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FINAL FEASIBILITY STUDY REPORT SITE 15 NAS PENSACOLA FL
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ENSAFE, INC

FINAL FEASIBILITY STUDY REPORT
SITE 15
NAVAL AIR STATION
PENSACOLA, FLORIDA

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Pensacola, Florida

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19. Abstract
This Feasibility Study (FS) develops, evaluates, and compares four soil and four groundwater remedial action alternatives that may be used to mitigate hazards and threats to human health and the environment at Site 15 at Naval Air Station (NAS) Pensacola. The FS addresses soil and groundwater contamination as recommended in the *Final Remedial Investigation Report for Site 15, Naval Air Station Pensacola, Pensacola, Florida* (EnSafe, December 12, 1997) (RI).

The FS evaluates the RI, the baseline risk assessment (BRA), and potential applicable, relevant, or appropriate requirements (ARARs) to develop remedial goals (RGs) for Site 15. Based on the proposed industrial use of Site 15 in the future, a remedial goal of 1E-06 for current or future site workers has been established. Site 15 soil samples exceed the industrial-based risk at 24 sample points with the most frequently detected contaminants being arsenic and dieldrin. Florida Department of Environmental Protection (FDEP) does not require remediation to below Soil Cleanup Target Levels (SCTLs). Twenty-three soil sample locations exceeded the FDEP SCTLs for industrial use. Subsurface soil samples did not reflect site impacts. Contamination detected in shallow groundwater at two locations was evaluated during the FS. Site 15 groundwater and soil alternatives are developed separately since they are not interdependent.

Based on the USEPA guidance document from the Office of Solid Waste and Emergency Response (OSWER) Directive 9355.3-01, *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (Interim Final, October 1988) four soil and four groundwater alternatives are developed and screened in this FS. An alternative with no remedial actions is proposed for both soil and groundwater and, as required by the National Contingency Plan (NCP), includes a review once every five years for 30 years. The other three soil and groundwater alternatives are listed below.

Soil

- Institutional controls are not the same as no-action. Controls are implemented to limit access and exposure to contaminated soil.
- Excavation and offsite disposal. Site 15 soil exceeding chemical specific RGs (approximately 580 yd³) would be removed from the site and taken to a disposal facility.
- Asphalt cover and limited excavation. Under this alternative, an asphalt cover would be placed over contaminated soil so that access is physically restricted. In addition, areas where an asphalt cover is not feasible, limited excavation and offsite disposal will be used.

Groundwater

- Monitored natural processes/institutional controls. This alternative is not the same as "no action." Under this alternative, contaminated water will be left in place. Institutional controls would be implemented at the site to limit access. Groundwater would be monitored and the base master plan would be amended to prevent consumption of any water exceeding remedial goals. Natural attenuation would include modeling and evaluation of contaminant degradation rates to determine feasibility. In addition, an annual sampling and analysis program must be conducted throughout the process to confirm that degradation is proceeding at rates consistent with meeting cleanup objectives.
- Groundwater recovery and discharge. In this alternative the contaminated groundwater would be actively recovered and disposed offsite.
- Groundwater recovery and ex-situ treatment. In this alternative, the contaminated groundwater would be actively recovered and treated in an onsite treatment system. Two treatment alternatives are considered, 1) treatment with solidification/stabilization and solids removal and 2) treatment with ion exchange. Under this alternative the groundwater would be monitored and expected to meet remedial goals.

These alternatives are initially evaluated using the three screening criteria of implementability, effectiveness, and cost. Then, as per the *National Contingency Plan* (NCP), a detailed analysis of alternatives is performed on all alternatives, using the criteria of long-term effectiveness; short-term effectiveness; reduction of toxicity, mobility, or volume; implementability; cost; compliance with ARARs; overall protection of human health and the environment; state acceptance; and community acceptance.

A comparative analysis of the alternatives a summarized below:

Threshold Criteria: In an industrial-use scenario at Site 15, institutional controls for soil and natural attenuation for groundwater would require no further actions to protect human health.

Balancing Criteria: In an industrial-use scenario at Site 15, institutional controls for soil and the natural attenuation for groundwater would require no further actions to protect human health. Short-term impacts from covering the soil are greater than for the other three soil alternatives but are controllable. All alternatives are implementable, with groundwater recovery and treatment and the asphalt cover having the highest costs. Institutional controls is the lowest cost of soil alternatives 2, 3, and 4 and groundwater recovery and discharge is the lowest cost of groundwater alternative 2, 3, and 4..

Modifying Criteria: These criteria will be addressed during the FS review period and the public comment period for the ROD.

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List of Acronyms and Abbreviations

ACL	alternate concentration limit
ARARs	applicable or relevant and appropriate requirements
BEQ	benzo(a)pyrene equivalent
bls	below land surface
BRA	baseline risk assessment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CG	cleanup goal
CGL	cleanup goal from leaching
CLP	Contract Laboratory Program
CNET	Chief of Naval Aviation and Training
COC	chemical of concern
COPC	chemical of potential concern
CSA	Clean Water Act
E&E	Ecology & Environment, Inc.
EP	extraction procedure
ERA	ecological risk assessment
FOTW	federally owned treatment works
FDEP	Florida Department of Environmental Protection
FGGC	Florida Groundwater Guidance Concentration
FPDWS	Florida Primary Drinking Water Standards
FS	feasibility study
FSDWS	Florida Secondary Drinking Water Standard
FSWQS	Florida Surface Water Quality Standards
GPM	gallons per minute
HDPE	high density polyethylene
HHRA	human health risk assessment
HI	hazard index
HQ	hazard quotient
IAS	Initial Assessment Study
ILCR	incremental life-time excess cancer rate
IRP	Installation Restoration Program

MCL	maximum contaminant level
MCLG	maximum concentration level goals
msl	mean sea level
MSMA	monosodium methanarsonate
μg/kg	microgram per kilogram
μg/L	microgram per liter
mg/kg	milligram per kilogram
NAS	Naval Air Station
NCP	National Contingency Plan
NEESA	Naval Energy and Environmental Support Activity
NPL	National Priorities List
O&M	operation and maintenance
OSWER	Office of Solid Waste and Emergency Response
PAH	polynuclear aromatic hydrocarbons
PCB	polychlorinated biphenyl
ppm	part per million
PRG	Preliminary Remediation Goal
PPE	personal protective equipment
RAGS	Risk Assessment Guidance under Superfund
RBC	risk-based concentration
RC	reference concentration
RGO	remedial goal option
RI	Remedial Investigation
RME	reasonable maximum exposure
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
SCTL	Soil Cleanup Target Levels
SDWA	Safe Drinking Water Act
sf	square feet
SMCL	secondary maximum contaminant level
SSL	soil screening level
TBC	chemical specific regulations to be considered
TCLP	toxicity characteristic leaching procedure
TRPH	total recoverable petroleum hydrocarbons
USEPA	U.S. Environmental Protection Agency
UST	underground storage tank
VOC	volatile organic compound

1.0 INTRODUCTION

1.1 Purpose and Organization of Report

The purpose of this Feasibility Study (FS) is to develop, evaluate, and compare remedial action alternatives to mitigate hazards and threats to human health and the environment from soil and groundwater contamination at Site 15 at the Naval Air Station (NAS) Pensacola, Florida.

The FS is being performed under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and the Superfund Amendments and Reauthorization Act of 1986 (SARA), based upon the findings reported in the *Final Remedial Investigation Report, Site 15, Naval Air Station, Pensacola, Florida* (EnSafe, 1997). As required by SARA, the NAS Pensacola Restoration Advisory Board (RAB) provides a focus for community input to the remedial decision making process. The RAB meets on a regular basis and the meetings are open to the public. The RAB consists of community members, regulators, Navy Southern Division (SouthDiv) representatives, and NAS Pensacola representatives. Upon completion of the FS, a Proposed Plan that documents the FS process and presents the preferred alternative for the site will be made available for public comment to ensure that decision makers are aware of public concerns. The decision makers for NAS Pensacola include the Florida Department of Environmental Protection (FDEP), the United States Environmental Protection Agency (USEPA), SouthDiv, and NAS Pensacola. The results of the FS process will be documented in the Record of Decision (ROD).

This FS report has been organized according to the format in the Office of Solid Waste and Emergency Response (OSWER) Directive 9355.3-01, *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (Interim Final, October 1988):

- **Section 1, Introduction:** This section presents Site 15's history and background and the results of previous investigations, including the remedial investigation (RI) and baseline risk assessment (BRA).

- **Section 2, Basis for Feasibility Study Action:** This section presents the areas requiring feasibility study (FS) analysis and remedial action objectives. The objectives were developed using RI characterization and assessments and by considering applicable or relevant and appropriate requirements (ARARs). This section also presents site remedial goals and volumes and/or areas that require remediation.

- **Section 3, Identification and Screening of Technologies:** This section presents response actions and identifies and screens remedial technologies that may be used to achieve remedial action objectives.

- **Section 4, Development and Screening of Alternatives:** This section presents representative technologies that meet the screening criteria (i.e., implementability, effectiveness, and cost) and combines them into site remedial alternatives.

- **Section 5, Detailed Analysis of Alternatives:** This section evaluates the individual alternatives in detail with respect to the nine evaluation criteria identified in OSWER Directive 9355.3-01, *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (Interim Final, October 1988).

- **Section 6, Comparative Analysis of Alternatives:** This section assesses the relative performance of the alternatives, presenting strengths and weaknesses to prioritize or rank them relative to the nine evaluation criteria.

1.2 Background Information

The following section summarizes the RI findings. For more details on RI methods and results, refer to the RI Report (EnSafe, December 1997).

1.2.1 Site Description and History

As shown on Figure 1-1, Site Location Map, Site 15 is in the northern portion of NAS Pensacola. The site includes the golf course maintenance facilities which are approximately 600 feet south of Bayou Grande. It is accessible from the west via an unpaved road. Land surface across the site is generally level and unpaved, except for small paved areas used for equipment wash-down. These areas, shown on Figure 1-2, Site Map, include three concrete wash-down pads, each covering approximately 250 square feet or less, and two asphalt pads covering less than 50 square feet. Six buildings are in the immediate site vicinity:

- Building 2640, large equipment (tractor/mower) storage
- Building 747, office space
- Building 3447, equipment maintenance and storage
- Buildings 1851 and 1776, equipment storage
- Building 3586, controlled storage of bulk quantities of fertilizers, pesticides, and herbicides

Additionally, Building 2692 was on the site's western portion from the 1960s until early 1996, when its aboveground portion was razed; the building's concrete slab floor is still onsite. From 1963 to 1979, Building 2692 and the adjacent outdoor area were used for pesticide storage (Geraghty & Miller [G&M], 1986). Neither the building's floor nor the outdoor area were paved, creating the potential for direct infiltration of spilled or leaking pesticides. However, this building was re-floored with concrete and used to store dry material (sand and fertilizer) before 1996.

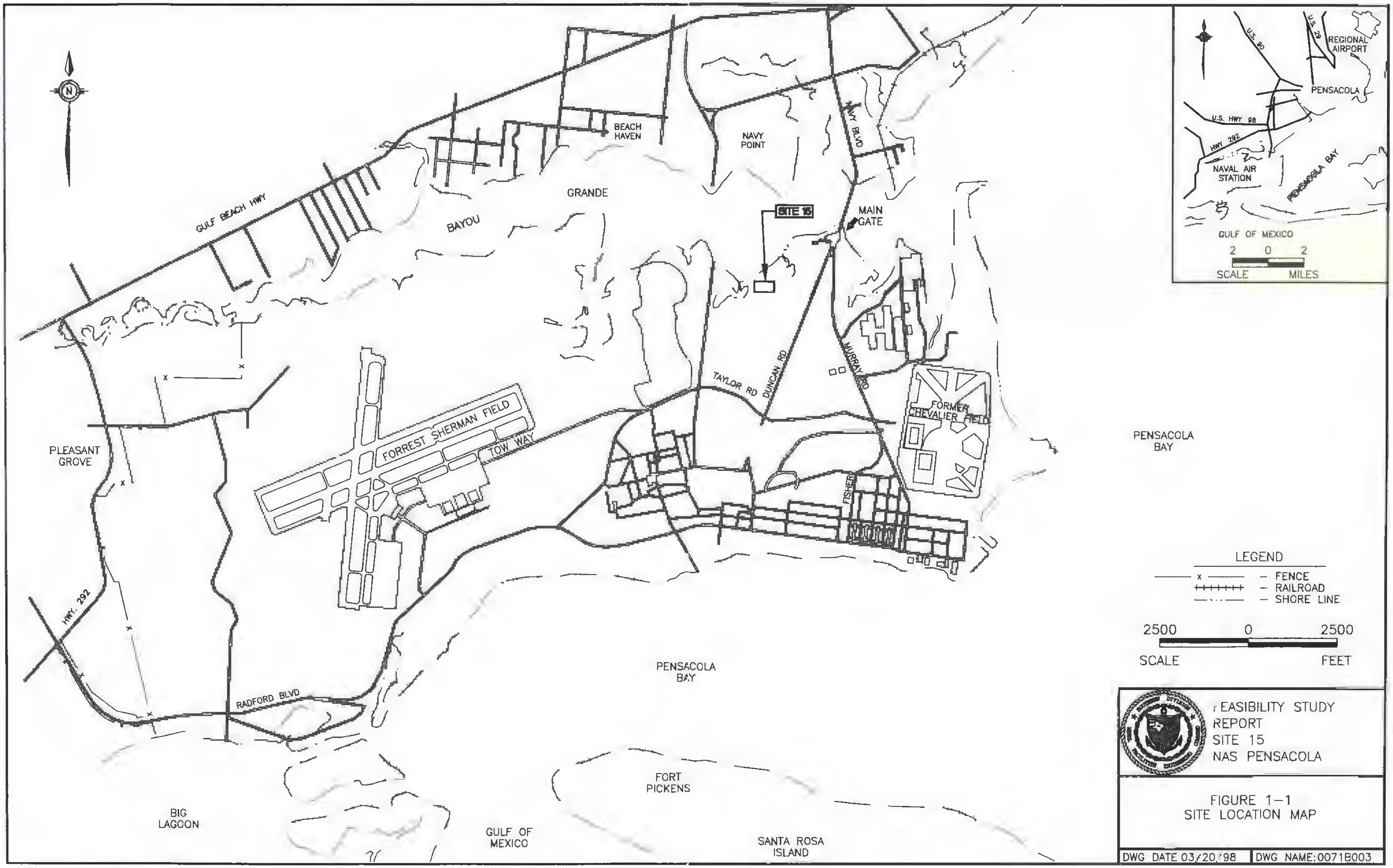

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FIGURE 1–1
SITE LOCATION MAP

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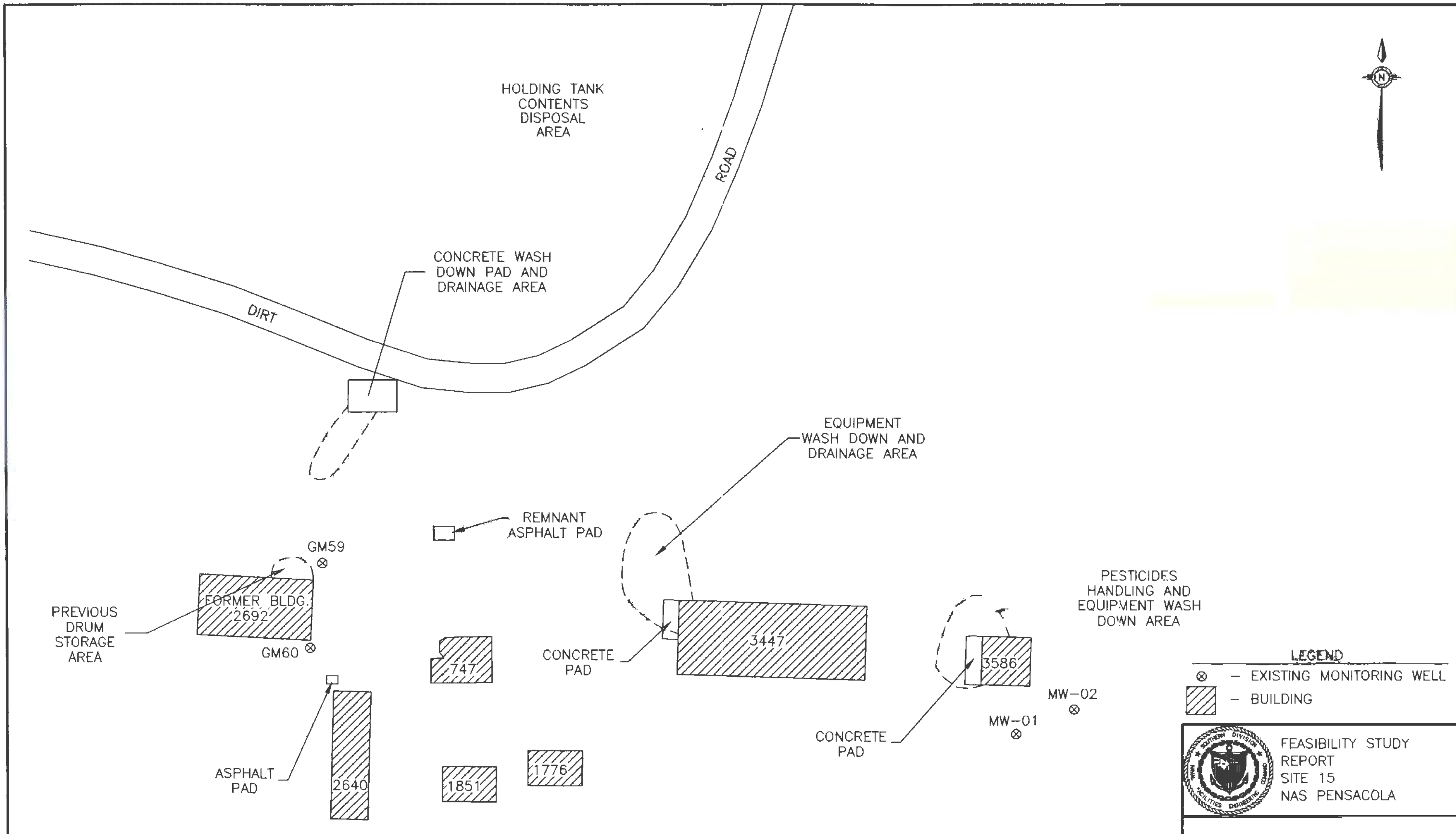


FIGURE 1–2
SITE MAP

DWG DATE 04/15/98 | DWG NAME 0071B004

Currently, tractors and large mowers are rinsed on the concrete wash-down pads northeast of Building 2692 and northwest of Building 3447. Pollution prevention practices and procedures have eliminated releases of contaminants.

From 1963 to the present, fertilizer, pesticide, and herbicide materials to be applied to the NAS Pensacola golf course have been and are stored and mixed at the golf course maintenance facility. Application equipment is also rinsed at the facility's wash-down pads. The original Site 15 area identified in previous investigations included Building 2692, the pesticide storage area just off Building 2692's northeastern corner, and the asphalt wash-down pad northwest of Building 2640.

