

**Letter
Work Plan
for
Geochemical Investigation
at the Area A Landfill**

**Naval Submarine Base
New London
Groton, Connecticut**



**Engineering Field Activity Northeast
Naval Facilities Engineering Command**

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TETRA TECH NUS, INC.

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- 1 General Site Plan

1.0 INTRODUCTION

This letter Work Plan (WP) for the Area A Landfill at the Naval Submarine Base-New London (NSB-NLON) in Groton, Connecticut describes the approach for investigating the geochemistry of groundwater flowing through the Area A Landfill. This task was added to Contract Task Order (CTO) No. 816 under Scope Change Memorandum (SCM) No. 4, dated July 23, 2002, from the Navy to TetraTech NUS, Inc. (TtNUS). SCM No. 4 directed TtNUS to prepare a letter WP to supplement the Area A Landfill Groundwater Monitoring Plan (GMP) for NSB-NLON, Groton, Connecticut (TtNUS, 1999). Figure 1 illustrates the general site conditions and existing monitoring well locations. Since the geochemical sampling will coincide with a regularly scheduled groundwater monitoring sampling event, this WP will only detail activities specific to the geochemical investigation. All other related activities (i.e., water level measurement, sampling, decontamination, and quality control) will follow procedures already detailed in the Area A Landfill GMP (TtNUS, 1999).

1.1 PURPOSE

The chemical composition of groundwater samples in the Area A Landfill is highly dependent upon the screen interval of each well. Monitoring wells are screened across one or more geologic horizons in the vicinity of the landfill. As such, the geochemical composition of the groundwater sample is characteristic of the geologic media in the screened interval. The proximity of groundwater recharge and discharge areas at the site adds more complexity to the groundwater geochemistry. The most complex geochemical reactions appear to be within the dredge spoil material wherein organic-rich, estuarine to marine sediments are reacting with relatively fresh, aerobic recharging groundwater. Geochemical reactions within this zone may result in mobilization, transport and re-precipitation of many metals. A geochemical conceptual model has been proposed for the site and additional data will be collected and analyzed to test and refine the model.

Additional monitoring of select wells will be conducted in conjunction with a regularly scheduled groundwater monitoring event. During the monitoring event, monitoring wells along two transects that follow the path of groundwater flow through the Area A Landfill will be sampled. The monitoring wells were selected to sample groundwater samples from the major aquifer materials present in the Area A Landfill. The purpose of this additional groundwater monitoring is to verify and refine the geochemical conceptual model provided in the Year 2 Annual GMP for the Area A Landfill (TtNUS, 2002). This report is currently being finalized.

Analytical data will be used to test several hypotheses developed in the conceptual model including the presence of sulfide minerals in the dredge spoils, their reactions with relatively aerobic groundwater, and

re-precipitation of metals as oxyhydroxides. Data evaluation will include the use of simple geochemical equilibrium models (e.g., PRHEEQC) to calculate the solubilities and saturation indices of key constituents. Further, data may be plotted on activity:activity and/or Eh/pH plots to clarify the changes in groundwater composition along a flow path.

Results will be included in the Year 3 Annual GMP for Area A Landfill. It will include the following:

- Description of investigation and field methods used to complete the investigation.
- Discussion of the results of the investigation.
- Summary of the analytical results.
- Isoconcentration Map(s).
- Potentiometric surface map.
- Geochemical Modeling Results (as necessary).
- Conclusions and Recommendations.

2.0 SAMPLING AND ANALYSIS PLAN ADDENDUM

The Scope of Work for the geochemical groundwater sampling event includes the following tasks:

- Mobilization/Demobilization
- Well Development
- Water Level Measurement
- Groundwater Sampling and Analysis
- Decontamination
- Investigation-Derived Waste Management
- Surveying

The following paragraphs provide the main tasks associated with this investigation. Since the geochemical groundwater sampling event will be conducted in conjunction with a groundwater monitoring event, many of the routine tasks are covered by the procedures included in the GMP (TtNUS, 1999).

