of the separator. Spacing between these elements shall be spaced 3/16" apart for the removal of a minimum of 99.9% of free droplets 40 micron in size or greater. The elements are positioned to create an angle of repose of 90 degrees to facilitate the removal of solids that may tend to build up on the coalescing surfaces, which would increase velocities to the point of discharging an unacceptable design flow rate shall be maintained throughout the separator packed bed including entrance and exit so as to prevent re-entrainment of oils with water. Flow through the polypropylene coalescing media shall be crossflow perpendicular to the vertical media elements such that all 132 square feet/cubic foot of coalescing media surfaces shall be pointing upwards so as not to be available for contact with the crossflowing oily water. The media shall have a minimum void of 87% void volume to facilitate sludge and dirt particles as they fall off the vertical elements and settle in the sludge compartment. The media when installed in crossflow OWS shall meet US EPA Method 413.2 and also European Standard 858-1 for oil water separators.

**Baffles**
An oil retention & underflow weir, and overflow weir. Position underflow weir to prevent re-suspension of settled solids.

**Sludge Chamber**
The sludge chamber shall be located prior to the coalescing compartment for the settling of any solids. It shall also prevent any solids from entering the clean water chamber. (Larger amounts of solids can be collected in a sludge hopper as an option.)

**Oil Skimmer**
The oil separation chamber will be provided with a rotatable pipe skimmer for gravity decanting of the separated oil to an integral product storage tank or an external product storage tank.

**Clean Water Chamber**
The tank will be provided with a clean water chamber which allows the water to leave the separator by pumped / gravity flow through the clean water outlet port

**Vents**
1" vents will be provided with vent piping to atmosphere.

# APPENDIX E

# REMEDIAL ALTERNATIVES COST ESTIMATES


E.1 - SOIL ALTERNATIVES COST ESTIMATES

E.2 - GROUNDWATER ALTERNATIVES COST ESTIMATES

E.3 - SEDIMENT ALTERNATIVES COST ESTIMATES

E.4 - LNAPL ALTERNATIVES COST ESTIMATES

# APPENDIX E.1

# SOIL ALTERNATIVES COST ESTIMATES

**E.1.1 – ZONE 1**

**E.1.2 – ZONE 2**

**E.1.3 – ZONE 3**

**E.1.4 – ZONE 4**

**E.1.5 – ZONE 5**

**E.1.6 – ZONE 6**

**E.1.7 – ZONE 7**

# APPENDIX E.1.1

# ZONE 1

# ALTERNATIVES S-1.1, S-1.2, S-1.3, S-1.4, and S-1.5

**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-1.1: NO ACTION**
**Annual Cost**

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| Item | Item Cost every 5 years | Notes |
|---|---|---|
| Five-Year Review | $23,000 | |
| Subtotal | $23,000 | |
| Contingency @ 10% | $2,300 | |
| **TOTAL** | **$25,300** | |

**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-1.1: NO ACTION**
**Present Worth Analysis**



| Year | Capital Cost | Annual Cost | Total Year Cost | Annual Discount Rate at 7% | Present Worth |
|---|---|---|---|---|---|
| 0 | $0 | | $0 | 1.000 | $0 |
| 1 | | | $0 | 0.935 | $0 |
| 2 | | | $0 | 0.873 | $0 |
| 3 | | | $0 | 0.816 | $0 |
| 4 | | | $0 | 0.763 | $0 |
| 5 | | $25,300 | $25,300 | 0.713 | $18,039 |
| 6 | | | $0 | 0.666 | $0 |
| 7 | | | $0 | 0.623 | $0 |
| 8 | | | $0 | 0.582 | $0 |
| 9 | | | $0 | 0.544 | $0 |
| 10 | | $25,300 | $25,300 | 0.508 | $12,852 |
| 11 | | | $0 | 0.475 | $0 |
| 12 | | | $0 | 0.444 | $0 |
| 13 | | | $0 | 0.415 | $0 |
| 14 | | | $0 | 0.388 | $0 |
| 15 | | $25,300 | $25,300 | 0.362 | $9,159 |
| 16 | | | $0 | 0.339 | $0 |
| 17 | | | $0 | 0.317 | $0 |
| 18 | | | $0 | 0.296 | $0 |
| 19 | | | $0 | 0.277 | $0 |
| 20 | | $25,300 | $25,300 | 0.258 | $6,527 |
| 21 | | | $0 | 0.242 | $0 |
| 22 | | | $0 | 0.226 | $0 |
| 23 | | | $0 | 0.211 | $0 |
| 24 | | | $0 | 0.197 | $0 |
| 25 | | $25,300 | $25,300 | 0.184 | $4,655 |
| 26 | | | $0 | 0.172 | $0 |
| 27 | | | $0 | 0.161 | $0 |
| 28 | | | $0 | 0.150 | $0 |
| 29 | | | $0 | 0.141 | $0 |
| 30 | | $25,300 | $25,300 | 0.131 | $3,314 |
| | | | | **TOTAL PRESENT WORTH** | **$54,547** |

**ZONE 1, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-1.2: LUCs and Monitoring**
**CAPITAL COST**

| Item | Quantity | Unit | Unit Cost | | | | Extended Cost | | | | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Subcontract | Material | Labor | Equipment | Subcontract | Material | Labor | Equipment | |
| **1 PROJECT PLANNING** | | | | | | | | | | | |
| 1.1 Prepare Documents & Plans including Permits/Variances | 140 | hr | | | $35.00 | | $0 | $0 | $4,900 | $0 | $4,900 |
| 1.2 Prepare LUC RD Documents | 60 | hr | | | $35.00 | | $0 | $0 | $2,100 | $0 | $2,100 |
| **2 PRE-DESIGN INVESTIGATION** | | | | | | | | | | | |
| 2.1 Field Personnel - prep, field, and follow-up | 3 | days | | | $350.00 | | $0 | $0 | $1,050 | $0 | $1,050 |
| 2.2 Travel & Mob | 1 | ls | $1,100.00 | | | | $1,100 | $0 | $0 | $0 | $1,100 |
| 2.3 Geoprobe - Equipment and Operator | 2 | day | $2,400.00 | | | | $4,800 | $0 | $0 | $0 | $4,800 |
| 2.4 Supplies & PID | 2 | day | $600.00 | | | | $1,200 | $0 | $0 | $0 | $1,200 |
| 2.5 Soil Sample Analysis (SPLP Lead, ETPH, PAHs ) | 1 | ls | $6,830.00 | | | | $6,830 | $0 | $0 | $0 | $6,830 |
| 2.6 Evaluate Data, Prepare Report, and Upload to NIRIS | 1 | ea | $32,000.00 | | | | $32,000 | $0 | $0 | $0 | $32,000 |
| **3 FIELD SUPPORT** | | | | | | | | | | | |
| 3.1 Construction Survey Support | 1 | day | $1,050.00 | | | | $1,050 | $0 | $0 | $0 | $1,050 |
| **Subtotal** | | | | | | | $46,980 | $0 | $8,050 | $0 | $55,030 |
| **Local Area Adjustments** | | | | | | | 100.0% | 98.6% | 104.2% | 104.2% | |
| | | | | | | | $46,980 | $0 | $8,388 | $0 | $55,368 |
| Overhead on Labor Cost @ 30% | | | | | | | | | $2,516 | | $2,516 |
| G & A on Labor Cost @ 10% | | | | | | | | | $839 | | $839 |
| G & A on Material Cost @ 10% | | | | | | | | $0 | | | $0 |
| G & A on Subcontract Cost @ 10% | | | | | | | $4,698 | | | | $4,698 |
| G & A on Equipment Cost @ 10% | | | | | | | | | | $0 | $0 |
| **Total Direct Cost** | | | | | | | $51,678 | $0 | $11,743 | $0 | $63,421 |
| Indirects on Total Direct Cost @ 0% | | | | | | | | | | | $0 |
| Profit on Total Direct Cost @ 10% | | | | | | | | | | | $6,342 |
| **Subtotal** | | | | | | | | | | | $69,763 |
| Health & Safety Monitoring @ 0% | | | | | | | | | | | $0 |
| **Total Field Cost** | | | | | | | | | | | $69,763 |
| Contingency on Total Field Costs @ 0% | | | | | | | | | | | $0 |
| Engineering on Total Field Cost @ 0% | | | | | | | | | | | $0 |
| **TOTAL COST** | | | | | | | | | | | **$69,763** |

**ZONE 1, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-1.2: LUCs and Monitoring**
**ANNUAL COST**

| Item | Item Cost Years 1 & 2 | Item Cost Years 3 & 4 | Item Cost Years 5 through 30 | Item Cost Annually | Item Cost Every 5 Years | Notes |
|---|---|---|---|---|---|---|
| Pavement Maintenance | | | | $10,425 | | Repave 10% of contaminated areas yearly. |
| Groundwater Sampling | $22,272 | $11,136 | $5,568 | | | 4 Wells. Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Labor and supplies for sampling |
| Groundwater Analysis | $3,360 | $1,680 | $840 | | | 4 wells, Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Analysis for PAHs. |
| Groundwater Report | $5,000 | $5,000 | $5,000 | | | |
| Inspection | | | | $1,000 | | Annual LUC inspection |
| Site Review | | | | | $23,000 | 5-year review |
| Subtotal | $30,632 | $17,816 | $11,408 | $11,425 | $23,000 | |
| Contingency at 10% | $3,063 | $1,782 | $1,141 | $1,142 | $2,300 | |
| **TOTAL** | $33,695 | $19,598 | $12,549 | $12,567 | $25,300 | |

**ZONE 1, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-1.2: LUCs and Monitoring**
**PRESENT WORTH ANALYSIS**

| Year | Capital Cost | Annual Cost | Total Year Cost | Annual Discount Rate at 7% | Present Worth |
|---|---|---|---|---|---|
| 0 | $69,763 | | $69,763 | 1.000 | $69,763 |
| 1 | | $46,262 | $46,262 | 0.935 | $43,255 |
| 2 | | $46,262 | $46,262 | 0.873 | $40,387 |
| 3 | | $32,165 | $32,165 | 0.816 | $26,247 |
| 4 | | $32,165 | $32,165 | 0.763 | $24,542 |
| 5 | | $50,416 | $50,416 | 0.713 | $35,947 |
| 6 | | $25,116 | $25,116 | 0.666 | $16,727 |
| 7 | | $25,116 | $25,116 | 0.623 | $15,647 |
| 8 | | $25,116 | $25,116 | 0.582 | $14,618 |
| 9 | | $25,116 | $25,116 | 0.544 | $13,663 |
| 10 | | $50,416 | $50,416 | 0.508 | $25,611 |
| 11 | | $25,116 | $25,116 | 0.475 | $11,930 |
| 12 | | $25,116 | $25,116 | 0.444 | $11,152 |
| 13 | | $25,116 | $25,116 | 0.415 | $10,423 |
| 14 | | $25,116 | $25,116 | 0.388 | $9,745 |
| 15 | | $50,416 | $50,416 | 0.362 | $18,251 |
| 16 | | $25,116 | $25,116 | 0.339 | $8,514 |
| 17 | | $25,116 | $25,116 | 0.317 | $7,962 |
| 18 | | $25,116 | $25,116 | 0.296 | $7,434 |
| 19 | | $25,116 | $25,116 | 0.277 | $6,957 |
| 20 | | $50,416 | $50,416 | 0.258 | $13,007 |
| 21 | | $25,116 | $25,116 | 0.242 | $6,078 |
| 22 | | $25,116 | $25,116 | 0.226 | $5,676 |
| 23 | | $25,116 | $25,116 | 0.211 | $5,299 |
| 24 | | $25,116 | $25,116 | 0.197 | $4,948 |
| 25 | | $50,416 | $50,416 | 0.184 | $9,277 |
| 26 | | $25,116 | $25,116 | 0.172 | $4,320 |
| 27 | | $25,116 | $25,116 | 0.161 | $4,044 |
| 28 | | $25,116 | $25,116 | 0.150 | $3,767 |
| 29 | | $25,116 | $25,116 | 0.141 | $3,541 |
| 30 | | $50,416 | $50,416 | 0.131 | $6,605 |
| | | | | **TOTAL PRESENT WORTH** | **$485,338** |

**ZONE 1, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-1.3 IN SITU TREATMENT (ENHANCED BIOREMEDIATION) TO MEET I/C DECs AND PMCs, LUCs, AND MONITORING**
**Capital Cost**

| | | | | Unit Cost | | | Extended Cost | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Item | Quantity | Unit | Subcontract | Material | Labor | Equipment | Subcontract | Material | Labor | Equipment | Subtotal |
| **1 PROJECT PLANNING** | | | | | | | | | | | |
| 1.1 Prepare LUC RD Documents | 60 | hr | | | $35.00 | | $0 | $0 | $2,100 | $0 | $2,100 |
| 1.2 Prepare Documents & Plans including Permits | 150 | hr | | | $35.00 | | $0 | $0 | $5,250 | $0 | $5,250 |
| **2 PRE-DESIGN INVESTIGATION** | | | | | | | | | | | |
| 2.1 Field Personnel - prep, field, and follow-up | 3.0 | days | | | $350.00 | | $0 | $0 | $1,050 | $0 | $1,050 |
| 2.2 Travel & Mob | 1 | ls | $1,100.00 | | | | $1,100 | $0 | $0 | $0 | $1,100 |
| 2.3 Geoprobe - Equipment and Operator | 2 | day | $2,400.00 | | | | $4,800 | $0 | $0 | $0 | $4,800 |
| 2.4 Supplies & PID | 2 | day | $600.00 | | | | $1,200 | $0 | $0 | $0 | $1,200 |
| 2.5 Soil Sample Analysis (SPLP Lead, ETPH, PAHs ) | 1 | ls | $6,830.00 | | | | $6,830 | $0 | $0 | $0 | $6,830 |
| 2.6 Evaluate Data, Prepare Report, and Upload to NIRIS | 1 | ea | $32,000.00 | | | | $32,000 | $0 | $0 | $0 | $32,000 |
| **3 MOBILIZATION, DEMOBILIZATION AND FIELD SUPPORT** | | | | | | | | | | | |
| 3.1 Storage Trailer (1) | 1 | mo | | | | $99.00 | $0 | $0 | $0 | $99 | $99 |
| 3.2 Underground Utility Clearances | 1 | ls | $3,500.00 | | | | $3,500 | $0 | $0 | $0 | $3,500 |
| 3.3 Construction Survey | 1 | day | $2,125.00 | | | | $2,125 | $0 | $0 | $0 | $2,125 |
| 3.4 Large Diameter Auger Mobilization/Demobilization | 1 | ea | $100,000.00 | | | | $100,000 | $0 | $0 | $0 | $100,000 |
| 3.5 Backhoe Mobilization/Demobilization | 2 | ea | | | $85.00 | $261.00 | $0 | $0 | $170 | $522 | $692 |
| 3.6 Temporary Fencing | 1 | ls | | $500.00 | | | $0 | $500 | $0 | $0 | $500 |
| 3.7 Field Construction Mgt. (1 person) | 15 | day | | $200.00 | $350.00 | | $0 | $3,000 | $5,250 | $0 | $8,250 |
| 3.8 Site Health & Safety and QA/QC | 15 | day | | $200.00 | $325.00 | | $0 | $3,000 | $4,875 | $0 | $7,875 |
| **4 IN-SITU TREATMENT** | | | | | | | | | | | |
| 4.1 Pavement Removal | 3,689 | sy | | $2.22 | $1.63 | $3.85 | $0 | $8,189 | $6,013 | $14,202 | $28,404 |
| 4.2 Off Site Transportation & Recycling, Asphalt | 461 | tons | $19.50 | | | | $8,991 | $0 | $0 | $0 | $8,991 |
| 4.3 Treatability Test | 1 | ls | $20,000.00 | | | | $20,000 | $0 | $0 | $0 | $20,000 |
| 4.4 Utility Relocation - Steam Lines | 1 | ls | $75,000.00 | | | | $75,000 | $0 | $0 | $0 | $75,000 |
| 4.5 Auger - Deep Soil Mixing | 1,067 | cy | $50.00 | | | | $53,350 | $0 | $0 | $0 | $53,350 |
| 4.6 Backhoe - Shallow Soil Mixing | 2,037 | cy | $35.00 | | | | $71,296 | $0 | $0 | $0 | $71,296 |
| 4.7 ORC | 5,380 | lb | $9.00 | | | | $48,420 | $0 | $0 | $0 | $48,420 |
| **5 BACKFILL AND SITE RESTORATION** | | | | | | | | | | | |
| 5.1 Asphalt, 2" Binder, 1" Topping, Small Areas | 33,200 | sf | | $1.03 | $0.24 | $0.30 | $0 | $34,196 | $7,968 | $9,960 | $52,124 |
| **6 POST CONSTRUCTION COST** | | | | | | | | | | | |
| 6.1 Contractor Completion Report | 60 | hr | | | $35.00 | | $0 | $0 | $2,100 | $0 | $2,100 |
| 6.2 Remedial Action Closeout Report | 60 | hr | | | $35.00 | | $0 | $0 | $2,100 | $0 | $2,100 |
| **Subtotal** | | | | | | | $428,613 | $48,885 | $36,876 | $24,783 | $539,157 |
| **Local Area Adjustments** | | | | | | | 100.0% | 98.6% | 104.2% | 104.2% | |
| **Subtotal** | | | | | | | $428,613 | $48,201 | $38,425 | $25,824 | $541,062 |
| Overhead on Labor Cost @ 30% | | | | | | | | | $11,527 | | $11,527 |
| G & A on Labor Cost @ 10% | | | | | | | | | $3,842 | | $3,842 |
| G & A on Material Cost @ 10% | | | | | | | | $4,820 | | | $4,820 |
| G & A on Equipment Cost @ 10% | | | | | | | | | | $2,582 | $2,582 |
| G & A on Subcontract Cost @ 10% | | | | | | | $42,861 | | | | $42,861 |
| Tax on Materials and Equipment Cost @ 6% | | | | | | | | $2,892 | | $1,549 | $4,442 |
| **Total Direct Cost** | | | | | | | $471,474 | $55,913 | $53,795 | $29,956 | $611,138 |
| Indirects on Total Direct Cost @ 30% | | | (excluding transportation and disposal cost) | | | | | | | | $180,644 |
| Profit on Total Direct Cost @ 10% | | | | | | | | | | | $61,114 |

**ZONE 1, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-1.3 IN SITU TREATMENT (ENHANCED BIOREMEDIATION) TO MEET I/C DECs AND PMCs, LUCs, AND MONITORING**
**Capital Cost**

| | | | Unit Cost | | | | Extended Cost | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Item | Quantity | Unit | Subcontract | Material | Labor | Equipment | Subcontract | Material | Labor | Equipment | Subtotal |
| **Subtotal** | | | | | | | | | | | $852,895 |
| Health & Safety Monitoring @ | 3% | (includes air quality monitoring) | | | | | | | | | $25,587 |
| **Total Field Cost** | | | | | | | | | | | $878,482 |
| Contingency on Total Field Costs @ | 20% | | | | | | | | | | $175,696 |
| Engineering on Total Field Cost @ | 15% | | | | | | | | | | $131,772 |
| **TOTAL CAPITAL COST** | | | | | | | | | | | **$1,185,951** |

**ZONE 1, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-1.3 IN SITU TREATMENT (ENHANCED BIOREMEDIATION) TO MEET I/C DECs AND PMCs, LUCs, AND MONITORING**
**ANNUAL COST**

| Item | Item Cost Year 1 | Item Cost Years 1 & 2 | Item Cost Years 3 & 4 | Item Cost Years 5 through 30 | Item Cost Annually | Item Cost Every 5 Years | Notes |
|---|---|---|---|---|---|---|---|
| Soil Sampling | $3,462 | | | | | | 7 locations at Year 1. One day geoprobe plus labor to sample. |
| Soil Analysis | $1,470 | | | | | | 7 locations. Analysis for PAHs. |
| Pavement Maintenance | | | | | $10,425 | | Repave 10% of contaminated areas yearly. |
| Groundwater Sampling | | $22,272 | $11,136 | $5,568 | | | 4 Wells. Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Labor and supplies for sampling |
| Groundwater Analysis | | $3,360 | $1,680 | $840 | | | 4 wells, Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Analysis for PAHs. |
| Groundwater Report | | $5,000 | $5,000 | $5,000 | | | |
| Inspection | | | | | $1,000 | | Annual LUC inspection |
| Site Review | | | | | | $23,000 | 5-year review |
| Subtotal | $4,932 | $30,632 | $17,816 | $11,408 | $11,425 | $23,000 | |
| Contingency at 10% | $493 | $3,063 | $1,782 | $1,141 | $1,142 | $2,300 | |
| **TOTAL** | $5,425 | $33,695 | $19,598 | $12,549 | $12,567 | $25,300 | |

**ZONE 1, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**

**ALTERNATIVE S-1.3 IN SITU TREATMENT (ENHANCED BIOREMEDIATION) TO MEET I/C DECs AND PMCs, LUCs, AND MONITORING**

**PRESENT WORTH ANALYSIS**

| Year | Capital Cost | Annual Cost | Total Year Cost | Annual Discount Rate at 7% | Present Worth |
|---|---|---|---|---|---|
| 0 | $1,185,951 | | $1,185,951 | 1.000 | $1,185,951 |
| 1 | | $51,688 | $51,688 | 0.935 | $48,328 |
| 2 | | $46,262 | $46,262 | 0.873 | $40,387 |
| 3 | | $32,165 | $32,165 | 0.816 | $26,247 |
| 4 | | $32,165 | $32,165 | 0.763 | $24,542 |
| 5 | | $50,416 | $50,416 | 0.713 | $35,947 |
| 6 | | $25,116 | $25,116 | 0.666 | $16,727 |
| 7 | | $25,116 | $25,116 | 0.623 | $15,647 |
| 8 | | $25,116 | $25,116 | 0.582 | $14,618 |
| 9 | | $25,116 | $25,116 | 0.544 | $13,663 |
| 10 | | $50,416 | $50,416 | 0.508 | $25,611 |
| 11 | | $25,116 | $25,116 | 0.475 | $11,930 |
| 12 | | $25,116 | $25,116 | 0.444 | $11,152 |
| 13 | | $25,116 | $25,116 | 0.415 | $10,423 |
| 14 | | $25,116 | $25,116 | 0.388 | $9,745 |
| 15 | | $50,416 | $50,416 | 0.362 | $18,251 |
| 16 | | $25,116 | $25,116 | 0.339 | $8,514 |
| 17 | | $25,116 | $25,116 | 0.317 | $7,962 |
| 18 | | $25,116 | $25,116 | 0.296 | $7,434 |
| 19 | | $25,116 | $25,116 | 0.277 | $6,957 |
| 20 | | $50,416 | $50,416 | 0.258 | $13,007 |
| 21 | | $25,116 | $25,116 | 0.242 | $6,078 |
| 22 | | $25,116 | $25,116 | 0.226 | $5,676 |
| 23 | | $25,116 | $25,116 | 0.211 | $5,299 |
| 24 | | $25,116 | $25,116 | 0.197 | $4,948 |
| 25 | | $50,416 | $50,416 | 0.184 | $9,277 |
| 26 | | $25,116 | $25,116 | 0.172 | $4,320 |
| 27 | | $25,116 | $25,116 | 0.161 | $4,044 |
| 28 | | $25,116 | $25,116 | 0.150 | $3,767 |
| 29 | | $25,116 | $25,116 | 0.141 | $3,541 |
| 30 | | $50,416 | $50,416 | 0.131 | $6,605 |
| | | | | **TOTAL PRESENT WORTH** | **$1,606,598** |

**ZONE 1, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-1.4 EXCAVATION TO MEET I/C DECs AND PMCs, OFF-SITE TREATMENT (LTTD) AND DISPOSAL (LANDFILLING), LUCs, AND MONITORING**
**Capital Cost**

| | | | | Unit Cost | | | Extended Cost | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Item | Quantity | Unit | Subcontract | Material | Labor | Equipment | Subcontract | Material | Labor | Equipment | Subtotal |
| **1 PROJECT PLANNING** | | | | | | | | | | | |
| 1.1 Prepare LUC RD Documents | 60 | hr | | | $35.00 | | $0 | $0 | $2,100 | $0 | $2,100 |
| 1.2 Prepare Documents & Plans including Permits | 150 | hr | | | $35.00 | | $0 | $0 | $5,250 | $0 | $5,250 |
| **2 PRE-DESIGN INVESTIGATION** | | | | | | | | | | | |
| 2.1 Field Personnel - prep, field, and follow-up | 3.0 | days | | | $350.00 | | $0 | $0 | $1,050 | $0 | $1,050 |
| 2.2 Travel & Mob | 1 | ls | $1,100.00 | | | | $1,100 | $0 | $0 | $0 | $1,100 |
| 2.3 Geoprobe - Equipment and Operator | 2 | day | $2,400.00 | | | | $4,800 | $0 | $0 | $0 | $4,800 |
| 2.4 Supplies & PID | 2 | day | $600.00 | | | | $1,200 | $0 | $0 | $0 | $1,200 |
| 2.5 Soil Sample Analysis (SPLP Lead, ETPH, PAHs ) | 1 | ls | $6,830.00 | | | | $6,830 | $0 | $0 | $0 | $6,830 |
| 2.6 Evaluate Data, Prepare Report, and Upload to NIRIS | 1 | ea | $32,000.00 | | | | $32,000 | $0 | $0 | $0 | $32,000 |
| **3 MOBILIZATION, DEMOBILIZATION AND FIELD SUPPORT** | | | | | | | | | | | |
| 3.1 Office Trailer | 1.5 | mo | | $375.00 | | | $0 | $563 | $0 | $0 | $563 |
| 3.2 Field Office Support | 1.5 | mo | | $240.00 | | | $0 | $360 | $0 | $0 | $360 |
| 3.3 Utility Connection/Disconnection (phone/electric) | 1 | ls | $1,500.00 | | | | $1,500 | $0 | $0 | $0 | $1,500 |
| 3.4 Site Utilities | 1.5 | mo | | $230.00 | | | $0 | $345 | $0 | $0 | $345 |
| 3.5 Underground Utility Clearances | 1 | ls | $1,500.00 | | | | $1,500 | $0 | $0 | $0 | $1,500 |
| 3.6 Construction Survey Support | 2 | day | $1,050.00 | | | | $2,100 | $0 | $0 | $0 | $2,100 |
| 3.7 Equipment Mobilization/Demobilization, 70 to 150 HP | 6 | ea | | | $64.00 | $117.00 | $0 | $0 | $384 | $702 | $1,086 |
| 3.8 Site Superintendent | 44 | day | | | $355.00 | | $0 | $0 | $15,620 | $0 | $15,620 |
| 3.9 Site Health & Safety and QA/QC | 44 | day | | | $325.00 | | $0 | $0 | $14,300 | $0 | $14,300 |
| 3.10 Materials Storage Pad, 25' X 25' | 625 | sf | | $3.64 | $0.74 | $1.09 | $0 | $2,275 | $463 | $681 | $3,419 |
| **4 DECONTAMINATION** | | | | | | | | | | | |
| 4.1 Decontamination Services | 1.5 | mo | | | | $5,045.46 | $0 | $0 | $0 | $7,568 | $7,568 |
| 4.2 Equipment Decon Pad | 1.5 | ls | | $1,750.00 | $1,500.00 | $425.00 | $0 | $2,625 | $2,250 | $638 | $5,513 |
| 4.3 Decon Water | 1,500.0 | gal | | $0.20 | | | $0 | $300 | $0 | $0 | $300 |
| 4.4 Decon Water Storage Tank, 6,000 gallon | 1.5 | mo | | | | $784.24 | $0 | $0 | $0 | $1,176 | $1,176 |
| 4.5 Clean Water Storage Tank, 4,000 gallon | 1.5 | mo | | | | $705.22 | $0 | $0 | $0 | $1,058 | $1,058 |
| 4.6 Disposal of Decon Waste (liquid & solid) | 1.5 | mo | $950.00 | | | | $1,425 | $0 | $0 | $0 | $1,425 |
| **5 EXCAVATION AND DISPOSAL** | | | | | | | | | | | |
| 5.1 Pavement Removal, bituminous driveways | 3,689 | sy | | $2.22 | $1.63 | $3.85 | $0 | $8,189 | $6,013 | $14,202 | $28,404 |
| 5.2 Excavator, 1/2 cy Capacity | 1.5 | mo | | | $13,050.40 | $7,087.20 | $0 | $0 | $19,576 | $10,631 | $30,206 |
| 5.3 Site Labor, (1 laborer) | 1.5 | mo | | | $5,561.60 | | $0 | $0 | $8,342 | $0 | $8,342 |
| 5.4 Tractor Loader 1 to 1-1/4 cy | 1.5 | mo | | | $10,058.40 | $4,383.00 | $0 | $0 | $15,088 | $6,575 | $21,662 |
| 5.5 Characterization/Offsite Disposal Soil Testing | 28 | ea | $210.00 | $10.00 | | | $5,880 | $280 | $0 | $0 | $6,160 |
| 5.6 Confirmation Testing - PAHs, Rapid Turn | 17 | ea | $420.00 | | | | $7,140 | $0 | $0 | $0 | $7,140 |
| 5.7 Off Site Transportation & Disposal, High PAHs | 4,194 | tons | $100.00 | | | | $419,400 | $0 | $0 | $0 | $419,400 |
| 5.8 Off Site Transportation & Recycling, Asphalt | 461 | tons | $19.50 | | | | $8,991 | $0 | $0 | $0 | $8,991 |
| **6 BACKFILL AND SITE RESTORATION** | | | | | | | | | | | |
| 6.1 Clean Backfill | 2,796 | cy | | $8.00 | | | $0 | $22,368 | $0 | $0 | $22,368 |
| 6.2 Tractor Loader 1 to 1-1/4 cy | 1 | wk | | | $2,286.00 | $1,195.00 | $0 | $0 | $2,286 | $1,195 | $3,481 |
| 6.3 Vibrating Roller, 2-Drum, 7.5 HP, 1/2 time Operator | 1 | wk | | | $1,143.00 | $613.00 | $0 | $0 | $1,143 | $613 | $1,756 |
| 6.4 Vibratory Plate, 1/2 time Operator | 1 | wk | | | $632.00 | $114.00 | $0 | $0 | $632 | $114 | $746 |
| 6.5 Asphalt, 2" Binder, 1" Topping, Small Areas | 33,200 | sf | | $1.03 | $0.24 | $0.30 | $0 | $34,196 | $7,968 | $9,960 | $52,124 |
| **7 POST CONSTRUCTION COST** | | | | | | | | | | | |
| 7.1 Contractor Completion Report | 40 | hr | | | $35.00 | | $0 | $0 | $1,400 | $0 | $1,400 |
| 7.2 Remedial Action Closeout Report | 40 | hr | | | $35.00 | | $0 | $0 | $1,400 | $0 | $1,400 |
| **Subtotal** | | | | | | | $493,866 | $71,501 | $105,264 | $55,113 | $725,744 |
| **Local Area Adjustments** | | | | | | | 100.0% | 98.6% | 104.2% | 104.2% | |

**ZONE 1, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-1.4 EXCAVATION TO MEET I/C DECs AND PMCs, OFF-SITE TREATMENT (LTTD) AND DISPOSAL (LANDFILLING), LUCs, AND MONITORING**
**Capital Cost**

| Item | Quantity | Unit | Unit Cost Subcontract | Unit Cost Material | Unit Cost Labor | Unit Cost Equipment | Extended Cost Subcontract | Extended Cost Material | Extended Cost Labor | Extended Cost Equipment | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Subtotal** | | | | | | | $493,866 | $70,500 | $109,685 | $57,427 | $731,479 |
| Overhead on Labor Cost @ | 30% | | | | | | | | $32,906 | | $32,906 |
| G & A on Labor Cost @ | 10% | | | | | | | | $10,969 | | $10,969 |
| G & A on Material Cost @ | 10% | | | | | | | $7,050 | | | $7,050 |
| G & A on Equipment Cost @ | 10% | | | | | | | | | $5,743 | $5,743 |
| G & A on Subcontract Cost @ | 10% | | | | | | $49,387 | | | | $49,387 |
| Tax on Materials and Equipment Cost @ | 6% | | | | | | | $4,230 | | $3,446 | $7,676 |
| **Total Direct Cost** | | | | | | | $543,253 | $81,780 | $153,559 | $66,616 | $845,208 |
| Indirects on Total Direct Cost @ | 30% | (excluding transportation and disposal cost) | | | | | | | | | $124,617 |
| Profit on Total Direct Cost @ | 10% | | | | | | | | | | $84,521 |
| **Subtotal** | | | | | | | | | | | $1,054,346 |
| Health & Safety Monitoring @ | 3% | (includes air quality monitoring) | | | | | | | | | $31,630 |
| **Total Field Cost** | | | | | | | | | | | $1,085,976 |
| Contingency on Total Field Costs @ | 20% | | | | | | | | | | $217,195 |
| Engineering on Total Field Cost @ | 10% | | | | | | | | | | $108,598 |
| **TOTAL CAPITAL COST** | | | | | | | | | | | **$1,411,769** |

**ZONE 1, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-1.4 EXCAVATION TO MEET I/C DECs AND PMCs, OFF-SITE TREATMENT (LTTD) AND DISPOSAL (LANDFILLING), LUCs, AND MONITORING**
**ANNUAL COST**

| Item | Item Cost Years 1 & 2 | Item Cost Years 3 & 4 | Item Cost Years 5 through 30 | Item Cost Annually | Item Cost Every 5 Years | Notes |
|---|---|---|---|---|---|---|
| Pavement | | | | $10,425 | | Repave 10% of contaminated areas yearly. |
| Groundwater Sampling | $22,272 | $11,136 | $5,568 | | | 4 Wells. Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Labor and supplies for sampling |
| Groundwater Analysis | $3,360 | $1,680 | $840 | | | 4 wells, Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Analysis for PAHs. |
| Groundwater Report | $5,000 | $5,000 | $5,000 | | | |
| Inspection | | | | $1,000 | | Annual LUC inspection |
| Site Review | | | | | $23,000 | 5-year review |
| Subtotal | $30,632 | $17,816 | $11,408 | $11,425 | $23,000 | |
| Contingency at 10% | $3,063 | $1,782 | $1,141 | $1,142 | $2,300 | |
| **TOTAL** | $33,695 | $19,598 | $12,549 | $12,567 | $25,300 | |

**ZONE 1, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-1.4 EXCAVATION TO MEET I/C DECs AND PMCs, OFF-SITE TREATMENT (LTTD) AND DISPOSAL (LANDFILLING), LUCs, AND MONITORING**
**Present Worth Analysis**

| Year | Capital Cost | Annual Cost | Total Year Cost | Annual Discount Rate at 7% | Present Worth |
|---|---|---|---|---|---|
| 0 | $1,411,769 | | $1,411,769 | 1.000 | $1,411,769 |
| 1 | | $46,262 | $46,262 | 0.935 | $43,255 |
| 2 | | $46,262 | $46,262 | 0.873 | $40,387 |
| 3 | | $32,165 | $32,165 | 0.816 | $26,247 |
| 4 | | $32,165 | $32,165 | 0.763 | $24,542 |
| 5 | | $50,416 | $50,416 | 0.713 | $35,947 |
| 6 | | $25,116 | $25,116 | 0.666 | $16,727 |
| 7 | | $25,116 | $25,116 | 0.623 | $15,647 |
| 8 | | $25,116 | $25,116 | 0.582 | $14,618 |
| 9 | | $25,116 | $25,116 | 0.544 | $13,663 |
| 10 | | $50,416 | $50,416 | 0.508 | $25,611 |
| 11 | | $25,116 | $25,116 | 0.475 | $11,930 |
| 12 | | $25,116 | $25,116 | 0.444 | $11,152 |
| 13 | | $25,116 | $25,116 | 0.415 | $10,423 |
| 14 | | $25,116 | $25,116 | 0.388 | $9,745 |
| 15 | | $50,416 | $50,416 | 0.362 | $18,251 |
| 16 | | $25,116 | $25,116 | 0.339 | $8,514 |
| 17 | | $25,116 | $25,116 | 0.317 | $7,962 |
| 18 | | $25,116 | $25,116 | 0.296 | $7,434 |
| 19 | | $25,116 | $25,116 | 0.277 | $6,957 |
| 20 | | $50,416 | $50,416 | 0.258 | $13,007 |
| 21 | | $25,116 | $25,116 | 0.242 | $6,078 |
| 22 | | $25,116 | $25,116 | 0.226 | $5,676 |
| 23 | | $25,116 | $25,116 | 0.211 | $5,299 |
| 24 | | $25,116 | $25,116 | 0.197 | $4,948 |
| 25 | | $50,416 | $50,416 | 0.184 | $9,277 |
| 26 | | $25,116 | $25,116 | 0.172 | $4,320 |
| 27 | | $25,116 | $25,116 | 0.161 | $4,044 |
| 28 | | $25,116 | $25,116 | 0.15 | $3,767 |
| 29 | | $25,116 | $25,116 | 0.141 | $3,541 |
| 30 | | $50,416 | $50,416 | 0.131 | $6,605 |
| | | | | **TOTAL PRESENT WORTH** | **$1,827,344** |

**ZONE 1, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-1.5 EXCAVATION TO MEET RESIDENTIAL DECs AND PMCs, ON-SITE DEWATERING, AND OFF-SITE TREATMENT (LTTD) AND DISPOSAL (LANDFILLING AND INCINERATION)**
**Capital Cost**

| Item | Quantity | Unit | Unit Cost Subcontract | Unit Cost Material | Unit Cost Labor | Unit Cost Equipment | Extended Cost Subcontract | Extended Cost Material | Extended Cost Labor | Extended Cost Equipment | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1 PROJECT PLANNING** | | | | | | | | | | | |
| 1.1 Prepare Documents & Plans including Permits | 200 | hr | | | $35.00 | | $0 | $0 | $7,000 | $0 | $7,000 |
| **2 PRE-DESIGN INVESTIGATION** | | | | | | | | | | | |
| 2.1 Field Personnel - prep, field, and follow-up | 3 | days | | | $350.00 | | $0 | $0 | $1,050 | $0 | $1,050 |
| 2.2 Travel & Mob | 1 | ls | $1,100.00 | | | | $1,100 | $0 | $0 | $0 | $1,100 |
| 2.3 Geoprobe - Equipment and Operator | 2 | day | $2,400.00 | | | | $4,800 | $0 | $0 | $0 | $4,800 |
| 2.4 Supplies & PID | 2 | day | $600.00 | | | | $1,200 | $0 | $0 | $0 | $1,200 |
| 2.5 Soil Sample Analysis (SPLP Lead, ETPH, PAHs ) | 1 | ls | $6,830.00 | | | | $6,830 | $0 | $0 | $0 | $6,830 |
| 2.6 Evaluate Data, Prepare Report, and Upload to NIRIS | 1 | ea | $32,000.00 | | | | $32,000 | $0 | $0 | $0 | $32,000 |
| **3 MOBILIZATION, DEMOBILIZATION AND FIELD SUPPORT** | | | | | | | | | | | |
| 3.1 Office Trailer | 12 | mo | | | | $375.00 | $0 | $0 | $0 | $4,500 | $4,500 |
| 3.2 Field Office Support | 12 | mo | | $155.00 | | | $0 | $1,860 | $0 | $0 | $1,860 |
| 3.3 Storage Trailer (1) | 12 | mo | | | | $99.00 | $0 | $0 | $0 | $1,188 | $1,188 |
| 3.4 Utility Connection/Disconnection (phone/electric) | 1 | ls | $1,500.00 | | | | $1,500 | $0 | $0 | $0 | $1,500 |
| 3.5 Site Utilities | 12 | mo | $150.00 | | | | $1,800 | $0 | $0 | $0 | $1,800 |
| 3.6 Construction Survey Support | 2 | day | $975.00 | | | | $1,950 | $0 | $0 | $0 | $1,950 |
| 3.7 Equipment Mobilization/Demobilization | 8 | ea | | | $85.00 | $261.00 | $0 | $0 | $680 | $2,088 | $2,768 |
| 3.8 Site Superintendent | 264 | day | | | $355.00 | | $0 | $0 | $93,720 | $0 | $93,720 |
| 3.9 Site Health & Safety and QA/QC | 264 | day | | | $325.00 | | $0 | $0 | $85,800 | $0 | $85,800 |
| 3.10 Materials Storage Pad, 25' X 25' | 625 | sf | | $3.64 | $0.74 | $1.09 | $0 | $2,275 | $463 | $681 | $3,419 |
| 3.11 Dewatering Pad, 40' X 40' , six | 9,600 | sf | | $5.62 | $0.85 | $1.24 | $0 | $53,952 | $8,160 | $11,904 | $74,016 |
| 3.12 Maintain Dewatering Pad, Replace Top 32x | 51,200 | sf | | $0.32 | $0.11 | $0.13 | $0 | $16,384 | $5,632 | $6,656 | $28,672 |
| **4 DECONTAMINATION** | | | | | | | | | | | |
| 4.1 Decontamination Services | 12 | mo | | | | $5,045.46 | $0 | $0 | $0 | $60,546 | $60,546 |
| 4.2 Equipment Decon Pad | 1 | ls | | $1,750.00 | $1,500.00 | $425.00 | $0 | $1,750 | $1,500 | $425 | $3,675 |
| 4.3 Decon Water | 12,000 | gal | | $0.20 | | | $0 | $2,400 | $0 | $0 | $2,400 |
| 4.4 Decon Water Storage Tank, 6,000 gallon | 12 | mo | | | | $784.24 | $0 | $0 | $0 | $9,411 | $9,411 |
| 4.5 Clean Water Storage Tank, 4,000 gallon | 12 | mo | | | | $705.22 | $0 | $0 | $0 | $8,463 | $8,463 |
| 4.6 Disposal of Decon Waste (liquid & solid) | 12 | mo | $950.00 | | | | $11,400 | $0 | $0 | $0 | $11,400 |
| **5 SHEET PILING, EXCAVATION, DEWATERING, AND DISPOSAL** | | | | | | | | | | | |
| 5.1 Pavement Removal | 12,111 | sy | | $2.22 | $1.63 | $3.85 | $0 | $26,887 | $19,741 | $46,628 | $93,256 |
| 5.2 Excavator, 2 CY Capacity | 12 | mo | | | $12,064.80 | $17,678.20 | $0 | $0 | $144,778 | $212,138 | $356,916 |
| 5.3 Site Labor, (3 laborers) | 12 | mo | | | $16,684.80 | | $0 | $0 | $200,218 | $0 | $200,218 |
| 5.4 Sheet Piles, 1950' x 15', tiebacks, drive, extract & salvage | 29,250 | sf | | $8.48 | $6.96 | $9.15 | $0 | $247,894 | $203,580 | $267,638 | $719,111 |
| 5.5 FE Loader 3 1/2 to 5 cy, two | 24 | mo | | | $9,288.40 | $13,544.60 | $0 | $0 | $222,922 | $325,070 | $547,992 |
| 5.6 Crane, 25 Ton with Clamshell Bucket, 1 CY | 7 | mo | | | $12,262.80 | $4,490.91 | $0 | $0 | $85,840 | $31,436 | $117,276 |
| 5.7 Vacuum Truck, 5000 gal to remove NAPL | 1 | wk | | | $1,182.00 | $1,947.20 | $0 | $0 | $1,182 | $1,947 | $3,129 |
| 5.8 Characterization Soil Testing - mercury | 5 | ea | $49.00 | $10.00 | | | $245 | $50 | $0 | $0 | $295 |
| 5.9 Characterization Soil Testing - PAH, ETPH | 143 | ea | $310.80 | $10.00 | | | $44,444 | $1,430 | $0 | $0 | $45,874 |
| 5.10 Confirmation Soil Testing - ETPH, PAH, rapid | 55 | ea | $621.60 | | | | $34,188 | $0 | $0 | $0 | $34,188 |
| 5.11 Confirmation Soil Testing - mercury, rapid | 5 | ea | $98.00 | | | | $490 | $0 | $0 | $0 | $490 |
| 5.12 Off Site Transportation & Disposal, TPH < 2500 mg/kg | 60,648 | tons | $40.00 | | | | $2,425,920 | $0 | $0 | $0 | $2,425,920 |
| 5.13 Off Site Transportation & Disposal, High TPH or PAH Soil | 29,910 | tons | $100.00 | | | | $2,991,000 | $0 | $0 | $0 | $2,991,000 |
| 5.14 Off Site Transportation & Recycling, Asphalt | 1,514 | tons | $19.50 | | | | $29,513 | $0 | $0 | $0 | $29,513 |
| 5.15 Off Site Transportation & Disposal, NAPL | 3,900 | gal | $10.00 | | | | $39,000 | $0 | $0 | $0 | $39,000 |
| 5.16 Centrifugal 15 gpm 1 HP Pump, to Treatment, 6 for 7 mo | 42 | mo | | $2,211 | $636 | | $0 | $92,881 | $26,700 | $0 | $119,581 |
| 5.17 5,000 lb Liquid-Phase GAC Adsorption Units | 12 | ea | | $24,600.00 | | | $0 | $295,200 | $0 | $0 | $295,200 |
| 5.18 Replace GAC | 540,000 | lb | | $2.00 | | | $0 | $1,080,000 | $0 | $0 | $1,080,000 |
| 5.19 Bag Filter System | 12 | ea | | $14,000.00 | $225.00 | | $0 | $168,000 | $2,700 | $0 | $170,700 |
| 5.20 Replace Filter Bags | 1,776 | ea | | $60.00 | | | $0 | $106,560 | $0 | $0 | $106,560 |
| 5.21 Diaphragm Pump, from Treatment to Sewer, 6 for 7 mo | 42 | mo | | | | $542.48 | $0 | $0 | $0 | $22,784 | $22,784 |
| 5.22 Piping , 2" PVC, from Treatment to Storm Sewer | 1,200 | ft | | $0.51 | $0.72 | | $0 | $612 | $864 | $0 | $1,476 |
| **6 BACKFILL AND SITE RESTORATION** | | | | | | | | | | | |
| 6.1 Clean Backfill | 62,833 | cy | | $8.00 | | | $0 | $502,664 | $0 | $0 | $502,664 |
| 6.2 FE Loader 3 1/2 to 5 cy | 7 | mo | | | $9,288.40 | $13,544.60 | $0 | $0 | $65,019 | $94,812 | $159,831 |

**ZONE 1, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-1.5 EXCAVATION TO MEET RESIDENTIAL DECs AND PMCs, ON-SITE DEWATERING, AND OFF-SITE TREATMENT (LTTD) AND DISPOSAL (LANDFILLING AND INCINERATION)**
**Capital Cost**

| Item | Quantity | Unit | Unit Cost Subcontract | Unit Cost Material | Unit Cost Labor | Unit Cost Equipment | Extended Cost Subcontract | Extended Cost Material | Extended Cost Labor | Extended Cost Equipment | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 6.3 Vibrating Roller, 2-Drum, 7.5 HP | 7 | mo | | | $10,058.40 | $2,494.40 | $0 | $0 | $70,409 | $17,461 | $87,870 |
| 6.4 Vibratory Plate for use around Utilities | 7 | mo | | | | $297.00 | $0 | $0 | $0 | $2,079 | $2,079 |
| 6.5 Top Dress Soil | 2,815 | cy | $31.50 | | | | $88,673 | $0 | $0 | $0 | $88,673 |
| 6.6 Site Restoration, seed, fertilization, mulch | 152 | msf | $75.00 | | | | $11,400 | $0 | $0 | $0 | $11,400 |
| **7 POST CONSTRUCTION COST** | | | | | | | | | | | |
| 7.1 Contractor Completion Report | 240 | hr | | | $35.00 | | $0 | $0 | $8,400 | $0 | $8,400 |
| 7.2 Remedial Action Closeout Report | 240 | hr | | | $35.00 | | $0 | $0 | $8,400 | $0 | $8,400 |
| **Subtotal** | | | | | | | $5,727,453 | $2,600,798 | $1,264,755 | $1,127,855 | $10,720,862 |
| **Local Area Adjustments** | | | | | | | 100.0% | 98.6% | 104.2% | 104.2% | |
| **Subtotal** | | | | | | | $5,727,453 | $2,564,387 | $1,317,875 | $1,175,225 | $10,784,940 |
| Overhead on Labor Cost @ 30% | | | | | | | | | $395,363 | | $395,363 |
| G & A on Labor Cost @ 10% | | | | | | | | | $131,788 | | $131,788 |
| G & A on Material Cost @ 10% | | | | | | | | $256,439 | | | $256,439 |
| G & A on Equipment Cost @ 10% | | | | | | | | | | $117,523 | $117,523 |
| G & A on Subcontract Cost @ 10% | | | | | | | $572,745 | | | | $572,745 |
| Tax on Materials and Equipment Cost @ 6% | | | | | | | | $153,863 | | $70,514 | $224,377 |
| **Total Direct Cost** | | | | | | | $6,300,198 | $2,974,689 | $1,845,025 | $1,363,261 | $12,483,174 |
| Indirects on Total Direct Cost @ 30% | | (excluding transportation and disposal cost) | | | | | | | | | $2,107,602 |
| Profit on Total Direct Cost @ 10% | | | | | | | | | | | $1,248,317 |
| **Subtotal** | | | | | | | | | | | $15,839,093 |
| Health & Safety Monitoring @ 2% | | (includes air quality monitoring) | | | | | | | | | $316,782 |
| **Total Field Cost** | | | | | | | | | | | $16,155,875 |
| Contingency on Total Field Costs @ 20% | | | | | | | | | | | $3,231,175 |
| Engineering on Total Field Cost @ 5% | | | | | | | | | | | $807,794 |
| **TOTAL CAPITAL COST** | | | | | | | | | | | **$20,194,844** |

# APPENDIX E.1.2

# ZONE 2

# ALTERNATIVES S-2.1, S-2.2, S-2.3, S-2.4, S-2.5, and S-2.6

**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-2.1: NO ACTION**
**Annual Cost**

1/15/2010 11:28 AM

| Item | Item Cost every 5 years | Notes |
|---|---|---|
| Five-Year Review | $23,000 | |
| Subtotal | $23,000 | |
| Contingency @ 10% | $2,300 | |
| **TOTAL** | **$25,300** | |

**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-2.1: NO ACTION**
**Present Worth Analysis**

1/15/2010 11:28 AM

| Year | Capital Cost | Annual Cost | Total Year Cost | Annual Discount Rate at 7% | Present Worth |
|---|---|---|---|---|---|
| 0 | $0 | | $0 | 1.000 | $0 |
| 1 | | | $0 | 0.935 | $0 |
| 2 | | | $0 | 0.873 | $0 |
| 3 | | | $0 | 0.816 | $0 |
| 4 | | | $0 | 0.763 | $0 |
| 5 | | $25,300 | $25,300 | 0.713 | $18,039 |
| 6 | | | $0 | 0.666 | $0 |
| 7 | | | $0 | 0.623 | $0 |
| 8 | | | $0 | 0.582 | $0 |
| 9 | | | $0 | 0.544 | $0 |
| 10 | | $25,300 | $25,300 | 0.508 | $12,852 |
| 11 | | | $0 | 0.475 | $0 |
| 12 | | | $0 | 0.444 | $0 |
| 13 | | | $0 | 0.415 | $0 |
| 14 | | | $0 | 0.388 | $0 |
| 15 | | $25,300 | $25,300 | 0.362 | $9,159 |
| 16 | | | $0 | 0.339 | $0 |
| 17 | | | $0 | 0.317 | $0 |
| 18 | | | $0 | 0.296 | $0 |
| 19 | | | $0 | 0.277 | $0 |
| 20 | | $25,300 | $25,300 | 0.258 | $6,527 |
| 21 | | | $0 | 0.242 | $0 |
| 22 | | | $0 | 0.226 | $0 |
| 23 | | | $0 | 0.211 | $0 |
| 24 | | | $0 | 0.197 | $0 |
| 25 | | $25,300 | $25,300 | 0.184 | $4,655 |
| 26 | | | $0 | 0.172 | $0 |
| 27 | | | $0 | 0.161 | $0 |
| 28 | | | $0 | 0.150 | $0 |
| 29 | | | $0 | 0.141 | $0 |
| 30 | | $25,300 | $25,300 | 0.131 | $3,314 |
| | | | | **TOTAL PRESENT WORTH** | **$54,547** |

**ZONE 2, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-2.2: LUCs and MONITORING**
**CAPITAL COST**

| Item | Quantity | Unit | Unit Cost | | | | Extended Cost | | | | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Subcontract | Material | Labor | Equipment | Subcontract | Material | Labor | Equipment | |
| **1 PROJECT PLANNING** | | | | | | | | | | | |
| 1.1 Prepare Documents & Plans including Permits/Variances | 140 | hr | | | $35.00 | | $0 | $0 | $4,900 | $0 | $4,900 |
| 1.2 Prepare LUC RD Documents | 60 | hr | | | $35.00 | | $0 | $0 | $2,100 | $0 | $2,100 |
| **2 PRE-DESIGN INVESTIGATION** | | | | | | | | | | | |
| 2.1 Field Personnel - prep, field, and follow-up | 1.5 | days | | | $350.00 | | $0 | $0 | $525 | $0 | $525 |
| 2.2 Travel & Mob | 1 | ls | $550.00 | | | | $550 | $0 | $0 | $0 | $550 |
| 2.3 Geoprobe - Equipment and Operator | 1 | day | $2,400.00 | | | | $2,400 | $0 | $0 | $0 | $2,400 |
| 2.4 Supplies & PID | 1 | day | $600.00 | | | | $600 | $0 | $0 | $0 | $600 |
| 2.5 Soil Sample Analysis (SPLP Lead, ETPH ) | 1 | ls | $420.00 | | | | $420 | $0 | $0 | $0 | $420 |
| 2.6 Evaluate Data, Prepare Report, and Upload to NIRIS | 1 | ea | $7,000.00 | | | | $7,000 | $0 | $0 | $0 | $7,000 |
| **3 FIELD SUPPORT** | | | | | | | | | | | |
| 3.1 Construction Survey Support | 1 | day | $1,050.00 | | | | $1,050 | $0 | $0 | $0 | $1,050 |
| **Subtotal** | | | | | | | $12,020 | $0 | $7,525 | $0 | $19,545 |
| **Local Area Adjustments** | | | | | | | 100.0% | 98.6% | 104.2% | 104.2% | |
| | | | | | | | $12,020 | $0 | $7,841 | $0 | $19,861 |
| Overhead on Labor Cost @ 30% | | | | | | | | | $2,352 | | $2,352 |
| G & A on Labor Cost @ 10% | | | | | | | | | $784 | | $784 |
| G & A on Material Cost @ 10% | | | | | | | | $0 | | | $0 |
| G & A on Subcontract Cost @ 10% | | | | | | | $1,202 | | | | $1,202 |
| G & A on Equipment Cost @ 10% | | | | | | | | | | $0 | $0 |
| Tax on Materials and Equipment Cost @ 6% | | | | | | | | $0 | | $0 | $0 |
| **Total Direct Cost** | | | | | | | $13,222 | $0 | $10,977 | $0 | $24,199 |
| Indirects on Total Direct Cost @ 0% | | | | | | | | | | | $0 |
| Profit on Total Direct Cost @ 10% | | | | | | | | | | | $2,420 |
| **Subtotal** | | | | | | | | | | | $26,619 |
| Health & Safety Monitoring @ 0% | | | | | | | | | | | $0 |
| **Total Field Cost** | | | | | | | | | | | $26,619 |
| Contingency on Total Field Costs @ 0% | | | | | | | | | | | $0 |
| Engineering on Total Field Cost @ 0% | | | | | | | | | | | $0 |
| **TOTAL COST** | | | | | | | | | | | **$26,619** |

**ZONE 2, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-2.2: LUCs and MONITORING**
**ANNUAL COST**

| Item | Item Cost Years 1 & 2 | Item Cost Years 3 & 4 | Item Cost Years 5 through 30 | Item Cost Annually | Item Cost Every 5 Years | Notes |
|---|---|---|---|---|---|---|
| Pavement Maintenance | | | | $2,010 | | Repave 10% of contaminated areas yearly |
| Groundwater Sampling | $22,272 | $11,136 | $5,568 | | | 4 Wells. Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Labor and supplies for sampling |
| Groundwater Analysis | $784 | $392 | $196 | | | 4 wells, Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Analysis for lead |
| Groundwater Report | $5,000 | $5,000 | $5,000 | | | |
| Inspection | | | | $1,000 | | Annual LUC inspection |
| Site Review | | | | | $23,000 | 5-year review |
| Subtotal | $28,056 | $16,528 | $10,764 | $3,010 | $23,000 | |
| Contingency at 10% | $2,806 | $1,653 | $1,076 | $301 | $2,300 | |
| **TOTAL** | $30,862 | $18,181 | $11,840 | $3,311 | $25,300 | |

**ZONE 2, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-2.2: LUCs and MONITORING**
**PRESENT WORTH ANALYSIS**

| Year | Capital Cost | Annual Cost | Total Year Cost | Annual Discount Rate at 7% | Present Worth |
|---|---|---|---|---|---|
| 0 | $26,619 | | $26,619 | 1.000 | $26,619 |
| 1 | | $34,172 | $34,172 | 0.935 | $31,951 |
| 2 | | $34,172 | $34,172 | 0.873 | $29,832 |
| 3 | | $21,491 | $21,491 | 0.816 | $17,537 |
| 4 | | $21,491 | $21,491 | 0.763 | $16,398 |
| 5 | | $40,451 | $40,451 | 0.713 | $28,842 |
| 6 | | $15,151 | $15,151 | 0.666 | $10,091 |
| 7 | | $15,151 | $15,151 | 0.623 | $9,439 |
| 8 | | $15,151 | $15,151 | 0.582 | $8,818 |
| 9 | | $15,151 | $15,151 | 0.544 | $8,242 |
| 10 | | $40,451 | $40,451 | 0.508 | $20,549 |
| 11 | | $15,151 | $15,151 | 0.475 | $7,197 |
| 12 | | $15,151 | $15,151 | 0.444 | $6,727 |
| 13 | | $15,151 | $15,151 | 0.415 | $6,288 |
| 14 | | $15,151 | $15,151 | 0.388 | $5,879 |
| 15 | | $40,451 | $40,451 | 0.362 | $14,643 |
| 16 | | $15,151 | $15,151 | 0.339 | $5,136 |
| 17 | | $15,151 | $15,151 | 0.317 | $4,803 |
| 18 | | $15,151 | $15,151 | 0.296 | $4,485 |
| 19 | | $15,151 | $15,151 | 0.277 | $4,197 |
| 20 | | $40,451 | $40,451 | 0.258 | $10,436 |
| 21 | | $15,151 | $15,151 | 0.242 | $3,667 |
| 22 | | $15,151 | $15,151 | 0.226 | $3,424 |
| 23 | | $15,151 | $15,151 | 0.211 | $3,197 |
| 24 | | $15,151 | $15,151 | 0.197 | $2,985 |
| 25 | | $40,451 | $40,451 | 0.184 | $7,443 |
| 26 | | $15,151 | $15,151 | 0.172 | $2,606 |
| 27 | | $15,151 | $15,151 | 0.161 | $2,439 |
| 28 | | $15,151 | $15,151 | 0.150 | $2,273 |
| 29 | | $15,151 | $15,151 | 0.141 | $2,136 |
| 30 | | $40,451 | $40,451 | 0.131 | $5,299 |
| | | | | **TOTAL PRESENT WORTH** | **$313,576** |

**ZONE 2, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-2.3: CAPPING TO PREVENT LEACHING, LUCS, AND MONITORING**
**Capital Cost**

| Item | Quantity | Unit | Unit Cost Subcontract | Unit Cost Material | Unit Cost Labor | Unit Cost Equipment | Extended Cost Subcontract | Extended Cost Material | Extended Cost Labor | Extended Cost Equipment | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1 PROJECT PLANNING** | | | | | | | | | | | |
| 1.1 Prepare LUC RD Documents | 60 | hr | | | $35.00 | | $0 | $0 | $2,100 | $0 | $2,100 |
| 1.2 Prepare Documents & Plans including Permits | 150 | hr | | | $35.00 | | $0 | $0 | $5,250 | $0 | $5,250 |
| **2 PRE-DESIGN INVESTIGATION** | | | | | | | | | | | |
| 2.1 Field Personnel - prep, field, and follow-up | 1.5 | days | | | $350.00 | | $0 | $0 | $525 | $0 | $525 |
| 2.2 Travel & Mob | 1 | ls | $550.00 | | | | $550 | $0 | $0 | $0 | $550 |
| 2.3 Geoprobe - Equipment and Operator | 1 | day | $2,400.00 | | | | $2,400 | $0 | $0 | $0 | $2,400 |
| 2.4 Supplies & PID | 1 | day | $600.00 | | | | $600 | $0 | $0 | $0 | $600 |
| 2.5 Soil Sample Analysis (SPLP Lead, ETPH ) | 1 | ls | $420.00 | | | | $420 | $0 | $0 | $0 | $420 |
| 2.6 Evaluate Data, Prepare Report, and Upload to NIRIS | 1 | ea | $7,000.00 | | | | $7,000 | $0 | $0 | $0 | $7,000 |
| **3 MOBILIZATION, DEMOBILIZATION AND FIELD SUPPORT** | | | | | | | | | | | |
| 3.1 Office Trailer | 0.5 | mo | | | | $375.00 | $0 | $0 | $0 | $188 | $188 |
| 3.2 Field Office Support | 0.5 | mo | | $155.00 | | | $0 | $78 | $0 | $0 | $78 |
| 3.3 Storage Trailer (1) | 0.5 | mo | | | | $99.00 | $0 | $0 | $0 | $50 | $50 |
| 3.4 Utility Connection/Disconnection (phone/electric) | 1 | ls | $1,500.00 | | | | $1,500 | $0 | $0 | $0 | $1,500 |
| 3.5 Site Utilities | 0.5 | mo | $150.00 | | | | $75 | $0 | $0 | $0 | $75 |
| 3.6 Underground Utility Clearances | 1 | ls | $1,500.00 | | | | $1,500 | $0 | $0 | $0 | $1,500 |
| 3.7 Construction Survey Support | 2 | day | $975.00 | | | | $1,950 | $0 | $0 | $0 | $1,950 |
| 3.8 Equipment Mobilization/Demobilization | 4 | ea | | | $85.00 | $261.00 | $0 | $0 | $340 | $1,044 | $1,384 |
| 3.9 Site Superintendent | 11 | day | | | $355.00 | | $0 | $0 | $3,905 | $0 | $3,905 |
| 3.10 Site Health & Safety and QA/QC | 11 | day | | | $325.00 | | $0 | $0 | $3,575 | $0 | $3,575 |
| 3.11 Materials Storage Pad, 25' X 25' | 625 | sf | | $3.64 | $0.74 | $1.09 | $0 | $2,275 | $463 | $681 | $3,419 |
| **4 DECONTAMINATION** | | | | | | | | | | | |
| 4.1 Decontamination Services | 0.5 | mo | | | | $5,045.46 | $0 | $0 | $0 | $2,523 | $2,523 |
| 4.2 Equipment Decon Pad | 1 | ls | | $3,500.00 | $3,000.00 | $425.00 | $0 | $3,500 | $3,000 | $425 | $6,925 |
| 4.3 Decon Water | 500 | gal | | $0.20 | | | $0 | $100 | $0 | $0 | $100 |
| 4.4 Decon Water Storage Tank, 6,000 gallon | 0.5 | mo | | | | $784.24 | $0 | $0 | $0 | $392 | $392 |
| 4.5 Clean Water Storage Tank, 4,000 gallon | 0.5 | mo | | | | $705.22 | $0 | $0 | $0 | $353 | $353 |
| 4.6 Disposal of Decon Waste (liquid & solid) | 0.5 | mo | $950.00 | | | | $475 | $0 | $0 | $0 | $475 |
| **5 EXCAVATION AND DISPOSAL** | | | | | | | | | | | |
| 5.1 Pavement Removal | 711 | sy | | $2.22 | $1.63 | $3.85 | $0 | $1,579 | $1,159 | $2,738 | $5,476 |
| 5.2 Excavator, 1/2 cy Capacity | 2 | days | | | $593.20 | $547.60 | $0 | $0 | $1,186 | $1,095 | $2,282 |
| 5.3 Site Labor, (3 laborers) | 2 | days | | | $758.40 | | $0 | $0 | $1,517 | $0 | $1,517 |
| 5.4 Tractor Loader 1 to 1-1/4 cy | 2 | days | | | $457.20 | $322.00 | $0 | $0 | $914 | $644 | $1,558 |
| 5.5 Characterization Testing -mass and TCLP lead | 9 | ea | $168.00 | $10.00 | | | $1,512 | $90 | $0 | $0 | $1,602 |
| 5.6 Confirmation Testing - mass and SPLP lead, rapid | 3 | ea | $336.00 | | | | $1,008 | $0 | $0 | $0 | $1,008 |
| 5.7 Off Site Transportation & Disposal, High Lead | 623 | tons | $120.00 | | | | $74,700 | $0 | $0 | $0 | $74,700 |
| 5.8 Off Site Transportation & Recycling, Asphalt | 89 | tons | $19.50 | | | | $1,735 | $0 | $0 | $0 | $1,735 |
| **6 BACKFILL, CAPPING AND SITE RESTORATION** | | | | | | | | | | | |
| 6.1 60-mil VLDPE Geomembrane | 6,400 | sf | | $0.48 | $1.43 | $0.27 | $0 | $3,072 | $9,152 | $1,728 | $13,952 |
| 6.2 12 oz/sy Cushion Geotextile, Small Areas | 711 | sy | | $2.19 | $0.12 | $0.05 | $0 | $1,557 | $85 | $32 | $1,675 |
| 6.3 Clean Sand | 474 | cy | | $4.00 | $0.50 | $1.07 | $0 | $1,896 | $235 | $505 | $2,635 |
| 6.4 Asphalt, 2" Binder, 1" Topping, Small Areas | 6,400 | sf | | $1.03 | $0.24 | $0.30 | $0 | $6,592 | $1,536 | $1,920 | $10,048 |
| **7 POST CONSTRUCTION COST** | | | | | | | | | | | |
| 7.1 Contractor Completion Report | 40 | hr | | | $35.00 | | $0 | $0 | $1,400 | $0 | $1,400 |
| 7.2 Remedial Action Closeout Report | 40 | hr | | | $35.00 | | $0 | $0 | $1,400 | $0 | $1,400 |
| **Subtotal** | | | | | | | $95,425 | $20,739 | $37,742 | $14,316 | $168,222 |
| **Local Area Adjustments** | | | | | | | 100.0% | 98.6% | 104.2% | 104.2% | |
| **Subtotal** | | | | | | | $95,425 | $20,448 | $39,327 | $14,918 | $170,118 |

**ZONE 2, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-2.3: CAPPING TO PREVENT LEACHING, LUCS, AND MONITORING**
**Capital Cost**

| Item | Quantity | Unit | Unit Cost Subcontract | Unit Cost Material | Unit Cost Labor | Unit Cost Equipment | Extended Cost Subcontract | Extended Cost Material | Extended Cost Labor | Extended Cost Equipment | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Overhead on Labor Cost @ 30% | | | | | | | | | $11,798 | | $11,798 |
| G & A on Labor Cost @ 10% | | | | | | | | | $3,933 | | $3,933 |
| G & A on Material Cost @ 10% | | | | | | | | $2,045 | | | $2,045 |
| G & A on Equipment Cost @ 10% | | | | | | | | | | $1,492 | $1,492 |
| G & A on Subcontract Cost @ 10% | | | | | | | $9,542 | | | | $9,542 |
| Tax on Materials and Equipment Cost @ 6% | | | | | | | | $1,227 | | $895 | $2,122 |
| **Total Direct Cost** | | | | | | | $104,967 | $23,720 | $55,058 | $17,305 | $201,050 |
| Indirects on Total Direct Cost @ 30% | | (excluding transportation and disposal cost) | | | | | | | | | $37,242 |
| Profit on Total Direct Cost @ 10% | | | | | | | | | | | $20,105 |
| **Subtotal** | | | | | | | | | | | $258,397 |
| Health & Safety Monitoring @ 3% | | (includes air quality monitoring) | | | | | | | | | $7,752 |
| **Total Field Cost** | | | | | | | | | | | $266,149 |
| Contingency on Total Field Costs @ 20% | | | | | | | | | | | $53,230 |
| Engineering on Total Field Cost @ 15% | | | | | | | | | | | $39,922 |
| **TOTAL CAPITAL COST** | | | | | | | | | | | **$359,301** |

**ZONE 2, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-2.3: CAPPING TO PREVENT LEACHING, LUCS, AND MONITORING**
**ANNUAL COST**

| Item | Item Cost Years 1 & 2 | Item Cost Years 3 & 4 | Item Cost Years 5 through 30 | Item Cost Annually | Item Cost Every 5 Years | Notes |
|---|---|---|---|---|---|---|
| Pavement Maintenance | | | | $2,010 | | Repave 10% of contaminated areas yearly. |
| Groundwater Sampling | $22,272 | $11,136 | $5,568 | | | 4 Wells. Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Labor and supplies for sampling |
| Groundwater Analysis | $784 | $392 | $196 | | | 4 wells, Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Analysis for lead. |
| Groundwater Report | $5,000 | $5,000 | $5,000 | | | |
| Inspection | | | | $1,000 | | Annual LUC inspection |
| Site Review | | | | | $23,000 | 5-year review |
| Subtotal | $28,056 | $16,528 | $10,764 | $3,010 | $23,000 | |
| Contingency at 10% | $2,806 | $1,653 | $1,076 | $301 | $2,300 | |
| **TOTAL** | $30,862 | $18,181 | $11,840 | $3,311 | $25,300 | |

**ZONE 2, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-2.3: CAPPING TO PREVENT LEACHING, LUCS, AND MONITORING**
**Present Worth Analysis**

| Year | Capital Cost | Annual Cost | Total Year Cost | Annual Discount Rate at 7% | Present Worth |
|---|---|---|---|---|---|
| 0 | $359,301 | | $359,301 | 1.000 | $359,301 |
| 1 | | $34,172 | $34,172 | 0.935 | $31,951 |
| 2 | | $34,172 | $34,172 | 0.873 | $29,832 |
| 3 | | $21,491 | $21,491 | 0.816 | $17,537 |
| 4 | | $21,491 | $21,491 | 0.763 | $16,398 |
| 5 | | $40,451 | $40,451 | 0.713 | $28,842 |
| 6 | | $15,151 | $15,151 | 0.666 | $10,091 |
| 7 | | $15,151 | $15,151 | 0.623 | $9,439 |
| 8 | | $15,151 | $15,151 | 0.582 | $8,818 |
| 9 | | $15,151 | $15,151 | 0.544 | $8,242 |
| 10 | | $40,451 | $40,451 | 0.508 | $20,549 |
| 11 | | $15,151 | $15,151 | 0.475 | $7,197 |
| 12 | | $15,151 | $15,151 | 0.444 | $6,727 |
| 13 | | $15,151 | $15,151 | 0.415 | $6,288 |
| 14 | | $15,151 | $15,151 | 0.388 | $5,879 |
| 15 | | $40,451 | $40,451 | 0.362 | $14,643 |
| 16 | | $15,151 | $15,151 | 0.339 | $5,136 |
| 17 | | $15,151 | $15,151 | 0.317 | $4,803 |
| 18 | | $15,151 | $15,151 | 0.296 | $4,485 |
| 19 | | $15,151 | $15,151 | 0.277 | $4,197 |
| 20 | | $40,451 | $40,451 | 0.258 | $10,436 |
| 21 | | $15,151 | $15,151 | 0.242 | $3,667 |
| 22 | | $15,151 | $15,151 | 0.226 | $3,424 |
| 23 | | $15,151 | $15,151 | 0.211 | $3,197 |
| 24 | | $15,151 | $15,151 | 0.197 | $2,985 |
| 25 | | $40,451 | $40,451 | 0.184 | $7,443 |
| 26 | | $15,151 | $15,151 | 0.172 | $2,606 |
| 27 | | $15,151 | $15,151 | 0.161 | $2,439 |
| 28 | | $15,151 | $15,151 | 0.15 | $2,273 |
| 29 | | $15,151 | $15,151 | 0.141 | $2,136 |
| 30 | | $40,451 | $40,451 | 0.131 | $5,299 |
| | | | | **TOTAL PRESENT WORTH** | **$646,258** |