Commercial application equipment such as tractors, sprayer tanks, spreaders, etc., are currently used in routine golf course maintenance. Equipment cleaning is currently conducted at a wash stand which collects the rinsate for re-use. Before construction of the wash stand, these rinsates, reported to contain organic phosphates, chlorinated hydrocarbons, carbaryl, and carbamates, had infiltrated directly into the sandy soil (G&M, 1984).

Building 3586, approximately 375 feet east of Building 2692, has been used to rinse equipment and store and handle herbicides and pesticides since its 1979 construction. Previously, a sink outside the building and a drain in a concrete pad north of the building collected pesticide/herbicide residue wastes and discharged them to an underground holding tank. The contents were periodically pumped out by a contracted agent before the tank's removal in approximately 1993. During the removal, the tank's contents were placed in an area north of the dirt road. Wash stands are currently used for equipment rinsing to collect the rinsate for re-use.

In summary, based on site history, Site 15 areas with the potential for contaminant release include:

- Pesticide/drum storage areas at Building 2692's former location;
- Four equipment rinsate/pesticide handling areas:
  - the asphalt pad northwest of Building 2640
  - the concrete wash-down pad and drainage area northwest of Building 2692
  - the wash-down and drainage area at the northwest corner of Building 3447
  - the pesticide handling area adjacent to Building 3586's west side
- Equipment storage Building 2640
- Holding tank contents disposal area north of the dirt road

Currently, waste minimization procedures are in place at handling areas to eliminate the potential for additional contamination from the areas being addressed in this FS.

1.2.2 Chronology of Events and Previous Investigation

Site 15 has been studied as part of several previous investigations at NAS Pensacola. Their scope and findings are summarized in the following subsections. Applicable analytical results from previous investigations are referenced in the following discussion and presented in Appendix B of the Site 15 RI report.

1983 — Initial Assessment Study

The Initial Assessment Study (IAS) report prepared by the Naval Energy and Environmental Support Activity (NEESA) identified sites potentially posing a threat to human health or the environment due to contamination from past hazardous materials operations. Historical records, aerial photographs, field inspections, and personnel interviews were used to identify 29 potentially contaminated sites at NAS Pensacola. Site 15 was among those identified for evaluation by this study. According to the IAS report conclusions, discarded pesticide rinsates were not sufficiently concentrated to constitute a threat to human health or the environment. Further study was not recommended (NEESA, 1983). Since environmental sampling and laboratory analyses were not performed, the information required to thoroughly assess the magnitude and extent of residual contamination was not available.

Confirmation Study

In 1984, G&M was retained by the Navy to perform a Confirmation Study at NAS Pensacola. It consisted of two parts: a Verification Study in 1984 and a Characterization Study in 1986.

1984 — Verification Study

The 1984 Verification Study examined the asphalt wash-down pad and the pesticide storage area adjacent to Building 2692. At three soil borings completed to 2 feet below land surface (bls), samples were collected and analyzed for arsenic and pesticides. The analytical results indicated arsenic and organic pesticides in site soil, with concentrations consistently decreasing with depth. Detected total arsenic concentrations ranged from 1.6 parts per million (ppm) to 31 ppm; total pesticides ranged from 0.02 ppm to 23.4 ppm. Appendix B, Table B-1 of the RI report, presents the analytical results. The installation of shallow monitoring wells and additional soil borings was recommended to assess groundwater quality and define the extent of soil impact (G&M, 1984).

1986 — Characterization Study

Two shallow monitoring wells (GM-59 and GM-60) and six additional soil borings approximately 2 feet deep were completed during the 1986 Characterization Study (G&M, 1986). Groundwater samples were analyzed for pesticides, polychlorinated biphenyls (PCBs), and arsenic; soil was analyzed for arsenic only using the extraction procedure (EP) toxicity methodology. The only parameter detected in groundwater was arsenic (0.153 ppm), which was detected in the sample from well GM-59. Two of the concentrations exceeded the Florida Primary Drinking Water Standards (FPDWS) of 50 micrograms per liter (μg/L). Arsenic was also detected in several soil samples. Appendix B, Tables B-2 and B-3 of the RI report present the analytical results. A program to delineate the areal extent of soil contamination was recommended, with soil removal to appropriate levels, along with monitoring well re-sampling and analysis for arsenic (G&M, 1986).

1991 — Contamination Assessment/Remedial Activities Investigation

As a part of the Navy's Installation Restoration Program (IRP), Ecology and Environment, Inc. (E&E), performed Phase I of a Contamination Assessment/Remedial Activities Investigation at Site 15. The objective was to identify principal areas and primary contaminants of concern and to recommend any subsequent investigations.

Fieldwork included site reconnaissance, surface emission surveys, particulate air screening, utilities surveys, collection and laboratory analyses of soil and groundwater samples, and a hydrologic assessment. Only screening level analyses were conducted on most soil and temporary groundwater well samples. Samples from GM-59 and GM-60 were analyzed using Contract Laboratory Program (CLP) level analyses. This analytical approach was conducted to focus additional investigative efforts on areas where screening detections were significant. Additionally, groundwater samples were often turbid and most were analyzed unfiltered, a method which has been associated with erroneously high metal concentrations.

Investigative results indicated the potential presence of metals (particularly arsenic), total recoverable petroleum hydrocarbons (TRPHs), volatile organic compounds (VOCs), polynuclear aromatic hydrocarbons (PAHs), and pesticides in site soil. Relatively low metals concentrations (particularly arsenic) and dieldrin/4,4-DDE were detected in the groundwater samples. Appendix B, Tables B-4, B-5, and B-6 of the RI report, present the analytical results. Limited additional assessment was recommended for Site 15. Complete results are presented in an Interim Data Report for the site (E&E, 1991).

Building 3586 UST Removal

The underground storage tank (UST) immediately south of Building 3586 which was used as a rinsate holding tank was removed, along with associated soil, during 1993. It's contents were spread across a nearby portion of the golf course, approximately 200 feet north-northwest of Building 3447 (Figure 1-2, Site Map). No analytical results or other specific information were available from this removal activity.

1.2.3 Physiography

NAS Pensacola is in the Gulf Coast lowlands on a peninsula bounded by Pensacola Bay to the south and east and Bayou Grande to the north. The main topographic feature is a bluff paralleling the southern and eastern shorelines of the peninsula. Landward of the bluff is a gently rolling upland with elevations up to 40 feet above mean sea level (msl) (USGS, 1970a, b). In the base's eastern part, a low and nearly level marine terrace lies east of the bluff with elevations of approximately 5 feet or less above msl. The area includes the Chief of Naval Education and Training (CNET) and Magazine Point.

Sandy soils typify the NAS Pensacola area. Consequently, most rainfall infiltrates directly into the subsurface, resulting in few natural streams. Streams on base generally are man-made and channelized. Numerous natural wetlands occur in low-lying areas.

1.2.4 Stratigraphy and Hydrogeology

Stratigraphy beneath the Florida Panhandle generally consists of Quaternary marine terrace and fluvial deposits, underlain by a thick sequence of interlayered fine-grained clastic deposits and Tertiary age carbonate strata (Southeastern Geological Society [SEGS], 1986). Three main regional hydrogeologic units have been described within this stratigraphic column (in descending order): the surficial/Sand-and-Gravel Aquifer, the Intermediate System, and the Floridian Aquifer system.

As discussed in the RI Report, site groundwater is encountered 10 to 15 feet below ground surface (bgs) across most of the site, except along the Bayou and the tidal pond. Groundwater flows generally to the north-northwest along Bayou Grande, and to the north-northeast along the tidal pond. In general, the potentiometric surface mimics topography. There has been little to no variation in the surface configuration during multiple events; however, water levels appear to vary seasonally.

The surficial aquifer beneath the site is 30 to 40 feet thick, comprised of a homogeneous fine- to medium-grained sand. The majority of monitoring wells in the unit are screened at or near the water table, with terminal depths ranging from 15 to 20 feet bgs. Two wells (GR-39 and GR-40) were completed to the intermediate confining unit. The surficial aquifer is not used as a potable drinking water source; given the availability of alternate superior-quality water supplies, it is unlikely that the surficial aquifer will be used as a potable source in the future. However, because the aquifer is considered a G-II aquifer (i.e., a potential future source of drinking water), FPDWS are considered an ARAR at this site. Refer to the Site 15 RI report for more detail.

1.3 Nature and Extent

This discussion is based primarily on the results presented in the RI report. To determine the nature and extent of contamination, samples were collected and compared to Preliminary

Remediation Goals (PRGs). A BRA was then performed using the sampling results to determine the risks to human health and the environment associated with site contamination. For more details, refer to the Site 15 RI report.

1.3.1 Establishment of Preliminary Remediation Goals

Florida Department of Environmental Protection (FDEP) and/or USEPA risk-based concentrations (RBCs), general guidance concentrations, and promulgated standards were defined as PRGs for the RI. PRGs have been used to evaluate Site 15 analytical results for contaminant distribution and identification of contaminants of concern (COCs). The RI addresses the relationship between detected parameter concentrations and the PRGs, which were cited in the RI report for surface and subsurface soil and groundwater and are presented below. Parameter concentrations below PRGs are not discussed.

Surface and Subsurface Soil PRGs

- RBCs for residential surface soil and soil screening levels (SSLs) transfer scenario from soil to groundwater for subsurface soil (USEPA, 1996a).

- Selected soil cleanup goals (CGs) residential scenario and leaching scenario (CGLs) (FDEP, 1995, [with 1996 and 1997 revisions]).

- USEPA, OSWER draft revised *Interim Soil Lead Guidance* (USEPA, 1994a).

- Title 40 Code of Federal Regulations (CFR) Part 761.125 Requirements for PCB Spill Cleanup (USEPA, 1988).

- USEPA, OSWER *Soil Screening Guidance* (USEPA, 1994b).

Analytical results for soil were compared to different standards based on sample depth. Surface soil samples (0 to 2 feet) were compared to the health-risk based standards from the above references and to soil leachability-based standards considered protective of groundwater. Subsurface soil samples (below 2 feet) were also compared to soil leachability-based standards.

Groundwater PRGs

- Florida Primary Drinking Water Standards (FPDWS), Florida Secondary Drinking Water Standards (FSDWS), and the Florida Surface Water Quality Standards (FSWQS); (FDEP, June 2, 1994).

- Florida Groundwater Guidance Concentrations (FGGC) (FDEP, June 2, 1994).

- USEPA Maximum Contaminant Levels (MCLs) and Secondary Maximum Contaminant Levels (SMCLs) (USEPA 1996b).

1.3.2 Remedial Investigation Assessment

The Site 15 RI field investigation was completed through a multi-phase effort by EnSafe. The results of the RI follow.

Soil Contamination

Several inorganic and organic parameters exceeding PRGs were detected in site soil samples. However, based on the detections' magnitude and frequency, arsenic and dieldrin are the primary parameters of concern in soil. Arsenic was detected across the site's full extent due to the handling of various arsenic-based herbicides and pesticides, such as the commonly used herbicide monosodium methanarsonate (MSMA). As shown in Figure 1-3, Arsenic Detections in Site 15 Surface Soil Exceeding PRGs and RCs, the two areas of greatest surface soil arsenic concentration

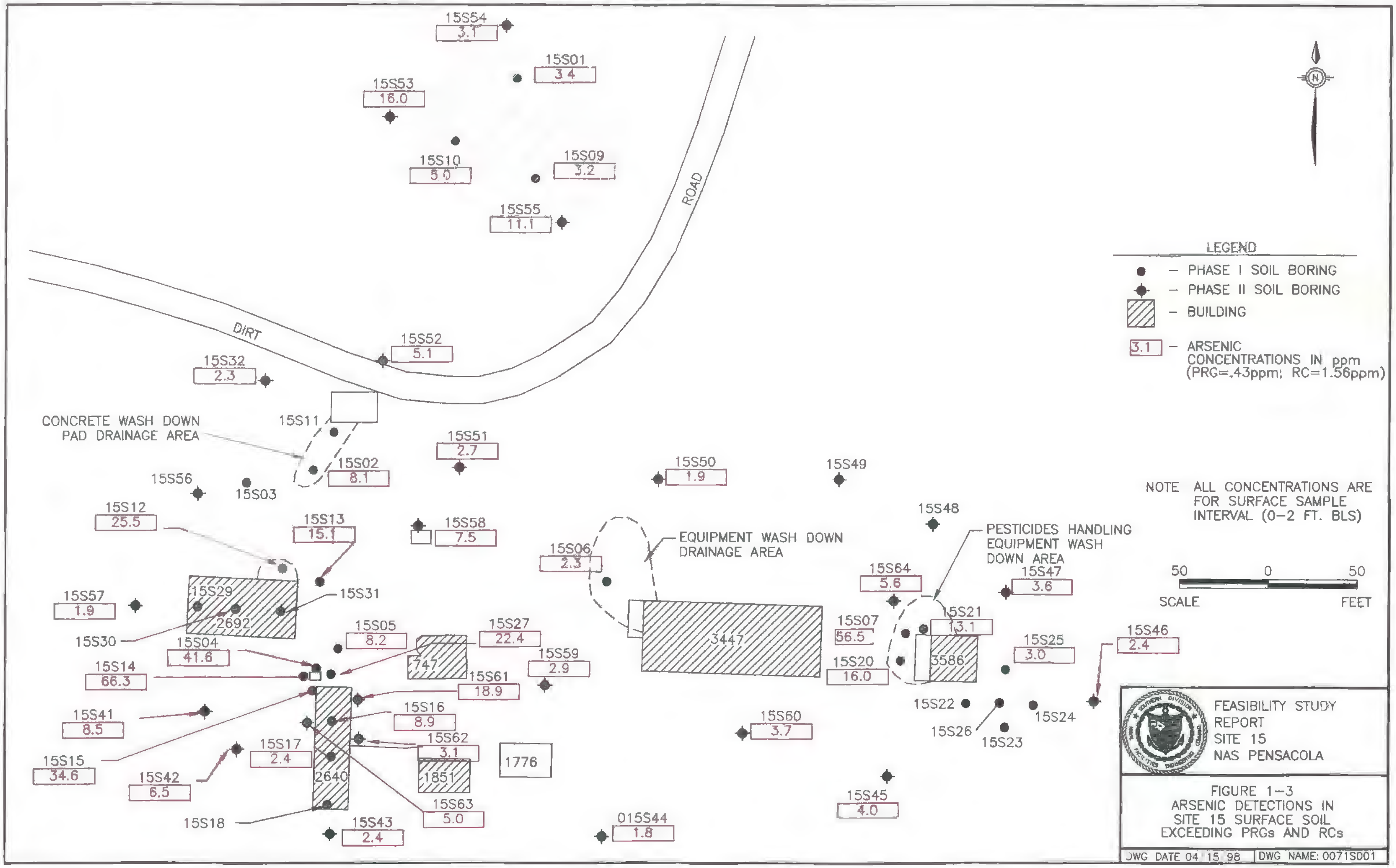


FIGURE 1–3
ARSENIC DETECTIONS IN SITE 15 SURFACE SOIL EXCEEDING PRGs AND RCs

are the asphalt pad northwest of Building 2640 and the concrete pad west-northwest of Building 3586. However, isolated detections were realized throughout Site 15 and north of the road in the old disposal area.

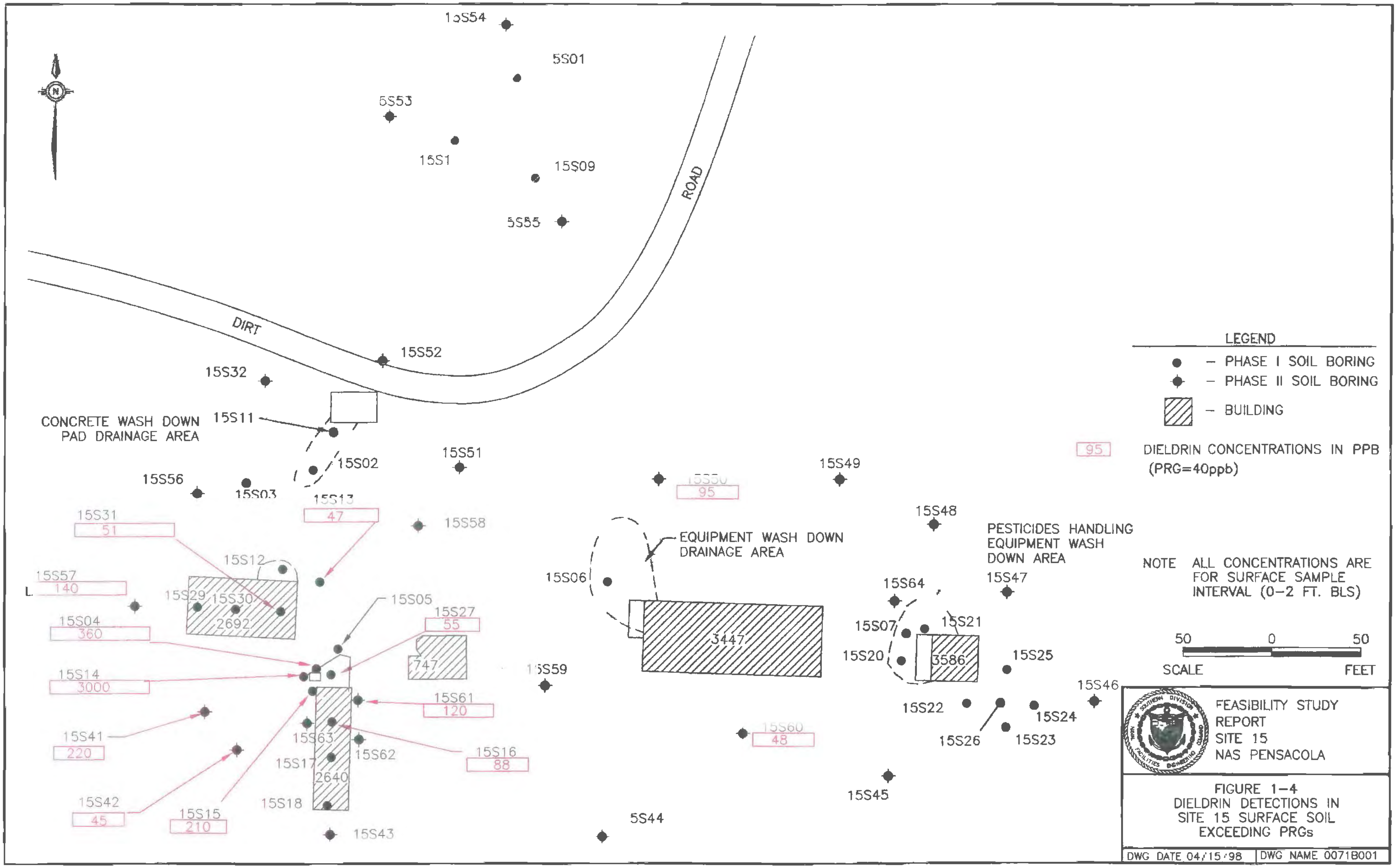
Dieldrin was detected primarily across the site's western-southwestern portion, where storage Building 2692 and equipment storage shed 2640 are located. Dieldrin concentrations exceeding 50 ppb were limited to the area northwest and east of Building 2640's asphalt wash-down pad and beneath the building and at boring 15S50, north of Building 3447. As shown in Figure 1-4, Dieldrin Detections in Site 15 Surface Soil Exceeding PRGs, the areas of greatest surface soil dieldrin concentration are immediately surrounding the asphalt pad.