Wells along two transects through the Area A Landfill will be sampled as part of the investigation (see Figure 1). The wells along each transect have been selected to sample all major types of geologic media (i.e., dredge spoil, landfill, bedrock, alluvium) at the site. The first transect, which is through the west/central portion of the landfill includes the following monitoring wells:

Transect 1-1'

- 4MW1S*
- 2LMW29A
- 2LMW29F (if water levels allow)
- 2LMW7D
- 2LMW7S
- 2WMW40DS*

It should be noted that 2LMW29F is to be included in the program; however, based on field reconnaissance, the monitoring well is currently dry. The well will be checked again prior to sampling to verify its condition. All efforts will be made to collect a sample from the well.

The second transect, which is through the eastern portion of the landfill, includes the following wells:

Transect 2-2'

- 2LMW20S*
- 2LMW32F
- 2LMW32DS
- 2LMW32B
- 2WMW46DS*

In addition, monitoring well 2WMW21S* will also be sampled as a reference dredge spoil data point. Wells marked with "*" indicate that the well is part of the existing groundwater monitoring program. Samples from each well will be collected and analyzed to measure concentrations of the following:

- Total and dissolved TAL inorganics
- Alkalinity
- Chemical Oxygen Demand (COD)
- Chloride
- Hardness
- Sulfate
- Total Dissolved Solids (TDS)
- Total Suspended Solids (TSS)
- Dissolved Sulfide
- Total Organic Carbon (TOC)
- Dissolved Hydrogen

- Dissolved Methane
- pH – measured in field using field probe.
- Dissolved Oxygen (DO) – measured in field using field probe(verification w/ CHEMetrics kits K-7501 low range & K-7512 high range).
- Oxidation-Reduction Potential (ORP) – measured in field using field probe.
- Salinity – measured in field using field probe.
- Specific Conductance – measured in field using field probe.
- Turbidity – measured in field using a LaMotte Model 2020 portable Turbidity meter.
- Temperature – measured in field using field probe.
- Iron (II) – measured in field using HACH kit Model IR-18C. [Perform appropriate dilutions to allow for accurate Iron (II) measurements.]
- Manganese (II) – measured in field using HACH kit Pocket Colorimeter™ model. [Perform appropriate dilutions to allow for accurate Manganese (II) measurements.]

A total of 12 groundwater samples will be collected from the 12 wells specified in this WP. In addition, two field duplicate samples will be collected from randomly selected wells. A rinsate blank will also be collected from non-dedicated sampling equipment.

2.1 MOBILIZATION/DEMOBILIZATION

This task will include the following subtasks:

- Review of this letter WP with the project team.
- Procurement of equipment, subcontractors, and supplies.
- Arranging for shipment of equipment and supplies to and from the work site.
- Meeting with the NSB-NLON Environmental Department to review scheduled field activities, to obtain equipment laydown areas for TtNUS, and to discuss IDW issues.

TtNUS will also secure the services of an analytical laboratory subcontractor, surveyor, and an IDW disposal subcontractor as part of this task. After procurement of the laboratory subcontractor, the remaining mobilization activities will be completed accordingly based on the work schedule developed between TtNUS and the Navy.

2.2 WELL DEVELOPMENT

The monitoring wells within the limits of the Area A Landfill have not been sampled since the Phase II Remedial Investigation. In addition, the wells were altered during the installation of the Cap system. As

such, the wells will be re-developed in order to remove any fine particulates that may have accumulated at the bottom of the well, and within the well screen and sand pack surrounding the well screen. Re-development will restore the permeability of the sand pack and the efficiency of the well. Wells will be re-developed using a Grundfos Redi-Flo or equivalent submersible pump until the discharge water is visibly clear and the turbidity is less than 5 Nephelometric Turbidity Units (NTUs), as measured with a LaMotte 2020 Turbidimeter, or for two hours, whichever occurs first. All development water will be stored in 55-gallon drums for transportation and disposal by the IDW subcontractor.