**ZONE 2, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-2.4 IN SITU TREATMENT (STABILIZATION /SOLIDIFICATION) TO MEET I/C PMCs, LUCs, AND MONITORING**
**Capital Cost**

| Item | Quantity | Unit | Unit Cost Subcontract | Unit Cost Material | Unit Cost Labor | Unit Cost Equipment | Extended Cost Subcontract | Extended Cost Material | Extended Cost Labor | Extended Cost Equipment | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1 PROJECT PLANNING** | | | | | | | | | | | |
| 1.1 Prepare LUC RD Documents | 60 | hr | | | $35.00 | | $0 | $0 | $2,100 | $0 | $2,100 |
| 1.2 Prepare Documents & Plans including Permits | 150 | hr | | | $35.00 | | $0 | $0 | $5,250 | $0 | $5,250 |
| **2 PRE-DESIGN INVESTIGATION** | | | | | | | | | | | |
| 2.1 Field Personnel - prep, field, and follow-up | 1.5 | days | | | $350.00 | | $0 | $0 | $525 | $0 | $525 |
| 2.2 Travel & Mob | 1 | ls | $550.00 | | | | $550 | $0 | $0 | $0 | $550 |
| 2.3 Geoprobe - Equipment and Operator | 1 | day | $2,400.00 | | | | $2,400 | $0 | $0 | $0 | $2,400 |
| 2.4 Supplies & PID | 1 | day | $600.00 | | | | $600 | $0 | $0 | $0 | $600 |
| 2.5 Soil Sample Analysis (SPLP Lead, ETPH ) | 1 | ls | $420.00 | | | | $420 | $0 | $0 | $0 | $420 |
| 2.6 Evaluate Data, Prepare Report, and Upload to NIRIS | 1 | ea | $7,000.00 | | | | $7,000 | $0 | $0 | $0 | $7,000 |
| **3 MOBILIZATION, DEMOBILIZATION AND FIELD SUPPORT** | | | | | | | | | | | |
| 3.1 Storage Trailer (1) | 1 | mo | | | | $99.00 | $0 | $0 | $0 | $99 | $99 |
| 3.2 Underground Utility Clearances | 1 | ls | $3,500.00 | | | | $3,500 | $0 | $0 | $0 | $3,500 |
| 3.3 Construction Survey | 1 | day | $2,125.00 | | | | $2,125 | $0 | $0 | $0 | $2,125 |
| 3.4 Large Diameter Auger Mobilization/Demobilization | 1 | ea | $100,000.00 | | | | $100,000 | $0 | $0 | $0 | $100,000 |
| 3.5 Temporary Fencing | 1 | ls | | $500.00 | | | $0 | $500 | $0 | $0 | $500 |
| 3.6 Field Construction Mgt. (1 person) | 6 | day | | $200.00 | $350.00 | | $0 | $1,200 | $2,100 | $0 | $3,300 |
| 3.7 Site Health & Safety and QA/QC | 6 | day | | $200.00 | $325.00 | | $0 | $1,200 | $1,950 | $0 | $3,150 |
| **4 IN-SITU TREATMENT** | | | | | | | | | | | |
| 4.1 Pavement Removal | 711 | sy | | $2.22 | $1.63 | $3.85 | $0 | $1,579 | $1,159 | $2,738 | $5,476 |
| 4.2 Off Site Transportation & Recycling, Asphalt | 89 | tons | $19.50 | | | | $1,735 | $0 | $0 | $0 | $1,735 |
| 4.3 Treatability Test | 1 | ls | $5,000.00 | | | | $5,000 | $0 | $0 | $0 | $5,000 |
| 4.4 Auger Soil | 1,126 | cy | $60.00 | | | | $67,560 | $0 | $0 | $0 | $67,560 |
| 4.5 Utility Relocation - Storm and Sanitary Sewer Lines | 1 | ls | $20,000.00 | | | | $20,000 | $0 | $0 | $0 | $20,000 |
| 4.6 Post-Treatment Soil Testing - SPLP | 2 | ea | $119.00 | $10.00 | | | $238 | $20 | $0 | $0 | $258 |
| 4.7 Off Site Transportation & Disposal, Excess Stablized Soi | 173 | tons | $25.00 | | | | $4,313 | $0 | $0 | $0 | $4,313 |
| **5 BACKFILL AND SITE RESTORATION** | | | | | | | | | | | |
| 5.1 Asphalt, 2" Binder, 1" Topping, Small Areas | 6,400 | sf | | $1.03 | $0.24 | $0.30 | $0 | $6,592 | $1,536 | $1,920 | $10,048 |
| **6 POST CONSTRUCTION COST** | | | | | | | | | | | |
| 6.1 *Contractor Completion Report* | 40 | hr | | | $35.00 | | $0 | $0 | $1,400 | $0 | $1,400 |
| 6.2 Remedial Action Closeout Report | 40 | hr | | | $35.00 | | $0 | $0 | $1,400 | $0 | $1,400 |
| **Subtotal** | | | | | | | $215,440 | $11,091 | $17,420 | $4,757 | $248,708 |
| **Local Area Adjustments** | | | | | | | 100.0% | 98.6% | 104.2% | 104.2% | |
| **Subtotal** | | | | | | | $215,440 | $10,935 | $18,152 | $4,957 | $249,484 |
| Overhead on Labor Cost @ 30% | | | | | | | | | $5,446 | | $5,446 |
| G & A on Labor Cost @ 10% | | | | | | | | | $1,815 | | $1,815 |
| G & A on Material Cost @ 10% | | | | | | | | $1,094 | | | $1,094 |
| G & A on Equipment Cost @ 10% | | | | | | | | | | $496 | $496 |
| G & A on Subcontract Cost @ 10% | | | | | | | $21,544 | | | | $21,544 |
| Tax on Materials and Equipment Cost @ 6% | | | | | | | | $656 | | $297 | $954 |
| **Total Direct Cost** | | | | | | | $236,984 | $12,685 | $25,412 | $5,750 | $280,831 |
| Indirects on Total Direct Cost @ 30% | | | (excluding transportation and disposal cost) | | | | | | | | $82,435 |
| Profit on Total Direct Cost @ 10% | | | | | | | | | | | $28,083 |
| **Subtotal** | | | | | | | | | | | $391,350 |
| Health & Safety Monitoring @ 3% | | | (includes air quality monitoring) | | | | | | | | $11,740 |

**ZONE 2, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-2.4 IN SITU TREATMENT (STABILIZATION /SOLIDIFICATION) TO MEET I/C PMCs, LUCs, AND MONITORING**
**Capital Cost**

| Item | Quantity | Unit | Unit Cost Subcontract | Unit Cost Material | Unit Cost Labor | Unit Cost Equipment | Extended Cost Subcontract | Extended Cost Material | Extended Cost Labor | Extended Cost Equipment | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total Field Cost** | | | | | | | | | | | $403,090 |
| Contingency on Total Field Costs @ 20% | | | | | | | | | | | $80,618 |
| Engineering on Total Field Cost @ 15% | | | | | | | | | | | $60,464 |
| **TOTAL CAPITAL COST** | | | | | | | | | | | **$544,172** |

**ZONE 2, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-2.4 IN SITU TREATMENT (STABILIZATION /SOLIDIFICATION) TO MEET I/C PMCs, LUCs, AND MONITORING**
**ANNUAL COST**

| Item | Item Cost Years 1 & 2 | Item Cost Years 3 & 4 | Item Cost Years 5 through 30 | Item Cost Annually | Item Cost Every 5 Years | Notes |
|---|---|---|---|---|---|---|
| Pavement Maintenance | | | | $2,010 | | Repave 10% of contaminated areas yearly. |
| Groundwater Sampling | $22,272 | $11,136 | $5,568 | | | 4 Wells. Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Labor and supplies for sampling |
| Groundwater Analysis | $784 | $392 | $196 | | | 4 wells, Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Analysis for lead. |
| Groundwater Report | $5,000 | $5,000 | $5,000 | | | |
| Inspection | | | | $1,000 | | Annual LUC inspection |
| Site Review | | | | | $23,000 | 5-year review |
| Subtotal | $28,056 | $16,528 | $10,764 | $3,010 | $23,000 | |
| Contingency at 10% | $2,806 | $1,653 | $1,076 | $301 | $2,300 | |
| **TOTAL** | $30,862 | $18,181 | $11,840 | $3,311 | $25,300 | |

**ZONE 2, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-2.4 IN SITU TREATMENT (STABILIZATION /SOLIDIFICATION) TO MEET I/C PMCs, LUCs, AND MONITORING**
**Present Worth Analysis**

| Year | Capital Cost | Annual Cost | Total Year Cost | Annual Discount Rate at 7% | Present Worth |
|---|---|---|---|---|---|
| 0 | $544,172 | | $544,172 | 1.000 | $544,172 |
| 1 | | $34,172 | $34,172 | 0.935 | $31,951 |
| 2 | | $34,172 | $34,172 | 0.873 | $29,832 |
| 3 | | $21,491 | $21,491 | 0.816 | $17,537 |
| 4 | | $21,491 | $21,491 | 0.763 | $16,398 |
| 5 | | $40,451 | $40,451 | 0.713 | $28,842 |
| 6 | | $15,151 | $15,151 | 0.666 | $10,091 |
| 7 | | $15,151 | $15,151 | 0.623 | $9,439 |
| 8 | | $15,151 | $15,151 | 0.582 | $8,818 |
| 9 | | $15,151 | $15,151 | 0.544 | $8,242 |
| 10 | | $40,451 | $40,451 | 0.508 | $20,549 |
| 11 | | $15,151 | $15,151 | 0.475 | $7,197 |
| 12 | | $15,151 | $15,151 | 0.444 | $6,727 |
| 13 | | $15,151 | $15,151 | 0.415 | $6,288 |
| 14 | | $15,151 | $15,151 | 0.388 | $5,879 |
| 15 | | $40,451 | $40,451 | 0.362 | $14,643 |
| 16 | | $15,151 | $15,151 | 0.339 | $5,136 |
| 17 | | $15,151 | $15,151 | 0.317 | $4,803 |
| 18 | | $15,151 | $15,151 | 0.296 | $4,485 |
| 19 | | $15,151 | $15,151 | 0.277 | $4,197 |
| 20 | | $40,451 | $40,451 | 0.258 | $10,436 |
| 21 | | $15,151 | $15,151 | 0.242 | $3,667 |
| 22 | | $15,151 | $15,151 | 0.226 | $3,424 |
| 23 | | $15,151 | $15,151 | 0.211 | $3,197 |
| 24 | | $15,151 | $15,151 | 0.197 | $2,985 |
| 25 | | $40,451 | $40,451 | 0.184 | $7,443 |
| 26 | | $15,151 | $15,151 | 0.172 | $2,606 |
| 27 | | $15,151 | $15,151 | 0.161 | $2,439 |
| 28 | | $15,151 | $15,151 | 0.15 | $2,273 |
| 29 | | $15,151 | $15,151 | 0.141 | $2,136 |
| 30 | | $40,451 | $40,451 | 0.131 | $5,299 |
| | | | | **TOTAL PRESENT WORTH** | **$831,128** |

**ZONE 2, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-2.5 EXCAVATION TO MEET I/C PMCs, OFF-SITE TREATMENT (STABILIZATION /SOLIDIFICATION) AND DISPOSAL (LANDFILLING), LUCs, AND MONITORING**
**Capital Cost**

| Item | Quantity | Unit | Unit Cost Subcontract | Unit Cost Material | Unit Cost Labor | Unit Cost Equipment | Extended Cost Subcontract | Extended Cost Material | Extended Cost Labor | Extended Cost Equipment | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1 PROJECT PLANNING** | | | | | | | | | | | |
| 1.1 Prepare LUC RD Documents | 60 | hr | | | $35.00 | | $0 | $0 | $2,100 | $0 | $2,100 |
| 1.2 Prepare Documents & Plans including Permits | 150 | hr | | | $35.00 | | $0 | $0 | $5,250 | $0 | $5,250 |
| **2 PRE-DESIGN INVESTIGATION** | | | | | | | | | | | |
| 2.1 Field Personnel - prep, field, and follow-up | 1.5 | days | | | $350.00 | | $0 | $0 | $525 | $0 | $525 |
| 2.2 Travel & Mob | 1 | ls | $550.00 | | | | $550 | $0 | $0 | $0 | $550 |
| 2.3 Geoprobe - Equipment and Operator | 1 | day | $2,400.00 | | | | $2,400 | $0 | $0 | $0 | $2,400 |
| 2.4 Supplies & PID | 1 | day | $600.00 | | | | $600 | $0 | $0 | $0 | $600 |
| 2.5 Soil Sample Analysis (SPLP Lead, ETPH ) | 1 | ls | $420.00 | | | | $420 | $0 | $0 | $0 | $420 |
| 2.6 Evaluate Data, Prepare Report, and Upload to NIRIS | 1 | ea | $7,000.00 | | | | $7,000 | $0 | $0 | $0 | $7,000 |
| **3 MOBILIZATION, DEMOBILIZATION AND FIELD SUPPORT** | | | | | | | | | | | |
| 3.1 Office Trailer | 1 | mo | | $375.00 | | | $0 | $375 | $0 | $0 | $375 |
| 3.2 Field Office Support | 1 | mo | | $240.00 | | | $0 | $240 | $0 | $0 | $240 |
| 3.3 Utility Connection/Disconnection (phone/electric) | 1 | ls | $1,500.00 | | | | $1,500 | $0 | $0 | $0 | $1,500 |
| 3.4 Site Utilities | 1 | mo | | $230.00 | | | $0 | $230 | $0 | $0 | $230 |
| 3.5 Underground Utility Clearances | 1 | ls | $1,500.00 | | | | $1,500 | $0 | $0 | $0 | $1,500 |
| 3.6 Construction Survey Support | 1 | day | $1,050.00 | | | | $1,050 | $0 | $0 | $0 | $1,050 |
| 3.7 Equipment Mobilization/Demobilization, 70 to 150 HP | 6 | ea | | | $64.00 | $117.00 | $0 | $0 | $384 | $702 | $1,086 |
| 3.8 Site Superintendent | 22 | day | | | $355.00 | | $0 | $0 | $7,810 | $0 | $7,810 |
| 3.9 Site Health & Safety and QA/QC | 22 | day | | | $325.00 | | $0 | $0 | $7,150 | $0 | $7,150 |
| 3.10 Materials Storage Pad, 25' X 25' | 625 | sf | | $3.64 | $0.74 | $1.09 | $0 | $2,275 | $463 | $681 | $3,419 |
| **4 DECONTAMINATION** | | | | | | | | | | | |
| 4.1 Decontamination Services | 1 | mo | | | | $5,045.46 | $0 | $0 | $0 | $5,045 | $5,045 |
| 4.2 Equipment Decon Pad | 1 | ls | | $1,750.00 | $1,500.00 | $425.00 | $0 | $1,750 | $1,500 | $425 | $3,675 |
| 4.3 Decon Water | 1,000 | gal | | $0.20 | | | $0 | $200 | $0 | $0 | $200 |
| 4.4 Decon Water Storage Tank, 6,000 gallon | 1 | mo | | | | $784.24 | $0 | $0 | $0 | $784 | $784 |
| 4.5 Clean Water Storage Tank, 4,000 gallon | 1 | mo | | | | $705.22 | $0 | $0 | $0 | $705 | $705 |
| 4.6 Disposal of Decon Waste (liquid & solid) | 1 | mo | $950.00 | | | | $950 | $0 | $0 | $0 | $950 |
| **5 EXCAVATION AND DISPOSAL** | | | | | | | | | | | |
| 5.1 Pavement Removal, bituminous driveways | 711 | sy | | $2.22 | $1.63 | $3.85 | $0 | $1,579 | $1,159 | $2,738 | $5,476 |
| 5.2 Excavator, 1/2 cy Capacity | 1 | mo | | | $13,050.40 | $7,087.20 | $0 | $0 | $13,050 | $7,087 | $20,138 |
| 5.3 Site Labor, (1 laborer) | 1 | mo | | | $5,561.60 | | $0 | $0 | $5,562 | $0 | $5,562 |
| 5.4 Tractor Loader 1 to 1-1/4 cy | 1 | mo | | | $10,058.40 | $4,383.00 | $0 | $0 | $10,058 | $4,383 | $14,441 |
| 5.5 Characterization Testing - Lead, TCLP Lead | 12 | ea | $168.00 | $10.00 | | | $2,016 | $120 | $0 | $0 | $2,136 |
| 5.6 Confirmation Testing - Lead & SPLP Lead, Rapid Turn | 5 | ea | $336.00 | | | | $1,680 | $0 | $0 | $0 | $1,680 |
| 5.7 Off Site Transportation & Disposal, High Lead | 1,689 | tons | $120.00 | | | | $202,680 | $0 | $0 | $0 | $202,680 |
| 5.8 Off Site Transportation & Recycling, Asphalt | 89 | tons | $19.50 | | | | $1,735 | $0 | $0 | $0 | $1,735 |
| **6 BACKFILL AND SITE RESTORATION** | | | | | | | | | | | |
| 6.1 Clean Backfill | 1,126 | cy | | $8.00 | | | $0 | $9,008 | $0 | $0 | $9,008 |
| 6.2 Tractor Loader 1 to 1-1/4 cy | 2 | days | | | $457.20 | $322.00 | $0 | $0 | $914 | $644 | $1,558 |
| 6.3 Vibrating Roller, 2-Drum, 7.5 HP, 1/2 time Operator | 2 | days | | | $228.60 | $189.60 | $0 | $0 | $457 | $379 | $836 |
| 6.4 Vibratory Plate, 1/2 time Operator | 2 | days | | | $126.40 | $32.00 | $0 | $0 | $253 | $64 | $317 |
| 6.5 Asphalt, 2" Binder, 1" Topping, Small Areas | 6,400 | sf | | $1.03 | $0.24 | $0.30 | $0 | $6,592 | $1,536 | $1,920 | $10,048 |
| **7 POST CONSTRUCTION COST** | | | | | | | | | | | |
| 7.1 Contractor Completion Report | 40 | hr | | | $35.00 | | $0 | $0 | $1,400 | $0 | $1,400 |
| 7.2 Remedial Action Closeout Report | 40 | hr | | | $35.00 | | $0 | $0 | $1,400 | $0 | $1,400 |
| **Subtotal** | | | | | | | $224,081 | $22,369 | $60,971 | $25,558 | $332,979 |
| **Local Area Adjustments** | | | | | | | 100.0% | 98.6% | 104.2% | 104.2% | |
| **Subtotal** | | | | | | | $224,081 | $22,056 | $63,532 | $26,632 | $336,300 |

**ZONE 2, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-2.5 EXCAVATION TO MEET I/C PMCs, OFF-SITE TREATMENT (STABILIZATION /SOLIDIFICATION) AND DISPOSAL (LANDFILLING), LUCs, AND MONITORING**
**Capital Cost**

| Item | Quantity | Unit | Unit Cost Subcontract | Unit Cost Material | Unit Cost Labor | Unit Cost Equipment | Extended Cost Subcontract | Extended Cost Material | Extended Cost Labor | Extended Cost Equipment | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Overhead on Labor Cost @ | 30% | | | | | | | | $19,060 | | $19,060 |
| G & A on Labor Cost @ | 10% | | | | | | | | $6,353 | | $6,353 |
| G & A on Material Cost @ | 10% | | | | | | | $2,206 | | | $2,206 |
| G & A on Equipment Cost @ | 10% | | | | | | | | | $2,663 | $2,663 |
| G & A on Subcontract Cost @ | 10% | | | | | | $22,408 | | | | $22,408 |
| Tax on Materials and Equipment Cost @ | 6% | | | | | | | $1,323 | | $1,598 | $2,921 |
| **Total Direct Cost** | | | | | | | $246,489 | $25,584 | $88,945 | $30,893 | $391,911 |
| Indirects on Total Direct Cost @ | 30% | (excluding transportation and disposal cost) | | | | | | | | | $55,964 |
| Profit on Total Direct Cost @ | 10% | | | | | | | | | | $39,191 |
| **Subtotal** | | | | | | | | | | | $487,066 |
| Health & Safety Monitoring @ | 3% | (includes air quality monitoring) | | | | | | | | | $14,612 |
| **Total Field Cost** | | | | | | | | | | | $501,678 |
| Contingency on Total Field Costs @ | 20% | | | | | | | | | | $100,336 |
| Engineering on Total Field Cost @ | 10% | | | | | | | | | | $50,168 |
| **TOTAL CAPITAL COST** | | | | | | | | | | | **$652,181** |

**ZONE 2, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-2.5 EXCAVATION TO MEET I/C PMCs, OFF-SITE TREATMENT (STABILIZATION /SOLIDIFICATION) AND DISPOSAL (LANDFILLING), LUCs, AND MONITORING**
**ANNUAL COST**

| Item | Item Cost Years 1 & 2 | Item Cost Years 3 & 4 | Item Cost Years 5 through 30 | Item Cost Annually | Item Cost Every 5 Years | Notes |
|---|---|---|---|---|---|---|
| Pavement Maintenance | | | | $2,010 | | Repave 10% of contaminated areas yearly. |
| Groundwater Sampling | $22,272 | $11,136 | $5,568 | | | 4 Wells. Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Labor and supplies for sampling |
| Groundwater Analysis | $784 | $392 | $196 | | | 4 wells, Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Analysis for lead. |
| Groundwater Report | $5,000 | $5,000 | $5,000 | | | |
| Inspection | | | | $1,000 | | Annual LUC inspection |
| Site Review | | | | | $23,000 | 5-year review |
| Subtotal | $28,056 | $16,528 | $10,764 | $3,010 | $23,000 | |
| Contingency at 10% | $2,806 | $1,653 | $1,076 | $301 | $2,300 | |
| **TOTAL** | $30,862 | $18,181 | $11,840 | $3,311 | $25,300 | |

**ZONE 2, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-2.5 EXCAVATION TO MEET I/C PMCs, OFF-SITE TREATMENT (STABILIZATION /SOLIDIFICATION) AND DISPOSAL (LANDFILLING), LUCs, AND MONITORING**
**Present Worth Analysis**

| Year | Capital Cost | Annual Cost | Total Year Cost | Annual Discount Rate at 7% | Present Worth |
|---|---|---|---|---|---|
| 0 | $652,181 | | $652,181 | 1.000 | $652,181 |
| 1 | | $34,172 | $34,172 | 0.935 | $31,951 |
| 2 | | $34,172 | $34,172 | 0.873 | $29,832 |
| 3 | | $21,491 | $21,491 | 0.816 | $17,537 |
| 4 | | $21,491 | $21,491 | 0.763 | $16,398 |
| 5 | | $40,451 | $40,451 | 0.713 | $28,842 |
| 6 | | $15,151 | $15,151 | 0.666 | $10,091 |
| 7 | | $15,151 | $15,151 | 0.623 | $9,439 |
| 8 | | $15,151 | $15,151 | 0.582 | $8,818 |
| 9 | | $15,151 | $15,151 | 0.544 | $8,242 |
| 10 | | $40,451 | $40,451 | 0.508 | $20,549 |
| 11 | | $15,151 | $15,151 | 0.475 | $7,197 |
| 12 | | $15,151 | $15,151 | 0.444 | $6,727 |
| 13 | | $15,151 | $15,151 | 0.415 | $6,288 |
| 14 | | $15,151 | $15,151 | 0.388 | $5,879 |
| 15 | | $40,451 | $40,451 | 0.362 | $14,643 |
| 16 | | $15,151 | $15,151 | 0.339 | $5,136 |
| 17 | | $15,151 | $15,151 | 0.317 | $4,803 |
| 18 | | $15,151 | $15,151 | 0.296 | $4,485 |
| 19 | | $15,151 | $15,151 | 0.277 | $4,197 |
| 20 | | $40,451 | $40,451 | 0.258 | $10,436 |
| 21 | | $15,151 | $15,151 | 0.242 | $3,667 |
| 22 | | $15,151 | $15,151 | 0.226 | $3,424 |
| 23 | | $15,151 | $15,151 | 0.211 | $3,197 |
| 24 | | $15,151 | $15,151 | 0.197 | $2,985 |
| 25 | | $40,451 | $40,451 | 0.184 | $7,443 |
| 26 | | $15,151 | $15,151 | 0.172 | $2,606 |
| 27 | | $15,151 | $15,151 | 0.161 | $2,439 |
| 28 | | $15,151 | $15,151 | 0.15 | $2,273 |
| 29 | | $15,151 | $15,151 | 0.141 | $2,136 |
| 30 | | $40,451 | $40,451 | 0.131 | $5,299 |
| | | | | **TOTAL PRESENT WORTH** | **$939,138** |

**ZONE 2, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-2.6 EXCAVATION TO MEET RESIDENTIAL DEC AND PMC, ON-SITE DEWATERING, AND OFF-SITE TREATMENT (LTTD AND STABILIZATION /SOLIDIFICATION) AND DISPOSAL (LANDFILLING)**
**Capital Cost**

| Item | Quantity | Unit | Unit Cost Subcontract | Unit Cost Material | Unit Cost Labor | Unit Cost Equipment | Extended Cost Subcontract | Extended Cost Material | Extended Cost Labor | Extended Cost Equipment | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1 PROJECT PLANNING** | | | | | | | | | | | |
| 1.1 Prepare Documents & Plans including Permits | 150 | hr | | | $35.00 | | $0 | $0 | $5,250 | $0 | $5,250 |
| **2 PRE-DESIGN INVESTIGATION** | | | | | | | | | | | |
| 2.1 Field Personnel - prep, field, and follow-up | 1.5 | days | | | $350.00 | | $0 | $0 | $525 | $0 | $525 |
| 2.2 Travel & Mob | 1 | ls | $550.00 | | | | $550 | $0 | $0 | $0 | $550 |
| 2.3 Geoprobe - Equipment and Operator | 1 | day | $2,400.00 | | | | $2,400 | $0 | $0 | $0 | $2,400 |
| 2.4 Supplies & PID | 1 | day | $600.00 | | | | $600 | $0 | $0 | $0 | $600 |
| 2.5 Soil Sample Analysis (SPLP Lead, ETPH ) | 1 | ls | $420.00 | | | | $420 | $0 | $0 | $0 | $420 |
| 2.6 Evaluate Data, Prepare Report, and Upload to NIRIS | 1 | ea | $7,000.00 | | | | $7,000 | $0 | $0 | $0 | $7,000 |
| **3 MOBILIZATION, DEMOBILIZATION AND FIELD SUPPORT** | | | | | | | | | | | |
| 3.1 Office Trailer | 3 | mo | | | | $375.00 | $0 | $0 | $0 | $1,125 | $1,125 |
| 3.2 Field Office Support | 3 | mo | | $155.00 | | | $0 | $465 | $0 | $0 | $465 |
| 3.3 Storage Trailer (1) | 3 | mo | | | | $99.00 | $0 | $0 | $0 | $297 | $297 |
| 3.4 Utility Connection/Disconnection (phone/electric) | 1 | ls | $1,500.00 | | | | $1,500 | $0 | $0 | $0 | $1,500 |
| 3.5 Site Utilities | 3 | mo | $150.00 | | | | $450 | $0 | $0 | $0 | $450 |
| 3.6 Construction Survey Support | 2 | day | $975.00 | | | | $1,950 | $0 | $0 | $0 | $1,950 |
| 3.7 Equipment Mobilization/Demobilization | 8 | ea | | | $85.00 | $261.00 | $0 | $0 | $680 | $2,088 | $2,768 |
| 3.8 Site Superintendent | 66 | day | | | $355.00 | | $0 | $0 | $23,430 | $0 | $23,430 |
| 3.9 Site Health & Safety and QA/QC | 66 | day | | | $325.00 | | $0 | $0 | $21,450 | $0 | $21,450 |
| 3.10 Materials Storage Pad, 25' X 25' | 625 | sf | | $3.64 | $0.74 | $1.09 | $0 | $2,275 | $463 | $681 | $3,419 |
| 3.11 Dewatering Pad, 40' X 40' | 1,600 | sf | | $5.62 | $0.85 | $1.24 | $0 | $8,992 | $1,360 | $1,984 | $12,336 |
| 3.12 Maintain Dewatering Pad, Replace Top 5x | 8,000 | sf | | $0.32 | $0.11 | $0.13 | $0 | $2,560 | $880 | $1,040 | $4,480 |
| **4 DECONTAMINATION** | | | | | | | | | | | |
| 4.1 Decontamination Services | 3 | mo | | | | $5,045.46 | $0 | $0 | $0 | $15,136 | $15,136 |
| 4.2 Equipment Decon Pad | 1 | ls | | $1,750.00 | $1,500.00 | $425.00 | $0 | $1,750 | $1,500 | $425 | $3,675 |
| 4.3 Decon Water | 3,000 | gal | | $0.20 | | | $0 | $600 | $0 | $0 | $600 |
| 4.4 Decon Water Storage Tank, 6,000 gallon | 3 | mo | | | | $784.24 | $0 | $0 | $0 | $2,353 | $2,353 |
| 4.5 Clean Water Storage Tank, 4,000 gallon | 3 | mo | | | | $705.22 | $0 | $0 | $0 | $2,116 | $2,116 |
| 4.6 Disposal of Decon Waste (liquid & solid) | 3 | mo | $950.00 | | | | $2,850 | $0 | $0 | $0 | $2,850 |
| **5 SHEET PILING, EXCAVATION, DEWATERING, AND DISPOSAL** | | | | | | | | | | | |
| 5.1 Pavement Removal | 3,556 | sy | | $2.22 | $1.63 | $3.85 | $0 | $7,893 | $5,796 | $13,689 | $27,378 |
| 5.2 Excavator, 2 CY Capacity | 3 | mo | | | $12,064.80 | $17,678.20 | $0 | $0 | $36,194 | $53,035 | $89,229 |
| 5.3 Site Labor, (3 laborers) | 3 | mo | | | $16,684.80 | | $0 | $0 | $50,054 | $0 | $50,054 |
| 5.4 Sheet Piles, 1000' x 15', tiebacks, drive, extract & salvag | 15,000 | sf | | $8.48 | $6.96 | $9.15 | $0 | $127,125 | $104,400 | $137,250 | $368,775 |
| 5.5 FE Loader 3 1/2 to 5 cy, two | 6 | mo | | | $9,288.40 | $13,544.60 | $0 | $0 | $55,730 | $81,268 | $136,998 |
| 5.6 Crane, 25 Ton with Clamshell Bucket, 1 CY | 1 | mo | | | $12,262.80 | $4,490.91 | $0 | $0 | $12,263 | $4,491 | $16,754 |
| 5.7 Characterization Soil Testing - Lead, TCLP Lead, ETPH | 60 | ea | $268.80 | $10.00 | | | $16,128 | $600 | $0 | $0 | $16,728 |
| 5.8 Confirmation Soil Testing - Lead, SPLP Lead, ETPH, ra | 13 | ea | $537.60 | | | | $6,989 | $0 | $0 | $0 | $6,989 |
| 5.9 Off Site Transportation & Disposal, Lead < 1000 mg/kg | 8,451 | tons | $40.00 | | | | $338,040 | $0 | $0 | $0 | $338,040 |
| 5.10 Off Site Transportation & Disposal, High Lead Soil | 1,689 | tons | $120.00 | | | | $202,680 | $0 | $0 | $0 | $202,680 |
| 5.11 Off Site Transportation & Disposal, High TPH Soil | 278 | tons | $100.00 | | | | $27,750 | $0 | $0 | $0 | $27,750 |
| 5.12 Off Site Transportation & Recycling, Asphalt | 444 | tons | $19.50 | | | | $8,658 | $0 | $0 | $0 | $8,658 |
| 5.13 Centrifugal 15 gpm 1 HP Pump, to Treatment, | 2 | mo | | $2,211 | $636 | | $0 | $4,423 | $1,271 | $0 | $5,694 |
| 5.14 5,000 lb Liquid-Phase GAC Adsorption Units | 2 | ea | | $24,600.00 | | | $0 | $49,200 | $0 | $0 | $49,200 |
| 5.15 Replace GAC | 90,000 | lb | | $2.00 | | | $0 | $180,000 | $0 | $0 | $180,000 |
| 5.16 Bag Filter System | 2 | ea | | $14,000.00 | $225.00 | | $0 | $28,000 | $450 | $0 | $28,450 |
| 5.17 Replace Filter Bags | 288 | ea | | $60.00 | | | $0 | $17,280 | $0 | $0 | $17,280 |
| 5.18 Diaphragm Pump, from Treatment to Storm Sewer | 2 | mo | | | | $542.48 | $0 | $0 | $0 | $1,085 | $1,085 |
| 5.19 Piping , 2" PVC, from Treatment to Storm Sewer | 200 | ft | | $0.51 | $0.72 | | $0 | $102 | $144 | $0 | $246 |
| **6 BACKFILL AND SITE RESTORATION** | | | | | | | | | | | |
| 6.1 Clean Backfill | 6,648 | cy | | $8.00 | | | $0 | $53,184 | $0 | $0 | $53,184 |
| 6.2 FE Loader 3 1/2 to 5 cy | 2 | mo | | | $9,288.40 | $13,544.60 | $0 | $0 | $18,577 | $27,089 | $45,666 |
| 6.3 Vibrating Roller, 2-Drum, 7.5 HP | 2 | mo | | | $10,058.40 | $2,494.40 | $0 | $0 | $20,117 | $4,989 | $25,106 |
| 6.4 Vibratory Plate for use around Utilities | 2 | mo | | | | $297.00 | $0 | $0 | $0 | $594 | $594 |

**ZONE 2, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-2.6 EXCAVATION TO MEET RESIDENTIAL DEC AND PMC, ON-SITE DEWATERING, AND OFF-SITE TREATMENT (LTTD AND STABILIZATION /SOLIDIFICATION) AND DISPOSAL (LANDFILLING)**
**Capital Cost**

| Item | Quantity | Unit | Unit Cost Subcontract | Unit Cost Material | Unit Cost Labor | Unit Cost Equipment | Extended Cost Subcontract | Extended Cost Material | Extended Cost Labor | Extended Cost Equipment | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 6.5 Top Dress Soil | 593 | cy | $31.50 | | | | $18,680 | $0 | $0 | $0 | $18,680 |
| 6.6 Site Restoration, seed, fertilization, mulch | 32 | msf | $75.00 | | | | $2,400 | $0 | $0 | $0 | $2,400 |
| **7 POST CONSTRUCTION COST** | | | | | | | | | | | |
| 7.1 Contractor Completion Report | 80 | hr | - | | $35.00 | | $0 | $0 | $2,800 | $0 | $2,800 |
| 7.2 Remedial Action Closeout Report | 80 | hr | | | $35.00 | | $0 | $0 | $2,800 | $0 | $2,800 |
| **Subtotal** | | | | | | | $639,044 | $484,449 | $366,134 | $350,734 | $1,840,362 |
| **Local Area Adjustments** | | | | | | | 100.0% | 98.6% | 104.2% | 104.2% | |
| **Subtotal** | | | | | | | $639,044 | $477,667 | $381,512 | $365,465 | $1,863,688 |
| Overhead on Labor Cost @ 30% | | | | | | | | | $114,454 | | $114,454 |
| G & A on Labor Cost @ 10% | | | | | | | | | $38,151 | | $38,151 |
| G & A on Material Cost @ 10% | | | | | | | | $47,767 | | | $47,767 |
| G & A on Equipment Cost @ 10% | | | | | | | | | | $36,546 | $36,546 |
| G & A on Subcontract Cost @ 10% | | | | | | | $63,904 | | | | $63,904 |
| Tax on Materials and Equipment Cost @ 6% | | | | | | | | $28,660 | | $21,928 | $50,588 |
| **Total Direct Cost** | | | | | | | $702,949 | $554,094 | $534,116 | $423,939 | $2,215,098 |
| Indirects on Total Direct Cost @ 30% | | (excluding transportation and disposal cost) | | | | | | | | | $490,536 |
| Profit on Total Direct Cost @ 10% | | | | | | | | | | | $221,510 |
| **Subtotal** | | | | | | | | | | | $2,927,144 |
| Health & Safety Monitoring @ 2% | | (includes air quality monitoring) | | | | | | | | | $58,543 |
| **Total Field Cost** | | | | | | | | | | | $2,985,687 |
| Contingency on Total Field Costs @ 20% | | | | | | | | | | | $597,137 |
| Engineering on Total Field Cost @ 10% | | | | | | | | | | | $298,569 |
| **TOTAL CAPITAL COST** | | | | | | | | | | | **$3,881,393** |

# APPENDIX E.1.3

# ZONE 3

# ALTERNATIVES S-3.1, S-3.2, S-3.3, S-3.4, S-3.5, and S-3.6

**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-3.1: NO ACTION**
**Annual Cost**

1/15/2010 11:30 AM

| Item | Item Cost every 5 years | Notes |
|---|---|---|
| Five-Year Review | $23,000 | |
| Subtotal | $23,000 | |
| Contingency @ 10% | $2,300 | |
| **TOTAL** | **$25,300** | |

**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-3.1: NO ACTION**
**Present Worth Analysis**

1/15/2010 11:30 AM

| Year | Capital Cost | Annual Cost | Total Year Cost | Annual Discount Rate at 7% | Present Worth |
|---|---|---|---|---|---|
| 0 | $0 | | $0 | 1.000 | $0 |
| 1 | | | $0 | 0.935 | $0 |
| 2 | | | $0 | 0.873 | $0 |
| 3 | | | $0 | 0.816 | $0 |
| 4 | | | $0 | 0.763 | $0 |
| 5 | | $25,300 | $25,300 | 0.713 | $18,039 |
| 6 | | | $0 | 0.666 | $0 |
| 7 | | | $0 | 0.623 | $0 |
| 8 | | | $0 | 0.582 | $0 |
| 9 | | | $0 | 0.544 | $0 |
| 10 | | $25,300 | $25,300 | 0.508 | $12,852 |
| 11 | | | $0 | 0.475 | $0 |
| 12 | | | $0 | 0.444 | $0 |
| 13 | | | $0 | 0.415 | $0 |
| 14 | | | $0 | 0.388 | $0 |
| 15 | | $25,300 | $25,300 | 0.362 | $9,159 |
| 16 | | | $0 | 0.339 | $0 |
| 17 | | | $0 | 0.317 | $0 |
| 18 | | | $0 | 0.296 | $0 |
| 19 | | | $0 | 0.277 | $0 |
| 20 | | $25,300 | $25,300 | 0.258 | $6,527 |
| 21 | | | $0 | 0.242 | $0 |
| 22 | | | $0 | 0.226 | $0 |
| 23 | | | $0 | 0.211 | $0 |
| 24 | | | $0 | 0.197 | $0 |
| 25 | | $25,300 | $25,300 | 0.184 | $4,655 |
| 26 | | | $0 | 0.172 | $0 |
| 27 | | | $0 | 0.161 | $0 |
| 28 | | | $0 | 0.150 | $0 |
| 29 | | | $0 | 0.141 | $0 |
| 30 | | $25,300 | $25,300 | 0.131 | $3,314 |
| | | | | **TOTAL PRESENT WORTH** | **$54,547** |

**ZONE 3, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-3.2: LUCs and MONITORING**
**CAPITAL COST**

| Item | Quantity | Unit | Unit Cost | | | | Extended Cost | | | | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Subcontract | Material | Labor | Equipment | Subcontract | Material | Labor | Equipment | |
| **1 PROJECT PLANNING** | | | | | | | | | | | |
| 1.1 Prepare Documents & Plans including Permits/Variances | 140 | hr | | | $35.00 | | $0 | $0 | $4,900 | $0 | $4,900 |
| 1.2 Prepare LUC RD Documents | 60 | hr | | | $35.00 | | $0 | $0 | $2,100 | $0 | $2,100 |
| **2 PRE-DESIGN INVESTIGATION** | | | | | | | | | | | |
| 2.1 Field Personnel - prep, field, and follow-up | 1.5 | days | | | $350.00 | | $0 | $0 | $525 | $0 | $525 |
| 2.2 Travel & Mob | 1 | ls | $550.00 | | | | $550 | $0 | $0 | $0 | $550 |
| 2.3 Geoprobe - Equipment and Operator | 1 | day | $2,400.00 | | | | $2,400 | $0 | $0 | $0 | $2,400 |
| 2.4 Supplies & PID | 1 | day | $600.00 | | | | $600 | $0 | $0 | $0 | $600 |
| 2.5 Soil Sample Analysis (Lead, SPLP Lead) | 1 | ls | $1,435.00 | | | | $1,435 | $0 | $0 | $0 | $1,435 |
| 2.6 Evaluate Data, Prepare Report, and Upload to NIRIS | 1 | ea | $12,000.00 | | | | $12,000 | $0 | $0 | $0 | $12,000 |
| **3 FIELD SUPPORT** | | | | | | | | | | | |
| 3.1 Construction Survey Support | 1 | day | $1,050.00 | | | | $1,050 | $0 | $0 | $0 | $1,050 |
| **Subtotal** | | | | | | | $18,035 | $0 | $7,525 | $0 | $25,560 |
| **Local Area Adjustments** | | | | | | | 100.0% | 98.6% | 104.2% | 104.2% | |
| | | | | | | | $18,035 | $0 | $7,841 | $0 | $25,876 |
| Overhead on Labor Cost @ 30% | | | | | | | | | $2,352 | | $2,352 |
| G & A on Labor Cost @ 10% | | | | | | | | | $784 | | $784 |
| G & A on Material Cost @ 10% | | | | | | | | $0 | | | $0 |
| G & A on Subcontract Cost @ 10% | | | | | | | $1,804 | | | | $1,804 |
| G & A on Equipment Cost @ 10% | | | | | | | | | | $0 | $0 |
| Tax on Materials and Equipment Cost @ 6% | | | | | | | | $0 | | $0 | $0 |
| **Total Direct Cost** | | | | | | | $19,839 | $0 | $10,977 | $0 | $30,816 |
| Indirects on Total Direct Cost @ 0% | | | | | | | | | | | $0 |
| Profit on Total Direct Cost @ 10% | | | | | | | | | | | $3,082 |
| **Subtotal** | | | | | | | | | | | $33,898 |
| Health & Safety Monitoring @ 0% | | | | | | | | | | | $0 |
| **Total Field Cost** | | | | | | | | | | | $33,898 |
| Contingency on Total Field Costs @ 0% | | | | | | | | | | | $0 |
| Engineering on Total Field Cost @ 0% | | | | | | | | | | | $0 |
| **TOTAL COST** | | | | | | | | | | | **$33,898** |

**ZONE 3, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-3.2: LUCs and MONITORING**
**ANNUAL COST**

| Item | Item Cost Years 1 & 2 | Item Cost Years 3 & 4 | Item Cost Years 5 through 30 | Item Cost Annually | Item Cost Every 5 Years | Notes |
|---|---|---|---|---|---|---|
| Pavement Maintenance | | | | $2,755 | | Repave 10% of contaminated areas yearly |
| Groundwater Sampling | $22,272 | $11,136 | $5,568 | | | 4 Wells. Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Labor and supplies for sampling |
| Groundwater Analysis | $784 | $392 | $196 | | | 4 wells, Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Analysis for lead |
| Groundwater Report | $5,000 | $5,000 | $5,000 | | | |
| Inspection | | | | $1,000 | | Annual LUC inspection |
| Site Review | | | | | $23,000 | 5-year review |
| Subtotal | $28,056 | $16,528 | $10,764 | $3,755 | $23,000 | |
| Contingency at 10% | $2,806 | $1,653 | $1,076 | $376 | $2,300 | |
| **TOTAL** | $30,862 | $18,181 | $11,840 | $4,131 | $25,300 | |

**ZONE 3, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-3.2: LUCs and MONITORING**
**PRESENT WORTH ANALYSIS**

| Year | Capital Cost | Annual Cost | Total Year Cost | Annual Discount Rate at 7% | Present Worth |
|---|---|---|---|---|---|
| 0 | $33,898 | | $33,898 | 1.000 | $33,898 |
| 1 | | $34,992 | $34,992 | 0.935 | $32,718 |
| 2 | | $34,992 | $34,992 | 0.873 | $30,548 |
| 3 | | $22,312 | $22,312 | 0.816 | $18,206 |
| 4 | | $22,312 | $22,312 | 0.763 | $17,024 |
| 5 | | $41,271 | $41,271 | 0.713 | $29,426 |
| 6 | | $15,971 | $15,971 | 0.666 | $10,637 |
| 7 | | $15,971 | $15,971 | 0.623 | $9,950 |
| 8 | | $15,971 | $15,971 | 0.582 | $9,295 |
| 9 | | $15,971 | $15,971 | 0.544 | $8,688 |
| 10 | | $41,271 | $41,271 | 0.508 | $20,966 |
| 11 | | $15,971 | $15,971 | 0.475 | $7,586 |
| 12 | | $15,971 | $15,971 | 0.444 | $7,091 |
| 13 | | $15,971 | $15,971 | 0.415 | $6,628 |
| 14 | | $15,971 | $15,971 | 0.388 | $6,197 |
| 15 | | $41,271 | $41,271 | 0.362 | $14,940 |
| 16 | | $15,971 | $15,971 | 0.339 | $5,414 |
| 17 | | $15,971 | $15,971 | 0.317 | $5,063 |
| 18 | | $15,971 | $15,971 | 0.296 | $4,728 |
| 19 | | $15,971 | $15,971 | 0.277 | $4,424 |
| 20 | | $41,271 | $41,271 | 0.258 | $10,648 |
| 21 | | $15,971 | $15,971 | 0.242 | $3,865 |
| 22 | | $15,971 | $15,971 | 0.226 | $3,610 |
| 23 | | $15,971 | $15,971 | 0.211 | $3,370 |
| 24 | | $15,971 | $15,971 | 0.197 | $3,146 |
| 25 | | $41,271 | $41,271 | 0.184 | $7,594 |
| 26 | | $15,971 | $15,971 | 0.172 | $2,747 |
| 27 | | $15,971 | $15,971 | 0.161 | $2,571 |
| 28 | | $15,971 | $15,971 | 0.150 | $2,396 |
| 29 | | $15,971 | $15,971 | 0.141 | $2,252 |
| 30 | | $41,271 | $41,271 | 0.131 | $5,407 |
| | | | | **TOTAL PRESENT WORTH** | **$331,034** |

**ZONE 3, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-3.3: CAPPING TO ALLOW I/C SITE USE AND PREVENT LEACHING, LUCS, AND MONITORING**
**Capital Cost**

| Item | Quantity | Unit | Unit Cost Subcontract | Unit Cost Material | Unit Cost Labor | Unit Cost Equipment | Extended Cost Subcontract | Extended Cost Material | Extended Cost Labor | Extended Cost Equipment | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1 PROJECT PLANNING** | | | | | | | | | | | |
| 1.1 Prepare Documents & Plans including Permits | 150 | hr | | | $35.00 | | $0 | $0 | $5,250 | $0 | $5,250 |
| 1.2 Prepare LUC RD Documents | 60 | hr | | | $35.00 | | $0 | $0 | $2,100 | $0 | $2,100 |
| **2 PRE-DESIGN INVESTIGATION** | | | | | | | | | | | |
| 2.1 Field Personnel - prep, field, and follow-up | 1.5 | days | | | $350.00 | | $0 | $0 | $525 | $0 | $525 |
| 2.2 Travel & Mob | 1 | ls | $550.00 | | | | $550 | $0 | $0 | $0 | $550 |
| 2.3 Geoprobe - Equipment and Operator | 1 | day | $2,400.00 | | | | $2,400 | $0 | $0 | $0 | $2,400 |
| 2.4 Supplies & PID | 1 | day | $600.00 | | | | $600 | $0 | $0 | $0 | $600 |
| 2.5 Soil Sample Analysis (Lead, SPLP Lead) | 1 | ls | $1,435.00 | | | | $1,435 | $0 | $0 | $0 | $1,435 |
| 2.6 Evaluate Data, Prepare Report, and Upload to NIRIS | 1 | ea | $12,000.00 | | | | $12,000 | $0 | $0 | $0 | $12,000 |
| **3 MOBILIZATION, DEMOBILIZATION AND FIELD SUPPORT** | | | | | | | | | | | |
| 3.1 Office Trailer | 0.5 | mo | | | | $375.00 | $0 | $0 | $0 | $188 | $188 |
| 3.2 Field Office Support | 0.5 | mo | | $155.00 | | | $0 | $78 | $0 | $0 | $78 |
| 3.3 Storage Trailer (1) | 0.5 | mo | | | | $99.00 | $0 | $0 | $0 | $50 | $50 |
| 3.4 Utility Connection/Disconnection (phone/electric) | 1 | ls | $1,500.00 | | | | $1,500 | $0 | $0 | $0 | $1,500 |
| 3.5 Site Utilities | 0.5 | mo | $150.00 | | | | $75 | $0 | $0 | $0 | $75 |
| 3.6 Underground Utility Clearances | 1 | ls | $1,500.00 | | | | $1,500 | $0 | $0 | $0 | $1,500 |
| 3.7 Construction Survey Support | 2 | day | $975.00 | | | | $1,950 | $0 | $0 | $0 | $1,950 |
| 3.8 Equipment Mobilization/Demobilization | 4 | ea | | | $85.00 | $261.00 | $0 | $0 | $340 | $1,044 | $1,384 |
| 3.9 Site Superintendent | 11 | day | | | $355.00 | | $0 | $0 | $3,905 | $0 | $3,905 |
| 3.10 Site Health & Safety and QA/QC | 11 | day | | | $325.00 | | $0 | $0 | $3,575 | $0 | $3,575 |
| 3.11 Materials Storage Pad, 25' X 25' | 625 | sf | | $3.64 | $0.74 | $1.09 | $0 | $2,275 | $463 | $681 | $3,419 |
| **4 DECONTAMINATION** | | | | | | | | | | | |
| 4.1 Decontamination Services | 0.5 | mo | | | | $5,045.46 | $0 | $0 | $0 | $2,523 | $2,523 |
| 4.2 Equipment Decon Pad | 1 | ls | | $3,500.00 | $3,000.00 | $425.00 | $0 | $3,500 | $3,000 | $425 | $6,925 |
| 4.3 Decon Water | 500 | gal | | $0.20 | | | $0 | $100 | $0 | $0 | $100 |
| 4.4 Decon Water Storage Tank, 6,000 gallon | 0.5 | mo | | | | $784.24 | $0 | $0 | $0 | $392 | $392 |
| 4.5 Clean Water Storage Tank, 4,000 gallon | 0.5 | mo | | | | $705.22 | $0 | $0 | $0 | $353 | $353 |
| 4.6 Disposal of Decon Waste (liquid & solid) | 0.5 | mo | $950.00 | | | | $475 | $0 | $0 | $0 | $475 |
| **5 EXCAVATION AND DISPOSAL** | | | | | | | | | | | |
| 5.1 Pavement Removal | 975 | sy | | $2.22 | $1.63 | $3.85 | $0 | $2,165 | $1,589 | $3,754 | $7,508 |
| 5.2 Excavator, 1/2 cy Capacity | 3 | days | | | $593.20 | $547.60 | $0 | $0 | $1,780 | $1,643 | $3,422 |
| 5.3 Site Labor, (3 laborers) | 3 | days | | | $758.40 | | $0 | $0 | $2,275 | $0 | $2,275 |
| 5.4 Tractor Loader 1 to 1-1/4 cy | 3 | days | | | $457.20 | $322.00 | $0 | $0 | $1,372 | $966 | $2,338 |
| 5.5 Characterization Testing -mass and TCLP lead | 12 | ea | $168.00 | $10.00 | | | $2,016 | $120 | $0 | $0 | $2,136 |
| 5.6 Confirmation Testing - mass and SPLP lead, rapid | 4 | ea | $336.00 | | | | $1,344 | $0 | $0 | $0 | $1,344 |
| 5.7 Off Site Transportation & Disposal, High Lead | 854 | tons | $120.00 | | | | $102,420 | $0 | $0 | $0 | $102,420 |
| 5.8 Off Site Transportation & Recycling, Asphalt | 122 | tons | $19.50 | | | | $2,378 | $0 | $0 | $0 | $2,378 |
| **6 BACKFILL, CAPPING AND SITE RESTORATION** | | | | | | | | | | | |
| 6.1 60-mil VLDPE Geomembrane | 8,775 | sf | | $0.48 | $1.43 | $0.27 | $0 | $4,212 | $12,548 | $2,369 | $19,130 |
| 6.2 12 oz/sy Cushion Geotextile, Small Areas | 975 | sy | | $2.19 | $0.12 | $0.05 | $0 | $2,135 | $117 | $44 | $2,296 |
| 6.3 Clean Sand | 650 | cy | | $4.00 | $0.50 | $1.07 | $0 | $2,600 | $322 | $692 | $3,614 |
| 6.4 Asphalt, 2" Binder, 1" Topping, Small Areas | 8,775 | sf | | $1.03 | $0.24 | $0.30 | $0 | $9,038 | $2,106 | $2,633 | $13,777 |
| **7 POST CONSTRUCTION COST** | | | | | | | | | | | |
| 7.1 Contractor Completion Report | 40 | hr | | | $35.00 | | $0 | $0 | $1,400 | $0 | $1,400 |
| 7.2 Remedial Action Closeout Report | 40 | hr | | | $35.00 | | $0 | $0 | $1,400 | $0 | $1,400 |
| **Subtotal** | | | | | | | $130,643 | $26,223 | $44,066 | $17,755 | $218,687 |
| **Local Area Adjustments** | | | | | | | 100.0% | 98.6% | 104.2% | 104.2% | |
| **Subtotal** | | | | | | | $130,643 | $25,855 | $45,917 | $18,501 | $220,916 |

**ZONE 3, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-3.3: CAPPING TO ALLOW I/C SITE USE AND PREVENT LEACHING, LUCS, AND MONITORING**
**Capital Cost**

| Item | Quantity | Unit | Unit Cost Subcontract | Unit Cost Material | Unit Cost Labor | Unit Cost Equipment | Extended Cost Subcontract | Extended Cost Material | Extended Cost Labor | Extended Cost Equipment | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Overhead on Labor Cost @ | 30% | | | | | | | | $13,775 | | $13,775 |
| G & A on Labor Cost @ | 10% | | | | | | | | $4,592 | | $4,592 |
| G & A on Material Cost @ | 10% | | | | | | | $2,586 | | | $2,586 |
| G & A on Equipment Cost @ | 10% | | | | | | | | | $1,850 | $1,850 |
| G & A on Subcontract Cost @ | 10% | | | | | | $13,064 | | | | $13,064 |
| Tax on Materials and Equipment Cost @ | 6% | | | | | | | $1,551 | | $1,110 | $2,661 |
| **Total Direct Cost** | | | | | | | $143,707 | $29,992 | $64,284 | $21,461 | $259,444 |
| Indirects on Total Direct Cost @ | 30% | (excluding transportation and disposal cost) | | | | | | | | | $46,251 |
| Profit on Total Direct Cost @ | 10% | | | | | | | | | | $25,944 |
| **Subtotal** | | | | | | | | | | | $331,640 |
| Health & Safety Monitoring @ | 3% | (includes air quality monitoring) | | | | | | | | | $9,949 |
| **Total Field Cost** | | | | | | | | | | | $341,589 |
| Contingency on Total Field Costs @ | 20% | | | | | | | | | | $68,318 |
| Engineering on Total Field Cost @ | 15% | | | | | | | | | | $51,238 |
| **TOTAL CAPITAL COST** | | | | | | | | | | | **$461,145** |

**ZONE 3, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-3.3: CAPPING TO ALLOW I/C SITE USE AND PREVENT LEACHING, LUCS, AND MONITORING**
**ANNUAL COST**

| Item | Item Cost Years 1 & 2 | Item Cost Years 3 & 4 | Item Cost Years 5 through 30 | Item Cost Annually | Item Cost Every 5 Years | Notes |
|---|---|---|---|---|---|---|
| Pavement Maintenance | | | | $2,755 | | Repave 10% of contaminated areas yearly. |
| Groundwater Sampling | $22,272 | $11,136 | $5,568 | | | 4 Wells. Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Labor and supplies for sampling |
| Groundwater Analysis | $784 | $392 | $196 | | | 4 wells, Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Analysis for lead. |
| Groundwater Report | $5,000 | $5,000 | $5,000 | | | |
| Inspection | | | | $1,000 | | Annual LUC inspection |
| Site Review | | | | | $23,000 | 5-year review |
| Subtotal | $28,056 | $16,528 | $10,764 | $3,755 | $23,000 | |
| Contingency at 10% | $2,806 | $1,653 | $1,076 | $376 | $2,300 | |
| **TOTAL** | $30,862 | $18,181 | $11,840 | $4,131 | $25,300 | |

**ZONE 3, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-3.3: CAPPING TO ALLOW I/C SITE USE AND PREVENT LEACHING, LUCS, AND MONITORING**
**Present Worth Analysis**

| Year | Capital Cost | Annual Cost | Total Year Cost | Annual Discount Rate at 7% | Present Worth |
|---|---|---|---|---|---|
| 0 | $461,145 | | $461,145 | 1.000 | $461,145 |
| 1 | | $34,992 | $34,992 | 0.935 | $32,718 |
| 2 | | $34,992 | $34,992 | 0.873 | $30,548 |
| 3 | | $22,312 | $22,312 | 0.816 | $18,206 |
| 4 | | $22,312 | $22,312 | 0.763 | $17,024 |
| 5 | | $41,271 | $41,271 | 0.713 | $29,426 |
| 6 | | $15,971 | $15,971 | 0.666 | $10,637 |
| 7 | | $15,971 | $15,971 | 0.623 | $9,950 |
| 8 | | $15,971 | $15,971 | 0.582 | $9,295 |
| 9 | | $15,971 | $15,971 | 0.544 | $8,688 |
| 10 | | $41,271 | $41,271 | 0.508 | $20,966 |
| 11 | | $15,971 | $15,971 | 0.475 | $7,586 |
| 12 | | $15,971 | $15,971 | 0.444 | $7,091 |
| 13 | | $15,971 | $15,971 | 0.415 | $6,628 |
| 14 | | $15,971 | $15,971 | 0.388 | $6,197 |
| 15 | | $41,271 | $41,271 | 0.362 | $14,940 |
| 16 | | $15,971 | $15,971 | 0.339 | $5,414 |
| 17 | | $15,971 | $15,971 | 0.317 | $5,063 |
| 18 | | $15,971 | $15,971 | 0.296 | $4,728 |
| 19 | | $15,971 | $15,971 | 0.277 | $4,424 |
| 20 | | $41,271 | $41,271 | 0.258 | $10,648 |
| 21 | | $15,971 | $15,971 | 0.242 | $3,865 |
| 22 | | $15,971 | $15,971 | 0.226 | $3,610 |
| 23 | | $15,971 | $15,971 | 0.211 | $3,370 |
| 24 | | $15,971 | $15,971 | 0.197 | $3,146 |
| 25 | | $41,271 | $41,271 | 0.184 | $7,594 |
| 26 | | $15,971 | $15,971 | 0.172 | $2,747 |
| 27 | | $15,971 | $15,971 | 0.161 | $2,571 |
| 28 | | $15,971 | $15,971 | 0.15 | $2,396 |
| 29 | | $15,971 | $15,971 | 0.141 | $2,252 |
| 30 | | $41,271 | $41,271 | 0.131 | $5,407 |
| | | | | **TOTAL PRESENT WORTH** | **$758,282** |

**ZONE 3, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-3.4 IN SITU TREATMENT (STABILIZATION /SOLIDIFICATION) TO MEET I/C PMCs, LUCs, AND MONITORING**
**Capital Cost**

| Item | Quantity | Unit | Unit Cost Subcontract | Unit Cost Material | Unit Cost Labor | Unit Cost Equipment | Extended Cost Subcontract | Extended Cost Material | Extended Cost Labor | Extended Cost Equipment | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1 PROJECT PLANNING** | | | | | | | | | | | |
| 1.1 Prepare LUC RD Documents | 60 | hr | | | $35.00 | | $0 | $0 | $2,100 | $0 | $2,100 |
| 1.2 Prepare Documents & Plans including Permits | 150 | hr | | | $35.00 | | $0 | $0 | $5,250 | $0 | $5,250 |
| **2 PRE-DESIGN INVESTIGATION** | | | | | | | | | | | |
| 2.1 Field Personnel - prep, field, and follow-up | 1.5 | days | | | $350.00 | | $0 | $0 | $525 | $0 | $525 |
| 2.2 Travel & Mob | 1 | ls | $550.00 | | | | $550 | $0 | $0 | $0 | $550 |
| 2.3 Geoprobe - Equipment and Operator | 1 | day | $2,400.00 | | | | $2,400 | $0 | $0 | $0 | $2,400 |
| 2.4 Supplies & PID | 1 | day | $600.00 | | | | $600 | $0 | $0 | $0 | $600 |
| 2.5 Soil Sample Analysis (Lead, SPLP Lead) | 1 | ls | $1,435.00 | | | | $1,435 | $0 | $0 | $0 | $1,435 |
| 2.6 Evaluate Data, Prepare Report, and Upload to NIRIS | 1 | ea | $12,000.00 | | | | $12,000 | $0 | $0 | $0 | $12,000 |
| **3 MOBILIZATION, DEMOBILIZATION AND FIELD SUPPORT** | | | | | | | | | | | |
| 3.1 Storage Trailer (1) | 1 | mo | | | | $99.00 | $0 | $0 | $0 | $99 | $99 |
| 3.2 Underground Utility Clearances | 1 | ls | $3,500.00 | | | | $3,500 | $0 | $0 | $0 | $3,500 |
| 3.3 Construction Survey | 1 | day | $2,125.00 | | | | $2,125 | $0 | $0 | $0 | $2,125 |
| 3.4 Large Diameter Auger Mobilization/Demobilization | 1 | ea | $100,000.00 | | | | $100,000 | $0 | $0 | $0 | $100,000 |
| 3.5 Temporary Fencing | 1 | ls | | $500.00 | | | $0 | $500 | $0 | $0 | $500 |
| 3.6 Field Construction Mgt. (1 person) | 8 | day | | $200.00 | $350.00 | | $0 | $1,600 | $2,800 | $0 | $4,400 |
| 3.7 Site Health & Safety and QA/QC | 8 | day | | $200.00 | $325.00 | | $0 | $1,600 | $2,600 | $0 | $4,200 |
| **4 IN-SITU TREATMENT** | | | | | | | | | | | |
| 4.1 Pavement Removal | 975 | sy | | $2.22 | $1.63 | $3.85 | $0 | $2,165 | $1,589 | $3,754 | $7,508 |
| 4.2 Off Site Transportation & Recycling, Asphalt | 122 | tons | $19.50 | | | | $2,378 | $0 | $0 | $0 | $2,378 |
| 4.3 Treatability Test | 1 | ls | $5,000.00 | | | | $5,000 | $0 | $0 | $0 | $5,000 |
| 4.4 Auger Soil | 1,544 | cy | $60.00 | | | | $92,640 | $0 | $0 | $0 | $92,640 |
| 4.5 Utility Relocation - Storm and Sanitary Sewer Lines | 1 | ls | $50,000.00 | | | | $50,000 | $0 | $0 | $0 | $50,000 |
| 4.6 Post-Treatment Soil Testing - SPLP | 2 | ea | $119.00 | $10.00 | | | $238 | $20 | $0 | $0 | $258 |
| 4.7 Off Site Transportation & Disposal, Excess Stablized Soi | 240 | tons | $25.00 | | | | $6,000 | $0 | $0 | $0 | $6,000 |
| **5 BACKFILL AND SITE RESTORATION** | | | | | | | | | | | |
| 5.1 Asphalt, 2" Binder, 1" Topping, Small Areas | 8,775 | sf | | $1.03 | $0.24 | $0.30 | $0 | $9,038 | $2,106 | $2,633 | $13,777 |
| **6 POST CONSTRUCTION COST** | | | | | | | | | | | |
| 6.1 Contractor Completion Report | 40 | hr | | | $35.00 | | $0 | $0 | $1,400 | $0 | $1,400 |
| 6.2 Remedial Action Closeout Report | 40 | hr | | | $35.00 | | $0 | $0 | $1,400 | $0 | $1,400 |
| **Subtotal** | | | | | | | $278,866 | $14,923 | $19,770 | $6,485 | $320,044 |
| **Local Area Adjustments** | | | | | | | 100.0% | 98.6% | 104.2% | 104.2% | |
| **Subtotal** | | | | | | | $278,866 | $14,714 | $20,601 | $6,758 | $320,938 |
| Overhead on Labor Cost @ 30% | | | | | | | | | $6,180 | | $6,180 |
| G & A on Labor Cost @ 10% | | | | | | | | | $2,060 | | $2,060 |
| G & A on Material Cost @ 10% | | | | | | | | $1,471 | | | $1,471 |
| G & A on Equipment Cost @ 10% | | | | | | | | | | $676 | $676 |
| G & A on Subcontract Cost @ 10% | | | | | | | $27,887 | | | | $27,887 |
| Tax on Materials and Equipment Cost @ 6% | | | | | | | | $883 | | $405 | $1,288 |
| **Total Direct Cost** | | | | | | | $306,753 | $17,068 | $28,841 | $7,839 | $360,500 |
| Indirects on Total Direct Cost @ 30% | | (excluding transportation and disposal cost) | | | | | | | | | $105,637 |
| Profit on Total Direct Cost @ 10% | | | | | | | | | | | $36,050 |
| **Subtotal** | | | | | | | | | | | $502,187 |
| Health & Safety Monitoring @ 3% | | (includes air quality monitoring) | | | | | | | | | $15,066 |

**ZONE 3, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-3.4 IN SITU TREATMENT (STABILIZATION /SOLIDIFICATION) TO MEET I/C PMCs, LUCs, AND MONITORING**
**Capital Cost**

| Item | Quantity | Unit | Unit Cost Subcontract | Unit Cost Material | Unit Cost Labor | Unit Cost Equipment | Extended Cost Subcontract | Extended Cost Material | Extended Cost Labor | Extended Cost Equipment | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total Field Cost** | | | | | | | | | | | $517,253 |
| Contingency on Total Field Costs @ 20% | | | | | | | | | | | $103,451 |
| Engineering on Total Field Cost @ 15% | | | | | | | | | | | $77,588 |
| **TOTAL CAPITAL COST** | | | | | | | | | | | **$698,291** |

**ZONE 3, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-3.4 IN SITU TREATMENT (STABILIZATION /SOLIDIFICATION) TO MEET I/C PMCs, LUCs, AND MONITORING**
**ANNUAL COST**

| Item | Item Cost Years 1 & 2 | Item Cost Years 3 & 4 | Item Cost Years 5 through 30 | Item Cost Annually | Item Cost Every 5 Years | Notes |
|---|---|---|---|---|---|---|
| Pavement Maintenance | | | | $2,755 | | Repave 10% of contaminated areas yearly. |
| Groundwater Sampling | $22,272 | $11,136 | $5,568 | | | 4 Wells. Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Labor and supplies for sampling |
| Groundwater Analysis | $448 | $224 | $112 | | | 4 wells, Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Analysis for lead. |
| Groundwater Report | $5,000 | $5,000 | $5,000 | | | |
| Inspection | | | | $1,000 | | Annual LUC inspection |
| Site Review | | | | | $23,000 | 5-year review |
| Subtotal | $27,720 | $16,360 | $10,680 | $3,755 | $23,000 | |
| Contingency at 10% | $2,772 | $1,636 | $1,068 | $376 | $2,300 | |
| **TOTAL** | $30,492 | $17,996 | $11,748 | $4,131 | $25,300 | |

**ZONE 3, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-3.4 IN SITU TREATMENT (STABILIZATION /SOLIDIFICATION) TO MEET I/C PMCs, LUCs, AND MONI**
**PRESENT WORTH ANALYSIS**

| Year | Capital Cost | Annual Cost | Total Year Cost | Annual Discount Rate at 7% | Present Worth |
|---|---|---|---|---|---|
| 0 | $698,291 | | $698,291 | 1.000 | $698,291 |
| 1 | | $34,623 | $34,623 | 0.935 | $32,372 |
| 2 | | $34,623 | $34,623 | 0.873 | $30,226 |
| 3 | | $22,127 | $22,127 | 0.816 | $18,056 |
| 4 | | $22,127 | $22,127 | 0.763 | $16,883 |
| 5 | | $41,179 | $41,179 | 0.713 | $29,361 |
| 6 | | $15,879 | $15,879 | 0.666 | $10,575 |
| 7 | | $15,879 | $15,879 | 0.623 | $9,893 |
| 8 | | $15,879 | $15,879 | 0.582 | $9,242 |
| 9 | | $15,879 | $15,879 | 0.544 | $8,638 |
| 10 | | $41,179 | $41,179 | 0.508 | $20,919 |
| 11 | | $15,879 | $15,879 | 0.475 | $7,542 |
| 12 | | $15,879 | $15,879 | 0.444 | $7,050 |
| 13 | | $15,879 | $15,879 | 0.415 | $6,590 |
| 14 | | $15,879 | $15,879 | 0.388 | $6,161 |
| 15 | | $41,179 | $41,179 | 0.362 | $14,907 |
| 16 | | $15,879 | $15,879 | 0.339 | $5,383 |
| 17 | | $15,879 | $15,879 | 0.317 | $5,034 |
| 18 | | $15,879 | $15,879 | 0.296 | $4,700 |
| 19 | | $15,879 | $15,879 | 0.277 | $4,398 |
| 20 | | $41,179 | $41,179 | 0.258 | $10,624 |
| 21 | | $15,879 | $15,879 | 0.242 | $3,843 |
| 22 | | $15,879 | $15,879 | 0.226 | $3,589 |
| 23 | | $15,879 | $15,879 | 0.211 | $3,350 |
| 24 | | $15,879 | $15,879 | 0.197 | $3,128 |
| 25 | | $41,179 | $41,179 | 0.184 | $7,577 |
| 26 | | $15,879 | $15,879 | 0.172 | $2,731 |
| 27 | | $15,879 | $15,879 | 0.161 | $2,557 |
| 28 | | $15,879 | $15,879 | 0.150 | $2,382 |
| 29 | | $15,879 | $15,879 | 0.141 | $2,239 |
| 30 | | $41,179 | $41,179 | 0.131 | $5,394 |
| | | | | **TOTAL PRESENT WORTH** | **$993,634** |

**ZONE 3, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-3.5 EXCAVATION TO MEET I/C DEC AND PMC, OFF-SITE TREATMENT (STABILIZATION /SOLIDIFICATION) AND DISPOSAL (LANDFILLING), LUCs, AND MONITORING**
**Capital Cost**

| | | | Unit Cost | | | | Extended Cost | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Item | Quantity | Unit | Subcontract | Material | Labor | Equipment | Subcontract | Material | Labor | Equipment | Subtotal |
| **1 PROJECT PLANNING** | | | | | | | | | | | |
| 1.1 Prepare LUC RD Documents | 60 | hr | | | $35.00 | | $0 | $0 | $2,100 | $0 | $2,100 |
| 1.2 Prepare Documents & Plans including Permits | 150 | hr | | | $35.00 | | $0 | $0 | $5,250 | $0 | $5,250 |
| **2 PRE-DESIGN INVESTIGATION** | | | | | | | | | | | |
| 2.1 Field Personnel - prep, field, and follow-up | 1.5 | days | | | $350.00 | | $0 | $0 | $525 | $0 | $525 |
| 2.2 Travel & Mob | 1 | ls | $550.00 | | | | $550 | $0 | $0 | $0 | $550 |
| 2.3 Geoprobe - Equipment and Operator | 1 | day | $2,400.00 | | | | $2,400 | $0 | $0 | $0 | $2,400 |
| 2.4 Supplies & PID | 1 | day | $600.00 | | | | $600 | $0 | $0 | $0 | $600 |
| 2.5 Soil Sample Analysis (Lead, SPLP Lead) | 1 | ls | $1,435.00 | | | | $1,435 | $0 | $0 | $0 | $1,435 |
| 2.6 Evaluate Data, Prepare Report, and Upload to NIRIS | 1 | ea | $12,000.00 | | | | $12,000 | $0 | $0 | $0 | $12,000 |
| **3 MOBILIZATION, DEMOBILIZATION AND FIELD SUPPORT** | | | | | | | | | | | |
| 3.1 Office Trailer | 1 | mo | | $375.00 | | | $0 | $375 | $0 | $0 | $375 |
| 3.2 Field Office Support | 1 | mo | | $240.00 | | | $0 | $240 | $0 | $0 | $240 |
| 3.4 Utility Connection/Disconnection (phone/electric) | 1 | ls | $1,500.00 | | | | $1,500 | $0 | $0 | $0 | $1,500 |
| 3.5 Site Utilities | 1 | mo | | $230.00 | | | $0 | $230 | $0 | $0 | $230 |
| 3.6 Underground Utility Clearances | 1 | ls | $1,500.00 | | | | $1,500 | $0 | $0 | $0 | $1,500 |
| 3.7 Construction Survey Support | 1 | day | $1,050.00 | | | | $1,050 | $0 | $0 | $0 | $1,050 |
| 3.8 Equipment Mobilization/Demobilization, 70 to 150 HP | 6 | ea | | | $64.00 | $117.00 | $0 | $0 | $384 | $702 | $1,086 |
| 3.9 Site Superintendent | 22 | day | | | $355.00 | | $0 | $0 | $7,810 | $0 | $7,810 |
| 3.10 Site Health & Safety and QA/QC | 22 | day | | | $325.00 | | $0 | $0 | $7,150 | $0 | $7,150 |
| 3.11 Materials Storage Pad, 25' X 25' | 625 | sf | | $3.64 | $0.74 | $1.09 | $0 | $2,275 | $463 | $681 | $3,419 |
| **4 DECONTAMINATION** | | | | | | | | | | | |
| 4.1 Decontamination Services | 1 | mo | | | | $5,045.46 | $0 | $0 | $0 | $5,045 | $5,045 |
| 4.2 Equipment Decon Pad | 1 | ls | | $1,750.00 | $1,500.00 | $425.00 | $0 | $1,750 | $1,500 | $425 | $3,675 |
| 4.3 Decon Water | 1,000 | gal | | $0.20 | | | $0 | $200 | $0 | $0 | $200 |
| 4.4 Decon Water Storage Tank, 6,000 gallon | 1 | mo | | | | $784.24 | $0 | $0 | $0 | $784 | $784 |
| 4.5 Clean Water Storage Tank, 4,000 gallon | 1 | mo | | | | $705.22 | $0 | $0 | $0 | $705 | $705 |
| 4.6 Disposal of Decon Waste (liquid & solid) | 1 | mo | $950.00 | | | | $950 | $0 | $0 | $0 | $950 |
| **5 EXCAVATION AND DISPOSAL** | | | | | | | | | | | |
| 5.1 Pavement Removal, bituminous driveways | 975 | sy | | $2.22 | $1.63 | $3.85 | $0 | $2,165 | $1,589 | $3,754 | $7,508 |
| 5.2 Excavator, 1/2 cy Capacity | 1 | mo | | | $13,050.40 | $7,087.20 | $0 | $0 | $13,050 | $7,087 | $20,138 |
| 5.3 Site Labor, (1 laborer) | 1 | mo | | | $5,561.60 | | $0 | $0 | $5,562 | $0 | $5,562 |
| 5.4 Tractor Loader 1 to 1-1/4 cy | 1 | mo | | | $10,058.40 | $4,383.00 | $0 | $0 | $10,058 | $4,383 | $14,441 |
| 5.5 Characterization/Offsite Disposal Soil Testing | 16 | ea | $168.00 | $10.00 | | | $2,688 | $160 | $0 | $0 | $2,848 |
| 5.6 Confirmation Testing - Lead & TCLP Lead, Rapid Turn | 6 | ea | $336.00 | | | | $2,016 | $0 | $0 | $0 | $2,016 |
| 5.7 Off Site Transportation & Disposal, High Lead | 2,316 | tons | $120.00 | | | | $277,920 | $0 | $0 | $0 | $277,920 |
| 5.8 Off Site Transportation & Recycling, Asphalt | 122 | tons | $19.50 | | | | $2,378 | $0 | $0 | $0 | $2,378 |
| **6 BACKFILL AND SITE RESTORATION** | | | | | | | | | | | |
| 6.1 Clean Backfill | 1,544 | cy | | $8.00 | | | $0 | $12,352 | $0 | $0 | $12,352 |
| 6.2 Tractor Loader 1 to 1-1/4 cy | 3 | days | | | $457.20 | $322.00 | $0 | $0 | $1,372 | $966 | $2,338 |
| 6.3 Vibrating Roller, 2-Drum, 7.5 HP, 1/2 time Operator | 3 | days | | | $228.60 | $189.60 | $0 | $0 | $686 | $569 | $1,255 |
| 6.4 Vibratory Plate, 1/2 time Operator | 3 | days | | | $126.40 | $32.00 | $0 | $0 | $379 | $96 | $475 |
| 6.5 Asphalt, 2" Binder, 1" Topping, Small Areas | 8,775 | sf | | $1.03 | $0.24 | $0.30 | $0 | $9,038 | $2,106 | $2,633 | $13,777 |
| **7 POST CONSTRUCTION COST** | | | | | | | | | | | |
| 7.1 Contractor Completion Report | 40 | hr | | | $35.00 | | $0 | $0 | $1,400 | $0 | $1,400 |
| 7.2 Remedial Action Closeout Report | 40 | hr | | | $35.00 | | $0 | $0 | $1,400 | $0 | $1,400 |
| **Subtotal** | | | | | | | $306,987 | $28,785 | $62,784 | $27,830 | $426,386 |
| **Local Area Adjustments** | | | | | | | 100.0% | 98.6% | 104.2% | 104.2% | |
| **Subtotal** | | | | | | | $306,987 | $28,382 | $65,421 | $28,999 | $429,789 |