Subsurface soil samples exceeded the USEPA SSL for dieldrin (1 μg/kg) in 13 sample locations. However, only one sample location at the asphalt pad (15S04) exceeded the FDEP CG for leaching (20 μg/kg) at a depth of 5 feet. Arsenic in one subsurface sample (15S13) exceeded its USEPA SSL of 15 mg/kg at a depth of 10 feet (16.2 mg/kg), but it is less than the FEDP CGL (29 mg/kg). These two isolated occurrences do not reflect subsurface soil as a source of potential groundwater contamination.

Groundwater Contamination

Arsenic commonly exceeded its PRG and reference concentration (RC); it was the primary parameter of interest detected in groundwater. Arsenic was not detected in intermediate depth groundwater samples above the FPDWS, indicating that arsenic has not migrated downward appreciably.

Three areas of PRG exceedances in groundwater have been identified and are shown in Figure 1-5, Maximum Arsenic Concentration Detected in Groundwater Samples During All Sample Phases as: the area immediately surrounding the asphalt pad at Building 2640's northwestern corner, an area



DIRT ROAD
LEGEND
– PHASE I SOIL BORING
– PHASE II SOIL BORING
– BUILDING
95 DIELDRIN CONCENTRATIONS IN PPB (PRG=40ppb)
CONCRETE WASH DOWN PAD DRAINAGE AREA
EQUIPMENT WASH DOWN DRAINAGE AREA
PESTICIDES HANDLING EQUIPMENT WASH DOWN AREA
NOTE ALL CONCENTRATIONS ARE FOR SURFACE SAMPLE INTERVAL (0–2 FT. BLS)
50 0 50
SCALE FEET
15S54
5S01
5S53
15S1
15S09
5S55
15S52
15S32
15S11
15S02
15S51
15S56
15S03
15S13 47
15S31 51
15S58
15S12
15S57 140
15S29
15S30
2692
15S05
15S27 55
15S04 360
747
15S14 3000
15S61 120
15S41 220
15S63
15S62
15S16 88
15S17
2640
15S42 45
15S15 210
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15S43
15S50 95
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15S47
15S07
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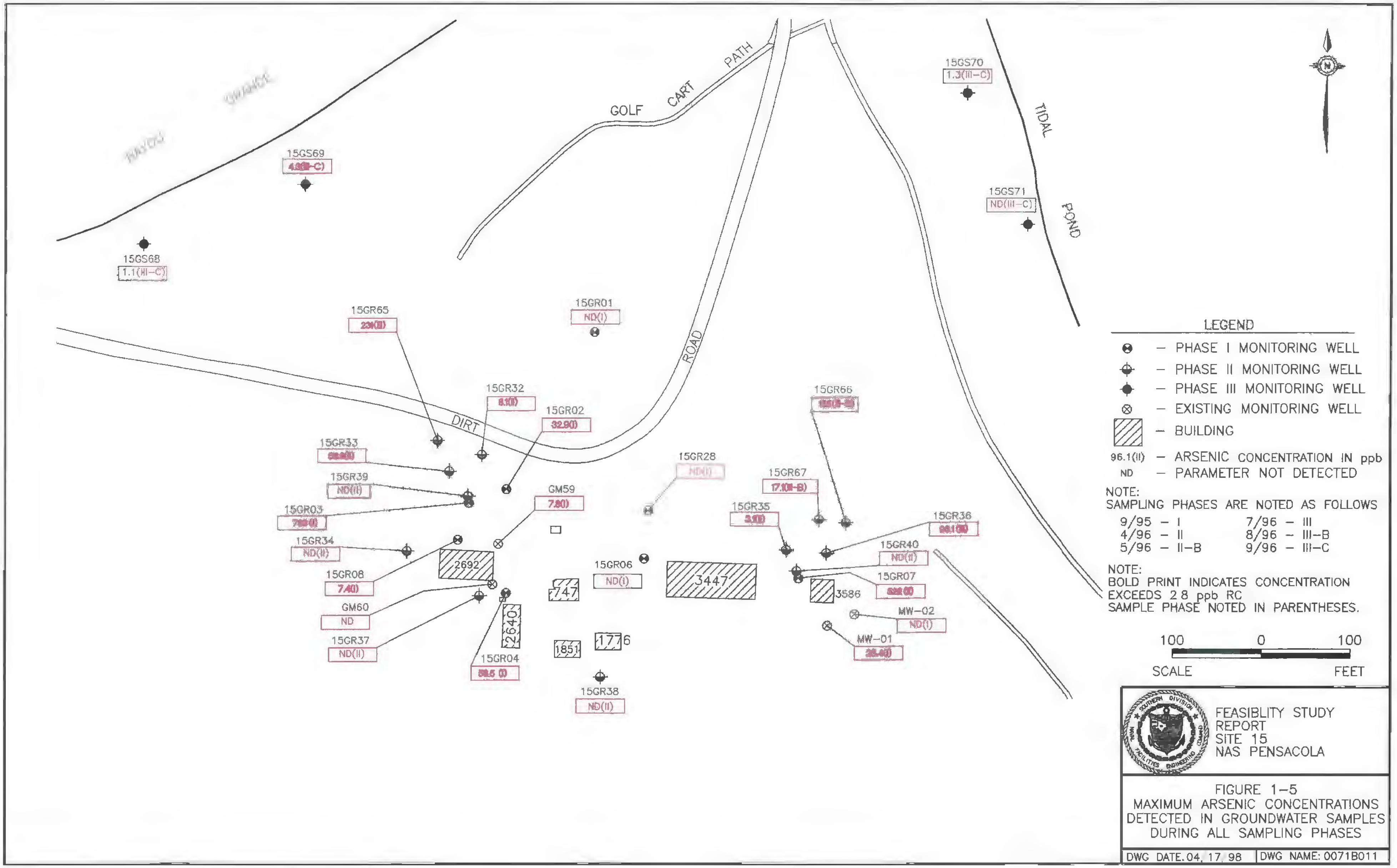
FIGURE 1–4
DIELDRIN DETECTIONS IN SITE 15 SURFACE SOIL EXCEEDING PRGs
DWG DATE 04/15/98
DWG NAME 0071B001


BAYOU
GRANDE
GOLF CART PATH
DIRT ROAD
TIDAL POND
15GS68
1.1(III–C)
15GS69
15GS70
1.3(III–C)
15GS71
ND(III–C)
15GR65
15GR01
ND(I)
15GR32
8.1(II)
15GR02
32.9(I)
15GR33
15GR39
ND(II)
15GR03
15GR34
ND(II)
15GR08
7.4(I)
GM59
7.8(I)
GM60
ND
15GR37
ND(II)
15GR04
15GR06
ND(I)
15GR38
ND(II)
15GR28
ND(I)
15GR66
15GR67
17.1(II–B)
15GR35
15GR36
15GR40
ND(II)
15GR07
MW–02
ND(I)
MW–01
2692
2640
747
1851
1776
3447
3586
N
LEGEND
– PHASE I MONITORING WELL
– PHASE II MONITORING WELL
– PHASE III MONITORING WELL
– EXISTING MONITORING WELL
– BUILDING
96.1(II) – ARSENIC CONCENTRATION IN ppb
ND – PARAMETER NOT DETECTED
NOTE:
SAMPLING PHASES ARE NOTED AS FOLLOWS
9/95 – I
4/96 – II
5/96 – II–B
7/96 – III
8/96 – III–B
9/96 – III–C
NOTE:
BOLD PRINT INDICATES CONCENTRATION EXCEEDS 2.8 ppb RC
SAMPLE PHASE NOTED IN PARENTHESES.
100 0 100
SCALE FEET
FEASIBLITY STUDY REPORT
SITE 15
NAS PENSACOLA
FIGURE 1–5
MAXIMUM ARSENIC CONCENTRATIONS DETECTED IN GROUNDWATER SAMPLES DURING ALL SAMPLING PHASES
DWG DATE: 04/17/98
DWG NAME: 0071B011

north of Building 2692, and an area north of Building 3586. The areas of the highest arsenic concentrations in shallow groundwater are north of Buildings 2692 and 3586, downgradient of areas where soil arsenic concentrations exceed PRGs. The groundwater sampling results from the most downgradient monitoring wells, 15GS68 through 15GS71 adjacent to Bayou Grande and the tidal pond, indicate that arsenic concentrations above PRGs do not extend beyond the golf course to the north. Rather, given the distribution and magnitude, arsenic concentrations in groundwater above PRGs are limited to the site and immediately downgradient areas. One potential downgradient area east of the site will be monitored during Remedial Design/Remedial Action (RD/RA). This is important in that exposure of the nearest surface water receptors to deleterious effects levels is not evident from existing data.

1.3.3 Baseline Risk Assessment

The BRA for the Site 15 RI included a human health risk assessment (HHRA) and an ecological risk assessment (ERA).

Human Health Risk Assessment

One of the primary steps of the HHRA is to determine chemicals of potential concern (COPCs). For any COPC to be considered a COC and warrant assessment for remedial action, it must meet two criteria. First, the COPC must contribute to an exposure pathway with a residential excess cancer risk exceeding 1E-06 or a hazard index (HI) greater than 1 for any of the exposure scenarios evaluated in the risk assessment. Second, the COPC must have an residential risk projection greater than 1E-06 or a hazard quotient (HQ) greater than 0.1. This approach to determine COCs is conservative since USEPA Region IV uses the cumulative risk of 1E-04 as the criterion. The cumulative risk threshold used to identify COCs for the Site 15 BRA is two orders of magnitude more conservative at 1E-06. The Site 15 COCs identified for surface soil in the HHRA are alpha-chlordane, arsenic, benzo(a) pyrene equivalents (BEQs), dieldrin, and gamma-chlordane. The groundwater COCs are arsenic and dieldrin.

The risk and hazard posed by contaminants at Site 15 were assessed for the current and hypothetical future site worker and the hypothetical future site resident under reasonable maximum exposure (RME) assumptions. For surface soil, the incidental ingestion and dermal contact pathways were assessed. For groundwater, the ingestion pathway was evaluated. The following discussion summarizes the HHRA results for Site 15.

Six of 53 soil sample locations had reported concentrations resulting in a residential cumulative HI greater than 1. Arsenic concentrations contribute to the HI at all six locations and is the primary hazard driver at locations 15S04, 15S07, 15S12, 15S14, and 15S15. Alpha-chlordane and beta-chlordane are the primary hazard drivers at sample location 15S16. Dieldrin contributes to the HI at sample location 15S14. The cumulative HI calculated for the site worker is less than 1 for Site 15 soil sample locations.

Forty-eight of 53 soil sample locations had reported concentrations resulting in a residential cumulative risk greater than 1E-6. Arsenic was the primary driver of risk at the 48 locations. However, dieldrin contributed to human health risk at six of the locations and BEQs contributed at five sample locations. Alpha-chlordane and gamma-chlordane contributed to the risk calculated for two sample locations, 15S13 and 15S16, which were also impacted by dieldrin and arsenic. Twenty-four sample locations had reported concentrations resulting in an industrial cumulative risk greater than 1E-6. Arsenic was the primary driver of risk at the 24 locations with contributions from dieldrin at two locations and alpha-chlordane and BEQs at one locations each. Figure 1-6, Cumulative Risk in Site 15 Surface Soil Industrial Scenario, presents the cumulative point risk calculated for the site worker at Site 15 soil sampling locations.

In three phases of Site 15 groundwater sampling, 12 of 28 well locations had reported concentrations resulting in a residential cumulative HI greater than 1. Arsenic was the primary

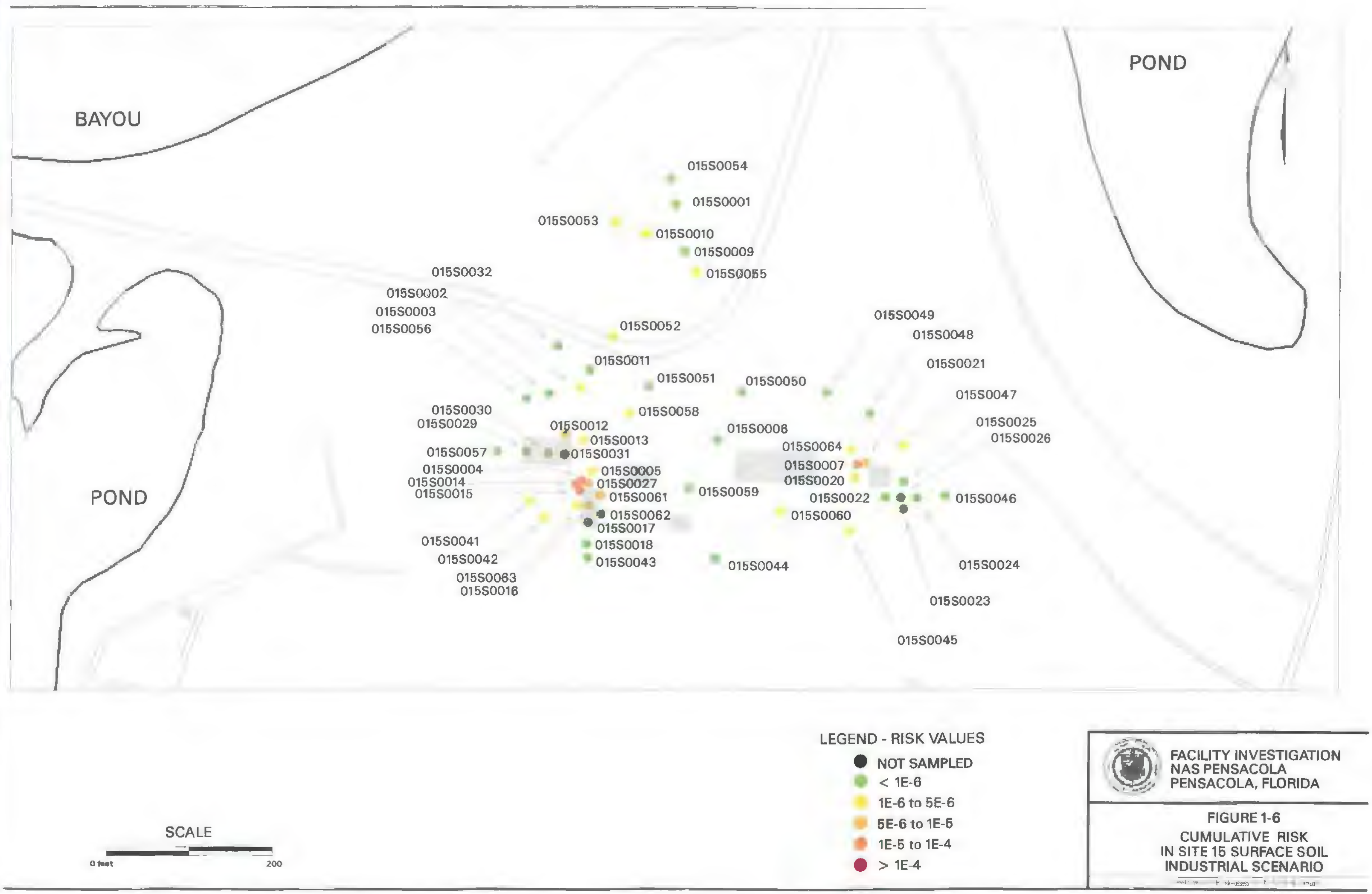


FIGURE 1-6
CUMULATIVE RISK
IN SITE 15 SURFACE SOIL
INDUSTRIAL SCENARIO

hazard driver at the 12 sample locations. Six of the 28 well locations had reported concentrations resulting in an industrial cumulative HI greater than 1, with arsenic also the primary hazard driver.

The 28 wells sampled had reported concentrations resulting in both residential and industrial cumulative risk greater than 1E-6. However, only seven locations had arsenic concentrations exceeding the FPDWS (50 μg/L). As stated above, arsenic was the primary risk driver in groundwater. Dieldrin contributed to the risk estimates at 19 well locations. However, the FGGC for dieldrin is 0.1 μg/L. Analytical results indicated the FGGC was exceeded at one well, 15GS68 (0.11 μg/L). This value is considered essentially equivalent to the FGGC; subsequent sampling did not confirm the presence of dieldrin. Therefore, dieldrin concentrations in groundwater do not warrant further attention during the FS.

Not all exposure scenarios used in the human health BRA are realistic, given the sites's current and projected use. However, the analysis was performed during the RI for risk management decision making. Given parameter concentrations in site media, the State of Florida's goal of 1E-06 residential excess risk threshold, and the USEPA's 1E-04 to 1E-06 acceptable risk range, the estimated risk associated with detected parameters in Site 15 soil and groundwater are summarized as:

- Arsenic, dieldrin, chlordane, and BEQ contributed to the risk estimated for one or more of the soil exposure pathways evaluated. No COCs would be identified in soil based on USEPA's acceptable risk range and associated *Risk Assessment Guidance for Superfund* (USEPA, RAGS, 1989a) information. However, based on comparison with the more conservative Florida risk threshold goal used in the BRA, these parameters contribute to risk.

- Arsenic and dieldrin each contribute to the risk estimated for the groundwater ingestion exposure pathway, although dieldrin did not exceed its FGGC. Therefore, dieldrin does not warrant further attention in the FS.

Remedial goal options (RGOs) representing risk/hazard criteria for soil at Site 15 for residential and industrial scenarios are presented in Table 1-1, Site 15 Remedial Goal Options. Assuming exposure pathways are complete, soil chemical concentrations less than or equal to Table 1-1 concentrations meet the specified risk threshold and HI of 1. However, it is important to note that if the residential scenario is considered a desirable goal for site soil, using the RGOs in Table 1-1, background arsenic (1.56 mg/kg) already presents a cancer risk of up to 3.75 E-06 to future site residents. Excess risk should be measured from this departure point, because the National Contingency Plan (NCP) does not require remediation of National Priorities List (NPL) sites to risk levels below natural conditions.

Table 1-1
Site 15 Remedial Goal Options (mg/kg)

Compound	Mean Detected Concentration	Range of Detected Concentrations	RC	Residential 1E-06	Residential 1E-05	Industrial 1E-06	Industrial 1E-05
Arsenic	8.78	0.29-66.3	1.56	0.416	4.16	3.53	35.3
α Chlordane	0.197	0.00058-3.1	—	0.401	4.01	2.42	24.2
BEQ	0.154	0.0089-1.6	—	0.071	0.71	0.43	4.3
Dieldrin	0.159	0.0005-3.0	—	0.033	0.33	0.2	2.0
γ Chlordane	0.153	0.0005-2.0	—	0.401	4.01	2.42	24..2

Ecological Risk Assessment

The eastern cottontail rabbit and the American robin were selected as assessment endpoint wildlife species for the ecological component of the BRA. This risk evaluation indicates potential sub-lethal effects to these species from maximum detected arsenic, mercury, and possibly surface soil pesticide concentrations. However, associated calculations are based on conservative assumptions (i.e., the rabbit or robin receives 100% of its diet from areas of maximum contaminant concentrations), which in reality, do not occur. Downgradient surface water, sediment, and biota (within Bayou Grande and Wetland 65) were not at risk from the site, given their distance, the shallow groundwater quality adjacent to the water bodies, and the nature and limited extent of site-impacted groundwater. The bayou and wetland will be further evaluated during the RIs for Sites 40 and 41.