2.3 WATER LEVEL MEASUREMENT AND SAMPLING

Water level measurement and sampling will follow TtNUS Standard Operating Procedures (SOP) SA-1-1. Additional information regarding water level measurement is provided in Section 4.1.3 of the GMP (TtNUS, 1999). Additional information regarding purging and sampling of monitoring wells is provided in Sections 4.1.6 and 4.1.7 of the GMP. The geochemical sampling event will follow these procedures since the sampling will be conducted in conjunction with the next groundwater monitoring and sampling event.

Analytical method and bottle and shipping requirements for the geochemical groundwater sampling event are detailed in Table 1.

2.4 DECONTAMINATION

Decontamination tasks will follow the procedures specified in Section 4.1.8 of the GMP (TtNUS, 1999).

2.5 INVESTIGATION-DERIVED WASTE (IDW) MANAGEMENT

The types of investigation-derived waste that may be generated during this monitoring event include purge water, decontamination fluids, and used personal protective equipment (PPE).

Development water, purge water and decontamination fluids from wells that are part of the existing groundwater monitoring program will be transported to the OT-10 area and discharged into the treatment system. Development water, purge water and decontamination fluids from the 7 wells that are not part of the existing groundwater monitoring program will be containerized in 55-gallon drums and temporarily stored at NSB-NLON at a location designated by NSB-NLON until it can be characterized and disposed off-site by an approved waste disposal subcontractor. All drums with IDW will be labeled, identifying contents, point-of-origin, date of generation, and the NSB-NLON point-of-contact. Prior to disposal, the drums will be sampled and analyzed by the IDW subcontractor in order to generate a waste characterization profile.

Used PPE will be placed in trash bags and discarded in a trash receptacle at NSB-NLON.

2.6 SURVEYING

Existing information for the monitoring wells included in this investigation are provided in Table 2. It should be noted that during the installation of the landfill cap system, many of the wells were modified to coincide with the new ground surface elevation. Due to this adjustment, the vertical elevations and horizontal locations of all existing monitoring wells within the boundaries of the Area A Landfill will be re-surveyed by a Connecticut-licensed surveyor at the completion of the field investigation. This re-surveying task is being completed as part of the regularly scheduled groundwater monitoring event, and will include the wells specified within this Geochemical WP. Existing benchmarks established during previous surveying activities will be used. All horizontal locations will re-surveyed to the nearest 0.1 foot. All elevations will be measured to the nearest 0.01 foot. The surveyor will determine elevations for the ground surface, the top of protective casing, and the top of the inside riser pipe for each monitoring well. The FOL will provide the correct sample location name to the surveyor so that database nomenclature is consistent with location names in the GMP and the database. Upon receiving the survey data from the surveyor, the TtNUS Project Manager will check the survey data for consistency with the location names in the GMP and the database.

3.0 SAMPLE IDENTIFICATION SYSTEM

Sample identification will follow the procedures specified within the GMP (TtNUS, 1999).

REFERENCES

Tetra Tech NUS, Inc. (TtNUS). January 1999. Groundwater Monitoring Plan for Area A Landfill, Naval Submarine Base-New London, Groton, Connecticut. King of Prussia, Pennsylvania

Tetra Tech NUS, Inc. (TtNUS). March 2002. Draft Year 2 Annual Groundwater Monitoring Report, Area A Landfill, Naval Submarine Base-New London, Groton, Connecticut. King of Prussia, Pennsylvania.