**ZONE 3, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-3.5 EXCAVATION TO MEET I/C DEC AND PMC, OFF-SITE TREATMENT (STABILIZATION /SOLIDIFICATION) AND DISPOSAL (LANDFILLING), LUCs, AND MONITORING**
**Capital Cost**

| Item | Quantity | Unit | Unit Cost Subcontract | Unit Cost Material | Unit Cost Labor | Unit Cost Equipment | Extended Cost Subcontract | Extended Cost Material | Extended Cost Labor | Extended Cost Equipment | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Overhead on Labor Cost @ | 30% | | | | | | | | $19,626 | | $19,626 |
| G & A on Labor Cost @ | 10% | | | | | | | | $6,542 | | $6,542 |
| G & A on Material Cost @ | 10% | | | | | | | $2,838 | | | $2,838 |
| G & A on Equipment Cost @ | 10% | | | | | | | | | $2,900 | $2,900 |
| G & A on Subcontract Cost @ | 10% | | | | | | $30,699 | | | | $30,699 |
| Tax on Materials and Equipment Cost @ | 6% | | | | | | | $1,703 | | $1,740 | $3,443 |
| **Total Direct Cost** | | | | | | | $337,686 | $32,923 | $91,589 | $33,639 | $495,837 |
| Indirects on Total Direct Cost @ | 30% | (excluding transportation and disposal cost) | | | | | | | | | $64,377 |
| Profit on Total Direct Cost @ | 10% | | | | | | | | | | $49,584 |
| **Subtotal** | | | | | | | | | | | $609,797 |
| Health & Safety Monitoring @ | 3% | (includes air quality monitoring) | | | | | | | | | $18,294 |
| **Total Field Cost** | | | | | | | | | | | $628,091 |
| Contingency on Total Field Costs @ | 20% | | | | | | | | | | $125,618 |
| Engineering on Total Field Cost @ | 10% | | | | | | | | | | $62,809 |
| **TOTAL CAPITAL COST** | | | | | | | | | | | **$816,518** |

**ZONE 3, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-3.5 EXCAVATION TO MEET I/C DEC AND PMC, OFF-SITE TREATMENT (STABILIZATION /SOLIDIFICATION) AND DISPOSAL (LANDFILLING), LUCs, AND MONITORING**
**ANNUAL COST**

| Item | Item Cost Years 1 & 2 | Item Cost Years 3 & 4 | Item Cost Years 5 through 30 | Item Cost Annually | Item Cost Every 5 Years | Notes |
|---|---|---|---|---|---|---|
| Pavement Maintenance | | | | $2,755 | | Repave 10% of contaminated areas yearly. |
| Groundwater Sampling | $22,272 | $11,136 | $5,568 | | | 4 Wells. Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Labor and supplies for sampling |
| Groundwater Analysis | $784 | $392 | $196 | | | 4 wells, Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Analysis for lead. |
| Groundwater Report | $5,000 | $5,000 | $5,000 | | | |
| Inspection | | | | $1,000 | | Annual LUC inspection |
| Site Review | | | | | $23,000 | 5-year review |
| Subtotal | $28,056 | $16,528 | $10,764 | $3,755 | $23,000 | |
| Contingency at 10% | $2,806 | $1,653 | $1,076 | $376 | $2,300 | |
| **TOTAL** | $30,862 | $18,181 | $11,840 | $4,131 | $25,300 | |

**ZONE 3, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-3.5 EXCAVATION TO MEET I/C DEC AND PMC, OFF-SITE TREATMENT (STABILIZATION /SOLIDIFICATION) AND DISPOSAL (LANDFILLING), LUCs, AND MONITORING**
**Present Worth Analysis**

| Year | Capital Cost | Annual Cost | Total Year Cost | Annual Discount Rate at 7% | Present Worth |
|---|---|---|---|---|---|
| 0 | $816,518 | | $816,518 | 1.000 | $816,518 |
| 1 | | $34,992 | $34,992 | 0.935 | $32,718 |
| 2 | | $34,992 | $34,992 | 0.873 | $30,548 |
| 3 | | $22,312 | $22,312 | 0.816 | $18,206 |
| 4 | | $22,312 | $22,312 | 0.763 | $17,024 |
| 5 | | $41,271 | $41,271 | 0.713 | $29,426 |
| 6 | | $15,971 | $15,971 | 0.666 | $10,637 |
| 7 | | $15,971 | $15,971 | 0.623 | $9,950 |
| 8 | | $15,971 | $15,971 | 0.582 | $9,295 |
| 9 | | $15,971 | $15,971 | 0.544 | $8,688 |
| 10 | | $41,271 | $41,271 | 0.508 | $20,966 |
| 11 | | $15,971 | $15,971 | 0.475 | $7,586 |
| 12 | | $15,971 | $15,971 | 0.444 | $7,091 |
| 13 | | $15,971 | $15,971 | 0.415 | $6,628 |
| 14 | | $15,971 | $15,971 | 0.388 | $6,197 |
| 15 | | $41,271 | $41,271 | 0.362 | $14,940 |
| 16 | | $15,971 | $15,971 | 0.339 | $5,414 |
| 17 | | $15,971 | $15,971 | 0.317 | $5,063 |
| 18 | | $15,971 | $15,971 | 0.296 | $4,728 |
| 19 | | $15,971 | $15,971 | 0.277 | $4,424 |
| 20 | | $41,271 | $41,271 | 0.258 | $10,648 |
| 21 | | $15,971 | $15,971 | 0.242 | $3,865 |
| 22 | | $15,971 | $15,971 | 0.226 | $3,610 |
| 23 | | $15,971 | $15,971 | 0.211 | $3,370 |
| 24 | | $15,971 | $15,971 | 0.197 | $3,146 |
| 25 | | $41,271 | $41,271 | 0.184 | $7,594 |
| 26 | | $15,971 | $15,971 | 0.172 | $2,747 |
| 27 | | $15,971 | $15,971 | 0.161 | $2,571 |
| 28 | | $15,971 | $15,971 | 0.15 | $2,396 |
| 29 | | $15,971 | $15,971 | 0.141 | $2,252 |
| 30 | | $41,271 | $41,271 | 0.131 | $5,407 |
| | | | | **TOTAL PRESENT WORTH** | **$1,113,654** |

**ZONE 3, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**

**ALTERNATIVE S-3.6 EXCAVATION TO MEET RESIDENTIAL DECs AND PMCs, ON-SITE DEWATERING, AND OFF-SITE TREATMENT (LTTD AND SOLIDIFICATION/STABILIZATION) AND DISPOSAL (LANDFILLING)**
**Capital Cost**

| | | | | Unit Cost | | | Extended Cost | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Item | Quantity | Unit | Subcontract | Material | Labor | Equipment | Subcontract | Material | Labor | Equipment | Subtotal |
| **1 PROJECT PLANNING** | | | | | | | | | | | |
| 1.1 Prepare Documents & Plans including Permits | 200 | hr | | | $35.00 | | $0 | $0 | $7,000 | $0 | $7,000 |
| **2 PRE-DESIGN INVESTIGATION** | | | | | | | | | | | |
| 2.1 Field Personnel - prep, field, and follow-up | 1.5 | days | | | $350.00 | | $0 | $0 | $525 | $0 | $525 |
| 2.2 Travel & Mob | 1 | ls | $550.00 | | | | $550 | $0 | $0 | $0 | $550 |
| 2.3 Geoprobe - Equipment and Operator | 1 | day | $2,400.00 | | | | $2,400 | $0 | $0 | $0 | $2,400 |
| 2.4 Supplies & PID | 1 | day | $600.00 | | | | $600 | $0 | $0 | $0 | $600 |
| 2.5 Soil Sample Analysis (Lead, SPLP Lead) | 1 | ls | $1,435.00 | | | | $1,435 | $0 | $0 | $0 | $1,435 |
| 2.6 Evaluate Data, Prepare Report, and Upload to NIRIS | 1 | ea | $12,000.00 | | | | $12,000 | $0 | $0 | $0 | $12,000 |
| **3 MOBILIZATION, DEMOBILIZATION AND FIELD SUPPORT** | | | | | | | | | | | |
| 3.1 Office Trailer | 4 | mo | | | | $375.00 | $0 | $0 | $0 | $1,500 | $1,500 |
| 3.2 Field Office Support | 4 | mo | | $155.00 | | | $0 | $620 | $0 | $0 | $620 |
| 3.3 Storage Trailer (1) | 4 | mo | | | | $99.00 | $0 | $0 | $0 | $396 | $396 |
| 3.4 Utility Connection/Disconnection (phone/electric) | 1 | ls | $1,500.00 | | | | $1,500 | $0 | $0 | $0 | $1,500 |
| 3.5 Site Utilities | 4 | mo | $150.00 | | | | $600 | $0 | $0 | $0 | $600 |
| 3.6 Construction Survey Support | 2 | day | $975.00 | | | | $1,950 | $0 | $0 | $0 | $1,950 |
| 3.7 Equipment Mobilization/Demobilization | 8 | ea | | | $85.00 | $261.00 | $0 | $0 | $680 | $2,088 | $2,768 |
| 3.8 Site Superintendent | 88 | day | | | $355.00 | | $0 | $0 | $31,240 | $0 | $31,240 |
| 3.9 Site Health & Safety and QA/QC | 88 | day | | | $325.00 | | $0 | $0 | $28,600 | $0 | $28,600 |
| 3.10 Materials Storage Pad, 25' X 25' | 625 | sf | | $3.64 | $0.74 | $1.09 | $0 | $2,275 | $463 | $681 | $3,419 |
| 3.11 Dewatering Pad, 40' X 40' | 1,600 | sf | | $5.62 | $0.85 | $1.24 | $0 | $8,992 | $1,360 | $1,984 | $12,336 |
| 3.12 Maintain Dewatering Pad, Replace Top 4> | 6,400 | sf | | $0.32 | $0.11 | $0.13 | $0 | $2,048 | $704 | $832 | $3,584 |
| **4 DECONTAMINATION** | | | | | | | | | | | |
| 4.1 Decontamination Services | 4 | mo | | | | $5,045.46 | $0 | $0 | $0 | $20,182 | $20,182 |
| 4.2 Equipment Decon Pad | 1 | ls | | $1,750.00 | $1,500.00 | $425.00 | $0 | $1,750 | $1,500 | $425 | $3,675 |
| 4.3 Decon Water | 4,000 | gal | | $0.20 | | | $0 | $800 | $0 | $0 | $800 |
| 4.4 Decon Water Storage Tank, 6,000 gallon | 4 | mo | | | | $784.24 | $0 | $0 | $0 | $3,137 | $3,137 |
| 4.5 Clean Water Storage Tank, 4,000 gallon | 4 | mo | | | | $705.22 | $0 | $0 | $0 | $2,821 | $2,821 |
| 4.6 Disposal of Decon Waste (liquid & solid) | 4 | mo | $950.00 | | | | $3,800 | $0 | $0 | $0 | $3,800 |
| **5 SHEET PILING, EXCAVATION, DEWATERING, AND DISPOSAL** | | | | | | | | | | | |
| 5.1 Pavement Removal | 2,098 | sy | | $2.22 | $1.63 | $3.85 | $0 | $4,657 | $3,419 | $8,076 | $16,153 |
| 5.2 Reinforced Concrete Floor Slab Remova | 141 | cy | | | $59.00 | $43.50 | $0 | $0 | $8,326 | $6,138 | $14,464 |
| 5.3 Excavator, 2 CY Capacity | 4 | mo | | | $12,064.80 | $17,678.20 | $0 | $0 | $48,259 | $70,713 | $118,972 |
| 5.4 Site Labor, (3 laborers) | 4 | mo | | | $16,684.80 | | $0 | $0 | $66,739 | $0 | $66,739 |
| 5.5 Sheet Piles, 800' x 15', tiebacks, drive, extract & salvage | 12,000 | sf | | $8.48 | $6.96 | $9.15 | $0 | $101,700 | $83,520 | $109,800 | $295,020 |
| 5.6 FE Loader 3 1/2 to 5 cy, two | 8 | mo | | | $9,288.40 | $13,544.60 | $0 | $0 | $74,307 | $108,357 | $182,664 |
| 5.7 Crane, 25 Ton with Clamshell Bucket, 1 CY | 1 | mo | | | $12,262.80 | $4,490.91 | $0 | $0 | $12,263 | $4,491 | $16,754 |
| 5.8 Characterization Soil Testing - Lead, TCLP, ETPH, PAH | 47 | ea | $478.80 | $10.00 | | | $22,504 | $470 | $0 | $0 | $22,974 |
| 5.9 Confirmation Soil Testing - SPLP, Lead, ETPH, PAH, ra | 20 | ea | $957.60 | | | | $19,152 | $0 | $0 | $0 | $19,152 |
| 5.10 Off Site Transportation & Disposal, High Lead Soi | 7,835 | tons | $120.00 | | | | $940,140 | $0 | $0 | $0 | $940,140 |
| 5.11 Off Site Transportation & Disposal, High TPH or PAH Sc | 6,668 | tons | $100.00 | | | | $666,750 | $0 | $0 | $0 | $666,750 |
| 5.12 Off Site Transportation & Recycling, Asphalt, Concrete | 474 | tons | $19.50 | | | | $9,243 | $0 | $0 | $0 | $9,243 |
| 5.13 Centrifugal 15 gpm 1 HP Pump, to Treatment, | 1 | mo | | $2,211 | $636 | | $0 | $2,211 | $636 | $0 | $2,847 |
| 5.14 5,000 lb Liquid-Phase GAC Adsorption Units | 2 | ea | | $24,600.00 | | | $0 | $49,200 | $0 | $0 | $49,200 |
| 5.15 Replace GAC | 70,000 | lb | | $2.00 | | | $0 | $140,000 | $0 | $0 | $140,000 |
| 5.16 Bag Filter System | 2 | ea | | $14,000.00 | $225.00 | | $0 | $28,000 | $450 | $0 | $28,450 |
| 5.17 Replace Filter Bags | 240 | ea | | $60.00 | | | $0 | $14,400 | $0 | $0 | $14,400 |
| 5.18 Diaphragm Pump, from Treatment to Storm Sewe | 1 | mo | | | | $542.48 | $0 | $0 | $0 | $542 | $542 |
| 5.19 Piping , 2" PVC, from Treatment to Storm Sewe | 200 | ft | | $0.51 | $0.72 | | $0 | $102 | $144 | $0 | $246 |
| **6 BACKFILL AND SITE RESTORATION** | | | | | | | | | | | |

**ZONE 3, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**

**ALTERNATIVE S-3.6 EXCAVATION TO MEET RESIDENTIAL DECs AND PMCs, ON-SITE DEWATERING, AND OFF-SITE TREATMENT (LTTD AND SOLIDIFICATION/STABILIZATION) AND DISPOSAL (LANDFILLING)**
**Capital Cost**

| Item | Quantity | Unit | Unit Cost Subcontract | Unit Cost Material | Unit Cost Labor | Unit Cost Equipment | Extended Cost Subcontract | Extended Cost Material | Extended Cost Labor | Extended Cost Equipment | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 6.1 Clean Backfill | 9,634 | cy | | $8.00 | | | $0 | $77,072 | $0 | $0 | $77,072 |
| 6.2 FE Loader 3 1/2 to 5 cy | 2 | mo | | | $9,288.40 | $13,544.60 | $0 | $0 | $18,577 | $27,089 | $45,666 |
| 6.3 Vibrating Roller, 2-Drum, 7.5 HP | 2 | mo | | | $10,058.40 | $2,494.40 | $0 | $0 | $20,117 | $4,989 | $25,106 |
| 6.4 Vibratory Plate for use around Utilities | 2 | mo | | | | $297.00 | $0 | $0 | $0 | $594 | $594 |
| 6.5 Top Dress Soil | 350 | cy | $31.50 | | | | $11,025 | $0 | $0 | $0 | $11,025 |
| 6.6 Site Restoration, seed, fertilization, mulch | 26.9 | msf | $75.00 | | | | $2,018 | $0 | $0 | $0 | $2,018 |
| **7 POST CONSTRUCTION COST** | | | | | | | | | | | |
| 7.1 Contractor Completion Report | 80 | hr | | | $35.00 | | $0 | $0 | $2,800 | $0 | $2,800 |
| 7.2 Remedial Action Closeout Report | 80 | hr | | | $35.00 | | $0 | $0 | $2,800 | $0 | $2,800 |
| **Subtotal** | | | | | | | $1,695,666 | $434,298 | $414,428 | $374,836 | $2,919,227 |
| **Local Area Adjustments** | | | | | | | 100.0% | 98.6% | 104.2% | 104.2% | |
| **Subtotal** | | | | | | | $1,695,666 | $428,217 | $431,834 | $390,579 | $2,946,296 |
| Overhead on Labor Cost @ 30% | | | | | | | | | $129,550 | | $129,550 |
| G & A on Labor Cost @ 10% | | | | | | | | | $43,183 | | $43,183 |
| G & A on Material Cost @ 10% | | | | | | | | $42,822 | | | $42,822 |
| G & A on Equipment Cost @ 10% | | | | | | | | | | $39,058 | $39,058 |
| G & A on Subcontract Cost @ 10% | | | | | | | $169,567 | | | | $169,567 |
| Tax on Materials and Equipment Cost @ 6% | | | | | | | | $25,693 | | $23,435 | $49,128 |
| **Total Direct Cost** | | | | | | | $1,865,233 | $496,732 | $604,568 | $453,071 | $3,419,604 |
| Indirects on Total Direct Cost @ 30% | | (excluding transportation and disposal cost) | | | | | | | | | $539,901 |
| Profit on Total Direct Cost @ 10% | | | | | | | | | | | $341,960 |
| **Subtotal** | | | | | | | | | | | $4,301,466 |
| Health & Safety Monitoring @ 2% | | (includes air quality monitoring) | | | | | | | | | $86,029 |
| **Total Field Cost** | | | | | | | | | | | $4,387,495 |
| Contingency on Total Field Costs @ 20% | | | | | | | | | | | $877,499 |
| Engineering on Total Field Cost @ 10% | | | | | | | | | | | $438,750 |
| **TOTAL CAPITAL COST** | | | | | | | | | | | **$5,703,744** |

# APPENDIX E.1.4

# ZONE 4

# ALTERNATIVES S-4.1, S-4.2, S-4.3, S-4.4, S-4.5, and S-4.6

**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-4.1: NO ACTION**
**Annual Cost**

1/15/2010 11:32 AM

| Item | Item Cost every 5 years | Notes |
|---|---|---|
| Five-Year Review | $23,000 | |
| Subtotal | $23,000 | |
| Contingency @ 10% | $2,300 | |
| **TOTAL** | **$25,300** | |

**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-4.1: NO ACTION**
**Present Worth Analysis**

| Year | Capital Cost | Annual Cost | Total Year Cost | Annual Discount Rate at 7% | Present Worth |
|---|---|---|---|---|---|
| 0 | $0 | | $0 | 1.000 | $0 |
| 1 | | | $0 | 0.935 | $0 |
| 2 | | | $0 | 0.873 | $0 |
| 3 | | | $0 | 0.816 | $0 |
| 4 | | | $0 | 0.763 | $0 |
| 5 | | $25,300 | $25,300 | 0.713 | $18,039 |
| 6 | | | $0 | 0.666 | $0 |
| 7 | | | $0 | 0.623 | $0 |
| 8 | | | $0 | 0.582 | $0 |
| 9 | | | $0 | 0.544 | $0 |
| 10 | | $25,300 | $25,300 | 0.508 | $12,852 |
| 11 | | | $0 | 0.475 | $0 |
| 12 | | | $0 | 0.444 | $0 |
| 13 | | | $0 | 0.415 | $0 |
| 14 | | | $0 | 0.388 | $0 |
| 15 | | $25,300 | $25,300 | 0.362 | $9,159 |
| 16 | | | $0 | 0.339 | $0 |
| 17 | | | $0 | 0.317 | $0 |
| 18 | | | $0 | 0.296 | $0 |
| 19 | | | $0 | 0.277 | $0 |
| 20 | | $25,300 | $25,300 | 0.258 | $6,527 |
| 21 | | | $0 | 0.242 | $0 |
| 22 | | | $0 | 0.226 | $0 |
| 23 | | | $0 | 0.211 | $0 |
| 24 | | | $0 | 0.197 | $0 |
| 25 | | $25,300 | $25,300 | 0.184 | $4,655 |
| 26 | | | $0 | 0.172 | $0 |
| 27 | | | $0 | 0.161 | $0 |
| 28 | | | $0 | 0.150 | $0 |
| 29 | | | $0 | 0.141 | $0 |
| 30 | | $25,300 | $25,300 | 0.131 | $3,314 |
| | | | | **TOTAL PRESENT WORTH** | **$54,547** |

**ZONE 4, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-4.2: LUCs and Monitoring**
**CAPITAL COST**

| Item | Quantity | Unit | Unit Cost | | | | Extended Cost | | | | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Subcontract | Material | Labor | Equipment | Subcontract | Material | Labor | Equipment | |
| **1 PROJECT PLANNING** | | | | | | | | | | | |
| 1.1 Prepare Documents & Plans including Permits/Variances | 140 | hr | | | $35.00 | | $0 | $0 | $4,900 | $0 | $4,900 |
| 1.2 Prepare LUC RD Documents | 60 | hr | | | $35.00 | | $0 | $0 | $2,100 | $0 | $2,100 |
| **2 PRE-DESIGN INVESTIGATION** | | | | | | | | | | | |
| 2.1 Field Personnel - prep, field, and follow-up | 1.5 | days | | | $350.00 | | $0 | $0 | $525 | $0 | $525 |
| 2.2 Travel & Mob | 1 | ls | $550.00 | | | | $550 | $0 | $0 | $0 | $550 |
| 2.3 Geoprobe - Equipment and Operator | 1 | day | $2,400.00 | | | | $2,400 | $0 | $0 | $0 | $2,400 |
| 2.4 Supplies & PID | 1 | day | $600.00 | | | | $600 | $0 | $0 | $0 | $600 |
| 2.5 Soil Sample Analysis (Lead, SPLP Lead) | 1 | ls | $2,050.00 | | | | $2,050 | $0 | $0 | $0 | $2,050 |
| 2.6 Evaluate Data, Prepare Report, and Upload to NIRIS | 1 | ea | $22,000.00 | | | | $22,000 | $0 | $0 | $0 | $22,000 |
| **3 FIELD SUPPORT** | | | | | | | | | | | |
| 3.1 Construction Survey Support | 1 | day | $1,050.00 | | | | $1,050 | $0 | $0 | $0 | $1,050 |
| **Subtotal** | | | | | | | $28,650 | $0 | $7,525 | $0 | $36,175 |
| **Local Area Adjustments** | | | | | | | 100.0% | 98.6% | 104.2% | 104.2% | |
| | | | | | | | $28,650 | $0 | $7,841 | $0 | $36,491 |
| Overhead on Labor Cost @ 30% | | | | | | | | | $2,352 | | $2,352 |
| G & A on Labor Cost @ 10% | | | | | | | | | $784 | | $784 |
| G & A on Material Cost @ 10% | | | | | | | | $0 | | | $0 |
| G & A on Subcontract Cost @ 10% | | | | | | | $2,865 | | | | $2,865 |
| G & A on Equipment Cost @ 10% | | | | | | | | | | $0 | $0 |
| **Total Direct Cost** | | | | | | | $31,515 | $0 | $10,977 | $0 | $42,492 |
| Indirects on Total Direct Cost @ 0% | | | | | | | | | | | $0 |
| Profit on Total Direct Cost @ 10% | | | | | | | | | | | $4,249 |
| **Subtotal** | | | | | | | | | | | $46,742 |
| Health & Safety Monitoring @ 0% | | | | | | | | | | | $0 |
| **Total Field Cost** | | | | | | | | | | | $46,742 |
| Contingency on Total Field Costs @ 0% | | | | | | | | | | | $0 |
| Engineering on Total Field Cost @ 0% | | | | | | | | | | | $0 |
| **TOTAL COST** | | | | | | | | | | | **$46,742** |

**ZONE 4, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-4.2: LUCs and Monitoring**
**ANNUAL COST**

| Item | Item Cost Years 1 & 2 | Item Cost Years 3 & 4 | Item Cost Years 5 through 30 | Item Cost Annually | Item Cost Every 5 Years | Notes |
|---|---|---|---|---|---|---|
| Pavement Maintenance | | | | $10,488 | | Repave 10% of contaminated areas yearly |
| Groundwater Sampling | $22,272 | $11,136 | $5,568 | | | 4 Wells. Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Labor and supplies for sampling |
| Groundwater Analysis | $2,800 | $1,400 | $700 | | | 4 wells, Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Analysis for TPH and lead |
| Groundwater Report | $5,000 | $5,000 | $5,000 | | | |
| Inspection | | | | $1,000 | | Annual LUC inspection |
| Site Review | | | | | $23,000 | 5-year review |
| Subtotal | $30,072 | $17,536 | $11,268 | $11,488 | $23,000 | |
| Contingency at 10% | $3,007 | $1,754 | $1,127 | $1,149 | $2,300 | |
| **TOTAL** | $33,079 | $19,290 | $12,395 | $12,636 | $25,300 | |

**ZONE 4, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-4.2: LUCs and Monitoring**
**PRESENT WORTH ANALYSIS**

| Year | Capital Cost | Annual Cost | Total Year Cost | Annual Discount Rate at 7% | Present Worth |
|---|---|---|---|---|---|
| 0 | $46,742 | | $46,742 | 1.000 | $46,742 |
| 1 | | $45,716 | $45,716 | 0.935 | $42,744 |
| 2 | | $45,716 | $45,716 | 0.873 | $39,910 |
| 3 | | $31,926 | $31,926 | 0.816 | $26,052 |
| 4 | | $31,926 | $31,926 | 0.763 | $24,360 |
| 5 | | $50,331 | $50,331 | 0.713 | $35,886 |
| 6 | | $25,031 | $25,031 | 0.666 | $16,671 |
| 7 | | $25,031 | $25,031 | 0.623 | $15,594 |
| 8 | | $25,031 | $25,031 | 0.582 | $14,568 |
| 9 | | $25,031 | $25,031 | 0.544 | $13,617 |
| 10 | | $50,331 | $50,331 | 0.508 | $25,568 |
| 11 | | $25,031 | $25,031 | 0.475 | $11,890 |
| 12 | | $25,031 | $25,031 | 0.444 | $11,114 |
| 13 | | $25,031 | $25,031 | 0.415 | $10,388 |
| 14 | | $25,031 | $25,031 | 0.388 | $9,712 |
| 15 | | $50,331 | $50,331 | 0.362 | $18,220 |
| 16 | | $25,031 | $25,031 | 0.339 | $8,486 |
| 17 | | $25,031 | $25,031 | 0.317 | $7,935 |
| 18 | | $25,031 | $25,031 | 0.296 | $7,409 |
| 19 | | $25,031 | $25,031 | 0.277 | $6,934 |
| 20 | | $50,331 | $50,331 | 0.258 | $12,985 |
| 21 | | $25,031 | $25,031 | 0.242 | $6,058 |
| 22 | | $25,031 | $25,031 | 0.226 | $5,657 |
| 23 | | $25,031 | $25,031 | 0.211 | $5,282 |
| 24 | | $25,031 | $25,031 | 0.197 | $4,931 |
| 25 | | $50,331 | $50,331 | 0.184 | $9,261 |
| 26 | | $25,031 | $25,031 | 0.172 | $4,305 |
| 27 | | $25,031 | $25,031 | 0.161 | $4,030 |
| 28 | | $25,031 | $25,031 | 0.150 | $3,755 |
| 29 | | $25,031 | $25,031 | 0.141 | $3,529 |
| 30 | | $50,331 | $50,331 | 0.131 | $6,593 |
| | | | | **TOTAL PRESENT WORTH** | **$460,184** |

**ZONE 4, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-4.3: CAPPING TO ALLOW I/C SITE USE AND PREVENT LEACHING, LUCS, AND MONITORING**
**Capital Cost**

| Item | Quantity | Unit | Unit Cost Subcontract | Unit Cost Material | Unit Cost Labor | Unit Cost Equipment | Extended Cost Subcontract | Extended Cost Material | Extended Cost Labor | Extended Cost Equipment | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1 PROJECT PLANNING** | | | | | | | | | | | |
| 1.1 Prepare LUC RD Documents | 60 | hr | | | $35.00 | | $0 | $0 | $2,100 | $0 | $2,100 |
| 1.2 Prepare Documents & Plans including Permits | 150 | hr | | | $35.00 | | $0 | $0 | $5,250 | $0 | $5,250 |
| **2 PRE-DESIGN INVESTIGATION** | | | | | | | | | | | |
| 2.1 Field Personnel - prep, field, and follow-up | 1.5 | days | | | $350.00 | | $0 | $0 | $525 | $0 | $525 |
| 2.2 Travel & Mob | 1 | ls | $550.00 | | | | $550 | $0 | $0 | $0 | $550 |
| 2.3 Geoprobe - Equipment and Operator | 1 | day | $2,400.00 | | | | $2,400 | $0 | $0 | $0 | $2,400 |
| 2.4 Supplies & PID | 1 | day | $600.00 | | | | $600 | $0 | $0 | $0 | $600 |
| 2.5 Soil Sample Analysis (Lead, SPLP Lead) | 1 | ls | $2,050.00 | | | | $2,050 | $0 | $0 | $0 | $2,050 |
| 2.6 Evaluate Data, Prepare Report, and Upload to NIRIS | 1 | ea | $22,000.00 | | | | $22,000 | $0 | $0 | $0 | $22,000 |
| **3 MOBILIZATION, DEMOBILIZATION AND FIELD SUPPORT** | | | | | | | | | | | |
| 3.1 Office Trailer | 1 | mo | | | | $375.00 | $0 | $0 | $0 | $375 | $375 |
| 3.2 Field Office Support | 1 | mo | | $155.00 | | | $0 | $155 | $0 | $0 | $155 |
| 3.3 Storage Trailer (1) | 1 | mo | | | | $99.00 | $0 | $0 | $0 | $99 | $99 |
| 3.4 Utility Connection/Disconnection (phone/electric) | 1 | ls | $1,500.00 | | | | $1,500 | $0 | $0 | $0 | $1,500 |
| 3.5 Site Utilities | 1 | mo | $150.00 | | | | $150 | $0 | $0 | $0 | $150 |
| 3.6 Underground Utility Clearances | 1 | ls | $1,500.00 | | | | $1,500 | $0 | $0 | $0 | $1,500 |
| 3.7 Construction Survey Support | 2 | day | $975.00 | | | | $1,950 | $0 | $0 | $0 | $1,950 |
| 3.8 Equipment Mobilization/Demobilization | 4 | ea | | | $85.00 | $261.00 | $0 | $0 | $340 | $1,044 | $1,384 |
| 3.9 Site Superintendent | 22 | day | | | $355.00 | | $0 | $0 | $7,810 | $0 | $7,810 |
| 3.10 Site Health & Safety and QA/QC | 22 | day | | | $325.00 | | $0 | $0 | $7,150 | $0 | $7,150 |
| 3.11 Materials Storage Pad, 25' X 25' | 625 | sf | | $3.64 | $0.74 | $1.09 | $0 | $2,275 | $463 | $681 | $3,419 |
| **4 DECONTAMINATION** | | | | | | | | | | | |
| 4.1 Decontamination Services | 1 | mo | | | | $5,045.46 | $0 | $0 | $0 | $5,045 | $5,045 |
| 4.2 Equipment Decon Pad | 1 | ls | | $3,500.00 | $3,000.00 | $425.00 | $0 | $3,500 | $3,000 | $425 | $6,925 |
| 4.3 Decon Water | 500 | gal | | $0.20 | | | $0 | $100 | $0 | $0 | $100 |
| 4.4 Decon Water Storage Tank, 6,000 gallon | 1 | mo | | | | $784.24 | $0 | $0 | $0 | $784 | $784 |
| 4.5 Clean Water Storage Tank, 4,000 gallon | 1 | mo | | | | $705.22 | $0 | $0 | $0 | $705 | $705 |
| 4.6 Disposal of Decon Waste (liquid & solid) | 1 | mo | $950.00 | | | | $950 | $0 | $0 | $0 | $950 |
| **5 EXCAVATION AND DISPOSAL** | | | | | | | | | | | |
| 5.1 Pavement Removal | 3,711 | sy | | $2.22 | $1.63 | $3.85 | $0 | $8,239 | $6,049 | $14,288 | $28,576 |
| 5.2 Excavator, 1/2 cy Capacity | 2 | wk | | | $2,966.00 | $1,973.00 | $0 | $0 | $5,932 | $3,946 | $9,878 |
| 5.3 Site Labor, (3 laborers) | 2 | wk | | | $3,792.00 | | $0 | $0 | $7,584 | $0 | $7,584 |
| 5.4 Tractor Loader 1 to 1-1/4 cy | 2 | wk | | | $2,286.00 | $1,195.00 | $0 | $0 | $4,572 | $2,390 | $6,962 |
| 5.5 Characterization Testing - PAH, TPH, lead, TCLP | 25 | ea | $478.80 | $10.00 | | | $11,970 | $250 | $0 | $0 | $12,220 |
| 5.6 Confirmation Testing - PAH, TPH, lead, SPLP, rapid | 8 | ea | $957.60 | | | | $7,661 | $0 | $0 | $0 | $7,661 |
| 5.7 Off Site Transportation & Disposal, High PAH/ TPH | 1,556 | tons | $100.00 | | | | $155,550 | $0 | $0 | $0 | $155,550 |
| 5.8 Off Site Transportation & Disposal, High Lead | 1,692 | tons | $120.00 | | | | $203,040 | $0 | $0 | $0 | $203,040 |
| 5.9 Off Site Transportation & Recycling, Asphalt | 464 | tons | $19.50 | | | | $9,038 | $0 | $0 | $0 | $9,038 |
| **6 BACKFILL, CAPPING AND SITE RESTORATION** | | | | | | | | | | | |
| 6.1 60-mil VLDPE Geomembrane | 17,400 | sf | | $0.48 | $1.43 | $0.27 | $0 | $8,352 | $24,882 | $4,698 | $37,932 |
| 6.2 12 oz/sy Cushion Geotextile, Small Areas | 1,933 | sy | | $2.19 | $0.12 | $0.05 | $0 | $4,234 | $232 | $87 | $4,553 |
| 6.3 Clean Sand | 2,326 | cy | | $4.00 | $0.50 | $1.07 | $0 | $9,304 | $1,151 | $2,477 | $12,933 |
| 6.4 Asphalt, 2" Binder, 1" Topping, Small Areas | 33,400 | sf | | $1.03 | $0.24 | $0.30 | $0 | $34,402 | $8,016 | $10,020 | $52,438 |
| **7 POST CONSTRUCTION COST** | | | | | | | | | | | |
| 7.1 Contractor Completion Report | 40 | hr | | | $35.00 | | $0 | $0 | $1,400 | $0 | $1,400 |
| 7.2 Remedial Action Closeout Report | 40 | hr | | | $35.00 | | $0 | $0 | $1,400 | $0 | $1,400 |
| **Subtotal** | | | | | | | $420,909 | $70,811 | $87,856 | $47,065 | $626,641 |
| **Local Area Adjustments** | | | | | | | 100.0% | 98.6% | 104.2% | 104.2% | |
| **Subtotal** | | | | | | | $420,909 | $69,819 | $91,546 | $49,042 | $631,316 |

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**ZONE 4, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-4.3: CAPPING TO ALLOW I/C SITE USE AND PREVENT LEACHING, LUCS, AND MONITORING**
**Capital Cost**

| Item | Quantity | Unit | Unit Cost Subcontract | Unit Cost Material | Unit Cost Labor | Unit Cost Equipment | Extended Cost Subcontract | Extended Cost Material | Extended Cost Labor | Extended Cost Equipment | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Overhead on Labor Cost @ 30% | | | | | | | | | $27,464 | | $27,464 |
| G & A on Labor Cost @ 10% | | | | | | | | | $9,155 | | $9,155 |
| G & A on Material Cost @ 10% | | | | | | | | $6,982 | | | $6,982 |
| G & A on Equipment Cost @ 10% | | | | | | | | | | $4,904 | $4,904 |
| G & A on Subcontract Cost @ 10% | | | | | | | -$42,091 | | | | $42,091 |
| Tax on Materials and Equipment Cost @ 6% | | | | | | | | $4,189 | | $2,943 | $7,132 |
| **Total Direct Cost** | | | | | | | $463,000 | $80,990 | $128,164 | $56,889 | $729,043 |
| Indirects on Total Direct Cost @ 30% | | (excluding transportation and disposal cost) | | | | | | | | | $108,139 |
| Profit on Total Direct Cost @ 10% | | | | | | | | | | | $72,904 |
| **Subtotal** | | | | | | | | | | | $910,087 |
| Health & Safety Monitoring @ 3% | | (includes air quality monitoring) | | | | | | | | | $27,303 |
| **Total Field Cost** | | | | | | | | | | | $937,390 |
| Contingency on Total Field Costs @ 20% | | | | | | | | | | | $187,478 |
| Engineering on Total Field Cost @ 15% | | | | | | | | | | | $140,608 |
| **TOTAL CAPITAL COST** | | | | | | | | | | | **$1,265,476** |

**ZONE 4, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-4.3: CAPPING TO ALLOW I/C SITE USE AND PREVENT LEACHING, LUCS, AND MONITORING**
**ANNUAL COST**

| Item | Item Cost Years 1 & 2 | Item Cost Years 3 & 4 | Item Cost Years 5 through 30 | Item Cost Annually | Item Cost Every 5 Years | Notes |
|---|---|---|---|---|---|---|
| Pavement Maintenance | | | | $10,488 | | Repave 10% of contaminated areas yearly. |
| Groundwater Sampling | $22,272 | $11,136 | $5,568 | | | 4 Wells. Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Labor and supplies for sampling |
| Groundwater Analysis | $2,800 | $1,400 | $700 | | | 4 wells, Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Analysis for TPH and lead. |
| Groundwater Report | $5,000 | $5,000 | $5,000 | | | |
| Inspection | | | | $1,000 | | Annual LUC inspection |
| Site Review | | | | | $23,000 | 5-year review |
| Subtotal | $30,072 | $17,536 | $11,268 | $11,488 | $23,000 | |
| Contingency at 10% | $3,007 | $1,754 | $1,127 | $1,149 | $2,300 | |
| **TOTAL** | $33,079 | $19,290 | $12,395 | $12,636 | $25,300 | |

**ZONE 4, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-4.3: CAPPING TO ALLOW I/C SITE USE AND PREVENT LEACHING, LUCS, AND MONITORING**
**PRESENT WORTH ANALYSIS**

| Year | Capital Cost | Annual Cost | Total Year Cost | Annual Discount Rate at 7% | Present Worth |
|---|---|---|---|---|---|
| 0 | $1,265,476 | | $1,265,476 | 1.000 | $1,265,476 |
| 1 | | $45,716 | $45,716 | 0.935 | $42,744 |
| 2 | | $45,716 | $45,716 | 0.873 | $39,910 |
| 3 | | $31,926 | $31,926 | 0.816 | $26,052 |
| 4 | | $31,926 | $31,926 | 0.763 | $24,360 |
| 5 | | $50,331 | $50,331 | 0.713 | $35,886 |
| 6 | | $25,031 | $25,031 | 0.666 | $16,671 |
| 7 | | $25,031 | $25,031 | 0.623 | $15,594 |
| 8 | | $25,031 | $25,031 | 0.582 | $14,568 |
| 9 | | $25,031 | $25,031 | 0.544 | $13,617 |
| 10 | | $50,331 | $50,331 | 0.508 | $25,568 |
| 11 | | $25,031 | $25,031 | 0.475 | $11,890 |
| 12 | | $25,031 | $25,031 | 0.444 | $11,114 |
| 13 | | $25,031 | $25,031 | 0.415 | $10,388 |
| 14 | | $25,031 | $25,031 | 0.388 | $9,712 |
| 15 | | $50,331 | $50,331 | 0.362 | $18,220 |
| 16 | | $25,031 | $25,031 | 0.339 | $8,486 |
| 17 | | $25,031 | $25,031 | 0.317 | $7,935 |
| 18 | | $25,031 | $25,031 | 0.296 | $7,409 |
| 19 | | $25,031 | $25,031 | 0.277 | $6,934 |
| 20 | | $50,331 | $50,331 | 0.258 | $12,985 |
| 21 | | $25,031 | $25,031 | 0.242 | $6,058 |
| 22 | | $25,031 | $25,031 | 0.226 | $5,657 |
| 23 | | $25,031 | $25,031 | 0.211 | $5,282 |
| 24 | | $25,031 | $25,031 | 0.197 | $4,931 |
| 25 | | $50,331 | $50,331 | 0.184 | $9,261 |
| 26 | | $25,031 | $25,031 | 0.172 | $4,305 |
| 27 | | $25,031 | $25,031 | 0.161 | $4,030 |
| 28 | | $25,031 | $25,031 | 0.150 | $3,755 |
| 29 | | $25,031 | $25,031 | 0.141 | $3,529 |
| 30 | | $50,331 | $50,331 | 0.131 | $6,593 |
| | | | | **TOTAL PRESENT WORTH** | **$1,678,919** |

**ZONE 4, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-4.4 IN SITU TREATMENT (ENHANCED BIOREMEDIATION AND STABILIZATION/SOLIDIFICATION) TO MEET I/C DECs AND PMCs, LUCs, AND MONITORING**
**Capital Cost**

| Item | Quantity | Unit | Unit Cost Subcontract | Unit Cost Material | Unit Cost Labor | Unit Cost Equipment | Extended Cost Subcontract | Extended Cost Material | Extended Cost Labor | Extended Cost Equipment | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1 PROJECT PLANNING** | | | | | | | | | | | |
| 1.1 Prepare LUC RD Documents | 60 | hr | | | $35.00 | | $0 | $0 | $2,100 | $0 | $2,100 |
| 1.2 Prepare Documents & Plans including Permits | 150 | hr | | | $35.00 | | $0 | $0 | $5,250 | $0 | $5,250 |
| **2 PRE-DESIGN INVESTIGATION** | | | | | | | | | | | |
| 2.1 Field Personnel - prep, field, and follow-up | 1.5 | days | | | $350.00 | | $0 | $0 | $525 | $0 | $525 |
| 2.2 Travel & Mob | 1 | ls | $550.00 | | | | $550 | $0 | $0 | $0 | $550 |
| 2.3 Geoprobe - Equipment and Operator | 1 | day | $2,400.00 | | | | $2,400 | $0 | $0 | $0 | $2,400 |
| 2.4 Supplies & PID | 1 | day | $600.00 | | | | $600 | $0 | $0 | $0 | $600 |
| 2.5 Soil Sample Analysis (Lead, SPLP Lead) | 1 | ls | $2,050.00 | | | | $2,050 | $0 | $0 | $0 | $2,050 |
| 2.6 Evaluate Data, Prepare Report, and Upload to NIRIS | 1 | ea | $22,000.00 | | | | $22,000 | $0 | $0 | $0 | $22,000 |
| **3 MOBILIZATION, DEMOBILIZATION AND FIELD SUPPORT** | | | | | | | | | | | |
| 3.1 Storage Trailer (1) | 1 | mo | | | | $99.00 | $0 | $0 | $0 | $99 | $99 |
| 3.2 Underground Utility Clearances | 1 | ls | $3,500.00 | | | | $3,500 | $0 | $0 | $0 | $3,500 |
| 3.3 Construction Survey | 1 | day | $2,125.00 | | | | $2,125 | $0 | $0 | $0 | $2,125 |
| 3.4 Large Diameter Auger Mobilization/Demobilization | 1 | ea | $100,000.00 | | | | $100,000 | $0 | $0 | $0 | $100,000 |
| 3.5 Backhoe Mobilization/Demobilization | 2 | ea | | | $85.00 | $261.00 ## | $0 | $170 | $522 | $692 | m09-01 54 36.50- |
| 3.6 Temporary Fencing | 1 | ls | | $500.00 | | | $0 | $500 | $0 | $0 | $500 |
| 3.7 Field Construction Mgt. (1 person) | 20 | day | | $200.00 | $350.00 | | $0 | $4,000 | $7,000 | $0 | $11,000 |
| 3.8 Site Health & Safety and QA/QC | 20 | day | | $200.00 | $325.00 | | $0 | $4,000 | $6,500 | $0 | $10,500 |
| **4 IN-SITU TREATMENT** | | | | | | | | | | | |
| 4.1 Pavement Removal | 3,711 | sy | | $2.22 | $1.63 | $3.85 | $0 | $8,239 | $6,049 | $14,288 | $28,576 |
| 4.2 Off Site Transportation & Recycling, Asphalt | 464 | tons | $19.50 | | | | $9,038 | $0 | $0 | $0 | $9,038 |
| 4.3 Bioremediation Treatability Test | 1 | ls | $20,000.00 | | | | $20,000 | $0 | $0 | $0 | $20,000 |
| 4.4 Stabilization Treatability Test | 1 | ls | $5,000.00 | | | | $5,000 | $0 | $0 | $0 | $5,000 |
| 4.5 Utility Relocation - Storm and Sanitary Sewer Lines | 1 | ls | $50,000.00 | | | | $50,000 | $0 | $0 | $0 | $50,000 |
| 4.6 Auger - Deep Soil Cement Mixing | 3,061 | cy | $60.00 | | | | $183,660 | $0 | $0 | $0 | $183,660 |
| 4.7 Backhoe - Shallow ORC Soil Mixing | 1,037 | cy | $35.00 | | | | $36,295 | $0 | $0 | $0 | $36,295 |
| 4.8 ORC | 8,360 | lb | $9.00 | | | | $75,240 | $0 | $0 | $0 | $75,240 |
| 4.9 Post-Treatment Soil Testing - SPLP | 4 | ea | $119.00 | $10.00 | | | $476 | $40 | $0 | $0 | $516 |
| 4.10 Off Site Transportation & Disposal, Excess Stab. Soil | 158 | tons | $25.00 | | | | $3,938 | $0 | $0 | $0 | $3,938 |
| **5 BACKFILL AND SITE RESTORATION** | | | | | | | | | | | |
| 5.1 Asphalt, 2" Binder, 1" Topping, Small Areas | 33,400 | sf | | $1.03 | $0.24 | $0.30 | $0 | $34,402 | $8,016 | $10,020 | $52,438 |
| **6 POST CONSTRUCTION COST** | | | | | | | | | | | |
| 6.1 Contractor Completion Report | 60 | hr | | | $35.00 | | $0 | $0 | $2,100 | $0 | $2,100 |
| 6.2 Remedial Action Closeout Report | 60 | hr | | | $35.00 | | $0 | $0 | $2,100 | $0 | $2,100 |
| **Subtotal** | | | | | | | $516,872 | $51,351 | $40,162 | $25,099 | $633,483 |
| **Local Area Adjustments** | | | | | | | 100.0% | 98.6% | 104.2% | 104.2% | |
| **Subtotal** | | | | | | | $516,872 | $50,632 | $41,849 | $26,153 | $635,505 |
| Overhead on Labor Cost @ 30% | | | | | | | | | $12,555 | | $12,555 |
| G & A on Labor Cost @ 10% | | | | | | | | | $4,185 | | $4,185 |
| G & A on Material Cost @ 10% | | | | | | | | $5,063 | | | $5,063 |
| G & A on Equipment Cost @ 10% | | | | | | | | | | $2,615 | $2,615 |
| G & A on Subcontract Cost @ 10% | | | | | | | $51,687 | | | | $51,687 |
| Tax on Materials and Equipment Cost @ 6% | | | | | | | | $3,038 | | $1,569 | $4,607 |
| **Total Direct Cost** | | | | | | | $568,559 | $58,733 | $58,588 | $30,337 | $716,218 |
| Indirects on Total Direct Cost @ 30% | | | (excluding transportation and disposal cost) | | | | | | | | $210,973 |
| Profit on Total Direct Cost @ 10% | | | | | | | | | | | $71,622 |

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**ZONE 4, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-4.4 IN SITU TREATMENT (ENHANCED BIOREMEDIATION AND STABILIZATION/SOLIDIFICATION) TO MEET I/C DECs AND PMCs, LUCs, AND MONITORING**
**Capital Cost**

| Item | Quantity | Unit | Unit Cost Subcontract | Unit Cost Material | Unit Cost Labor | Unit Cost Equipment | Extended Cost Subcontract | Extended Cost Material | Extended Cost Labor | Extended Cost Equipment | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Subtotal** | | | | | | | | | | | $998,812 |
| Health & Safety Monitoring @ 3% | | (includes air quality monitoring) | | | | | | | | | $29,964 |
| **Total Field Cost** | | | | | | | | | | | $1,028,776 |
| Contingency on Total Field Costs @ 20% | | | | | | | | | | | $205,755 |
| Engineering on Total Field Cost @ 15% | | | | | | | | | | | $154,316 |
| **TOTAL CAPITAL COST** | | | | | | | | | | | **$1,388,848** |

**ZONE 4, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-4.4 IN SITU TREATMENT (ENHANCED BIOREMEDIATION AND STABILIZATION/SOLIDIFICATION) TO MEET I/C DECs AND PMCs, LUCs, AND MONITORING**
**ANNUAL COST**

| Item | Item Cost Year 1 | Item Cost Years 1 & 2 | Item Cost Years 3 & 4 | Item Cost Years 5 through 30 | Item Cost Annually | Item Cost Every 5 Years | Notes |
|---|---|---|---|---|---|---|---|
| Soil Sampling | $2,581 | | | | | | 4 locations at Year 1. Half-day geoprobe plus labor to sample. |
| Soil Analysis | $730 | | | | | | 4 locations. Analyze 3 for PAHs and 1 for ETPH. |
| Pavement Maintenance | | | | | $10,488 | | Repave 10% of contaminated areas yearly. |
| Groundwater Sampling | | $22,272 | $11,136 | $5,568 | | | 4 Wells. Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Labor and supplies for sampling |
| Groundwater Analysis | | $2,800 | $1,400 | $700 | | | 4 wells, Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Analysis for TPH and lead. |
| Groundwater Report | | $5,000 | $5,000 | $5,000 | | | |
| Inspection | | | | | $1,000 | | Annual LUC inspection |
| Site Review | | | | | | $23,000 | 5-year review |
| Subtotal | $3,311 | $30,072 | $17,536 | $11,268 | $11,488 | $23,000 | |
| Contingency at 10% | $331 | $3,007 | $1,754 | $1,127 | $1,149 | $2,300 | |
| **TOTAL** | $3,642 | $33,079 | $19,290 | $12,395 | $12,636 | $25,300 | |

**ZONE 4, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-4.4 IN SITU TREATMENT (ENHANCED BIOREMEDIATION AND STABILIZATION/SOLIDIFICATION)**
**TO MEET I/C DECs AND PMCs, LUCs, AND MONITORING**
**PRESENT WORTH ANALYSIS**

| Year | Capital Cost | Annual Cost | Total Year Cost | Annual Discount Rate at 7% | Present Worth |
|---|---|---|---|---|---|
| 0 | $1,388,848 | | $1,388,848 | 1.000 | $1,388,848 |
| 1 | | $49,358 | $49,358 | 0.935 | $46,149 |
| 2 | | $45,716 | $45,716 | 0.873 | $39,910 |
| 3 | | $31,926 | $31,926 | 0.816 | $26,052 |
| 4 | | $31,926 | $31,926 | 0.763 | $24,360 |
| 5 | | $50,331 | $50,331 | 0.713 | $35,886 |
| 6 | | $25,031 | $25,031 | 0.666 | $16,671 |
| 7 | | $25,031 | $25,031 | 0.623 | $15,594 |
| 8 | | $25,031 | $25,031 | 0.582 | $14,568 |
| 9 | | $25,031 | $25,031 | 0.544 | $13,617 |
| 10 | | $50,331 | $50,331 | 0.508 | $25,568 |
| 11 | | $25,031 | $25,031 | 0.475 | $11,890 |
| 12 | | $25,031 | $25,031 | 0.444 | $11,114 |
| 13 | | $25,031 | $25,031 | 0.415 | $10,388 |
| 14 | | $25,031 | $25,031 | 0.388 | $9,712 |
| 15 | | $50,331 | $50,331 | 0.362 | $18,220 |
| 16 | | $25,031 | $25,031 | 0.339 | $8,486 |
| 17 | | $25,031 | $25,031 | 0.317 | $7,935 |
| 18 | | $25,031 | $25,031 | 0.296 | $7,409 |
| 19 | | $25,031 | $25,031 | 0.277 | $6,934 |
| 20 | | $50,331 | $50,331 | 0.258 | $12,985 |
| 21 | | $25,031 | $25,031 | 0.242 | $6,058 |
| 22 | | $25,031 | $25,031 | 0.226 | $5,657 |
| 23 | | $25,031 | $25,031 | 0.211 | $5,282 |
| 24 | | $25,031 | $25,031 | 0.197 | $4,931 |
| 25 | | $50,331 | $50,331 | 0.184 | $9,261 |
| 26 | | $25,031 | $25,031 | 0.172 | $4,305 |
| 27 | | $25,031 | $25,031 | 0.161 | $4,030 |
| 28 | | $25,031 | $25,031 | 0.150 | $3,755 |
| 29 | | $25,031 | $25,031 | 0.141 | $3,529 |
| 30 | | $50,331 | $50,331 | 0.131 | $6,593 |
| | | | | **TOTAL PRESENT WORTH** | **$1,805,696** |

**ZONE 4, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-4.5 EXCAVATION TO MEET I/C DEC AND PMC, OFF-SITE TREATMENT (LTTD AND STABILIZATION /SOLIDIFICATION) AND DISPOSAL (LANDFILLING), LUCs, AND MONITORING**
**Capital Cost**

| Item | Quantity | Unit | Unit Cost Subcontract | Unit Cost Material | Unit Cost Labor | Unit Cost Equipment | Extended Cost Subcontract | Extended Cost Material | Extended Cost Labor | Extended Cost Equipment | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1 PROJECT PLANNING** | | | | | | | | | | | |
| 1.1 Prepare LUC RD Documents | 60 | hr | | | $35.00 | | $0 | $0 | $2,100 | $0 | $2,100 |
| 1.2 Prepare Documents & Plans including Permits | 150 | hr | | | $35.00 | | $0 | $0 | $5,250 | $0 | $5,250 |
| **2 PRE-DESIGN INVESTIGATION** | | | | | | | | | | | |
| 2.1 Field Personnel - prep, field, and follow-up | 1.5 | days | | | $350.00 | | $0 | $0 | $525 | $0 | $525 |
| 2.2 Travel & Mob | 1 | ls | $550.00 | | | | $550 | $0 | $0 | $0 | $550 |
| 2.3 Geoprobe - Equipment and Operator | 1 | day | $2,400.00 | | | | $2,400 | $0 | $0 | $0 | $2,400 |
| 2.4 Supplies & PID | 1 | day | $600.00 | | | | $600 | $0 | $0 | $0 | $600 |
| 2.5 Soil Sample Analysis (Lead, SPLP Lead) | 1 | ls | $2,050.00 | | | | $2,050 | $0 | $0 | $0 | $2,050 |
| 2.6 Evaluate Data, Prepare Report, and Upload to NIRIS | 1 | ea | $22,000.00 | | | | $22,000 | $0 | $0 | $0 | $22,000 |
| **3 MOBILIZATION, DEMOBILIZATION AND FIELD SUPPORT** | | | | | | | | | | | |
| 3.1 Office Trailer | 2 | mo | | $375.00 | | | $0 | $750 | $0 | $0 | $750 |
| 3.2 Field Office Support | 2 | mo | | $240.00 | | | $0 | $480 | $0 | $0 | $480 |
| 3.4 Utility Connection/Disconnection (phone/electric) | 1 | ls | $1,500.00 | | | | $1,500 | $0 | $0 | $0 | $1,500 |
| 3.5 Site Utilities | 2 | mo | | $230.00 | | | $0 | $460 | $0 | $0 | $460 |
| 3.6 Underground Utility Clearances | 1 | ls | $1,500.00 | | | | $1,500 | $0 | $0 | $0 | $1,500 |
| 3.7 Construction Survey Support | 2 | day | $1,050.00 | | | | $2,100 | $0 | $0 | $0 | $2,100 |
| 3.8 Equipment Mobilization/Demobilization, 70 to 150 HP | 6 | ea | | | $64.00 | $117.00 | $0 | $0 | $384 | $702 | $1,086 |
| 3.9 Site Superintendent | 44 | day | | | $355.00 | | $0 | $0 | $15,620 | $0 | $15,620 |
| 3.10 Site Health & Safety and QA/QC | 44 | day | | | $325.00 | | $0 | $0 | $14,300 | $0 | $14,300 |
| 3.11 Materials Storage Pad, 25' X 25' | 625 | sf | | $3.64 | $0.74 | $1.09 | $0 | $2,275 | $463 | $681 | $3,419 |
| **4 DECONTAMINATION** | | | | | | | | | | | |
| 4.1 Decontamination Services | 2 | mo | | | | $5,045.46 | $0 | $0 | $0 | $10,091 | $10,091 |
| 4.2 Equipment Decon Pad | 2 | ls | | $1,750.00 | $1,500.00 | $425.00 | $0 | $3,500 | $3,000 | $850 | $7,350 |
| 4.3 Decon Water | 2,000 | gal | | $0.20 | | | $0 | $400 | $0 | $0 | $400 |
| 4.4 Decon Water Storage Tank, 6,000 gallon | 2 | mo | | | | $784.24 | $0 | $0 | $0 | $1,568 | $1,568 |
| 4.5 Clean Water Storage Tank, 4,000 gallon | 2 | mo | | | | $705.22 | $0 | $0 | $0 | $1,410 | $1,410 |
| 4.6 Disposal of Decon Waste (liquid & solid) | 2 | mo | $950.00 | | | | $1,900 | $0 | $0 | $0 | $1,900 |
| **5 EXCAVATION AND DISPOSAL** | | | | | | | | | | | |
| 5.1 Pavement Removal, bituminous driveways | 3,711 | sy | | $2.22 | $1.63 | $3.85 | $0 | $8,239 | $6,049 | $14,288 | $28,576 |
| 5.2 Excavator, 1/2 cy Capacity | 2 | mo | | | $13,050.40 | $7,087.20 | $0 | $0 | $26,101 | $14,174 | $40,275 |
| 5.3 Site Labor, (1 laborer) | 2 | mo | | | $5,561.60 | | $0 | $0 | $11,123 | $0 | $11,123 |
| 5.4 Tractor Loader 1 to 1-1/4 cy | 2 | mo | | | $10,058.40 | $4,383.00 | $0 | $0 | $20,117 | $8,766 | $28,883 |
| 5.5 Characterization/Offsite Disposal Soil Testing | 41 | ea | $478.80 | $10.00 | | | $19,631 | $410 | $0 | $0 | $20,041 |
| 5.6 Confirmation Testing - Lead, PAH, TPH, & TCLP Lead, | 14 | ea | $957.60 | | | | $13,406 | $0 | $0 | $0 | $13,406 |
| 5.7 Off Site Transportation & Disposal, High PAHs, High TPI | 1,556 | tons | $100.00 | | | | $155,550 | $0 | $0 | $0 | $155,550 |
| 5.8 Off Site Transportation & Disposal, High Lead | 4,592 | tons | $120.00 | | | | $550,980 | $0 | $0 | $0 | $550,980 |
| 5.9 Off Site Transportation & Recycling, Asphalt | 464 | tons | $19.50 | | | | $9,038 | $0 | $0 | $0 | $9,038 |
| **6 BACKFILL AND SITE RESTORATION** | | | | | | | | | | | |
| 6.1 Clean Backfill | 4,098 | cy | | $8.00 | | | $0 | $32,784 | $0 | $0 | $32,784 |
| 6.2 Tractor Loader 1 to 1-1/4 cy | 1 | wk | | | $2,286.00 | $1,195.00 | $0 | $0 | $2,286 | $1,195 | $3,481 |
| 6.3 Vibrating Roller, 2-Drum, 7.5 HP, 1/2 time Operator | 1 | wk | | | $1,143.00 | $613.00 | $0 | $0 | $1,143 | $613 | $1,756 |
| 6.4 Vibratory Plate, 1/2 time Operator | 1 | wk | | | $632.00 | $114.00 | $0 | $0 | $632 | $114 | $746 |
| 6.5 Asphalt, 2" Binder, 1" Topping, Small Areas | 33,400 | sf | | $1.03 | $0.24 | $0.30 | $0 | $34,402 | $8,016 | $10,020 | $52,438 |
| **7 POST CONSTRUCTION COST** | | | | | | | | | | | |
| 7.1 Contractor Completion Report | 60 | hr | | | $35.00 | | $0 | $0 | $2,100 | $0 | $2,100 |
| 7.2 Remedial Action Closeout Report | 60 | hr | | | $35.00 | | $0 | $0 | $2,100 | $0 | $2,100 |
| **Subtotal** | | | | | | | $783,205 | $83,700 | $121,308 | $64,473 | $1,052,687 |
| **Local Area Adjustments** | | | | | | | 100.0% | 98.6% | 104.2% | 104.2% | |
| **Subtotal** | | | | | | | $783,205 | $82,528 | $126,403 | $67,181 | $1,059,318 |

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**ZONE 4, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-4.5 EXCAVATION TO MEET I/C DEC AND PMC, OFF-SITE TREATMENT (LTTD AND STABILIZATION /SOLIDIFICATION) AND DISPOSAL (LANDFILLING), LUCs, AND MONITORING**
**Capital Cost**

| Item | Quantity | Unit | Unit Cost Subcontract | Unit Cost Material | Unit Cost Labor | Unit Cost Equipment | Extended Cost Subcontract | Extended Cost Material | Extended Cost Labor | Extended Cost Equipment | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Overhead on Labor Cost @ | 30% | | | | | | | | $37,921 | | $37,921 |
| G & A on Labor Cost @ | 10% | | | | | | | | $12,640 | | $12,640 |
| G & A on Material Cost @ | 10% | | | | | | | $8,253 | | | $8,253 |
| G & A on Equipment Cost @ | 10% | | | | | | | | | $6,718 | $6,718 |
| G & A on Subcontract Cost @ | 10% | | | | | | $78,321 | | | | $78,321 |
| Tax on Materials and Equipment Cost @ | 6% | | | | | | | $4,952 | | $4,031 | $8,983 |
| **Total Direct Cost** | | | | | | | $861,526 | $95,732 | $176,965 | $77,930 | $1,212,153 |
| Indirects on Total Direct Cost @ | 30% | (excluding transportation and disposal cost) | | | | | | | | | $148,405 |
| Profit on Total Direct Cost @ | 10% | | | | | | | | | | $121,215 |
| **Subtotal** | | | | | | | | | | | $1,481,774 |
| Health & Safety Monitoring @ | 3% | (includes air quality monitoring) | | | | | | | | | $44,453 |
| **Total Field Cost** | | | | | | | | | | | $1,526,227 |
| Contingency on Total Field Costs @ | 20% | | | | | | | | | | $305,245 |
| Engineering on Total Field Cost @ | 10% | | | | | | | | | | $152,623 |
| **TOTAL CAPITAL COST** | | | | | | | | | | | **$1,984,095** |

**ZONE 4, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-4.5 EXCAVATION TO MEET I/C DEC AND PMC, OFF-SITE TREATMENT (LTTD AND STABILIZATION /SOLIDIFICATION) AND DISPOSAL (LANDFILLING), LUCs, AND MONITORING**
**ANNUAL COST**

| Item | Item Cost Years 1 & 2 | Item Cost Years 3 & 4 | Item Cost Years 5 through 30 | Item Cost Annually | Item Cost Every 5 Years | Notes |
|---|---|---|---|---|---|---|
| Pavement Maintenance | | | | $10,488 | | Repave 10% of contaminated areas yearly. |
| Groundwater Sampling | $22,272 | $11,136 | $5,568 | | | 4 Wells. Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Labor and supplies for sampling |
| Groundwater Analysis | $2,800 | $1,400 | $700 | | | 4 wells, Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Analysis for TPH and lead. |
| Groundwater Report | $5,000 | $5,000 | $5,000 | | | |
| Inspection | | | | $1,000 | | Annual LUC inspection |
| Site Review | | | | | $23,000 | 5-year review |
| Subtotal | $30,072 | $17,536 | $11,268 | $11,488 | $23,000 | |
| Contingency at 10% | $3,007 | $1,754 | $1,127 | $1,149 | $2,300 | |
| **TOTAL** | $33,079 | $19,290 | $12,395 | $12,636 | $25,300 | |

**ZONE 4, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-4.5 EXCAVATION TO MEET I/C DEC AND PMC, OFF-SITE TREATMENT (LTTD AND STABILIZATION /SOLIDIFICATION) AND DISPOSAL (LANDFILLING), LUCs, AND MONITORING**
**Present Worth Analysis**

| Year | Capital Cost | Annual Cost | Total Year Cost | Annual Discount Rate at 7% | Present Worth |
|---|---|---|---|---|---|
| 0 | $1,984,095 | | $1,984,095 | 1.000 | $1,984,095 |
| 1 | | $45,716 | $45,716 | 0.935 | $42,744 |
| 2 | | $45,716 | $45,716 | 0.873 | $39,910 |
| 3 | | $31,926 | $31,926 | 0.816 | $26,052 |
| 4 | | $31,926 | $31,926 | 0.763 | $24,360 |
| 5 | | $50,331 | $50,331 | 0.713 | $35,886 |
| 6 | | $25,031 | $25,031 | 0.666 | $16,671 |
| 7 | | $25,031 | $25,031 | 0.623 | $15,594 |
| 8 | | $25,031 | $25,031 | 0.582 | $14,568 |
| 9 | | $25,031 | $25,031 | 0.544 | $13,617 |
| 10 | | $50,331 | $50,331 | 0.508 | $25,568 |
| 11 | | $25,031 | $25,031 | 0.475 | $11,890 |
| 12 | | $25,031 | $25,031 | 0.444 | $11,114 |
| 13 | | $25,031 | $25,031 | 0.415 | $10,388 |
| 14 | | $25,031 | $25,031 | 0.388 | $9,712 |
| 15 | | $50,331 | $50,331 | 0.362 | $18,220 |
| 16 | | $25,031 | $25,031 | 0.339 | $8,486 |
| 17 | | $25,031 | $25,031 | 0.317 | $7,935 |
| 18 | | $25,031 | $25,031 | 0.296 | $7,409 |
| 19 | | $25,031 | $25,031 | 0.277 | $6,934 |
| 20 | | $50,331 | $50,331 | 0.258 | $12,985 |
| 21 | | $25,031 | $25,031 | 0.242 | $6,058 |
| 22 | | $25,031 | $25,031 | 0.226 | $5,657 |
| 23 | | $25,031 | $25,031 | 0.211 | $5,282 |
| 24 | | $25,031 | $25,031 | 0.197 | $4,931 |
| 25 | | $50,331 | $50,331 | 0.184 | $9,261 |
| 26 | | $25,031 | $25,031 | 0.172 | $4,305 |
| 27 | | $25,031 | $25,031 | 0.161 | $4,030 |
| 28 | | $25,031 | $25,031 | 0.15 | $3,755 |
| 29 | | $25,031 | $25,031 | 0.141 | $3,529 |
| 30 | | $50,331 | $50,331 | 0.131 | $6,593 |
| | | | | **TOTAL PRESENT WORTH** | **$2,397,538** |

**ZONE 4, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**

**ALTERNATIVE S-4.6 EXCAVATION TO MEET RESIDENTIAL DECs AND PMCs, ON-SITE DEWATERING, AND OFF-SITE TREATMENT (LTTD AND SOLIDIFICATION/STABILIZATION ) AND DISPOSAL (LANDFILLING)**
**Capital Cost**

| | | | | Unit Cost | | | Extended Cost | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Item | Quantity | Unit | Subcontract | Material | Labor | Equipment | Subcontract | Material | Labor | Equipment | Subtotal |
| **1 PROJECT PLANNING** | | | | | | | | | | | |
| 1.1 Prepare Documents & Plans including Permits | 200 | hr | | | $35.00 | | $0 | $0 | $7,000 | $0 | $7,000 |
| **2 PRE-DESIGN INVESTIGATION** | | | | | | | | | | | |
| 2.1 Field Personnel - prep, field, and follow-up | 1.5 | days | | | $350.00 | | $0 | $0 | $525 | $0 | $525 |
| 2.2 Travel & Mob | 1 | ls | $550.00 | | | | $550 | $0 | $0 | $0 | $550 |
| 2.3 Geoprobe - Equipment and Operator | 1 | day | $2,400.00 | | | | $2,400 | $0 | $0 | $0 | $2,400 |
| 2.4 Supplies & PID | 1 | day | $600.00 | | | | $600 | $0 | $0 | $0 | $600 |
| 2.5 Soil Sample Analysis (Lead, SPLP Lead) | 1 | ls | $2,050.00 | | | | $2,050 | $0 | $0 | $0 | $2,050 |
| 2.6 Evaluate Data, Prepare Report, and Upload to NIRIS | 1 | ea | $22,000.00 | | | | $22,000 | $0 | $0 | $0 | $22,000 |
| **3 MOBILIZATION, DEMOBILIZATION AND FIELD SUPPORT** | | | | | | | | | | | |
| 3.1 Office Trailer | 5 | mo | | | | $375.00 | $0 | $0 | $0 | $1,875 | $1,875 |
| 3.2 Field Office Support | 5 | mo | | $155.00 | | | $0 | $775 | $0 | $0 | $775 |
| 3.3 Storage Trailer (1) | 5 | mo | | | | $99.00 | $0 | $0 | $0 | $495 | $495 |
| 3.4 Utility Connection/Disconnection (phone/electric) | 1 | ls | $1,500.00 | | | | $1,500 | $0 | $0 | $0 | $1,500 |
| 3.5 Site Utilities | 5 | mo | $150.00 | | | | $750 | $0 | $0 | $0 | $750 |
| 3.6 Construction Survey Support | 2 | day | $975.00 | | | | $1,950 | $0 | $0 | $0 | $1,950 |
| 3.7 Equipment Mobilization/Demobilization | 8 | ea | | | $85.00 | $261.00 | $0 | $0 | $680 | $2,088 | $2,768 |
| 3.8 Site Superintendent | 110 | day | | | $355.00 | | $0 | $0 | $39,050 | $0 | $39,050 |
| 3.9 Site Health & Safety and QA/QC | 110 | day | | | $325.00 | | $0 | $0 | $35,750 | $0 | $35,750 |
| 3.10 Materials Storage Pad, 25' X 25' | 625 | sf | | $3.64 | $0.74 | $1.09 | $0 | $2,275 | $463 | $681 | $3,419 |
| 3.11 Dewatering Pad, 40' X 40' , twc | 3,200 | sf | | $5.62 | $0.85 | $1.24 | $0 | $17,984 | $2,720 | $3,968 | $24,672 |
| 3.12 Maintain Dewatering Pad, Replace Top 5x Each | 11,200 | sf | | $0.32 | $0.11 | $0.13 | $0 | $3,584 | $1,232 | $1,456 | $6,272 |
| **4 DECONTAMINATION** | | | | | | | | | | | |
| 4.1 Decontamination Services | 5 | mo | | | | $5,045.46 | $0 | $0 | $0 | $25,227 | $25,227 |
| 4.2 Equipment Decon Pad | 1 | ls | | $1,750.00 | $1,500.00 | $425.00 | $0 | $1,750 | $1,500 | $425 | $3,675 |
| 4.3 Decon Water | 5,000 | gal | | $0.20 | | | $0 | $1,000 | $0 | $0 | $1,000 |
| 4.4 Decon Water Storage Tank, 6,000 gallon | 5 | mo | | | | $784.24 | $0 | $0 | $0 | $3,921 | $3,921 |
| 4.5 Clean Water Storage Tank, 4,000 gallon | 5 | mo | | | | $705.22 | $0 | $0 | $0 | $3,526 | $3,526 |
| 4.6 Disposal of Decon Waste (liquid & solid) | 5 | mo | $950.00 | | | | $4,750 | $0 | $0 | $0 | $4,750 |
| **5 SHEET PILING, EXCAVATION, DEWATERING, AND DISPOSAL** | | | | | | | | | | | |
| 5.1 Pavement Removal | 6,667 | sy | | $2.22 | $1.63 | $3.85 | $0 | $14,800 | $10,867 | $25,667 | $51,333 |
| 5.2 Excavator, 2 CY Capacity | 5 | mo | | | $12,064.80 | $17,678.20 | $0 | $0 | $60,324 | $88,391 | $148,715 |
| 5.3 Site Labor, (3 laborers) | 5 | mo | | | $16,684.80 | | $0 | $0 | $83,424 | $0 | $83,424 |
| 5.4 Sheet Piles, 1450' x 15', tiebacks, drive, extract & salvag | 18,000 | sf | | $8.48 | $6.96 | $9.15 | $0 | $152,550 | $125,280 | $164,700 | $442,530 |
| 5.5 FE Loader 3 1/2 to 5 cy | 5 | mo | | | $9,288.40 | $13,544.60 | $0 | $0 | $46,442 | $67,723 | $114,165 |
| 5.6 Crane, 25 Ton with Clamshell Bucket, 1 CY | 2.5 | mo | | | $12,262.80 | $4,490.91 | $0 | $0 | $30,657 | $11,227 | $41,884 |
| 5.7 Characterization Soil Testing - Lead, TCLP, PAH, ETPH | 58 | ea | $478.80 | $10.00 | | | $27,770 | $580 | $0 | $0 | $28,350 |
| 5.8 Confirmation Soil Testing - SPLP, Lead, ETPH, PAH, ra | 26 | ea | $957.60 | | | | $24,898 | $0 | $0 | $0 | $24,898 |
| 5.9 Off Site Transportation & Disposal, Lead < 1000 mg/kg | 13,122 | tons | $40.00 | | | | $524,880 | $0 | $0 | $0 | $524,880 |
| 5.10 Off Site Transportation & Disposal, High Lead Soi | 6,303 | tons | $120.00 | | | | $756,360 | $0 | $0 | $0 | $756,360 |
| 5.11 Off Site Transportation & Disposal, High TPH or PAH Sc | 5,181 | tons | $100.00 | | | | $518,100 | $0 | $0 | $0 | $518,100 |
| 5.12 Off Site Transportation & Recycling, Asphalt | 834 | tons | $19.50 | | | | $16,263 | $0 | $0 | $0 | $16,263 |
| 5.13 Centrifugal 15 gpm 1 HP Pump, to Treatment, 2 for 2 mc | 2 | mo | | $2,211 | $636 | | $0 | $4,423 | $1,271 | $0 | $5,694 |
| 5.14 5,000 lb Liquid-Phase GAC Adsorption Units | 4 | ea | | $24,600.00 | | | $0 | $98,400 | $0 | $0 | $98,400 |
| 5.15 Replace GAC | 160,000 | lb | | $2.00 | | | $0 | $320,000 | $0 | $0 | $320,000 |
| 5.16 Bag Filter System | 4 | ea | | $14,000.00 | $225.00 | | $0 | $56,000 | $900 | $0 | $56,900 |
| 5.17 Replace Filter Bags | 544 | ea | | $60.00 | | | $0 | $32,640 | $0 | $0 | $32,640 |
| 5.18 Diaphragm Pump, from Treatment to Sewer, 2 for 2 mc | 4 | mo | | | | $542.48 | $0 | $0 | $0 | $2,170 | $2,170 |
| 5.19 Piping , 2" PVC, from Treatment to Storm Sewe | 400 | ft | | $0.51 | $0.72 | | $0 | $204 | $288 | $0 | $492 |
| **6 BACKFILL AND SITE RESTORATION** | | | | | | | | | | | |