1.3.4 Arsenic Fate and Transport

Arsenic fate and transport characteristics vary with oxidation state. In water, arsenic occurs primarily as four species, two inorganic and two organic; the inorganic arsenic is arsenite (As[III]) or arsenate (As[V]) and organic arsenic is methanarsonic acid or dimethyl arsenic acid (Hem, 1989). Geogenic arsenic is almost exclusively arsenite or arsenate. According to Nriagu (1994), soluble arsenic is dictated by redox conditions, pH, biological activity, and available adsorptive material, but not solubility.

As(V) typically dominates in aerobic or aquatic environments; Eh/pH relationship diagrams provided by Vance (1995) suggest that arsenate ion will prevail between a pH of 3 to 7 standard units. As(III) typically dominates under reducing conditions and in more basic environments (pH from 7 to 11). Elemental arsenic (i.e., As[III] and As[V]) and arsine (AsH_3) may be present under extreme reducing conditions. Methylated arsenic compounds (i.e., organic arsenic) are highly volatile; organic arsenic fate-and-transport mechanisms are typically more complicated than for inorganic mechanisms.

Many arsenic compounds sorb strongly to soil; therefore transport in groundwater or surface water is limited. Sorbtion with hydrous iron oxides is the primary removal mechanism under most environmental conditions. As(V), the most immobile form, can be mobilized:

- Under reducing conditions that favor As(III) formation.
- Under alkaline and saline conditions.
- In the presence of other ions that compete for sorption sites.
- In the presence of organic compounds that form complexes with arsenic.

Site 15 groundwater is assumed to be aerobic in a lower pH regime where arsenate should prevail. This assumption is based on the following:

- Shallow water table aquifers are typically aerobic,
- Rapid vertical infiltration from recharge is highly oxygenated,
- Dissolved oxygen readings away from hydrocarbon detections are high, and
- The source of the arsenic is in the form of arsenate.

Assuming redox conditions impede or encourage arsenic mobility, pH changes due to rainfall or fertilizer application could change arsenic mobility based on the presence of ferrous iron in a lower pH regime. Groundwater Eh/pH measurements are needed to evaluate the mobility of arsenic. Arsine gas generation by biological activity is unknown, but due to the porous nature of the media, it may be difficult to collect enough gas to detect its presence.

The empirical data are critical to fate and transport analyses: under current conditions (i.e., containment of ongoing mixing, rinsate, and wash-down operations), arsenic does not pose a threat to surface water receptors. The absence of arsenic at downgradient monitoring locations (assuming no easterly flow component toward the tidal pond), given the site's history of pesticide/herbicide handling, suggests that aquifer characteristics are adequate to immobilize arsenic and prevent transport to downgradient water bodies.

2.0 BASIS FOR FEASIBILITY STUDY

The CERCLA remedy selection's overall objective is to select remedies that protect human health and the environment over time and reduce untreated waste. The RI assesses site conditions, while the risk assessment assesses risk and hazard. Data from the RI and risk assessment are used to gauge the magnitude of site risk and identify areas that may require an FS. ARARs and risk management techniques are then used to develop realistic remedial goals (RGs) and thus determine what areas require remediation.

Development of remedial action objectives for areas that may require FS analysis have been based on ARARs and the BRA, as required by the NCP. Groundwater objectives have been developed using ARARs. RGs are used to delineate areas of media requiring an FS. Remedial volumes are then calculated for remedial technology and alternative evaluation. This section explains the methods used to determine the nature and extent of media requiring remediation.

At Site 15, this process included screening analytical data against risk goals and ARARs, assessing risk, and using professional judgement to develop criteria to screen media for FS evaluation. The established criteria for each medium are presented in this section, which also summarizes the criteria evaluation. The summary details each decision to either eliminate or include a sample point for further evaluation under the FS process.

2.1 Delineation of Media Requiring FS Evaluation

Areas requiring FS at Site 15 were identified using a residential scenario as defined in the BRA. A 1E-06 residential risk threshold and a hazard index of 1 were used as screening criteria for surface soil; surface and subsurface soil were screened using USEPA and FDEP leachability guidance. Groundwater was screened using FPDWS, FSDWS, FSWQS, MCLs, SMCLs, and FGGCs. Although Site 15 is industrial and expected to remain so, residential screening values were used to conservatively evaluate the magnitude of site impacts. The following media were reviewed at Site 15:

Media Evaluated

- Surface soil — 0 to 2 feet bgs (where results were only available for 0 to 1 feet bgs, concentrations for 0 to 2 feet bgs were assigned equivalency)

- Subsurface soil — 2 feet bgs to the top of the groundwater table

- Shallow groundwater — top of water table (i.e., approximately 20 feet bgs)

2.1.1 Surface Soil

The criteria for evaluating surface soil medium are detailed below.

- Surface soil sample points were screened against a cumulative residential risk threshold of 1E-06 and an HI of 1.

- Soil exceeding the cumulative risk and/or HI criteria under an asphalt/concrete cover was not considered for removal due to lack of an exposure pathway. (Land use restrictions will ensure continued cover and pathway protection).

- Sample points exceeding the cumulative risk and/or hazard criteria were screened to determine which individual contaminant had a residential-based risk of 1E-06 or hazard index of at least 0.1. Except for arsenic, inorganics that are similar to RCs were eliminated from further evaluation.

Contaminants exceeding residential-based risk and hazard at these sites include one inorganic, one SVOC, and pesticides. The most frequently detected contaminants were arsenic and dieldrin. Table 2-1, Residential- and Industrial-Based Risk and Hazard, identifies Site 15 surface soil risk and hazard exceedances.

2.1.2 Subsurface Soil

Subsurface soil concentrations were compared to PRGs that are either USEPA SSLs or FDEP leachability CGLs. Exceedances were reviewed to determine (1) if they indicate contaminant mass at a depth that could threaten human health and/or the environment, and (2) if the contaminant PRG exceedances warrant remedial action. Criteria used to define "risk" from subsurface soil to shallow groundwater are presented below.

- Consistent detections laterally in adjacent borings, indicating the presence of a contaminant source area. Exceedances surrounded by borings in which contaminant concentrations are below PRGs are assumed to be isolated. If an exceedance is at a distance greater than approximately 100 feet from another exceedance, then it is also assumed to be isolated. The distance of 100 feet was arbitrarily chosen for use as a basis for volume determination.

- Consistent detections vertically in the soil column, indicating the presence of a contaminant "smear zone" (i.e., contaminants deposited throughout the soil column) caused by continued leaching from a residual source.

- Presence of contaminants in subsurface soil and the water table, clearly establishing a soil-groundwater analytical coupling and suggesting presence of a smear zone associated with groundwater contamination.

Table 2-1
Residential- and Industrial-Based Risk and Hazard
Surface Soil — Site 15

Sample Location	Constituents	Residential Cumulative Hazard Index	Residential Cumulative Risk	Industrial Cumulative Hazard Index	Industrial Cumulative Risk	Comments
15S01	Arsenic	< 1.0	8.3E-06	< 1.0	< 1E-06	
15S02	Arsenic, BEQ	< 1.0	2.1E-05	< 1.0	2.6E-06	
15S03	Arsenic	< 1.0	3.8E-06	< 1.0	< 1E-06	Arsenic occurs naturally at a level resulting in a background residential risk of 3.7E-06
15S04	Arsenic, Dieldrin	1.9	1.1E-04	< 1.0	1.4E-05	
15S05	Arsenic	< 1.0	2.0E-05	< 1.0	2.4E-06	
15S06	Arsenic	< 1.0	6.6E-06	< 1.0	< 1.0E-06	
15S07	Arsenic	2.45	1.4E-04	< 1.0	1.6E-05	
15S09	Arsenic	< 1.0	7.8E-06	< 1.0	< 1.0E-06	
15S10	Arsenic	< 1.0	1.3E-05	< 1.0	1.5E-06	
15S11	Arsenic	< 1.0	3.3E-06	< 1 0	< 1.0E-06	Arsenic occurs naturally at a level resulting in a background residential risk of 3.7E-06
15S12	Arsenic	1.1	6.1E-05	< 1.0	7.3E-06	

Table 2-1
Residential- and Industrial-Based Risk and Hazard
Surface Soil — Site 15

Sample Location	Constituents	Residential Cumulative Hazard Index	Residential Cumulative Risk	Industrial Cumulative Hazard Index	Industrial Cumulative Risk	Comments
15S13	Arsenic, Dieldrin, alpha- and gamma-Chlordane	<1.0	4.0E-05	<1.0	5.0E-06	
15S14	Arsenic, Dieldrin	3.8	2.5E-04	<1.0	3.4E-05	
15S15	Arsenic, Dieldrin	1.6	9.0E-05	<1.0	1.1E-05	
15S16	Arsenic, Dieldrin, alpha- and gamma-Chlordane	1.7	3.7E-05	<1.0	5.1E-06	Under Building 2640
15S17	Arsenic	<1.0	6.8E-06	<1.0	<1.0E-06	
15S18	Arsenic	<1.0	3.0E-06	<1.0	<1.0E-06	Arsenic occurs naturally at a level resulting in a background residential risk of 3.7E-06
15S20	Arsenic	<1.0	3 9E-05	<1.0	4.7E-06	
15S21	Arsenic, BEQ	<1.0	5.4E-05	<1.0	7.5E-06	
15S24	Arsenic	<1.0	3.7E-06	<1.0	<1.0E-06	Arsenic occurs naturally at a level resulting in a background residential risk of 3.7E-06
15S25	Arsenic	<1.0	7.8E-06	<1.0	<1.0E-06	

Table 2-1
Residential- and Industrial-Based Risk and Hazard
Surface Soil — Site 15

Sample Location	Constituents	Residential Cumulative Hazard Index	Residential Cumulative Risk	Industrial Cumulative Hazard Index	Industrial Cumulative Risk	Comments
15S27	Arsenic, Dieldrin	<1.0	5.6E-05	<1.0	6.7E-06	
15S30	Arsenic, Dieldrin	<1.0	1.9E-06	<1.0	<1.0E-06	Arsenic occurs naturally at a level resulting in a background residential risk of 3.7E-06
15S31	Arsenic, Dieldrin	<1.0	3.9E-06	<1.0	<1.0E-06	Arsenic occurs naturally at a level resulting in a background residential risk of 3.7E-06
15S32	Arsenic	<1.0	5.5E-06	<1.0	<1.0E-06	
15S41	Arsenic	<1.0	2.0E-05	<1.0	2.4E-06	
15S42	Arsenic	<1.0	1.6E-05	<1.0	1.8E-06	
15S43	Arsenic	<1.0	5.8E-06	<1.0	<1.0E-06	
15S44	Arsenic	<1.0	4.3E-06	<1.0	<1.0E-06	
15S45	Arsenic	<1.0	9.7E-06	<1.0	1.1E-06	
15S46	Arsenic	<1.0	5.8E-06	<1.0	<1.0E-06	
15S47	Arsenic, BEQ	<1.0	1.0E-05	<1.0	1.3E-06	
15S48	Arsenic, BEQ	<1.0	4.9E-06	<1.0	<1.0E-06	

Table 2-1
Residential- and Industrial-Based Risk and Hazard
Surface Soil — Site 15

Sample Location	Constituents	Residential Cumulative Hazard Index	Residential Cumulative Risk	Industrial Cumulative Hazard Index	Industrial Cumulative Risk	Comments
15S49	Arsenic	<1.0	1.6E-06	<1.0	<1.0E-06	Arsenic occurs naturally at a level resulting in a background residential risk of 3.7E-06
15S50	Arsenic	<1.0	4.6E-06	<1.0	<1.0E-06	
15S51	Arsenic	<1.0	6.5E-06	<1.0	<1.0E-06	
15S52	Arsenic	<1.0	1.2E-05	<1.0	1.4E-06	
15S53	Arsenic	<1.0	3.8E-05	<1.0	4.5E-06	
15S54	Arsenic	<1.0	7.4E-06	<1.0	<1.0E-06	
15S55	Arsenic	<1.0	2.7E-05	<1.0	3.1E-06	
15S56	Arsenic	<1.0	1.0E-06	<1.0	<1.0E-06	Arsenic occurs naturally at a level resulting in a background residential risk of 3.7E-06
15S57	Arsenic	<1.0	4.6E-06	<1.0	<1.0E-06	
15S58	Arsenic	<1.0	1.8E-05	<1.0	2.1E-06	
15S59	Arsenic	<1.0	7.0E-06	<1.0	<1.0E-06	
15S60	Arsenic	<1.0	8.9E-06	<1.0	1.0E-06	

Table 2-1
Residential- and Industrial-Based Risk and Hazard
Surface Soil — Site 15

Sample Location	Constituents	Residential Cumulative Hazard Index	Residential Cumulative Risk	Industrial Cumulative Hazard Index	Industrial Cumulative Risk	Comments
15S61	Arsenic	<1.0	4.5E-05	<1.0	5.4E-06	
15S62	Arsenic	<1.0	7.4E-06	<1.0	<1.0E-06	
15S63	Arsenic	<1.0	1.2E-05	<1.0	1.4E-06	
15S64	Arsenic, BEQ	<1.0	1.6E-05	<1.0	2.0E-06	

Site 15 subsurface samples reflected exceedances of dieldrin's USEPA SSL (1 μg/kg) at 13 sample locations. However, samples from only one location, 15S04, exceeded the FDEP CGL (20 μg/kg). Arsenic analytical results reflected exceedences of its USEPA SSL (15 mg/kg) at one of 53 sample locations (15S13). The arsenic concentration at this sample location was 16.2 mg/kg, roughly equivalent to arsenic's USEPA SSL (15 mg/kg) and less than the FDEP CGL (29 mg/kg). Therefore, based on the isolated and limited contaminant concentrations, Site 15 subsurface soil is not considered a significant source area and is not a potential groundwater contamination source.

2.1.3 Groundwater

Groundwater concentrations have been compared to either FGGC, FPDWS, FSDWS, FSWQS, SMCL, or MCLs. All PRG exceedances reported in the RI were reviewed to determine whether they indicated a contaminant plume or mass that poses a risk to human health and the environment. The purpose of the groundwater assessment is to delineate all areas requiring an FS. The criteria used to define "risk" are listed below.

- Concentrations exceeding FPDWS or USEPA MCLs, whichever are most stringent. PRG exceedances were eliminated from further evaluation if the exceedance was below the FPDWS or MCL. In cases where an FPDWS or MCL is not provided, the FGGC, FSWQS, FSDWS, or SMCL was used for comparison.

- Inorganic PRG exceedances less than RCs are considered to be background. Background compounds indicate natural conditions and will not be considered for remediation.

- Because the use of surficial groundwater is limited by the likelihood of saltwater intrusion and the presence of secondary metals such as aluminum, iron, and manganese above FSDWSs, these constituents were not considered for FS evaluation.

Groundwater contamination was detected in shallow groundwater only. Therefore, only shallow groundwater was evaluated during the FS. Figure 1-5, Maximum Arsenic Concentration Detected in Groundwater Samples During All Sample Phases, shows groundwater RC exceedances for arsenic in each monitoring well.

2.2 Remedial Action Objectives

Selection of remedial alternatives begins during the planning of the RI, when PRGs are set, based on readily available information, such as the presence of chemical-specific ARARs. As the RI/FS proceeds, goals are modified as needed to reflect understanding of the site and identified ARARs. Final RGs are established when the remedy is selected. The goals must establish acceptable exposure levels protective of human health and the environment and consider ARARs.

In developing remedial objectives for the FS, three issues were addressed:

- Chemical-specific ARARs and other regulations to be considered (TBCs).

- Contaminant spatial distribution in the media of concern, as determined by the RI.

- The BRA, including human health, ecological assessments, and exposure pathways.

The RG is based on reasonable future use as industrial. This will serve as the basis for remedial decision making during the FS.

2.2.1 Chemical-Specific ARARs and TBCs

Per the NCP, RGs must establish acceptable exposure levels that protect human health and the environment by considering the following:

- ARARs under federal or state environmental or facility siting laws, if available, and the following factors:

  - Acceptable exposure levels to the human population, including sensitive subgroups, without adverse effects during a lifetime or part of a lifetime, incorporating an adequate margin of safety.

  - For known or suspected carcinogens, acceptable exposure levels are generally concentrations that represent an excess upper-bound lifetime cancer risk between 1E-06 and 1E-04. 1E-06 is the point of departure for determining RGs for alternatives when ARARs are not available, or are not significantly protective because of the presence of multiple contaminants or multiple exposure pathways.

  - Technical limitations, quantification limits, uncertainties, etc.

- Non-zero maximum concentration level goals (MCLGs), established under the Safe Drinking Water Act (SDWA), are relevant and appropriate for ground or surface waters that are current or potential sources of drinking water. When MCLGs are set at zero, MCLs shall be attained when relevant and appropriate to the release's circumstances.

- When multiple contaminants or pathways are present, or when attainment of chemical-specific ARARs will result in cumulative risk exceeding 1E-04, risk- or technology-based goals may be developed.

- Water quality criteria established under the Clean Water Act (CWA) shall be attained where relevant and appropriate.

- Alternate Concentration Limits (ACLs) may be established in accordance with CERCLA Section 121(d)(2)(B)(ii).

- Environmental evaluations shall be performed.

Chemical-specific ARARs will be considered in developing remedial objectives for the site. These and others are listed in Appendix A. ARARs that might impact the selection and screening of technologies, such as land-ban criteria, will be considered in the technologies discussion, if appropriate.

2.2.2 Remedial Goals

Site 15 RGs have been proposed to protect human health and the environment, given current and future land use. Site 15 has been used for industrial and recreational purposes in the past, as described in Section 1, Background Information. Maintaining an industrial use reduces future risk to human health.

Site 15 RGs are set at an industrial point risk of 1E-06. Based on industrial use, institutional controls will be implemented in accordance with the land use restriction agreement (LURA) among the state of Florida, USEPA, and the U.S. Navy. This industrial RG is in lieu of the 1E-06 residential risk threshold as outlined by FDEP. However, FDEP would not require remediation of surface soil to levels lower the Soil Cleanup Target Levels (SCTLs) for industrial use. These concentrations, presented in Table 2-2, Soil Threshold Concentrations, were used as the basis to calculate remedial volumes.

Site 15 contaminant concentrations exceed the FDEP SCTLs in surface soil at 23 sample locations. The primary contaminant at these locations is arsenic, with dieldrin contamination at sample locations 15S04, 15S14, and 15S15 and BEQ contamination at sample location 15S21. Sample location 15S16, one of the 23 locations, is beneath Building 2640 where the exposure pathway is incomplete. The remaining sample locations exceeding the threshold are not covered.