TABLE 1

**SUMMARY OF ANALYSIS, BOTTLE REQUIREMENTS, PRESERVATION REQUIREMENTS, AND HOLDING TIMES
SITE 2 – AREA A LANDFILL
NSB-NLON, GROTON, CONNECTICUT
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Parameter	Sample Container⁽¹⁾	Container Volume⁽¹⁾	Preservation	Maximum Holding Time⁽²⁾	Analytical Methodology
GROUNDWATER					
Total TAL Inorganics	High Density Polyethylene (HDPE)	(1) 500 mL	HNO ₃ to pH < 2	180 days to analysis except mercury which is 28 days to analysis	CLP ILM04.1 ⁽³⁾
Dissolved TAL Inorganics (field filtered)	HDPE	(1) 500 mL	HNO ₃ to pH < 2 Filter size – 0.45 micron	180 days to analysis except mercury which is 28 days to analysis	CLP ILM04.1 ⁽³⁾
TOC	Glass, Teflon-lined cap	(1) 100 mL	H ₂ SO ₄ to a pH < 2; Cool to 4°C	28 days to analysis	EPA 415.1
COD	Glass, Teflon-lined cap	(1) 1 L	HCl to a pH < 2; Cool to 4°C	28 days to analysis	EPA 410.1
TDS	Glass, Teflon-lined cap	(1) 250 mL	Cool to 4°C	14 days to analysis	EPA 160.1
Alkalinity	Glass, Teflon-lined cap	(1) 250 mL	Cool to 4°C	7 days to analysis	EPA 310.1
Chloride	Glass, Teflon lined cap	(1) 125 mL	Cool to 4°C	28 days to analysis	EPA 325.4
Sulfate	Glass, Teflon lined cap	(1) 250 mL	Cool to 4°C	28 days to analysis	EPA 375.4
Hardness	Glass, Teflon lined cap	(1) 250 mL	HNO ₃ to pH < 2	180 days to analysis	SM 2340
TSS	Glass, Teflon-lined cap	(1) 250 mL	Cool to 4°C	14 days to analysis	EPA 160.2
Dissolved Sulfide	Glass, Teflon-lined cap	(1) 1 L	NaOH to a pH > 12; Cool to 4°C	7 days to analysis	EPA 376.2
Dissolved Hydrogen and Methane	Glass, foil lined cap	(1) 60 mL	HCl to a pH < 2; Cool to 4°C	14 days to analysis	RSK 175
Iron (II)	HACH kit	HACH kit	HACH kit Model IR-18C	Analysis Immediately (Dilute as necessary)	HACH Color Disc/1,10 Phenanthroline
Manganese (II)	HACH kit	HACH kit	HACH kit Pocket Colorimeter™ model	Analysis Immediately (Dilute as necessary)	HACH Colorimeter/Cold Periodate

TABLE 1

SUMMARY OF ANALYSIS, BOTTLE REQUIREMENTS, PRESERVATION REQUIREMENTS, AND HOLDING TIMES
 SITE 2 – AREA A LANDFILL
 NSB-NLON, GROTON, CONNECTICUT
 PAGE 2 OF 2

Parameter	Sample Container ⁽¹⁾	Container Volume ⁽¹⁾	Preservation	Maximum Holding Time ⁽²⁾	Analytical Methodology
GROUNDWATER (Continued)					
Specific Conductance	Field probe	Field probe	Field probe	Field probe	Field probe
pH	Field probe	Field probe	Field probe	Field probe	Field probe
Salinity	Field probe	Field probe	Field probe	Field probe	Field probe
Turbidity	Field probe	Field probe	Field probe	Field probe	Field probe
Temperature	Field probe	Field probe	Field probe	Field probe	Field probe
Dissolved Oxygen	Field probe/Field Test Kit	Field probe/Field Test Kit	Field probe(verification w/ CHEMetrics kits	Field probe/Analysis Immediately	Field probe/Field Test Kit Rhodazine D & Indigo Carmine
ORP	Field probe	Field probe	Field probe	Field probe	Field probe

TOC – Total Organic Carbon.

COD – Chemical Oxygen Demand.

TDS – Total Dissolved Solids.

TSS – Total Suspended Solids.

ORP – Oxidation Reduction Potential

HCl – Hydrochloric acid

HNO₃ – Nitric Acid

H₂SO₄ – Sulfuric Acid

NaOH – Sodium Hydroxide

1 Container type and volume may vary based upon the laboratory.

2 Holding times based upon date of sample collection.

3 Methodology as per CLP SOW ILM04.1, Standard Methods for the Examination of Water and Wastewater, USEPA Methods for the Chemical Analysis of Water and Wastes.