**ZONE 4, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**

**ALTERNATIVE S-4.6 EXCAVATION TO MEET RESIDENTIAL DECs AND PMCs, ON-SITE DEWATERING, AND OFF-SITE TREATMENT (LTTD AND SOLIDIFICATION/STABILIZATION ) AND DISPOSAL (LANDFILLING)**
**Capital Cost**

| Item | Quantity | Unit | Unit Cost Subcontract | Unit Cost Material | Unit Cost Labor | Unit Cost Equipment | Extended Cost Subcontract | Extended Cost Material | Extended Cost Labor | Extended Cost Equipment | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 6.1 Clean Backfill | 15,848 | cy | | $8.00 | | | $0 | $126,784 | $0 | $0 | $126,784 |
| 6.2 FE Loader 3 1/2 to 5 cy, twc | 8 | mo | | | $9,288.40 | $13,544.60 | $0 | $0 | $74,307 | $108,357 | $182,664 |
| 6.3 Vibrating Roller, 2-Drum, 7.5 HP | 4 | mo | | | $10,058.40 | $2,494.40 | $0 | $0 | $40,234 | $9,978 | $50,211 |
| 6.4 Vibratory Plate for use around Utilities | 4 | mo | | | | $297.00 | $0 | $0 | $0 | $1,188 | $1,188 |
| 6.5 Top Dress Soil | 1,111 | cy | $31.50 | | | | $34,997 | $0 | $0 | $0 | $34,997 |
| 6.6 Site Restoration, seed, fertilization, mulch | 60 | msf | $75.00 | | | | $4,500 | $0 | $0 | $0 | $4,500 |
| **7 POST CONSTRUCTION COST** | | | | | | | | | | | |
| 7.1 Contractor Completion Report | 120 | hr | | | $35.00 | | $0 | $0 | $4,200 | $0 | $4,200 |
| 7.2 Remedial Action Closeout Report | 120 | hr | | | $35.00 | | $0 | $0 | $4,200 | $0 | $4,200 |
| **Subtotal** | | | | | | | $1,944,318 | $833,749 | $571,313 | $523,063 | $3,872,443 |
| **Local Area Adjustments** | | | | | | | 100.0% | 98.6% | 104.2% | 104.2% | |
| **Subtotal** | | | | | | | $1,944,318 | $822,076 | $595,309 | $545,032 | $3,906,734 |
| Overhead on Labor Cost @ 30% | | | | | | | | | $178,593 | | $178,593 |
| G & A on Labor Cost @ 10% | | | | | | | | | $59,531 | | $59,531 |
| G & A on Material Cost @ 10% | | | | | | | | $82,208 | | | $82,208 |
| G & A on Equipment Cost @ 10% | | | | | | | | | | $54,503 | $54,503 |
| G & A on Subcontract Cost @ 10% | | | | | | | $194,432 | | | | $194,432 |
| Tax on Materials and Equipment Cost @ 6% | | | | | | | | $49,325 | | $32,702 | $82,026 |
| **Total Direct Cost** | | | | | | | $2,138,749 | $953,609 | $833,432 | $632,237 | $4,558,027 |
| Indirects on Total Direct Cost @ 30% | | (excluding transportation and disposal cost) | | | | | | | | | $821,302 |
| Profit on Total Direct Cost @ 10% | | | | | | | | | | | $455,803 |
| **Subtotal** | | | | | | | | | | | $5,835,131 |
| Health & Safety Monitoring @ 2% | | (includes air quality monitoring) | | | | | | | | | $116,703 |
| **Total Field Cost** | | | | | | | | | | | $5,951,834 |
| Contingency on Total Field Costs @ 20% | | | | | | | | | | | $1,190,367 |
| Engineering on Total Field Cost @ 10% | | | | | | | | | | | $595,183 |
| **TOTAL CAPITAL COST** | | | | | | | | | | | **$7,737,384** |

# APPENDIX E.1.5

# ZONE 5

# ALTERNATIVES S-5.1, S-5.2, S-5.3, S-5.4, and S-5.5

**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-5.1: NO ACTION**
**Annual Cost**

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| Item | Item Cost every 5 years | Notes |
|---|---|---|
| Five-Year Review | $23,000 | |
| Subtotal | $23,000 | |
| Contingency @ 10% | $2,300 | |
| **TOTAL** | **$25,300** | |

**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-5.1: NO ACTION**
**Present Worth Analysis**

| Year | Capital Cost | Annual Cost | Total Year Cost | Annual Discount Rate at 7% | Present Worth |
|---|---|---|---|---|---|
| 0 | $0 | | $0 | 1.000 | $0 |
| 1 | | | $0 | 0.935 | $0 |
| 2 | | | $0 | 0.873 | $0 |
| 3 | | | $0 | 0.816 | $0 |
| 4 | | | $0 | 0.763 | $0 |
| 5 | | $25,300 | $25,300 | 0.713 | $18,039 |
| 6 | | | $0 | 0.666 | $0 |
| 7 | | | $0 | 0.623 | $0 |
| 8 | | | $0 | 0.582 | $0 |
| 9 | | | $0 | 0.544 | $0 |
| 10 | | $25,300 | $25,300 | 0.508 | $12,852 |
| 11 | | | $0 | 0.475 | $0 |
| 12 | | | $0 | 0.444 | $0 |
| 13 | | | $0 | 0.415 | $0 |
| 14 | | | $0 | 0.388 | $0 |
| 15 | | $25,300 | $25,300 | 0.362 | $9,159 |
| 16 | | | $0 | 0.339 | $0 |
| 17 | | | $0 | 0.317 | $0 |
| 18 | | | $0 | 0.296 | $0 |
| 19 | | | $0 | 0.277 | $0 |
| 20 | | $25,300 | $25,300 | 0.258 | $6,527 |
| 21 | | | $0 | 0.242 | $0 |
| 22 | | | $0 | 0.226 | $0 |
| 23 | | | $0 | 0.211 | $0 |
| 24 | | | $0 | 0.197 | $0 |
| 25 | | $25,300 | $25,300 | 0.184 | $4,655 |
| 26 | | | $0 | 0.172 | $0 |
| 27 | | | $0 | 0.161 | $0 |
| 28 | | | $0 | 0.150 | $0 |
| 29 | | | $0 | 0.141 | $0 |
| 30 | | $25,300 | $25,300 | 0.131 | $3,314 |
| | | | | **TOTAL PRESENT WORTH** | **$54,547** |

**ZONE 5, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-5.2: LUCs and Monitoring**
**CAPITAL COST**

| Item | Quantity | Unit | Unit Cost | | | | Extended Cost | | | | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Subcontract | Material | Labor | Equipment | Subcontract | Material | Labor | Equipment | |
| **1 PROJECT PLANNING** | | | | | | | | | | | |
| 1.1 Prepare Documents & Plans including Permits/Variances | 140 | hr | | | $35.00 | | $0 | $0 | $4,900 | $0 | $4,900 |
| 1.2 Prepare LUC RD Documents | 60 | hr | | | $35.00 | | $0 | $0 | $2,100 | $0 | $2,100 |
| **2 PRE-DESIGN INVESTIGATION** | | | | | | | | | | | |
| 2.1 Field Personnel - prep, field, and follow-up | 1.5 | days | | | $350.00 | | $0 | $0 | $525 | $0 | $525 |
| 2.2 Travel & Mob | 1 | ls | $550.00 | | | | $550 | $0 | $0 | $0 | $550 |
| 2.3 Geoprobe - Equipment and Operator | 1 | day | $2,400.00 | | | | $2,400 | $0 | $0 | $0 | $2,400 |
| 2.4 Supplies & PID | 1 | day | $600.00 | | | | $600 | $0 | $0 | $0 | $600 |
| 2.5 Soil Sample Analysis (Lead, SPLP Lead) | 1 | ls | $805.00 | | | | $805 | $0 | $0 | $0 | $805 |
| 2.6 Evaluate Data, Prepare Report, and Upload to NIRIS | 1 | ea | $7,000.00 | | | | $7,000 | $0 | $0 | $0 | $7,000 |
| **3 FIELD SUPPORT** | | | | | | | | | | | |
| 3.1 Construction Survey Support | 1 | day | $1,050.00 | | | | $1,050 | $0 | $0 | $0 | $1,050 |
| **Subtotal** | | | | | | | $12,405 | $0 | $7,525 | $0 | $19,930 |
| **Local Area Adjustments** | | | | | | | 100.0% | 98.6% | 104.2% | 104.2% | |
| | | | | | | | $12,405 | $0 | $7,841 | $0 | $20,246 |
| Overhead on Labor Cost @ 30% | | | | | | | | | $2,352 | | $2,352 |
| G & A on Labor Cost @ 10% | | | | | | | | | $784 | | $784 |
| G & A on Material Cost @ 10% | | | | | | | | $0 | | | $0 |
| G & A on Subcontract Cost @ 10% | | | | | | | $1,241 | | | | $1,241 |
| G & A on Equipment Cost @ 10% | | | | | | | | | | $0 | $0 |
| **Total Direct Cost** | | | | | | | $13,646 | $0 | $10,977 | $0 | $24,623 |
| Indirects on Total Direct Cost @ 0% | | | | | | | | | | | $0 |
| Profit on Total Direct Cost @ 10% | | | | | | | | | | | $2,462 |
| **Subtotal** | | | | | | | | | | | $27,085 |
| *Health & Safety Monitoring @ 0%* | | | | | | | | | | | $0 |
| **Total Field Cost** | | | | | | | | | | | $27,085 |
| Contingency on Total Field Costs @ 0% | | | | | | | | | | | $0 |
| Engineering on Total Field Cost @ 0% | | | | | | | | | | | $0 |
| **TOTAL COST** | | | | | | | | | | | **$27,085** |

**ZONE 5, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-5.2: LUCs and Monitoring**
**ANNUAL COST**

| Item | Item Cost Years 1 & 2 | Item Cost Years 3 & 4 | Item Cost Years 5 through 30 | Item Cost Annually | Item Cost Every 5 Years | Notes |
|---|---|---|---|---|---|---|
| Pavement Maintenane | | | | $691 | | Repave 10% of contaminated areas yearly |
| Groundwater Sampling | $22,272 | $11,136 | $5,568 | | | 4 Wells. Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Labor and supplies for sampling |
| Groundwater Analysis | $2,016 | $1,008 | $504 | | | 4 wells, Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Analysis for TPH. |
| Groundwater Report | $5,000 | $5,000 | $5,000 | | | |
| Inspection | | | | $1,000 | | Annual LUC inspection |
| Site Review | | | | | $23,000 | 5-year review |
| Subtotal | $29,288 | $17,144 | $11,072 | $1,691 | $23,000 | |
| Contingency at 10% | $2,929 | $1,714 | $1,107 | $169 | $2,300 | |
| **TOTAL** | $32,217 | $18,858 | $12,179 | $1,860 | $25,300 | |

**ZONE 5, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-5.2: LUCs and Monitoring**
**PRESENT WORTH ANALYSIS**

| Year | Capital Cost | Annual Cost | Total Year Cost | Annual Discount Rate at 7% | Present Worth |
|---|---|---|---|---|---|
| 0 | $27,085 | | $27,085 | 1.000 | $27,085 |
| 1 | | $34,077 | $34,077 | 0.935 | $31,862 |
| 2 | | $34,077 | $34,077 | 0.873 | $29,749 |
| 3 | | $20,718 | $20,718 | 0.816 | $16,906 |
| 4 | | $20,718 | $20,718 | 0.763 | $15,808 |
| 5 | | $39,339 | $39,339 | 0.713 | $28,049 |
| 6 | | $14,039 | $14,039 | 0.666 | $9,350 |
| 7 | | $14,039 | $14,039 | 0.623 | $8,746 |
| 8 | | $14,039 | $14,039 | 0.582 | $8,171 |
| 9 | | $14,039 | $14,039 | 0.544 | $7,637 |
| 10 | | $39,339 | $39,339 | 0.508 | $19,984 |
| 11 | | $14,039 | $14,039 | 0.475 | $6,669 |
| 12 | | $14,039 | $14,039 | 0.444 | $6,233 |
| 13 | | $14,039 | $14,039 | 0.415 | $5,826 |
| 14 | | $14,039 | $14,039 | 0.388 | $5,447 |
| 15 | | $39,339 | $39,339 | 0.362 | $14,241 |
| 16 | | $14,039 | $14,039 | 0.339 | $4,759 |
| 17 | | $14,039 | $14,039 | 0.317 | $4,450 |
| 18 | | $14,039 | $14,039 | 0.296 | $4,156 |
| 19 | | $14,039 | $14,039 | 0.277 | $3,889 |
| 20 | | $39,339 | $39,339 | 0.258 | $10,149 |
| 21 | | $14,039 | $14,039 | 0.242 | $3,397 |
| 22 | | $14,039 | $14,039 | 0.226 | $3,173 |
| 23 | | $14,039 | $14,039 | 0.211 | $2,962 |
| 24 | | $14,039 | $14,039 | 0.197 | $2,766 |
| 25 | | $39,339 | $39,339 | 0.184 | $7,238 |
| 26 | | $14,039 | $14,039 | 0.172 | $2,415 |
| 27 | | $14,039 | $14,039 | 0.161 | $2,260 |
| 28 | | $14,039 | $14,039 | 0.150 | $2,106 |
| 29 | | $14,039 | $14,039 | 0.141 | $1,980 |
| 30 | | $39,339 | $39,339 | 0.131 | $5,153 |
| | | | | **TOTAL PRESENT WORTH** | **$302,617** |

**ZONE 5, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-5.3 IN SITU TREATMENT (ENHANCED BIOREMEDIATION) TO MEET I/C DECs AND PMCs, LUCs, AND MONITORING**
**Capital Cost**

| Item | Quantity | Unit | Unit Cost Subcontract | Unit Cost Material | Unit Cost Labor | Unit Cost Equipment | Extended Cost Subcontract | Extended Cost Material | Extended Cost Labor | Extended Cost Equipment | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1 PROJECT PLANNING** | | | | | | | | | | | |
| 1.1 Prepare LUC RD Documents | 60 | hr | | | $35.00 | | $0 | $0 | $2,100 | $0 | $2,100 |
| 1.2 Prepare Documents & Plans including Permits | 150 | hr | | | $35.00 | | $0 | $0 | $5,250 | $0 | $5,250 |
| **2 PRE-DESIGN INVESTIGATION** | | | | | | | | | | | |
| 2.1 Field Personnel - prep, field, and follow-up | 1.5 | days | | | $350.00 | | $0 | $0 | $525 | $0 | $525 |
| 2.2 Travel & Mob | 1 | ls | $550.00 | | | | $550 | $0 | $0 | $0 | $550 |
| 2.3 Geoprobe - Equipment and Operator | 1 | day | $2,400.00 | | | | $2,400 | $0 | $0 | $0 | $2,400 |
| 2.4 Supplies & PID | 1 | day | $600.00 | | | | $600 | $0 | $0 | $0 | $600 |
| 2.5 Soil Sample Analysis (Lead, SPLP Lead) | 1 | ls | $805.00 | | | | $805 | $0 | $0 | $0 | $805 |
| 2.6 Evaluate Data, Prepare Report, and Upload to NIRIS | 1 | ea | $7,000.00 | | | | $7,000 | $0 | $0 | $0 | $7,000 |
| **3 MOBILIZATION, DEMOBILIZATION AND FIELD SUPPORT** | | | | | | | | | | | |
| 3.1 Storage Trailer (1) | 1 | mo | | | | $99.00 | $0 | $0 | $0 | $99 | $99 |
| 3.2 Underground Utility Clearances | 1 | ls | $3,500.00 | | | | $3,500 | $0 | $0 | $0 | $3,500 |
| 3.3 Construction Survey | 1 | day | $2,125.00 | | | | $2,125 | $0 | $0 | $0 | $2,125 |
| 3.4 Mobilization/Demobilization for Shallow Soil Mixing | 1 | ea | $30,000.00 | | | | $30,000 | $0 | $0 | $0 | $30,000 |
| 3.5 Temporary Fencing | 1 | ls | | $500.00 | | | $0 | $500 | $0 | $0 | $500 |
| 3.6 Field Construction Mgt. (1 person) | 3 | day | | $200.00 | $350.00 | | $0 | $600 | $1,050 | $0 | $1,650 |
| 3.7 Site Health & Safety and QA/QC | 3 | day | | $200.00 | $325.00 | | $0 | $600 | $975 | $0 | $1,575 |
| **4 IN-SITU TREATMENT** | | | | | | | | | | | |
| 4.1 Pavement Removal | 244 | sy | | $2.22 | $1.63 | $3.85 | $0 | $543 | $398 | $941 | $1,882 |
| 4.2 Off Site Transportation & Recycling, Asphalt | 15 | tons | $19.50 | | | | $293 | $0 | $0 | $0 | $293 |
| 4.3 Treatability Test | 1 | ls | $20,000.00 | | | | $20,000 | $0 | $0 | $0 | $20,000 |
| 4.4 Utility Relocation - Sanitary Sewer | 1 | ls | $10,000.00 | | | | $10,000 | $0 | $0 | $0 | $10,000 |
| 4.5 Backhoe - Shallow Soil Mixing | 234 | cy | $35.00 | | | | $8,190 | $0 | $0 | $0 | $8,190 |
| 4.6 ORC | 48,550 | lb | $9.00 | | | | $436,950 | $0 | $0 | $0 | $436,950 |
| **5 BACKFILL AND SITE RESTORATION** | | | | | | | | | | | |
| 5.1 Asphalt, 2" Binder, 1" Topping, Small Areas | 2,200 | sf | | $1.03 | $0.24 | $0.30 | $0 | $2,266 | $528 | $660 | $3,454 |
| **6 POST CONSTRUCTION COST** | | | | | | | | | | | |
| 6.1 Contractor Completion Report | 60 | hr | | | $35.00 | | $0 | $0 | $2,100 | $0 | $2,100 |
| 6.2 Remedial Action Closeout Report | 60 | hr | | | $35.00 | | $0 | $0 | $2,100 | $0 | $2,100 |
| **Subtotal** | | | | | | | $522,413 | $4,509 | $15,026 | $1,700 | $543,648 |
| **Local Area Adjustments** | | | | | | | 100.0% | 98.6% | 104.2% | 104.2% | |
| **Subtotal** | | | | | | | $522,413 | $4,446 | $15,658 | $1,772 | $544,287 |
| Overhead on Labor Cost @ 30% | | | | | | | | | $4,697 | | $4,697 |
| G & A on Labor Cost @ 10% | | | | | | | | | $1,566 | | $1,566 |
| G & A on Material Cost @ 10% | | | | | | | | $445 | | | $445 |
| G & A on Equipment Cost @ 10% | | | | | | | | | | $177 | $177 |
| G & A on Subcontract Cost @ 10% | | | | | | | $52,241 | | | | $52,241 |
| Tax on Materials and Equipment Cost @ 6% | | | | | | | | $267 | | $106 | $373 |
| **Total Direct Cost** | | | | | | | $574,654 | $5,157 | $21,921 | $2,055 | $603,786 |
| Indirects on Total Direct Cost @ 30% | | | (excluding transportation and disposal cost) | | | | | | | | $181,048 |
| Profit on Total Direct Cost @ 10% | | | | | | | | | | | $60,379 |
| **Subtotal** | | | | | | | | | | | $845,213 |
| Health & Safety Monitoring @ 3% | | | (includes air quality monitoring) | | | | | | | | $25,356 |

**ZONE 5, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-5.3 IN SITU TREATMENT (ENHANCED BIOREMEDIATION) TO MEET I/C DECs AND PMCs, LUCs, AND MONITORING**
**Capital Cost**

| Item | Quantity | Unit | Unit Cost Subcontract | Unit Cost Material | Unit Cost Labor | Unit Cost Equipment | Extended Cost Subcontract | Extended Cost Material | Extended Cost Labor | Extended Cost Equipment | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total Field Cost** | | | | | | | | | | | $870,569 |
| Contingency on Total Field Costs @ 20% | | | | | | | | | | | $174,114 |
| Engineering on Total Field Cost @ 15% | | | | | | | | | | | $130,585 |
| **TOTAL CAPITAL COST** | | | | | | | | | | | **$1,175,268** |

**ZONE 5, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-5.3 IN SITU TREATMENT (ENHANCED BIOREMEDIATION) TO MEET I/C DECs AND PMCs, LUCs, AND MONITORING**
**ANNUAL COST**

| Item | Item Cost Year 1 | Item Cost Years 1 & 2 | Item Cost Years 3 & 4 | Item Cost Years 5 through 30 | Item Cost Annually | Item Cost Every 5 Years | Notes |
|---|---|---|---|---|---|---|---|
| Soil Sampling | $2,580 | | | | | | 1 location at Year 1. Half-day geoprobe plus labor to sample. |
| Soil Analysis | $100 | | | | | | 1 location. Analysis for ETPH |
| Pavement Maintenance | | | | | $691 | | Repave 10% of contaminated areas yearly. |
| Groundwater Sampling | | $22,272 | $11,136 | $5,568 | | | 4 Wells. Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Labor and supplies for sampling |
| Groundwater Analysis | | $2,016 | $1,008 | $504 | | | 4 wells, Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Analysis for TPH. |
| Groundwater Report | | $5,000 | $5,000 | $5,000 | | | |
| Inspection | | | | | $1,000 | | Annual LUC inspection |
| Site Review | | | | | | $23,000 | 5-year review |
| Subtotal | $2,680 | $29,288 | $17,144 | $11,072 | $1,691 | $23,000 | |
| Contingency at 10% | $268 | $2,929 | $1,714 | $1,107 | $169 | $2,300 | |
| **TOTAL** | $2,948 | $32,217 | $18,858 | $12,179 | $1,860 | $25,300 | |

**ZONE 5, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-5.3 IN SITU TREATMENT (ENHANCED BIOREMEDIATION) TO MEET I/C DECs AND PMCs, LUCs, AND MONITORING**
**PRESENT WORTH ANALYSIS**

| Year | Capital Cost | Annual Cost | Total Year Cost | Annual Discount Rate at 7% | Present Worth |
|---|---|---|---|---|---|
| 0 | $1,175,268 | | $1,175,268 | 1.000 | $1,175,268 |
| 1 | | $37,025 | $37,025 | 0.935 | $34,618 |
| 2 | | $34,077 | $34,077 | 0.873 | $29,749 |
| 3 | | $20,718 | $20,718 | 0.816 | $16,906 |
| 4 | | $20,718 | $20,718 | 0.763 | $15,808 |
| 5 | | $39,339 | $39,339 | 0.713 | $28,049 |
| 6 | | $14,039 | $14,039 | 0.666 | $9,350 |
| 7 | | $14,039 | $14,039 | 0.623 | $8,746 |
| 8 | | $14,039 | $14,039 | 0.582 | $8,171 |
| 9 | | $14,039 | $14,039 | 0.544 | $7,637 |
| 10 | | $39,339 | $39,339 | 0.508 | $19,984 |
| 11 | | $14,039 | $14,039 | 0.475 | $6,669 |
| 12 | | $14,039 | $14,039 | 0.444 | $6,233 |
| 13 | | $14,039 | $14,039 | 0.415 | $5,826 |
| 14 | | $14,039 | $14,039 | 0.388 | $5,447 |
| 15 | | $39,339 | $39,339 | 0.362 | $14,241 |
| 16 | | $14,039 | $14,039 | 0.339 | $4,759 |
| 17 | | $14,039 | $14,039 | 0.317 | $4,450 |
| 18 | | $14,039 | $14,039 | 0.296 | $4,156 |
| 19 | | $14,039 | $14,039 | 0.277 | $3,889 |
| 20 | | $39,339 | $39,339 | 0.258 | $10,149 |
| 21 | | $14,039 | $14,039 | 0.242 | $3,397 |
| 22 | | $14,039 | $14,039 | 0.226 | $3,173 |
| 23 | | $14,039 | $14,039 | 0.211 | $2,962 |
| 24 | | $14,039 | $14,039 | 0.197 | $2,766 |
| 25 | | $39,339 | $39,339 | 0.184 | $7,238 |
| 26 | | $14,039 | $14,039 | 0.172 | $2,415 |
| 27 | | $14,039 | $14,039 | 0.161 | $2,260 |
| 28 | | $14,039 | $14,039 | 0.150 | $2,106 |
| 29 | | $14,039 | $14,039 | 0.141 | $1,980 |
| 30 | | $39,339 | $39,339 | 0.131 | $5,153 |
| | | | | **TOTAL PRESENT WORTH** | **$1,453,557** |

**ZONE 5, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-5.4 EXCAVATION TO MEET I/C DEC AND PMC, OFF-SITE TREATMENT (LTTD) AND DISPOSAL (LANDFILLING), LUCs, AND MONITORING**
**Capital Cost**

| Item | Quantity | Unit | Unit Cost Subcontract | Unit Cost Material | Unit Cost Labor | Unit Cost Equipment | Extended Cost Subcontract | Extended Cost Material | Extended Cost Labor | Extended Cost Equipment | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1 PROJECT PLANNING** | | | | | | | | | | | |
| 1.1 Prepare LUC RD Documents | 60 | hr | | | $35.00 | | $0 | $0 | $2,100 | $0 | $2,100 |
| 1.2 Prepare Documents & Plans including Permits | 150 | hr | | | $35.00 | | $0 | $0 | $5,250 | $0 | $5,250 |
| **2 PRE-DESIGN INVESTIGATION** | | | | | | | | | | | |
| 2.1 Field Personnel - prep, field, and follow-up | 1.5 | days | | | $350.00 | | $0 | $0 | $525 | $0 | $525 |
| 2.2 Travel & Mob | 1 | ls | $550.00 | | | | $550 | $0 | $0 | $0 | $550 |
| 2.3 Geoprobe - Equipment and Operator | 1 | day | $2,400.00 | | | | $2,400 | $0 | $0 | $0 | $2,400 |
| 2.4 Supplies & PID | 1 | day | $600.00 | | | | $600 | $0 | $0 | $0 | $600 |
| 2.5 Soil Sample Analysis (Lead, SPLP Lead) | 1 | ls | $805.00 | | | | $805 | $0 | $0 | $0 | $805 |
| 2.6 Evaluate Data, Prepare Report, and Upload to NIRIS | 1 | ea | $7,000.00 | | | | $7,000 | $0 | $0 | $0 | $7,000 |
| **3 MOBILIZATION, DEMOBILIZATION AND FIELD SUPPORT** | | | | | | | | | | | |
| 3.1 Office Trailer | 0.5 | mo | | $375.00 | | | $0 | $188 | $0 | $0 | $188 |
| 3.2 Field Office Support | 0.5 | mo | | $240.00 | | | $0 | $120 | $0 | $0 | $120 |
| 3.3 Utility Connection/Disconnection (phone/electric) | 1 | ls | $1,500.00 | | | | $1,500 | $0 | $0 | $0 | $1,500 |
| 3.4 Site Utilities | 0.5 | mo | | $230.00 | | | $0 | $115 | $0 | $0 | $115 |
| 3.5 Underground Utility Clearances | 1 | ls | $1,500.00 | | | | $1,500 | $0 | $0 | $0 | $1,500 |
| 3.6 Construction Survey Support | 1 | day | $1,050.00 | | | | $1,050 | $0 | $0 | $0 | $1,050 |
| 3.7 Equipment Mobilization/Demobilization, 70 to 150 HP | 6 | ea | | | $64.00 | $117.00 | $0 | $0 | $384 | $702 | $1,086 |
| 3.8 Site Superintendent | 14 | day | | | $355.00 | | $0 | $0 | $4,970 | $0 | $4,970 |
| 3.9 Site Health & Safety and QA/QC | 14 | day | | | $325.00 | | $0 | $0 | $4,550 | $0 | $4,550 |
| 3.10 Materials Storage Pad, 25' X 25' | 625 | sf | | $3.64 | $0.74 | $1.09 | $0 | $2,275 | $463 | $681 | $3,419 |
| **4 DECONTAMINATION** | | | | | | | | | | | |
| 4.1 Decontamination Services | 0.5 | mo | | | | $5,045.46 | $0 | $0 | $0 | $2,523 | $2,523 |
| 4.2 Equipment Decon Pad | 0.5 | ls | | $1,750.00 | $1,500.00 | $425.00 | $0 | $875 | $750 | $213 | $1,838 |
| 4.3 Decon Water | 5,000 | gal | | $0.20 | | | $0 | $1,000 | $0 | $0 | $1,000 |
| 4.4 Decon Water Storage Tank, 6,000 gallon | 0.5 | mo | | | | $784.24 | $0 | $0 | $0 | $392 | $392 |
| 4.5 Clean Water Storage Tank, 4,000 gallon | 0.5 | mo | | | | $705.22 | $0 | $0 | $0 | $353 | $353 |
| 4.6 Disposal of Decon Waste (liquid & solid) | 0.5 | mo | $950.00 | | | | $475 | $0 | $0 | $0 | $475 |
| **5 EXCAVATION AND DISPOSAL** | | | | | | | | | | | |
| 5.1 Pavement Removal, bituminous driveways | 244 | sy | | $2.22 | $1.63 | $3.85 | $0 | $543 | $398 | $941 | $1,882 |
| 5.2 Excavator, 1/2 cy Capacity | 1 | wk | | | $2,966.00 | $1,973.00 | $0 | $0 | $2,966 | $1,973 | $4,939 |
| 5.3 Site Labor, (1 laborer) | 1 | wk | | | $1,264.00 | | $0 | $0 | $1,264 | $0 | $1,264 |
| 5.4 Tractor Loader 1 to 1-1/4 cy | 1 | wk | | | $2,286.00 | $1,195.00 | $0 | $0 | $2,286 | $1,195 | $3,481 |
| 5.5 Characterization/Offsite Disposal Soil Testing | 28 | ea | $100.80 | $10.00 | | | $2,822 | $280 | $0 | $0 | $3,102 |
| 5.6 Confirmation Testing - ETPH Rapid Turn | 3 | ea | $201.60 | | | | $605 | $0 | $0 | $0 | $605 |
| 5.7 Off Site Transportation & Disposal, High TPH | 351 | tons | $100.00 | | | | $35,100 | $0 | $0 | $0 | $35,100 |
| 5.8 Off Site Transportation & Recycling, Asphalt | 15 | tons | $19.50 | | | | $293 | $0 | $0 | $0 | $293 |
| **6 BACKFILL AND SITE RESTORATION** | | | | | | | | | | | |
| 6.1 Clean Backfill | 234 | cy | | $8.00 | | | $0 | $1,872 | $0 | $0 | $1,872 |
| 6.2 Tractor Loader 1 to 1-1/4 cy | 1 | day | | | $457.20 | $322.00 | $0 | $0 | $457 | $322 | $779 |
| 6.3 Vibrating Roller, 2-Drum, 7.5 HP, 1/2 time Operator | 1 | day | | | $228.60 | $189.60 | $0 | $0 | $229 | $190 | $418 |
| 6.4 Vibratory Plate, 1/2 time Operator | 1 | day | | | $126.40 | $32.00 | $0 | $0 | $126 | $32 | $158 |
| 6.5 Asphalt, 2" Binder, 1" Topping, Small Areas | 2,200 | sf | | $1.03 | $0.24 | $0.30 | $0 | $2,266 | $528 | $660 | $3,454 |
| **7 POST CONSTRUCTION COST** | | | | | | | | | | | |
| 7.1 Contractor Completion Report | 20 | hr | | | $35.00 | | $0 | $0 | $700 | $0 | $700 |
| 7.2 Remedial Action Closeout Report | 20 | hr | | | $35.00 | | $0 | $0 | $700 | $0 | $700 |
| **Subtotal** | | | | | | | $54,700 | $9,533 | $28,646 | $10,176 | $103,055 |
| ***Local Area Adjustments*** | | | | | | | 100.0% | 98.6% | 104.2% | 104.2% | |
| **Subtotal** | | | | | | | $54,700 | $9,400 | $29,849 | $10,603 | $104,552 |

**ZONE 5, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-5.4 EXCAVATION TO MEET I/C DEC AND PMC, OFF-SITE TREATMENT (LTTD) AND DISPOSAL (LANDFILLING), LUCs, AND MONITORING**
**Capital Cost**

| Item | Quantity | Unit | Unit Cost Subcontract | Unit Cost Material | Unit Cost Labor | Unit Cost Equipment | Extended Cost Subcontract | Extended Cost Material | Extended Cost Labor | Extended Cost Equipment | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Overhead on Labor Cost @ | 30% | | | | | | | | $8,955 | | $8,955 |
| G & A on Labor Cost @ | 10% | | | | | | | | $2,985 | | $2,985 |
| G & A on Material Cost @ | 10% | | | | | | | $940 | | | $940 |
| G & A on Equipment Cost @ | 10% | | | | | | | | | $1,060 | $1,060 |
| G & A on Subcontract Cost @ | 10% | | | | | | $5,470 | | | | $5,470 |
| Tax on Materials and Equipment Cost @ | 6% | | | | | | | $564 | | $636 | $1,200 |
| **Total Direct Cost** | | | | | | | $60,170 | $10,904 | $41,789 | $12,300 | $125,162 |
| Indirects on Total Direct Cost @ | 30% | (excluding transportation and disposal cost) | | | | | | | | | $26,788 |
| Profit on Total Direct Cost @ | 10% | | | | | | | | | | $12,516 |
| **Subtotal** | | | | | | | | | | | $164,467 |
| Health & Safety Monitoring @ | 3% | (includes air quality monitoring) | | | | | | | | | $4,934 |
| **Total Field Cost** | | | | | | | | | | | $169,401 |
| Contingency on Total Field Costs @ | 20% | | | | | | | | | | $33,880 |
| Engineering on Total Field Cost @ | 10% | | | | | | | | | | $16,940 |
| **TOTAL CAPITAL COST** | | | | | | | | | | | **$220,221** |

**ZONE 5, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-5.4 EXCAVATION TO MEET I/C DEC AND PMC, OFF-SITE TREATMENT (LTTD) AND DISPOSAL (LANDFILLING), LUCs, AND MONITORING**
**ANNUAL COST**

| Item | Item Cost Years 1 & 2 | Item Cost Years 3 & 4 | Item Cost Years 5 through 30 | Item Cost Annually | Item Cost Every 5 Years | Notes |
|---|---|---|---|---|---|---|
| Pavement Maintenance | | | | $691 | | Repave 10% of contaminated areas yearly. |
| Groundwater Sampling | $22,272 | $11,136 | $5,568 | | | 4 Wells. Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Labor and supplies for sampling |
| Groundwater Analysis | $2,016 | $1,008 | $504 | | | 4 wells, Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Analysis for TPH. |
| Groundwater Report | $5,000 | $5,000 | $5,000 | | | |
| Inspection | | | | $1,000 | | Annual LUC inspection |
| Site Review | | | | | $23,000 | 5-year review |
| Subtotal | $29,288 | $17,144 | $11,072 | $1,691 | $23,000 | |
| Contingency at 10% | $2,929 | $1,714 | $1,107 | $169 | $2,300 | |
| **TOTAL** | $32,217 | $18,858 | $12,179 | $1,860 | $25,300 | |

**ZONE 5, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-5.4 EXCAVATION TO MEET I/C DEC AND PMC, OFF-SITE TREATMENT (LTTD) AND DISPOSAL (LANDFILLING), LUCs, AND MONITORING**
**Present Worth Analysis**

| Year | Capital Cost | Annual Cost | Total Year Cost | Annual Discount Rate at 7% | Present Worth |
|---|---|---|---|---|---|
| 0 | $220,221 | | $220,221 | 1.000 | $220,221 |
| 1 | | $34,077 | $34,077 | 0.935 | $31,862 |
| 2 | | $34,077 | $34,077 | 0.873 | $29,749 |
| 3 | | $20,718 | $20,718 | 0.816 | $16,906 |
| 4 | | $20,718 | $20,718 | 0.763 | $15,808 |
| 5 | | $39,339 | $39,339 | 0.713 | $28,049 |
| 6 | | $14,039 | $14,039 | 0.666 | $9,350 |
| 7 | | $14,039 | $14,039 | 0.623 | $8,746 |
| 8 | | $14,039 | $14,039 | 0.582 | $8,171 |
| 9 | | $14,039 | $14,039 | 0.544 | $7,637 |
| 10 | | $39,339 | $39,339 | 0.508 | $19,984 |
| 11 | | $14,039 | $14,039 | 0.475 | $6,669 |
| 12 | | $14,039 | $14,039 | 0.444 | $6,233 |
| 13 | | $14,039 | $14,039 | 0.415 | $5,826 |
| 14 | | $14,039 | $14,039 | 0.388 | $5,447 |
| 15 | | $39,339 | $39,339 | 0.362 | $14,241 |
| 16 | | $14,039 | $14,039 | 0.339 | $4,759 |
| 17 | | $14,039 | $14,039 | 0.317 | $4,450 |
| 18 | | $14,039 | $14,039 | 0.296 | $4,156 |
| 19 | | $14,039 | $14,039 | 0.277 | $3,889 |
| 20 | | $39,339 | $39,339 | 0.258 | $10,149 |
| 21 | | $14,039 | $14,039 | 0.242 | $3,397 |
| 22 | | $14,039 | $14,039 | 0.226 | $3,173 |
| 23 | | $14,039 | $14,039 | 0.211 | $2,962 |
| 24 | | $14,039 | $14,039 | 0.197 | $2,766 |
| 25 | | $39,339 | $39,339 | 0.184 | $7,238 |
| 26 | | $14,039 | $14,039 | 0.172 | $2,415 |
| 27 | | $14,039 | $14,039 | 0.161 | $2,260 |
| 28 | | $14,039 | $14,039 | 0.15 | $2,106 |
| 29 | | $14,039 | $14,039 | 0.141 | $1,980 |
| 30 | | $39,339 | $39,339 | 0.131 | $5,153 |
| | | | | **TOTAL PRESENT WORTH** | **$495,753** |

**ZONE 5, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-5.5 EXCAVATION TO MEET RESIDENTIAL DECs AND PMCs, ON-SITE DEWATERING, AND OFF-SITE TREATMENT (LTTD) AND DISPOSAL (LANDFILLING)**
**Capital Cost**

| | | | Unit Cost | | | | Extended Cost | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Item | Quantity | Unit | Subcontract | Material | Labor | Equipment | Subcontract | Material | Labor | Equipment | Subtotal |
| **1 PROJECT PLANNING** | | | | | | | | | | | |
| 1.1 Prepare Documents & Plans including Permits | 200 | hr | | | $35.00 | | $0 | $0 | $7,000 | $0 | $7,000 |
| **2 PRE-DESIGN INVESTIGATION** | | | | | | | | | | | |
| 2.1 Field Personnel - prep, field, and follow-up | 1.5 | days | | | $350.00 | | $0 | $0 | $525 | $0 | $525 |
| 2.2 Travel & Mob | 1 | ls | $550.00 | | | | $550 | $0 | $0 | $0 | $550 |
| 2.3 Geoprobe - Equipment and Operator | 1 | day | $2,400.00 | | | | $2,400 | $0 | $0 | $0 | $2,400 |
| 2.4 Supplies & PID | 1 | day | $600.00 | | | | $600 | $0 | $0 | $0 | $600 |
| 2.5 Soil Sample Analysis (Lead, SPLP Lead) | 1 | ls | $805.00 | | | | $805 | $0 | $0 | $0 | $805 |
| 2.6 Evaluate Data, Prepare Report, and Upload to NIRIS | 1 | ea | $7,000.00 | | | | $7,000 | $0 | $0 | $0 | $7,000 |
| **3 MOBILIZATION, DEMOBILIZATION AND FIELD SUPPORT** | | | | | | | | | | | |
| 3.1 Office Trailer | 2 | mo | | | | $375.00 | $0 | $0 | $0 | $750 | $750 |
| 3.2 Field Office Support | 2 | mo | | $155.00 | | | $0 | $310 | $0 | $0 | $310 |
| 3.3 Storage Trailer (1) | 2 | mo | | | | $99.00 | $0 | $0 | $0 | $198 | $198 |
| 3.4 Utility Connection/Disconnection (phone/electric) | 1 | ls | $1,500.00 | | | | $1,500 | $0 | $0 | $0 | $1,500 |
| 3.5 Site Utilities | 2 | mo | $150.00 | | | | $300 | $0 | $0 | $0 | $300 |
| 3.6 Construction Survey Support | 2 | day | $975.00 | | | | $1,950 | $0 | $0 | $0 | $1,950 |
| 3.7 Equipment Mobilization/Demobilization | 8 | ea | | | $85.00 | $261.00 | $0 | $0 | $680 | $2,088 | $2,768 |
| 3.8 Site Superintendent | 44 | day | | | $355.00 | | $0 | $0 | $15,620 | $0 | $15,620 |
| 3.9 Site Health & Safety and QA/QC | 44 | day | | | $325.00 | | $0 | $0 | $14,300 | $0 | $14,300 |
| 3.10 Materials Storage Pad, 25' X 25' | 625 | sf | | $3.64 | $0.74 | $1.09 | $0 | $2,275 | $463 | $681 | $3,419 |
| 3.11 Dewatering Pad, 40' X 40' | 1,600 | sf | | $5.62 | $0.85 | $1.24 | $0 | $8,992 | $1,360 | $1,984 | $12,336 |
| 3.12 Maintain Dewatering Pad, Replace Top 4x | 6,400 | sf | | $0.32 | $0.11 | $0.13 | $0 | $2,048 | $704 | $832 | $3,584 |
| **4 DECONTAMINATION** | | | | | | | | | | | |
| 4.1 Decontamination Services | 2 | mo | | | | $5,045.46 | $0 | $0 | $0 | $10,091 | $10,091 |
| 4.2 Equipment Decon Pad | 1 | ls | | $1,750.00 | $1,500.00 | $425.00 | $0 | $1,750 | $1,500 | $425 | $3,675 |
| 4.3 Decon Water | 2,000 | gal | | $0.20 | | | $0 | $400 | $0 | $0 | $400 |
| 4.4 Decon Water Storage Tank, 6,000 gallon | 2 | mo | | | | $784.24 | $0 | $0 | $0 | $1,568 | $1,568 |
| 4.5 Clean Water Storage Tank, 4,000 gallon | 2 | mo | | | | $705.22 | $0 | $0 | $0 | $1,410 | $1,410 |
| 4.6 Disposal of Decon Waste (liquid & solid) | 2 | mo | $950.00 | | | | $1,900 | $0 | $0 | $0 | $1,900 |
| **5 SHEET PILING, EXCAVATION, DEWATERING, AND DISPOSAL** | | | | | | | | | | | |
| 5.1 Pavement Removal | 4,778 | sy | | $2.22 | $1.63 | $3.85 | $0 | $10,606 | $7,787 | $18,394 | $36,787 |
| 5.2 Excavator, 2 CY Capacity | 2 | mo | | | $12,064.80 | $17,678.20 | $0 | $0 | $24,130 | $35,356 | $59,486 |
| 5.3 Site Labor, (3 laborers) | 2 | mo | | | $16,684.80 | | $0 | $0 | $33,370 | $0 | $33,370 |
| 5.4 Sheet Piles, 580' x 8', tiebacks, drive, extract & salvage | 4,640 | sf | | $8.48 | $6.96 | $9.15 | $0 | $39,324 | $32,294 | $42,456 | $114,074 |
| 5.5 FE Loader 3 1/2 to 5 cy | 2 | mo | | | $9,288.40 | $13,544.60 | $0 | $0 | $18,577 | $27,089 | $45,666 |
| 5.6 Crane, 25 Ton with Clamshell Bucket, 1 CY | 1 | mo | | | $12,262.80 | $4,490.91 | $0 | $0 | $12,263 | $4,491 | $16,754 |
| 5.7 Characterization Soil Testing - PAH, ETPH | 50 | ea | $310.80 | $10.00 | | | $15,540 | $500 | $0 | $0 | $16,040 |
| 5.8 Confirmation Soil Testing - PAH, ETPH, rapid | 24 | ea | $621.60 | | | | $14,918 | $0 | $0 | $0 | $14,918 |
| 5.9 Off Site Transportation & Disposal, TPH < 2500 mg/kg | 12,921 | tons | $40.00 | | | | $516,840 | $0 | $0 | $0 | $516,840 |
| 5.10 Off Site Transportation & Disposal, High TPH Soil | 995 | tons | $100.00 | | | | $99,450 | $0 | $0 | $0 | $99,450 |
| 5.11 Off Site Transportation & Recycling, Asphalt | 597 | tons | $19.50 | | | | $11,642 | $0 | $0 | $0 | $11,642 |
| 5.12 Centrifugal 15 gpm 1 HP Pump, to Treatment, | 1 | mo | | $2,211 | $636 | | $0 | $2,211 | $636 | $0 | $2,847 |
| 5.13 5,000 lb Liquid-Phase GAC Adsorption Units | 2 | ea | | $24,600.00 | | | $0 | $49,200 | $0 | $0 | $49,200 |
| 5.14 Replace GAC | 70,000 | lb | | $2.00 | | | $0 | $140,000 | $0 | $0 | $140,000 |
| 5.15 Bag Filter System | 2 | ea | | $14,000.00 | $225.00 | | $0 | $28,000 | $450 | $0 | $28,450 |
| 5.16 Replace Filter Bags | 224 | ea | | $60.00 | | | $0 | $13,440 | $0 | $0 | $13,440 |
| 5.17 Diaphragm Pump, from Treatment to Storm Sewer | 1 | mo | | | | $542.48 | $0 | $0 | $0 | $542 | $542 |
| 5.18 Piping , 2" PVC, from Treatment to Storm Sewer | 200 | ft | | $0.51 | $0.72 | | $0 | $102 | $144 | $0 | $246 |
| **6 BACKFILL AND SITE RESTORATION** | | | | | | | | | | | |
| 6.1 Clean Backfill | 8,878 | cy | | $8.00 | | | $0 | $71,024 | $0 | $0 | $71,024 |
| 6.2 FE Loader 3 1/2 to 5 cy, two | 2 | mo | | | $9,288.40 | $13,544.60 | $0 | $0 | $18,577 | $27,089 | $45,666 |
| 6.3 Vibrating Roller, 2-Drum, 7.5 HP | 1 | mo | | | $10,058.40 | $2,494.40 | $0 | $0 | $10,058 | $2,494 | $12,553 |
| 6.4 Vibratory Plate for use around Utilities | 1 | mo | | | | $297.00 | $0 | $0 | $0 | $297 | $297 |
| 6.5 Top Dress Soil | 796 | cy | $31.50 | | | | $25,074 | $0 | $0 | $0 | $25,074 |

**ZONE 5, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-5.5 EXCAVATION TO MEET RESIDENTIAL DECs AND PMCs, ON-SITE DEWATERING, AND OFF-SITE TREATMENT (LTTD) AND DISPOSAL (LANDFILLING)**
**Capital Cost**

| Item | Quantity | Unit | Unit Cost Subcontract | Unit Cost Material | Unit Cost Labor | Unit Cost Equipment | Extended Cost Subcontract | Extended Cost Material | Extended Cost Labor | Extended Cost Equipment | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 6.6 Site Restoration, seed, fertilization, mulch | 43 | msf | $75.00 | | | | $3,225 | $0 | $0 | $0 | $3,225 |
| **7 POST CONSTRUCTION COST** | | | | | | | | | | | |
| 7.1 Contractor Completion Report | 80 | hr | | | $35.00 | | $0 | $0 | $2,800 | $0 | $2,800 |
| 7.2 Remedial Action Closeout Report | 80 | hr | | | $35.00 | | $0 | $0 | $2,800 | $0 | $2,800 |
| **Subtotal** | | | | | | | $703,694 | $370,183 | $206,037 | $178,237 | $1,458,151 |
| **Local Area Adjustments** | | | | | | | 100.0% | 98.6% | 104.2% | 104.2% | |
| **Subtotal** | | | | | | | $703,694 | $365,000 | $214,691 | $185,723 | $1,469,108 |
| Overhead on Labor Cost @ 30% | | | | | | | | | $64,407 | | $64,407 |
| G & A on Labor Cost @ 10% | | | | | | | | | $21,469 | | $21,469 |
| G & A on Material Cost @ 10% | | | | | | | | $36,500 | | | $36,500 |
| G & A on Equipment Cost @ 10% | | | | | | | | | | $18,572 | $18,572 |
| G & A on Subcontract Cost @ 10% | | | | | | | $70,369 | | | | $70,369 |
| Tax on Materials and Equipment Cost @ 6% | | | | | | | | $21,900 | | $11,143 | $33,043 |
| **Total Direct Cost** | | | | | | | $774,063 | $423,400 | $300,567 | $215,439 | $1,713,469 |
| Indirects on Total Direct Cost @ 30% | | (excluding transportation and disposal cost) | | | | | | | | | $325,091 |
| Profit on Total Direct Cost @ 10% | | | | | | | | | | | $171,347 |
| **Subtotal** | | | | | | | | | | | $2,209,907 |
| Health & Safety Monitoring @ 2% | | (includes air quality monitoring) | | | | | | | | | $44,198 |
| **Total Field Cost** | | | | | | | | | | | $2,254,105 |
| Contingency on Total Field Costs @ 20% | | | | | | | | | | | $450,821 |
| Engineering on Total Field Cost @ 10% | | | | | | | | | | | $225,411 |
| **TOTAL CAPITAL COST** | | | | | | | | | | | **$2,930,337** |

# APPENDIX E.1.6

# ZONE 6

# ALTERNATIVES S-6.1, S-6.2, S-6.3, and S-6.4

**ZONE 6, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-6.1: LUCs and Monitoring**
**CAPITAL COST**

| Item | Quantity | Unit | Unit Cost | | | | Extended Cost | | | | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Subcontract | Material | Labor | Equipment | Subcontract | Material | Labor | Equipment | |
| **1 PROJECT PLANNING** | | | | | | | | | | | |
| 1.1 Prepare Documents & Plans including Permits/Variances | 140 | hr | | | $35.00 | | $0 | $0 | $4,900 | $0 | $4,900 |
| 1.2 Prepare LUC RD Documents | 60 | hr | | | $35.00 | | $0 | $0 | $2,100 | $0 | $2,100 |
| **2 PRE-DESIGN INVESTIGATION** | | | | | | | | | | | |
| 2.1 Field Personnel - prep, field, and follow-up | 1.5 | days | | | $350.00 | | $0 | $0 | $525 | $0 | $525 |
| 2.2 Travel & Mob | 1 | ls | $550.00 | | | | $550 | $0 | $0 | $0 | $550 |
| 2.3 Geoprobe - Equipment and Operator | 1 | day | $2,400.00 | | | | $2,400 | $0 | $0 | $0 | $2,400 |
| 2.4 Supplies & PID | 1 | day | $600.00 | | | | $600 | $0 | $0 | $0 | $600 |
| 2.5 Soil Sample Analysis (Lead, SPLP Lead) | 1 | ls | $805.00 | | | | $805 | $0 | $0 | $0 | $805 |
| 2.6 Evaluate Data, Prepare Report, and Upload to NIRIS | 1 | ea | $7,000.00 | | | | $7,000 | $0 | $0 | $0 | $7,000 |
| **3 FIELD SUPPORT** | | | | | | | | | | | |
| 3.1 Construction Survey Support | 1 | day | $1,050.00 | | | | $1,050 | $0 | $0 | $0 | $1,050 |
| **Subtotal** | | | | | | | $12,405 | $0 | $7,525 | $0 | $19,930 |
| **Local Area Adjustments** | | | | | | | 100.0% | 98.6% | 104.2% | 104.2% | |
| | | | | | | | $12,405 | $0 | $7,841 | $0 | $20,246 |
| Overhead on Labor Cost @ 30% | | | | | | | | | $2,352 | | $2,352 |
| G & A on Labor Cost @ 10% | | | | | | | | | $784 | | $784 |
| G & A on Material Cost @ 10% | | | | | | | | $0 | | | $0 |
| G & A on Subcontract Cost @ 10% | | | | | | | $1,241 | | | | $1,241 |
| G & A on Equipment Cost @ 10% | | | | | | | | | | $0 | $0 |
| **Total Direct Cost** | | | | | | | $13,646 | $0 | $10,977 | $0 | $24,623 |
| Indirects on Total Direct Cost @ 0% | | | | | | | | | | | $0 |
| Profit on Total Direct Cost @ 10% | | | | | | | | | | | $2,462 |
| **Subtotal** | | | | | | | | | | | $27,085 |
| Health & Safety Monitoring @ 0% | | | | | | | | | | | $0 |
| **Total Field Cost** | | | | | | | | | | | $27,085 |
| Contingency on Total Field Costs @ 0% | | | | | | | | | | | $0 |
| Engineering on Total Field Cost @ 0% | | | | | | | | | | | $0 |
| **TOTAL COST** | | | | | | | | | | | **$27,085** |

**ZONE 6, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-6.1: LUCs and Monitoring**
**ANNUAL COST**

| Item | Item Cost Years 1 & 2 | Item Cost Years 3 & 4 | Item Cost Years 5 through 30 | Item Cost Annually | Item Cost Every 5 Years | Notes |
|---|---|---|---|---|---|---|
| Pavement Maintenance | | | | $2,261 | | Repave 10% of contaminated areas yearly. |
| Groundwater Sampling | $22,272 | $11,136 | $5,568 | | | 4 Wells. Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Labor and supplies for sampling |
| Groundwater Analysis | $2,016 | $1,008 | $504 | | | 4 wells, Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Analysis for TPH. |
| Groundwater Report | $5,000 | $5,000 | $5,000 | | | |
| Inspection | | | | $1,000 | | Annual LUC inspection |
| Site Review | | | | | $23,000 | 5-year review |
| Subtotal | $29,288 | $17,144 | $11,072 | $3,261 | $23,000 | |
| Contingency at 10% | $2,929 | $1,714 | $1,107 | $326 | $2,300 | |
| **TOTAL** | $32,217 | $18,858 | $12,179 | $3,587 | $25,300 | |

**ZONE 6, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-6.1: LUCs and Monitoring**
**PRESENT WORTH ANALYSIS**

| Year | Capital Cost | Annual Cost | Total Year Cost | Annual Discount Rate at 7% | Present Worth |
|---|---|---|---|---|---|
| 0 | $27,085 | | $27,085 | 1.000 | $27,085 |
| 1 | | $35,804 | $35,804 | 0.935 | $33,476 |
| 2 | | $35,804 | $35,804 | 0.873 | $31,257 |
| 3 | | $22,445 | $22,445 | 0.816 | $18,315 |
| 4 | | $22,445 | $22,445 | 0.763 | $17,126 |
| 5 | | $41,066 | $41,066 | 0.713 | $29,280 |
| 6 | | $15,766 | $15,766 | 0.666 | $10,500 |
| 7 | | $15,766 | $15,766 | 0.623 | $9,822 |
| 8 | | $15,766 | $15,766 | 0.582 | $9,176 |
| 9 | | $15,766 | $15,766 | 0.544 | $8,577 |
| 10 | | $41,066 | $41,066 | 0.508 | $20,862 |
| 11 | | $15,766 | $15,766 | 0.475 | $7,489 |
| 12 | | $15,766 | $15,766 | 0.444 | $7,000 |
| 13 | | $15,766 | $15,766 | 0.415 | $6,543 |
| 14 | | $15,766 | $15,766 | 0.388 | $6,117 |
| 15 | | $41,066 | $41,066 | 0.362 | $14,866 |
| 16 | | $15,766 | $15,766 | 0.339 | $5,345 |
| 17 | | $15,766 | $15,766 | 0.317 | $4,998 |
| 18 | | $15,766 | $15,766 | 0.296 | $4,667 |
| 19 | | $15,766 | $15,766 | 0.277 | $4,367 |
| 20 | | $41,066 | $41,066 | 0.258 | $10,595 |
| 21 | | $15,766 | $15,766 | 0.242 | $3,815 |
| 22 | | $15,766 | $15,766 | 0.226 | $3,563 |
| 23 | | $15,766 | $15,766 | 0.211 | $3,327 |
| 24 | | $15,766 | $15,766 | 0.197 | $3,106 |
| 25 | | $41,066 | $41,066 | 0.184 | $7,556 |
| 26 | | $15,766 | $15,766 | 0.172 | $2,712 |
| 27 | | $15,766 | $15,766 | 0.161 | $2,538 |
| 28 | | $15,766 | $15,766 | 0.150 | $2,365 |
| 29 | | $15,766 | $15,766 | 0.141 | $2,223 |
| 30 | | $41,066 | $41,066 | 0.131 | $5,380 |
| | | | | **TOTAL PRESENT WORTH** | **$324,048** |

**ZONE 6, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-6.2 IN SITU TREATMENT (ENHANCED BIOREMEDIATION) TO MEET I/C DECs AND PMCs, LUCs, AND MONITORING**
**Capital Cost**

| | | | | Unit Cost | | | | Extended Cost | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Item | Quantity | Unit | Subcontract | Material | Labor | Equipment | Subcontract | Material | Labor | Equipment | Subtotal |
| **1 PROJECT PLANNING** | | | | | | | | | | | |
| 1.1 Prepare LUC RD Documents | 60 | hr | | | $35.00 | | $0 | $0 | $2,100 | $0 | $2,100 |
| 1.2 Prepare Documents & Plans including Permits | 150 | hr | | | $35.00 | | $0 | $0 | $5,250 | $0 | $5,250 |
| **2 PRE-DESIGN INVESTIGATION** | | | | | | | | | | | |
| 2.1 Field Personnel - prep, field, and follow-up | 1.5 | days | | | $350.00 | | $0 | $0 | $525 | $0 | $525 |
| 2.2 Travel & Mob | 1 | ls | $550.00 | | | | $550 | $0 | $0 | $0 | $550 |
| 2.3 Geoprobe - Equipment and Operator | 1 | day | $2,400.00 | | | | $2,400 | $0 | $0 | $0 | $2,400 |
| 2.4 Supplies & PID | 1 | day | $600.00 | | | | $600 | $0 | $0 | $0 | $600 |
| 2.5 Soil Sample Analysis (Lead, SPLP Lead) | 1 | ls | $805.00 | | | | $805 | $0 | $0 | $0 | $805 |
| 2.6 Evaluate Data, Prepare Report, and Upload to NIRIS | 1 | ea | $7,000.00 | | | | $7,000 | $0 | $0 | $0 | $7,000 |
| **3 MOBILIZATION, DEMOBILIZATION AND FIELD SUPPORT** | | | | | | | | | | | |
| 3.1 Storage Trailer (1) | 1 | mo | | | | $99.00 | $0 | $0 | $0 | $99 | $99 |
| 3.2 Underground Utility Clearances | 1 | ls | $3,500.00 | | | | $3,500 | $0 | $0 | $0 | $3,500 |
| 3.3 Construction Survey | 1 | day | $2,125.00 | | | | $2,125 | $0 | $0 | $0 | $2,125 |
| 3.4 Mobilization/Demobilization for Shallow Soil Mixing | 1 | ea | $30,000.00 | | | | $30,000 | $0 | $0 | $0 | $30,000 |
| 3.5 Temporary Fencing | 1 | ls | | $500.00 | | | $0 | $500 | $0 | $0 | $500 |
| 3.6 Field Construction Mgt. (1 person) | 4 | day | | $200.00 | $350.00 | | $0 | $800 | $1,400 | $0 | $2,200 |
| 3.7 Site Health & Safety and QA/QC | 4 | day | | $200.00 | $325.00 | | $0 | $800 | $1,300 | $0 | $2,100 |
| **4 IN-SITU TREATMENT** | | | | | | | | | | | |
| 4.1 Pavement Removal | 800 | sy | | $2.22 | $1.63 | $3.85 | $0 | $1,776 | $1,304 | $3,080 | $6,160 |
| 4.2 Off Site Transportation & Recycling, Asphalt | 101 | tons | $19.50 | | | | $1,960 | $0 | $0 | $0 | $1,960 |
| 4.3 Treatability Test | 1 | ls | $20,000.00 | | | | $20,000 | $0 | $0 | $0 | $20,000 |
| 4.4 Utility Relocation - Sanitary Sewer | 1 | ls | $10,000.00 | | | | $10,000 | $0 | $0 | $0 | $10,000 |
| 4.5 Backhoe - Shallow Soil Mixing | 733 | cy | $35.00 | | | | $25,655 | $0 | $0 | $0 | $25,655 |
| 4.6 ORC | 97,600 | lb | $9.00 | | | | $878,400 | $0 | $0 | $0 | $878,400 |
| **5 BACKFILL AND SITE RESTORATION** | | | | | | | | | | | |
| 5.1 Asphalt, 2" Binder, 1" Topping, Small Areas | 7,200 | sf | | $1.03 | $0.24 | $0.30 | $0 | $7,416 | $1,728 | $2,160 | $11,304 |
| **6 POST CONSTRUCTION COST** | | | | | | | | | | | |
| 6.1 Contractor Completion Report | 60 | hr | | | $35.00 | | $0 | $0 | $2,100 | $0 | $2,100 |
| 6.2 Remedial Action Closeout Report | 60 | hr | | | $35.00 | | $0 | $0 | $2,100 | $0 | $2,100 |
| **Subtotal** | | | | | | | $982,995 | $11,292 | $17,807 | $5,339 | $1,017,433 |
| **Local Area Adjustments** | | | | | | | 100.0% | 98.6% | 104.2% | 104.2% | |
| **Subtotal** | | | | | | | $982,995 | $11,134 | $18,555 | $5,563 | $1,018,247 |
| Overhead on Labor Cost @ 30% | | | | | | | | | $5,566 | | $5,566 |
| G & A on Labor Cost @ 10% | | | | | | | | | $1,855 | | $1,855 |
| G & A on Material Cost @ 10% | | | | | | | | $1,113 | | | $1,113 |
| G & A on Equipment Cost @ 10% | | | | | | | | | | $556 | $556 |
| G & A on Subcontract Cost @ 10% | | | | | | | $98,299 | | | | $98,299 |
| Tax on Materials and Equipment Cost @ 6% | | | | | | | | $668 | | $334 | $1,002 |
| **Total Direct Cost** | | | | | | | $1,081,294 | $12,915 | $25,977 | $6,453 | $1,126,640 |
| Indirects on Total Direct Cost @ 30% | | | (excluding transportation and disposal cost) | | | | | | | | $337,404 |
| Profit on Total Direct Cost @ 10% | | | | | | | | | | | $112,664 |
| **Subtotal** | | | | | | | | | | | $1,576,708 |
| Health & Safety Monitoring @ 3% | | | (includes air quality monitoring) | | | | | | | | $47,301 |

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**ZONE 6, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-6.2 IN SITU TREATMENT (ENHANCED BIOREMEDIATION) TO MEET I/C DECs AND PMCs, LUCs, AND MONITORING**
**Capital Cost**

| Item | Quantity | Unit | Unit Cost Subcontract | Unit Cost Material | Unit Cost Labor | Unit Cost Equipment | Extended Cost Subcontract | Extended Cost Material | Extended Cost Labor | Extended Cost Equipment | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total Field Cost** | | | | | | | | | | | $1,624,009 |
| Contingency on Total Field Costs @ 20% | | | | | | | | | | | $324,802 |
| Engineering on Total Field Cost @ 15% | | | | | | | | | | | $243,601 |
| **TOTAL CAPITAL COST** | | | | | | | | | | | **$2,192,412** |

**ZONE 6, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-6.2 IN SITU TREATMENT (ENHANCED BIOREMEDIATION) TO MEET I/C DECs AND PMCs, LUCs, AND MONITORING**
**ANNUAL COST**

| Item | Item Cost Year 1 | Item Cost Years 1 & 2 | Item Cost Years 3 & 4 | Item Cost Years 5 through 30 | Item Cost Annually | Item Cost Every 5 Years | Notes |
|---|---|---|---|---|---|---|---|
| Soil Sampling | $2,580 | | | | | | 2 locations at Year 1. Half-day geoprobe plus labor to sample. |
| Soil Analysis | $200 | | | | | | 2 locations. Analysis for ETPH |
| Pavement Maintenance | | | | | $2,261 | | Repave 10% of contaminated areas yearly. |
| Groundwater Sampling | | $22,272 | $11,136 | $5,568 | | | 4 Wells. Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Labor and supplies for sampling |
| Groundwater Analysis | | $2,016 | $1,008 | $504 | | | 4 wells, Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Analysis for TPH. |
| Groundwater Report | | $5,000 | $5,000 | $5,000 | | | |
| Inspection | | | | | $1,000 | | Annual LUC inspection |
| Site Review | | | | | | $23,000 | 5-year review |
| Subtotal | $2,780 | $29,288 | $17,144 | $11,072 | $3,261 | $23,000 | |
| Contingency at 10% | $278 | $2,929 | $1,714 | $1,107 | $326 | $2,300 | |
| **TOTAL** | $3,058 | $32,217 | $18,858 | $12,179 | $3,587 | $25,300 | |

**ZONE 6, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-6.2 IN SITU TREATMENT (ENHANCED BIOREMEDIATION) TO MEET I/C DECs AND PMCs, LUCs, AND MONITORING**
**PRESENT WORTH ANALYSIS**

| Year | Capital Cost | Annual Cost | Total Year Cost | Annual Discount Rate at 7% | Present Worth |
|---|---|---|---|---|---|
| 0 | $2,192,412 | | $2,192,412 | 1.000 | $2,192,412 |
| 1 | | $38,862 | $38,862 | 0.935 | $36,336 |
| 2 | | $35,804 | $35,804 | 0.873 | $31,257 |
| 3 | | $22,445 | $22,445 | 0.816 | $18,315 |
| 4 | | $22,445 | $22,445 | 0.763 | $17,126 |
| 5 | | $41,066 | $41,066 | 0.713 | $29,280 |
| 6 | | $15,766 | $15,766 | 0.666 | $10,500 |
| 7 | | $15,766 | $15,766 | 0.623 | $9,822 |
| 8 | | $15,766 | $15,766 | 0.582 | $9,176 |
| 9 | | $15,766 | $15,766 | 0.544 | $8,577 |
| 10 | | $41,066 | $41,066 | 0.508 | $20,862 |
| 11 | | $15,766 | $15,766 | 0.475 | $7,489 |
| 12 | | $15,766 | $15,766 | 0.444 | $7,000 |
| 13 | | $15,766 | $15,766 | 0.415 | $6,543 |
| 14 | | $15,766 | $15,766 | 0.388 | $6,117 |
| 15 | | $41,066 | $41,066 | 0.362 | $14,866 |
| 16 | | $15,766 | $15,766 | 0.339 | $5,345 |
| 17 | | $15,766 | $15,766 | 0.317 | $4,998 |
| 18 | | $15,766 | $15,766 | 0.296 | $4,667 |
| 19 | | $15,766 | $15,766 | 0.277 | $4,367 |
| 20 | | $41,066 | $41,066 | 0.258 | $10,595 |
| 21 | | $15,766 | $15,766 | 0.242 | $3,815 |
| 22 | | $15,766 | $15,766 | 0.226 | $3,563 |
| 23 | | $15,766 | $15,766 | 0.211 | $3,327 |
| 24 | | $15,766 | $15,766 | 0.197 | $3,106 |
| 25 | | $41,066 | $41,066 | 0.184 | $7,556 |
| 26 | | $15,766 | $15,766 | 0.172 | $2,712 |
| 27 | | $15,766 | $15,766 | 0.161 | $2,538 |
| 28 | | $15,766 | $15,766 | 0.150 | $2,365 |
| 29 | | $15,766 | $15,766 | 0.141 | $2,223 |
| 30 | | $41,066 | $41,066 | 0.131 | $5,380 |
| | | | | **TOTAL PRESENT WORTH** | **$2,492,234** |

**ZONE 6, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-6.3 EXCAVATION TO MEET I/C DEC AND PMC, OFF-SITE TREATMENT (LTTD) AND DISPOSAL (LANDFILLING), LUCs, AND MONITORING**
**Capital Cost**

| | | | | Unit Cost | | | | Extended Cost | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Item | Quantity | Unit | Subcontract | Material | Labor | Equipment | Subcontract | Material | Labor | Equipment | Subtotal |
| **1 PROJECT PLANNING** | | | | | | | | | | | |
| 1.1 Prepare LUC RD Documents | 60 | hr | | | $35.00 | | $0 | $0 | $2,100 | $0 | $2,100 |
| 1.2 Prepare Documents & Plans including Permits | 150 | hr | | | $35.00 | | $0 | $0 | $5,250 | $0 | $5,250 |
| **2 PRE-DESIGN INVESTIGATION** | | | | | | | | | | | |
| 2.1 Field Personnel - prep, field, and follow-up | 1.5 | days | | | $350.00 | | $0 | $0 | $525 | $0 | $525 |
| 2.2 Travel & Mob | 1 | ls | $550.00 | | | | $550 | $0 | $0 | $0 | $550 |
| 2.3 Geoprobe - Equipment and Operator | 1 | day | $2,400.00 | | | | $2,400 | $0 | $0 | $0 | $2,400 |
| 2.4 Supplies & PID | 1 | day | $600.00 | | | | $600 | $0 | $0 | $0 | $600 |
| 2.5 Soil Sample Analysis (Lead, SPLP Lead) | 1 | ls | $805.00 | | | | $805 | $0 | $0 | $0 | $805 |
| 2.6 Evaluate Data, Prepare Report, and Upload to NIRIS | 1 | ea | $7,000.00 | | | | $7,000 | $0 | $0 | $0 | $7,000 |
| **3 MOBILIZATION, DEMOBILIZATION AND FIELD SUPPORT** | | | | | | | | | | | |
| 3.1 Office Trailer | 0.5 | mo | | $375.00 | | | $0 | $188 | $0 | $0 | $188 |
| 3.2 Field Office Support | 0.5 | mo | | $240.00 | | | $0 | $120 | $0 | $0 | $120 |
| 3.3 Utility Connection/Disconnection (phone/electric) | 1 | ls | $1,500.00 | | | | $1,500 | $0 | $0 | $0 | $1,500 |
| 3.4 Site Utilities | 0.5 | mo | | $230.00 | | | $0 | $115 | $0 | $0 | $115 |
| 3.5 Underground Utility Clearances | 1 | ls | $1,500.00 | | | | $1,500 | $0 | $0 | $0 | $1,500 |
| 3.6 Construction Survey Support | 1 | day | $1,050.00 | | | | $1,050 | $0 | $0 | $0 | $1,050 |
| 3.7 Equipment Mobilization/Demobilization, 70 to 150 HP | 6 | ea | | | $64.00 | $117.00 | $0 | $0 | $384 | $702 | $1,086 |
| 3.8 Site Superintendent | 22 | day | | | $355.00 | | $0 | $0 | $7,810 | $0 | $7,810 |
| 3.9 Site Health & Safety and QA/QC | 22 | day | | | $325.00 | | $0 | $0 | $7,150 | $0 | $7,150 |
| 3.10 Materials Storage Pad, 25' X 25' | 625 | sf | | $3.64 | $0.74 | $1.09 | $0 | $2,275 | $463 | $681 | $3,419 |
| **4 DECONTAMINATION** | | | | | | | | | | | |
| 4.1 Decontamination Services | 0.5 | mo | | | | $5,045.46 | $0 | $0 | $0 | $2,523 | $2,523 |
| 4.2 Equipment Decon Pad | 0.5 | ls | | $1,750.00 | $1,500.00 | $425.00 | $0 | $875 | $750 | $213 | $1,838 |
| 4.3 Decon Water | 5,000 | gal | | $0.20 | | | $0 | $1,000 | $0 | $0 | $1,000 |
| 4.4 Decon Water Storage Tank, 6,000 gallon | 0.5 | mo | | | | $784.24 | $0 | $0 | $0 | $392 | $392 |
| 4.5 Clean Water Storage Tank, 4,000 gallon | 0.5 | mo | | | | $705.22 | $0 | $0 | $0 | $353 | $353 |
| 4.6 Disposal of Decon Waste (liquid & solid) | 0.5 | mo | $950.00 | | | | $475 | $0 | $0 | $0 | $475 |
| **5 EXCAVATION AND DISPOSAL** | | | | | | | | | | | |
| 5.1 Pavement Removal, bituminous driveways | 800 | sy | | $2.22 | $1.63 | $3.85 | $0 | $1,776 | $1,304 | $3,080 | $6,160 |
| 5.2 Excavator, 1/2 cy Capacity | 2 | wk | | | $2,966.00 | $1,973.00 | $0 | $0 | $5,932 | $3,946 | $9,878 |
| 5.3 Site Labor, (1 laborer) | 2 | wk | | | $1,264.00 | | $0 | $0 | $2,528 | $0 | $2,528 |
| 5.4 Tractor Loader 1 to 1-1/4 cy | 2 | wk | | | $2,286.00 | $1,195.00 | $0 | $0 | $4,572 | $2,390 | $6,962 |
| 5.5 Characterization/Offsite Disposal Soil Testing | 15 | ea | $100.80 | $10.00 | | | $1,512 | $150 | $0 | $0 | $1,662 |
| 5.6 Confirmation Testing - ETPH Rapid Turn | 5 | ea | $201.60 | | | | $1,008 | $0 | $0 | $0 | $1,008 |
| 5.7 Off Site Transportation & Disposal, High TPH | 1,100 | tons | $100.00 | | | | $109,950 | $0 | $0 | $0 | $109,950 |
| 5.8 Off Site Transportation & Recycling, Asphalt | 101 | tons | $19.50 | | | | $1,960 | $0 | $0 | $0 | $1,960 |
| **6 BACKFILL AND SITE RESTORATION** | | | | | | | | | | | |
| 6.1 Clean Backfill | 733 | cy | | $8.00 | | | $0 | $5,864 | $0 | $0 | $5,864 |
| 6.2 Tractor Loader 1 to 1-1/4 cy | 2 | day | | | $457.20 | $322.00 | $0 | $0 | $914 | $644 | $1,558 |
| 6.3 Vibrating Roller, 2-Drum, 7.5 HP, 1/2 time Operator | 2 | day | | | $228.60 | $189.60 | $0 | $0 | $457 | $379 | $836 |
| 6.4 Vibratory Plate, 1/2 time Operator | 2 | day | | | $126.40 | $32.00 | $0 | $0 | $253 | $64 | $317 |
| 6.5 Asphalt, 2" Binder, 1" Topping, Small Areas | 7,200 | sf | | $1.03 | $0.24 | $0.30 | $0 | $7,416 | $1,728 | $2,160 | $11,304 |
| **7 POST CONSTRUCTION COST** | | | | | | | | | | | |
| 7.1 Contractor Completion Report | 30 | hr | | | $35.00 | | $0 | $0 | $1,050 | $0 | $1,050 |
| 7.2 Remedial Action Closeout Report | 30 | hr | | | $35.00 | | $0 | $0 | $1,050 | $0 | $1,050 |
| **Subtotal** | | | | | | | $130,310 | $19,779 | $44,220 | $17,526 | $211,835 |
| **Local Area Adjustments** | | | | | | | 100.0% | 98.6% | 104.2% | 104.2% | |
| **Subtotal** | | | | | | | $130,310 | $19,502 | $46,077 | $18,263 | $214,151 |