Table 2-2
Soil Threshold Concentrations

Parameter	Concentration (mg/kg)
Arsenic	3.7
BEQs	0.5
Dieldrin	0.3
chlordane	11.0

Groundwater RGs are FPDWS, FSDWS, FSWQS, or MCLs, whichever is more stringent. Guidance concentrations (i.e., FGGCs) are TBCs. Samples from 10 monitoring well locations exceeded arsenic's RGs, although samples from only seven locations exceeded the FPDWS of 50 μg/L. The other three locations exceeded the arsenic RG but were less than the FPDWS.

2.3 Remedial Volumes

Remedial volumes for soil and groundwater cleanup have been determined, based on the contaminants exceeding Site 15 RGs.

2.3.1 Remedial Soil Volumes

In Section 2.1, site soil was screened using residential hazard and risk. RGs based on land use remaining industrial, which were presented in Section 2.2.2 for a future site worker, are FDEPs SCTLs. Where contamination was not completely delineated, remedial soil volumes were calculated on a sample-point basis to a depth of 2 feet bgs and a 10-foot radius to estimate cost and soil volumes. The criteria to develop remedial volumes are presented below.

- Sample locations with cumulative risk less than the industrial-based goal of 1E-06 were eliminated from further evaluation under the FS.

- Sample locations with contaminant concentrations greater than FDEP SCTLs were used to delineate the area and volume of surface soil to be evaluated for remedial alternatives in the FS.

- Sample location 15S16 was excluded from proposed remediation since it is beneath Building 2640 and protected from receptors.

Contaminant-specific screening of point risk data indicate that 23 Site 15 sample locations exceed the risk threshold levels for future site workers. These areas are presented in Table 2-3, Site 15 Surface Soil Volume Estimates. Figure 2-1, Soil Exceeding Remedial Goals, shows the areas listed in Table 2-3. The total estimated volume of soil requiring further evaluation at Site 15 is 580 yd^3. In comparison, if cleanup goals were based on a 1E-06 residential risk threshold, the estimated soil volume requiring further evaluation would be 1120 yd^3.

2.3.2 Remedial Groundwater Volumes

Shallow groundwater under approximately 40,000 square feet (sf) of Site 15 is contaminated by arsenic. Figure 2-2, Site 15 Groundwater Remediation Areas, shows the area of shallow groundwater contamination, which was determined by the data review presented in Section 2.1.3. To determine the total volume of groundwater requiring remedial action, an effective water-bearing porosity of 35% was assumed for the shallow groundwater zone. The total surface area of groundwater contamination was multiplied by the aquifer thickness (20 feet) and porosity, then converted to gallons, resulting in an estimated contaminated water volume of 2.1 million gallons.

Table 2-3
Site 15 Surface Soil Volume Estimates

Affected Area Designation	Contaminants Exceeding RG	Soil Volume Affected (yd^3)	Basis
15S04, S05, S14, S15, S27, S61, S63	Arsenic, Dieldrin	140	Exceeds FDEP SCTLs
15S12, S13	Arsenic	80	Exceeds FDEP SCTL
15S41, S42	Arsenic	80	Exceeds FDEP SCTL
15S07, S20, S21, S64	Arsenic, BEQ	80	Exceeds FDEP SCTLs
15S02	Arsenic	30	Exceeds FDEP SCTL
15S10	Arsenic	30	Exceeds FDEP SCTL
15S45	Arsenic	30	Exceeds FDEP SCTL
15S52	Arsenic	30	Exceeds FDEP SCTL
15S53	Arsenic	30	Exceeds FDEP SCTL
15S55	Arsenic	30	Exceeds FDEP SCTL
15S58	Arsenic	20	Exceeds FDEP SCTL
Total Soil Volume		580	

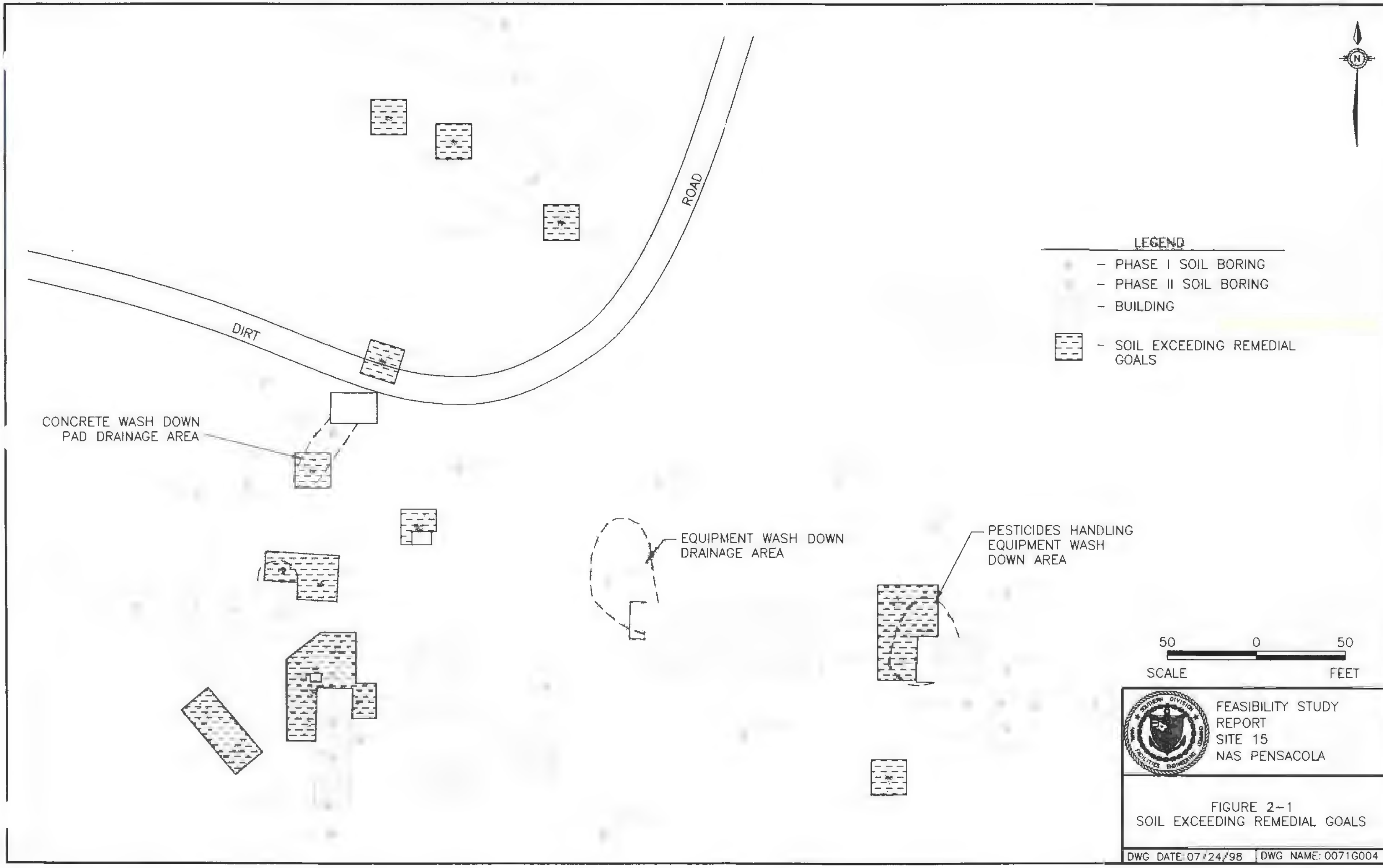


FIGURE 2-1
SOIL EXCEEDING REMEDIAL GOALS

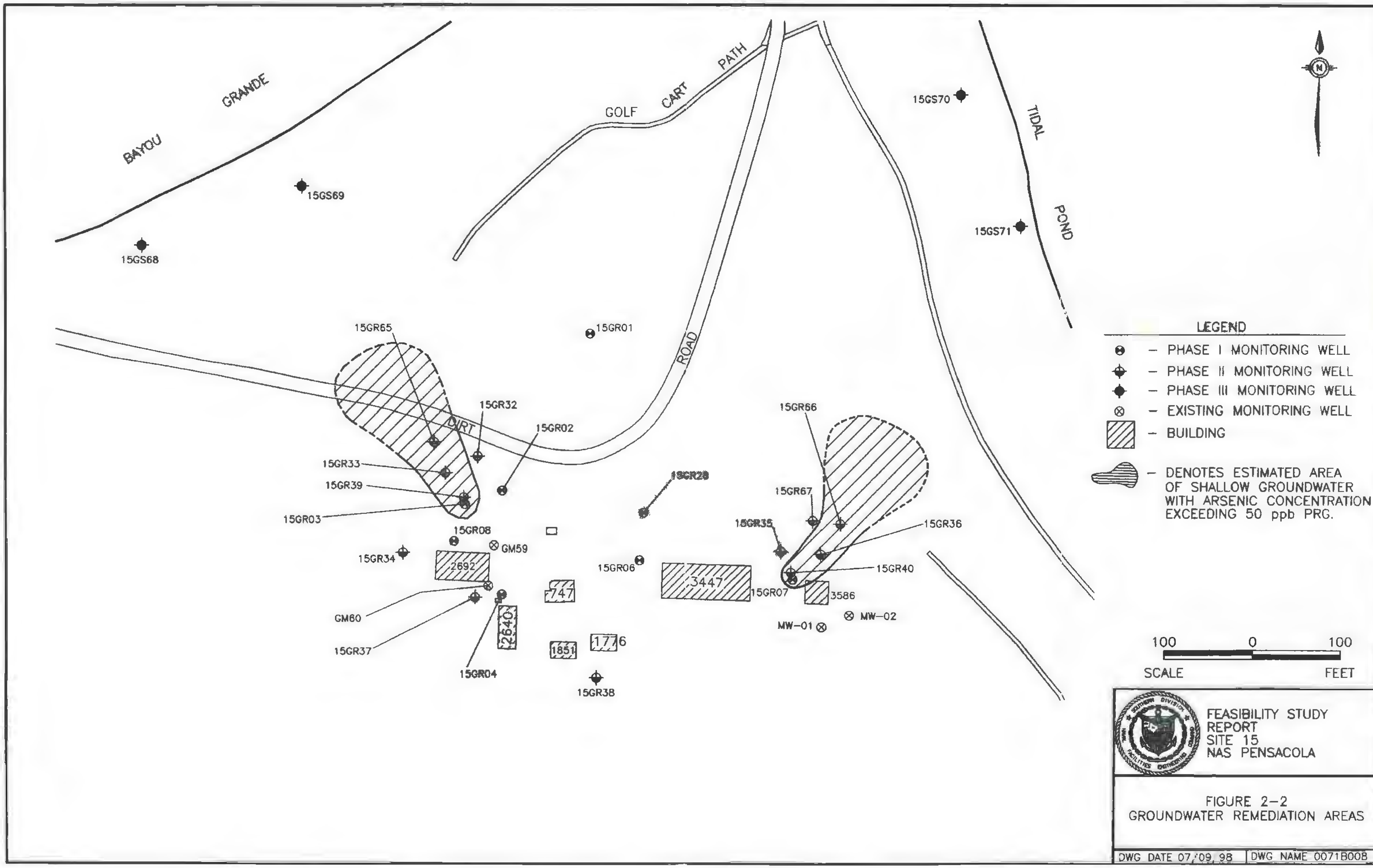


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FIGURE 2–2
GROUNDWATER REMEDIATION AREAS

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3.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

This section describes the initial steps of remedy selection: identification and screening of applicable technologies. Once technologies are identified, they are reviewed for effectiveness, implementability, and cost. Screening occurs when technologies are either eliminated from further consideration or retained for further consideration. Alternatives for remedial action at Site 15 will be developed from the technologies retained.

3.1 CERCLA Response Actions

The USEPA has established program goals, management principles, and expectations for response actions being conducted under CERCLA at sites such as Site 15. These goals and principles are outlined in the NCP, which provides guidance for conducting the RI/FS and selecting a remedy. Based on the NCP, the purpose of remedy selection is to assure that implemented technologies protect human health and the environment by eliminating, reducing, and/or controlling risks posed through each pathway. Program goals, principles, and expectations are outlined below.

3.1.1 Program Goal

The goal of the FS is to select remedies based on fundamental criteria including (1) protecting human health and the environment, (2) complying with ARARs, and (3) reducing untreated hazardous waste.

3.1.2 Program Management Principles

To implement this goal, the NCP outlines the following principles to manage the response actions. Sites should be remediated in operable units when: (1) significant risk must be reduced quickly, (2) a phased analysis and response is necessary or appropriate, given the site's size or complexity, or (3) when the expected final remedy must be expedited. Interim responses should implement the expected final remedy. Site-specific data needs, alternatives evaluation, and the selected remedy's documentation should reflect the scope and complexity of the site contamination being addressed.

3.1.3 Expectations

In the NCP, USEPA broadly categorizes remedial action alternatives into general response actions for consideration in the FS:

Response Actions

- **Treatment**: Use treatment to address the principal threats posed by a site, where practicable.

- **Containment**: Use engineering controls such as containment for waste that poses a relatively low long-term threat or where treatment is impractical.

- **Combination**: Combine appropriate methods to protect human health and the environment.

- **Institutional Controls**: Use institutional controls such as water and land use restrictions to supplement engineering controls (as appropriate) to prevent or limit exposure to hazardous substances, pollutants, or contaminants in the short- or long-term. Do not substitute institutional controls for active response measures as the sole remedy, unless active measures are determined to be impractical.

- **Innovative Technology**: Consider an innovative technology when it offers the potential for comparable or better treatment, performance, or ease of implementation, less adverse impacts, or lower costs than demonstrated technologies.

- **Groundwater Restoration:** Restore usable groundwater to its beneficial uses, whenever practical, in a reasonable amount of time. Where this cannot be accomplished, USEPA expects the selected remedial response to prevent further plume migration, prevent exposure to contaminated groundwater, and evaluate further risk reduction.

3.1.4 General Response Actions

General response actions are media-specific actions that can achieve remedial action objectives alone or with others. Remedial action alternatives types are summarized below.

Remedial Action Alternative Types

- **Source Control Actions:** Source control actions are a range of alternatives that reduce the toxicity, mobility, or volume of the hazardous substances, pollutants, or contaminants by treatment. The range considered in an FS should include an alternative that removes or destroys these constituents of concern to the maximum extent feasible, eliminating or reducing the need for long-term management. In addition, alternatives are to be considered that treat the principal threats posed by the site, but vary in the degree of treatment and the quantities and characteristics of residuals and untreated waste that must be managed.

- **Containment Actions:** One or more alternatives should be considered that protect human health and the environment primarily by preventing or controlling exposure to site contaminants through engineering or institutional controls. Examples of engineering controls are extraction or injection wells and institutional controls such as water and land use or access restrictions.

- **Groundwater Response Actions:** Groundwater remediation actions should be assessed that attain site-specific goals within different restoration time periods. These alternatives should use one or more methods such as groundwater extraction, treatment, and in-situ actions.

3.2 Identification of Technologies

This section describes technology types that may be applied to meet the response actions described above.

3.2.1 No Action/Limited Action

The NCP requires evaluation of a no-action alternative as a basis of comparison with other remedial alternatives. Because no action may result in contaminants remaining onsite, CERCLA requires a review and evaluation of site conditions every five years, if this alternative is selected.

3.2.2 Natural Attenuation

Natural attenuation refers to dilution, dispersion, advection, and biotic degradation of contaminants in surficial groundwater and surface soil. Consideration of this option requires modeling and evaluation of contaminant degradation rates and transport during remedial design. Sampling and analysis must be conducted throughout the process to confirm that degradation is proceeding at rates consistent with meeting remediation objectives and to assure that receptors are not threatened.

3.2.3 Institutional Controls

The responses associated with institutional controls reduce potential hazards by limiting human exposure, not by reducing hazardous substances volume, mobility, or toxicity. Examples are listed below (from CERCLA RI/FS guidance).

Types of Institutional Controls

- Site access controls
- Public awareness, education
- Groundwater use restrictions
- Long-term monitoring
- Land use restrictions
- Warning against excavation, soil use

3.2.4 Removal/Excavation

Removal/excavation provides complete removal of contaminated media. Removal/excavation includes the following:

- excavating soil with heavy equipment
- subsurface drains (interceptor trenches/french drains)
- groundwater extraction/recovery wells

3.2.5 Containment

Groundwater is contained by installing a network of groundwater extraction wells or subsurface drains to produce a hydraulic barrier and eliminate or reduce groundwater migration. Vertical barriers such as slurry walls, high density polyethylene (HDPE) sheeting or sheet piling may also be used to reduce horizontal transport of contaminants in groundwater from contaminated soil zones.

A surface cap of asphalt, concrete, soil barriers, or synthetic membranes indirectly provides containment by reducing contaminant transport through soil by percolation of precipitation. These containment options can be used alone or combined to isolate contaminated soil and/or groundwater.

3.2.6 Treatment

Groundwater treatment technologies include carbon adsorption, biological treatment, coagulation, precipitation, solids separation, stripping, or destruction of volatiles by ultraviolet radiation. Soil may be treated by multiple technologies such as ex-situ biological degradation, low temperature thermal desorption, incineration, or chemical/physical processes such as soil washing, solidification, or stabilization.

3.2.7 Discharge/Disposal

Groundwater may be treated and discharged to the federally owned treatment works (FOTW), treated and discharged to surface water, or reinjected into the aquifer. Excavated soil may be disposed of either offsite at a hazardous or nonhazardous waste landfill, used as site fill material, or isolated in an onsite containment unit.

3.3 Preliminary Technology Screening

Table 3-1, Technology Screening for Site 15 Soil, and Table 3-2, Technology Screening for Site 15 Groundwater, present the treatment technologies applicable to site contaminants: primarily arsenic in soil and arsenic in groundwater. For simplicity, the list focuses on site-specific contaminants (i.e.,arsenic), given the difficulty of addressing inorganic contaminants in soil and groundwater. These tables are consistent with technology-screening techniques presented in the NCP and USEPA guidance because they include containment, removal, disposal, and treatment options. The screening criteria are implementability, effectiveness, and cost.