TABLE 2

MONITORING WELL CONSTRUCTION DETAILS
 SITE 2 - AREA A LANDFILL
 NSB-NLON, GROTON, CONNETICUT
 PAGE 1 OF 2

Location	Elevation Top of Riser ⁽¹⁾ (feet)	Elevation Top of Casing ⁽¹⁾ (feet)	Depth to Top of Bedrock (feet)	Borehole Diameter (inches)	Well Diameter (inches)	Screened Aquifer	Screen Material	Screen Slot Size	Depth to Top of Screen (feet)	Depth to Bottom of Screen (feet)
4MW1S	129.55	129.74	4.50	8	2	Bedrock	PVC	0.01	8.50	18.50
2LMW29A*	90.96	NA ⁽²⁾	n/a ⁽³⁾	9	2	Overburden (Alluvium)	PVC	0.01	11.00	16.00
2LMW29F*	90.30	NA	n/a	9	2	Overburden (fill)	PVC	0.01	3.42	8.42
2LMW7D*	85.16	85.16	28.50	9	6	Bedrock	PVC	0.01	33.50	43.59
2LMW7S*	84.37	84.50	30.00	9	2	Overburden (fill/dredge)	PVC	0.01	11.65	21.65
2WMW40DS	73.21	73.69	n/a	8.5	2	Overburden (dredge)	PVC	0.006	4.00	14.00
2LMW20S	86.83	87.23	n/a	9	2	Overburden	PVC	0.01	9.00	19.00
2LMW32F*	82.95	NA	n/a	9	2	Overburden (fill)	PVC	0.01	17.00	22.00
2LMW32DS*	82.69	NA	n/a	9	2	Overburden (dredge)	PVC	0.01	19.00	24.00
2LMW32B*	82.74	NA	63.50	9	2	Bedrock	PVC	0.01	76.20	86.20
2WMW46DS	73.53	74.10	n/a	9	2	Overburden (dredge)	PVC	0.006	4.00	14.00

TABLE 2

MONITORING WELL CONSTRUCTION DETAILS
 SITE 2 - AREA A LANDFILL
 NSB-NLON, GROTON, CONNETICUT
 PAGE 2 OF 2

Location	Elevation Top of Riser ⁽¹⁾ (feet)	Elevation Top of Casing ⁽¹⁾ (feet)	Drilling Method	Contractor	Casing Material	Depth to Seal (feet)	Seal Material	Total Depth (feet)	Ground Surface Elevation ⁽¹⁾ (feet)
4MW1S	119.48	109.48	HSA	HNUS	PVC	3.0	Bentonite Pellets	18.50	127.98
2LMW29A*	77.80	72.80	HSA	HNUS	PVC	8.0	Enviroplug Chips	16.00	88.80
2LMW29F*	85.28	80.28	HSA	HNUS	PVC	1.5	Bentonite Chips	15.50	88.70
2LMW7D*	49.60	39.51	Air Rotary	Atlantic	Steel/Open	33.5	Grout/Casing	43.59	83.10
2LMW7S*	71.15	61.15	HSA	Atlantic	PVC	6.5	Bentonite	50.00	82.80
2WMW40DS	67.46	57.46	Drive/Wash	EDI	PVC	2.0	Bentonite	14.00	71.46
2LMW20S	78.23	68.23	Air Rotary	HNUS	PVC	5.0	Bentonite Pellets	26.00	87.23
2LMW32F*	63.80	58.80	Spin Casing	HNUS	PVC	0.0	Bentonite Chips	24.00	80.80
2LMW32DS*	61.80	56.80	Spin Casing	HNUS	PVC	15.0	Bentonite Slurry	23.00	80.80
2LMW32B*	4.40	-5.6	Spin Casing	HNUS	PVC	64.0	Bentonite Slurry	86.00	80.60
2WMW46DS	67.76	57.76	Drive/Wash	EDI	PVC	2.0	Bentonite	14.00	71.76

Notes:

* Elevation data (1982 Base Datum) represents conditions prior to the installation of landfill cap except for wells 4MW1S, 2WMW40DS, 2LMW20S, and 2WMW46DS. The remaining well locations will be re-surveyed to update the elevation data.

1 - All elevation data is referenced to the 1982 Base Datum. 1982 Base Datum = 1988 NGVD + 2.39 feet.

2 - NA - Not available.

3 - n/a - Not applicable.