H:\NSB New London\FS\Appendix revisions\Appendix E\Appendix E 1 6\Alt S-6.3 New rev 07-10 jwl\capcost

**ZONE 6, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-6.3 EXCAVATION TO MEET I/C DEC AND PMC, OFF-SITE TREATMENT (LTTD) AND DISPOSAL (LANDFILLING), LUCs, AND MONITORING**
**Capital Cost**

| Item | Quantity | Unit | Unit Cost Subcontract | Unit Cost Material | Unit Cost Labor | Unit Cost Equipment | Extended Cost Subcontract | Extended Cost Material | Extended Cost Labor | Extended Cost Equipment | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Overhead on Labor Cost @ | 30% | | | | | | | | $13,823 | | $13,823 |
| G & A on Labor Cost @ | 10% | | | | | | | | $4,608 | | $4,608 |
| G & A on Material Cost @ | 10% | | | | | | | $1,950 | | | $1,950 |
| G & A on Equipment Cost @ | 10% | | | | | | | | | $1,826 | $1,826 |
| G & A on Subcontract Cost @ | 10% | | | | | | $13,031 | | | | $13,031 |
| Tax on Materials and Equipment Cost @ | 6% | | | | | | | $1,170 | | $1,096 | $2,266 |
| **Total Direct Cost** | | | | | | | $143,341 | $22,622 | $64,508 | $21,185 | $251,655 |
| Indirects on Total Direct Cost @ | 30% | (excluding transportation and disposal cost) | | | | | | | | | $41,781 |
| Profit on Total Direct Cost @ | 10% | | | | | | | | | | $25,166 |
| **Subtotal** | | | | | | | | | | | $318,602 |
| Health & Safety Monitoring @ | 3% | (includes air quality monitoring) | | | | | | | | | $9,558 |
| **Total Field Cost** | | | | | | | | | | | $328,160 |
| Contingency on Total Field Costs @ | 20% | | | | | | | | | | $65,632 |
| Engineering on Total Field Cost @ | 10% | | | | | | | | | | $32,816 |
| **TOTAL CAPITAL COST** | | | | | | | | | | | **$426,608** |

**ZONE 6, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-6.3 EXCAVATION TO MEET I/C DEC AND PMC, OFF-SITE TREATMENT (LTTD) AND DISPOSAL (LANDFILLING), LUCs, AND MONITORING**
**ANNUAL COST**

| Item | Item Cost Years 1 & 2 | Item Cost Years 3 & 4 | Item Cost Years 5 through 30 | Item Cost Annually | Item Cost Every 5 Years | Notes |
|---|---|---|---|---|---|---|
| Pavement Maintenance | | | | $2,261 | | Repave 10% of contaminated areas yearly. |
| Groundwater Sampling | $22,272 | $11,136 | $5,568 | | | 4 Wells. Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Labor and supplies for sampling |
| Groundwater Analysis | $2,016 | $1,008 | $504 | | | 4 wells, Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Analysis for TPH. |
| Groundwater Report | $5,000 | $5,000 | $5,000 | | | |
| Inspection | | | | $1,000 | | Annual LUC inspection |
| Site Review | | | | | $23,000 | 5-year review |
| Subtotal | $29,288 | $17,144 | $11,072 | $3,261 | $23,000 | |
| Contingency at 10% | $2,929 | $1,714 | $1,107 | $326 | $2,300 | |
| **TOTAL** | $32,217 | $18,858 | $12,179 | $3,587 | $25,300 | |

**ZONE 6, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-6.3 EXCAVATION TO MEET I/C DEC AND PMC, OFF-SITE TREATMENT (LTTD) AND DISPOSAL (LANDFILLING), LUCs, AND MONITORING**
**Present Worth Analysis**

| Year | Capital Cost | Annual Cost | Total Year Cost | Annual Discount Rate at 7% | Present Worth |
|---|---|---|---|---|---|
| 0 | $426,608 | | $426,608 | 1.000 | $426,608 |
| 1 | | $35,804 | $35,804 | 0.935 | $33,476 |
| 2 | | $35,804 | $35,804 | 0.873 | $31,257 |
| 3 | | $22,445 | $22,445 | 0.816 | $18,315 |
| 4 | | $22,445 | $22,445 | 0.763 | $17,126 |
| 5 | | $41,066 | $41,066 | 0.713 | $29,280 |
| 6 | | $15,766 | $15,766 | 0.666 | $10,500 |
| 7 | | $15,766 | $15,766 | 0.623 | $9,822 |
| 8 | | $15,766 | $15,766 | 0.582 | $9,176 |
| 9 | | $15,766 | $15,766 | 0.544 | $8,577 |
| 10 | | $41,066 | $41,066 | 0.508 | $20,862 |
| 11 | | $15,766 | $15,766 | 0.475 | $7,489 |
| 12 | | $15,766 | $15,766 | 0.444 | $7,000 |
| 13 | | $15,766 | $15,766 | 0.415 | $6,543 |
| 14 | | $15,766 | $15,766 | 0.388 | $6,117 |
| 15 | | $41,066 | $41,066 | 0.362 | $14,866 |
| 16 | | $15,766 | $15,766 | 0.339 | $5,345 |
| 17 | | $15,766 | $15,766 | 0.317 | $4,998 |
| 18 | | $15,766 | $15,766 | 0.296 | $4,667 |
| 19 | | $15,766 | $15,766 | 0.277 | $4,367 |
| 20 | | $41,066 | $41,066 | 0.258 | $10,595 |
| 21 | | $15,766 | $15,766 | 0.242 | $3,815 |
| 22 | | $15,766 | $15,766 | 0.226 | $3,563 |
| 23 | | $15,766 | $15,766 | 0.211 | $3,327 |
| 24 | | $15,766 | $15,766 | 0.197 | $3,106 |
| 25 | | $41,066 | $41,066 | 0.184 | $7,556 |
| 26 | | $15,766 | $15,766 | 0.172 | $2,712 |
| 27 | | $15,766 | $15,766 | 0.161 | $2,538 |
| 28 | | $15,766 | $15,766 | 0.15 | $2,365 |
| 29 | | $15,766 | $15,766 | 0.141 | $2,223 |
| 30 | | $41,066 | $41,066 | 0.131 | $5,380 |
| | | | | **TOTAL PRESENT WORTH** | **$723,570** |

**ZONE 6, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-6.4 EXCAVATION TO MEET RESIDENTIAL DECs AND PMCs, ON-SITE DEWATERING, AND OFF-SITE TREATMENT (LTTD) AND DISPOSAL (LANDFILLING)**
**Capital Cost**

| | | | | Unit Cost | | | | Extended Cost | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Item | Quantity | Unit | Subcontract | Material | Labor | Equipment | Subcontract | Material | Labor | Equipment | Subtotal |
| **1 PROJECT PLANNING** | | | | | | | | | | | |
| 1.1 Prepare Documents & Plans including Permits | 200 | hr | | | $35.00 | | $0 | $0 | $7,000 | $0 | $7,000 |
| **2 PRE-DESIGN INVESTIGATION** | | | | | | | | | | | |
| 2.1 Field Personnel - prep, field, and follow-up | 1.5 | days | | | $350.00 | | $0 | $0 | $525 | $0 | $525 |
| 2.2 Travel & Mob | 1 | ls | $550.00 | | | | $550 | $0 | $0 | $0 | $550 |
| 2.3 Geoprobe - Equipment and Operator | 1 | day | $2,400.00 | | | | $2,400 | $0 | $0 | $0 | $2,400 |
| 2.4 Supplies & PID | 1 | day | $600.00 | | | | $600 | $0 | $0 | $0 | $600 |
| 2.5 Soil Sample Analysis (Lead, SPLP Lead) | 1 | ls | $805.00 | | | | $805 | $0 | $0 | $0 | $805 |
| 2.6 Evaluate Data, Prepare Report, and Upload to NIRIS | 1 | ea | $7,000.00 | | | | $7,000 | $0 | $0 | $0 | $7,000 |
| **3 MOBILIZATION, DEMOBILIZATION AND FIELD SUPPORT** | | | | | | | | | | | |
| 3.1 Office Trailer | 2 | mo | | | | $375.00 | $0 | $0 | $0 | $750 | $750 |
| 3.2 Field Office Support | 2 | mo | | $155.00 | | | $0 | $310 | $0 | $0 | $310 |
| 3.3 Storage Trailer (1) | 2 | mo | | | | $99.00 | $0 | $0 | $0 | $198 | $198 |
| 3.4 Utility Connection/Disconnection (phone/electric) | 1 | ls | $1,500.00 | | | | $1,500 | $0 | $0 | $0 | $1,500 |
| 3.5 Site Utilities | 2 | mo | $150.00 | | | | $300 | $0 | $0 | $0 | $300 |
| 3.6 Construction Survey Support | 2 | day | $975.00 | | | | $1,950 | $0 | $0 | $0 | $1,950 |
| 3.7 Equipment Mobilization/Demobilization | 8 | ea | | | $85.00 | $261.00 | $0 | $0 | $680 | $2,088 | $2,768 |
| 3.8 Site Superintendent | 44 | day | | | $355.00 | | $0 | $0 | $15,620 | $0 | $15,620 |
| 3.9 Site Health & Safety and QA/QC | 44 | day | | | $325.00 | | $0 | $0 | $14,300 | $0 | $14,300 |
| 3.10 Materials Storage Pad, 25' X 25' | 625 | sf | | $3.64 | $0.74 | $1.09 | $0 | $2,275 | $463 | $681 | $3,419 |
| 3.11 Dewatering Pad, 40' X 40' | 1,600 | sf | | $5.62 | $0.85 | $1.24 | $0 | $8,992 | $1,360 | $1,984 | $12,336 |
| 3.12 Maintain Dewatering Pad, Replace Top 4x | 6,400 | sf | | $0.32 | $0.11 | $0.13 | $0 | $2,048 | $704 | $832 | $3,584 |
| **4 DECONTAMINATION** | | | | | | | | | | | |
| 4.1 Decontamination Services | 2 | mo | | | | $5,045.46 | $0 | $0 | $0 | $10,091 | $10,091 |
| 4.2 Equipment Decon Pad | 1 | ls | | $1,750.00 | $1,500.00 | $425.00 | $0 | $1,750 | $1,500 | $425 | $3,675 |
| 4.3 Decon Water | 2,000 | gal | | $0.20 | | | $0 | $400 | $0 | $0 | $400 |
| 4.4 Decon Water Storage Tank, 6,000 gallon | 2 | mo | | | | $784.24 | $0 | $0 | $0 | $1,568 | $1,568 |
| 4.5 Clean Water Storage Tank, 4,000 gallon | 2 | mo | | | | $705.22 | $0 | $0 | $0 | $1,410 | $1,410 |
| 4.6 Disposal of Decon Waste (liquid & solid) | 2 | mo | $950.00 | | | | $1,900 | $0 | $0 | $0 | $1,900 |
| **5 SHEET PILING, EXCAVATION, DEWATERING, AND DISPOSAL** | | | | | | | | | | | |
| 5.1 Pavement Removal | 6,566 | sy | | $2.22 | $1.63 | $3.85 | $0 | $14,577 | $10,703 | $25,279 | $50,558 |
| 5.2 Excavator, 2 CY Capacity | 2 | mo | | | $12,064.80 | $17,678.20 | $0 | $0 | $24,130 | $35,356 | $59,486 |
| 5.3 Site Labor, (3 laborers) | 2 | mo | | | $16,684.80 | | $0 | $0 | $33,370 | $0 | $33,370 |
| 5.4 Sheet Piles, 470' x 8', tiebacks, drive, extract & salvage | 3,769 | sf | | $8.48 | $6.96 | $9.15 | $0 | $31,942 | $26,232 | $34,486 | $92,661 |
| 5.5 FE Loader 3 1/2 to 5 cy, two | 4 | mo | | | $9,288.40 | $13,544.60 | $0 | $0 | $37,154 | $54,178 | $91,332 |
| 5.6 Crane, 25 Ton with Clamshell Bucket, 1 CY | 1 | mo | | | $12,262.80 | $4,490.91 | $0 | $0 | $12,263 | $4,491 | $16,754 |
| 5.7 Characterization Soil Testing - ETPH | 54 | ea | $100.80 | $10.00 | | | $5,443 | $540 | $0 | $0 | $5,983 |
| 5.8 Confirmation Soil Testing - ETPH, rapid | 26 | ea | $201.60 | | | | $5,242 | $0 | $0 | $0 | $5,242 |
| 5.9 Off Site Transportation & Disposal, TPH < 2500 mg/kg | 11,454 | tons | $40.00 | | | | $458,160 | $0 | $0 | $0 | $458,160 |
| 5.10 Off Site Transportation & Disposal, High TPH Soil | 1,100 | tons | $100.00 | | | | $109,950 | $0 | $0 | $0 | $109,950 |
| 5.11 Off Site Transportation & Recycling, Asphalt | 821 | tons | $19.50 | | | | $16,000 | $0 | $0 | $0 | $16,000 |
| 5.12 Centrifugal 15 gpm 1 HP Pump, to Treatment, | 1 | mo | | $2,211 | $636 | | $0 | $2,211 | $636 | $0 | $2,847 |
| 5.13 5,000 lb Liquid-Phase GAC Adsorption Units | 2 | ea | | $24,600.00 | | | $0 | $49,200 | $0 | $0 | $49,200 |
| 5.14 Replace GAC | 60,000 | lb | | $2.00 | | | $0 | $120,000 | $0 | $0 | $120,000 |
| 5.15 Bag Filter System | 2 | ea | | $14,000.00 | $225.00 | | $0 | $28,000 | $450 | $0 | $28,450 |
| 5.16 Replace Filter Bags | 192 | ea | | $60.00 | | | $0 | $11,520 | $0 | $0 | $11,520 |
| 5.17 Diaphragm Pump, from Treatment to Storm Sewer | 1 | mo | | | | $542.48 | $0 | $0 | $0 | $542 | $542 |
| 5.18 Piping , 2" PVC, from Treatment to Storm Sewer | 200 | ft | | $0.51 | $0.72 | | $0 | $102 | $144 | $0 | $246 |
| **6 BACKFILL AND SITE RESTORATION** | | | | | | | | | | | |
| 6.1 Clean Backfill | 7,822 | cy | | $8.00 | | | $0 | $62,576 | $0 | $0 | $62,576 |
| 6.2 FE Loader 3 1/2 to 5 cy | 1 | mo | | | $9,288.40 | $13,544.60 | $0 | $0 | $9,288 | $13,545 | $22,833 |
| 6.3 Vibrating Roller, 2-Drum, 7.5 HP | 1 | mo | | | $10,058.40 | $2,494.40 | $0 | $0 | $10,058 | $2,494 | $12,553 |
| 6.4 Vibratory Plate for use around Utilities | 1 | mo | | | | $297.00 | $0 | $0 | $0 | $297 | $297 |

**ZONE 6, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-6.4 EXCAVATION TO MEET RESIDENTIAL DECs AND PMCs, ON-SITE DEWATERING, AND OFF-SITE TREATMENT (LTTD) AND DISPOSAL (LANDFILLING)**
**Capital Cost**

| | | | | Unit Cost | | | | Extended Cost | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Item | Quantity | Unit | Subcontract | Material | Labor | Equipment | Subcontract | Material | Labor | Equipment | Subtotal |
| 6.5 Top Dress Soil | 1,094 | cy | $31.50 | | | | $34,461 | $0 | $0 | $0 | $34,461 |
| 6.6 Site Restoration, seed, fertilization, mulch | 59 | msf | $75.00 | | | | $4,425 | $0 | $0 | $0 | $4,425 |
| **7 POST CONSTRUCTION COST** | | | | | | | | | | | |
| 7.1 Contractor Completion Report | 80 | hr | | | $35.00 | | $0 | $0 | $2,800 | $0 | $2,800 |
| 7.2 Remedial Action Closeout Report | 80 | hr | | | $35.00 | | $0 | $0 | $2,800 | $0 | $2,800 |
| **Subtotal** | | | | | | | $650,686 | $336,443 | $212,178 | $190,698 | $1,390,005 |
| **Local Area Adjustments** | | | | | | | 100.0% | 98.6% | 104.2% | 104.2% | |
| **Subtotal** | | | | | | | $650,686 | $331,733 | $221,090 | $198,707 | $1,402,216 |
| Overhead on Labor Cost @ 30% | | | | | | | | | $66,327 | | $66,327 |
| G & A on Labor Cost @ 10% | | | | | | | | | $22,109 | | $22,109 |
| G & A on Material Cost @ 10% | | | | | | | | $33,173 | | | $33,173 |
| G & A on Equipment Cost @ 10% | | | | | | | | | | $19,871 | $19,871 |
| G & A on Subcontract Cost @ 10% | | | | | | | $65,069 | | | | $65,069 |
| Tax on Materials and Equipment Cost @ 6% | | | | | | | | $19,904 | | $11,922 | $31,826 |
| **Total Direct Cost** | | | | | | | $715,754 | $384,810 | $309,526 | $230,500 | $1,640,590 |
| Indirects on Total Direct Cost @ 30% | | | (excluding transportation and disposal cost) | | | | | | | | $316,374 |
| Profit on Total Direct Cost @ 10% | | | | | | | | | | | $164,059 |
| **Subtotal** | | | | | | | | | | | $2,121,024 |
| Health & Safety Monitoring @ 2% | | | (includes air quality monitoring) | | | | | | | | $42,420 |
| **Total Field Cost** | | | | | | | | | | | $2,163,444 |
| Contingency on Total Field Costs @ 20% | | | | | | | | | | | $432,689 |
| Engineering on Total Field Cost @ 10% | | | | | | | | | | | $216,344 |
| **TOTAL CAPITAL COST** | | | | | | | | | | | **$2,812,477** |

# APPENDIX E.1.7

# ZONE 7

# ALTERNATIVES S-7.1, S-7.2, S-7.3, S-7.4, S-7.5, and S-7.6

**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-7.1: NO ACTION**
**Annual Cost**

1/15/2010 11:35 AM

| Item | Item Cost every 5 years | Notes |
|---|---|---|
| Five-Year Review | $23,000 | |
| Subtotal | $23,000 | |
| Contingency @ 10% | $2,300 | |
| **TOTAL** | **$25,300** | |

**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-7.1: NO ACTION**
**Present Worth Analysis**

1/15/2010 11:35 AM

| Year | Capital Cost | Annual Cost | Total Year Cost | Annual Discount Rate at 7% | Present Worth |
|---|---|---|---|---|---|
| 0 | $0 | | $0 | 1.000 | $0 |
| 1 | | | $0 | 0.935 | $0 |
| 2 | | | $0 | 0.873 | $0 |
| 3 | | | $0 | 0.816 | $0 |
| 4 | | | $0 | 0.763 | $0 |
| 5 | | $25,300 | $25,300 | 0.713 | $18,039 |
| 6 | | | $0 | 0.666 | $0 |
| 7 | | | $0 | 0.623 | $0 |
| 8 | | | $0 | 0.582 | $0 |
| 9 | | | $0 | 0.544 | $0 |
| 10 | | $25,300 | $25,300 | 0.508 | $12,852 |
| 11 | | | $0 | 0.475 | $0 |
| 12 | | | $0 | 0.444 | $0 |
| 13 | | | $0 | 0.415 | $0 |
| 14 | | | $0 | 0.388 | $0 |
| 15 | | $25,300 | $25,300 | 0.362 | $9,159 |
| 16 | | | $0 | 0.339 | $0 |
| 17 | | | $0 | 0.317 | $0 |
| 18 | | | $0 | 0.296 | $0 |
| 19 | | | $0 | 0.277 | $0 |
| 20 | | $25,300 | $25,300 | 0.258 | $6,527 |
| 21 | | | $0 | 0.242 | $0 |
| 22 | | | $0 | 0.226 | $0 |
| 23 | | | $0 | 0.211 | $0 |
| 24 | | | $0 | 0.197 | $0 |
| 25 | | $25,300 | $25,300 | 0.184 | $4,655 |
| 26 | | | $0 | 0.172 | $0 |
| 27 | | | $0 | 0.161 | $0 |
| 28 | | | $0 | 0.150 | $0 |
| 29 | | | $0 | 0.141 | $0 |
| 30 | | $25,300 | $25,300 | 0.131 | $3,314 |
| | | | | **TOTAL PRESENT WORTH** | **$54,547** |

**ZONE 7, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-7.2: LUCs and Monitoring**
**CAPITAL COST**

| Item | Quantity | Unit | Unit Cost | | | | Extended Cost | | | | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Subcontract | Material | Labor | Equipment | Subcontract | Material | Labor | Equipment | |
| **1 PROJECT PLANNING** | | | | | | | | | | | |
| 1.1 Prepare Documents & Plans including Permits/Variances | 140 | hr | | | $35.00 | | $0 | $0 | $4,900 | $0 | $4,900 |
| 1.2 Prepare LUC RD Documents | 60 | hr | | | $35.00 | | $0 | $0 | $2,100 | $0 | $2,100 |
| **2 PRE-DESIGN INVESTIGATION** | | | | | | | | | | | |
| 2.1 Field Personnel - prep, field, and follow-up | 4.5 | days | | | $350.00 | | $0 | $0 | $1,575 | $0 | $1,575 |
| 2.2 Travel & Mob | 1 | ls | $1,660.00 | | | | $1,660 | $0 | $0 | $0 | $1,660 |
| 2.3 Geoprobe - Equipment and Operator | 3 | day | $2,400.00 | | | | $7,200 | $0 | $0 | $0 | $7,200 |
| 2.4 Supplies & PID | 3 | day | $600.00 | | | | $1,800 | $0 | $0 | $0 | $1,800 |
| 2.5 Soil Sample Analysis (Lead, Antimony, SPLP, PAHs ) | 1 | ls | $10,600.00 | | | | $10,600 | $0 | $0 | $0 | $10,600 |
| 2.6 Evaluate Data, Prepare Report, and Upload to NIRIS | 1 | ea | $32,000.00 | | | | $32,000 | $0 | $0 | $0 | $32,000 |
| **3 FIELD SUPPORT** | | | | | | | | | | | |
| 3.1 Construction Survey Support | 1 | day | $1,050.00 | | | | $1,050 | $0 | $0 | $0 | $1,050 |
| **Subtotal** | | | | | | | $54,310 | $0 | $8,575 | $0 | $62,885 |
| **Local Area Adjustments** | | | | | | | 100.0% | 98.6% | 104.2% | 104.2% | |
| | | | | | | | $54,310 | $0 | $8,935 | $0 | $63,245 |
| Overhead on Labor Cost @ 30% | | | | | | | | | $2,681 | | $2,681 |
| G & A on Labor Cost @ 10% | | | | | | | | | $894 | | $894 |
| G & A on Material Cost @ 10% | | | | | | | | $0 | | | $0 |
| G & A on Subcontract Cost @ 10% | | | | | | | $5,431 | | | | $5,431 |
| G & A on Equipment Cost @ 10% | | | | | | | | | | $0 | $0 |
| **Total Direct Cost** | | | | | | | $59,741 | $0 | $12,509 | $0 | $72,250 |
| Indirects on Total Direct Cost @ 0% | | | | | | | | | | | $0 |
| Profit on Total Direct Cost @ 10% | | | | | | | | | | | $7,225 |
| **Subtotal** | | | | | | | | | | | $79,475 |
| Health & Safety Monitoring @ 0% | | | | | | | | | | | $0 |
| **Total Field Cost** | | | | | | | | | | | $79,475 |
| Contingency on Total Field Costs @ 0% | | | | | | | | | | | $0 |
| Engineering on Total Field Cost @ 0% | | | | | | | | | | | $0 |
| **TOTAL COST** | | | | | | | | | | | **$79,475** |

**ZONE 7, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-7.2: LUCs and Monitoring**
**ANNUAL COST**

| Item | Item Cost Years 1 & 2 | Item Cost Years 3 & 4 | Item Cost Years 5 through 30 | Item Cost Annually | Item Cost Every 5 Years | Notes |
|---|---|---|---|---|---|---|
| Pavement Maintenance | | | | $27,436 | | Repave 10% of contaminated areas yearly. |
| Groundwater Sampling | $22,272 | $11,136 | $5,568 | | | 4 Wells. Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Labor and supplies for sampling |
| Groundwater Analysis | $3,360 | $1,680 | $840 | | | 4 wells, Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Analysis for PAHs. |
| Groundwater Report | $5,000 | $5,000 | $5,000 | | | |
| Inspection | | | | $1,000 | | Annual LUC inspection |
| Site Review | | | | | $23,000 | 5-year review |
| Subtotal | $30,632 | $17,816 | $11,408 | $28,436 | $23,000 | |
| Contingency at 10% | $3,063 | $1,782 | $1,141 | $2,844 | $2,300 | |
| **TOTAL** | $33,695 | $19,598 | $12,549 | $31,280 | $25,300 | |

**ZONE 7, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-7.2: LUCs and Monitoring**
**PRESENT WORTH ANALYSIS**

| Year | Capital Cost | Annual Cost | Total Year Cost | Annual Discount Rate at 7% | Present Worth |
|---|---|---|---|---|---|
| 0 | $79,475 | | $79,475 | 1.000 | $79,475 |
| 1 | | $64,975 | $64,975 | 0.935 | $60,752 |
| 2 | | $64,975 | $64,975 | 0.873 | $56,723 |
| 3 | | $50,877 | $50,877 | 0.816 | $41,516 |
| 4 | | $50,877 | $50,877 | 0.763 | $38,819 |
| 5 | | $69,128 | $69,128 | 0.713 | $49,289 |
| 6 | | $43,828 | $43,828 | 0.666 | $29,190 |
| 7 | | $43,828 | $43,828 | 0.623 | $27,305 |
| 8 | | $43,828 | $43,828 | 0.582 | $25,508 |
| 9 | | $43,828 | $43,828 | 0.544 | $23,843 |
| 10 | | $69,128 | $69,128 | 0.508 | $35,117 |
| 11 | | $43,828 | $43,828 | 0.475 | $20,819 |
| 12 | | $43,828 | $43,828 | 0.444 | $19,460 |
| 13 | | $43,828 | $43,828 | 0.415 | $18,189 |
| 14 | | $43,828 | $43,828 | 0.388 | $17,005 |
| 15 | | $69,128 | $69,128 | 0.362 | $25,025 |
| 16 | | $43,828 | $43,828 | 0.339 | $14,858 |
| 17 | | $43,828 | $43,828 | 0.317 | $13,894 |
| 18 | | $43,828 | $43,828 | 0.296 | $12,973 |
| 19 | | $43,828 | $43,828 | 0.277 | $12,140 |
| 20 | | $69,128 | $69,128 | 0.258 | $17,835 |
| 21 | | $43,828 | $43,828 | 0.242 | $10,606 |
| 22 | | $43,828 | $43,828 | 0.226 | $9,905 |
| 23 | | $43,828 | $43,828 | 0.211 | $9,248 |
| 24 | | $43,828 | $43,828 | 0.197 | $8,634 |
| 25 | | $69,128 | $69,128 | 0.184 | $12,720 |
| 26 | | $43,828 | $43,828 | 0.172 | $7,538 |
| 27 | | $43,828 | $43,828 | 0.161 | $7,056 |
| 28 | | $43,828 | $43,828 | 0.150 | $6,574 |
| 29 | | $43,828 | $43,828 | 0.141 | $6,180 |
| 30 | | $69,128 | $69,128 | 0.131 | $9,056 |
| | | | | **TOTAL PRESENT WORTH** | **$727,252** |

**ZONE 7, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-7.3: CAPPING TO ALLOW I/C SITE USE AND PREVENT LEACHING, LUCS, AND MONITORING**
***Capital Cost***

| Item | Quantity | Unit | Unit Cost Subcontract | Unit Cost Material | Unit Cost Labor | Unit Cost Equipment | Extended Cost Subcontract | Extended Cost Material | Extended Cost Labor | Extended Cost Equipment | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1 PROJECT PLANNING** | | | | | | | | | | | |
| 1.1 Prepare Documents & Plans including Permits | 150 | hr | | | $35.00 | | $0 | $0 | $5,250 | $0 | $5,250 |
| 1.2 Prepare LUC RD Documents | 60 | hr | | | $35.00 | | $0 | $0 | $2,100 | $0 | $2,100 |
| **2 PRE-DESIGN INVESTIGATION** | | | | | | | | | | | |
| 2.1 Field Personnel - prep, field, and follow-up | 4.5 | days | | | $350.00 | | $0 | $0 | $1,575 | $0 | $1,575 |
| 2.2 Travel & Mob | 1 | ls | $1,660.00 | | | | $1,660 | $0 | $0 | $0 | $1,660 |
| 2.3 Geoprobe - Equipment and Operator | 3 | day | $2,400.00 | | | | $7,200 | $0 | $0 | $0 | $7,200 |
| 2.4 Supplies & PID | 3 | day | $600.00 | | | | $1,800 | $0 | $0 | $0 | $1,800 |
| 2.5 Soil Sample Analysis (Lead, Antimony, SPLP, PAHs ) | 1 | ls | $10,600.00 | | | | $10,600 | $0 | $0 | $0 | $10,600 |
| 2.6 Evaluate Data, Prepare Report, and Upload to NIRIS | 1 | ea | $32,000.00 | | | | $32,000 | $0 | $0 | $0 | $32,000 |
| **3 MOBILIZATION, DEMOBILIZATION AND FIELD SUPPORT** | | | | | | | | | | | |
| 3.1 Office Trailer | 2 | mo | | | | $375.00 | $0 | $0 | $0 | $750 | $750 |
| 3.2 Field Office Support | 2 | mo | | $155.00 | | | $0 | $310 | $0 | $0 | $310 |
| 3.3 Storage Trailer (1) | 2 | mo | | | | $99.00 | $0 | $0 | $0 | $198 | $198 |
| 3.4 Utility Connection/Disconnection (phone/electric) | 2 | ls | $1,500.00 | | | | $3,000 | $0 | $0 | $0 | $3,000 |
| 3.5 Site Utilities | 2 | mo | $150.00 | | | | $300 | $0 | $0 | $0 | $300 |
| 3.6 Underground Utility Clearances | 2 | ls | $1,500.00 | | | | $3,000 | $0 | $0 | $0 | $3,000 |
| 3.7 Construction Survey Support | 2 | day | $975.00 | | | | $1,950 | $0 | $0 | $0 | $1,950 |
| 3.8 Equipment Mobilization/Demobilization | 4 | ea | | | $85.00 | $261.00 | $0 | $0 | $340 | $1,044 | $1,384 |
| 3.9 Site Superintendent | 33 | day | | | $355.00 | | $0 | $0 | $11,715 | $0 | $11,715 |
| 3.10 Site Health & Safety and QA/QC | 33 | day | | | $325.00 | | $0 | $0 | $10,725 | $0 | $10,725 |
| 3.11 Materials Storage Pad, 25' X 25' | 625 | sf | | $3.64 | $0.74 | $1.09 | $0 | $2,275 | $463 | $681 | $3,419 |
| **4 DECONTAMINATION** | | | | | | | | | | | |
| 4.1 Decontamination Services | 2 | mo | | | | $5,045.46 | $0 | $0 | $0 | $10,091 | $10,091 |
| 4.2 Equipment Decon Pad | 2 | ls | | $3,500.00 | $3,000.00 | $425.00 | $0 | $7,000 | $6,000 | $850 | $13,850 |
| 4.3 Decon Water | 2,000 | gal | | $0.20 | | | $0 | $400 | $0 | $0 | $400 |
| 4.4 Decon Water Storage Tank, 6,000 gallon | 2 | mo | | | | $784.24 | $0 | $0 | $0 | $1,568 | $1,568 |
| 4.5 Clean Water Storage Tank, 4,000 gallon | 2 | mo | | | | $705.22 | $0 | $0 | $0 | $1,410 | $1,410 |
| 4.6 Disposal of Decon Waste (liquid & solid) | 2 | mo | $950.00 | | | | $1,900 | $0 | $0 | $0 | $1,900 |
| **5 EXCAVATION AND DISPOSAL** | | | | | | | | | | | |
| 5.1 Pavement Removal | 9,708 | sy | | $2.22 | $1.63 | $3.85 | $0 | $21,553 | $15,825 | $37,378 | $74,755 |
| 5.2 Excavator, 1/2 cy Capacity | 1.5 | mo | | | $13,050.40 | $7,087.20 | $0 | $0 | $19,576 | $10,631 | $30,206 |
| 5.3 Site Labor, (3 laborers) | 1.5 | mo | | | $16,684.80 | | $0 | $0 | $25,027 | $0 | $25,027 |
| 5.4 Tractor Loader 1 to 1-1/4 cy | 1.5 | mo | | | $10,058.40 | $4,383.00 | $0 | $0 | $15,088 | $6,575 | $21,662 |
| 5.5 Characterization Soil Testing - Lead, PAH, & TCLP Lead | 38 | ea | $378.00 | $10.00 | | | $14,364 | $380 | $0 | $0 | $14,744 |
| 5.6 Confirmation Testing - Lead, PAH, & SPLP Lead, rapid | 28 | ea | $756.00 | | | | $21,168 | $0 | $0 | $0 | $21,168 |
| 5.7 Off Site Transportation & Disposal, No Treatment | 1,616 | tons | $40.00 | | | | $64,620 | $0 | $0 | $0 | $64,620 |
| 5.8 Off Site Transportation & Disposal, High PAHs | 5,819 | tons | $100.00 | | | | $581,850 | $0 | $0 | $0 | $581,850 |
| 5.9 Off Site Transportation & Disposal, High Lead | 1,061 | tons | $120.00 | | | | $127,260 | $0 | $0 | $0 | $127,260 |
| 5.10 Off Site Transportation & Recycling, Asphalt | 1,214 | tons | $19.50 | | | | $23,663 | $0 | $0 | $0 | $23,663 |
| **6 BACKFILL, CAPPING AND SITE RESTORATION** | | | | | | | | | | | |
| 6.1 60-mil VLDPE Geomembrane | 27,736 | sf | | $0.48 | $1.43 | $0.27 | $0 | $13,313 | $39,662 | $7,489 | $60,464 |
| 6.2 12 oz/sy Cushion Geotextile, Small Areas | 3,082 | sy | | $2.19 | $0.12 | $0.05 | $0 | $6,749 | $370 | $139 | $7,258 |
| 6.3 Clean Sand | 5,920 | cy | | $4.00 | $0.50 | $1.07 | $0 | $23,680 | $2,930 | $6,305 | $32,915 |
| 6.4 Asphalt, 2" Binder, 1" Topping, Small Areas | 87,376 | sf | | $1.03 | $0.24 | $0.30 | $0 | $89,997 | $20,970 | $26,213 | $137,180 |
| **7 POST CONSTRUCTION COST** | | | | | | | | | | | |
| 7.1 Contractor Completion Report | 120 | hr | | | $35.00 | | $0 | $0 | $4,200 | $0 | $4,200 |
| 7.2 Remedial Action Closeout Report | 120 | hr | | | $35.00 | | $0 | $0 | $4,200 | $0 | $4,200 |
| **Subtotal** | | | | | | | $896,335 | $165,657 | $186,016 | $111,321 | $1,359,329 |
| **Local Area Adjustments** | | | | | | | 100.0% | 98.6% | 104.2% | 104.2% | |

**ZONE 7, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-7.3: CAPPING TO ALLOW I/C SITE USE AND PREVENT LEACHING, LUCS, AND MONITORING**
**Capital Cost**

| Item | Quantity | Unit | Unit Cost Subcontract | Unit Cost Material | Unit Cost Labor | Unit Cost Equipment | Extended Cost Subcontract | Extended Cost Material | Extended Cost Labor | Extended Cost Equipment | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Subtotal** | | | | | | | $896,335 | $163,338 | $193,828 | $115,996 | $1,369,498 |
| Overhead on Labor Cost @ 30% | | | | | | | | | $58,148 | | $58,148 |
| G & A on Labor Cost @ 10% | | | | | | | | | $19,383 | | $19,383 |
| G & A on Material Cost @ 10% | | | | | | | | $16,334 | | | $16,334 |
| G & A on Equipment Cost @ 10% | | | | | | | | | | $11,600 | $11,600 |
| G & A on Subcontract Cost @ 10% | | | | | | | $89,634 | | | | $89,634 |
| Tax on Materials and Equipment Cost @ 6% | | | | | | | | $9,800 | | $6,960 | $16,760 |
| **Total Direct Cost** | | | | | | | $985,969 | $189,472 | $271,360 | $134,556 | $1,581,356 |
| Indirects on Total Direct Cost @ 30% | | (excluding transportation and disposal cost) | | | | | | | | | $234,619 |
| Profit on Total Direct Cost @ 10% | | | | | | | | | | | $158,136 |
| **Subtotal** | | | | | | | | | | | $1,974,111 |
| Health & Safety Monitoring @ 3% | | (includes air quality monitoring) | | | | | | | | | $59,223 |
| **Total Field Cost** | | | | | | | | | | | $2,033,334 |
| Contingency on Total Field Costs @ 20% | | | | | | | | | | | $406,667 |
| Engineering on Total Field Cost @ 15% | | | | | | | | | | | $305,000 |
| **TOTAL CAPITAL COST** | | | | | | | | | | | **$2,745,001** |

**ZONE 7, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-7.3: CAPPING TO ALLOW I/C SITE USE AND PREVENT LEACHING, LUCS, AND MONITORING**
**ANNUAL COST**

| Item | Item Cost Years 1 & 2 | Item Cost Years 3 & 4 | Item Cost Years 5 through 30 | Item Cost Annually | Item Cost Every 5 Years | Notes |
|---|---|---|---|---|---|---|
| Pavement Maintenance | | | | $27,436 | | Repave 10% of contaminated areas yearly. |
| Groundwater Sampling | $22,272 | $11,136 | $5,568 | | | 4 Wells. Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Labor and supplies for sampling |
| Groundwater Analysis | $3,360 | $1,680 | $840 | | | 4 wells, Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Analysis for PAHs. |
| Groundwater Report | $5,000 | $5,000 | $5,000 | | | |
| Inspection | | | | $1,000 | | Annual LUC inspection |
| Site Review | | | | | $23,000 | 5-year review |
| Subtotal | $30,632 | $17,816 | $11,408 | $28,436 | $23,000 | |
| Contingency at 10% | $3,063 | $1,782 | $1,141 | $2,844 | $2,300 | |
| **TOTAL** | $33,695 | $19,598 | $12,549 | $31,280 | $25,300 | |

**ZONE 7, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-7.3: CAPPING TO ALLOW I/C SITE USE AND PREVENT LEACHING, LUCS, AND MONITORING**
**Present Worth Analysis**

| Year | Capital Cost | Annual Cost | Total Year Cost | Annual Discount Rate at 7% | Present Worth |
|---|---|---|---|---|---|
| 0 | $2,745,001 | | $2,745,001 | 1.000 | $2,745,001 |
| 1 | | $64,975 | $64,975 | 0.935 | $60,752 |
| 2 | | $64,975 | $64,975 | 0.873 | $56,723 |
| 3 | | $50,877 | $50,877 | 0.816 | $41,516 |
| 4 | | $50,877 | $50,877 | 0.763 | $38,819 |
| 5 | | $69,128 | $69,128 | 0.713 | $49,289 |
| 6 | | $43,828 | $43,828 | 0.666 | $29,190 |
| 7 | | $43,828 | $43,828 | 0.623 | $27,305 |
| 8 | | $43,828 | $43,828 | 0.582 | $25,508 |
| 9 | | $43,828 | $43,828 | 0.544 | $23,843 |
| 10 | | $69,128 | $69,128 | 0.508 | $35,117 |
| 11 | | $43,828 | $43,828 | 0.475 | $20,819 |
| 12 | | $43,828 | $43,828 | 0.444 | $19,460 |
| 13 | | $43,828 | $43,828 | 0.415 | $18,189 |
| 14 | | $43,828 | $43,828 | 0.388 | $17,005 |
| 15 | | $69,128 | $69,128 | 0.362 | $25,025 |
| 16 | | $43,828 | $43,828 | 0.339 | $14,858 |
| 17 | | $43,828 | $43,828 | 0.317 | $13,894 |
| 18 | | $43,828 | $43,828 | 0.296 | $12,973 |
| 19 | | $43,828 | $43,828 | 0.277 | $12,140 |
| 20 | | $69,128 | $69,128 | 0.258 | $17,835 |
| 21 | | $43,828 | $43,828 | 0.242 | $10,606 |
| 22 | | $43,828 | $43,828 | 0.226 | $9,905 |
| 23 | | $43,828 | $43,828 | 0.211 | $9,248 |
| 24 | | $43,828 | $43,828 | 0.197 | $8,634 |
| 25 | | $69,128 | $69,128 | 0.184 | $12,720 |
| 26 | | $43,828 | $43,828 | 0.172 | $7,538 |
| 27 | | $43,828 | $43,828 | 0.161 | $7,056 |
| 28 | | $43,828 | $43,828 | 0.15 | $6,574 |
| 29 | | $43,828 | $43,828 | 0.141 | $6,180 |
| 30 | | $69,128 | $69,128 | 0.131 | $9,056 |
| | | | | **TOTAL PRESENT WORTH** | **$3,392,778** |

**ZONE 7, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-7.4 IN SITU TREATMENT (ENHANCED BIOREMEDIATION AND STABILIZATION/SOLIDIFICATION) TO MEET I/C PMCs, LUCs, AND MONITORING**
**Capital Cost**

| | | | | Unit Cost | | | Extended Cost | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Item | Quantity | Unit | Subcontract | Material | Labor | Equipment | Subcontract | Material | Labor | Equipment | Subtotal |
| **1 PROJECT PLANNING** | | | | | | | | | | | |
| 1.1 Prepare LUC RD Documents | 60 | hr | | | $35.00 | | $0 | $0 | $2,100 | $0 | $2,100 |
| 1.2 Prepare Documents & Plans including Permits | 150 | hr | | | $35.00 | | $0 | $0 | $5,250 | $0 | $5,250 |
| **2 PRE-DESIGN INVESTIGATION** | | | | | | | | | | | |
| 2.1 Field Personnel - prep, field, and follow-up | 4.5 | days | | | $350.00 | | $0 | $0 | $1,575 | $0 | $1,575 |
| 2.2 Travel & Mob | 1 | ls | $1,660.00 | | | | $1,660 | $0 | $0 | $0 | $1,660 |
| 2.3 Geoprobe - Equipment and Operator | 3 | day | $2,400.00 | | | | $7,200 | $0 | $0 | $0 | $7,200 |
| 2.4 Supplies & PID | 3 | day | $600.00 | | | | $1,800 | $0 | $0 | $0 | $1,800 |
| 2.5 Soil Sample Analysis (Lead, Antimony, SPLP, PAHs ) | 1 | ls | $10,600.00 | | | | $10,600 | $0 | $0 | $0 | $10,600 |
| 2.6 Evaluate Data, Prepare Report, and Upload to NIRIS | 1 | ea | $32,000.00 | | | | $32,000 | $0 | $0 | $0 | $32,000 |
| **3 MOBILIZATION, DEMOBILIZATION AND FIELD SUPPORT** | | | | | | | | | | | |
| 3.1 Storage Trailer (1) | 2 | mo | | | | $99.00 | $0 | $0 | $0 | $198 | $198 |
| 3.2 Underground Utility Clearances | 1 | ls | $3,500.00 | | | | $3,500 | $0 | $0 | $0 | $3,500 |
| 3.3 Construction Survey | 2 | day | $2,125.00 | | | | $4,250 | $0 | $0 | $0 | $4,250 |
| 3.4 Large Diameter Auger Mobilization/Demobilization | 1 | ea | $100,000.00 | | | | $100,000 | $0 | $0 | $0 | $100,000 |
| 3.5 Backhoe Mobilization/Demobilization | 2 | ea | | | $85.00 | $261.00 | $0 | $0 | $170 | $522 | $692 |
| 3.6 Temporary Fencing | 1 | ls | | $500.00 | | | $0 | $500 | $0 | $0 | $500 |
| 3.7 Field Construction Mgt. (1 person) | 43 | day | | $200.00 | $350.00 | | $0 | $8,600 | $15,050 | $0 | $23,650 |
| 3.8 Site Health & Safety and QA/QC | 43 | day | | $200.00 | $325.00 | | $0 | $8,600 | $13,975 | $0 | $22,575 |
| **4 IN-SITU TREATMENT** | | | | | | | | | | | |
| 4.1 Pavement Removal | 9,708 | sy | | $2.22 | $1.63 | $3.85 | $0 | $21,553 | $15,825 | $37,378 | $74,755 |
| 4.2 Off Site Transportation & Recycling, Asphalt | 1,214 | tons | $19.50 | | | | $23,663 | $0 | $0 | $0 | $23,663 |
| 4.3 Bioremediation Treatability Test | 1 | ls | $20,000.00 | | | | $20,000 | $0 | $0 | $0 | $20,000 |
| 4.4 Stabilization Treatability Test | 1 | ls | $5,000.00 | | | | $5,000 | $0 | $0 | $0 | $5,000 |
| 4.5 Utility Relocation - Storm, Sanitary Sewer & Steam Lines | 1 | ls | $100,000.00 | | | | $100,000 | $0 | $0 | $0 | $100,000 |
| 4.6 Auger - Deep Soil Cement Mixing | 5,473 | cy | $60.00 | | | | $328,380 | $0 | $0 | $0 | $328,380 |
| 4.7 Backhoe - Shallow ORC Soil Mixing | 3,893 | cy | $35.00 | | | | $136,255 | $0 | $0 | $0 | $136,255 |
| 4.8 ORC | 1,400 | lb | $9.00 | | | | $12,600 | $0 | $0 | $0 | $12,600 |
| 4.9 Post-Treatment Soil Testing - SPLP lead & antimony | 6 | ea | $168.00 | $10.00 | | | $1,008 | $60 | $0 | $0 | $1,068 |
| 4.10 Off Site Transportation & Disposal, Excess Stab. Soil | 900 | tons | $25.00 | | | | $22,500 | $0 | $0 | $0 | $22,500 |
| **5 BACKFILL AND SITE RESTORATION** | | | | | | | | | | | |
| 5.1 Asphalt, 2" Binder, 1" Topping, Small Areas | 87,376 | sf | | $1.03 | $0.24 | $0.30 | $0 | $89,997 | $20,970 | $26,213 | $137,180 |
| **6 POST CONSTRUCTION COST** | | | | | | | | | | | |
| 6.1 Contractor Completion Report | 100 | hr | | | $35.00 | | $0 | $0 | $3,500 | $0 | $3,500 |
| 6.2 Remedial Action Closeout Report | 100 | hr | | | $35.00 | | $0 | $0 | $3,500 | $0 | $3,500 |
| **Subtotal** | | | | | | | $810,416 | $129,310 | $81,915 | $64,310 | $1,085,952 |
| **Local Area Adjustments** | | | | | | | 100.0% | 98.6% | 104.2% | 104.2% | |
| **Subtotal** | | | | | | | $810,416 | $127,500 | $85,355 | $67,011 | $1,090,283 |
| Overhead on Labor Cost @ 30% | | | | | | | | | $25,607 | | $25,607 |
| G & A on Labor Cost @ 10% | | | | | | | | | $8,536 | | $8,536 |
| G & A on Material Cost @ 10% | | | | | | | | $12,750 | | | $12,750 |
| G & A on Equipment Cost @ 10% | | | | | | | | | | $6,701 | $6,701 |
| G & A on Subcontract Cost @ 10% | | | | | | | $81,042 | | | | $81,042 |
| Tax on Materials and Equipment Cost @ 6% | | | | | | | | $7,650 | | $4,021 | $11,671 |
| **Total Direct Cost** | | | | | | | $891,458 | $147,900 | $119,498 | $77,733 | $1,236,588 |

**ZONE 7, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-7.4 IN SITU TREATMENT (ENHANCED BIOREMEDIATION AND STABILIZATION/SOLIDIFICATION) TO MEET I/C PMCs, LUCs, AND MONITORING**
**Capital Cost**

| | | | Unit Cost | | | | Extended Cost | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Item | Quantity | Unit | Subcontract | Material | Labor | Equipment | Subcontract | Material | Labor | Equipment | Subtotal |
| Indirects on Total Direct Cost @ | 30% | (excluding transportation and disposal cost) | | | | | | | | | $357,128 |
| Profit on Total Direct Cost @ | 10% | | | | | | | | | | $123,659 |
| **Subtotal** | | | | | | | | | | | $1,717,375 |
| Health & Safety Monitoring @ | 3% | (includes air quality monitoring) | | | | | | | | | $51,521 |
| **Total Field Cost** | | | | | | | | | | | $1,768,896 |
| Contingency on Total Field Costs @ | 20% | | | | | | | | | | $353,779 |
| Engineering on Total Field Cost @ | 15% | | | | | | | | | | $265,334 |
| **TOTAL CAPITAL COST** | | | | | | | | | | | **$2,388,009** |

**ZONE 7, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**

**ALTERNATIVE S-7.4 IN SITU TREATMENT (ENHANCED BIOREMEDIATION AND STABILIZATION/SOLIDIFICATION) TO MEET I/C PMCs, LUCs, AND MONITORING**
**ANNUAL COST**

| Item | Item Cost Year 1 | Item Cost Years 1 & 2 | Item Cost Years 3 & 4 | Item Cost Years 5 through 30 | Item Cost Annually | Item Cost Every 5 Years | Notes |
|---|---|---|---|---|---|---|---|
| Soil Sampling | $8,824 | | | | | | 12 locations at Year 1. Two days geoprobe plus labor to sample. |
| Soil Analysis | $2,520 | | | | | | 12 locations. Analysis for PAHs. |
| Pavement Maintenance | | | | | $27,436 | | Repave 10% of contaminated areas yearly. |
| Groundwater Sampling | | $22,272 | $11,136 | $5,568 | | | 4 Wells. Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Labor and supplies for sampling |
| Groundwater Analysis | | $3,360 | $1,680 | $840 | | | 4 wells, Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Analysis for PAHs. |
| Groundwater Report | | $5,000 | $5,000 | $5,000 | | | |
| Inspection | | | | | $1,000 | | Annual LUC inspection |
| Site Review | | | | | | $23,000 | 5-year review |
| Subtotal | $11,344 | $30,632 | $17,816 | $11,408 | $28,436 | $23,000 | |
| Contingency at 10% | $1,134 | $3,063 | $1,782 | $1,141 | $2,844 | $2,300 | |
| **TOTAL** | $12,478 | $33,695 | $19,598 | $12,549 | $31,280 | $25,300 | |

**ZONE 7, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-7.4 IN SITU TREATMENT (ENHANCED BIOREMEDIATION AND STABILIZATION/SOLIDIFICATION)**
**TO MEET I/C PMCs, LUCs, AND MONITORING**
**PRESENT WORTH ANALYSIS**

| Year | Capital Cost | Annual Cost | Total Year Cost | Annual Discount Rate at 7% | Present Worth |
|---|---|---|---|---|---|
| 0 | $2,388,009 | | $2,388,009 | 1.000 | $2,388,009 |
| 1 | | $77,453 | $77,453 | 0.935 | $72,419 |
| 2 | | $64,975 | $64,975 | 0.873 | $56,723 |
| 3 | | $50,877 | $50,877 | 0.816 | $41,516 |
| 4 | | $50,877 | $50,877 | 0.763 | $38,819 |
| 5 | | $69,128 | $69,128 | 0.713 | $49,289 |
| 6 | | $43,828 | $43,828 | 0.666 | $29,190 |
| 7 | | $43,828 | $43,828 | 0.623 | $27,305 |
| 8 | | $43,828 | $43,828 | 0.582 | $25,508 |
| 9 | | $43,828 | $43,828 | 0.544 | $23,843 |
| 10 | | $69,128 | $69,128 | 0.508 | $35,117 |
| 11 | | $43,828 | $43,828 | 0.475 | $20,819 |
| 12 | | $43,828 | $43,828 | 0.444 | $19,460 |
| 13 | | $43,828 | $43,828 | 0.415 | $18,189 |
| 14 | | $43,828 | $43,828 | 0.388 | $17,005 |
| 15 | | $69,128 | $69,128 | 0.362 | $25,025 |
| 16 | | $43,828 | $43,828 | 0.339 | $14,858 |
| 17 | | $43,828 | $43,828 | 0.317 | $13,894 |
| 18 | | $43,828 | $43,828 | 0.296 | $12,973 |
| 19 | | $43,828 | $43,828 | 0.277 | $12,140 |
| 20 | | $69,128 | $69,128 | 0.258 | $17,835 |
| 21 | | $43,828 | $43,828 | 0.242 | $10,606 |
| 22 | | $43,828 | $43,828 | 0.226 | $9,905 |
| 23 | | $43,828 | $43,828 | 0.211 | $9,248 |
| 24 | | $43,828 | $43,828 | 0.197 | $8,634 |
| 25 | | $69,128 | $69,128 | 0.184 | $12,720 |
| 26 | | $43,828 | $43,828 | 0.172 | $7,538 |
| 27 | | $43,828 | $43,828 | 0.161 | $7,056 |
| 28 | | $43,828 | $43,828 | 0.150 | $6,574 |
| 29 | | $43,828 | $43,828 | 0.141 | $6,180 |
| 30 | | $69,128 | $69,128 | 0.131 | $9,056 |
| | | | | **TOTAL PRESENT WORTH** | **$3,047,454** |

**ZONE 7, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-7.5 EXCAVATION TO MEET I/C DEC AND PMC, OFF-SITE TREATMENT (LTTD AND STABILIZATION /SOLIDIFICATION) AND DISPOSAL (LANDFILLING), LUCs, AND MONITORING**
**Capital Cost**

| | | | Unit Cost | | | | Extended Cost | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Item | Quantity | Unit | Subcontract | Material | Labor | Equipment | Subcontract | Material | Labor | Equipment | Subtotal |
| **1 PROJECT PLANNING** | | | | | | | | | | | |
| 1.1 Prepare LUC RD Documents | 60 | hr | | | $35.00 | | $0 | $0 | $2,100 | $0 | $2,100 |
| 1.2 Prepare Documents & Plans including Permits | 150 | hr | | | $35.00 | | $0 | $0 | $5,250 | $0 | $5,250 |
| **2 PRE-DESIGN INVESTIGATION** | | | | | | | | | | | |
| 2.1 Field Personnel - prep, field, and follow-up | 4.5 | days | | | $350.00 | | $0 | $0 | $1,575 | $0 | $1,575 |
| 2.2 Travel & Mob | 1 | ls | $1,660.00 | | | | $1,660 | $0 | $0 | $0 | $1,660 |
| 2.3 Geoprobe - Equipment and Operator | 3 | day | $2,400.00 | | | | $7,200 | $0 | $0 | $0 | $7,200 |
| 2.4 Supplies & PID | 3 | day | $600.00 | | | | $1,800 | $0 | $0 | $0 | $1,800 |
| 2.5 Soil Sample Analysis (Lead, Antimony, SPLP, PAHs ) | 1 | ls | $10,600.00 | | | | $10,600 | $0 | $0 | $0 | $10,600 |
| 2.6 Evaluate Data, Prepare Report, and Upload to NIRIS | 1 | ea | $32,000.00 | | | | $32,000 | $0 | $0 | $0 | $32,000 |
| **3 MOBILIZATION, DEMOBILIZATION AND FIELD SUPPORT** | | | | | | | | | | | |
| 3.1 Office Trailer | 5 | mo | | $375.00 | | | $0 | $1,875 | $0 | $0 | $1,875 |
| 3.2 Field Office Support | 5 | mo | | $240.00 | | | $0 | $1,200 | $0 | $0 | $1,200 |
| 3.4 Utility Connection/Disconnection (phone/electric) | 1 | ls | $1,500.00 | | | | $1,500 | $0 | $0 | $0 | $1,500 |
| 3.5 Site Utilities | 5 | mo | | $230.00 | | | $0 | $1,150 | $0 | $0 | $1,150 |
| 3.6 Underground Utility Clearances | 1 | ls | $1,500.00 | | | | $1,500 | $0 | $0 | $0 | $1,500 |
| 3.7 Construction Survey Support | 3 | day | $1,050.00 | | | | $3,150 | $0 | $0 | $0 | $3,150 |
| 3.8 Equipment Mobilization/Demobilization, 70 to 150 HP | 6 | ea | | | $64.00 | $117.00 | $0 | $0 | $384 | $702 | $1,086 |
| 3.9 Site Superintendent | 132 | day | | | $355.00 | | $0 | $0 | $46,860 | $0 | $46,860 |
| 3.10 Site Health & Safety and QA/QC | 132 | day | | | $325.00 | | $0 | $0 | $42,900 | $0 | $42,900 |
| 3.11 Materials Storage Pad, 25' X 25' | 625 | sf | | $3.64 | $0.74 | $1.09 | $0 | $2,275 | $463 | $681 | $3,419 |
| **4 DECONTAMINATION** | | | | | | | | | | | |
| 4.1 Decontamination Services | 5 | mo | | | | $5,045.46 | $0 | $0 | $0 | $25,227 | $25,227 |
| 4.2 Equipment Decon Pad | 5 | ls | | $1,750.00 | $1,500.00 | $425.00 | $0 | $8,750 | $7,500 | $2,125 | $18,375 |
| 4.3 Decon Water | 5,000 | gal | | $0.20 | | | $0 | $1,000 | $0 | $0 | $1,000 |
| 4.4 Decon Water Storage Tank, 6,000 gallon | 5 | mo | | | | $784.24 | $0 | $0 | $0 | $3,921 | $3,921 |
| 4.5 Clean Water Storage Tank, 4,000 gallon | 5 | mo | | | | $705.22 | $0 | $0 | $0 | $3,526 | $3,526 |
| 4.6 Disposal of Decon Waste (liquid & solid) | 5 | mo | $950.00 | | | | $4,750 | $0 | $0 | $0 | $4,750 |
| **5 EXCAVATION AND DISPOSAL** | | | | | | | | | | | |
| 5.1 Pavement Removal, bituminous driveways | 9,708 | sy | | $2.22 | $1.63 | $3.85 | $0 | $21,553 | $15,825 | $37,378 | $74,755 |
| 5.2 Excavator, 1/2 cy Capacity | 5 | mo | | | $13,050.40 | $7,087.20 | $0 | $0 | $65,252 | $35,436 | $100,688 |
| 5.3 Site Labor, (1 laborer) | 5 | mo | | | $5,561.60 | | $0 | $0 | $27,808 | $0 | $27,808 |
| 5.4 Tractor Loader 1 to 1-1/4 cy | 5 | mo | | | $10,058.40 | $4,383.00 | $0 | $0 | $50,292 | $21,915 | $72,207 |
| 5.5 Characterization Testing - SPLP, Lead, PAH, TPH | 49 | ea | $478.80 | $10.00 | | | $23,461 | $490 | $0 | $0 | $23,951 |
| 5.6 Confirmation Testing - SPLP, Lead, PAH, rapid | 29 | ea | $756.00 | | | | $21,924 | $0 | $0 | $0 | $21,924 |
| 5.7 Off Site Transportation & Disposal, Lead < 1000 mg/kg | 150 | tons | $40.00 | | | | $6,000 | $0 | $0 | $0 | $6,000 |
| 5.8 Off Site Transportation & Disposal, High PAHs | 5,840 | tons | $100.00 | | | | $583,950 | $0 | $0 | $0 | $583,950 |
| 5.9 Off Site Transportation & Disposal, High Lead | 8,210 | tons | $120.00 | | | | $985,140 | $0 | $0 | $0 | $985,140 |
| 5.10 Off Site Transportation & Recycling, Asphalt | 1,214 | tons | $19.50 | | | | $23,663 | $0 | $0 | $0 | $23,663 |
| **6 BACKFILL AND SITE RESTORATION** | | | | | | | | | | | |
| 6.1 Clean Backfill | 9,466 | cy | | $8.00 | | | $0 | $75,728 | $0 | $0 | $75,728 |
| 6.2 Tractor Loader 1 to 1-1/4 cy | 1 | mo | | | $2,286.00 | $1,195.00 | $0 | $0 | $2,286 | $1,195 | $3,481 |
| 6.3 Vibrating Roller, 2-Drum, 7.5 HP, 1/2 time Operator | 1 | mo | | | $1,143.00 | $613.00 | $0 | $0 | $1,143 | $613 | $1,756 |
| 6.4 Vibratory Plate, 1/2 time Operator | 1 | mo | | | $632.00 | $114.00 | $0 | $0 | $632 | $114 | $746 |
| 6.5 Asphalt, 2" Binder, 1" Topping, Small Areas | 87,376 | sf | | $1.03 | $0.24 | $0.30 | $0 | $89,997 | $20,970 | $26,213 | $137,180 |
| **7 POST CONSTRUCTION COST** | | | | | | | | | | | |
| 7.1 Contractor Completion Report | 80 | hr | | | $35.00 | | $0 | $0 | $2,800 | $0 | $2,800 |
| 7.2 Remedial Action Closeout Report | 80 | hr | | | $35.00 | | $0 | $0 | $2,800 | $0 | $2,800 |
| **Subtotal** | | | | | | | $1,708,298 | $204,018 | $296,840 | $159,046 | $2,368,202 |
| **Local Area Adjustments** | | | | | | | 100.0% | 98.6% | 104.2% | 104.2% | |
| **Subtotal** | | | | | | | $1,708,298 | $201,162 | $309,307 | $165,726 | $2,384,493 |

**ZONE 7, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
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**Capital Cost**

| Item | Quantity | Unit | Unit Cost Subcontract | Unit Cost Material | Unit Cost Labor | Unit Cost Equipment | Extended Cost Subcontract | Extended Cost Material | Extended Cost Labor | Extended Cost Equipment | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Overhead on Labor Cost @ 30% | | | | | | | | | $92,792 | | $92,792 |
| G & A on Labor Cost @ 10% | | | | | | | | | $30,931 | | $30,931 |
| G & A on Material Cost @ 10% | | | | | | | | $20,116 | | | $20,116 |
| G & A on Equipment Cost @ 10% | | | | | | | | | | $16,573 | $16,573 |
| G & A on Subcontract Cost @ 10% | | | | | | | $170,830 | | | | $170,830 |
| Tax on Materials and Equipment Cost @ 6% | | | | | | | | $12,070 | | $9,944 | $22,013 |
| **Total Direct Cost** | | | | | | | $1,879,128 | $233,348 | $433,029 | $192,242 | $2,737,748 |
| Indirects on Total Direct Cost @ 30% | | (excluding transportation and disposal cost) | | | | | | | | | $340,273 |
| Profit on Total Direct Cost @ 10% | | | | | | | | | | | $273,775 |
| **Subtotal** | | | | | | | | | | | $3,351,796 |
| Health & Safety Monitoring @ 3% | | (includes air quality monitoring) | | | | | | | | | $100,554 |
| **Total Field Cost** | | | | | | | | | | | $3,452,350 |
| Contingency on Total Field Costs @ 20% | | | | | | | | | | | $690,470 |
| Engineering on Total Field Cost @ 10% | | | | | | | | | | | $345,235 |
| **TOTAL CAPITAL COST** | | | | | | | | | | | **$4,488,055** |

**ZONE 7, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**

**ALTERNATIVE S-7.5 EXCAVATION TO MEET I/C DEC AND PMC, OFF-SITE TREATMENT (LTTD AND STABILIZATION /SOLIDIFICATION) AND DISPOSAL (LANDFILLING), LUCs, AND MONITORING**
**ANNUAL COST**

| Item | Item Cost Years 1 & 2 | Item Cost Years 3 & 4 | Item Cost Years 5 through 30 | Item Cost Annually | Item Cost Every 5 Years | Notes |
|---|---|---|---|---|---|---|
| Pavement Maintenance | | | | $27,436 | | Repave 10% of contaminated areas yearly. |
| Groundwater Sampling | $22,272 | $11,136 | $5,568 | | | 4 Wells. Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Labor and supplies for sampling |
| Groundwater Analysis | $3,360 | $1,680 | $840 | | | 4 wells, Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Analysis for PAHs. |
| Groundwater Report | $5,000 | $5,000 | $5,000 | | | |
| Inspection | | | | $1,000 | | Annual LUC inspection |
| Site Review | | | | | $23,000 | 5-year review |
| Subtotal | $30,632 | $17,816 | $11,408 | $28,436 | $23,000 | |
| Contingency at 10% | $3,063 | $1,782 | $1,141 | $2,844 | $2,300 | |
| **TOTAL** | $33,695 | $19,598 | $12,549 | $31,280 | $25,300 | |

**ZONE 7, LOWER SUBASE**
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**Present Worth Analysis**

| Year | Capital Cost | Annual Cost | Total Year Cost | Annual Discount Rate at 7% | Present Worth |
|---|---|---|---|---|---|
| 0 | $4,488,055 | | $4,488,055 | 1.000 | $4,488,055 |
| 1 | | $64,975 | $64,975 | 0.935 | $60,752 |
| 2 | | $64,975 | $64,975 | 0.873 | $56,723 |
| 3 | | $50,877 | $50,877 | 0.816 | $41,516 |
| 4 | | $50,877 | $50,877 | 0.763 | $38,819 |
| 5 | | $69,128 | $69,128 | 0.713 | $49,289 |
| 6 | | $43,828 | $43,828 | 0.666 | $29,190 |
| 7 | | $43,828 | $43,828 | 0.623 | $27,305 |
| 8 | | $43,828 | $43,828 | 0.582 | $25,508 |
| 9 | | $43,828 | $43,828 | 0.544 | $23,843 |
| 10 | | $69,128 | $69,128 | 0.508 | $35,117 |
| 11 | | $43,828 | $43,828 | 0.475 | $20,819 |
| 12 | | $43,828 | $43,828 | 0.444 | $19,460 |
| 13 | | $43,828 | $43,828 | 0.415 | $18,189 |
| 14 | | $43,828 | $43,828 | 0.388 | $17,005 |
| 15 | | $69,128 | $69,128 | 0.362 | $25,025 |
| 16 | | $43,828 | $43,828 | 0.339 | $14,858 |
| 17 | | $43,828 | $43,828 | 0.317 | $13,894 |
| 18 | | $43,828 | $43,828 | 0.296 | $12,973 |
| 19 | | $43,828 | $43,828 | 0.277 | $12,140 |
| 20 | | $69,128 | $69,128 | 0.258 | $17,835 |
| 21 | | $43,828 | $43,828 | 0.242 | $10,606 |
| 22 | | $43,828 | $43,828 | 0.226 | $9,905 |
| 23 | | $43,828 | $43,828 | 0.211 | $9,248 |
| 24 | | $43,828 | $43,828 | 0.197 | $8,634 |
| 25 | | $69,128 | $69,128 | 0.184 | $12,720 |
| 26 | | $43,828 | $43,828 | 0.172 | $7,538 |
| 27 | | $43,828 | $43,828 | 0.161 | $7,056 |
| 28 | | $43,828 | $43,828 | 0.15 | $6,574 |
| 29 | | $43,828 | $43,828 | 0.141 | $6,180 |
| 30 | | $69,128 | $69,128 | 0.131 | $9,056 |
| | | | | **TOTAL PRESENT WORTH** | **$5,135,832** |

**ZONE 7, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-7.6 EXCAVATION TO MEET RESIDENTIAL DECs AND PMCs, ON-SITE DEWATERING, AND OFF-SITE TREATMENT (LTTD AND SOLIDIFICATION/STABILIZATION) AND DISPOSAL (LANDFILLING)**
**Capital Cost**

| Item | Quantity | Unit | Unit Cost Subcontract | Unit Cost Material | Unit Cost Labor | Unit Cost Equipment | Extended Cost Subcontract | Extended Cost Material | Extended Cost Labor | Extended Cost Equipment | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1 PROJECT PLANNING** | | | | | | | | | | | |
| 1.1 Prepare Documents & Plans including Permits | 200 | hr | | | $35.00 | | $0 | $0 | $7,000 | $0 | $7,000 |
| **2 PRE-DESIGN INVESTIGATION** | | | | | | | | | | | |
| 2.1 Field Personnel - prep, field, and follow-up | 4.5 | days | | | $350.00 | | $0 | $0 | $1,575 | $0 | $1,575 |
| 2.2 Travel & Mob | 1 | ls | $1,660.00 | | | | $1,660 | $0 | $0 | $0 | $1,660 |
| 2.3 Geoprobe - Equipment and Operator | 3 | day | $2,400.00 | | | | $7,200 | $0 | $0 | $0 | $7,200 |
| 2.4 Supplies & PID | 3 | day | $600.00 | | | | $1,800 | $0 | $0 | $0 | $1,800 |
| 2.5 Soil Sample Analysis (Lead, Antimony, SPLP, PAHs ) | 1 | ls | $10,600.00 | | | | $10,600 | $0 | $0 | $0 | $10,600 |
| 2.6 Evaluate Data, Prepare Report, and Upload to NIRIS | 1 | ea | $32,000.00 | | | | $32,000 | $0 | $0 | $0 | $32,000 |
| **3 MOBILIZATION, DEMOBILIZATION AND FIELD SUPPORT** | | | | | | | | | | | |
| 3.1 Office Trailer | 10 | mo | | | | $375.00 | $0 | $0 | $0 | $3,750 | $3,750 |
| 3.2 Field Office Support | 10 | mo | | $155.00 | | | $0 | $1,550 | $0 | $0 | $1,550 |
| 3.3 Storage Trailer (1) | 10 | mo | | | | $99.00 | $0 | $0 | $0 | $990 | $990 |
| 3.4 Utility Connection/Disconnection (phone/electric) | 1 | ls | $1,500.00 | | | | $1,500 | $0 | $0 | $0 | $1,500 |
| 3.5 Site Utilities | 10 | mo | $150.00 | | | | $1,500 | $0 | $0 | $0 | $1,500 |
| 3.6 Construction Survey Support | 2 | day | $975.00 | | | | $1,950 | $0 | $0 | $0 | $1,950 |
| 3.7 Equipment Mobilization/Demobilization | 8 | ea | | | $85.00 | $261.00 | $0 | $0 | $680 | $2,088 | $2,768 |
| 3.8 Site Superintendent | 220 | day | | | $355.00 | | $0 | $0 | $78,100 | $0 | $78,100 |
| 3.9 Site Health & Safety and QA/QC | 220 | day | | | $325.00 | | $0 | $0 | $71,500 | $0 | $71,500 |
| 3.10 Materials Storage Pad, 25' X 25' | 625 | sf | | $3.64 | $0.74 | $1.09 | $0 | $2,275 | $463 | $681 | $3,419 |
| 3.11 Dewatering Pad, 40' X 40' , five | 8,000 | sf | | $5.62 | $0.85 | $1.24 | $0 | $44,960 | $6,800 | $9,920 | $61,680 |
| 3.12 Maintain Dewatering Pad, Replace Top 27x | 43,200 | sf | | $0.32 | $0.11 | $0.13 | $0 | $13,824 | $4,752 | $5,616 | $24,192 |
| **4 DECONTAMINATION** | | | | | | | | | | | |
| 4.1 Decontamination Services | 10 | mo | | | | $5,045.46 | $0 | $0 | $0 | $50,455 | $50,455 |
| 4.2 Equipment Decon Pad | 1 | ls | | $1,750.00 | $1,500.00 | $425.00 | $0 | $1,750 | $1,500 | $425 | $3,675 |
| 4.3 Decon Water | 10,000 | gal | | $0.20 | | | $0 | $2,000 | $0 | $0 | $2,000 |
| 4.4 Decon Water Storage Tank, 6,000 gallon | 10 | mo | | | | $784.24 | $0 | $0 | $0 | $7,842 | $7,842 |
| 4.5 Clean Water Storage Tank, 4,000 gallon | 10 | mo | | | | $705.22 | $0 | $0 | $0 | $7,052 | $7,052 |
| 4.6 Disposal of Decon Waste (liquid & solid) | 10 | mo | $950.00 | | | | $9,500 | $0 | $0 | $0 | $9,500 |
| **5 SHEET PILING, EXCAVATION, DEWATERING, AND DISPOSAL** | | | | | | | | | | | |
| 5.1 Pavement Removal | 23,751 | sy | | $2.22 | $1.63 | $3.85 | $0 | $52,727 | $38,714 | $91,442 | $182,884 |
| 5.2 Excavator, 2 CY Capacity | 10 | mo | | | $12,064.80 | $17,678.20 | $0 | $0 | $120,648 | $176,782 | $297,430 |
| 5.3 Site Labor, (3 laborers) | 10 | mo | | | $16,684.80 | | $0 | $0 | $166,848 | $0 | $166,848 |
| 5.4 Sheet Piles, 1500' x 8', tiebacks, drive, extract & salvage | 12,000 | sf | | $8.48 | $6.96 | $9.15 | $0 | $101,700 | $83,520 | $109,800 | $295,020 |
| 5.5 FE Loader 3 1/2 to 5 cy, two | 20 | mo | | | $9,288.40 | $13,544.60 | $0 | $0 | $185,768 | $270,892 | $456,660 |
| 5.6 Crane, 25 Ton with Clamshell Bucket, 1 CY | 6 | mo | | | $12,262.80 | $4,490.91 | $0 | $0 | $73,577 | $26,945 | $100,522 |
| 5.7 Characterization Soil Testing - Lead, TCLP, PAH, ETPH | 62 | ea | $478.80 | $10.00 | | | $29,686 | $620 | $0 | $0 | $30,306 |
| 5.8 Confirmation Testing - SPLP, Lead, ETPH, PAH, rapid | 60 | ea | $957.60 | | | | $57,456 | $0 | $0 | $0 | $57,456 |
| 5.9 Off Site Transportation & Disposal, Lead < 1000 mg/kg | 31,140 | tons | $40.00 | | | | $1,245,600 | $0 | $0 | $0 | $1,245,600 |
| 5.10 Off Site Transportation & Disposal, High Lead Soil | 30,995 | tons | $120.00 | | | | $3,719,340 | $0 | $0 | $0 | $3,719,340 |
| 5.11 Off Site Transportation & Disposal, High PAH Soil | 29,333 | tons | $100.00 | | | | $2,933,250 | $0 | $0 | $0 | $2,933,250 |
| 5.12 Off Site Transportation & Recycling, Asphalt | 2,969 | tons | $19.50 | | | | $57,886 | $0 | $0 | $0 | $57,886 |
| 5.13 Centrifugal 15 gpm 1 HP Pump, 5 for 6 mo | 30 | mo | | $2,211 | $636 | | $0 | $66,344 | $19,071 | $0 | $85,415 |
| 5.14 5,000 lb Liquid-Phase GAC Adsorption Units | 10 | ea | | $24,600.00 | | | $0 | $246,000 | $0 | $0 | $246,000 |
| 5.15 Replace GAC | 450,000 | lb | | $2.00 | | | $0 | $900,000 | $0 | $0 | $900,000 |
| 5.16 Bag Filter System | 10 | ea | | $14,000.00 | $225.00 | | $0 | $140,000 | $2,250 | $0 | $142,250 |
| 5.17 Replace Filter Bags | 1,520 | ea | | $60.00 | | | $0 | $91,200 | $0 | $0 | $91,200 |
| 5.18 Diaphragm Pump, from Treatment to Sewer, 5 for 6 mo | 30 | mo | | | | $542.48 | $0 | $0 | $0 | $16,274 | $16,274 |
| 5.19 Piping , 2" PVC, from Treatment to Storm Sewer | 1,000 | ft | | $0.51 | $0.72 | | $0 | $510 | $720 | $0 | $1,230 |
| **6 BACKFILL AND SITE RESTORATION** | | | | | | | | | | | |
| 6.1 Clean Backfill | 58,999 | cy | | $8.00 | | | $0 | $471,992 | $0 | $0 | $471,992 |
| 6.2 FE Loader 3 1/2 to 5 cy | 7 | mo | | | $9,288.40 | $13,544.60 | $0 | $0 | $65,019 | $94,812 | $159,831 |
| 6.3 Vibrating Roller, 2-Drum, 7.5 HP | 7 | mo | | | $10,058.40 | $2,494.40 | $0 | $0 | $70,409 | $17,461 | $87,870 |