Implementability encompasses a technology's technical and administrative feasibility. Technical implementability is used to eliminate technology types and process options that are clearly ineffective or unworkable. Information from RI site characterization is used to screen out technologies and process options. Administrative implementability emphasizes the institutional aspects such as the ability to obtain necessary permits for offsite actions; the availability of

Table 3-1
Technology Screening for Site 15 Soil

Technology	Objective	Implementability	Effectiveness	Cost
No Action				
None	Leave contaminated soil in place	No action	Does not remove the source.	No capital cost, low operation and maintenance (O&M) cost. (Five-year review)
Institutional Controls				
Institutional controls (land use restriction)	Leave contaminated soil in place	Site access would be controlled.	Does not remove the source.	Low capital cost, low O&M cost.
Institutional Controls and monitoring	Leave contaminated soil in place	Site access would be controlled and a review will be conducted every five years for 30 years.	Does not remove the source.	Low capital cost, low to moderate O&M cost depending on number of samples.
Containment				
Surface cap or cover	Capping will limit human contact with soil and reduce infiltration of rainwater through contaminated soil. Materials may include asphalt, concrete, soil barriers, or synthetic membranes.	Most contamination is confined to small areas and would be easily capped. Controls for surface runoff would have to be included with the cap construction.	This technology is effective at reducing contact, ingestion, or inhalation risks. The cap must be maintained for at least 30 years.	Low to moderate capital cost, low O&M cost.
In-situ Soil Technologies				
In-situ solidification/ stabilization	Solidification physically binds contaminants within a stabilized mass, while stabilization uses chemical reactions to reduce the contaminants' mobility.	Easily applied with shallow depths (12 to 18 inches). Environmental factors can affect stabilizations's long-term sustainability.	This method will reduce the mobilization of arsenic but will not remove the potential of contact. However, there is no indication that site contaminants are mobile. This technology will not provide additional protection if the primary form is As(V).	Moderate to high capital cost, low to moderate O&M cost

Table 3-1
Technology Screening for Site 15 Soil

Technology	Objective	Implementability	Effectiveness	Cost
In-situ vitrification	Passing electric current through the soil forming vitreous material	Requires soil to be conductive. Requires the use of electrodes with large amounts of energy to be placed into soil to form vitreous material. The off-gas must be collected The potential for heating water in the surficial aquifer may inhibit implementability.	One treatment can treat up to 1,000 tons and depths of 20 feet. However, there is no indication that site contaminants are mobile. This technology will not provide additional protection if the primary form is As(V). As groundwater in the surficial aquifer is heated, energy losses may result and limit effectiveness.	Moderate to high capital cost and O&M costs. Inefficient energy use may result in increased costs.
Soil flushing	Soil flushing uses water or a solvent to leach contaminants from the soil. Groundwater extraction must be a part of this remedy to prevent spreading contamination in groundwater.	If not properly implemented, this technology introduces further contaminants (solvent) into the soil and can potentially mobilize otherwise immobile contaminants. Hydrology must be favorable to contain soil flushing fluids. Contaminant geochemistry must also be favorable. AS(III) is mobile and could be flushed. As(V) is not likely to mobilize. Soil flushing benefits must be evaluated against potentially inadequate containment and the risk of converting arsenic to a more toxic form.	Soil flushing is designed to treat volatile and inorganic compounds. This technology produces residuals that must be treated. Time for cleanup is longer than with most other technologies.	Low capital cost, moderate to high O&M cost, although capital cost may be increased by the need for groundwater recovery and treatment.
Ex-situ Soil Technologies				
Offsite disposal	Contaminated soil is excavated and disposed of offsite at a licensed special or hazardous waste disposal facility. The contaminated soil may be treated or placed in a hazardous waste landfill by the facility.	Soil must be excavated and transported offsite. Transportation can increase liability with distance.	Offsite disposal is effective at reducing risk from the site when the contaminated soil is replaced with clean fill. Additional worker risk is controlled during excavation and transportation by proper use of personal protective equipment (PPE) and engineering controls.	Moderate to high capital cost, depending on disposal requirements and volumes; no O&M cost.

Table 3-1
Technology Screening for Site 15 Soil

Technology	Objective	Implementability	Effectiveness	Cost
Soil Washing	Contaminated soil is excavated and washed using water to separate contaminants sorbed onto the fine soil particles from the rest of the soil matrix. Leaching agents, surfactants, chelating agents, abrasion, particle-size separation techniques, and pH adjustment are used to optimize the separation process.	Treatability studies usually precede full-scale implementation to optimize the formula for washing fluid. Large amounts of residuals are produced and must be treated or disposed of offsite. If contaminant is in the form of As(III) it may be easily removed from soil matrix, but if As(V) is present, it may need to be converted to As(III) and then removed.	Soil washing is designed to remove SVOCs, fuel hydrocarbons, and inorganics. It is less effective at treating VOCs and pesticides.	Moderate to high capital cost, high O&M cost.

Table 3-2
Technology Screening for Site 15 Groundwater

Technology	Objective	Implementability	Effectiveness	Cost
No Action				
None	Leave contaminated groundwater in place	No action	If arsenic is As(V) it is not likely to migrate from the present location.	No capital costs, low O&M cost. (Five-year review)
Institutional Controls				
Institutional controls (land use restriction)	Leave contaminated groundwater in place; prevent future use as drinking water.	Site access would be controlled.	If arsenic is As(V) it is not likely to migrate from the present location. Future aquifer uses would be limited.	Low capital cost, low to moderate O&M cost.
Institutional Controls and monitoring	Leave contaminated groundwater in place; prevent future use as drinking water; monitor plumes to ensure no adverse impacts to down-gradient water bodies.	Site access would be controlled and groundwater would need to be monitored.	If arsenic is As(V), it is not likely to migrate from the present location. Future aquifer uses would be limited.	Low capital cost, moderate to high O&M cost.
In-situ Groundwater Treatment				
Air sparging	Air is injected into the aquifer to oxidize arsenic.	Requires the placement of wells and pumps to inject air into the aquifer.	Air sparging may be effective at oxidizing arsenic form As(III) to As(V). If Arsenic is in a stable state of As(V), it will remain As(V).	Low capital and O&M cost.
Passive treatment walls	Passive treatment walls are installed, usually in trenches, across the flow path of a contaminant plume. The treatment walls are constructed of a permeable material that reacts with or acts as a catalyst for contaminants' reactions. Reactions transform contaminants into a less toxic or mobile form.	Due to site hydrology most contamination will pass through the upper 20 feet of the upper zone. A hanging wall would be placed 25 to 30 feet down from the surface to intercept the contaminated zone. Running sands may restrict the depth at which a continuous wall can be installed.	Passive treatment walls are primarily designed to treat inorganic and volatile organic compounds. Long-term effectiveness is questionable because the reactive material is expended and must be replaced. This process has only been proven in laboratory testing for arsenic.	High capital cost, low to high O&M cost.
Ex-situ Groundwater Technologies				
Coagulation/ precipitation and solids separation	Chemicals are added to extracted groundwater to form insoluble, agglomerated solids, with separation by settling or mechanical filtration.	As a result of separation technology, residuals are generated that require further treatment or disposal.	Coagulation/precipitation with solids separation is designed to treat inorganic compounds.	Low to moderate capital cost, moderate to high O&M cost. Chemicals used for treatment can significantly increase the cost.

Table 3-2
Technology Screening for Site 15 Groundwater

Technology	Objective	Implementability	Effectiveness	Cost
Disposal	Groundwater is extracted and discharged to the FOTW, where it is treated along with the sanitary sewage.	The FOTW can treat the groundwater generated. The water must meet general pretreatment standards before being accepted by the treatment works.	Will effectively contain groundwater exceeding remedial goals.	Low to moderate capital cost, moderate O&M cost.
Column filtration	Extracted groundwater is passed through a sand filter designed to remove arsenic.	The groundwater must be pumped through the column at a rate that will not disturb the column's compaction.	Long-term effectiveness is questionable because the reactive material is expended and must be replaced. This process has only been proven in laboratory testing for arsenic.	Unknown capital cost, high O&M cost.
Ion exchange	Ion exchange can treat extracted groundwater. It transfers one ion from an insoluble material for a different ion in solution.	The waste regenerant must be disposed of and the ion-exchange resins can be ruined if not operated properly.	Ion exchange is designed to treat inorganic compounds. It can often remove unwanted ions preferentially.	Moderate capital cost, low to moderate O&M cost. Chemicals needed and disposal of waste for this process may increase cost.

treatment, storage, and disposal services (including capacity); and the availability of necessary equipment and skilled workers to implement the technology.

Effectiveness screening is based on how effective each technology would be in protecting human health and the environment. Each technology should be evaluated with regard to its effectiveness in providing protection and reducing contaminants' toxicity, mobility, or volume. Both short- and long-term effectiveness should be evaluated; short-term refers to construction and implementation; long-term refers to the period after the remedial action is complete.

Costs used in screening process include estimated capital, operation, and maintenance costs and do not include detailed estimates. At this stage, cost analysis is based on engineering judgment, and each processes' cost is evaluated as to whether it is high, low, or medium relative to other process options.

3.4 Technology Screening Results

Implementability, effectiveness, and cost criteria were used to screen the technologies and to draw the following conclusions. ***The following technologies were screened from further consideration***:

- **In-situ solidification/stabilization** due to ineffectiveness for arsenic removal. This technology is designed to stabilize arsenic and reduce contaminant mobility. In-situ solidification/stabilization is performed at shallow depths (i.e., three to 12 inches) and would not implementable to two feet without a multi-layered effort. The small volumes do not justify the front end effort and cost associated with layered solidification/stabilization.

- **In-situ vitrification** due to ineffectiveness in arsenic removal. This technology stabilizes and reduces the mobility of arsenic in soil by forming vitreous material, which does not remove arsenic from the soil. The small volumes of soil do not justify the front end effort and cost associated with in-situ vitrification.

- **Soil flushing** due to the closeness of Bayou Grande and Tidal Pond and the potential to contaminate two bodies of water. This technology mobilizes arsenic in its attempt to remove contamination and could pose a risk to Bayou Grande and Tidal Pond. The small volumes do not justify the front end effort and cost associated with soil flushing.

- **Ex-situ soil washing** due to cost ineffectiveness for low soil volume. At Site 15, the soil volume to be treated is relatively small, 610 yd^3. The small volumes do not justify the initial setup and equipment cost associated with ex-situ soil washing.

- **Air sparging** due to ineffectiveness in arsenic removal. Sparging may be useful in changing the arsenic valence state, but it is limited in its ability to control arsenic if it is already in an immobile form.

- **Column filtration** because it has not been proven to work for arsenic outside the laboratory. This process would be inefficient and costly for treating large volumes of groundwater with low concentrations of arsenic.

- **Passive treatment wall** because it applies only to arsenic in the form of As(III). It has not been proven to work for arsenic outside the laboratory.

Retained Soil Technologies

- **Soil containment:** Surface cover
- **Onsite treatment:** Excavation

- **Offsite disposal:** Appropriate landfill
- **No action:** No action
- **Institutional controls:** Land use restriction, five-year review

Retained Groundwater Technologies

- **In-situ management:** Monitored natural processes with institutional controls.
- **Disposal options:** Disposal to FOTW
- **Ex-situ Treatment:** Coagulation/precipitation and solids separation, and ion exchange
- **No action:** No action
- **Institutional controls:** Land use restriction.

The NCP requires evaluation of a no-action alternative as a basis of comparison to other remedial alternatives. Because no action may result in contaminants remaining onsite, CERCLA, as amended, requires a review and evaluation of site conditions every five years. The no-action alternative will be carried through and analyzed throughout the FS process.

4.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES

Following identification and screening of technologies, general response actions and process options are combined to form alternatives that address the entire site. These process options were chosen as representative of technology types. In assembling alternatives, the NCP goal of evaluating a range of alternatives was considered, but due to small quantities and limited extent of contamination, alternatives have been limited. In keeping with this goal and constraint, alternatives vary in level of effort, balance of containment versus treatment measures, cost, and remediation time frame. Alternatives respond to the remedial needs for groundwater and soil separately to facilitate development and evaluation. Groundwater and soil alternatives are not interdependent. Screening of alternatives is based on overall site implementability, effectiveness, and cost.

4.1 Development of Alternatives

The following alternatives have been developed.

Groundwater

- Alternative 1 — No action
- Alternative 2 — Monitored natural attenuation
- Alternative 3 — Groundwater recovery and discharge to FOTW
- Alternative 4a — Groundwater recovery and ex-situ coagulation/precipitation
- Alternative 4b — Groundwater recovery and ex-situ ionic exchange

Soil

- Alternative 1 — No action
- Alternative 2 — Institutional controls
- Alternative 3 — Limited excavation to industrial scenario and offsite disposal
- Alternative 4 — Asphalt cover with institutional controls and limited excavation

4.2 Groundwater Remedial Alternative Screening

4.2.1 Alternative 1: No Action

In the no-action alternative, no additional actions will be implemented at Site 15. Groundwater in which contaminants exceed ARARs will depend on natural processes to attenuate contaminant concentrations.

No Action: Technical Approach

The only contaminant consistently exceeding RCs and PRGs during the RI was arsenic. During six sampling events, arsenic exceeded 50 $\mu g/L$ (the FPDWS and FSWQS) in 7 of 28 monitoring wells: 15GR03, 15GR04, 15GR07, 15GR33, 15GR36, 15GR65, and 15GR66. Site 15 contaminant trends (i.e., sample variability over the six events) are illustrated on Figure 4-1, Arsenic Concentrations Quantified During RI Sampling Events. As shown in this figure, 15GR04 and 15GR33 were sampled only once, and concentrations barely exceeded the FPDWS. Concentrations in 15GR07 are decreasing with time and remain less than the FPDWS after five sampling events. Concentrations in 15GR03 decreased by approximately 50% from the first sample in August 1995 to the second and third samples in May and July 1996.

Arsenic did not exceed its FPDWS in intermediate-depth wells (15GR39 and 15GR40). Wells completed along Bayou Grande and the tidal pond — 15GS68, 15GS69, 15GS70, and 15GS71 — did not contain arsenic concentrations exceeding the FPDWS or FSWQS, indicating that downgradient water quality, assuming no easterly component of groundwater flow, does not exceed ARARs.

In this alternative, several assumptions have been made: (1) the contamination is As(V), a low mobility arsenic form that will not move from its present location, (2) the potential source of contamination has been eliminated through pollution prevention methods and procedures, and

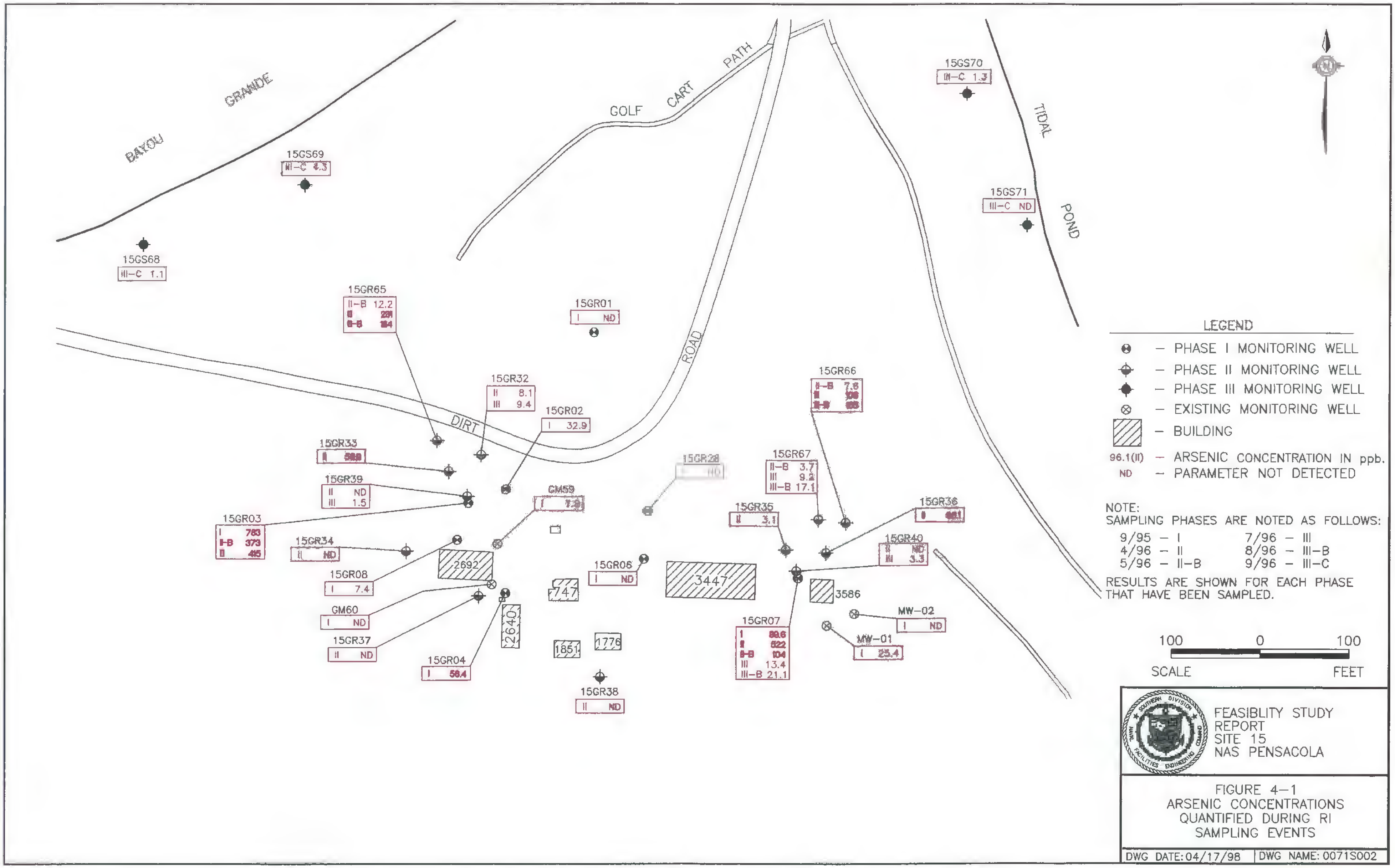


FIGURE 4-1
ARSENIC CONCENTRATIONS QUANTIFIED DURING RI SAMPLING EVENTS

(3) infiltration from Bayou Grande and the tidal pond is negligible. Groundwater conditions will remain unchanged, except for natural processes and a review will be conducted every five years for 30 years as required by NCP.

No Action: Implementability

This alternative is technically and administratively feasible. Construction, operation, and/or maintenance is not required for this alternative. There are no technology-specific regulations associated with it.

No Action: Effectiveness

Sampling data from near Bayou Grande and the tidal pond do not reflect the presence of arsenic above ARARs, indicating that current conditions protect surface water. The groundwater system appears to be effective in protecting surface water bodies and potential ecological receptors and does not warrant further remedial action for ecological protection. Contamination mobility will be limited due to arsenic's low mobility at Site 15. The toxicity and volume will only change due to natural processes.

No Action: Cost

The no-action alternative does not include construction, operation, and/or maintenance and has no associated cost except for a review every five years for the next 30 years. Costs associated with the review are presented in Table 4-1.

Table 4-1
Alternative 1 — No Action
Groundwater Cost

Action	Quantity	Cost per Unit	Total Cost
Five Year Review	LS[1]	$10,000	$10,000
Present value sub total at 6% discount over 30 years			$24,400
Total Cost			**$24,400** [2]

Notes:
1 — Lump sum
2 — Cost based on review once every five years for 30 years.

4.2.2 Alternative 2: Monitored Natural Processes/Institutional Controls

In this alternative, groundwater would be monitored on a fixed schedule to evaluate continued impacts to the aquifer and to determine if site contamination poses a risk to downgradient surface water bodies. Institutional controls will eliminate the pathway to potential receptors by restricting land and water use.

Monitored Natural Processes: Technical Approach

In this alternative, groundwater will be monitored to verify arsenic contamination does not pose a threat to downgradient receptors. Institutional controls will be implemented to eliminate the groundwater consumption pathway.

The technical basis for this approach includes an evaluation of:

- Groundwater travel times
- Downgradient monitoring locations
- Arsenic's fate and transport characteristics

Groundwater Travel Times

Groundwater was modeled to:

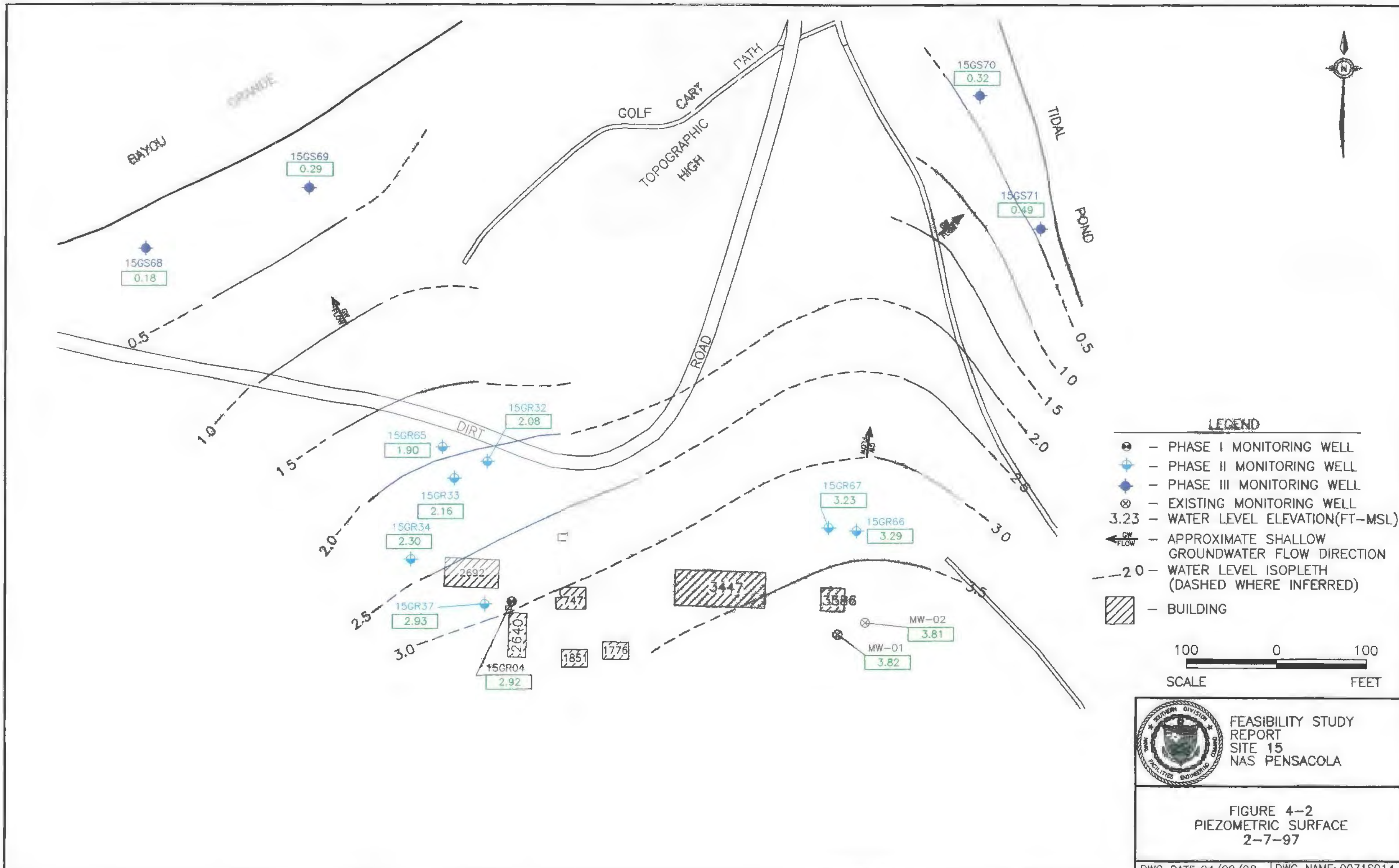
- Determine groundwater velocities between Site 15 and Bayou Grande, and between Site 15 and the tidal pond.

- Evaluate the suitability of existing monitoring wells for ongoing monitoring of Site 15 contamination.

Groundwater velocities were evaluated using the site-specific potentiometric surface and site-specific aquifer parameters. The 1997 potentiometric surface shown in Figure 4-2, Site 15 Potientiometric Surface, was used for the evaluation because it included wells on Bayou Grande's shoreline and the tidal pond. Site specific aquifer properties listed below were used;

transmissivity:	1,680 ft^2/day
hydraulic conductivity:	67.65 ft/day
effective porosity:	0.35
aquifer thickness:	20 feet

The numerical particle-tracking model, GW-Path, was used to evaluate groundwater flow from Site 15 to the water bodies under natural conditions (i.e., no pumping). The GW-Path model accounts for the actual groundwater flow directions onsite (i.e., radial flow, convergence), whereas most analytical methods assume a uniform hydraulic gradient across the site. The use of a more realistic, measured surface better approximates groundwater flow characteristics. More information on the GW-Path program is in the users' manual.



FEASIBILITY STUDY REPORT
SITE 15
NAS PENSACOLA

FIGURE 4–2
PIEZOMETRIC SURFACE
2–7–97

DWG DATE: 04/09/98 | DWG NAME: 0071S014

As can be inferred from the high hydraulic conductivity estimated for the site, groundwater travel times between the site and the water bodies are short. Travel times were estimated using "indicator" wells in the arsenic plumes' center; on the western side of the site, 15GR03 and 15GR65; on the eastern side of the site, 15GR66 and 15GR07. GW-Path results indicate that groundwater flow from the western portion of the site (i.e., near 15GR03 or 15GR65) will travel north to Bayou Grande in slightly more than one year under static conditions. Due to a slightly shallower hydraulic gradient in the eastern portion of the site, groundwater near 15GR66 and 15GR07 will reach the tidal pond in one to two years, depending on the discharge point. Figure 4-3, Particle Pathlines, shows one-year particle pathlines from these "indicator" wells.

Suitability of Monitoring Wells 15GS68, 15GS69, 15GS70, and 15GS71

To evaluate the suitability of monitoring wells 15GS68, 15GS69, 15GS70, and 15GS71 for long-term monitoring of the arsenic plumes, the plumes were tracked for one year to determine whether they would intercept a water body near one monitoring well. This evaluation assumed that the groundwater plume on each side of the site was circular, with a radius of 50 feet. The western plume encompassed 15GR03, 15GR29, 15GR32, 15GR32, and 15GR35. The eastern plume encompassed 15GR07, 15GR35, 15GR36, 15GR40, 15GR66, and 15GR67.

The GW-Path model indicated that groundwater from the site's western portion is effectively monitored by 15GS69, which is in the center of the plume as it intercepts the bayou. 15GS68 lies south of the modeled plume. The site's eastern plume intercepts the tidal pond near 15GS70; 15GS71 appears to be south of the plume pathlines. Since monitoring data does not fully address the potential for flow to the east toward the Tidal Pond, a monitoring well will be installed south of 15GS71 due east of 15GR66 to evaluate the potential of contaminant transport to the east. An additional monitoring well may be necessary north of 15GS70 to evaluate the full width of the discharge boundary.

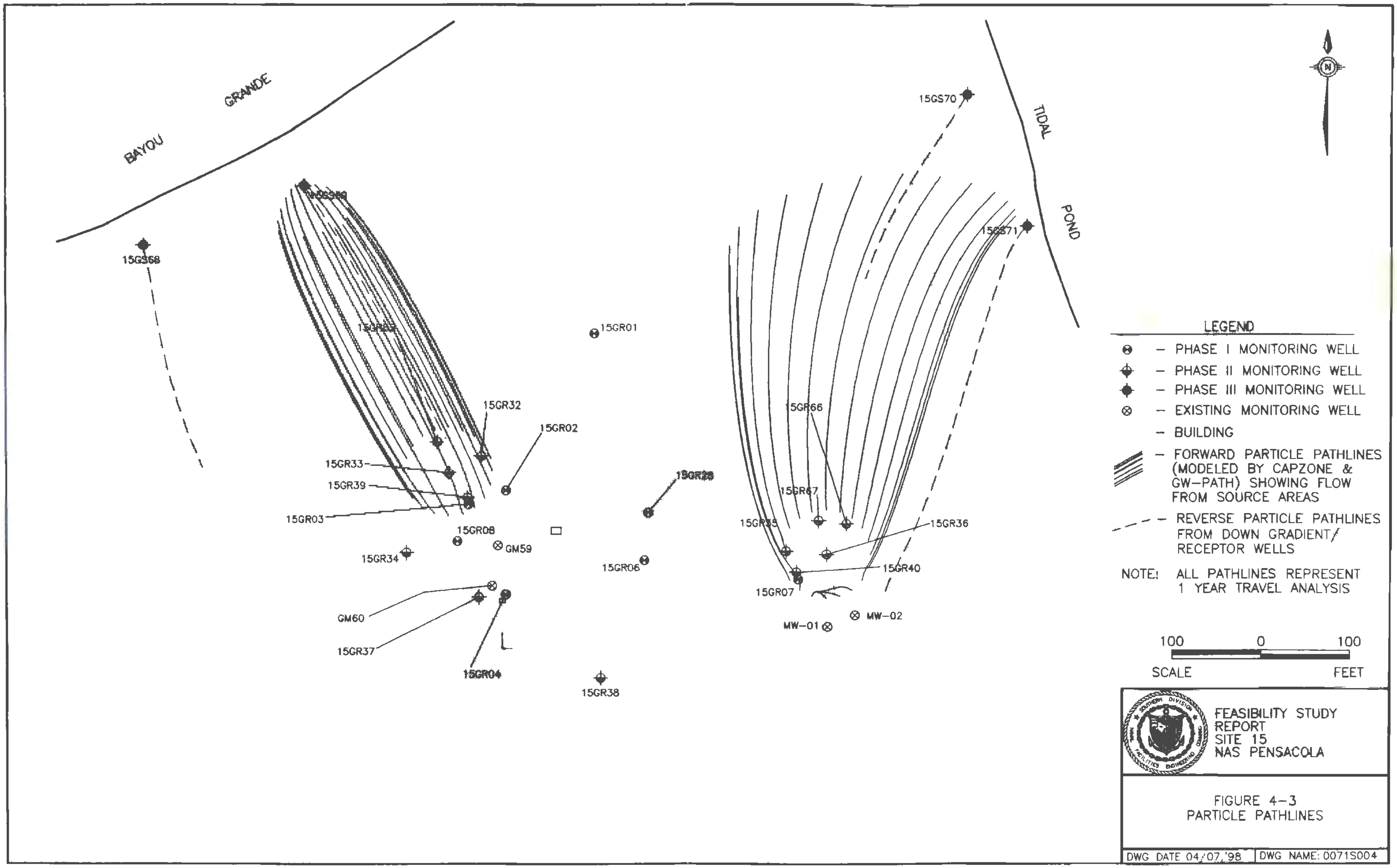


FIGURE 4–3
PARTICLE PATHLINES

Fate and Transport Analysis

Section 1.3.4 presents a detailed arsenic fate and transport analysis. To summarize, arsenic may be present in several oxidation states (-III, 0, III, and V). Fate and transport characteristics vary with oxidation state. As(V) is typically dominant in aerobic or aquatic environments, commonly as arsenate compounds. Groundwater at Site 15, as elsewhere at NAS Pensacola, is expected to be aerobic. Arsenic, therefore, is expected to be in its immobile form, As(V).

Technical Basis

A review of historical sampling data indicates that, arsenic exceeded 50 μg/L (the FPDWS and FWSQS) during six sampling events in 7 of 28 monitoring wells: 15GR03, 15GR04, 15GR07, 15GR33, 15GR36, 15GR65, and 15GR66. Arsenic was detected in 15GR03, 15GR07, 15GR65, and 15GR66 at least three times.

Concentrations in 15GR07 are decreasing with time and have decreased to below FPDWS after five sampling events. Concentrations in 15GR03 have decreased by 50% since the first sampling round. Concentrations in 15GR65 and 15GR66 have increased since initial sampling rounds. Arsenic at downgradient monitoring points 15GS69 and 15GS70 is significantly below FPDWS with concentrations of 4.3 μg/L and 1.3 μg/L.

Given the travel-time analysis, and the fact that pesticides have been stored, mixed, and rinsed at the facility for more than thirty years, it is highly probable arsenic would be present at downgradient monitoring wells if it were present as As(III). However, samples from both 15GS69 and 15GS70, downgradient of the two hot spots, had less than 5 μg/L arsenic. The absence of site contaminants in 15GS69 and 15GS70 strongly suggests that arsenic transport is not occurring, given the age of the site and that groundwater travels from the site's central portion to the downgradient receptors in one year.

A monitored natural process alternative, with appropriate institutional controls, could provide sufficient data to ensure that downgradient receptors are not impacted. The only Site 15 wells to be sampled are the 14 at which arsenic concentrations have been previously detected, the four that are adjacent to Bayou Grande and the tidal pond, and the two additional wells, one north of 15GS70 and one east of 15GR66 and south of 15GS71. Institutional controls will be implemented by the LURA and eliminate pathways for potential receptors.

In this alternative, groundwater conditions will remain unchanged, except for natural processes. Monitoring will include sampling the previously mentioned 20 wells for arsenic, dissolved oxygen (DO), oxidation reduction potential (ORP), and pH each year for 30 years. Five QA/QC samples will be collected each time to ensure analysis quality. The analytical data will be collected and reported. Modeling will be performed, if necessary, to evaluate contaminant fate and transport.

Monitored Natural Processes: Implementability

This alternative is technically feasible. Groundwater could be monitored using existing monitoring wells, plus two new wells. No other construction, operation, or maintenance would be required initially. However, monitoring well maintenance or other construction might be required during long-term monitoring. No technology-specific regulations would apply.

This alternative is administratively feasible. Through the LURA, Site 15 would be designated an industrial area and the use of the groundwater beneath the site would be restricted.

Monitored Natural Processes: Effectiveness

Monitoring data collected near Bayou Grande and the tidal pond do not reflect the presence of arsenic, indicating that current conditions are protective of surface water. The groundwater system is effectively protecting surface water bodies and does not warrant further remedial action for ecological protection. Because institutional controls will be included in this alternative, groundwater consumption will be prevented. Contaminant mobility will be limited by arsenic's valence state. The toxicity and volume will only change due to natural processes.

Monitored Natural Processes: Cost

Cost components for the natural attenuation alternative would include:

- Initial natural attenuation assessment
- Fate-and-transport modeling
- Installation of two additional monitoring wells
- Groundwater sampling and analysis
- Engineering, institutional controls, and report compilation

Capital and long-term monitoring costs for Alternative 2 are estimated in Table 4-2.

4.2.3 Alternative 3: Groundwater Recovery and Discharge to FOTW

Groundwater recovery is possible using various well collection configurations. The overall objective of the groundwater recovery system is containment of groundwater in exceedance of FPDWS for arsenic, and mass removal from the aquifer.

Groundwater Recovery and Discharge: Technical Approach

In this alternative, groundwater would be extracted and discharged to the FOTW through the sanitary sewer system. The FOTW has enough capacity for the maximum projected flow rates. Effluent concentrations would be required to meet FOTW discharge criteria. Extracting groundwater would remove contaminated groundwater and contain the arsenic plume.

The CAPZONE analytical modeling program and GW-Path particle tracking software were used to evaluate one recovery well's ability to extract Site 15 groundwater. Modeling assumptions were

Table 4-2
Alternative 2 — Monitored Natural Processes/Institutional Controls
Groundwater Cost

Action	Quantity	Cost per Unit	Total Cost
Monitoring Initial Startup			
Monitoring Wells	2	$2,500	$5,000
Groundwater sampling (field work)	100 hours	$130/hour	$13,000
Groundwater analysis (As only)	20 samples 5 QA/QC	$30/sample	$750
ORP, DO, and pH (field test equipment cost)	LS	$1	$1,000
Evaluation/modeling	180 hrs.	$94/hour	$16,900
Reporting/engineering	LS	20% cost	$7,300
Misc.: equipment, travel, supplies, software, etc.	LS	25% cost	$9,200
Subtotal			$53,150
Institutional Controls	LS	$50,000	$50,000
Natural Attenuation Long-term Monitoring Annual Program			
Groundwater sampling (field work)	100 hours	$130/hour	$13,000
Groundwater analysis	19 samples per year 5 QA/QC per sampling event	$30/sample	$720
ORP, DO, and pH (field test equipment cost)	LS	1	$1,000
Evaluation	130 hours	$94/hour	$12,200
Reporting/engineering	LS	20% cost	$5,400
Misc., equipment, supplies, travel	LS	25% cost	$6,700
Annual Cost Subtotal			$39,000
Present value subtotal at 6% discount over 30 years			$537,000
Remedial Action Contractor Costs			$100,000
Total Cost			**$740,000**

the same as those described for Alternative 4.2.2, the particle tracking exercise. A single recovery well was modeled based on the following assumptions:

- The well would be installed downgradient of 15GR65, as seen in Figure 4-4, Proposed Recovery Wells.

- The well would be screened across the top 20 feet of the surficial aquifer.

- The well would extract groundwater at 30 gallons per minute (gpm).

- The aquifer would stabilize under pumping conditions within 24 hours.

Preliminary modeling indicates that the recovery well will generate a capture zone from 200 to 300 feet wide and roughly 400 to 450 feet long during the first year of operation.

Therefore, for evaluation in the FS, a conceptual groundwater recovery system would include:

- One recovery well installed through the top 20 feet of the surficial aquifer immediately downgradient of each plume. The wells would have an estimated pumping rate of 30 gpm.

- Both wells designed per site-specific hydrogeology (i.e., filter packs and screen sizes would be determined using site-specific grain-size analyses and projected recovery rates).

- Both wells equipped with pumps that could extract between 20 and 50 gpm. Head requirements would be determined during remedial design.