**ZONE 7, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE S-7.6 EXCAVATION TO MEET RESIDENTIAL DECs AND PMCs, ON-SITE DEWATERING, AND OFF-SITE TREATMENT (LTTD AND SOLIDIFICATION/STABILIZATION) AND DISPOSAL (LANDFILLING)**
**Capital Cost**

| Item | Quantity | Unit | Unit Cost Subcontract | Unit Cost Material | Unit Cost Labor | Unit Cost Equipment | Extended Cost Subcontract | Extended Cost Material | Extended Cost Labor | Extended Cost Equipment | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 6.4 Vibratory Plate for use around Utilities | 7 | mo | | | | $297.00 | $0 | $0 | $0 | $2,079 | $2,079 |
| 6.5 Top Dress Soil | 3,958 | cy | $31.50 | | | | $124,677 | $0 | $0 | $0 | $124,677 |
| 6.6 Site Restoration, seed, fertilization, mulch | 213.8 | msf | $75.00 | | | | $16,035 | $0 | $0 | $0 | $16,035 |
| **7 POST CONSTRUCTION COST** | | | | | | | | | | | |
| 7.1 Contractor Completion Report | 240 | hr | | | $35.00 | | $0 | $0 | $8,400 | $0 | $8,400 |
| 7.2 Remedial Action Closeout Report | 240 | hr | | | $35.00 | | $0 | $0 | $8,400 | $0 | $8,400 |
| **Subtotal** | | | | | | | $8,251,639 | $2,137,452 | $1,015,713 | $895,307 | $12,300,112 |
| **Local Area Adjustments** | | | | | | | 100.0% | 98.6% | 104.2% | 104.2% | |
| **Subtotal** | | | | | | | $8,251,639 | $2,107,528 | $1,058,373 | $932,910 | $12,350,450 |
| Overhead on Labor Cost @ 30% | | | | | | | | | $317,512 | | $317,512 |
| G & A on Labor Cost @ 10% | | | | | | | | | $105,837 | | $105,837 |
| G & A on Material Cost @ 10% | | | | | | | | $210,753 | | | $210,753 |
| G & A on Equipment Cost @ 10% | | | | | | | | | | $93,291 | $93,291 |
| G & A on Subcontract Cost @ 10% | | | | | | | $825,164 | | | | $825,164 |
| Tax on Materials and Equipment Cost @ 6% | | | | | | | | $126,452 | | $55,975 | $182,426 |
| **Total Direct Cost** | | | | | | | $9,076,803 | $2,444,732 | $1,481,723 | $1,082,176 | $14,085,434 |
| Indirects on Total Direct Cost @ 30% | | (excluding transportation and disposal cost) | | | | | | | | | $1,835,957 |
| Profit on Total Direct Cost @ 10% | | | | | | | | | | | $1,408,543 |
| **Subtotal** | | | | | | | | | | | $17,329,935 |
| Health & Safety Monitoring @ 2% | | (includes air quality monitoring) | | | | | | | | | $346,599 |
| **Total Field Cost** | | | | | | | | | | | $17,676,533 |
| Contingency on Total Field Costs @ 20% | | | | | | | | | | | $3,535,307 |
| Engineering on Total Field Cost @ 10% | | | | | | | | | | | $1,767,653 |
| **TOTAL CAPITAL COST** | | | | | | | | | | | **$22,979,493** |

# APPENDIX E.2

# GROUNDWATER ALTERNATIVES COST ESTIMATES

## E.2.1 – ZONE 1

## E.2.2 – ZONE 4

## E.2.3 – ZONE 7

# APPENDIX E.2.1

# ZONE 1

# ALTERNATIVES GW-1.1, GW-1.2, GW-1.3, GW-1.4, and GW-1.5

**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE GW-1.1: NO ACTION**
**Annual Cost**



| Item | Item Cost every 5 years | Notes |
|---|---|---|
| Five-Year Review | $23,000 | |
| Subtotal | $23,000 | |
| Contingency @ 10% | $2,300 | |
| **TOTAL** | **$25,300** | |

**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE GW-1.1: NO ACTION**
**Present Worth Analysis**



| Year | Capital Cost | Annual Cost | Total Year Cost | Annual Discount Rate at 7% | Present Worth |
|---|---|---|---|---|---|
| 0 | $0 | | $0 | 1.000 | $0 |
| 1 | | | $0 | 0.935 | $0 |
| 2 | | | $0 | 0.873 | $0 |
| 3 | | | $0 | 0.816 | $0 |
| 4 | | | $0 | 0.763 | $0 |
| 5 | | $25,300 | $25,300 | 0.713 | $18,039 |
| 6 | | | $0 | 0.666 | $0 |
| 7 | | | $0 | 0.623 | $0 |
| 8 | | | $0 | 0.582 | $0 |
| 9 | | | $0 | 0.544 | $0 |
| 10 | | $25,300 | $25,300 | 0.508 | $12,852 |
| 11 | | | $0 | 0.475 | $0 |
| 12 | | | $0 | 0.444 | $0 |
| 13 | | | $0 | 0.415 | $0 |
| 14 | | | $0 | 0.388 | $0 |
| 15 | | $25,300 | $25,300 | 0.362 | $9,159 |
| 16 | | | $0 | 0.339 | $0 |
| 17 | | | $0 | 0.317 | $0 |
| 18 | | | $0 | 0.296 | $0 |
| 19 | | | $0 | 0.277 | $0 |
| 20 | | $25,300 | $25,300 | 0.258 | $6,527 |
| 21 | | | $0 | 0.242 | $0 |
| 22 | | | $0 | 0.226 | $0 |
| 23 | | | $0 | 0.211 | $0 |
| 24 | | | $0 | 0.197 | $0 |
| 25 | | $25,300 | $25,300 | 0.184 | $4,655 |
| 26 | | | $0 | 0.172 | $0 |
| 27 | | | $0 | 0.161 | $0 |
| 28 | | | $0 | 0.150 | $0 |
| 29 | | | $0 | 0.141 | $0 |
| 30 | | $25,300 | $25,300 | 0.131 | $3,314 |
| | | | | **TOTAL PRESENT WORTH** | **$54,547** |

**ZONE 1, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE GW-1.2: NATURAL ATTENUATION, LUCs, AND MONITORING**
**CAPITAL COST**

| Item | Quantity | Unit | Unit Cost | | | | Extended Cost | | | | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Subcontract | Material | Labor | Equipment | Subcontract | Material | Labor | Equipment | |
| **1 PROJECT PLANNING** | | | | | | | | | | | |
| 1.1 Prepare Documents & Plans including Permits | 100 | hr | | | $37.00 | | $0 | $0 | $3,700 | $0 | $3,700 |
| 1.2 Prepare LUC RD Documents | 60 | hr | | | $37.00 | | $0 | $0 | $2,220 | $0 | $2,220 |
| 1.3 Pre-Design Investigation | 1 | ls | $6,305.00 | $1,067.00 | $7,770.00 | $773.00 | $6,305 | $1,067 | $7,770 | $773 | $15,915 |
| **Subtotal** | | | | | | | $6,305 | $1,067 | $13,690 | $773 | $21,835 |
| **Local Area Adjustments** | | | | | | | 100.0% | 98.6% | 104.2% | 104.2% | |
| | | | | | | | $6,305 | $1,052 | $14,265 | $805 | $22,428 |
| Overhead on Labor Cost @ 30% | | | | | | | | | $4,279 | | $4,279 |
| G & A on Labor Cost @ 10% | | | | | | | | | $1,426 | | $1,426 |
| G & A on Material Cost @ 10% | | | | | | | | $105 | | | $105 |
| G & A on Subcontract Cost @ 10% | | | | | | | $631 | | | | $631 |
| G & A on Equipment Cost @ 10% | | | | | | | | | | $81 | $81 |
| Tax on Materials and Equipment Cost @ 6% | | | | | | | | $63 | | $48 | $111 |
| **Total Direct Cost** | | | | | | | $6,936 | $1,220 | $19,971 | $934 | $29,061 |
| Indirects on Total Direct Cost @ 0% | | | | | | | | | | | $0 |
| Profit on Total Direct Cost @ 10% | | | | | | | | | | | $2,906 |
| **Subtotal** | | | | | | | | | | | $31,967 |
| Health & Safety Monitoring @ 0% | | | | | | | | | | | $0 |
| **Total Field Cost** | | | | | | | | | | | $31,967 |
| Contingency on Total Field Costs @ 20% | | | | | | | | | | | $6,393 |
| Engineering on Total Field Cost @ 0% | | | | | | | | | | | $0 |
| **TOTAL COST** | | | | | | | | | | | **$38,361** |

**ZONE 1, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDOI**
**GROTON, CONNECTICUT**
**ALTERNATIVE GW-1.2: NATURAL ATTENUATION, LUCs, AND MONITORIN**
**ANNUAL COST**

| Item | Item Cost Years 1 and 2 | Item Cost Years 3 and 4 | Item Cost Years 5 and 30 | Item Cost Every 5 Years | Notes |
|---|---|---|---|---|---|
| Groundwater Sampling | $33,408 | $16,704 | $8,352 | | 6 Wells (2 Performance Wells, 4 Migration Wells). Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Labor and supplies for sampling |
| Groundwater Analysis (Performance) | $1,456 | $728 | $364 | | 2 wells, Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Analysis for arsenic, copper, TPH. |
| Groundwater Analysis (Migration) | $2,912 | $1,456 | $728 | | 4 wells, Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Analysis for arsenic, copper, TPH. |
| Annual Report | $5,000 | $5,000 | $5,000 | | |
| Inspection | $1,000 | $1,000 | $1,000 | | Annual LUC inspection (assume 8 hours at $50/hr plus expense |
| Site Review | | | | $23,000 | 5-year review |
| Subtotal | $43,776 | $24,888 | $15,444 | $23,000 | |
| Contingency at 10% | $4,378 | $2,489 | $1,544 | $2,300 | |
| **TOTAL** | $48,154 | $27,377 | $16,988 | $25,300 | |

**ZONE 1, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE GW-1.2: NATURAL ATTENUATION, LUCs, AND MONITORING**
**PRESENT WORTH ANALYSIS**

| Year | Capital Cost | Annual Cost | Total Year Cost | Annual Discount Rate at 7% | Present Worth |
|---|---|---|---|---|---|
| 0 | $38,361 | | $38,361 | 1.000 | $38,361 |
| 1 | | $48,154 | $48,154 | 0.935 | $45,024 |
| 2 | | $48,154 | $48,154 | 0.873 | $42,038 |
| 3 | | $27,377 | $27,377 | 0.816 | $22,339 |
| 4 | | $27,377 | $27,377 | 0.763 | $20,888 |
| 5 | | $42,288 | $42,288 | 0.713 | $30,152 |
| 6 | | $16,988 | $16,988 | 0.666 | $11,314 |
| 7 | | $16,988 | $16,988 | 0.623 | $10,584 |
| 8 | | $16,988 | $16,988 | 0.582 | $9,887 |
| 9 | | $16,988 | $16,988 | 0.544 | $9,242 |
| 10 | | $42,288 | $42,288 | 0.508 | $21,483 |
| 11 | | $16,988 | $16,988 | 0.475 | $8,069 |
| 12 | | $16,988 | $16,988 | 0.444 | $7,543 |
| 13 | | $16,988 | $16,988 | 0.415 | $7,050 |
| 14 | | $16,988 | $16,988 | 0.388 | $6,591 |
| 15 | | $42,288 | $42,288 | 0.362 | $15,308 |
| 16 | | $16,988 | $16,988 | 0.339 | $5,759 |
| 17 | | $16,988 | $16,988 | 0.317 | $5,385 |
| 18 | | $16,988 | $16,988 | 0.296 | $5,029 |
| 19 | | $16,988 | $16,988 | 0.277 | $4,706 |
| 20 | | $42,288 | $42,288 | 0.258 | $10,910 |
| 21 | | $16,988 | $16,988 | 0.242 | $4,111 |
| 22 | | $16,988 | $16,988 | 0.226 | $3,839 |
| 23 | | $16,988 | $16,988 | 0.211 | $3,585 |
| 24 | | $16,988 | $16,988 | 0.197 | $3,347 |
| 25 | | $42,288 | $42,288 | 0.184 | $7,781 |
| 26 | | $16,988 | $16,988 | 0.172 | $2,922 |
| 27 | | $16,988 | $16,988 | 0.161 | $2,735 |
| 28 | | $16,988 | $16,988 | 0.150 | $2,548 |
| 29 | | $16,988 | $16,988 | 0.141 | $2,395 |
| 30 | | $42,288 | $42,288 | 0.131 | $5,540 |
| | | | | **TOTAL PRESENT WORTH** | **$376,467** |

**ZONE 1, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE GW-1.3: IN-SITU TREATMENT (Enhanced Bioremediation, Chemical Precipitation and Oxidation), LUCs, AND MONITORING**
**CAPITAL COST**

| Item | Quantity | Unit | Unit Cost Subcontract | Unit Cost Material | Unit Cost Labor | Unit Cost Equipment | Extended Cost Subcontract | Extended Cost Material | Extended Cost Labor | Extended Cost Equipment | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1 PROJECT PLANNING AND DOCUMENTS** | | | | | | | | | | | |
| 1.1 Prepare LUC RD Documents | 60 | hr | | | $37.00 | | $0 | $0 | $2,220 | $0 | $2,220 |
| 1.2 Prepare Documents & Plans including Permits | 300 | hr | | | $37.00 | | $0 | $0 | $11,100 | $0 | $11,100 |
| 1.3 Prepare Groundwater Monitoring Plan | 100 | hr | | | $37.00 | | $0 | $0 | $3,700 | $0 | $3,700 |
| 1.4 Completion Report | 150 | hr | | | $37.00 | | $0 | $0 | $5,550 | $0 | $5,550 |
| 1.5 Treatability Study: In-Situ Bioremediation | 1 | ls | $20,000.00 | | | | $20,000 | $0 | $0 | $0 | $20,000 |
| 1.6 Treatability Study: In-Situ Chemical Precipitation & Oxidation | 1 | ls | $5,000.00 | | | | $5,000 | $0 | $0 | $0 | $5,000 |
| 1.7 Pre-Design Investigation | 1 | ls | $6,305.00 | $1,067.00 | $7,770.00 | $773.00 | $6,305 | $1,067 | $7,770 | $773 | $15,915 |
| **2 MOBILIZATION/DEMOBILIZATION & SITE SUPPORT** | | | | | | | | | | | |
| 2.1 Utility Connection (electric) | 1 | ls | $10,000.00 | | | | $10,000 | $0 | $0 | $0 | $10,000 |
| 2.2 Underground Utility Clearances | 1 | ls | $7,600.00 | | | | $7,600 | $0 | $0 | $0 | $7,600 |
| 2.3 Construction Survey | 3 | day | $2,125.00 | | | | $6,375 | $0 | $0 | $0 | $6,375 |
| 2.4 Drill Rig Mobilization/Demobilization | 2 | ea | $2,000.00 | | | | $4,000 | $0 | $0 | $0 | $4,000 |
| 2.5 Field Construction Mgt. (1 person) | 30 | day | | $240.00 | $300.00 | | $0 | $7,200 | $9,000 | $0 | $16,200 |
| **3 IN-SITU BIOREMEDIATION** | | | | | | | | | | | |
| 3.1 Extraction Well, 4" dia, 6' deep, 4 wells | 24 | lf | $70.00 | | | | $1,680 | $0 | $0 | $0 | $1,680 |
| 3.2 Injection Well, 4" dia, 3' deep, 8 wells | 24 | lf | $70.00 | | | | $1,680 | $0 | $0 | $0 | $1,680 |
| 3.3 Well Development | 24 | hr | $200.00 | | | | $4,800 | $0 | $0 | $0 | $4,800 |
| 3.4 Well Bollard or Vault | 12 | ea | $500.00 | | | | $6,000 | $0 | $0 | $0 | $6,000 |
| 3.5 Collect/Containerize/Transport/Dispose IDW Off-Site | 2 | drum | $225.00 | | | | $450 | $0 | $0 | $0 | $450 |
| 3.6 Extraction Pump, 5 gpm | 4 | ea | | $760.00 | $218.00 | | $0 | $3,040 | $872 | $0 | $3,912 |
| 3.7 PVC pipe, 1" dia. w/trench | 400 | lf | | $0.41 | $4.43 | $7.62 | $0 | $164 | $1,772 | $3,048 | $4,984 |
| 3.8 Dissolved Oxygen In-Situ System | 1 | ls | | $30,000.00 | | | $0 | $30,000 | $0 | $0 | $30,000 |
| **4 IN-SITU CHEMICAL PRECIPITATION & OXIDATION** | | | | | | | | | | | |
| 4.1 DPT Rig (92 injection points @ 15' bgs) | 10 | day | $3,000.00 | | | | $30,000 | $0 | $0 | $0 | $30,000 |
| 4.2 Pump & Hose | 10 | day | | | | $166.40 | $0 | $0 | $0 | $1,664 | $1,664 |
| 4.3 Mix Tank & Equipment | 10 | day | | | | $200.00 | $0 | $0 | $0 | $2,000 | $2,000 |
| 4.4 Injection Point Supplies | 1,380 | lf | $4.00 | | | | $5,520 | $0 | $0 | $0 | $5,520 |
| 4.5 Site Labor, (2 laborers) | 20 | day | | | $309.60 | | $0 | $0 | $6,192 | $0 | $6,192 |
| 4.6 Ferric Chloride | 55 | gal | | $8.00 | | | $0 | $440 | $0 | $0 | $440 |
| 4.7 Treatment Water | 1 | ls | | $250.00 | | | $0 | $250 | $0 | $0 | $250 |
| 4.8 ORC | 3,680 | lb | | $9.00 | | | $0 | $33,120 | $0 | $0 | $33,120 |
| **5 SITE RESTORATION** | | | | | | | | | | | |
| 5.1 Top Dress Soil | 40 | cy | $31.50 | | | | $1,260 | $0 | $0 | $0 | $1,260 |
| 5.1 Pavement Repair | 1 | ls | $2,000.00 | | | | $2,000 | $0 | $0 | $0 | $2,000 |
| 5.2 Site Restoration, seed, fertilization, mulch | 1.0 | msf | $76.50 | | | | $77 | $0 | $0 | $0 | $77 |
| **Subtotal** | | | | | | | $112,747 | $75,281 | $48,176 | $7,485 | $243,689 |
| **Local Area Adjustments** | | | | | | | 100.0% | 98.6% | 104.2% | 104.2% | |
| ***Subtotal*** | | | | | | | $112,747 | $74,227 | $50,199 | $7,799 | $244,972 |
| Overhead on Labor Cost @ 30% | | | | | | | | | $15,060 | | $15,060 |
| G & A on Labor Cost @ 10% | | | | | | | | | $5,020 | | $5,020 |
| G & A on Material Cost @ 10% | | | | | | | | $7,423 | | | $7,423 |
| G & A on Equipment Cost @ 10% | | | | | | | | | | $780 | $780 |
| G & A on Subcontract Cost @ 10% | | | | | | | $11,275 | | | | $11,275 |
| Tax on Materials and Equipment Cost @ 6% | | | | | | | | $4,454 | | $468 | $4,922 |
| **Total Direct Cost** | | | | | | | $124,021 | $86,103 | $70,279 | $9,047 | $289,451 |
| Indirects on Total Direct Cost @ 15% | | | | | | | | | | | $43,418 |
| Profit on Total Direct Cost @ 6% | | | | | | | | | | | $17,367 |

**ZONE 1, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE GW-1.3: IN-SITU TREATMENT (Enhanced Bioremediation, Chemical Precipitation and Oxidation), LUCs, AND MONITORING**
**CAPITAL COST**

| Item | Quantity | Unit | Unit Cost Subcontract | Unit Cost Material | Unit Cost Labor | Unit Cost Equipment | Extended Cost Subcontract | Extended Cost Material | Extended Cost Labor | Extended Cost Equipment | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Subtotal** | | | | | | | | | | | $350,236 |
| Health & Safety Monitoring @ 2% | | | | | | | | | | | $7,005 |
| **Total Field Cost** | | | | | | | | | | | $357,240 |
| Contingency on Total Field Cost @ 25% | | | | | | | | | | | $89,310 |
| Engineering on Total Field Cost @ 10% | | | | | | | | | | | $35,724 |
| **TOTAL COST** | | | | | | | | | | | **$482,275** |

**ZONE 1, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE GW-1.3: IN-SITU TREATMENT (Enhanced Bioremediation, Chemical Precipitation and Oxidation), LUCs, AND MONITORING**
**Operation and Maintenance Costs per Year**

| | Item | Qty | Unit | Unit Cost | Subtotal Cost |
|---|---|---|---|---|---|
| 1 | Energy - Electric | 13,200 | kWh | $0.18 | $2,376 |
| 2 | DO-IT Rental & Chemicals | 12 | mo | $15,000.00 | $180,000 |
| 3 | Operating Labor (5 hours a week) | 260 | hr | $50.00 | $13,000 |
| 4 | Reports | 4 | ea | $2,500.00 | $10,000 |
| | Cost for one year operation (years 1 and 2) | | | | $205,376 |
| | Cost for six month operation (year 3) | | | | $102,688 |
| | Return DO-IT System (year 3) | | | | $3,500 |

**ZONE 1, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE GW-1.3: IN-SITU TREATMENT (Enhanced Bioremediation, Chemical Precipitation and Oxidation), LUCs, AND MONITORING**
**ANNUAL COST**

| Item | Item Cost Years 1 and 2 | Item Cost Years 3 and 4 | Item Cost Year 5 | Item Cost Every 5 Years | Notes |
|---|---|---|---|---|---|
| Groundwater Sampling | $33,408 | $16,704 | $8,352 | | 6 Wells (2 Performance Wells, 4 Migration Wells). Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Year 5. Labor and supplies for sampling |
| Groundwater Analysis (Performance) | $1,456 | $728 | $364 | | 2 wells, Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Year 5. Analysis for arsenic, copper, TPH. |
| Groundwater Analysis (Migration) | $2,912 | $1,456 | $728 | | 4 wells, Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Year 5. Analysis for arsenic, copper, TPH. |
| Annual Report | $5,000 | $5,000 | $5,000 | | |
| Inspection | $1,000 | $1,000 | $1,000 | | Annual LUC inspection (assume 8 hours at $50/hr plus expenses) |
| Site Review | | | | $23,000 | 5-year review |
| Subtotal | $43,776 | $24,888 | $15,444 | $23,000 | |
| Contingency at 10% | $4,378 | $2,489 | $1,544 | $2,300 | |
| **TOTAL** | $48,154 | $27,377 | $16,988 | $25,300 | |

**ZONE 1, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE GW-1.3: IN-SITU TREATMENT (Enhanced Bioremediation, Chemical Precipitation and Oxidation), LUCs, AND MONITORING**
**Present Worth Analysis**

| Year | Capital Cost | Operation and Maintenance Cost | Annual Cost | Total Year Cost | Annual Discount Rate at 7% | Present Worth |
|---|---|---|---|---|---|---|
| 0 | $482,275 | | | $482,275 | 1.000 | $482,275 |
| 1 | | $205,376 | $48,154 | $253,530 | 0.935 | $237,050 |
| 2 | | $205,376 | $48,154 | $253,530 | 0.873 | $221,331 |
| 3 | | $106,188 | $27,377 | $133,565 | 0.816 | $108,989 |
| 4 | | | $27,377 | $27,377 | 0.763 | $20,888 |
| 5 | | | $42,288 | $42,288 | 0.713 | $30,152 |
| | | | | | **TOTAL PRESENT WORTH** | **$1,100,685** |

**ZONE 1, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE GW-1.4: EXTRACTION, DISCHARGE AND DISPOSAL TO OFF-SITE POTW, LUCs, AND MONITORING**
**CAPITAL COST**

| Item | Quantity | Unit | Unit Cost Subcontract | Unit Cost Material | Unit Cost Labor | Unit Cost Equipment | Extended Cost Subcontract | Extended Cost Material | Extended Cost Labor | Extended Cost Equipment | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1 PROJECT PLANNING AND DOCUMENTS** | | | | | | | | | | | |
| 1.1 Prepare LUC RD Documents | 60 | hr | | | $37.00 | | $0 | $0 | $2,220 | $0 | $2,220 |
| 1.2 Prepare Documents & Plans including Permits | 300 | hr | | | $37.00 | | $0 | $0 | $11,100 | $0 | $11,100 |
| 1.3 Prepare Groundwater Monitoring Plan | 100 | hr | | | $37.00 | | $0 | $0 | $3,700 | $0 | $3,700 |
| 1.4 Completion Report | 150 | hr | | | $37.00 | | $0 | $0 | $5,550 | $0 | $5,550 |
| 1.5 Pre-Design Investigation | 1 | ls | $6,305.00 | $1,067.00 | $7,770.00 | $773.00 | $6,305 | $1,067 | $7,770 | $773 | $15,915 |
| **2 MOBILIZATION/DEMOBILIZATION & SITE SUPPORT** | | | | | | | | | | | |
| 2.1 Utility Connection (electric) | 1 | ls | $10,000.00 | | | | $10,000 | $0 | $0 | $0 | $10,000 |
| 2.2 Underground Utility Clearances | 1 | ls | $7,600.00 | | | | $7,600 | $0 | $0 | $0 | $7,600 |
| 2.3 Construction Survey | 2 | day | $2,125.00 | | | | $4,250 | $0 | $0 | $0 | $4,250 |
| 2.4 Drill Rig Mobilization/Demobilization | 2 | ea | $2,000.00 | | | | $4,000 | $0 | $0 | $0 | $4,000 |
| 2.5 Field Construction Mgt. (1 person) | 30 | day | | $240.00 | $300.00 | | $0 | $7,200 | $9,000 | $0 | $16,200 |
| **3 GROUNDWATER EXTRACTION, COPPER/TPH PLUME** | | | | | | | | | | | |
| 3.1 Extraction Well, 6" dia, 30' deep, 1 well | 30 | lf | $85.00 | | | | $2,550 | $0 | $0 | $0 | $2,550 |
| 3.2 Well Development | 4 | hr | $200.00 | | | | $800 | $0 | $0 | $0 | $800 |
| 3.3 Well Bollard or Vault | 1 | ea | $500.00 | | | | $500 | $0 | $0 | $0 | $500 |
| 3.4 Collect/Containerize/Transport/Dispose IDW Off-Site | 2 | drum | $225.00 | | | | $450 | $0 | $0 | $0 | $450 |
| 3.5 Extraction Pump, 20 gpm, 1 hp | 1 | ea | | $965.00 | $305.00 | | $0 | $965 | $305 | $0 | $1,270 |
| 3.6 PVC pipe, 1.5" dia. w/trench | 500 | lf | | $0.70 | $4.76 | $8.22 | $0 | $350 | $2,380 | $4,110 | $6,840 |
| 3.7 Tie-in to Existing Manhole | 1 | ea | | $500.00 | $1,000.00 | $1,250.00 | $0 | $500 | $1,000 | $1,250 | $2,750 |
| **4 GROUNDWATER EXTRACTION, ARSENIC/COPPER PLUME** | | | | | | | | | | | |
| 4.1 Extraction Well, 6" dia, 30' deep, 2 wells | 60 | lf | $85.00 | | | | $5,100 | $0 | $0 | $0 | $5,100 |
| 4.2 Well Development | 8 | hr | $200.00 | | | | $1,600 | $0 | $0 | $0 | $1,600 |
| 4.3 Well Bollard or Vault | 2 | ea | $500.00 | | | | $1,000 | $0 | $0 | $0 | $1,000 |
| 4.4 Collect/Containerize/Transport/Dispose IDW Off-Site | 4 | drum | $225.00 | | | | $900 | $0 | $0 | $0 | $900 |
| 4.5 Extraction Pump, 20 gpm, 1 hp | 2 | ea | | $965.00 | $305.00 | | $0 | $1,930 | $610 | $0 | $2,540 |
| 4.6 PVC pipe, 2" dia. w/trench | 1,000 | lf | | $1.30 | $5.63 | $9.72 | $0 | $1,300 | $5,630 | $9,720 | $16,650 |
| 4.7 Tie-in to Existing Manhole | 1 | ea | | $500.00 | $1,000.00 | $1,250.00 | $0 | $500 | $1,000 | $1,250 | $2,750 |
| **5 SITE RESTORATION** | | | | | | | | | | | |
| 5.1 Top Dress Soil | 80 | cy | $31.50 | | | | $2,520 | $0 | $0 | $0 | $2,520 |
| 5.2 Pavement Repair | 1 | ls | $2,000.00 | | | | $2,000 | $0 | $0 | $0 | $2,000 |
| 5.3 Site Restoration, seed, fertilization, mulch | 2.0 | msf | $76.50 | | | | $153 | $0 | $0 | $0 | $153 |
| **Subtotal** | | | | | | | $49,728 | $13,812 | $50,265 | $17,103 | $130,908 |
| **Local Area Adjustments** | | | | | | | 100.0% | 98.6% | 104.2% | 104.2% | |
| **Subtotal** | | | | | | | $49,728 | $13,619 | $52,376 | $17,821 | $133,544 |
| Overhead on Labor Cost @ 30% | | | | | | | | | $15,713 | | $15,713 |
| G & A on Labor Cost @ 10% | | | | | | | | | $5,238 | | $5,238 |
| G & A on Material Cost @ 10% | | | | | | | | $1,362 | | | $1,362 |
| G & A on Equipment Cost @ 10% | | | | | | | | | | $1,782 | $1,782 |
| G & A on Subcontract Cost @ 10% | | | | | | | $4,973 | | | | $4,973 |
| Tax on Materials and Equipment Cost @ 6% | | | | | | | | $817 | | $1,069 | $1,886 |
| **Total Direct Cost** | | | | | | | $54,701 | $15,798 | $73,327 | $20,673 | $164,498 |
| Indirects on Total Direct Cost @ 30% | | | | | | | | | | | $49,349 |
| Profit on Total Direct Cost @ 10% | | | | | | | | | | | $16,450 |
| **Subtotal** | | | | | | | | | | | $230,297 |
| Health & Safety Monitoring @ 2% | | | | | | | | | | | $4,606 |

**ZONE 1, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE GW-1.4: EXTRACTION, DISCHARGE AND DISPOSAL TO OFF-SITE POTW, LUCs, AND MONITORING**
**CAPITAL COST**

| Item | Quantity | Unit | Unit Cost Subcontract | Unit Cost Material | Unit Cost Labor | Unit Cost Equipment | Extended Cost Subcontract | Extended Cost Material | Extended Cost Labor | Extended Cost Equipment | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total Field Cost** | | | | | | | | | | | $234,903 |
| Contingency on Total Field Cost @ 25% | | | | | | | | | | | $58,726 |
| Engineering on Total Field Cost @ 15% | | | | | | | | | | | $35,235 |
| **TOTAL COST** | | | | | | | | | | | **$328,864** |

**ZONE 1, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE GW-1.4: EXTRACTION, DISCHARGE AND DISPOSAL TO OFF-SITE POTW, LUCs, AND MONITORING**
**Operation and Maintenance Costs per Year**

| | Item | Qty | Unit | Unit Cost | Subtotal Cost | Notes |
|---|---|---|---|---|---|---|
| | *Copper/TPH Plume* | | | | | |
| 1 | Energy - Electric | 6,600 | kWh | $0.18 | $1,188 | |
| 2 | Equipment Repair/Replacement | 1 | ls | $558.00 | $558 | 5% of Installation Cost |
| 3 | Operating Labor | 520 | hr | $50.00 | $26,000 | 10 hr per week |
| 4 | POTW Charge | 365 | day | $168.42 | $61,474 | $7.31 per 1,000 gallons (23,040 gpd) |
| 5 | System Report | 4 | ea | $5,000.00 | $20,000 | |
| | Subtotal Cost for One Year Operation | | | | $109,220 | |
| | *Arsenic/Copper Plume* | | | | | |
| 1 | Energy - Electric | 13,200 | kWh | $0.18 | $2,376 | |
| 2 | Equipment Repair/Replacement | 1 | ls | $1,264.50 | $1,265 | 5% of Installation Cost |
| 3 | Operating Labor | 520 | hr | $50.00 | $26,000 | 10 hr per week |
| 4 | POTW Charge | 365 | day | $421.06 | $153,685 | $7.31 per 1,000 gallons (57,600 gpd) |
| 5 | System Report | 4 | ea | $5,000.00 | $20,000 | |
| | Subtotal Cost for One Year Operation | | | | $203,326 | |

**ZONE 1, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE GW-1.4: EXTRACTION, DISCHARGE AND DISPOSAL TO OFF-SITE POTW, LUCs, AND MONITORING**
**ANNUAL COST**

| Item | Item Cost Years 1 and 2 | Item Cost Years 3 and 4 | Item Cost Years 5 and 30 | Item Cost Every 5 Years | Notes |
|---|---|---|---|---|---|
| Groundwater Sampling | $33,408 | $16,704 | $8,352 | | 6 Wells (2 Performance Wells, 4 Migration Wells). Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Labor and supplies for sampling |
| Groundwater Analysis (Performance) | $1,456 | $728 | $364 | | 2 wells, Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Analysis for arsenic, copper, TPH. |
| Groundwater Analysis (Migration) | $2,912 | $1,456 | $728 | | 4 wells, Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Analysis for arsenic, copper, TPH. |
| Annual Report | $5,000 | $5,000 | $5,000 | | |
| Inspection | $1,000 | $1,000 | $1,000 | | Annual LUC inspection (assume 8 hours at $50/hr plus expenses) |
| Site Review | | | | $23,000 | 5-year review |
| Subtotal | $43,776 | $24,888 | $15,444 | $23,000 | |
| Contingency at 10% | $4,378 | $2,489 | $1,544 | $2,300 | |
| **TOTAL** | $48,154 | $27,377 | $16,988 | $25,300 | |

**ZONE 1, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE GW-1.4: EXTRACTION, DISCHARGE AND DISPOSAL TO OFF-SITE POTW, LUCs, AND MONITORING**
**Present Worth Analysis**

| Year | Capital Cost | Operation and Maintenance Cost | Annual Cost | Total Year Cost | Annual Discount Rate at 7% | Present Worth |
|---|---|---|---|---|---|---|
| 0 | $328,864 | | | $328,864 | 1.000 | $328,864 |
| 1 | | $312,546 | $48,154 | $360,700 | 0.935 | $337,254 |
| 2 | | $312,546 | $48,154 | $360,700 | 0.873 | $314,891 |
| 3 | | $312,546 | $27,377 | $339,923 | 0.816 | $277,377 |
| 4 | | $312,546 | $27,377 | $339,923 | 0.763 | $259,361 |
| 5 | | $312,546 | $42,288 | $354,835 | 0.713 | $252,997 |
| 6 | | $312,546 | $16,988 | $329,535 | 0.666 | $219,470 |
| 7 | | $312,546 | $16,988 | $329,535 | 0.623 | $205,300 |
| 8 | | $312,546 | $16,988 | $329,535 | 0.582 | $191,789 |
| 9 | | $312,546 | $16,988 | $329,535 | 0.544 | $179,267 |
| 10 | | $312,546 | $42,288 | $354,835 | 0.508 | $180,256 |
| 11 | | $312,546 | $16,988 | $329,535 | 0.475 | $156,529 |
| 12 | | $203,326 | $16,988 | $220,314 | 0.444 | $97,820 |
| 13 | | $203,326 | $16,988 | $220,314 | 0.415 | $91,430 |
| 14 | | $203,326 | $16,988 | $220,314 | 0.388 | $85,482 |
| 15 | | $203,326 | $42,288 | $245,614 | 0.362 | $88,912 |
| 16 | | $203,326 | $16,988 | $220,314 | 0.339 | $74,687 |
| 17 | | $203,326 | $16,988 | $220,314 | 0.317 | $69,840 |
| 18 | | $203,326 | $16,988 | $220,314 | 0.296 | $65,213 |
| 19 | | $203,326 | $16,988 | $220,314 | 0.277 | $61,027 |
| 20 | | $203,326 | $42,288 | $245,614 | 0.258 | $63,368 |
| 21 | | $203,326 | $16,988 | $220,314 | 0.242 | $53,316 |
| 22 | | $203,326 | $16,988 | $220,314 | 0.226 | $49,791 |
| 23 | | $203,326 | $16,988 | $220,314 | 0.211 | $46,486 |
| 24 | | $203,326 | $16,988 | $220,314 | 0.197 | $43,402 |
| 25 | | $203,326 | $42,288 | $245,614 | 0.184 | $45,193 |
| 26 | | $203,326 | $16,988 | $220,314 | 0.172 | $37,894 |
| 27 | | | $16,988 | $16,988 | 0.161 | $2,735 |
| 28 | | | $16,988 | $16,988 | 0.150 | $2,548 |
| 29 | | | $16,988 | $16,988 | 0.141 | $2,395 |
| 30 | | | $42,288 | $42,288 | 0.131 | $5,540 |
| | | | | | **TOTAL PRESENT WORTH** | **$3,890,435** |

**ZONE 1, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE GW-1.5: EXTRACTION, ON-SITE TREATMENT (FILTRATION, OXIDATIVE FILTRATION, AND LIQUID-PHASE GAC ADSORPTION), DIRECT DISCHARGE TO THAMES RIVER, LUCs, AND MONITORING**
**CAPITAL COST**

| | | | Unit Cost | | | | Extended Cost | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Item | Quantity | Unit | Subcontract | Material | Labor | Equipment | Subcontract | Material | Labor | Equipment | Subtotal |
| **1 PROJECT PLANNING AND DOCUMENTS** | | | | | | | | | | | |
| 1.1 Prepare LUC RD Documents | 60 | hr | | | $37.00 | | $0 | $0 | $2,220 | $0 | $2,220 |
| 1.2 Prepare Documents & Plans including Permits | 300 | hr | | | $37.00 | | $0 | $0 | $11,100 | $0 | $11,100 |
| 1.3 Prepare Groundwater Monitoring Plan | 100 | hr | | | $37.00 | | $0 | $0 | $3,700 | $0 | $3,700 |
| 1.4 Completion Report | 150 | hr | | | $37.00 | | $0 | $0 | $5,550 | $0 | $5,550 |
| 1.5 Treatability Studies | 2 | ea | $5,000.00 | | | | $10,000 | $0 | $0 | $0 | $10,000 |
| 1.6 Pre-Design Investigation | 1 | ls | $6,305.00 | $1,067.00 | $7,770.00 | $773.00 | $6,305 | $1,067 | $7,770 | $773 | $15,915 |
| **2 MOBILIZATION/DEMOBILIZATION & SITE SUPPORT** | | | | | | | | | | | |
| 2.1 Office Trailer | 3 | mo | | | | $375.00 | $0 | $0 | $0 | $1,125 | $1,125 |
| 2.2 Field Office Equipment, Utilities, & Support | 3 | mo | | $470.00 | | | $0 | $1,410 | $0 | $0 | $1,410 |
| 2.3 Storage Trailer | 3 | mo | | | | $99.00 | $0 | $0 | $0 | $297 | $297 |
| 2.4 Trailer Utility Connections (phone/electric) | 1 | ls | $1,250.00 | | | | $1,250 | $0 | $0 | $0 | $1,250 |
| 2.5 Utility Connection (electric) | 1 | ls | $10,000.00 | | | | $10,000 | $0 | $0 | $0 | $10,000 |
| 2.6 Underground Utility Clearances | 1 | ls | $7,600.00 | | | | $7,600 | $0 | $0 | $0 | $7,600 |
| 2.7 Construction Survey | 6 | day | $2,125.00 | | | | $12,750 | $0 | $0 | $0 | $12,750 |
| 2.8 Drill Rig Mobilization/Demobilization | 2 | ea | $2,000.00 | | | | $4,000 | $0 | $0 | $0 | $4,000 |
| 2.9 Field Construction Mgt. (2 persons) | 120 | day | | $240.00 | $300.00 | | $0 | $28,800 | $36,000 | $0 | $64,800 |
| **3 GROUNDWATER EXTRACTION, COPPER/TPH PLUME** | | | | | | | | | | | |
| 3.1 Extraction Well, 6" dia, 30' deep, 1 well | 30 | lf | $85.00 | | | | $2,550 | $0 | $0 | $0 | $2,550 |
| 3.2 Well Development | 4 | hr | $200.00 | | | | $800 | $0 | $0 | $0 | $800 |
| 3.3 Well Bollard or Vault | 1 | ea | $500.00 | | | | $500 | $0 | $0 | $0 | $500 |
| 3.4 Collect/Containerize/Transport/Dispose IDW Off-Site | 2 | drum | $225.00 | | | | $450 | $0 | $0 | $0 | $450 |
| 3.5 Extraction Pump, 20 gpm, 1 hp | 1 | ea | | $965.00 | $305.00 | | $0 | $965 | $305 | $0 | $1,270 |
| 3.6 PVC pipe, 1.5" dia. w/trench | 500 | lf | | $0.70 | $4.76 | $8.22 | $0 | $350 | $2,380 | $4,110 | $6,840 |
| 3.7 Tie-in to Existing Manhole | 1 | ea | | $500.00 | $1,000.00 | $1,250.00 | $0 | $500 | $1,000 | $1,250 | $2,750 |
| **4 GROUNDWATER EXTRACTION, ARSENIC/COPPER PLUME** | | | | | | | | | | | |
| 4.1 Extraction Well, 6" dia, 30' deep, 2 wells | 60 | lf | $85.00 | | | | $5,100 | $0 | $0 | $0 | $5,100 |
| 4.2 Well Development | 8 | hr | $200.00 | | | | $1,600 | $0 | $0 | $0 | $1,600 |
| 4.3 Well Bollard or Vault | 2 | ea | $500.00 | | | | $1,000 | $0 | $0 | $0 | $1,000 |
| 4.4 Collect/Containerize/Transport/Dispose IDW Off-Site | 4 | drum | $225.00 | | | | $900 | $0 | $0 | $0 | $900 |
| 4.5 Extraction Pump, 20 gpm, 1 hp | 2 | ea | | $965.00 | $305.00 | | $0 | $1,930 | $610 | $0 | $2,540 |
| 4.6 PVC pipe, 2" dia. w/trench | 1,000 | lf | | $1.30 | $5.63 | $9.72 | $0 | $1,300 | $5,630 | $9,720 | $16,650 |
| 4.7 Tie-in to Existing Manhole | 1 | ea | | $500.00 | $1,000.00 | $1,250.00 | $0 | $500 | $1,000 | $1,250 | $2,750 |
| **5 ON-SITE TREATMENT SYSTEM INSTALLATION (Copper/TPH)** | | | | | | | | | | | |
| 5.1 Building Foundation/Equipment Pads | 28 | cy | $460.00 | | | | $12,880 | $0 | $0 | $0 | $12,880 |
| 5.2 Treatment Building | 1,000 | sf | $30.00 | | | | $30,000 | $0 | $0 | $0 | $30,000 |
| 5.3 Equipment Door | 1 | ea | $3,000.00 | | | | $3,000 | $0 | $0 | $0 | $3,000 |
| 5.4 Bag Filter, 53 sf, 12 bag | 1 | ea | | $14,793.00 | $225.00 | | $0 | $14,793 | $225 | $0 | $15,018 |
| 5.5 Liquid-Phase GAC Adsorption System, 1,500 lb | 1 | ea | | $540.00 | $410.00 | $134.00 | $0 | $540 | $410 | $0 | $950 |
| 5.6 Oxidative Filter System, twin 20-inch units | 1 | ea | | $18,000.00 | $360.00 | | $0 | $18,000 | $360 | $0 | $18,360 |
| 5.7 Discharge PVC pipe, 1.5" dia. w/trench | 200 | lf | | $0.70 | $4.76 | $8.22 | $0 | $140 | $952 | $1,644 | $2,736 |
| 5.8 Associated Instruments and Controls | 1 | ls | | $3,000.00 | $4,000.00 | | $0 | $3,000 | $4,000 | $0 | $7,000 |
| **6 ON-SITE TREATMENT SYSTEM INSTALLATION (Arsenic/Copper)** | | | | | | | | | | | |
| 6.1 Building Foundation/Equipment Pads | 28 | cy | $460.00 | | | | $12,880 | $0 | $0 | $0 | $12,880 |
| 6.2 Treatment Building | 1,000 | sf | $30.00 | | | | $30,000 | $0 | $0 | $0 | $30,000 |
| 6.3 Equipment Door | 1 | ea | $3,000.00 | | | | $3,000 | $0 | $0 | $0 | $3,000 |
| 6.4 Bag Filter, 75 sf, 17 bag | 1 | ea | | $21,239.00 | $250.00 | | $0 | $21,239 | $250 | $0 | $21,489 |
| 6.5 Oxidative Filter System, twin 30-inch units | 1 | ea | | $27,500.00 | $420.00 | | $0 | $27,500 | $420 | $0 | $27,920 |
| 6.6 Discharge PVC pipe, 2" dia. w/trench | 200 | lf | | $1.30 | $5.63 | $9.72 | $0 | $260 | $1,126 | $1,944 | $3,330 |
| 6.7 Associated Instruments and Controls | 1 | ls | | $2,500.00 | $3,500.00 | | $0 | $2,500 | $3,500 | $0 | $6,000 |
| **7 SITE RESTORATION** | | | | | | | | | | | |
| 7.1 Top Dress Soil | 80 | cy | $31.50 | | | | $2,520 | $0 | $0 | $0 | $2,520 |
| 7.2 Pavement Repair | 1 | ls | $2,000.00 | | | | $2,000 | $0 | $0 | $0 | $2,000 |
| 7.3 Site Restoration, seed, fertilization, mulch | 2.0 | msf | $76.50 | | | | $153 | $0 | $0 | $0 | $153 |

**ZONE 1, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE GW-1.5: EXTRACTION, ON-SITE TREATMENT (FILTRATION, OXIDATIVE FILTRATION, AND LIQUID-PHASE GAC ADSORPTION), DIRECT DISCHARGE TO THAMES RIVER, LUCs, AND MONITORING**
**CAPITAL COST**

| Item | Quantity | Unit | Unit Cost Subcontract | Unit Cost Material | Unit Cost Labor | Unit Cost Equipment | Extended Cost Subcontract | Extended Cost Material | Extended Cost Labor | Extended Cost Equipment | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Subtotal** | | | | | | | $161,238 | $124,794 | $88,508 | $22,113 | $396,653 |
| **Local Area Adjustments** | | | | | | | 100.0% | 98.6% | 104.2% | 104.2% | |
| **Subtotal** | | | | | | | $161,238 | $123,047 | $92,225 | $23,042 | $399,552 |
| Overhead on Labor Cost @ 30% | | | | | | | | | $27,668 | | $27,668 |
| G & A on Labor Cost @ 10% | | | | | | | | | $9,223 | | $9,223 |
| G & A on Material Cost @ 10% | | | | | | | | $12,305 | | | $12,305 |
| G & A on Equipment Cost @ 10% | | | | | | | | | | $2,304 | $2,304 |
| G & A on Subcontract Cost @ 10% | | | | | | | $16,124 | | | | $16,124 |
| Tax on Materials and Equipment Cost @ 6% | | | | | | | | $7,383 | | $1,383 | $8,765 |
| **Total Direct Cost** | | | | | | | $177,362 | $142,734 | $129,115 | $26,728 | $475,940 |
| Indirects on Total Direct Cost @ 30% | | | | | | | | | | | $142,782 |
| Profit on Total Direct Cost @ 10% | | | | | | | | | | | $47,594 |
| **Subtotal** | | | | | | | | | | | $666,316 |
| Health & Safety Monitoring @ 1% | | | | | | | | | | | $6,663 |
| **Total Field Cost** | | | | | | | | | | | $672,979 |
| Contingency on Total Field Cost @ 25% | | | | | | | | | | | $168,245 |
| Engineering on Total Field Cost @ 15% | | | | | | | | | | | $100,947 |
| **TOTAL COST** | | | | | | | | | | | **$942,171** |

**ZONE 1, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE GW-1.5: EXTRACTION, ON-SITE TREATMENT (FILTRATION, OXIDATIVE FILTRATION, AND LIQUID-PHASE GAC ADSORPTION), DIRECT DISCHARGE TO THAMES RIVER, LUCs, AND MONITORING**
**Operation and Maintenance Costs per Year**

| | Item | Qty | Unit | Unit Cost | Subtotal Cost | Notes |
|---|---|---|---|---|---|---|
| | *Copper/TPH Plume (Operate for 11 years)* | | | | | |
| 1 | Energy - Electric | 6,600 | kWh | $0.18 | $1,188 | |
| 2 | Equipment Repair/Replacement | 1 | ls | $2,411.20 | $2,411 | 5% of Installation Cost |
| 3 | Influent & Effluent Sampling | 52 | ea | $392.00 | $20,384 | copper, TPH, suspended solids, pH. Weekly |
| 4 | Replace Filter Bags | 52 | ea | $60.00 | $3,120 | 12 bags, weekly |
| 5 | Clean Oxidative Filter System, disposal of backwash | 12 | ea | $72.00 | $864 | 480 gal @ $0.15 per gallon |
| 6 | Replace GAC Carbon, 1,500 lbs. | 12 | ea | $3,000.00 | $36,000 | replace once a month |
| 7 | Operating Labor | 520 | hr | $50.00 | $26,000 | 10 hr per week |
| 8 | System Report | 4 | ea | $5,000.00 | $20,000 | |
| | Subtotal Cost for One Year Operation | | | | $109,967 | |
| | Replace Oxidative Filter Medium | | | | $7,500 | Every 5 years |
| | *Arsenic/Copper Plume (Operate for 26 years)* | | | | | |
| 1 | Energy - Electric | 13,200 | kWh | $0.18 | $2,376 | |
| 2 | Equipment Repair/Replacement | 1 | ls | $3,901.45 | $3,901 | 5% of Installation Cost |
| 3 | Influent & Effluent Sampling | 52 | ea | $196.00 | $10,192 | arsenic, copper, suspended solids, pH. Weekly |
| 4 | Replace Filter Bags | 52 | ea | $85.00 | $4,420 | 17 bags, weekly |
| 5 | Clean Oxidative Filter System, disposal of backwash | 12 | ea | $180.00 | $2,160 | 1,200 gal @ $0.15 per gallon |
| 6 | Operating Labor | 520 | hr | $50.00 | $26,000 | 10 hr per week |
| 7 | System Report | 4 | ea | $5,000.00 | $20,000 | |
| | Subtotal Cost for One Year Operation | | | | $69,049 | |
| | Replace Oxidative Filter Medium | | | | $11,000 | Every 5 years |

**ZONE 1, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE GW-1.5: EXTRACTION, ON-SITE TREATMENT (FILTRATION, OXIDATIVE FILTRATION, AND LIQUID-PHASE GAC ADSORPTION), DIRECT DISCHARGE TO THAMES RIVER, LUCs, AND MONITORING**
**ANNUAL COST**

| Item | Item Cost Years 1 and 2 | Item Cost Years 3 and 4 | Item Cost Years 5 and 30 | Item Cost Every 5 Years | Notes |
|---|---|---|---|---|---|
| Groundwater Sampling | $33,408 | $16,704 | $8,352 | | 6 Wells (2 Performance Wells, 4 Migration Wells). Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Labor and supplies for sampling |
| Groundwater Analysis (Performance) | $1,456 | $728 | $364 | | 2 wells, Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Analysis for arsenic, copper, TPH. |
| Groundwater Analysis (Migration) | $2,912 | $1,456 | $728 | | 4 wells, Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Analysis for arsenic, copper, TPH. |
| Annual Report | $5,000 | $5,000 | $5,000 | | |
| Inspection | $1,000 | $1,000 | $1,000 | | Annual LUC inspection (assume 8 hours at $50/hr plus expenses |
| Site Review | | | | $23,000 | 5-year review |
| Subtotal | $43,776 | $24,888 | $15,444 | $23,000 | |
| Contingency at 10% | $4,378 | $2,489 | $1,544 | $2,300 | |
| **TOTAL** | $48,154 | $27,377 | $16,988 | $25,300 | |

**ZONE 1, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE GW-1.5: EXTRACTION, ON-SITE TREATMENT (FILTRATION, OXIDATIVE FILTRATION, AND LIQUID-PHASE GAC ADSORPTION), DIRECT DISCHARGE TO THAMES RIVER, LUCs, AND MONITORING**
**Present Worth Analysis**

| Year | Capital Cost | Operation and Maintenance Cost | Annual Cost | Total Year Cost | Annual Discount Rate at 7% | Present Worth |
|---|---|---|---|---|---|---|
| 0 | $942,171 | | | $942,171 | 1.000 | $942,171 |
| 1 | | $179,017 | $48,154 | $227,170 | 0.935 | $212,404 |
| 2 | | $179,017 | $48,154 | $227,170 | 0.873 | $198,320 |
| 3 | | $179,017 | $27,377 | $206,393 | 0.816 | $168,417 |
| 4 | | $179,017 | $27,377 | $206,393 | 0.763 | $157,478 |
| 5 | | $197,517 | $42,288 | $239,805 | 0.713 | $170,981 |
| 6 | | $179,017 | $16,988 | $196,005 | 0.666 | $130,539 |
| 7 | | $179,017 | $16,988 | $196,005 | 0.623 | $122,111 |
| 8 | | $179,017 | $16,988 | $196,005 | 0.582 | $114,075 |
| 9 | | $179,017 | $16,988 | $196,005 | 0.544 | $106,627 |
| 10 | | $197,517 | $42,288 | $239,805 | 0.508 | $121,821 |
| 11 | | $179,017 | $16,988 | $196,005 | 0.475 | $93,102 |
| 12 | | $69,049 | $16,988 | $86,038 | 0.444 | $38,201 |
| 13 | | $69,049 | $16,988 | $86,038 | 0.415 | $35,706 |
| 14 | | $69,049 | $16,988 | $86,038 | 0.388 | $33,383 |
| 15 | | $80,049 | $42,288 | $122,338 | 0.362 | $44,286 |
| 16 | | $69,049 | $16,988 | $86,038 | 0.339 | $29,167 |
| 17 | | $69,049 | $16,988 | $86,038 | 0.317 | $27,274 |
| 18 | | $69,049 | $16,988 | $86,038 | 0.296 | $25,467 |
| 19 | | $69,049 | $16,988 | $86,038 | 0.277 | $23,832 |
| 20 | | $80,049 | $42,288 | $122,338 | 0.258 | $31,563 |
| 21 | | $69,049 | $16,988 | $86,038 | 0.242 | $20,821 |
| 22 | | $69,049 | $16,988 | $86,038 | 0.226 | $19,445 |
| 23 | | $69,049 | $16,988 | $86,038 | 0.211 | $18,154 |
| 24 | | $69,049 | $16,988 | $86,038 | 0.197 | $16,949 |
| 25 | | $80,049 | $42,288 | $122,338 | 0.184 | $22,510 |
| 26 | | $69,049 | $16,988 | $86,038 | 0.172 | $14,799 |
| 27 | | | $16,988 | $16,988 | 0.161 | $2,735 |
| 28 | | | $16,988 | $16,988 | 0.150 | $2,548 |
| 29 | | | $16,988 | $16,988 | 0.141 | $2,395 |
| 30 | | | $42,288 | $42,288 | 0.131 | $5,540 |
| | | | | | **TOTAL PRESENT WORTH** | **$2,952,822** |

# APPENDIX E.2.2

# ZONE 4

# ALTERNATIVES GW-4.1, GW-4.2, GW-4.3, GW-4.4, and GW-4.5

**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE GW-4.1: NO ACTION**
**Annual Cost**

| Item | Item Cost every 5 years | Notes |
|---|---|---|
| Five-Year Review | $23,000 | |
| Subtotal | $23,000 | |
| Contingency @ 10% | $2,300 | |
| **TOTAL** | **$25,300** | |

**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE GW-4.1: NO ACTION**
**Present Worth Analysis**

| Year | Capital Cost | Annual Cost | Total Year Cost | Annual Discount Rate at 7% | Present Worth |
|---|---|---|---|---|---|
| 0 | $0 | | $0 | 1.000 | $0 |
| 1 | | | $0 | 0.935 | $0 |
| 2 | | | $0 | 0.873 | $0 |
| 3 | | | $0 | 0.816 | $0 |
| 4 | | | $0 | 0.763 | $0 |
| 5 | | $25,300 | $25,300 | 0.713 | $18,039 |
| 6 | | | $0 | 0.666 | $0 |
| 7 | | | $0 | 0.623 | $0 |
| 8 | | | $0 | 0.582 | $0 |
| 9 | | | $0 | 0.544 | $0 |
| 10 | | $25,300 | $25,300 | 0.508 | $12,852 |
| 11 | | | $0 | 0.475 | $0 |
| 12 | | | $0 | 0.444 | $0 |
| 13 | | | $0 | 0.415 | $0 |
| 14 | | | $0 | 0.388 | $0 |
| 15 | | $25,300 | $25,300 | 0.362 | $9,159 |
| 16 | | | $0 | 0.339 | $0 |
| 17 | | | $0 | 0.317 | $0 |
| 18 | | | $0 | 0.296 | $0 |
| 19 | | | $0 | 0.277 | $0 |
| 20 | | $25,300 | $25,300 | 0.258 | $6,527 |
| 21 | | | $0 | 0.242 | $0 |
| 22 | | | $0 | 0.226 | $0 |
| 23 | | | $0 | 0.211 | $0 |
| 24 | | | $0 | 0.197 | $0 |
| 25 | | $25,300 | $25,300 | 0.184 | $4,655 |
| 26 | | | $0 | 0.172 | $0 |
| 27 | | | $0 | 0.161 | $0 |
| 28 | | | $0 | 0.150 | $0 |
| 29 | | | $0 | 0.141 | $0 |
| 30 | | $25,300 | $25,300 | 0.131 | $3,314 |
| | | | | **TOTAL PRESENT WORTH** | **$54,547** |

**ZONE 4, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE GW-4.2: NATURAL ATTENUATION, LUCs, AND MONITORING**
**CAPITAL COST**

| Item | Quantity | Unit | Unit Cost | | | | Extended Cost | | | | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Subcontract | Material | Labor | Equipment | Subcontract | Material | Labor | Equipment | |
| **1 PROJECT PLANNING** | | | | | | | | | | | |
| 1.1 Prepare Documents & Plans including Permits | 100 | hr | | | $37.00 | | $0 | $0 | $3,700 | $0 | $3,700 |
| 1.2 Prepare LUC RD Documents | 60 | hr | | | $37.00 | | $0 | $0 | $2,220 | $0 | $2,220 |
| 1.3 Pre-Design Investigation | 1 | ls | $3,527.00 | $1,067.00 | $7,140.00 | $773.00 | $3,527 | $1,067 | $7,140 | $773 | $12,507 |
| **Subtotal** | | | | | | | $3,527 | $1,067 | $13,060 | $773 | $18,427 |
| **Local Area Adjustments** | | | | | | | 100.0% | 98.6% | 104.2% | 104.2% | |
| | | | | | | | $3,527 | $1,052 | $13,609 | $805 | $18,993 |
| Overhead on Labor Cost @ 30% | | | | | | | | | $4,083 | | $4,083 |
| G & A on Labor Cost @ 10% | | | | | | | | | $1,361 | | $1,361 |
| G & A on Material Cost @ 10% | | | | | | | | $105 | | | $105 |
| G & A on Subcontract Cost @ 10% | | | | | | | $353 | | | | $353 |
| G & A on Equipment Cost @ 10% | | | | | | | | | | $81 | $81 |
| Tax on Materials and Equipment Cost @ 6% | | | | | | | | $63 | | $48 | $111 |
| **Total Direct Cost** | | | | | | | $3,880 | $1,220 | $19,052 | $934 | $25,086 |
| Indirects on Total Direct Cost @ 0% | | | | | | | | | | | $0 |
| Profit on Total Direct Cost @ 10% | | | | | | | | | | | $2,509 |
| **Subtotal** | | | | | | | | | | | $27,595 |
| Health & Safety Monitoring @ 0% | | | | | | | | | | | $0 |
| **Total Field Cost** | | | | | | | | | | | $27,595 |
| Contingency on Total Field Costs @ 20% | | | | | | | | | | | $5,519 |
| Engineering on Total Field Cost @ 0% | | | | | | | | | | | $0 |
| **TOTAL COST** | | | | | | | | | | | **$33,114** |

**ZONE 4, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE GW-4.2: NATURAL ATTENUATION, LUCs, AND MONITORING**
**ANNUAL COST**

| Item | Item Cost Years 1 and 2 | Item Cost Years 3 and 4 | Item Cost Years 5 and 30 | Item Cost Every 5 Years | Notes |
|---|---|---|---|---|---|
| Groundwater Sampling | $33,408 | $16,704 | $8,352 | | 6 Wells (2 Performance Wells, 4 Migration Wells). Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Labor and supplies for sampling |
| Groundwater Analysis (Performance) | $1,456 | $728 | $364 | | 2 wells, Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Analysis for arsenic, lead, TPH. |
| Groundwater Analysis (Migration) | $2,912 | $1,456 | $728 | | 4 wells, Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Analysis for arsenic, lead, TPH. |
| Annual Report | $5,000 | $5,000 | $5,000 | | |
| Inspection | $1,000 | $1,000 | $1,000 | | Annual LUC inspection (assume 8 hours at $50/hr plus expenses) |
| Site Review | | | | $23,000 | 5-year review |
| Subtotal | $43,776 | $24,888 | $15,444 | $23,000 | |
| Contingency at 10% | $4,378 | $2,489 | $1,544 | $2,300 | |
| **TOTAL** | $48,154 | $27,377 | $16,988 | $25,300 | |

**ZONE 4, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE GW-4.2: NATURAL ATTENUATION, LUCs, AND MONITORING**
**PRESENT WORTH ANALYSIS**

| Year | Capital Cost | Annual Cost | Total Year Cost | Annual Discount Rate at 7% | Present Worth |
|---|---|---|---|---|---|
| 0 | $33,114 | | $33,114 | 1.000 | $33,114 |
| 1 | | $48,154 | $48,154 | 0.935 | $45,024 |
| 2 | | $48,154 | $48,154 | 0.873 | $42,038 |
| 3 | | $27,377 | $27,377 | 0.816 | $22,339 |
| 4 | | $27,377 | $27,377 | 0.763 | $20,888 |
| 5 | | $42,288 | $42,288 | 0.713 | $30,152 |
| 6 | | $16,988 | $16,988 | 0.666 | $11,314 |
| 7 | | $16,988 | $16,988 | 0.623 | $10,584 |
| 8 | | $16,988 | $16,988 | 0.582 | $9,887 |
| 9 | | $16,988 | $16,988 | 0.544 | $9,242 |
| 10 | | $42,288 | $42,288 | 0.508 | $21,483 |
| 11 | | $16,988 | $16,988 | 0.475 | $8,069 |
| 12 | | $16,988 | $16,988 | 0.444 | $7,543 |
| 13 | | $16,988 | $16,988 | 0.415 | $7,050 |
| 14 | | $16,988 | $16,988 | 0.388 | $6,591 |
| 15 | | $42,288 | $42,288 | 0.362 | $15,308 |
| 16 | | $16,988 | $16,988 | 0.339 | $5,759 |
| 17 | | $16,988 | $16,988 | 0.317 | $5,385 |
| 18 | | $16,988 | $16,988 | 0.296 | $5,029 |
| 19 | | $16,988 | $16,988 | 0.277 | $4,706 |
| 20 | | $42,288 | $42,288 | 0.258 | $10,910 |
| 21 | | $16,988 | $16,988 | 0.242 | $4,111 |
| 22 | | $16,988 | $16,988 | 0.226 | $3,839 |
| 23 | | $16,988 | $16,988 | 0.211 | $3,585 |
| 24 | | $16,988 | $16,988 | 0.197 | $3,347 |
| 25 | | $42,288 | $42,288 | 0.184 | $7,781 |
| 26 | | $16,988 | $16,988 | 0.172 | $2,922 |
| 27 | | $16,988 | $16,988 | 0.161 | $2,735 |
| 28 | | $16,988 | $16,988 | 0.150 | $2,548 |
| 29 | | $16,988 | $16,988 | 0.141 | $2,395 |
| 30 | | $42,288 | $42,288 | 0.131 | $5,540 |
| | | | | **TOTAL PRESENT WORTH** | **$371,220** |

**ZONE 1, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE GW-4.3: IN-SITU TREATMENT (Enhanced Bioremediation, Chemical Precipitation and Oxidation), LUCs, AND MONITORING**
**CAPITAL COST**

| Item | Quantity | Unit | Unit Cost Subcontract | Unit Cost Material | Unit Cost Labor | Unit Cost Equipment | Extended Cost Subcontract | Extended Cost Material | Extended Cost Labor | Extended Cost Equipment | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1 PROJECT PLANNING AND DOCUMENTS** | | | | | | | | | | | |
| 1.1 Prepare LUC RD Documents | 60 | hr | | | $37.00 | | $0 | $0 | $2,220 | $0 | $2,220 |
| 1.2 Prepare Documents & Plans including Permits | 300 | hr | | | $37.00 | | $0 | $0 | $11,100 | $0 | $11,100 |
| 1.3 Prepare Groundwater Monitoring Plan | 100 | hr | | | $37.00 | | $0 | $0 | $3,700 | $0 | $3,700 |
| 1.4 Completion Report | 150 | hr | | | $37.00 | | $0 | $0 | $5,550 | $0 | $5,550 |
| 1.5 Treatability Study: In-Situ Bioremediation | 1 | ls | $20,000.00 | | | | $20,000 | $0 | $0 | $0 | $20,000 |
| 1.6 Treatability Study: In-Situ Chemical Precipitation & Oxidation | 1 | ls | $5,000.00 | | | | $5,000 | $0 | $0 | $0 | $5,000 |
| 1.7 Pre-Design Investigation | 1 | ls | $3,527.00 | $1,067.00 | $7,140.00 | $773.00 | $3,527 | $1,067 | $7,140 | $773 | $12,507 |
| **2 MOBILIZATION/DEMOBILIZATION & SITE SUPPORT** | | | | | | | | | | | |
| 2.1 Utility Connection (electric) | 1 | ls | $10,000.00 | | | | $10,000 | $0 | $0 | $0 | $10,000 |
| 2.2 Underground Utility Clearances | 1 | ls | $7,600.00 | | | | $7,600 | $0 | $0 | $0 | $7,600 |
| 2.3 Construction Survey | 3 | day | $2,125.00 | | | | $6,375 | $0 | $0 | $0 | $6,375 |
| 2.4 Drill Rig Mobilization/Demobilization | 2 | ea | $2,000.00 | | | | $4,000 | $0 | $0 | $0 | $4,000 |
| 2.5 Field Construction Mgt. (1 person) | 35 | day | | $240.00 | $300.00 | | $0 | $8,400 | $10,500 | $0 | $18,900 |
| **3 IN-SITU BIOREMEDIATION** | | | | | | | | | | | |
| 3.1 Extraction Well, 4" dia, 6' deep, 4 wells | 24 | lf | $70.00 | | | | $1,680 | $0 | $0 | $0 | $1,680 |
| 3.2 Injection Well, 4" dia, 3' deep, 8 wells | 24 | lf | $70.00 | | | | $1,680 | $0 | $0 | $0 | $1,680 |
| 3.3 Well Development | 24 | hr | $200.00 | | | | $4,800 | $0 | $0 | $0 | $4,800 |
| 3.4 Well Bollard or Vault | 12 | ea | $500.00 | | | | $6,000 | $0 | $0 | $0 | $6,000 |
| 3.5 Collect/Containerize/Transport/Dispose IDW Off-Site | 2 | drum | $225.00 | | | | $450 | $0 | $0 | $0 | $450 |
| 3.6 Extraction Pump, 5 gpm | 4 | ea | | $760.00 | $218.00 | | $0 | $3,040 | $872 | $0 | $3,912 |
| 3.7 PVC pipe, 1" dia. w/trench | 400 | lf | | $0.41 | $4.43 | $7.62 | $0 | $164 | $1,772 | $3,048 | $4,984 |
| 3.8 Dissolved Oxygen In-Situ System | 1 | ls | | $30,000.00 | | | $0 | $30,000 | $0 | $0 | $30,000 |
| **4 IN-SITU CHEMICAL PRECIPITATION & OXIDATION (Arsenic/TPH)** | | | | | | | | | | | |
| 4.1 DPT Rig (119 injection points @ 15' bgs) | 12 | day | $3,000.00 | | | | $36,000 | $0 | $0 | $0 | $36,000 |
| 4.2 Pump & Hose | 12 | day | | | | $166.40 | $0 | $0 | $0 | $1,997 | $1,997 |
| 4.3 Mix Tank & Equipment | 12 | day | | | | $200.00 | $0 | $0 | $0 | $2,400 | $2,400 |
| 4.4 Injection Point Supplies | 1,785 | lf | $4.00 | | | | $7,140 | $0 | $0 | $0 | $7,140 |
| 4.5 Site Labor, (2 laborers) | 24 | day | | | $309.60 | | $0 | $0 | $7,430 | $0 | $7,430 |
| 4.6 Ferric Chloride | 55 | gal | | $8.00 | | | $0 | $440 | $0 | $0 | $440 |
| 4.7 Treatment Water | 1 | ls | | $250.00 | | | $0 | $250 | $0 | $0 | $250 |
| 4.8 ORC | 4,760 | lb | | $9.00 | | | $0 | $42,840 | $0 | $0 | $42,840 |
| **5 IN-SITU CHEMICAL PRECIPITATION & OXIDATION (Lead)** | | | | | | | | | | | |
| 5.1 DPT Rig (43 injection points @ 15' bgs) | 3 | day | $3,000.00 | | | | $9,000 | $0 | $0 | $0 | $9,000 |
| 5.2 Pump & Hose | 3 | day | | | | $166.40 | $0 | $0 | $0 | $499 | $499 |
| 5.3 Mix Tank & Equipment | 3 | day | | | | $200.00 | $0 | $0 | $0 | $600 | $600 |
| 5.4 Injection Point Supplies | 645 | lf | $4.00 | | | | $2,580 | $0 | $0 | $0 | $2,580 |
| 5.5 Site Labor, (2 laborers) | 6 | day | | | $309.60 | | $0 | $0 | $1,858 | $0 | $1,858 |
| 5.6 Ammonium Phosphate | 20 | lb | | $8.00 | | | $0 | $160 | $0 | $0 | $160 |
| 5.7 Treatment Water | 1 | ls | | $250.00 | | | $0 | $250 | $0 | $0 | $250 |
| **6 SITE RESTORATION** | | | | | | | | | | | |
| 6.1 Top Dress Soil | 40 | cy | $31.50 | | | | $1,260 | $0 | $0 | $0 | $1,260 |
| 6.2 Pavement Repair | 1 | ls | $2,125.00 | | | | $2,125 | $0 | $0 | $0 | $2,125 |
| 6.3 Site Restoration, seed, fertilization, mulch | 1.0 | msf | $76.50 | | | | $77 | $0 | $0 | $0 | $77 |
| **Subtotal** | | | | | | | $129,294 | $86,611 | $52,142 | $9,317 | $277,364 |

**ZONE 1, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE GW-4.3: IN-SITU TREATMENT (Enhanced Bioremediation, Chemical Precipitation and Oxidation), LUCs, AND MONITORING**
**CAPITAL COST**

| Item | Quantity | Unit | Unit Cost Subcontract | Unit Cost Material | Unit Cost Labor | Unit Cost Equipment | Extended Cost Subcontract | Extended Cost Material | Extended Cost Labor | Extended Cost Equipment | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Local Area Adjustments** | | | | | | | 100.0% | 98.6% | 104.2% | 104.2% | |
| **Subtotal** | | | | | | | $129,294 | $85,398 | $54,332 | $9,708 | $278,732 |
| Overhead on Labor Cost @ 30% | | | | | | | | | $16,300 | | $16,300 |
| G & A on Labor Cost @ 10% | | | | | | | | | $5,433 | | $5,433 |
| G & A on Material Cost @ 10% | | | | | | | | $8,540 | | | $8,540 |
| G & A on Equipment Cost @ 10% | | | | | | | | | | $971 | $971 |
| G & A on Subcontract Cost @ 10% | | | | | | | $12,929 | | | | $12,929 |
| Tax on Materials and Equipment Cost @ 6% | | | | | | | | $5,124 | | $582 | $5,706 |
| **Total Direct Cost** | | | | | | | $142,223 | $99,062 | $76,065 | $11,262 | $328,611 |
| Indirects on Total Direct Cost @ 15% | | | | | | | | | | | $49,292 |
| Profit on Total Direct Cost @ 6% | | | | | | | | | | | $19,717 |
| **Subtotal** | | | | | | | | | | | $397,620 |
| Health & Safety Monitoring @ 2% | | | | | | | | | | | $7,952 |
| **Total Field Cost** | | | | | | | | | | | $405,572 |
| Contingency on Total Field Cost @ 25% | | | | | | | | | | | $101,393 |
| Engineering on Total Field Cost @ 10% | | | | | | | | | | | $40,557 |
| **TOTAL COST** | | | | | | | | | | | **$547,523** |

**ZONE 1, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE GW-4.3: IN-SITU TREATMENT (Enhanced Bioremediation, Chemical Precipitation and Oxidation), LUCs, AND MONITORING**
**Operation and Maintenance Costs per Year**

| | Item | Qty | Unit | Unit Cost | Subtotal Cost |
|---|---|---|---|---|---|
| 1 | Energy - Electric | 13,100 | kWh | $0.18 | $2,358 |
| 2 | DO-IT Rental & Chemicals | 12 | mo | $15,000.00 | $180,000 |
| 3 | Operating Labor (5 hours a week) | 260 | hr | $50.00 | $13,000 |
| 4 | Reports | 4 | ea | $2,500.00 | $10,000 |
| | Cost for one year operation (year 1) | | | | $205,358 |
| | Cost for six month operation (year 2) | | | | $102,679 |
| | Return DO-IT System (year 2) | | | | $3,500 |

**ZONE 1, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE GW-4.3: IN-SITU TREATMENT (Enhanced Bioremediation, Chemical Precipitation and Oxidation), LUCs, AND MONITORING**
**ANNUAL COST**

| Item | Item Cost Years 1 and 2 | Item Cost Years 3 and 4 | Item Cost Year 5 | Item Cost Every 5 Years | Notes |
|---|---|---|---|---|---|
| Groundwater Sampling | $33,408 | $16,704 | $8,352 | | 6 Wells (2 Performance Wells, 4 Migration Wells). Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Year 5. Labor and supplies for sampling |
| Groundwater Analysis (Performance) | $1,456 | $728 | $364 | | 2 wells, Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Year 5. Analysis for arsenic, lead, TPH. |
| Groundwater Analysis (Migration) | $2,912 | $1,456 | $728 | | 4 wells, Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Year 5. Analysis for arsenic, lead, TPH. |
| Annual Report | $5,000 | $5,000 | $5,000 | | |
| Inspection | $1,000 | $1,000 | $1,000 | | Annual LUC inspection (assume 8 hours at $50/hr plus expenses) |
| Site Review | | | | $23,000 | 5-year review |
| Subtotal | $43,776 | $24,888 | $15,444 | $23,000 | |
| Contingency at 10% | $4,378 | $2,489 | $1,544 | $2,300 | |
| **TOTAL** | $48,154 | $27,377 | $16,988 | $25,300 | |

**ZONE 1, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE GW-4.3: IN-SITU TREATMENT (Enhanced Bioremediation, Chemical Precipitation and Oxidation), LUCs, AND MONITORING**
**Present Worth Analysis**

| Year | Capital Cost | Operation and Maintenance Cost | Annual Cost | Total Year Cost | Annual Discount Rate at 7% | Present Worth |
|---|---|---|---|---|---|---|
| 0 | $547,523 | | | $547,523 | 1.000 | $547,523 |
| 1 | | $205,358 | $48,154 | $253,512 | 0.935 | $237,033 |
| 2 | | $106,179 | $48,154 | $154,333 | 0.873 | $134,732 |
| 3 | | | $27,377 | $27,377 | 0.816 | $22,339 |
| 4 | | | $27,377 | $27,377 | 0.763 | $20,888 |
| 5 | | | $42,288 | $42,288 | 0.713 | $30,152 |
| | | | | | **TOTAL PRESENT WORTH** | **$992,668** |

**ZONE 4, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE GW-4.4: EXTRACTION, DISCHARGE AND DISPOSAL TO OFF-SITE POTW, LUCs, AND MONITORING**
**CAPITAL COST**

| Item | Quantity | Unit | Unit Cost Subcontract | Unit Cost Material | Unit Cost Labor | Unit Cost Equipment | Extended Cost Subcontract | Extended Cost Material | Extended Cost Labor | Extended Cost Equipment | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1 PROJECT PLANNING AND DOCUMENTS** | | | | | | | | | | | |
| 1.1 Prepare LUC RD Documents | 60 | hr | | | $37.00 | | $0 | $0 | $2,220 | $0 | $2,220 |
| 1.2 Prepare Documents & Plans including Permits | 300 | hr | | | $37.00 | | $0 | $0 | $11,100 | $0 | $11,100 |
| 1.3 Prepare Groundwater Monitoring Plan | 100 | hr | | | $37.00 | | $0 | $0 | $3,700 | $0 | $3,700 |
| 1.4 Completion Report | 150 | hr | | | $37.00 | | $0 | $0 | $5,550 | $0 | $5,550 |
| 1.7 Pre-Design Investigation | 1 | ls | $3,527.00 | $1,067.00 | $7,140.00 | $773.00 | $3,527 | $1,067 | $7,140 | $773 | $12,507 |
| **2 MOBILIZATION/DEMOBILIZATION & SITE SUPPORT** | | | | | | | | | | | |
| 2.1 Utility Connection (electric) | 1 | ls | $10,000.00 | | | | $10,000 | $0 | $0 | $0 | $10,000 |
| 2.2 Underground Utility Clearances | 1 | ls | $7,600.00 | | | | $7,600 | $0 | $0 | $0 | $7,600 |
| 2.3 Construction Survey | 4 | day | $2,125.00 | | | | $8,500 | $0 | $0 | $0 | $8,500 |
| 2.4 Drill Rig Mobilization/Demobilization | 2 | ea | $2,000.00 | | | | $4,000 | $0 | $0 | $0 | $4,000 |
| 2.5 Field Construction Mgt. (1 person) | 40 | day | | $240.00 | $300.00 | | $0 | $9,600 | $12,000 | $0 | $21,600 |
| **3 GROUNDWATER EXTRACTION, ARSENIC/TPH PLUME** | | | | | | | | | | | |
| 3.1 Extraction Well, 6" dia, 30' deep, 3 wells | 90 | lf | $85.00 | | | | $7,650 | $0 | $0 | $0 | $7,650 |
| 3.2 Well Development | 12 | hr | $200.00 | | | | $2,400 | $0 | $0 | $0 | $2,400 |
| 3.3 Well Bollard or Vault | 3 | ea | $500.00 | | | | $1,500 | $0 | $0 | $0 | $1,500 |
| 3.4 Collect/Containerize/Transport/Dispose IDW Off-Site | 6 | drum | $225.00 | | | | $1,350 | $0 | $0 | $0 | $1,350 |
| 3.5 Extraction Pump, 10 gpm, 0.5 hp | 3 | ea | | $810.00 | $290.00 | | $0 | $2,430 | $870 | $0 | $3,300 |
| 3.6 PVC pipe, 2" dia. w/trench | 1,500 | lf | | $1.30 | $5.63 | $9.72 | $0 | $1,950 | $8,445 | $14,580 | $24,975 |
| 3.7 Tie-in to Existing Manhole | 1 | ea | | $500.00 | $1,000.00 | $1,250.00 | $0 | $500 | $1,000 | $1,250 | $2,750 |
| **4 GROUNDWATER EXTRACTION, LEAD PLUME** | | | | | | | | | | | |
| 4.1 Extraction Well, 6" dia, 30' deep, 3 wells | 90 | lf | $85.00 | | | | $7,650 | $0 | $0 | $0 | $7,650 |
| 4.2 Well Development | 12 | hr | $200.00 | | | | $2,400 | $0 | $0 | $0 | $2,400 |
| 4.3 Well Bollard or Vault | 3 | ea | $500.00 | | | | $1,500 | $0 | $0 | $0 | $1,500 |
| 4.4 Collect/Containerize/Transport/Dispose IDW Off-Site | 6 | drum | $225.00 | | | | $1,350 | $0 | $0 | $0 | $1,350 |
| 4.5 Extraction Pump, 40 gpm, 2 hp | 3 | ea | | $1,500.00 | $290.00 | | $0 | $4,500 | $870 | $0 | $5,370 |
| 4.6 PVC pipe, 4" dia. w/trench | 1,500 | lf | | $4.00 | $10.00 | $20.00 | $0 | $6,000 | $15,000 | $30,000 | $51,000 |
| 4.7 Tie-in to Existing Manhole | 1 | ea | | $500.00 | $1,000.00 | $1,250.00 | $0 | $500 | $1,000 | $1,250 | $2,750 |
| **5 SITE RESTORATION** | | | | | | | | | | | |
| 5.1 Top Dress Soil | 80 | cy | $31.50 | | | | $2,520 | $0 | $0 | $0 | $2,520 |
| 5.2 Pavement Repair | 1 | ls | $2,000.00 | | | | $2,000 | $0 | $0 | $0 | $2,000 |
| 5.3 Site Restoration, seed, fertilization, mulch | 2.0 | msf | $76.50 | | | | $153 | $0 | $0 | $0 | $153 |
| **Subtotal** | | | | | | | $64,100 | $26,547 | $68,895 | $47,853 | $207,395 |
| **Local Area Adjustments** | | | | | | | 100.0% | 98.6% | 104.2% | 104.2% | |
| **Subtotal** | | | | | | | $64,100 | $26,175 | $71,789 | $49,863 | $211,927 |
| Overhead on Labor Cost @ 30% | | | | | | | | | $21,537 | | $21,537 |
| G & A on Labor Cost @ 10% | | | | | | | | | $7,179 | | $7,179 |
| G & A on Material Cost @ 10% | | | | | | | | $2,618 | | | $2,618 |
| G & A on Equipment Cost @ 10% | | | | | | | | | | $4,986 | $4,986 |
| G & A on Subcontract Cost @ 10% | | | | | | | $6,410 | | | | $6,410 |
| Tax on Materials and Equipment Cost @ 6% | | | | | | | | $1,571 | | $2,992 | $4,562 |
| **Total Direct Cost** | | | | | | | $70,510 | $30,363 | $100,504 | $57,841 | $259,218 |
| Indirects on Total Direct Cost @ 30% | | | | | | | | | | | $77,765 |
| Profit on Total Direct Cost @ 10% | | | | | | | | | | | $25,922 |
| **Subtotal** | | | | | | | | | | | $362,906 |
| Health & Safety Monitoring @ 2% | | | | | | | | | | | $7,258 |

**ZONE 4, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE GW-4.4: EXTRACTION, DISCHARGE AND DISPOSAL TO OFF-SITE POTW, LUCs, AND MONITORING**
**CAPITAL COST**

| Item | Quantity | Unit | Unit Cost Subcontract | Unit Cost Material | Unit Cost Labor | Unit Cost Equipment | Extended Cost Subcontract | Extended Cost Material | Extended Cost Labor | Extended Cost Equipment | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total Field Cost** | | | | | | | | | | | $370,164 |
| Contingency on Total Field Cost @ 25% | | | | | | | | | | | $92,541 |
| Engineering on Total Field Cost @ 15% | | | | | | | | | | | $55,525 |
| ***TOTAL COST*** | | | | | | | | | | | **$518,229** |

**ZONE 4, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE GW-4.4: EXTRACTION, DISCHARGE AND DISPOSAL TO OFF-SITE POTW, LUCs, AND MONITORING**
**Operation and Maintenance Costs per Year**

| | Item | Qty | Unit | Unit Cost | Subtotal Cost | Notes |
|---|---|---|---|---|---|---|
| | *Arsenic/TPH Plume (Operate for 11 years)* | | | | | |
| 1 | Energy - Electric | 9,800 | kWh | $0.18 | $1,764 | |
| 2 | Equipment Repair/Replacement | 1 | ls | $1,871.25 | $1,871 | 5% of Installation Cost |
| 3 | Operating Labor | 520 | hr | $50.00 | $26,000 | 10 hr per week |
| 4 | POTW Charge | 365 | day | $315.79 | $115,264 | $7.31 per 1,000 gallons (43,200 gpd) |
| 5 | System Report | 4 | ea | $5,000.00 | $20,000 | |
| | Subtotal Cost for One Year Operation | | | | $164,899 | |
| | *Lead Plume (Operate for 27 years)* | | | | | |
| 1 | Energy - Electric | 39,500 | kWh | $0.18 | $7,110 | |
| 2 | Equipment Repair/Replacement | 1 | ls | $3,276.00 | $3,276 | 5% of Installation Cost |
| 3 | Operating Labor | 520 | hr | $50.00 | $26,000 | 10 hr per week |
| 4 | POTW Charge | 365 | day | $1,263.17 | $461,056 | $7.31 per 1,000 gallons (172,800 gpd) |
| 5 | System Report | 4 | ea | $5,000.00 | $20,000 | |
| | Subtotal Cost for One Year Operation | | | | $517,442 | |

**ZONE 4, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE GW-4.4: EXTRACTION, DISCHARGE AND DISPOSAL TO OFF-SITE POTW, LUCs, AND MONITORING**
**ANNUAL COST**

| Item | Item Cost Years 1 and 2 | Item Cost Years 3 and 4 | Item Cost Years 5 and 30 | Item Cost Every 5 Years | Notes |
|---|---|---|---|---|---|
| Groundwater Sampling | $33,408 | $16,704 | $8,352 | | 6 Wells (2 Performance Wells, 4 Migration Wells). Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Labor and supplies for sampling |
| Groundwater Analysis (Performance) | $1,456 | $728 | $364 | | 2 wells, Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Analysis for arsenic, lead, TPH. |
| Groundwater Analysis (Migration) | $2,912 | $1,456 | $728 | | 4 wells, Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Analysis for arsenic, lead, TPH. |
| Annual Report | $5,000 | $5,000 | $5,000 | | |
| Inspection | $1,000 | $1,000 | $1,000 | | Annual LUC inspection (assume 8 hours at $50/hr plus expenses) |
| Site Review | | | | $23,000 | 5-year review |
| Subtotal | $43,776 | $24,888 | $15,444 | $23,000 | |
| Contingency at 10% | $4,378 | $2,489 | $1,544 | $2,300 | |
| **TOTAL** | $48,154 | $27,377 | $16,988 | $25,300 | |

**ZONE 4, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE GW-4.4: EXTRACTION, DISCHARGE AND DISPOSAL TO OFF-SITE POTW, LUCs, AND MONITORING**
**Present Worth Analysis**

| Year | Capital Cost | Operation and Maintenance Cost | Annual Cost | Total Year Cost | Annual Discount Rate at 7% | Present Worth |
|---|---|---|---|---|---|---|
| 0 | $518,229 | | | $518,229 | 1.000 | $518,229 |
| 1 | | $682,342 | $48,154 | $730,495 | 0.935 | $683,013 |
| 2 | | $682,342 | $48,154 | $730,495 | 0.873 | $637,722 |
| 3 | | $682,342 | $27,377 | $709,718 | 0.816 | $579,130 |
| 4 | | $682,342 | $27,377 | $709,718 | 0.763 | $541,515 |
| 5 | | $682,342 | $42,288 | $724,630 | 0.713 | $516,661 |
| 6 | | $682,342 | $16,988 | $699,330 | 0.666 | $465,754 |
| 7 | | $682,342 | $16,988 | $699,330 | 0.623 | $435,683 |
| 8 | | $682,342 | $16,988 | $699,330 | 0.582 | $407,010 |
| 9 | | $682,342 | $16,988 | $699,330 | 0.544 | $380,436 |
| 10 | | $682,342 | $42,288 | $724,630 | 0.508 | $368,112 |
| 11 | | $682,342 | $16,988 | $699,330 | 0.475 | $332,182 |
| 12 | | $517,442 | $16,988 | $534,431 | 0.444 | $237,287 |
| 13 | | $517,442 | $16,988 | $534,431 | 0.415 | $221,789 |
| 14 | | $517,442 | $16,988 | $534,431 | 0.388 | $207,359 |
| 15 | | $517,442 | $42,288 | $559,731 | 0.362 | $202,623 |
| 16 | | $517,442 | $16,988 | $534,431 | 0.339 | $181,172 |
| 17 | | $517,442 | $16,988 | $534,431 | 0.317 | $169,415 |
| 18 | | $517,442 | $16,988 | $534,431 | 0.296 | $158,191 |
| 19 | | $517,442 | $16,988 | $534,431 | 0.277 | $148,037 |
| 20 | | $517,442 | $42,288 | $559,731 | 0.258 | $144,411 |
| 21 | | $517,442 | $16,988 | $534,431 | 0.242 | $129,332 |
| 22 | | $517,442 | $16,988 | $534,431 | 0.226 | $120,781 |
| 23 | | $517,442 | $16,988 | $534,431 | 0.211 | $112,765 |
| 24 | | $517,442 | $16,988 | $534,431 | 0.197 | $105,283 |
| 25 | | $517,442 | $42,288 | $559,731 | 0.184 | $102,990 |
| 26 | | $517,442 | $16,988 | $534,431 | 0.172 | $91,922 |
| 27 | | $517,442 | $16,988 | $534,431 | 0.161 | $86,043 |
| 28 | | | $16,988 | $16,988 | 0.150 | $2,548 |
| 29 | | | $16,988 | $16,988 | 0.141 | $2,395 |
| 30 | | | $42,288 | $42,288 | 0.131 | $5,540 |
| | | | | | **TOTAL PRESENT WORTH** | **$8,295,331** |

**ZONE 4, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE GW-4.5: EXTRACTION, ON-SITE TREATMENT (FILTRATION, OXIDATIVE FILTRATION, CHEMICAL PRECIPITATION, AND LIQUID-PHASE GAC ADSORPTION), DISCHARGE TO THAMES RIVER, LUCs, AND MONITORING**
**CAPITAL COST**

| Item | Quantity | Unit | Unit Cost Subcontract | Unit Cost Material | Unit Cost Labor | Unit Cost Equipment | Extended Cost Subcontract | Extended Cost Material | Extended Cost Labor | Extended Cost Equipment | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1 PROJECT PLANNING AND DOCUMENTS** | | | | | | | | | | | |
| 1.1 Prepare LUC RD Documents | 60 | hr | | | $37.00 | | $0 | $0 | $2,220 | $0 | $2,220 |
| 1.2 Prepare Documents & Plans including Permits | 300 | hr | | | $37.00 | | $0 | $0 | $11,100 | $0 | $11,100 |
| 1.3 Prepare Groundwater Monitoring Plan | 100 | hr | | | $37.00 | | $0 | $0 | $3,700 | $0 | $3,700 |
| 1.4 Completion Report | 150 | hr | | | $37.00 | | $0 | $0 | $5,550 | $0 | $5,550 |
| 1.5 Treatability Studies | 3 | ea | $5,000.00 | | | | $15,000 | $0 | $0 | $0 | $15,000 |
| 1.6 Pre-Design Investigation | 1 | ls | $3,527.00 | $1,067.00 | $7,140.00 | $773.00 | $3,527 | $1,067 | $7,140 | $773 | $12,507 |
| **2 MOBILIZATION/DEMOBILIZATION & SITE SUPPORT** | | | | | | | | | | | |
| 2.1 Office Trailer | 3 | mo | | | | $375.00 | $0 | $0 | $0 | $1,125 | $1,125 |
| 2.2 Field Office Equipment, Utilities, & Support | 3 | mo | | $470.00 | | | $0 | $1,410 | $0 | $0 | $1,410 |
| 2.3 Storage Trailer | 3 | mo | | | | $99.00 | $0 | $0 | $0 | $297 | $297 |
| 2.4 Trailer Utility Connections (phone/electric) | 1 | ls | $1,250.00 | | | | $1,250 | $0 | $0 | $0 | $1,250 |
| 2.5 Utility Connection (electric) | 1 | ls | $10,000.00 | | | | $10,000 | $0 | $0 | $0 | $10,000 |
| 2.6 Underground Utility Clearances | 1 | ls | $7,600.00 | | | | $7,600 | $0 | $0 | $0 | $7,600 |
| 2.7 Construction Survey | 6 | day | $2,125.00 | | | | $12,750 | $0 | $0 | $0 | $12,750 |
| 2.8 Drill Rig Mobilization/Demobilization | 2 | ea | $2,000.00 | | | | $4,000 | $0 | $0 | $0 | $4,000 |
| 2.9 Field Construction Mgt. (2 persons) | 120 | day | | $240.00 | $300.00 | | $0 | $28,800 | $36,000 | $0 | $64,800 |
| **3 GROUNDWATER EXTRACTION, ARSENIC/TPH PLUME** | | | | | | | | | | | |
| 3.1 Extraction Well, 6" dia, 30' deep, 3 wells | 90 | lf | $85.00 | | | | $7,650 | $0 | $0 | $0 | $7,650 |
| 3.2 Well Development | 12 | hr | $200.00 | | | | $2,400 | $0 | $0 | $0 | $2,400 |
| 3.3 Well Bollard or Vault | 3 | ea | $500.00 | | | | $1,500 | $0 | $0 | $0 | $1,500 |
| 3.4 Collect/Containerize/Transport/Dispose IDW Off-Site | 6 | drum | $225.00 | | | | $1,350 | $0 | $0 | $0 | $1,350 |
| 3.5 Extraction Pump, 10 gpm, 0.5 hp | 3 | ea | | $810.00 | $290.00 | | $0 | $2,430 | $870 | $0 | $3,300 |
| 3.6 PVC pipe, 2" dia. w/trench | 1,500 | lf | | $1.30 | $5.63 | $9.72 | $0 | $1,950 | $8,445 | $14,580 | $24,975 |
| 3.7 Tie-in to Existing Manhole | 1 | ea | | $500.00 | $1,000.00 | $1,250.00 | $0 | $500 | $1,000 | $1,250 | $2,750 |
| **4 GROUNDWATER EXTRACTION, LEAD PLUME** | | | | | | | | | | | |
| 4.1 Extraction Well, 6" dia, 30' deep, 3 wells | 90 | lf | $85.00 | | | | $7,650 | $0 | $0 | $0 | $7,650 |
| 4.2 Well Development | 12 | hr | $200.00 | | | | $2,400 | $0 | $0 | $0 | $2,400 |
| 4.3 Well Bollard or Vault | 3 | ea | $500.00 | | | | $1,500 | $0 | $0 | $0 | $1,500 |
| 4.4 Collect/Containerize/Transport/Dispose IDW Off-Site | 6 | drum | $225.00 | | | | $1,350 | $0 | $0 | $0 | $1,350 |
| 4.5 Extraction Pump, 40 gpm, 2 hp | 3 | ea | | $1,500.00 | $290.00 | | $0 | $4,500 | $870 | $0 | $5,370 |
| 4.6 PVC pipe, 2" dia. w/trench | 1,500 | lf | | $4.00 | $10.00 | $20.00 | $0 | $6,000 | $15,000 | $30,000 | $51,000 |
| 4.7 Tie-in to Existing Manhole | 1 | ea | | $500.00 | $1,000.00 | $1,250.00 | $0 | $500 | $1,000 | $1,250 | $2,750 |
| **5 ON-SITE TREATMENT SYSTEM INSTALLATION (Arsenic/TPH)** | | | | | | | | | | | |
| 5.1 Building Foundation/Equipment Pads | 42 | cy | $460.00 | | | | $19,320 | $0 | $0 | $0 | $19,320 |
| 5.2 Treatment Building | 1,500 | sf | $30.00 | | | | $45,000 | $0 | $0 | $0 | $45,000 |
| 5.3 Equipment Door | 1 | ea | $3,000.00 | | | | $3,000 | $0 | $0 | $0 | $3,000 |
| 5.4 Tank, 1,000 gal, 5' dia. | 1 | ea | | $2,730.00 | $263.00 | | $0 | $2,730 | $263 | $0 | $2,993 |
| 5.5 Tank Mixer, 0.5 hp, w/controls | 1 | ea | | $2,194.00 | $185.00 | | $0 | $2,194 | $185 | $0 | $2,379 |
| 5.6 Transfer Pump, 30 gpm, 1.5 hp | 1 | ea | | $990.00 | $245.00 | | $0 | $990 | $245 | $0 | $1,235 |
| 5.7 Bag Filter, 53 sf, 12 bag | 1 | ea | | $14,793.00 | $225.00 | | $0 | $14,793 | $225 | $0 | $15,018 |
| 5.8 Liquid-Phase GAC Adsorption System, 2,500 lb | 1 | ea | | $13,950.00 | $615.00 | $200.00 | $0 | $13,950 | $615 | $0 | $14,565 |
| 5.9 Oxidative Filter System, twin 24-inch units | 1 | ea | | $22,500.00 | $390.00 | | $0 | $22,500 | $390 | $0 | $22,890 |
| 5.10 Discharge PVC pipe, 2" dia. w/trench | 200 | lf | | $1.30 | $5.63 | $9.72 | $0 | $260 | $1,126 | $1,944 | $3,330 |
| 5.11 Associated Instruments and Controls | 1 | ls | | $4,000.00 | $6,000.00 | | $0 | $4,000 | $6,000 | $0 | $10,000 |
| **6 ON-SITE TREATMENT SYSTEM INSTALLATION (Lead)** | | | | | | | | | | | |
| 6.1 Building Foundation/Equipment Pads | 70 | cy | $460.00 | | | | $32,200 | $0 | $0 | $0 | $32,200 |
| 6.2 Treatment Building | 2,500 | sf | $30.00 | | | | $75,000 | $0 | $0 | $0 | $75,000 |
| 6.3 Equipment Door | 1 | ea | $3,000.00 | | | | $3,000 | $0 | $0 | $0 | $3,000 |
| 6.4 Tank, 7,500 gal, 10' dia. | 1 | ea | | $10,000.00 | $1,000.00 | | $0 | $10,000 | $1,000 | $0 | $11,000 |
| 6.5 Tank Mixer, 3 hp, w/controls | 1 | ea | | $4,000.00 | $300.00 | | $0 | $4,000 | $300 | $0 | $4,300 |
| 6.6 Chemical Feed System w/pump | 1 | ea | | $5,000.00 | $150.00 | | $0 | $5,000 | $150 | $0 | $5,150 |
| 6.7 Chemical Feed System Tank & Stand, 400 gal | 1 | ea | | $1,500.00 | $150.00 | | $0 | $1,500 | $150 | $0 | $1,650 |

**ZONE 4, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDOI**
**GROTON, CONNECTICUT**
**ALTERNATIVE GW-4.5: EXTRACTION, ON-SITE TREATMENT (FILTRATION, OXIDATIVE FILTRATION, CHEMICAL PRECIPITATION, AND LIQUID-PHASE GAC ADSORPTION), DISCHARGE TO THAMES RIVER, LUCs, AND MONITORING**
**CAPITAL COST**

| Item | Quantity | Unit | Unit Cost Subcontract | Unit Cost Material | Unit Cost Labor | Unit Cost Equipment | Extended Cost Subcontract | Extended Cost Material | Extended Cost Labor | Extended Cost Equipment | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 6.8 Chemical Feed System Tank Mixer, 1 hp | 1 | ea | | $1,000.00 | $100.00 | | $0 | $1,000 | $100 | $0 | $1,100 |
| 6.9 Transfer Pump, 120 gpm, 7.5 hp | 1 | ea | | $2,500.00 | $500.00 | | $0 | $2,500 | $500 | $0 | $3,000 |
| 6.10 Bag Filters, 101 sf, 23 bag | 3 | ea | | $28,328.00 | $375.00 | | $0 | $84,984 | $1,125 | $0 | $86,109 |
| 6.11 Discharge PVC pipe, 4" dia. w/trench | 300 | lf | | $4.00 | $10.00 | $9.72 | $0 | $1,200 | $3,000 | $2,916 | $7,116 |
| 6.12 Associated Instruments and Controls | 1 | ls | | $4,000.00 | $6,000.00 | | $0 | $4,000 | $6,000 | $0 | $10,000 |
| **7 SITE RESTORATION** | | | | | | | | | | | |
| 7.1 Top Dress Soil | 80 | cy | $31.50 | | | | $2,520 | $0 | $0 | $0 | $2,520 |
| 7.2 Pavement Repair | 1 | ls | $2,000.00 | | | | $2,000 | $0 | $0 | $0 | $2,000 |
| 7.3 Site Restoration, seed, fertilization, mulch | 2.0 | msf | $76.50 | | | | $153 | $0 | $0 | $0 | $153 |
| **Subtotal** | | | | | | | $262,120 | $222,758 | $114,269 | $54,135 | $653,282 |
| **Local Area Adjustments** | | | | | | | 100.0% | 98.6% | 104.2% | 104.2% | |
| **Subtotal** | | | | | | | $262,120 | $219,639 | $119,068 | $56,409 | $657,236 |
| Overhead on Labor Cost @ 30% | | | | | | | | | $35,720 | | $35,720 |
| G & A on Labor Cost @ 10% | | | | | | | | | $11,907 | | $11,907 |
| G & A on Material Cost @ 10% | | | | | | | | $21,964 | | | $21,964 |
| G & A on Equipment Cost @ 10% | | | | | | | | | | $5,641 | $5,641 |
| G & A on Subcontract Cost @ 10% | | | | | | | $26,212 | | | | $26,212 |
| Tax on Materials and Equipment Cost @ 6% | | | | | | | | $13,178 | | $3,385 | $16,563 |
| **Total Direct Cost** | | | | | | | $288,332 | $254,782 | $166,696 | $65,434 | $775,243 |
| Indirects on Total Direct Cost @ 30% | | | | | | | | | | | $232,573 |
| Profit on Total Direct Cost @ 10% | | | | | | | | | | | $77,524 |
| **Subtotal** | | | | | | | | | | | $1,085,341 |
| Health & Safety Monitoring @ 1% | | | | | | | | | | | $10,853 |
| **Total Field Cost** | | | | | | | | | | | $1,096,194 |
| Contingency on Total Field Cost @ 25% | | | | | | | | | | | $274,049 |
| Engineering on Total Field Cost @ 15% | | | | | | | | | | | $164,429 |
| **TOTAL COST** | | | | | | | | | | | **$1,534,672** |

**ZONE 4, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE GW-4.5: EXTRACTION, ON-SITE TREATMENT (FILTRATION, OXIDATIVE FILTRATION, CHEMICAL PRECIPITATION, AND LIQUID-PHASE GAC ADSORPTION), DISCHARGE TO THAMES RIVER, LUCs, AND MONITORING**
**Operation and Maintenance Costs per Year**

| | Item | Qty | Unit | Unit Cost | Subtotal Cost | Notes |
|---|---|---|---|---|---|---|
| | *Arsenic/TPH Plume (Operate for 11 years)* | | | | | |
| 1 | Energy - Electric | 23,000 | kWh | $0.18 | $4,140 | |
| 2 | Equipment Repair/Replacement | 1 | ls | $4,991.75 | $4,992 | 5% of Installation Cost |
| 3 | Influent & Effluent Sampling | 52 | ea | $392.00 | $20,384 | arsenic, TPH, suspended solids, pH. Weekly |
| 4 | Replace Filter Bags | 52 | ea | $60.00 | $3,120 | 12 bags, weekly |
| 5 | Clean Oxidative Filter, Dispose of Backwash | 12 | ea | $135.00 | $1,620 | 900 gal @ $0.15 per gallon |
| 6 | Replace GAC Carbon, 2,500 lbs. | 6 | ea | $7,500.00 | $45,000 | replace six times a year |
| 7 | Operating Labor | 520 | hr | $50.00 | $26,000 | 10 hr per week |
| 8 | System Report | 4 | ea | $5,000.00 | $20,000 | |
| | Subtotal Cost for One Year Operation | | | | $125,256 | |
| | Replace Oxidative Filter Medium | | | | $9,000 | Every 5 years |
| | *Lead Plume (Operate for 27 years)* | | | | | |
| 1 | Energy - Electric | 115,000 | kWh | $0.18 | $20,700 | |
| 2 | Equipment Repair/Replacement | 1 | ls | $9,247.25 | $9,247 | 5% of Installation Cost |
| 3 | Influent & Effluent Sampling | 52 | ea | $140.00 | $7,280 | lead, suspended solids, pH. Weekly |
| 4 | Ammonium Phosphate | 365 | day | $32.00 | $11,680 | 4 lb/day @ $8.00/lbs |
| 4 | Replace Filter Bags | 52 | ea | $345.00 | $17,940 | 69 bags, weekly |
| 5 | Operating Labor | 520 | hr | $50.00 | $26,000 | 10 hr per week |
| 6 | System Report | 4 | ea | $5,000.00 | $20,000 | |
| | Subtotal Cost for One Year Operation | | | | $112,847 | |

**ZONE 4, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE GW-4.5: EXTRACTION, ON-SITE TREATMENT (FILTRATION, OXIDATIVE FILTRATION, CHEMICAL PRECIPITATION, AND LIQUID-PHASE GAC ADSORPTION), DISCHARGE TO THAMES RIVER, LUCs, AND MONITORING**
**ANNUAL COST**

| Item | Item Cost Years 1 and 2 | Item Cost Years 3 and 4 | Item Cost Years 5 and 30 | Item Cost Every 5 Years | Notes |
|---|---|---|---|---|---|
| Groundwater Sampling | $33,408 | $16,704 | $8,352 | | 6 Wells (2 Performance Wells, 4 Migration Wells). Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Labor and supplies for sampling |
| Groundwater Analysis (Performance) | $1,456 | $728 | $364 | | 2 wells, Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Analysis for arsenic, lead, TPH. |
| Groundwater Analysis (Migration) | $2,912 | $1,456 | $728 | | 4 wells, Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Analysis for arsenic, lead, TPH. |
| Annual Report | $5,000 | $5,000 | $5,000 | | |
| Inspection | $1,000 | $1,000 | $1,000 | | Annual LUC inspection (assume 8 hours at $50/hr plus expenses |
| Site Review | | | | $23,000 | 5-year review |
| Subtotal | $43,776 | $24,888 | $15,444 | $23,000 | |
| Contingency at 10% | $4,378 | $2,489 | $1,544 | $2,300 | |
| **TOTAL** | $48,154 | $27,377 | $16,988 | $25,300 | |

**ZONE 4, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE GW-4.5: EXTRACTION, ON-SITE TREATMENT (FILTRATION, OXIDATIVE FILTRATION, CHEMICAL PRECIPITATION, AND LIQUID-PHASE GAC ADSORPTION), DISCHARGE TO THAMES RIVER, LUCs, AND MONITORING**
**Present Worth Analysis**

| Year | Capital Cost | Operation and Maintenance Cost | Annual Cost | Total Year Cost | Annual Discount Rate at 7% | Present Worth |
|---|---|---|---|---|---|---|
| 0 | $1,534,672 | | | $1,534,672 | 1.000 | $1,534,672 |
| 1 | | $238,103 | $48,154 | $286,257 | 0.935 | $267,650 |
| 2 | | $238,103 | $48,154 | $286,257 | 0.873 | $249,902 |
| 3 | | $238,103 | $27,377 | $265,480 | 0.816 | $216,632 |
| 4 | | $238,103 | $27,377 | $265,480 | 0.763 | $202,561 |
| 5 | | $247,103 | $42,288 | $289,391 | 0.713 | $206,336 |
| 6 | | $238,103 | $16,988 | $255,091 | 0.666 | $169,891 |
| 7 | | $238,103 | $16,988 | $255,091 | 0.623 | $158,922 |
| 8 | | $238,103 | $16,988 | $255,091 | 0.582 | $148,463 |
| 9 | | $238,103 | $16,988 | $255,091 | 0.544 | $138,770 |
| 10 | | $247,103 | $42,288 | $289,391 | 0.508 | $147,011 |
| 11 | | $238,103 | $16,988 | $255,091 | 0.475 | $121,168 |
| 12 | | $112,847 | $16,988 | $129,836 | 0.444 | $57,647 |
| 13 | | $112,847 | $16,988 | $129,836 | 0.415 | $53,882 |
| 14 | | $112,847 | $16,988 | $129,836 | 0.388 | $50,376 |
| 15 | | $112,847 | $42,288 | $155,136 | 0.362 | $56,159 |
| 16 | | $112,847 | $16,988 | $129,836 | 0.339 | $44,014 |
| 17 | | $112,847 | $16,988 | $129,836 | 0.317 | $41,158 |
| 18 | | $112,847 | $16,988 | $129,836 | 0.296 | $38,431 |
| 19 | | $112,847 | $16,988 | $129,836 | 0.277 | $35,964 |
| 20 | | $112,847 | $42,288 | $155,136 | 0.258 | $40,025 |
| 21 | | $112,847 | $16,988 | $129,836 | 0.242 | $31,420 |
| 22 | | $112,847 | $16,988 | $129,836 | 0.226 | $29,343 |
| 23 | | $112,847 | $16,988 | $129,836 | 0.211 | $27,395 |
| 24 | | $112,847 | $16,988 | $129,836 | 0.197 | $25,578 |
| 25 | | $112,847 | $42,288 | $155,136 | 0.184 | $28,545 |
| 26 | | $112,847 | $16,988 | $129,836 | 0.172 | $22,332 |
| 27 | | $112,847 | $16,988 | $129,836 | 0.161 | $20,904 |
| 28 | | | $16,988 | $16,988 | 0.150 | $2,548 |
| 29 | | | $16,988 | $16,988 | 0.141 | $2,395 |
| 30 | | | $42,288 | $42,288 | 0.131 | $5,540 |
| | | | | | **TOTAL PRESENT WORTH** | **$4,175,634** |

# APPENDIX E.2.3

# ZONE 7

# ALTERNATIVES GW-7.1, GW-7.2, GW-7.3, GW-7.4, and GW-7.5

**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE GW-7.1: NO ACTION**
**Annual Cost**

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| Item | Item Cost every 5 years | Notes |
|---|---|---|
| Five-Year Review | $23,000 | |
| Subtotal | $23,000 | |
| Contingency @ 10% | $2,300 | |
| **TOTAL** | **$25,300** | |

**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE GW-7.1: NO ACTION**
**Present Worth Analysis**



| Year | Capital Cost | Annual Cost | Total Year Cost | Annual Discount Rate at 7% | Present Worth |
|---|---|---|---|---|---|
| 0 | $0 | | $0 | 1.000 | $0 |
| 1 | | | $0 | 0.935 | $0 |
| 2 | | | $0 | 0.873 | $0 |
| 3 | | | $0 | 0.816 | $0 |
| 4 | | | $0 | 0.763 | $0 |
| 5 | | $25,300 | $25,300 | 0.713 | $18,039 |
| 6 | | | $0 | 0.666 | $0 |
| 7 | | | $0 | 0.623 | $0 |
| 8 | | | $0 | 0.582 | $0 |
| 9 | | | $0 | 0.544 | $0 |
| 10 | | $25,300 | $25,300 | 0.508 | $12,852 |
| 11 | | | $0 | 0.475 | $0 |
| 12 | | | $0 | 0.444 | $0 |
| 13 | | | $0 | 0.415 | $0 |
| 14 | | | $0 | 0.388 | $0 |
| 15 | | $25,300 | $25,300 | 0.362 | $9,159 |
| 16 | | | $0 | 0.339 | $0 |
| 17 | | | $0 | 0.317 | $0 |
| 18 | | | $0 | 0.296 | $0 |
| 19 | | | $0 | 0.277 | $0 |
| 20 | | $25,300 | $25,300 | 0.258 | $6,527 |
| 21 | | | $0 | 0.242 | $0 |
| 22 | | | $0 | 0.226 | $0 |
| 23 | | | $0 | 0.211 | $0 |
| 24 | | | $0 | 0.197 | $0 |
| 25 | | $25,300 | $25,300 | 0.184 | $4,655 |
| 26 | | | $0 | 0.172 | $0 |
| 27 | | | $0 | 0.161 | $0 |
| 28 | | | $0 | 0.150 | $0 |
| 29 | | | $0 | 0.141 | $0 |
| 30 | | $25,300 | $25,300 | 0.131 | $3,314 |
| | | | | **TOTAL PRESENT WORTH** | **$54,547** |

**ZONE 7, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE GW-7.2: NATURAL ATTENUATION, LUCs, AND MONITORING**
**CAPITAL COST**

| Item | Quantity | Unit | Unit Cost | | | | Extended Cost | | | | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Subcontract | Material | Labor | Equipment | Subcontract | Material | Labor | Equipment | |
| **1 PROJECT PLANNING** | | | | | | | | | | | |
| 1.1 Prepare Documents & Plans including Permits | 100 | hr | | | $37.00 | | $0 | $0 | $3,700 | $0 | $3,700 |
| 1.2 Prepare LUC RD Documents | 60 | hr | | | $37.00 | | $0 | $0 | $2,220 | $0 | $2,220 |
| 1.3 Pre-Design Investigation | 1 | ls | $1,486.00 | $640.00 | $4,284.00 | $464.00 | $1,486 | $640 | $4,284 | $464 | $6,874 |
| **Subtotal** | | | | | | | $1,486 | $640 | $10,204 | $464 | $12,794 |
| **Local Area Adjustments** | | | | | | | 100.0% | 98.6% | 104.2% | 104.2% | |
| | | | | | | | $1,486 | $631 | $10,633 | $483 | $13,233 |
| Overhead on Labor Cost @ 30% | | | | | | | | | $3,190 | | $3,190 |
| G & A on Labor Cost @ 10% | | | | | | | | | $1,063 | | $1,063 |
| G & A on Material Cost @ 10% | | | | | | | | $63 | | | $63 |
| G & A on Subcontract Cost @ 10% | | | | | | | $149 | | | | $149 |
| G & A on Equipment Cost @ 10% | | | | | | | | | | $48 | $48 |
| Tax on Materials and Equipment Cost @ 6% | | | | | | | | $38 | | $29 | $67 |
| **Total Direct Cost** | | | | | | | $1,635 | $732 | $14,886 | $561 | $17,813 |
| Indirects on Total Direct Cost @ 0% | | | | | | | | | | | $0 |
| Profit on Total Direct Cost @ 10% | | | | | | | | | | | $1,781 |
| **Subtotal** | | | | | | | | | | | $19,594 |
| Health & Safety Monitoring @ 0% | | | | | | | | | | | $0 |
| **Total Field Cost** | | | | | | | | | | | $19,594 |
| Contingency on Total Field Costs @ 20% | | | | | | | | | | | $3,919 |
| Engineering on Total Field Cost @ 0% | | | | | | | | | | | $0 |
| **TOTAL COST** | | | | | | | | | | | **$23,513** |

**ZONE 7, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDOI**
**GROTON, CONNECTICUT**
**ALTERNATIVE GW-7.2: NATURAL ATTENUATION, LUCs, AND MONITORIN**
**ANNUAL COST**

| Item | Item Cost Years 1 and 2 | Item Cost Years 3 and 4 | Item Cost Years 5 and 30 | Item Cost Every 5 Years | Notes |
|---|---|---|---|---|---|
| Groundwater Sampling | $33,408 | $16,704 | $8,352 | | 6 Wells (2 Performance Wells, 4 Migration Wells). Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Labor and supplies for sampling |
| Groundwater Analysis (Performance) | $224 | $112 | $56 | | 2 wells, Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Analysis for arsenic. |
| Groundwater Analysis (Migration) | $448 | $224 | $112 | | 4 wells, Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 30. Analysis for arsenic. |
| Annual Report | $5,000 | $5,000 | $5,000 | | |
| Inspection | $1,000 | $1,000 | $1,000 | | Annual LUC inspection (assume 8 hours at $50/hr plus expenses |
| Site Review | | | | $23,000 | 5-year review |
| Subtotal | $40,080 | $23,040 | $14,520 | $23,000 | |
| Contingency at 10% | $4,008 | $2,304 | $1,452 | $2,300 | |
| **TOTAL** | $44,088 | $25,344 | $15,972 | $25,300 | |

**ZONE 7, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE GW-7.2: NATURAL ATTENUATION, LUCs, AND MONITORING**
**PRESENT WORTH ANALYSIS**

| Year | Capital Cost | Annual Cost | Total Year Cost | Annual Discount Rate at 7% | Present Worth |
|---|---|---|---|---|---|
| 0 | $23,513 | | $23,513 | 1.000 | $23,513 |
| 1 | | $44,088 | $44,088 | 0.935 | $41,222 |
| 2 | | $44,088 | $44,088 | 0.873 | $38,489 |
| 3 | | $25,344 | $25,344 | 0.816 | $20,681 |
| 4 | | $25,344 | $25,344 | 0.763 | $19,337 |
| 5 | | $41,272 | $41,272 | 0.713 | $29,427 |
| 6 | | $15,972 | $15,972 | 0.666 | $10,637 |
| 7 | | $15,972 | $15,972 | 0.623 | $9,951 |
| 8 | | $15,972 | $15,972 | 0.582 | $9,296 |
| 9 | | $15,972 | $15,972 | 0.544 | $8,689 |
| 10 | | $41,272 | $41,272 | 0.508 | $20,966 |
| 11 | | $15,972 | $15,972 | 0.475 | $7,587 |
| 12 | | $15,972 | $15,972 | 0.444 | $7,092 |
| 13 | | $15,972 | $15,972 | 0.415 | $6,628 |
| 14 | | $15,972 | $15,972 | 0.388 | $6,197 |
| 15 | | $41,272 | $41,272 | 0.362 | $14,940 |
| 16 | | $15,972 | $15,972 | 0.339 | $5,415 |
| 17 | | $15,972 | $15,972 | 0.317 | $5,063 |
| 18 | | $15,972 | $15,972 | 0.296 | $4,728 |
| 19 | | $15,972 | $15,972 | 0.277 | $4,424 |
| 20 | | $41,272 | $41,272 | 0.258 | $10,648 |
| 21 | | $15,972 | $15,972 | 0.242 | $3,865 |
| 22 | | $15,972 | $15,972 | 0.226 | $3,610 |
| 23 | | $15,972 | $15,972 | 0.211 | $3,370 |
| 24 | | $15,972 | $15,972 | 0.197 | $3,146 |
| 25 | | $41,272 | $41,272 | 0.184 | $7,594 |
| 26 | | $15,972 | $15,972 | 0.172 | $2,747 |
| 27 | | $15,972 | $15,972 | 0.161 | $2,571 |
| 28 | | $15,972 | $15,972 | 0.150 | $2,396 |
| 29 | | $15,972 | $15,972 | 0.141 | $2,252 |
| 30 | | $41,272 | $41,272 | 0.131 | $5,407 |
| | | | | **TOTAL PRESENT WORTH** | **$341,889** |

**ZONE 7, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE GW-7.3: IN-SITU TREATMENT (Chemical Precipitation and Oxidation), LUCs, AND MONITORING**
**CAPITAL COST**

| Item | Quantity | Unit | Unit Cost Subcontract | Unit Cost Material | Unit Cost Labor | Unit Cost Equipment | Extended Cost Subcontract | Extended Cost Material | Extended Cost Labor | Extended Cost Equipment | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1 PROJECT PLANNING AND DOCUMENTS** | | | | | | | | | | | |
| 1.1 Prepare LUC RD Documents | 60 | hr | | | $37.00 | | $0 | $0 | $2,220 | $0 | $2,220 |
| 1.2 Prepare Documents & Plans including Permits | 300 | hr | | | $37.00 | | $0 | $0 | $11,100 | $0 | $11,100 |
| 1.3 Prepare Groundwater Monitoring Plan | 100 | hr | | | $37.00 | | $0 | $0 | $3,700 | $0 | $3,700 |
| 1.4 Completion Report | 150 | hr | | | $37.00 | | $0 | $0 | $5,550 | $0 | $5,550 |
| 1.5 Treatability Study: In-Situ Chemical Precipitation & Oxidation | 1 | ls | $5,000.00 | | | | $5,000 | $0 | $0 | $0 | $5,000 |
| 1.6 Pre-Design Investigation | 1 | ls | $1,486.00 | $640.00 | $4,284.00 | $464.00 | $1,486 | $640 | $4,284 | $464 | $6,874 |
| **2 MOBILIZATION/DEMOBILIZATION & SITE SUPPORT** | | | | | | | | | | | |
| 2.1 Utility Connection (electric) | 1 | ls | $10,000.00 | | | | $10,000 | $0 | $0 | $0 | $10,000 |
| 2.2 Underground Utility Clearances | 1 | ls | $7,600.00 | | | | $7,600 | $0 | $0 | $0 | $7,600 |
| 2.3 Construction Survey | 2 | day | $2,125.00 | | | | $4,250 | $0 | $0 | $0 | $4,250 |
| 2.4 Drill Rig Mobilization/Demobilization | 1 | ea | $2,000.00 | | | | $2,000 | $0 | $0 | $0 | $2,000 |
| 2.5 Field Construction Mgt. (1 person) | 20 | day | | $240.00 | $300.00 | | $0 | $4,800 | $6,000 | $0 | $10,800 |
| **3 IN-SITU CHEMICAL PRECIPITATION & OXIDATION (Arsenic)** | | | | | | | | | | | |
| 3.1 DPT Rig (74 injection points @ 15' bgs) | 9 | day | $3,000.00 | | | | $27,000 | $0 | $0 | $0 | $27,000 |
| 3.2 Pump & Hose | 9 | day | | | | $166.40 | $0 | $0 | $0 | $1,498 | $1,498 |
| 3.3 Mix Tank & Equipment | 9 | day | | | | $200.00 | $0 | $0 | $0 | $1,800 | $1,800 |
| 3.4 Injection Point Supplies | 1,110 | lf | $4.00 | | | | $4,440 | $0 | $0 | $0 | $4,440 |
| 3.5 Site Labor, (2 laborers) | 18 | day | | | $309.60 | | $0 | $0 | $5,573 | $0 | $5,573 |
| 3.6 Ferric Chloride | 55 | gal | | $8.00 | | | $0 | $440 | $0 | $0 | $440 |
| 3.7 Treatment Water | 1 | ls | | $250.00 | | | $0 | $250 | $0 | $0 | $250 |
| 3.8 ORC | 2,960 | lb | | $9.00 | | | $0 | $26,640 | $0 | $0 | $26,640 |
| **4 SITE RESTORATION** | | | | | | | | | | | |
| 4.1 Top Dress Soil | 30 | cy | $31.50 | | | | $945 | $0 | $0 | $0 | $945 |
| 4.2 Pavement Repair | 1 | ls | $1,800.00 | | | | $1,800 | $0 | $0 | $0 | $1,800 |
| 4.3 Site Restoration, seed, fertilization, mulch | 1.0 | msf | $76.50 | | | | $77 | $0 | $0 | $0 | $77 |
| **Subtotal** | | | | | | | $64,598 | $32,770 | $38,427 | $3,762 | $139,556 |
| **Local Area Adjustments** | | | | | | | 100.0% | 98.6% | 104.2% | 104.2% | |
| **Subtotal** | | | | | | | $64,598 | $32,311 | $40,041 | $3,920 | $140,869 |
| Overhead on Labor Cost @ 30% | | | | | | | | | $12,012 | | $12,012 |
| G & A on Labor Cost @ 10% | | | | | | | | | $4,004 | | $4,004 |
| G & A on Material Cost @ 10% | | | | | | | | $3,231 | | | $3,231 |
| G & A on Equipment Cost @ 10% | | | | | | | | | | $392 | $392 |
| G & A on Subcontract Cost @ 10% | | | | | | | $6,460 | | | | $6,460 |
| Tax on Materials and Equipment Cost @ 6% | | | | | | | | $1,939 | | $235 | $2,174 |
| **Total Direct Cost** | | | | | | | $71,057 | $37,481 | $56,057 | $4,547 | $169,142 |
| Indirects on Total Direct Cost @ 15% | | | | | | | | | | | $25,371 |
| Profit on Total Direct Cost @ 6% | | | | | | | | | | | $10,149 |
| **Subtotal** | | | | | | | | | | | $204,662 |
| Health & Safety Monitoring @ 2% | | | | | | | | | | | $4,093 |
| **Total Field Cost** | | | | | | | | | | | $208,755 |
| Contingency on Total Field Cost @ 25% | | | | | | | | | | | $52,189 |
| Engineering on Total Field Cost @ 10% | | | | | | | | | | | $20,876 |
| **TOTAL COST** | | | | | | | | | | | **$281,819** |

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**ZONE 7, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE GW-7.3: IN-SITU TREATMENT (Chemical Precipitation and Oxidation), LUCs, AND MONITORING**
**ANNUAL COST**

| Item | Item Cost Years 1 and 2 | Item Cost Years 3 and 4 | Item Cost Year 5 | Item Cost Every 5 Years | Notes |
|---|---|---|---|---|---|
| Groundwater Sampling | $33,408 | $16,704 | $8,352 | | 6 Wells (2 Performance Wells, 4 Migration Wells). Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Year 5. Labor and supplies for sampling |
| Groundwater Analysis (Performance) | $224 | $112 | $56 | | 2 wells, Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Year 5. Analysis for arsenic. |
| Groundwater Analysis (Migration) | $448 | $224 | $112 | | 4 wells, Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Year 5. Analysis for arsenic. |
| Annual Report | $5,000 | $5,000 | $5,000 | | |
| Inspection | $1,000 | $1,000 | $1,000 | | Annual LUC inspection (assume 8 hours at $50/hr plus expenses) |
| Site Review | | | | $23,000 | 5-year review |
| Subtotal | $40,080 | $23,040 | $14,520 | $23,000 | |
| Contingency at 10% | $4,008 | $2,304 | $1,452 | $2,300 | |
| **TOTAL** | $44,088 | $25,344 | $15,972 | $25,300 | |

**ZONE 7, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE GW-7.3: IN-SITU TREATMENT (Chemical Precipitation and Oxidation), LUCs, AND MONITORING**
**Present Worth Analysis**

| Year | Capital Cost | Annual Cost | Total Year Cost | Annual Discount Rate at 7% | Present Worth |
|---|---|---|---|---|---|
| 0 | $281,819 | | $281,819 | 1.000 | $281,819 |
| 1 | | $44,088 | $44,088 | 0.935 | $41,222 |
| 2 | | $44,088 | $44,088 | 0.873 | $38,489 |
| 3 | | $25,344 | $25,344 | 0.816 | $20,681 |
| 4 | | $25,344 | $25,344 | 0.763 | $19,337 |
| 5 | | $41,272 | $41,272 | 0.713 | $29,427 |
| | | | | **TOTAL PRESENT WORTH** | **$430,976** |

**ZONE 7, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE GW-7.4: EXTRACTION, DISCHARGE AND DISPOSAL TO OFF-SITE POTW, LUCs, AND MONITORING**
**CAPITAL COST**

| Item | Quantity | Unit | Unit Cost Subcontract | Unit Cost Material | Unit Cost Labor | Unit Cost Equipment | Extended Cost Subcontract | Extended Cost Material | Extended Cost Labor | Extended Cost Equipment | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1 PROJECT PLANNING AND DOCUMENTS** | | | | | | | | | | | |
| 1.1 Prepare LUC RD Documents | 60 | hr | | | $37.00 | | $0 | $0 | $2,220 | $0 | $2,220 |
| 1.2 Prepare Documents & Plans including Permits | 300 | hr | | | $37.00 | | $0 | $0 | $11,100 | $0 | $11,100 |
| 1.3 Prepare Groundwater Monitoring Plan | 100 | hr | | | $37.00 | | $0 | $0 | $3,700 | $0 | $3,700 |
| 1.4 Completion Report | 150 | hr | | | $37.00 | | $0 | $0 | $5,550 | $0 | $5,550 |
| 1.5 Pre-Design Investigation | 1 | ls | $1,486.00 | $640.00 | $4,284.00 | $464.00 | $1,486 | $640 | $4,284 | $464 | $6,874 |
| **2 MOBILIZATION/DEMOBILIZATION & SITE SUPPORT** | | | | | | | | | | | |
| 2.1 Utility Connection (electric) | 1 | ls | $10,000.00 | | | | $10,000 | $0 | $0 | $0 | $10,000 |
| 2.2 Underground Utility Clearances | 1 | ls | $7,600.00 | | | | $7,600 | $0 | $0 | $0 | $7,600 |
| 2.3 Construction Survey | 4 | day | $2,125.00 | | | | $8,500 | $0 | $0 | $0 | $8,500 |
| 2.4 Drill Rig Mobilization/Demobilization | 2 | ea | $2,000.00 | | | | $4,000 | $0 | $0 | $0 | $4,000 |
| 2.5 Field Construction Mgt. (1 person) | 30 | day | | $240.00 | $300.00 | | $0 | $7,200 | $9,000 | $0 | $16,200 |
| **3 GROUNDWATER EXTRACTION** | | | | | | | | | | | |
| 3.1 Extraction Well, 6" dia, 30' deep, 2 wells | 60 | lf | $85.00 | | | | $5,100 | $0 | $0 | $0 | $5,100 |
| 3.2 Well Development | 8 | hr | $200.00 | | | | $1,600 | $0 | $0 | $0 | $1,600 |
| 3.3 Well Bollard or Vault | 2 | ea | $500.00 | | | | $1,000 | $0 | $0 | $0 | $1,000 |
| 3.4 Collect/Containerize/Transport/Dispose IDW Off-Site | 4 | drum | $225.00 | | | | $900 | $0 | $0 | $0 | $900 |
| 3.5 Extraction Pump, 15 gpm, 0.75 hp | 2 | ea | | $915.00 | $290.00 | | $0 | $1,830 | $580 | $0 | $2,410 |
| 3.6 PVC pipe, 1" dia. w/trench | 1,000 | lf | | $0.41 | $4.48 | $7.62 | $0 | $410 | $4,480 | $7,620 | $12,510 |
| 3.7 Tie-in to Existing Manhole | 1 | ea | | $500.00 | $1,000.00 | $1,250.00 | $0 | $500 | $1,000 | $1,250 | $2,750 |
| **4 SITE RESTORATION** | | | | | | | | | | | |
| 4.1 Top Dress Soil | 60 | cy | $31.50 | | | | $1,890 | $0 | $0 | $0 | $1,890 |
| 4.2 Pavement Repair | 1 | ls | $1,600.00 | | | | $1,600 | $0 | $0 | $0 | $1,600 |
| 4.3 Site Restoration, seed, fertilization, mulch | 1.0 | msf | $76.50 | | | | $77 | $0 | $0 | $0 | $77 |
| **Subtotal** | | | | | | | $43,753 | $10,580 | $41,914 | $9,334 | $105,581 |
| **Local Area Adjustments** | | | | | | | 100.0% | 98.6% | 104.2% | 104.2% | |
| **Subtotal** | | | | | | | $43,753 | $10,432 | $43,674 | $9,726 | $107,585 |
| Overhead on Labor Cost @ 30% | | | | | | | | | $13,102 | | $13,102 |
| G & A on Labor Cost @ 10% | | | | | | | | | $4,367 | | $4,367 |
| G & A on Material Cost @ 10% | | | | | | | | $1,043 | | | $1,043 |
| G & A on Equipment Cost @ 10% | | | | | | | | | | $973 | $973 |
| G & A on Subcontract Cost @ 10% | | | | | | | $4,375 | | | | $4,375 |
| Tax on Materials and Equipment Cost @ 6% | | | | | | | | $626 | | $584 | $1,209 |
| **Total Direct Cost** | | | | | | | $48,128 | $12,101 | $61,144 | $11,282 | $132,655 |
| Indirects on Total Direct Cost @ 30% | | | | | | | | | | | $39,797 |
| Profit on Total Direct Cost @ 10% | | | | | | | | | | | $13,266 |
| **Subtotal** | | | | | | | | | | | $185,717 |
| Health & Safety Monitoring @ 2% | | | | | | | | | | | $3,714 |
| **Total Field Cost** | | | | | | | | | | | $189,431 |
| Contingency on Total Field Cost @ 25% | | | | | | | | | | | $47,358 |
| Engineering on Total Field Cost @ 15% | | | | | | | | | | | $28,415 |
| **TOTAL COST** | | | | | | | | | | | **$265,204** |

**ZONE 7, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE GW-7.4: EXTRACTION, DISCHARGE AND DISPOSAL TO OFF-SITE POTW, LUCs, AND MONITORING**
**Operation and Maintenance Costs per Year**

| | Item | Qty | Unit | Unit Cost | Subtotal Cost | Notes |
|---|---|---|---|---|---|---|
| | *Arsenic Plume (Operate for 20 years)* | | | | | |
| 1 | Energy - Electric | 9,800 | kWh | $0.18 | $1,764 | |
| 2 | Equipment Repair/Replacement | 1 | ls | $1,051.00 | $1,051 | 5% of Installation Cost |
| 3 | Operating Labor | 520 | hr | $50.00 | $26,000 | 10 hr per week |
| 4 | POTW Charge | 365 | day | $294.74 | $107,580 | $7.31 per 1,000 gallons (40,320 gpd) |
| 5 | System Report | 4 | ea | $5,000.00 | $20,000 | |
| | Subtotal Cost for One Year Operation | | | | $156,395 | |

**ZONE 7, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE GW-7.4: EXTRACTION, DISCHARGE AND DISPOSAL TO OFF-SITE POTW, LUCs, AND MONITORING**
**ANNUAL COST**

| Item | Item Cost Years 1 and 2 | Item Cost Years 3 and 4 | Item Cost Years 5 and 20 | Item Cost Every 5 Years | Notes |
|---|---|---|---|---|---|
| Groundwater Sampling | $33,408 | $16,704 | $8,352 | | 6 Wells (2 Performance Wells, 4 Migration Wells). Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 20. Labor and supplies for sampling |
| Groundwater Analysis (Performance) | $448 | $224 | $112 | | 2 wells, Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 20. Analysis for arsenic. |
| Groundwater Analysis (Migration) | $224 | $112 | $56 | | 4 wells, Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 20. Analysis for arsenic. |
| Annual Report | $5,000 | $5,000 | $5,000 | | |
| Inspection | $1,000 | $1,000 | $1,000 | | Annual LUC inspection (assume 8 hours at $50/hr plus expenses) |
| Site Review | | | | $23,000 | 5-year review |
| Subtotal | $40,080 | $23,040 | $14,520 | $23,000 | |
| Contingency at 10% | $4,008 | $2,304 | $1,452 | $2,300 | |
| **TOTAL** | $44,088 | $25,344 | $15,972 | $25,300 | |

**ZONE 7, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE GW-7.4: EXTRACTION, DISCHARGE AND DISPOSAL TO OFF-SITE POTW, LUCs, AND MONITORING**
**Present Worth Analysis**

| Year | Capital Cost | Operation and Maintenance Cost | Annual Cost | Total Year Cost | Annual Discount Rate at 7% | Present Worth |
|---|---|---|---|---|---|---|
| 0 | $265,204 | | | $265,204 | 1.000 | $265,204 |
| 1 | | $156,395 | $44,088 | $200,483 | 0.935 | $187,451 |
| 2 | | $156,395 | $44,088 | $200,483 | 0.873 | $175,021 |
| 3 | | $156,395 | $25,344 | $181,739 | 0.816 | $148,299 |
| 4 | | $156,395 | $25,344 | $181,739 | 0.763 | $138,667 |
| 5 | | $156,395 | $41,272 | $197,667 | 0.713 | $140,936 |
| 6 | | $156,395 | $15,972 | $172,367 | 0.666 | $114,796 |
| 7 | | $156,395 | $15,972 | $172,367 | 0.623 | $107,385 |
| 8 | | $156,395 | $15,972 | $172,367 | 0.582 | $100,317 |
| 9 | | $156,395 | $15,972 | $172,367 | 0.544 | $93,768 |
| 10 | | $156,395 | $41,272 | $197,667 | 0.508 | $100,415 |
| 11 | | $156,395 | $15,972 | $172,367 | 0.475 | $81,874 |
| 12 | | $156,395 | $15,972 | $172,367 | 0.444 | $76,531 |
| 13 | | $156,395 | $15,972 | $172,367 | 0.415 | $71,532 |
| 14 | | $156,395 | $15,972 | $172,367 | 0.388 | $66,878 |
| 15 | | $156,395 | $41,272 | $197,667 | 0.362 | $71,555 |
| 16 | | $156,395 | $15,972 | $172,367 | 0.339 | $58,432 |
| 17 | | $156,395 | $15,972 | $172,367 | 0.317 | $54,640 |
| 18 | | $156,395 | $15,972 | $172,367 | 0.296 | $51,021 |
| 19 | | $156,395 | $15,972 | $172,367 | 0.277 | $47,746 |
| 20 | | $156,395 | $41,272 | $197,667 | 0.258 | $50,998 |
| | | | | | **TOTAL PRESENT WORTH** | **$2,203,467** |

**ZONE 7, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE GW-7.5: EXTRACTION, ON-SITE TREATMENT (FILTRATION, OXIDATIVE FILTRATION), DISCHARGE TO THAMES RIVER, LUCs, AND MONITORING**
**CAPITAL COST**

| Item | Quantity | Unit | Unit Cost Subcontract | Unit Cost Material | Unit Cost Labor | Unit Cost Equipment | Extended Cost Subcontract | Extended Cost Material | Extended Cost Labor | Extended Cost Equipment | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1 PROJECT PLANNING AND DOCUMENTS** | | | | | | | | | | | |
| 1.1 Prepare LUC RD Documents | 60 | hr | | | $37.00 | | $0 | $0 | $2,220 | $0 | $2,220 |
| 1.2 Prepare Documents & Plans including Permits | 300 | hr | | | $37.00 | | $0 | $0 | $11,100 | $0 | $11,100 |
| 1.3 Prepare Groundwater Monitoring Plar | 100 | hr | | | $37.00 | | $0 | $0 | $3,700 | $0 | $3,700 |
| 1.4 Completion Report | 150 | hr | | | $37.00 | | $0 | $0 | $5,550 | $0 | $5,550 |
| 1.5 Treatability Studies | 1 | ea | $5,000.00 | | | | $5,000 | $0 | $0 | $0 | $5,000 |
| 1.6 Pre-Design Investigation | 1 | ls | $1,486.00 | $640.00 | $4,284.00 | $464.00 | $1,486 | $640 | $4,284 | $464 | $6,874 |
| **2 MOBILIZATION/DEMOBILIZATION & SITE SUPPORT** | | | | | | | | | | | |
| 2.1 Office Trailer | 2 | mo | | | | $375.00 | $0 | $0 | $0 | $750 | $750 |
| 2.2 Field Office Equipment, Utilities, & Support | 2 | mo | | $470.00 | | | $0 | $940 | $0 | $0 | $940 |
| 2.3 Storage Trailer | 2 | mo | | | | $99.00 | $0 | $0 | $0 | $198 | $198 |
| 2.4 Trailer Utility Connections (phone/electric) | 1 | ls | $1,250.00 | | | | $1,250 | $0 | $0 | $0 | $1,250 |
| 2.5 Utility Connection (electric) | 1 | ls | $10,000.00 | | | | $10,000 | $0 | $0 | $0 | $10,000 |
| 2.6 Underground Utility Clearances | 1 | ls | $7,600.00 | | | | $7,600 | $0 | $0 | $0 | $7,600 |
| 2.7 Construction Survey | 3 | day | $2,125.00 | | | | $6,375 | $0 | $0 | $0 | $6,375 |
| 2.8 Drill Rig Mobilization/Demobilization | 1 | ea | $2,000.00 | | | | $2,000 | $0 | $0 | $0 | $2,000 |
| 2.9 Field Construction Mgt. (2 persons) | 80 | day | | $240.00 | $300.00 | | $0 | $19,200 | $24,000 | $0 | $43,200 |
| **3 GROUNDWATER EXTRACTION, ARSENIC PLUME** | | | | | | | | | | | |
| 3.1 Extraction Well, 6" dia, 30' deep, 2 wells | 60 | lf | $85.00 | | | | $5,100 | $0 | $0 | $0 | $5,100 |
| 3.2 Well Development | 8 | hr | $200.00 | | | | $1,600 | $0 | $0 | $0 | $1,600 |
| 3.3 Well Bollard or Vault | 2 | ea | $500.00 | | | | $1,000 | $0 | $0 | $0 | $1,000 |
| 3.4 Collect/Containerize/Transport/Dispose IDW Off-Site | 4 | drum | $225.00 | | | | $900 | $0 | $0 | $0 | $900 |
| 3.5 Extraction Pump, 15 gpm, 0.75 hp | 2 | ea | | $915.00 | $290.00 | | $0 | $1,830 | $580 | $0 | $2,410 |
| 3.6 PVC pipe, 1" dia. w/trench | 1,000 | lf | | $0.41 | $4.48 | $7.62 | $0 | $410 | $4,480 | $7,620 | $12,510 |
| 3.7 Tie-in to Existing Manhole | 1 | ea | | $500.00 | $1,000.00 | $1,250.00 | $0 | $500 | $1,000 | $1,250 | $2,750 |
| **4 ON-SITE TREATMENT SYSTEM INSTALLATION** | | | | | | | | | | | |
| 4.1 Building Foundation/Equipment Pads | 10 | cy | $460.00 | | | | $4,600 | $0 | $0 | $0 | $4,600 |
| 4.2 Treatment Building | 500 | sf | $30.00 | | | | $15,000 | $0 | $0 | $0 | $15,000 |
| 4.3 Equipment Door | 1 | ea | $3,000.00 | | | | $3,000 | $0 | $0 | $0 | $3,000 |
| 4.4 Bag Filter, 53 sf, 12 bag | 1 | ea | | $14,793.00 | $225.00 | | $0 | $14,793 | $225 | $0 | $15,018 |
| 4.5 Oxidative Filter System, twin 24-inch units | 1 | ea | | $22,500.00 | $390.00 | | $0 | $22,500 | $390 | $0 | $22,890 |
| 4.6 Discharge PVC pipe, 2" dia. w/trench | 200 | lf | | $1.30 | $5.63 | $9.72 | $0 | $260 | $1,126 | $1,944 | $3,330 |
| 4.7 Associated Instruments and Controls | 1 | ls | | $2,000.00 | $3,000.00 | | $0 | $2,000 | $3,000 | $0 | $5,000 |
| **5 SITE RESTORATION** | | | | | | | | | | | |
| 5.1 Top Dress Soil | 60 | cy | $31.50 | | | | $1,890 | $0 | $0 | $0 | $1,890 |
| 5.2 Pavement Repair | 1 | ls | $1,600.00 | | | | $1,600 | $0 | $0 | $0 | $1,600 |
| 5.3 Site Restoration, seed, fertilization, mulch | 1.0 | msf | $76.50 | | | | $77 | $0 | $0 | $0 | $77 |
| **Subtotal** | | | | | | | $68,478 | $63,073 | $61,655 | $12,226 | $205,432 |
| **Local Area Adjustments** | | | | | | | 100.0% | 98.6% | 104.2% | 104.2% | |
| **Subtotal** | | | | | | | $68,478 | $62,190 | $64,245 | $12,739 | $207,651 |
| Overhead on Labor Cost @ 30% | | | | | | | | | $19,273 | | $19,273 |
| G & A on Labor Cost @ 10% | | | | | | | | | $6,424 | | $6,424 |
| G & A on Material Cost @ 10% | | | | | | | | $6,219 | | | $6,219 |
| G & A on Equipment Cost @ 10% | | | | | | | | | | $1,274 | $1,274 |
| G & A on Subcontract Cost @ 10% | | | | | | | $6,848 | | | | $6,848 |
| Tax on Materials and Equipment Cost @ 6% | | | | | | | | $3,731 | | $764 | $4,496 |
| **Total Direct Cost** | | | | | | | $75,325 | $72,140 | $89,942 | $14,778 | $252,186 |

**ZONE 7, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE GW-7.5: EXTRACTION, ON-SITE TREATMENT (FILTRATION, OXIDATIVE FILTRATION), DISCHARGE TO THAMES RIVER, LUCs, AND MONITORING**
**CAPITAL COST**

| Item | Quantity | Unit | Unit Cost Subcontract | Unit Cost Material | Unit Cost Labor | Unit Cost Equipment | Extended Cost Subcontract | Extended Cost Material | Extended Cost Labor | Extended Cost Equipment | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Indirects on Total Direct Cost @ 30% | | | | | | | | | | | $75,656 |
| Profit on Total Direct Cost @ 10% | | | | | | | | | | | $25,219 |
| **Subtotal** | | | | | | | | | | | $353,060 |
| Health & Safety Monitoring @ 1% | | | | | | | | | | | $3,531 |
| **Total Field Cost** | | | | | | | | | | | $356,591 |
| Contingency on Total Field Cost @ 25% | | | | | | | | | | | $89,148 |
| Engineering on Total Field Cost @ 15% | | | | | | | | | | | $53,489 |
| **TOTAL COST** | | | | | | | | | | | **$499,227** |

**ZONE 7, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE GW-7.5: EXTRACTION, ON-SITE TREATMENT (FILTRATION, OXIDATIVE FILTRATION), DISCHARGE TO THAMES RIVER, LUCs, AND MONITORING**

**Operation and Maintenance Costs per Year**

| | Item | Qty | Unit | Unit Cost | Subtotal Cost | Notes |
|---|---|---|---|---|---|---|
| | *Arsenic Plume (Operate for 18 years)* | | | | | |
| 1 | Energy - Electric | 9,800 | kWh | $0.18 | $1,764 | |
| 2 | Equipment Repair/Replacement | 1 | ls | $3,112.90 | $3,113 | 5% of Installation Cost |
| 3 | Influent & Effluent Sampling | 52 | ea | $140.00 | $7,280 | arsenic, suspended solids, pH. Weekly |
| 4 | Replace Filter Bags | 52 | ea | $60.00 | $3,120 | 12 bags, weekly |
| 5 | Clean Oxidative Filter, Dispose of Backwash | 12 | ea | $135.00 | $1,620 | 900 gal @ $0.15 per gallon |
| 6 | Operating Labor | 520 | hr | $50.00 | $26,000 | 10 hr per week |
| 7 | System Report | 4 | ea | $5,000.00 | $20,000 | |
| | Subtotal Cost for One Year Operation | | | | $62,897 | |
| | Replace Oxidative Filter Medium | | | | $9,000 | Every 5 years |

**ZONE 7, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE GW-7.5: EXTRACTION, ON-SITE TREATMENT (FILTRATION, OXIDATIVE FILTRATION), DISCHARGE TO THAMES RIVER, LUCs, AND MONITORING**

**ANNUAL COST**

| Item | Item Cost Years 1 and 2 | Item Cost Years 3 and 4 | Item Cost Years 5 and 20 | Item Cost Every 5 Years | Notes |
|---|---|---|---|---|---|
| Groundwater Sampling | $33,408 | $16,704 | $8,352 | | 6 Wells (2 Performance Wells, 4 Migration Wells). Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 20. Labor and supplies for sampling |
| Groundwater Analysis (Performance) | $224 | $112 | $56 | | 2 wells, Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 20. Analysis for arsenic. |
| Groundwater Analysis (Migration) | $448 | $224 | $112 | | 4 wells, Sample Quarterly Years 1 & 2, Semi-Annually Years 3 & 4, Annually Years 5 through 20. Analysis for arsenic. |
| Annual Report | $5,000 | $5,000 | $5,000 | | |
| Inspection | $1,000 | $1,000 | $1,000 | | Annual LUC inspection (assume 8 hours at $50/hr plus expenses |
| Site Review | | | | $23,000 | 5-year review |
| Subtotal | $40,080 | $23,040 | $14,520 | $23,000 | |
| Contingency at 10% | $4,008 | $2,304 | $1,452 | $2,300 | |
| **TOTAL** | $44,088 | $25,344 | $15,972 | $25,300 | |

**ZONE 7, LOWER SUBASE**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE GW-7.5: EXTRACTION, ON-SITE TREATMENT (FILTRATION, OXIDATIVE FILTRATION), DISCHARGE TO THAMES RIVER, LUCs, AND MONITORING**
**Present Worth Analysis**

| Year | Capital Cost | Operation and Maintenance Cost | Annual Cost | Total Year Cost | Annual Discount Rate at 7% | Present Worth |
|---|---|---|---|---|---|---|
| 0 | $499,227 | | | $499,227 | 1.000 | $499,227 |
| 1 | | $62,897 | $44,088 | $106,985 | 0.935 | $100,031 |
| 2 | | $62,897 | $44,088 | $106,985 | 0.873 | $93,398 |
| 3 | | $62,897 | $25,344 | $88,241 | 0.816 | $72,005 |
| 4 | | $62,897 | $25,344 | $88,241 | 0.763 | $67,328 |
| 5 | | $71,897 | $41,272 | $113,169 | 0.713 | $80,689 |
| 6 | | $62,897 | $15,972 | $78,869 | 0.666 | $52,527 |
| 7 | | $62,897 | $15,972 | $78,869 | 0.623 | $49,135 |
| 8 | | $62,897 | $15,972 | $78,869 | 0.582 | $45,902 |
| 9 | | $62,897 | $15,972 | $78,869 | 0.544 | $42,905 |
| 10 | | $71,897 | $41,272 | $113,169 | 0.508 | $57,490 |
| 11 | | $62,897 | $15,972 | $78,869 | 0.475 | $37,463 |
| 12 | | $62,897 | $15,972 | $78,869 | 0.444 | $35,018 |
| 13 | | $62,897 | $15,972 | $78,869 | 0.415 | $32,731 |
| 14 | | $62,897 | $15,972 | $78,869 | 0.388 | $30,601 |
| 15 | | $71,897 | $41,272 | $113,169 | 0.362 | $40,967 |
| 16 | | $62,897 | $15,972 | $78,869 | 0.339 | $26,737 |
| 17 | | $62,897 | $15,972 | $78,869 | 0.317 | $25,001 |
| 18 | | $62,897 | $15,972 | $78,869 | 0.296 | $23,345 |
| 19 | | | $15,972 | $15,972 | 0.277 | $4,424 |
| 20 | | | $41,272 | $41,272 | 0.258 | $10,648 |
| | | | | | **TOTAL PRESENT WORTH** | **$1,427,571** |

# APPENDIX E.3

# SEDIMENT ALTERNATIVES COST ESTIMATES

# ALTERNATIVES SD-1, SD-3, SD-4, SD-6, and SD-7

**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE SD-1: NO ACTION**
**Annual Cost**

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| Item | Item Cost every 5 years | Notes |
|---|---|---|
| Five-Year Review | $23,000 | |
| Subtotal | $23,000 | |
| Contingency @ 10% | $2,300 | |
| **TOTAL** | **$25,300** | |

**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE SD-1: NO ACTION**
**Present Worth Analysis**

1/5/2010 2:37 PM

| Year | Capital Cost | Annual Cost | Total Year Cost | Annual Discount Rate at 7% | Present Worth |
|---|---|---|---|---|---|
| 0 | $0 | | $0 | 1.000 | $0 |
| 1 | | | $0 | 0.935 | $0 |
| 2 | | | $0 | 0.873 | $0 |
| 3 | | | $0 | 0.816 | $0 |
| 4 | | | $0 | 0.763 | $0 |
| 5 | | $25,300 | $25,300 | 0.713 | $18,039 |
| 6 | | | $0 | 0.666 | $0 |
| 7 | | | $0 | 0.623 | $0 |
| 8 | | | $0 | 0.582 | $0 |
| 9 | | | $0 | 0.544 | $0 |
| 10 | | $25,300 | $25,300 | 0.508 | $12,852 |
| 11 | | | $0 | 0.475 | $0 |
| 12 | | | $0 | 0.444 | $0 |
| 13 | | | $0 | 0.415 | $0 |
| 14 | | | $0 | 0.388 | $0 |
| 15 | | $25,300 | $25,300 | 0.362 | $9,159 |
| 16 | | | $0 | 0.339 | $0 |
| 17 | | | $0 | 0.317 | $0 |
| 18 | | | $0 | 0.296 | $0 |
| 19 | | | $0 | 0.277 | $0 |
| 20 | | $25,300 | $25,300 | 0.258 | $6,527 |
| 21 | | | $0 | 0.242 | $0 |
| 22 | | | $0 | 0.226 | $0 |
| 23 | | | $0 | 0.211 | $0 |
| 24 | | | $0 | 0.197 | $0 |
| 25 | | $25,300 | $25,300 | 0.184 | $4,655 |
| 26 | | | $0 | 0.172 | $0 |
| 27 | | | $0 | 0.161 | $0 |
| 28 | | | $0 | 0.150 | $0 |
| 29 | | | $0 | 0.141 | $0 |
| 30 | | $25,300 | $25,300 | 0.131 | $3,314 |
| | | | | **TOTAL PRESENT WORTH** | **$54,547** |

**LOWER SUBASE FS**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE SD-3: CAPPING WITH PRE-DREDGING TO MEET RAOs, DEWATERING, ON-SITE TREATMENT & DISCHARGE OF DEWATERING FLUID, OFF-SITE DISPOSAL OF SEDIMENT , LUCs, and MONITORING**
**Capital Cost**

| | | | | Unit Cost | | | | Extended Cost | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Item | Quantity | Unit | Subcontract | Material | Labor | Equipment | Subcontract | Material | Labor | Equipment | Subtotal |
| **1 PROJECT PLANNING** | | | | | | | | | | | |
| 1.1 Prepare LUC RD Documents | 60 | hr | | | $37.00 | | $0 | $0 | $2,220 | $0 | $2,220 |
| 1.2 Prepare Documents & Plans including Permits | 400 | hr | | | $37.00 | | $0 | $0 | $14,800 | $0 | $14,800 |
| **2 MOBILIZATION AND DEMOBILIZATION** | | | | | | | | | | | |
| 2.1 Site Support Facilities (trailers, phone, electric, etc.) | 1 | ls | | $1,000.00 | | $3,500.00 | $0 | $1,000 | $0 | $3,500 | $4,500 |
| 2.2 Barge Mobilization | 6 | ea | | | | $2,500.00 | $0 | $0 | $0 | $15,000 | $15,000 |
| 2.3 Equipment Mobilization/Demobilization | 8 | ea | | | $170.00 | $522.00 | $0 | $0 | $1,360 | $4,176 | $5,536 |
| 2.4 Long-Reach Equipment Mobilization/Demobilization | 2 | ea | | | $300.00 | $975.00 | $0 | $0 | $600 | $1,950 | $2,550 |
| 2.5 Utility Connection/Disconnection (phone/electric) | 1 | ls | $1,250.00 | | | | $1,250 | $0 | $0 | $0 | $1,250 |
| **3 FIELD SUPPORT** | | | | | | | | | | | |
| 3.1 Office Trailer | 2 | mo | | | | $375.00 | $0 | $0 | $0 | $750 | $750 |
| 3.2 Field Office Equipment, Utilities, & Support | 2 | mo | | $470.00 | | | $0 | $940 | $0 | $0 | $940 |
| 3.3 Storage Trailer | 2 | mo | | | | $99.00 | $0 | $0 | $0 | $198 | $198 |
| 3.4 Site Superintendent | 60 | day | | $169.00 | $384.64 | | $0 | $10,140 | $23,078 | $0 | $33,218 |
| 3.5 Site Health & Safety | 50 | day | | $169.00 | $307.68 | | $0 | $8,450 | $15,384 | $0 | $23,834 |
| 3.6 Site QA/QC | 50 | day | | $169.00 | $307.68 | | $0 | $8,450 | $15,384 | $0 | $23,834 |
| 3.7 Bathymetric Survey ( pre-removal) | 1 | ea | $5,000.00 | | | | $5,000 | $0 | $0 | $0 | $5,000 |
| **4 DREDGING, AND DEWATERING** | | | | | | | | | | | |
| 4.1 Excavator on Barge, long-reach, 2 each | 62 | day | | | $466.96 | $4,437.40 | $0 | $0 | $28,952 | $275,119 | $304,070 |
| 4.2 Spoil Barge, 90' by 30', 6 each | 186 | day | | | | $748.40 | $0 | $0 | $0 | $139,202 | $139,202 |
| 4.3 Tugboats, 6 each | 186 | day | | | $340.48 | $663.40 | $0 | $0 | $63,329 | $123,392 | $186,722 |
| 4.4 Barge Barriers, fabric, membrane, etc. | 6 | ea | | $4,875.00 | | | $0 | $29,250 | $0 | $0 | $29,250 |
| 4.5 Trash Pumps, 3 each | 93 | day | | | | $117.00 | $0 | $0 | $0 | $10,881 | $10,881 |
| 4.6 Barge Geotextile Filter Membrane Replacement | 18 | ea | | $1,000.00 | | | $0 | $18,000 | $0 | $0 | $18,000 |
| 4.7 Turbidity Curtain | 1,600 | ft | | $39.90 | | | $0 | $63,840 | $0 | $0 | $63,840 |
| 4.8 Turbidity Monitoring Buoy, 4 each | 6 | mo | | | | $4,080.00 | $0 | $0 | $0 | $24,480 | $24,480 |
| 4.9 Dewatering Effluent Tank, 5,000 gal, 6 each | 9 | mo | | | | $781.00 | $0 | $0 | $0 | $7,029 | $7,029 |
| 4.10 Transfer Pump | 31 | day | | | | $66.40 | $0 | $0 | $0 | $2,058 | $2,058 |
| 4.11 Dredgeman/Laborers, 6 each | 186 | day | | | $309.86 | | $0 | $0 | $57,634 | $0 | $57,634 |
| 4.12 Fly Ash | 14,497 | tons | | $40.00 | | | $0 | $579,880 | $0 | $0 | $579,880 |
| 4.13 Front-End Loader | 31 | day | | | $430.24 | $854.40 | $0 | $0 | $13,337 | $26,486 | $39,824 |
| 4.14 Excavator | 31 | day | | | $466.96 | $2,635.00 | $0 | $0 | $14,476 | $81,685 | $96,161 |
| 4.15 Sampling Dewatered Sediment | 60 | ea | $2,000.00 | $50.00 | $100.00 | $50.00 | $120,000 | $3,000 | $6,000 | $3,000 | $132,000 |
| 4.16 Sampling Dewatered Fluid | 49 | ea | $740.00 | $50.00 | $100.00 | $50.00 | $36,260 | $2,450 | $4,900 | $2,450 | $46,060 |
| **5 CAPPING AND SITE RESTORATION** | | | | | | | | | | | |
| 5.1 Sand/Gravel Cap - 3 ft thick | 2,400 | cy | | $21.60 | | | $0 | $51,840 | $0 | $0 | $51,840 |
| 5.2 Load Barges with 3 CY Excavator | 2,400 | cy | $2.51 | | | | $6,024 | $0 | $0 | $0 | $6,024 |
| 5.3 Barge, 800 T, One for 2 Weeks for Sand/Gravel | 2 | wk | | | | $2,256.00 | $0 | $0 | $0 | $4,512 | $4,512 |
| 5.4 Barge-Mounted Clamshell to Unload Sand/Gravel | 12 | days | $4,020.25 | | | | $48,243 | $0 | $0 | $0 | $48,243 |
| 5.5 Bathymetric Survey ( post-removal) | 1 | ea | $5,000.00 | | | | $5,000 | $0 | $0 | $0 | $5,000 |
| **6 ON-SITE TREATMENT OF DEWATERING FLUID** | | | | | | | | | | | |
| 6.1 5,000 lb Liquid-Phase GAC Adsorption Units, 2 unit | 3 | mo | | $10,750.00 | $185.00 | | | $32,250 | $555 | $0 | $32,805 |
| 6.2 53 sf Pressurized Bag Filters, 2 unit | 3 | mo | | $818.00 | $125.00 | | | $2,454 | $375 | $0 | $2,829 |
| 6.3 Piping , 1" PE, for Treatment System | 300 | ft | | $89.00 | $1.21 | | $0 | $26,700 | $363 | $0 | $27,063 |
| 6.4 Replace Filter Bag Element | 132 | ea | | $5.00 | | | | $660 | $0 | $0 | $660 |
| 6.5 Replace GAC Adsorption Unit | 40,000 | lb | | $3.00 | | | | $120,000 | $0 | $0 | $120,000 |
| 6.6 Dredgeman/Laborers, 1 each, 3 shifts/day | 93 | day | | | $309.86 | | $0 | $0 | $28,817 | $0 | $28,817 |
| 6.7 Sampling Influent & Effluent | 31 | ea | $940.00 | $50.00 | $100.00 | $100.00 | $29,140 | $1,550 | $3,100 | $3,100 | $36,890 |

**LOWER SUBASE FS**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE SD-3: CAPPING WITH PRE-DREDGING TO MEET RAOs, DEWATERING, ON-SITE TREATMENT & DISCHARGE OF DEWATERING FLUID, OFF-SITE DISPOSAL OF SEDIMENT , LUCs, and MONITORING**
**Capital Cost**

| | | | | Unit Cost | | | Extended Cost | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Item | Quantity | Unit | Subcontract | Material | Labor | Equipment | Subcontract | Material | Labor | Equipment | Subtotal |
| **7 OFF-SITE TRANSPORTATION AND DISPOSAL** | | | | | | | | | | | |
| 7.1 Sediment Disposal, non-hazardous | 15,657 | tons | $40.00 | | | | $626,280 | $0 | $0 | $0 | $626,280 |
| **8 POST CONSTRUCTION COST** | | | | | | | | | | | |
| 8.1 Contractor Completion Report | 80 | hr | | | $37.00 | | $0 | $0 | $2,960 | $0 | $2,960 |
| 8.2 Remedial Action Closeout Report | 140 | hr | | | $37.00 | | $0 | $0 | $5,180 | $0 | $5,180 |
| **Subtotal** | | | | | | | $877,197 | $960,854 | $302,804 | $728,969 | $2,869,825 |
| Overhead on Labor Cost @ 30% | | | | | | | | | $90,841 | | $90,841 |
| G & A on Labor Cost @ 10% | | | | | | | | | $30,280 | | $30,280 |
| G & A on Material Cost @ 10% | | | | | | | | $96,085 | | | $96,085 |
| G & A on Equipment Cost @ 10% | | | | | | | | | | $72,897 | $72,897 |
| G & A on Subcontract Cost @ 10% | | | | | | | $87,720 | | | | $87,720 |
| Tax on Materials and Equipment Cost @ 6% | | | | | | | | $57,651 | | $43,738 | $101,389 |
| **Total Direct Cost** | | | | | | | $964,917 | $1,114,591 | $423,926 | $845,605 | $3,349,038 |
| * Indirects on Total Direct Cost @ 30% | | (excluding transportation and disposal cost) | | | | | | | | | $816,827 |
| Profit on Total Direct Cost @ 10% | | | | | | | | | | | $334,904 |
| **Total Field Cost** | | | | | | | | | | | $4,500,769 |
| Contingency on Total Field Costs @ 20% | | | | | | | | | | | $900,154 |
| Engineering on Total Field Cost @ 7% | | | | | | | | | | | $315,054 |
| **TOTAL CAPITAL COST** | | | | | | | | | | | **$5,715,977** |

**LOWER SUBASE FS**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE SD-3: CAPPING WITH PRE-DREDGING TO MEET RAOs, DEWATERING, ON-SITE TREATMENT & DISCHARGE OF DEWATERING FLUID, OFF-SITE DISPOSAL OF SEDIMENT , LUCs, and MONITORING**
**ANNUAL COST**

| Item | Item Cost Years 1 & 2 | Item Cost Years 3 through 30 | Item Cost Every 5 Years | Notes |
|---|---|---|---|---|
| Sediment and River Water Sampling | $20,204 | $10,102 | | Sediment and water at six locations on and around the cap. Sample semi-annually the first 2 years and annually thereafter. |
| Sediment Analysis | $5,208 | $2,604 | | Analyze sediments for PAHs, PCBs, and metals. |
| Water Analysis | $5,208 | $2,604 | | Analyze water for PAHs, PCBs, and metals. |
| Annual Report | $5,000 | $5,000 | | |
| Inspection | $1,000 | $1,000 | | Annual LUC inspection (assume 8 hours at $50/hr plus expenses) |
| Site Review | | | $23,000 | 5-year review |
| Subtotal | $36,620 | $21,310 | $23,000 | |
| Contingency at 10% | $3,662 | $2,131 | $2,300 | |
| **TOTAL** | **$40,282** | **$23,441** | **$25,300** | |
| Bathymetric Survey | $5,000 | | | Conduct survey in years 1, 3, 5, 10, 15, 20, 25, & 30. |

**LOWER SUBASE FS**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE SD-3: CAPPING WITH PRE-DREDGING TO MEET RAOs, DEWATERING, ON-SITE TREATMENT & DISCHARGE OF DEWATERING FLUID, OFF-SITE DISPOSAL OF SEDIMENT , LUCs, and MONITORING**
**Present Worth Analysis**

| Year | Capital Cost | Annual Cost | Total Year Cost | Annual Discount Rate at 7% | Present Worth |
|---|---|---|---|---|---|
| 0 | $5,715,977 | | $5,715,977 | 1.000 | $5,715,977 |
| 1 | | $45,282 | $45,282 | 0.935 | $42,339 |
| 2 | | $40,282 | $40,282 | 0.873 | $35,166 |
| 3 | | $28,441 | $28,441 | 0.816 | $23,208 |
| 4 | | $23,441 | $23,441 | 0.763 | $17,885 |
| 5 | | $53,741 | $53,741 | 0.713 | $38,317 |
| 6 | | $23,441 | $23,441 | 0.666 | $15,612 |
| 7 | | $23,441 | $23,441 | 0.623 | $14,604 |
| 8 | | $23,441 | $23,441 | 0.582 | $13,643 |
| 9 | | $23,441 | $23,441 | 0.544 | $12,752 |
| 10 | | $53,741 | $53,741 | 0.508 | $27,300 |
| 11 | | $23,441 | $23,441 | 0.475 | $11,134 |
| 12 | | $23,441 | $23,441 | 0.444 | $10,408 |
| 13 | | $23,441 | $23,441 | 0.415 | $9,728 |
| 14 | | $23,441 | $23,441 | 0.388 | $9,095 |
| 15 | | $53,741 | $53,741 | 0.362 | $19,454 |
| 16 | | $23,441 | $23,441 | 0.339 | $7,946 |
| 17 | | $23,441 | $23,441 | 0.317 | $7,431 |
| 18 | | $23,441 | $23,441 | 0.296 | $6,939 |
| 19 | | $23,441 | $23,441 | 0.277 | $6,493 |
| 20 | | $53,741 | $53,741 | 0.258 | $13,865 |
| 21 | | $23,441 | $23,441 | 0.242 | $5,673 |
| 22 | | $23,441 | $23,441 | 0.226 | $5,298 |
| 23 | | $23,441 | $23,441 | 0.211 | $4,946 |
| 24 | | $23,441 | $23,441 | 0.197 | $4,618 |
| 25 | | $53,741 | $53,741 | 0.184 | $9,888 |
| 26 | | $23,441 | $23,441 | 0.172 | $4,032 |
| 27 | | $23,441 | $23,441 | 0.161 | $3,774 |
| 28 | | $23,441 | $23,441 | 0.150 | $3,516 |
| 29 | | $23,441 | $23,441 | 0.141 | $3,305 |
| 30 | | $53,741 | $53,741 | 0.131 | $7,040 |
| | | | | **TOTAL PRESENT WORTH** | **$6,111,386** |

**LOWER SUBASE FS**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**

**ALTERNATIVE SD-4: CAPPING WITH PRE-DREDGING TO MEET RAOs, DEWATERING, OFF-SITE DISPOSAL OF SEDIMENT & DEWATERING FLUID, LUCs, and MONITORING**
**Capital Cost**

| | | | | Unit Cost | | | | Extended Cost | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Item | Quantity | Unit | Subcontract | Material | Labor | Equipment | Subcontract | Material | Labor | Equipment | Subtotal |
| **1 PROJECT PLANNING** | | | | | | | | | | | |
| 1.1 Prepare LUC RD Documents | 60 | hr | | | $37.00 | | $0 | $0 | $2,220 | $0 | $2,220 |
| 1.2 Prepare Documents & Plans including Permits | 400 | hr | | | $37.00 | | $0 | $0 | $14,800 | $0 | $14,800 |
| **2 MOBILIZATION AND DEMOBILIZATION** | | | | | | | | | | | |
| 2.1 Site Support Facilities (trailers, phone, electric, etc.) | 1 | ls | | $1,000.00 | | $3,500.00 | $0 | $1,000 | $0 | $3,500 | $4,500 |
| 2.2 Barge Mobilization | 6 | ea | | | | $2,500.00 | $0 | $0 | $0 | $15,000 | $15,000 |
| 2.3 Equipment Mobilization/Demobilization | 8 | ea | | | $170.00 | $522.00 | $0 | $0 | $1,360 | $4,176 | $5,536 |
| 2.4 Long-Reach Equipment Mobilization/Demobilization | 2 | ea | | | $300.00 | $975.00 | $0 | $0 | $600 | $1,950 | $2,550 |
| 2.5 Utility Connection/Disconnection (phone/electric) | 1 | ls | $1,250.00 | | | | $1,250 | $0 | $0 | $0 | $1,250 |
| **3 FIELD SUPPORT** | | | | | | | | | | | |
| 3.1 Office Trailer | 2 | mo | | | | $375.00 | $0 | $0 | $0 | $750 | $750 |
| 3.2 Field Office Equipment, Utilities, & Support | 2 | mo | | $470.00 | | | $0 | $940 | $0 | $0 | $940 |
| 3.3 Storage Trailer | 2 | mo | | | | $99.00 | $0 | $0 | $0 | $198 | $198 |
| 3.4 Site Superintendent | 60 | day | | $169.00 | $384.64 | | $0 | $10,140 | $23,078 | $0 | $33,218 |
| 3.5 Site Health & Safety | 50 | day | | $169.00 | $307.68 | | $0 | $8,450 | $15,384 | $0 | $23,834 |
| 3.6 Site QA/QC | 50 | day | | $169.00 | $307.68 | | $0 | $8,450 | $15,384 | $0 | $23,834 |
| 3.7 Bathymetric Survey ( pre-removal) | 1 | ea | $5,000.00 | | | | $5,000 | $0 | $0 | $0 | $5,000 |
| **4 DREDGING, AND DEWATERING** | | | | | | | | | | | |
| 4.1 Excavator on Barge, long-reach, 2 each | 62 | day | | | $466.96 | $4,437.40 | $0 | $0 | $28,952 | $275,119 | $304,070 |
| 4.2 Spoil Barge, 90' by 30', 6 each | 186 | day | | | | $748.40 | $0 | $0 | $0 | $139,202 | $139,202 |
| 4.3 Tugboats, 6 each | 186 | day | | | $340.48 | $663.40 | $0 | $0 | $63,329 | $123,392 | $186,722 |
| 4.4 Barge Barriers, fabric, membrane, etc. | 6 | ea | | $4,875.00 | | | $0 | $29,250 | $0 | $0 | $29,250 |
| 4.5 Trash Pumps, 3 each | 93 | day | | | | $117.00 | $0 | $0 | $0 | $10,881 | $10,881 |
| 4.6 Barge Geotextile Filter Membrane Replacement | 18 | ea | | $1,000.00 | | | $0 | $18,000 | $0 | $0 | $18,000 |
| 4.7 Turbidity Curtain | 1,600 | ft | | $39.90 | | | $0 | $63,840 | $0 | $0 | $63,840 |
| 4.8 Turbidity Monitoring Buoy, 4 each | 6 | mo | | | | $4,080.00 | $0 | $0 | $0 | $24,480 | $24,480 |
| 4.9 Dewatering Effluent Tank, 5,000 gal, 6 each | 9 | mo | | | | $781.00 | $0 | $0 | $0 | $7,029 | $7,029 |
| 4.10 Transfer Pump | 31 | day | | | | $66.40 | $0 | $0 | $0 | $2,058 | $2,058 |
| 4.11 Dredgeman/Laborers, 6 each | 186 | day | | | $309.86 | | $0 | $0 | $57,634 | $0 | $57,634 |
| 4.12 Fly Ash | 14,497 | tons | | $40.00 | | | $0 | $579,880 | $0 | $0 | $579,880 |
| 4.13 Front-End Loader | 31 | day | | | $430.24 | $854.40 | $0 | $0 | $13,337 | $26,486 | $39,824 |
| 4.14 Excavator | 31 | day | | | $466.96 | $2,635.00 | $0 | $0 | $14,476 | $81,685 | $96,161 |
| 4.15 Sampling Dewatered Sediment | 60 | ea | $2,000.00 | $50.00 | $100.00 | $50.00 | $120,000 | $3,000 | $6,000 | $3,000 | $132,000 |
| 4.16 Sampling Dewatered Fluid | 49 | ea | $740.00 | $50.00 | $100.00 | $50.00 | $36,260 | $2,450 | $4,900 | $2,450 | $46,060 |
| **5 CAPPING AND SITE RESTORATION** | | | | | | | | | | | |
| 5.1 Sand/Gravel Cap - 3 ft thick | 2,400 | cy | | $21.60 | | | $0 | $51,840 | $0 | $0 | $51,840 |
| 5.2 Load Barges with 3 CY Excavator | 2,400 | cy | $2.51 | | | | $6,024 | $0 | $0 | $0 | $6,024 |
| 5.3 Barge, 800 T, One for 2 Weeks for Sand/Gravel | 2 | wk | | | | $2,256.00 | $0 | $0 | $0 | $4,512 | $4,512 |
| 5.4 Barge-Mounted Clamshell to Unload Sand/Gravel | 12 | days | $4,020.25 | | | | $48,243 | $0 | $0 | $0 | $48,243 |
| 5.5 Bathymetric Survey ( post-removal) | 1 | ea | $5,000.00 | | | | $5,000 | $0 | $0 | $0 | $5,000 |
| **6 OFF-SITE TRANSPORTATION AND DISPOSAL** | | | | | | | | | | | |
| 6.1 Sediment Disposal, non-hazardous | 15,657 | tons | $40.00 | | | | $626,280 | $0 | $0 | $0 | $626,280 |
| 6.2 Disposal of Dewatering Liquids | 246,076 | gal | $0.15 | | | | $36,911 | $0 | $0 | $0 | $36,911 |
| 6.3 Transporation of Dewatering Liquids ($500/5,000 gal) | 50 | trip | $500.00 | | | | $25,000 | $0 | $0 | $0 | $25,000 |
| **7 POST CONSTRUCTION COST** | | | | | | | | | | | |
| 7.1 Contractor Completion Report | 80 | hr | | | $37.00 | | $0 | $0 | $2,960 | $0 | $2,960 |
| 7.2 Remedial Action Closeout Report | 140 | hr | | | $37.00 | | $0 | $0 | $5,180 | $0 | $5,180 |
| **Subtotal** | | | | | | | $909,968 | $777,240 | $269,594 | $725,869 | $2,682,672 |

**LOWER SUBASE FS**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**

**ALTERNATIVE SD-4: CAPPING WITH PRE-DREDGING TO MEET RAOs, DEWATERING, OFF-SITE DISPOSAL OF SEDIMENT & DEWATERING FLUID, LUCs, and MONITORING**
**Capital Cost**

| Item | Quantity | Unit | Unit Cost Subcontract | Unit Cost Material | Unit Cost Labor | Unit Cost Equipment | Extended Cost Subcontract | Extended Cost Material | Extended Cost Labor | Extended Cost Equipment | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Overhead on Labor Cost @ 30% | | | | | | | | | $80,878 | | $80,878 |
| G & A on Labor Cost @ 10% | | | | | | | | | $26,959 | | $26,959 |
| G & A on Material Cost @ 10% | | | | | | | | $77,724 | | | $77,724 |
| G & A on Equipment Cost @ 10% | | | | | | | | | | $72,587 | $72,587 |
| G & A on Subcontract Cost @ 10% | | | | | | | $90,997 | | | | $90,997 |
| Tax on Materials and Equipment Cost @ 6% | | | | | | | | $46,634 | | $43,552 | $90,187 |
| **Total Direct Cost** | | | | | | | $1,000,965 | $901,598 | $377,432 | $842,009 | $3,122,004 |
| * Indirects on Total Direct Cost @ 30% | | (excluding transportation and disposal cost) | | | | | | | | | $730,144 |
| Profit on Total Direct Cost @ 10% | | | | | | | | | | | $312,200 |
| **Total Field Cost** | | | | | | | | | | | $4,164,349 |
| Contingency on Total Field Costs @ 20% | | | | | | | | | | | $832,870 |
| Engineering on Total Field Cost @ 7% | | | | | | | | | | | $291,504 |
| **TOTAL CAPITAL COST** | | | | | | | | | | | **$5,288,723** |

**LOWER SUBASE FS**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE SD-4: CAPPING WITH PRE-DREDGING TO MEET RAOs, DEWATERING, OFF-SITE DISPOSAL OF SEDIMENT & DEWATERING FLUID, LUCs, and MONITORING**
**ANNUAL COST**

| Item | Item Cost Years 1 & 2 | Item Cost Years 3 through 30 | Item Cost Every 5 Years | Notes |
|---|---|---|---|---|
| Sediment and River Water Sampling | $20,204 | $10,102 | | Sediment and water at six locations on and around the cap. Sample semi-annually the first 2 years and annually thereafter. |
| Sediment Analysis | $5,208 | $2,604 | | Analyze sediments for PAHs, PCBs, and metals. |
| Water Analysis | $5,208 | $2,604 | | Analyze water for PAHs, PCBs, and metals. |
| Annual Report | $5,000 | $5,000 | | |
| Inspection | $1,000 | $1,000 | | Annual LUC inspection (assume 8 hours at $50/hr plus expenses) |
| Site Review | | | $23,000 | 5-year review |
| Subtotal | $36,620 | $21,310 | $23,000 | |
| Contingency at 10% | $3,662 | $2,131 | $2,300 | |
| **TOTAL** | **$40,282** | **$23,441** | **$25,300** | |
| Bathymetric Survey | $5,000 | | | Conduct survey in years 1, 3, 5, 10, 15, 20, 25, & 30. |

**LOWER SUBASE FS**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE SD-4: CAPPING WITH PRE-DREDGING TO MEET RAOs, DEWATERING, OFF-SITE DISPOSAL OF SEDIMENT & DEWATERING FLUID, LUCs, and MONITORING**
**Present Worth Analysis**

| Year | Capital Cost | Annual Cost | Total Year Cost | Annual Discount Rate at 7% | Present Worth |
|---|---|---|---|---|---|
| 0 | $5,288,723 | | $5,288,723 | 1.000 | $5,288,723 |
| 1 | | $45,282 | $45,282 | 0.935 | $42,339 |
| 2 | | $40,282 | $40,282 | 0.873 | $35,166 |
| 3 | | $28,441 | $28,441 | 0.816 | $23,208 |
| 4 | | $23,441 | $23,441 | 0.763 | $17,885 |
| 5 | | $53,741 | $53,741 | 0.713 | $38,317 |
| 6 | | $23,441 | $23,441 | 0.666 | $15,612 |
| 7 | | $23,441 | $23,441 | 0.623 | $14,604 |
| 8 | | $23,441 | $23,441 | 0.582 | $13,643 |
| 9 | | $23,441 | $23,441 | 0.544 | $12,752 |
| 10 | | $53,741 | $53,741 | 0.508 | $27,300 |
| 11 | | $23,441 | $23,441 | 0.475 | $11,134 |
| 12 | | $23,441 | $23,441 | 0.444 | $10,408 |
| 13 | | $23,441 | $23,441 | 0.415 | $9,728 |
| 14 | | $23,441 | $23,441 | 0.388 | $9,095 |
| 15 | | $53,741 | $53,741 | 0.362 | $19,454 |
| 16 | | $23,441 | $23,441 | 0.339 | $7,946 |
| 17 | | $23,441 | $23,441 | 0.317 | $7,431 |
| 18 | | $23,441 | $23,441 | 0.296 | $6,939 |
| 19 | | $23,441 | $23,441 | 0.277 | $6,493 |
| 20 | | $53,741 | $53,741 | 0.258 | $13,865 |
| 21 | | $23,441 | $23,441 | 0.242 | $5,673 |
| 22 | | $23,441 | $23,441 | 0.226 | $5,298 |
| 23 | | $23,441 | $23,441 | 0.211 | $4,946 |
| 24 | | $23,441 | $23,441 | 0.197 | $4,618 |
| 25 | | $53,741 | $53,741 | 0.184 | $9,888 |
| 26 | | $23,441 | $23,441 | 0.172 | $4,032 |
| 27 | | $23,441 | $23,441 | 0.161 | $3,774 |
| 28 | | $23,441 | $23,441 | 0.150 | $3,516 |
| 29 | | $23,441 | $23,441 | 0.141 | $3,305 |
| 30 | | $53,741 | $53,741 | 0.131 | $7,040 |
| | | | | **TOTAL PRESENT WORTH** | **$5,684,132** |

**LOWER SUBASE FS**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**

**ALTERNATIVE SD-6: DREDGING TO MEET PRGs, DEWATERING, ON-SITE TREATMENT & DISCHARGE OF DEWATERING FLUID, OFF-SITE DISPOSAL OF DEWATERED SEDIMENT**
**Capital Cost**

| | | | | Unit Cost | | | | Extended Cost | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Item | Quantity | Unit | Subcontract | Material | Labor | Equipment | Subcontract | Material | Labor | Equipment | Subtotal |
| **1 PROJECT PLANNING** | | | | | | | | | | | |
| 1.1 Prepare LUC RD Documents | 60 | hr | | | $37.00 | | $0 | $0 | $2,220 | $0 | $2,220 |
| 1.2 Prepare Documents & Plans including Permits | 400 | hr | | | $37.00 | | $0 | $0 | $14,800 | $0 | $14,800 |
| **2 MOBILIZATION AND DEMOBILIZATION** | | | | | | | | | | | |
| 2.1 Site Support Facilities (trailers, phone, electric, etc.) | 1 | ls | | $1,000.00 | | $3,500.00 | $0 | $1,000 | $0 | $3,500 | $4,500 |
| 2.2 Barge Mobilization | 6 | ea | | | | $2,500.00 | $0 | $0 | $0 | $15,000 | $15,000 |
| 2.3 Equipment Mobilization/Demobilization | 8 | ea | | | $170.00 | $522.00 | $0 | $0 | $1,360 | $4,176 | $5,536 |
| 2.4 Long-Reach Equipment Mobilization/Demobilization | 2 | ea | | | $300.00 | $975.00 | $0 | $0 | $600 | $1,950 | $2,550 |
| 2.5 Utility Connection/Disconnection (phone/electric) | 1 | ls | $1,250.00 | | | | $1,250 | $0 | $0 | $0 | $1,250 |
| **3 FIELD SUPPORT** | | | | | | | | | | | |
| 3.1 Office Trailer | 3 | mo | | | | $375.00 | $0 | $0 | $0 | $1,125 | $1,125 |
| 3.2 Field Office Equipment, Utilities, & Support | 3 | mo | | $470.00 | | | $0 | $1,410 | $0 | $0 | $1,410 |
| 3.3 Storage Trailer | 3 | mo | | | | $99.00 | $0 | $0 | $0 | $297 | $297 |
| 3.4 Site Superintendent | 70 | day | | $169.00 | $384.64 | | $0 | $11,830 | $26,925 | $0 | $38,755 |
| 3.5 Site Health & Safety | 60 | day | | $169.00 | $307.68 | | $0 | $10,140 | $18,461 | $0 | $28,601 |
| 3.6 Site QA/QC | 60 | day | | $169.00 | $307.68 | | $0 | $10,140 | $18,461 | $0 | $28,601 |
| 3.7 Bathymetric Survey (pre-removal) | 1 | ea | $7,500.00 | | | | $7,500 | $0 | $0 | $0 | $7,500 |
| **4 DREDGING, AND DEWATERING** | | | | | | | | | | | |
| 4.1 Excavator on Barge, long-reach (2 each) | 116 | day | | | $466.96 | $4,437.40 | $0 | $0 | $54,167 | $514,738 | $568,906 |
| 4.2 Spoil Barge, 90' by 30', 6 each | 348 | day | | | | $748.40 | $0 | $0 | $0 | $260,443 | $260,443 |
| 4.3 Tugboats, 6 each | 348 | day | | | $340.48 | $663.40 | $0 | $0 | $118,487 | $230,863 | $349,350 |
| 4.4 Barge Barriers, fabric, membrane, etc. | 6 | ea | | $4,875.00 | | | $0 | $29,250 | $0 | $0 | $29,250 |
| 4.5 Trash Pumps, 3 each | 348 | day | | | | $117.00 | $0 | $0 | $0 | $40,716 | $40,716 |
| 4.6 Barge Geotextile Filter Membrane Replacement | 36 | ea | | $1,000.00 | | | $0 | $36,000 | $0 | $0 | $36,000 |
| 4.7 Turbidity Curtain | 1,600 | ft | | $39.90 | | | $0 | $63,840 | $0 | $0 | $63,840 |
| 4.8 Turbidity Monitoring Buoy (4 each) | 12 | mo | | | | $4,080.00 | $0 | $0 | $0 | $48,960 | $48,960 |
| 4.9 Dewatering Effluent Tank, 5,000 gal, 6 each | 36 | mo | | | | $781.00 | $0 | $0 | $0 | $28,116 | $28,116 |
| 4.10 Transfer Pump | 58 | day | | | | $66.40 | $0 | $0 | $0 | $3,851 | $3,851 |
| 4.11 Dredgeman/Laborers, 6 each | 346 | day | | | $309.86 | | $0 | $0 | $107,212 | $0 | $107,212 |
| 4.12 Fly Ash | 2,222 | tons | | $40.00 | | | $0 | $88,880 | $0 | $0 | $88,880 |
| 4.13 Front-End Loader | 58 | day | | | $430.24 | $854.40 | $0 | $0 | $24,954 | $49,555 | $74,509 |
| 4.14 Excavator | 58 | day | | | $466.96 | $2,635.00 | $0 | $0 | $27,084 | $152,830 | $179,914 |
| 4.15 Sampling Sediment Verification | 27 | ea | $900.00 | $50.00 | $100.00 | $50.00 | $24,300 | $1,350 | $2,700 | $1,350 | $29,700 |
| 4.16 Sampling Dewatered Sediment | 116 | ea | $2,000.00 | $50.00 | $100.00 | $50.00 | $232,000 | $5,800 | $11,600 | $5,800 | $255,200 |
| 4.17 Sampling Dewatered Fluid | 95 | ea | $740.00 | $50.00 | $100.00 | $50.00 | $70,300 | $4,750 | $9,500 | $4,750 | $89,300 |
| **5 BACKFILL AND SITE RESTORATION** | | | | | | | | | | | |
| 5.1 Sand/Gravel Cap - 6 ft thick | 10,276 | cy | | $21.60 | | | $0 | $221,962 | $0 | $0 | $221,962 |
| 5.2 Load Barges with 3 CY Excavator | 10,276 | cy | $2.51 | | | | $25,793 | $0 | $0 | $0 | $25,793 |
| 5.3 Barge, 800 T, One for 3 Weeks for Sand/Gravel | 4 | wk | | | | $2,256.00 | $0 | $0 | $0 | $9,024 | $9,024 |
| 5.4 Barge-Mounted Clamshell to Unload Sand/Gravel | 20 | days | $4,020.25 | | | | $80,405 | $0 | $0 | $0 | $80,405 |
| 5.5 Bathymetric Survey (post-removal) | 1 | ea | $7,500.00 | | | | $7,500 | $0 | $0 | $0 | $7,500 |
| **6 ON-SITE TREATMENT OF DEWATERING FLUID** | | | | | | | | | | | |
| 6.1 5,000 lb Liquid-Phase GAC Adsorption Units, 2 unit | 6 | mo | | $10,750.00 | $185.00 | | | $64,500 | $1,110 | $0 | $65,610 |
| 6.2 53 sf Pressurized Bag Filters, 2 unit | 6 | mo | | $818.00 | $125.00 | | | $4,908 | $750 | $0 | $5,658 |
| 6.3 Piping , 1" PE, for Treatment System | 300 | ft | | $89.00 | $1.21 | | $0 | $26,700 | $363 | $0 | $27,063 |
| 6.4 Replace Filter Bag Element | 240 | ea | | $5.00 | | | | $1,200 | $0 | $0 | $1,200 |
| 6.5 Replace GAC Adsorption Unit | 75,000 | lb | | $3.00 | | | | $225,000 | $0 | $0 | $225,000 |
| 6.6 Dredgeman/Laborers, 1 each, 3 shifts/day | 174 | day | | | $309.86 | | $0 | $0 | $53,916 | $0 | $53,916 |
| 6.7 Sampling Influent & Effluent | 116 | ea | $940.00 | $50.00 | $100.00 | $100.00 | $109,040 | $5,800 | $11,600 | $11,600 | $138,040 |
| **7 OFF-SITE TRANSPORTATION AND DISPOSAL** | | | | | | | | | | | |
| 7.1 Sediment Disposal, non-hazardous | 29,985 | tons | $40.00 | | | | $1,199,400 | $0 | $0 | $0 | $1,199,400 |

**LOWER SUBASE FS**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**

**ALTERNATIVE SD-6: DREDGING TO MEET PRGs, DEWATERING, ON-SITE TREATMENT & DISCHARGE OF DEWATERING FLUID, OFF-SITE DISPOSAL OF DEWATERED SEDIMENT**
**Capital Cost**

| | | | Unit Cost | | | | Extended Cost | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Item | Quantity | Unit | Subcontract | Material | Labor | Equipment | Subcontract | Material | Labor | Equipment | Subtotal |
| **8 POST CONSTRUCTION COST** | | | | | | | | | | | |
| 8.1 Contractor Completion Report | 80 | hr | | | $37.00 | | $0 | $0 | $2,960 | $0 | $2,960 |
| 8.2 Remedial Action Closeout Report | 140 | hr | | | $37.00 | | $0 | $0 | $5,180 | $0 | $5,180 |
| **Subtotal** | | | | | | | $1,757,488 | $814,460 | $514,409 | $1,388,645 | $4,475,001 |
| Overhead on Labor Cost @ 30% | | | | | | | | | $154,323 | | $154,323 |
| G & A on Labor Cost @ 10% | | | | | | | | | $51,441 | | $51,441 |
| G & A on Material Cost @ 10% | | | | | | | | $81,446 | | | $81,446 |
| G & A on Equipment Cost @ 10% | | | | | | | | | | $138,865 | $138,865 |
| G & A on Subcontract Cost @ 10% | | | | | | | $175,749 | | | | $175,749 |
| Tax on Materials and Equipment Cost @ 6% | | | | | | | | $48,868 | | $83,319 | $132,186 |
| **Total Direct Cost** | | | | | | | $1,933,237 | $944,773 | $720,172 | $1,610,828 | $5,209,010 |
| * Indirects on Total Direct Cost @ 20% | | (excluding transportation and disposal cost) | | | | | | | | | $801,922 |
| Profit on Total Direct Cost @ 10% | | | | | | | | | | | $520,901 |
| **Total Field Cost** | | | | | | | | | | | $6,531,833 |
| Contingency on Total Field Costs @ 20% | | | | | | | | | | | $1,306,367 |
| Engineering on Total Field Cost @ 5% | | | | | | | | | | | $326,592 |
| **TOTAL CAPITAL COST** | | | | | | | | | | | **$8,164,791** |

**LOWER SUBASE FS**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**

**ALTERNATIVE SD-7: DREDGING TO MEET PRGs, DEWATERING, & OFF-SITE DISPOSAL OF DEWATERED SEDIMENT AND DEWATERED FLUIDS**
**Capital Cost**

| | | | | Unit Cost | | | | Extended Cost | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Item | Quantity | Unit | Subcontract | Material | Labor | Equipment | Subcontract | Material | Labor | Equipment | Subtotal |
| **1 PROJECT PLANNING** | | | | | | | | | | | |
| 1.1 Prepare LUC RD Documents | 60 | hr | | | $37.00 | | $0 | $0 | $2,220 | $0 | $2,220 |
| 1.2 Prepare Documents & Plans including Permits | 400 | hr | | | $37.00 | | $0 | $0 | $14,800 | $0 | $14,800 |
| **2 MOBILIZATION AND DEMOBILIZATION** | | | | | | | | | | | |
| 2.1 Site Support Facilities (trailers, phone, electric, etc.) | 1 | ls | | $1,000.00 | | $3,500.00 | $0 | $1,000 | $0 | $3,500 | $4,500 |
| 2.2 Barge Mobilization | 6 | ea | | | | $2,500.00 | $0 | $0 | $0 | $15,000 | $15,000 |
| 2.3 Equipment Mobilization/Demobilization | 8 | ea | | | $170.00 | $522.00 | $0 | $0 | $1,360 | $4,176 | $5,536 |
| 2.4 Long-Reach Equipment Mobilization/Demobilization | 2 | ea | | | $300.00 | $975.00 | $0 | $0 | $600 | $1,950 | $2,550 |
| 2.5 Utility Connection/Disconnection (phone/electric) | 1 | ls | $1,250.00 | | | | $1,250 | $0 | $0 | $0 | $1,250 |
| **3 FIELD SUPPORT** | | | | | | | | | | | |
| 3.1 Office Trailer | 3 | mo | | | | $375.00 | $0 | $0 | $0 | $1,125 | $1,125 |
| 3.2 Field Office Equipment, Utilities, & Support | 3 | mo | | $470.00 | | | $0 | $1,410 | $0 | $0 | $1,410 |
| 3.3 Storage Trailer | 3 | mo | | | | $99.00 | $0 | $0 | $0 | $297 | $297 |
| 3.4 Site Superintendent | 70 | day | | $169.00 | $384.64 | | $0 | $11,830 | $26,925 | $0 | $38,755 |
| 3.5 Site Health & Safety | 60 | day | | $169.00 | $307.68 | | $0 | $10,140 | $18,461 | $0 | $28,601 |
| 3.6 Site QA/QC | 60 | day | | $169.00 | $307.68 | | $0 | $10,140 | $18,461 | $0 | $28,601 |
| 3.7 Bathymetric Survey (pre-removal) | 1 | ea | $7,500.00 | | | | $7,500 | $0 | $0 | $0 | $7,500 |
| **4 DREDGING, AND DEWATERING** | | | | | | | | | | | |
| 4.1 Excavator on Barge, long-reach (2 each) | 116 | day | | | $466.96 | $4,437.40 | $0 | $0 | $54,167 | $514,738 | $568,906 |
| 4.2 Spoil Barge, 90' by 30', 6 each | 348 | day | | | | $748.40 | $0 | $0 | $0 | $260,443 | $260,443 |
| 4.3 Tugboats, 6 each | 348 | day | | | $340.48 | $663.40 | $0 | $0 | $118,487 | $230,863 | $349,350 |
| 4.4 Barge Barriers, fabric, membrane, etc. | 6 | ea | | $4,875.00 | | | $0 | $29,250 | $0 | $0 | $29,250 |
| 4.5 Trash Pumps, 3 each | 348 | day | | | | $117.00 | $0 | $0 | $0 | $40,716 | $40,716 |
| 4.6 Barge Geotextile Filter Membrane Replacement | 36 | ea | | $1,000.00 | | | $0 | $36,000 | $0 | $0 | $36,000 |
| 4.7 Turbidity Curtain | 1,600 | ft | | $39.90 | | | $0 | $63,840 | $0 | $0 | $63,840 |
| 4.8 Turbidity Monitoring Buoy (4 each) | 12 | mo | | | | $4,080.00 | $0 | $0 | $0 | $48,960 | $48,960 |
| 4.9 Dewatering Effluent Tank, 5,000 gal, 6 each | 36 | mo | | | | $781.00 | $0 | $0 | $0 | $28,116 | $28,116 |
| 4.10 Transfer Pump | 58 | day | | | | $66.40 | $0 | $0 | $0 | $3,851 | $3,851 |
| 4.11 Dredgeman/Laborers, 6 each | 348 | day | | | $309.86 | | $0 | $0 | $107,831 | $0 | $107,831 |
| 4.12 Fly Ash | 2,222 | tons | | $40.00 | | | $0 | $88,880 | $0 | $0 | $88,880 |
| 4.13 Front-End Loader | 58 | day | | | $430.24 | $854.40 | $0 | $0 | $24,954 | $49,555 | $74,509 |
| 4.14 Excavator | 58 | day | | | $466.96 | $2,635.00 | $0 | $0 | $27,084 | $152,830 | $179,914 |
| 4.15 Sampling Sediment Verification | 27 | ea | $900.00 | $50.00 | $100.00 | $50.00 | $24,300 | $1,350 | $2,700 | $1,350 | $29,700 |
| 4.16 Sampling Dewatered Sediment | 116 | ea | $2,000.00 | $50.00 | $100.00 | $50.00 | $232,000 | $5,800 | $11,600 | $5,800 | $255,200 |
| 4.17 Sampling Dewatered Fluid | 95 | ea | $740.00 | $50.00 | $100.00 | $50.00 | $70,300 | $4,750 | $9,500 | $4,750 | $89,300 |
| **5 BACKFILL AND SITE RESTORATION** | | | | | | | | | | | |
| 5.1 Sand/Gravel Cap - 6 ft thick | 10,276 | cy | | $21.60 | | | $0 | $221,962 | $0 | $0 | $221,962 |
| 5.2 Load Barges with 3 CY Excavator | 10,276 | cy | $2.51 | | | | $25,793 | $0 | $0 | $0 | $25,793 |
| 5.3 Barge, 800 T, One for 3 Weeks for Sand/Gravel | 4 | wk | | | | $2,256.00 | $0 | $0 | $0 | $9,024 | $9,024 |
| 5.4 Barge-Mounted Clamshell to Unload Sand/Gravel | 20 | days | $4,020.25 | | | | $80,405 | $0 | $0 | $0 | $80,405 |
| 5.5 Bathymetric Survey (post-removal) | 1 | ea | $7,500.00 | | | | $7,500 | $0 | $0 | $0 | $7,500 |
| **6 OFF-SITE TRANSPORTATION AND DISPOSAL** | | | | | | | | | | | |
| 6.1 Sediment Disposal, non-hazardous | 29,985 | tons | $40.00 | | | | $1,199,400 | $0 | $0 | $0 | $1,199,400 |
| 6.2 Disposal of Dewatering Liquids | 471,270 | gal | $0.15 | | | | $70,691 | $0 | $0 | $0 | $70,691 |
| 6.3 Transporation of Dewatering Liquids ($500/5,000 gal) | 95 | trip | $500.00 | | | | $47,500 | $0 | $0 | $0 | $47,500 |
| **7 POST CONSTRUCTION COST** | | | | | | | | | | | |
| 7.1 Contractor Completion Report | 80 | hr | | | $37.00 | | $0 | $0 | $2,960 | $0 | $2,960 |
| 7.2 Remedial Action Closeout Report | 140 | hr | | | $37.00 | | $0 | $0 | $5,180 | $0 | $5,180 |
| **Subtotal** | | | | | | | $1,766,638 | $486,352 | $447,290 | $1,377,045 | $4,077,325 |

**LOWER SUBASE FS**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**

**ALTERNATIVE SD-7: DREDGING TO MEET PRGs, DEWATERING, & OFF-SITE DISPOSAL OF DEWATERED SEDIMENT AND DEWATERED FLUIDS**
**Capital Cost**

| | | | Unit Cost | | | | Extended Cost | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Item | Quantity | Unit | Subcontract | Material | Labor | Equipment | Subcontract | Material | Labor | Equipment | Subtotal |
| Overhead on Labor Cost @ 30% | | | | | | | | | $134,187 | | $134,187 |
| G & A on Labor Cost @ 10% | | | | | | | | | $44,729 | | $44,729 |
| G & A on Material Cost @ 10% | | | | | | | | $48,635 | | | $48,635 |
| G & A on Equipment Cost @ 10% | | | | | | | | | | $137,705 | $137,705 |
| G & A on Subcontract Cost @ 10% | | | | | | | $176,664 | | | | $176,664 |
| Tax on Materials and Equipment Cost @ 6% | | | | | | | | $29,181 | | $82,623 | $111,804 |
| **Total Direct Cost** | | | | | | | $1,943,302 | $564,168 | $626,206 | $1,597,372 | $4,731,048 |
| * Indirects on Total Direct Cost @ 20% | | (excluding transportation and disposal cost) | | | | | | | | | $682,691 |
| Profit on Total Direct Cost @ 10% | | | | | | | | | | | $473,105 |
| **Total Field Cost** | | | | | | | | | | | $5,886,844 |
| Contingency on Total Field Costs @ 20% | | | | | | | | | | | $1,177,369 |
| Engineering on Total Field Cost @ 5% | | | | | | | | | | | $294,342 |
| **TOTAL CAPITAL COST** | | | | | | | | | | | **$7,358,555** |

# APPENDIX E.4

# LNAPL ALTERNATIVES COST ESTIMATES

## ALTERNATIVES LN-1 and LN-2

**ZONE 1, LOWER SUBASE - LNAPL REMEDIATION ALTERNATIVES**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE LN-1: SKIMMING, OFF-SITE DISPOSAL (INCINERATION), LUCs, AND MONITORING**
**CAPITAL COST**

| | | | Unit Cost | | | | Extended Cost | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Item | Quantity | Unit | Subcontract | Material | Labor | Equipment | Subcontract | Material | Labor | Equipment | Subtotal |
| **1 PROJECT PLANNING** | | | | | | | | | | | |
| 1.1 Prepare LUC RD Documents | 60 | hr | | | $35.00 | | $0 | $0 | $2,100 | $0 | $2,100 |
| 1.2 Prepare Documents & Plans including Permits | 200 | hr | | | $35.00 | | $0 | $0 | $7,000 | $0 | $7,000 |
| **2 MOBILIZATION/DEMOBILIZATION & SITE SUPPORT** | | | | | | | | | | | |
| 2.1 Utility Connection (electric) | 1 | ls | $10,000.00 | | | | $10,000 | $0 | $0 | $0 | $10,000 |
| 2.2 Underground Utility Clearances | 1 | ls | $3,500.00 | | | | $3,500 | $0 | $0 | $0 | $3,500 |
| 2.3 Construction Survey | 3 | day | $2,000.00 | | | | $6,000 | $0 | $0 | $0 | $6,000 |
| 2.4 Drill Rig Mobilization/Demobilization | 1 | ea | $2,000.00 | | | | $2,000 | $0 | $0 | $0 | $2,000 |
| 2.5 Field Construction Mgt. (1 person) | 21 | day | | $240.00 | $300.00 | | $0 | $5,040 | $6,300 | $0 | $11,340 |
| **3 WELL AND SKIMMER INSTALLATION** | | | | | | | | | | | |
| 3.1 Well, 6" dia, 15' deep, 22 wells | 330 | lf | $33.00 | | | | $10,890 | $0 | $0 | $0 | $10,890 |
| 3.2 Well, 6" dia, 15' deep, 6 wells | 90 | lf | $50.00 | | | | $4,500 | $0 | $0 | $0 | $4,500 |
| 3.3 Well Development | 112 | hr | $200.00 | | | | $22,400 | $0 | $0 | $0 | $22,400 |
| 3.3 Well Skimmer | 28 | ea | | $900.00 | $260.00 | | $0 | $25,200 | $7,280 | $0 | $32,480 |
| 3.4 Collect/Containerize IDW | 35 | drum | $50.00 | | | | $1,750 | $0 | $0 | $0 | $1,750 |
| 3.5 Transport/Dispose IDW Off Site | 35 | drum | $150.00 | | | | $5,250 | $0 | $0 | $0 | $5,250 |
| **4 SITE RESTORATION** | | | | | | | | | | | |
| 4.1 Pavement Repair | 700 | sy | | $10.40 | $24.00 | $1.96 | $0 | $7,280 | $16,800 | $1,372 | $25,452 |
| **Subtotal** | | | | | | | $66,290 | $37,520 | $39,480 | $1,372 | $144,662 |
| **Local Area Adjustments** | | | | | | | 100.0% | 96.6% | 105.0% | 105.0% | |
| **Subtotal** | | | | | | | $66,290 | $36,244 | $41,454 | $1,441 | $145,429 |
| Overhead on Labor Cost @ 30% | | | | | | | | | $12,436 | | $12,436 |
| G & A on Labor Cost @ 10% | | | | | | | | | $4,145 | | $4,145 |
| G & A on Material Cost @ 10% | | | | | | | | $3,624 | | | $3,624 |
| G & A on Equipment Cost @ 10% | | | | | | | | | | $144 | $144 |
| G & A on Subcontract Cost @ 10% | | | | | | | $6,629 | | | | $6,629 |
| Tax on Materials and Equipment Cost @ 6% | | | | | | | | $2,175 | | $86 | $2,261 |
| **Total Direct Cost** | | | | | | | $72,919 | $42,043 | $58,036 | $1,671 | $174,669 |
| Indirects on Total Direct Cost @ 30% | | | | | | | | | | | $52,401 |
| Profit on Total Direct Cost @ 10% | | | | | | | | | | | $17,467 |
| **Subtotal** | | | | | | | | | | | $244,537 |
| Health & Safety Monitoring @ 2% | | | | | | | | | | | $4,891 |
| **Total Field Cost** | | | | | | | | | | | $249,427 |
| Contingency on Total Field Cost @ 20% | | | | | | | | | | | $49,885 |
| Engineering on Total Field Cost @ 15% | | | | | | | | | | | $37,414 |
| **TOTAL COST** | | | | | | | | | | | **$336,727** |

**ZONE 1, LOWER SUBASE - LNAPL REMEDIATION ALTERNATIVES**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE LN-1: SKIMMING, OFF-SITE DISPOSAL (INCINERATION), LUCs, AND MONITORING**
**Operation and Maintenance Costs per Year**

| | Item | Qty | Unit | Unit Cost | Subtotal Cost | Notes |
|---|---|---|---|---|---|---|
| | *Year 1* | | | | | |
| 1 | Crew Collection of LNAPL (once a week) | 52 | week | $5,450.00 | $283,400 | |
| 2 | Transportation & Disposal | 1 | ls | $13,840.00 | $13,840 | |
| 3 | Reports | 4 | ea | $2,500.00 | $10,000 | |
| | Cost for Year 1 Operation | | | | $307,240 | |
| | *Years 2 through 5* | | | | | |
| 1 | Crew Collection of LNAPL (twice a month) | 12 | month | $10,899.00 | $130,788 | |
| 2 | Transportation & Disposal | 1 | ls | $6,390.00 | $6,390 | |
| 3 | Reports | 4 | ea | $2,500.00 | $10,000 | |
| | Cost for Years 2 through 5 Operation | | | | $147,178 | |
| | *Year 5* | | | | | |
| | Skimmers Replacement | 1 | ls | $28,000.00 | $28,000 | |
| | *Years 6 through 10* | | | | | |
| 1 | Crew Collection of LNAPL (once a month) | 12 | month | $5,450.00 | $65,400 | |
| 2 | Transportation & Disposal | 1 | ls | $3,190.00 | $3,190 | |
| 3 | Reports | 2 | ea | $2,500.00 | $5,000 | |
| | Cost for Years 6 and 7 Operation | | | | $73,590 | |
| | *Years 11 through 30* | | | | | |
| 1 | Crew Collection of LNAPL (once a month) | 12 | month | $5,450.00 | $65,400 | |
| 2 | Transportation & Disposal | 1 | ls | $1,770.00 | $1,770 | |
| 3 | Reports | 1 | ea | $2,500.00 | $2,500 | |
| | Cost for Years 8 through 30 Operation | | | | $69,670 | |

**ZONE 1, LOWER SUBASE - LNAPL REMEDIATION ALTERNATIVES**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE LN-1: SKIMMING, OFF-SITE DISPOSAL (INCINERATION), LUCs, AND MONITORING**
**ANNUAL COST**

| Item | Item Cost Year 1 | Item Cost Years 2 and 3 | Item Cost Years 4 and 5 | Item Cost Years 6 through 30 | Item Cost Every 5 Years | Notes |
|---|---|---|---|---|---|---|
| Groundwater Sampling | $9,300 | $4,650 | $2,325 | $2,325 | | Check 4 wells for presence of LNAPL. Quarterly Year 1, Semi-Annually Years 2 & 3, Annually Years 4 through 30. |
| Annual Report | $5,000 | $5,000 | $5,000 | $5,000 | | |
| Inspection | $1,000 | $1,000 | $1,000 | $1,000 | | Annual LUC inspection (assume 8 hours at $50/hr plus expenses) |
| Site Review | | | | | $23,000 | 5-year review |
| Subtotal | $15,300 | $10,650 | $8,325 | $8,325 | $23,000 | |
| Contingency at 10% | $1,530 | $1,065 | $833 | $833 | $2,300 | |
| **TOTAL** | $16,830 | $11,715 | $9,158 | $9,158 | $25,300 | |

**ZONE 1, LOWER SUBASE - LNAPL REMEDIATION ALTERNATIVES**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE LN-1: SKIMMING, OFF-SITE DISPOSAL (INCINERATION), LUCs, AND MONITORING**
**Present Worth Analysis**

| Year | Capital Cost | Operation and Maintenance Cost | Annual Cost | Total Year Cost | Annual Discount Rate at 7% | Present Worth |
|---|---|---|---|---|---|---|
| 0 | $336,727 | | | $336,727 | 1.000 | $336,727 |
| 1 | | $307,240 | $16,830 | $324,070 | 0.935 | $303,005 |
| 2 | | $147,178 | $11,715 | $158,893 | 0.873 | $138,714 |
| 3 | | $147,178 | $11,715 | $158,893 | 0.816 | $129,657 |
| 4 | | $147,178 | $9,158 | $156,336 | 0.763 | $119,284 |
| 5 | | $175,178 | $34,458 | $209,636 | 0.713 | $149,470 |
| 6 | | $73,590 | $9,158 | $82,748 | 0.666 | $55,110 |
| 7 | | $73,590 | $9,158 | $82,748 | 0.623 | $51,552 |
| 8 | | $73,590 | $9,158 | $82,748 | 0.582 | $48,159 |
| 9 | | $73,590 | $9,158 | $82,748 | 0.544 | $45,015 |
| 10 | | $73,590 | $34,458 | $108,048 | 0.508 | $54,888 |
| 11 | | $69,670 | $9,158 | $78,828 | 0.475 | $37,443 |
| 12 | | $69,670 | $9,158 | $78,828 | 0.444 | $34,999 |
| 13 | | $69,670 | $9,158 | $78,828 | 0.415 | $32,713 |
| 14 | | $69,670 | $9,158 | $78,828 | 0.388 | $30,585 |
| 15 | | $69,670 | $34,458 | $104,128 | 0.362 | $37,694 |
| 16 | | $69,670 | $9,158 | $78,828 | 0.339 | $26,723 |
| 17 | | $69,670 | $9,158 | $78,828 | 0.317 | $24,988 |
| 18 | | $69,670 | $9,158 | $78,828 | 0.296 | $23,333 |
| 19 | | $69,670 | $9,158 | $78,828 | 0.277 | $21,835 |
| 20 | | $69,670 | $34,458 | $104,128 | 0.258 | $26,865 |
| 21 | | $69,670 | $9,158 | $78,828 | 0.242 | $19,076 |
| 22 | | $69,670 | $9,158 | $78,828 | 0.226 | $17,815 |
| 23 | | $69,670 | $9,158 | $78,828 | 0.211 | $16,633 |
| 24 | | $69,670 | $9,158 | $78,828 | 0.197 | $15,529 |
| 25 | | $69,670 | $34,458 | $104,128 | 0.184 | $19,159 |
| 26 | | $69,670 | $9,158 | $78,828 | 0.172 | $13,558 |
| 27 | | $69,670 | $9,158 | $78,828 | 0.161 | $12,691 |
| 28 | | $69,670 | $9,158 | $78,828 | 0.15 | $11,824 |
| 29 | | $69,670 | $9,158 | $78,828 | 0.141 | $11,115 |
| 30 | | $69,670 | $34,458 | $104,128 | 0.131 | $13,641 |
| | | | | | **TOTAL PRESENT WORTH** | **$1,879,801** |

**ZONE 1, LOWER SUBASE - LNAPA REMEDIATION ALTERNATIVES**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE LN-2: IN-SITU TREATMENT (ENHANCED BIOREMEDIATION), LUCs, AND MONITORING**
**CAPITAL COST**

| Item | Quantity | Unit | Unit Cost Subcontract | Unit Cost Material | Unit Cost Labor | Unit Cost Equipment | Extended Cost Subcontract | Extended Cost Material | Extended Cost Labor | Extended Cost Equipment | Subtotal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1 PROJECT PLANNING** | | | | | | | | | | | |
| 1.1 Prepare LUC RD Documents | 60 | hr | | | $35.00 | | $0 | $0 | $2,100 | $0 | $2,100 |
| 1.2 Prepare Documents & Plans including Permits | 300 | hr | | | $35.00 | | $0 | $0 | $10,500 | $0 | $10,500 |
| **2 MOBILIZATION/DEMOBILIZATION & SITE SUPPORT** | | | | | | | | | | | |
| 2.1 Utility Connection (electric) | 1 | ls | $10,000.00 | | | | $10,000 | $0 | $0 | $0 | $10,000 |
| 2.2 Underground Utility Clearances | 1 | ls | $3,500.00 | | | | $3,500 | $0 | $0 | $0 | $3,500 |
| 2.3 Construction Survey | 3 | day | $2,000.00 | | | | $6,000 | $0 | $0 | $0 | $6,000 |
| 2.4 Drill Rig Mobilization/Demobilization | 1 | ea | $2,000.00 | | | | $2,000 | $0 | $0 | $0 | $2,000 |
| 2.5 Field Construction Mgt. (1 person) | 30 | day | | $240.00 | $300.00 | | $0 | $7,200 | $9,000 | $0 | $16,200 |
| **3 WELL INSTALLATION** | | | | | | | | | | | |
| 3.1 Extraction Well, 4" dia, 12' deep, 6 wells | 72 | lf | $45.00 | | | | $3,240 | $0 | $0 | $0 | $3,240 |
| 3.2 Re-Injection Well, 4" dia, 5' deep, 12 wells | 60 | lf | $30.00 | | | | $1,800 | $0 | $0 | $0 | $1,800 |
| 3.3 Well Development | 72 | hr | $200.00 | | | | $14,400 | $0 | $0 | $0 | $14,400 |
| 3.4 Collect/Containerize IDW | 18 | drum | $50.00 | | | | $900 | $0 | $0 | $0 | $900 |
| 3.5 Transport/Dispose IDW Off Site | 18 | drum | $150.00 | | | | $2,700 | $0 | $0 | $0 | $2,700 |
| 3.6 Extraction Pumps, 5 gpm | 6 | ea | | $675.00 | $200.00 | | $0 | $4,050 | $1,200 | $0 | $5,250 |
| 3.7 PVC pipe, 1-1/2" dia. w/trench | 600 | lf | | $1.10 | $3.66 | $6.20 | $0 | $660 | $2,196 | $3,720 | $6,576 |
| **4 TREATMENT SYSTEM** | | | | | | | | | | | |
| 4.1 Bench-Scale Treatability Study | 1 | ls | $15,000.00 | | | | $15,000 | $0 | $0 | $0 | $15,000 |
| 4.2 Oil/Water Separator | 1 | ea | | $1,200.00 | $300.00 | | $0 | $1,200 | $300 | $0 | $1,500 |
| 4.3 Superoxygenation & Nutrient Feed System | 1 | ls | | $155,500.00 | | | $0 | $155,500 | $0 | $0 | $155,500 |
| 4.4 Nutrients & Chemicals, initial loading | 1 | ls | | $20,000.00 | | | $0 | $20,000 | $0 | $0 | $20,000 |
| 4.5 ETEC Installation & Training | 1 | ls | $5,000.00 | | | | $5,000 | $0 | $0 | $0 | $5,000 |
| 4.6 Electric Feed | 1 | ea | $6,625.00 | | | | $6,625 | $0 | $0 | $0 | $6,625 |
| 4.7 Plumb/Electrify System | 1 | ls | | $2,000.00 | $5,000.00 | | $0 | $2,000 | $5,000 | $0 | $7,000 |
| 4.8 System Start-Up and Testing | 1 | ls | | $1,000.00 | $2,000.00 | | $0 | $1,000 | $2,000 | $0 | $3,000 |
| **5 SITE RESTORATION** | | | | | | | | | | | |
| 5.1 Pavement Repair | 500 | sy | | $10.40 | $24.00 | $1.96 | $0 | $5,200 | $12,000 | $980 | $18,180 |
| **Subtotal** | | | | | | | $71,165 | $196,810 | $44,296 | $4,700 | $316,971 |
| **Local Area Adjustments** | | | | | | | 100.0% | 96.6% | 105.0% | 105.0% | |
| **Subtotal** | | | | | | | $71,165 | $190,118 | $46,511 | $4,935 | $312,729 |
| Overhead on Labor Cost @ 30% | | | | | | | | | $13,953 | | $13,953 |
| G & A on Labor Cost @ 10% | | | | | | | | | $4,651 | | $4,651 |
| G & A on Material Cost @ 10% | | | | | | | | $19,012 | | | $19,012 |
| G & A on Equipment Cost @ 10% | | | | | | | | | | $494 | $494 |
| G & A on Subcontract Cost @ 10% | | | | | | | $7,117 | | | | $7,117 |
| Tax on Materials and Equipment Cost @ 6% | | | | | | | | $11,407 | | $296 | $11,703 |
| **Total Direct Cost** | | | | | | | $78,282 | $220,537 | $65,115 | $5,725 | $369,659 |
| Indirects on Total Direct Cost @ 30% | | | | | | | | | | | $110,898 |
| Profit on Total Direct Cost @ 10% | | | | | | | | | | | $36,966 |
| **Subtotal** | | | | | | | | | | | $517,522 |
| Health & Safety Monitoring @ 2% | | | | | | | | | | | $10,350 |
| **Total Field Cost** | | | | | | | | | | | $527,873 |
| Contingency on Total Field Cost @ 25% | | | | | | | | | | | $131,968 |
| Engineering on Total Field Cost @ 10% | | | | | | | | | | | $52,787 |
| **TOTAL COST** | | | | | | | | | | | **$712,628** |

**ZONE 1, LOWER SUBASE - LNAPA REMEDIATION ALTERNATIVES**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE LN-2: IN-SITU TREATMENT (ENHANCED BIOREMEDIATION), LUCs, AND MONITORING**
**Operation and Maintenance Costs per Year**

| | Item | Qty | Unit | Unit Cost | Subtotal Cost |
|---|---|---|---|---|---|
| | *Year 1* | | | | |
| 1 | Transportation, & Disposal of LNAPL | 1 | ls | $18,460.00 | $18,460 |
| 2 | Electric | 1 | ls | $29,000.00 | $29,000 |
| 3 | Nutrients & Chemicals | 12 | mo | $10,000.00 | $120,000 |
| 4 | Analysis | 36 | ea | $140.00 | $5,040 |
| 5 | ETEC Maintenance Contract | 1 | ls | $12,500.00 | $12,500 |
| 6 | Operator (10 hours a week) | 520 | hr | $95.00 | $49,400 |
| 7 | Reports | 4 | ea | $5,000.00 | $20,000 |
| | Cost for Year 1 Operation | | | | $254,400 |
| | *Years 2 and 3* | | | | |
| 1 | Transportation, & Disposal of LNAPL | 1 | ls | $9,940.00 | $9,940 |
| 2 | Electric | 1 | ls | $29,000.00 | $29,000 |
| 3 | Nutrients & Chemicals | 12 | mo | $10,000.00 | $120,000 |
| 4 | Analysis | 36 | ea | $140.00 | $5,040 |
| 5 | ETEC Maintenance Contract | 1 | ls | $12,500.00 | $12,500 |
| 6 | Operator (10 hours a week) | 520 | hr | $95.00 | $49,400 |
| 7 | Reports | 2 | ea | $5,000.00 | $10,000 |
| | Cost for Years 2 & 3 Operation | | | | $235,880 |
| | *Years 4 and 5* | | | | |
| 1 | Transportation, & Disposal of LNAPL | 1 | ea | $4,260.00 | $4,260 |
| 2 | Electric | 1 | ls | $29,000.00 | $29,000 |
| 3 | Nutrients & Chemicals | 12 | mo | $10,000.00 | $120,000 |
| 4 | Analysis | 36 | ea | $140.00 | $5,040 |
| 5 | Operator (10 hours a week) | 520 | hr | $95.00 | $49,400 |
| 6 | Reports | 1 | ea | $5,000.00 | $5,000 |
| | Cost for Years 4 & 5 Operation | | | | $212,700 |
| | *Years 6 through 8* | | | | |
| 1 | Transportation, & Disposal of LNAPL | 1 | ea | $2,840.00 | $2,840 |
| 2 | Electric | 1 | ls | $29,000.00 | $29,000 |
| 3 | Nutrients & Chemicals | 12 | mo | $10,000.00 | $120,000 |
| 4 | Analysis | 36 | ea | $140.00 | $5,040 |
| 5 | Operator (10 hours a week) | 520 | hr | $95.00 | $49,400 |
| 6 | Reports | 1 | ea | $5,000.00 | $5,000 |
| | Cost for Years 6 through 8 Operation | | | | $211,280 |
| | *Year 9* | | | | |
| 1 | Electric | 1 | ls | $29,000.00 | $29,000 |
| 2 | Nutrients & Chemicals | 12 | mo | $10,000.00 | $120,000 |
| 3 | Analysis | 36 | ea | $140.00 | $5,040 |
| 4 | Operator (10 hours a week) | 520 | hr | $95.00 | $49,400 |
| 5 | Reports | 1 | ea | $5,000.00 | $5,000 |
| | Cost for Year 9 Operation | | | | $208,440 |

**ZONE 1, LOWER SUBASE - LNAPA REMEDIATION ALTERNATIVES**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE LN-2: IN-SITU TREATMENT (ENHANCED BIOREMEDIATION), LUCs, AND MONITORING**
**ANNUAL COST**

| Item | Item Cost Year 1 | Item Cost Years 2 and 3 | Item Cost Years 4 and 5 | Item Cost Years 6 through 10 | Item Cost Every 5 Years | Notes |
|---|---|---|---|---|---|---|
| Groundwater Sampling | $9,300 | $4,650 | $2,325 | $2,325 | | Check 4 wells for presence of LNAPL. Quarterly Year 1, Semi-Annually Years 2 & 3, Annually Years 4 through 10. |
| Annual Report | $5,000 | $5,000 | $5,000 | $5,000 | | |
| Inspection | $1,000 | $1,000 | $1,000 | $1,000 | | Annual LUC inspection (assume 8 hours at $50/hr plus expenses) |
| Site Review | | | | | $23,000 | 5-year review |
| Subtotal | $15,300 | $10,650 | $8,325 | $8,325 | $23,000 | |
| Contingency at 10% | $1,530 | $1,065 | $833 | $833 | $2,300 | |
| **TOTAL** | $16,830 | $11,715 | $9,158 | $9,158 | $25,300 | |

**ZONE 1, LOWER SUBASE - LNAPA REMEDIATION ALTERNATIVES**
**NAVAL SUBMARINE BASE NEW LONDON**
**GROTON, CONNECTICUT**
**ALTERNATIVE LN-2: IN-SITU TREATMENT (ENHANCED BIOREMEDIATION), LUCs, AND MONITORING**
**Present Worth Analysis**

| Year | Capital Cost | Operation and Maintenance Cost | Annual Cost | Total Year Cost | Annual Discount Rate at 7% | Present Worth |
|---|---|---|---|---|---|---|
| 0 | $712,628 | | | $712,628 | 1.000 | $712,628 |
| 1 | | $254,400 | $16,830 | $271,230 | 0.935 | $253,600 |
| 2 | | $235,880 | $11,715 | $247,595 | 0.873 | $216,150 |
| 3 | | $235,880 | $11,715 | $247,595 | 0.816 | $202,038 |
| 4 | | $212,700 | $9,158 | $221,858 | 0.763 | $169,277 |
| 5 | | $212,700 | $34,458 | $247,158 | 0.713 | $176,223 |
| 6 | | $211,280 | $9,158 | $220,438 | 0.666 | $146,811 |
| 7 | | $211,280 | $9,158 | $220,438 | 0.623 | $137,333 |
| 8 | | $211,280 | $9,158 | $220,438 | 0.582 | $128,295 |
| 9 | | $208,440 | $9,158 | $217,598 | 0.544 | $118,373 |
| 10 | | | $34,458 | $34,458 | 0.508 | $17,504 |
| | | | | | **TOTAL PRESENT WORTH** | **$2,278,233** |