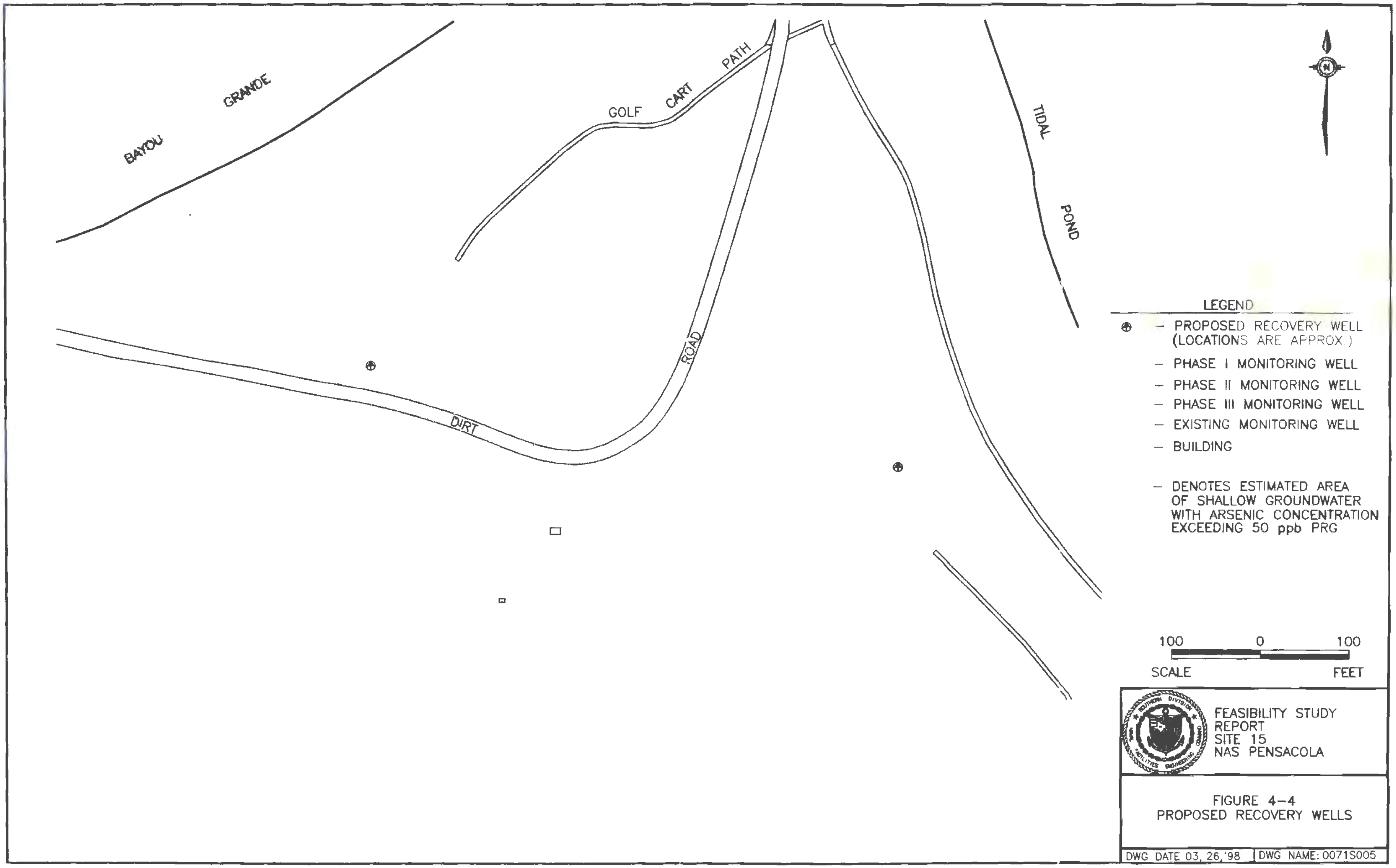


FIGURE 4–4
PROPOSED RECOVERY WELLS

- Both wells equipped with controls and telemetry in the maintenance complex.

- Discharge piping directly to the FOTW sewer system.

The groundwater area to be recovered by the single recovery well during one year would be 200 to 300 feet wide and 400 to 450 feet long, or approximately 120,000 square feet. Assuming a screened interval of 20 feet and a porosity of 0.35, the pore volume recovered by one well in one year would be 6.3 million gallons. Two wells will be operating at separate locations, so the total volume recovered during one year would be roughly 12.5 million gallons. An aquifer test would performed during the design phase to verify flow rates and capture zones.

Typically, groundwater recovery systems are designed to remove multiple pore volumes from impacted areas. For costing purposes, this FS assumes that removal of one pore volume per year would be required. For five-years operation, 62.5 million gallons of groundwater would be removed from impacted areas.

In this alternative, monitoring would include sampling the 18 monitoring wells and two proposed recovery wells for arsenic annually for 30 years. Proposed recovery wells are shown in Figure 4-4, Proposed Recovery Wells. Five QA/QC samples will be collected in each sampling event to ensure analysis quality. The analytical data will be collected and reported along with theoretical modeling results depicting the contaminant plume's changes.

Groundwater Recovery and Discharge: Implementability

Site 15 conditions would support a groundwater recovery system to capture the contaminated groundwater plume. Modeling results indicate that groundwater removal as a remedial alternative is technically viable and an aquifer test will be used to finalize the system design. Construction of the proposed recovery wells is technically feasible and commonly used. Operations would be expected to be reliable, but would require some pump maintenance, cleaning, and valve and seal replacement. Groundwater recovery is administratively feasible and is commonly used as a remedial alternative.

Discharge to the FOTW can be technically implemented. A delivery and piping connection to the sanitary sewer can be constructed to discharge extracted groundwater. The FOTW has enough capacity for the maximum flow rates. The need for pretreatment before discharge to the FOTW is uncertain and will be evaluated based on whether the FOTW can remove arsenic from extracted groundwater to acceptable discharge limits.

This alternative does not include the use of pretreatment, but it will be needed if the FOTW is unable to receive the proposed arsenic concentrations. Communication with NAS Pensacola staff to determine the pretreatment requirements will be necessary to complete the evaluation of this alternative's implementability. The remaining discussion of this alternative is based on the assumption that pretreatment is not required.

Groundwater Recovery and Discharge: Effectiveness

Groundwater removal and discharge offers additional protection for current and future site workers when combined with the use of institutional controls. The dimensions shown above for the capture zone are adequate to contain the western arsenic plume; in the groundwater removal scenario, a similar well would be required to contain the eastern plume. Groundwater removal, therefore, appears to be an effective means of capturing and containing arsenic exceeding FPDWS in groundwater. Aquifer testing and modeling will be required to finalize designs.

Groundwater Recovery and Discharge: Cost

Alternative 3 costs are based on operating two recovery wells, each with a flow rate of 30 gpm. Cost analysis is based on preliminary data and modeling for feasibility purposes and cannot be considered final. Table 4-3 breaks down expected costs for groundwater treatment.

4.2.4 Alternative 4: Groundwater Recovery and Ex-Situ Treatment

Groundwater recovery and treatment's goal is to: (1) contain groundwater in which contaminants exceed FPDWS and (2) remove mass from the aquifer and arsenic from extracted groundwater. Groundwater can be recovered using various well collection configurations; proposed locations are shown on Figure 4-4, Proposed Recovery Wells.

Groundwater Recovery and Ex-situ Treatment: Technical Approach

In this alternative, groundwater would be extracted, treated for arsenic, and discharged to the FOTW through the sanitary sewer system. Groundwater recovery assumptions are the same as for Alternative 3. The FOTW has enough capacity for the maximum projected flow rates. Treatment system effluent concentrations would have to meet pretreatment criteria of the FOTW. Groundwater treatment would use one of the following treatments alternatives.

Alternative 4a — Coagulation/Precipitation and Solids Separation

This alternative uses physical-chemical coagulation/precipitation and solids separation to remove arsenic from extracted groundwater. This process requires that extracted groundwater pass through two or more tanks where pH is adjusted, coagulation chemicals are added and mixed, and arsenic is precipitated in a sludge. The sludge generated by this treatment technology would need to be filter pressed to increase solid contents and remove excess fluid. The sludge generated by this process would be tested and placed in a Subtitle C or D landfill. This process is illustrated in Figure B-1 of Appendix B, Coagulation/Precipitation Process Flow Diagram.

Table 4-3
Alternative 3 — Groundwater Recovery and Discharge (Two Recovery Wells)
Groundwater Cost

Action	Quantity	Cost per Unit	Total Cost
Capital Costs for two wells pumping at 30 gpm			
Aquifer test	1	$30,000 each	$30,000
Extraction well construction	2	$5,000/well	$10,000
Pumps and switches	2	$3,000/pump	$6,000
Piping and connections/excavation and backfill	LS	$21,600	$21,600
Engineering support/report preparation	LS	20% cost	$13,500
Miscellaneous Supplies, equipment, travel, contingency	LS	25% cost	$16,900
Subtotal			$98,000
Annual Operation and Maintenance Costs			
Maintenance	12 months 8 hours/month	$65/hour	$6,400
Electricity (kilowatt hours)	10,000	$.07 each	$700
Replacement parts	2	$700 per pump	$1,400
Permitting/engineering support	LS	20% cost	$1,700
Miscellaneous equipment, supplies, travel, etc.	LS	25% cost	$2,100
FOTW Costs	12.5 million gallons	$3.83/1000 gal.	$47,900
Cost Subtotal			$60,000
Present value cost at 6% discount over 5 years			$253,000
Monitoring			
Sampling Labor	100 hrs.	$130/hr.	$13,000
Laboratory	20 samples per year 5 QA/QC samples per event	$30/sample	$750
Evaluation	40 hrs.	$75/hr.	$3,000
Engineering support/report preparation	LS	20% cost	$3,350
Miscellaneous Supplies, equipment, travel, contingency	LS	25% cost	$4,190
Cost Subtotal			$24,290
Present value cost at 6% discount over 5 years			$102,300
Institutional Controls (LURA and signs)	1	$50,000	50,000
Remedial Action Contractor Cost			$100,000
Total			**$603,300**

Alternative 4b — Ion Exchange

This alternative uses physical-chemical ionic exchange to filter arsenic from extracted groundwater as it passes through ion exchange chambers which introduce counter-ions (i.e., ions of opposite charge) to exchange with the arsenic. As exchange material used in ion exchange is exhausted, additional counter-ions are applied. The ion exchange process produces a liquid waste (treated water) that must be discharged to the FOTW. This process is illustrated in Figure B-2, Ionic Exchange Flow Diagram, in Appendix B.

As stated in Section 4.2.3, over five-years, 62.5 million gallons of groundwater will be removed from impacted areas.

Groundwater Recovery and Ex-Situ Treatment: Implementability

Site 15 conditions support groundwater recovery to capture the contaminated groundwater plume. Modeling results described in Alternative 3 indicate that groundwater recovery is technically viable. Operations would be expected to be reliable and require little maintenance. Groundwater recovery is administratively feasible and is commonly used as a remedial alternative. The groundwater treatment processes selected for this alternative are technically and administratively feasible. Discharge to the FOTW is technically and administratively implementable. A delivery and piping system can be constructed to transport extracted groundwater to a treatment system for removal of arsenic, then routed to the sanitary sewer/FOTW.

Groundwater Recovery and Ex-Situ Treatment: Effectiveness

Groundwater removal and discharge treatment offers additional protection for current and future site workers combined with institutional controls. Contaminated groundwater and potential risk to Bayou Grande and tidal pond, would be effectively contained and removed.

Alternative 4a

Coagulation/precipitation and solids separation are highly effective in removing arsenic. The treatment process shown on Figure B-1, Coagulation/Precipitation Conceptual Process Flow Diagram, would effectively remove contaminants to acceptable FOTW concentrations.

Alternative 4b

Ionic exchange is highly effective in removing arsenic. The treatment process shown on Figure B-2, Ionic Exchange Conceptual Flow Diagram, would effectively remove contaminants to acceptable FOTW concentrations.

Groundwater Recovery and Ex-Situ Treatment: Cost

Alternative 4a and 4b costs are based on operating two recovery wells, extracting a total of 12.5 million gallons per year. The estimated costs for Alternative 4a, groundwater removal and coagulation/precipitation and solids separation treatment are $3,824,000 for a Subtitle D disposal facility and $3,867,000 for a Subtitle C disposal facility. These totals include capital, annual operation and maintenance, and treatment. The estimated cost for Alternative 4b, groundwater removal and ionic-exchange treatment is $3,105,000, including capital, annual operation and maintenance, and treatment. Cost analysis is based on preliminary data and modeling for feasibility purposes and cannot be considered final. Costs for aquifer testing are included since it may be required during the design. Tables 4-4 and 4-5 present expected costs for groundwater coagulation/precipitation and solids separation treatment and groundwater ionic-exchange treatment.

Table 4-4
Alternative 4a — Groundwater Recovery and Coagulation/Precipitation and Solids Separation Treatment (Two Recovery Wells)
Groundwater Cost

Action	Quantity	Cost per Unit	Total Cost
Capital Costs for two wells pumping at 30 gpm			
Aquifer test	1	$30,000 each	$30,000
Recovery well construction	2	$5,000/well	$10,000
Pumps and switches	2	$3,000/pump	$6,000
Piping and connections/excavation and backfill	LS	$21,600	$21,600
Engineering support/report preparation	LS	20% cost	$13,500
Miscellaneous supplies, equipment, travel	LS	25% cost	$16,900
Subtotal			$98,000
Annual Operation and Maintenance Costs			
Maintenance	12 months 24 hours/day	$25/hour	$219,000
Electricity (kilowatt hours)	10,000	$.07 each	$700
Replacement parts	2	$700 per pump	$1400
Permitting/engineering support	LS	20% cost	$44,200
Miscellaneous equipment, supplies, travel, etc.	LS	25% cost	$55,300
FOTW Costs	12.5 million gallons	$3.83/1000 gal.	$47,900
Subtotal			$368,500
Present value cost at 6% discount over 5 years			$1,552,000
Monitoring			
Sampling Labor	100 hrs.	$130/hr	$13,000
Laboratory	20 samples 5 QA/QC per sampling event	$30/sample	$750
Evaluation	40 hrs.	$75/hr.	$3,000
Engineering support/report preparation	LS	20% cost	$3,350
Miscellaneous supplies, equipment, travel, contingency	LS	25% cost	$4,190
Subtotal			$24,240
Present value cost at 6% discount over 5 years			$102,300
Institutional Controls (LURA and signs)	1	$50,000	50,000
Remedial Action Contractor Costs			$100,000

Table 4-4
Alternative 4a — Groundwater Recovery and Coagulation/Precipitation and Solids Separation Treatment (Two Recovery Wells)
Groundwater Cost

Action	Quantity	Cost per Unit	Total Cost
Groundwater Physical/Chemical Treatment System Capital Costs			
Building	LS	$200,000	$200,000
Tanks	3	$18,700/tank	$56,100
Pumps and accessories	LS		$75,000
Treatment system	LS		$208,000
Process controls	LS		$83,200
Installation	LS		$100,000
Engineering	LS	20% cost	$144,500
Contingency	LS	25% cost	$181,000
Subtotal			$1,047,800
Annual Operating Costs			
Physical/chemical process	LS		$176,000
Present value cost at 6% discount over 5 years			$741,300
Subtitle D Disposal Facility			
Transportation	7 trucks (assuming 20 yd^3/ truck) hauling 30 miles	$3.50/loaded mile	$735
Sludge disposal	140 cubic yards	$150/cubic yard	$21,000
Engineering/oversight	LS	20% cost	$4,350
Contingency/miscellaneous	LS	25% cost	$5,430
Subtotal			$31,520
Present value cost at 6% discount over 5 years			$132,800
Subtitle C Disposal Facility			
Transportation	7 truck (assuming 20 yd^3 trucks) hauling 30 miles	$3.50/loaded mile	$735
Sludge disposal	140 cubic yard	$200/cubic yard	$28,000
Engineering/oversight	LS	20% cost	$5,750
Contingency/miscellaneous	LS	25% cost	$7,180
Subtotal			$41,665
Present value cost at 6% discount over 5 years			$175,500
Total Net Present Worth - Subtitle D Disposal			$3,824,000
Total Net Present Worth - Subtitle C Disposal			$3,867,000

Table 4-5
Alternative 4b — Groundwater Recovery and Ionic Exchange Treatment (Two Recovery Wells)
Groundwater Cost

Action	Quantity	Cost per Unit	Total Cost
Capital Costs for two wells pumping at 30 gpm			
Aquifer test	1	$30,000 each	$30,000
Recovery well construction	2	$5,000/well	$10,000
Pumps and switches	2	$3,000/pump	$6,000
Piping and connections/excavation and backfill	LS	$21,600	$21,600
Engineering support/report preparation	LS	20% cost	$13,500
Miscellaneous Supplies, equipment, travel	LS	25% cost	$16,900
Subtotal			$98,000
Annual Operation and Maintenance Costs			
Maintenance	12 months 24 hours/day	$25/hour	$219,000
Electricity (kilowatt hours)	10,000	$.07 each	$700
Replacement parts	2	$700 per pump	$1,400
Permitting/engineering support	LS	20% cost	$44,200
Miscellaneous equipment, supplies, travel	LS	25% cost	$55,300
FOTW Costs	12.5 million gallons	$3.83/1000 gal.	$47,900
Subtotal			$368,500
Present value cost at 6% discount over 5 years			$1,552,000
Monitoring			
Sampling Labor	100 hrs.	$130/hr	$13,000
Laboratory	20 samples 5 QA/QC per sampling event	$30/sample.	$750
Evaluation	40 hrs.	$75/hr.	$3,000
Engineering support/report preparation	LS	20% cost	$3,350
Miscellaneous supplies, equipment, travel, contingency	LS	20% cost	$4,190
Subtotal			$24,240
Present value cost at 6% discount over 5 years			$102,300
Institutional Controls (LURA and signs)	1	$50,000	$50,000
Remedial Action Contractor Costs			$100,000

Table 4-5
Alternative 4b — Groundwater Recovery and Ionic Exchange Treatment (Two Recovery Wells)
Groundwater Cost

Action	Quantity	Cost per Unit	Total Cost
Groundwater Physical/Chemical Treatment System Costs			
Building	LS	$200,000	$200,000
Tanks	3	$5,000/tank	$10,000
Pumps and accessories	LS	$25,000	$25,000
Treatment system	LS	$60,000	$60,000
Process controls	LS	$25,000	$25,000
Installation	LS	$60,000	$60,000
Engineering	LS	20% cost	$76,000
Contingency	LS	25% cost	$95,000
Subtotal			$551,000
Annual Operating Costs			
Physical/chemical process			$85,000
Present value cost at 6% discount over 5 years			$358,000
Disposal of Liquid Waste at Treatment Facility			
Treated water disposal	40,000 gallons/year	$1.20/gallon	$48,000
Engineering/oversight	LS	20% cost	$9,600
Contingency/miscellaneous	LS	25% cost	$12,000
Subtotal			$69,600
Present value cost at 6% discount over 5 years			$293,200
Total			$3,105,000

4.3 Soil Remedial Alternative Screening

4.3.1 Alternative 1: No Action

During the development and evaluation of alternatives, USEPA guidance requires that a no-action alternative be considered as a baseline against which all other alternatives will be evaluated. In the no-action alternative, no remedial actions would be taken to contain, remove, or treat soil contamination that exceeds risk-based cleanup goals. Soil would remain in place to attenuate according to natural biotic or abiotic processes.

No Action: Remedial Elements

No remedial elements are associated with the no-action alternative. However, as required by the NCP, a review will be conducted every five years for 30 years.

No Action: Implementability

This alternative is technically feasible. Because contaminated soil would remain at Site 15, this alternative would be subject to SARA requirements for review and evaluation every five years. The need for remedial action would be re-evaluated every five years and, as required by CERCLA, would be implemented for at least 30 years.

No Action: Effectiveness

Under current site conditions, surface soil exceeds the FDEP SCTL industrial threshold at 23 sample points. The no-action alternative would not provide any additional effectiveness for current or future site workers or residents. Risks would remain above the threshold for current and future industrial workers or residents exposed during activities in which they contact surface soil. This alternative would not reduce the contaminant toxicity, mobility, or volume. No risks would be posed during the short-term implementation phase.

No Action: Cost

Table 4-6 presents the costs associated with the no-action alternative.

Table 4-6
Alternative 1 — No Action
Soil Cost

Action	Quantity	Cost per Unit	Total Cost
Fiver Year Review	LS[2]	$10,000	$10,000
Present value sub total at 6% discount over 30 years			$24,400
Total Cost			**$24,400** [1]

Notes:
[1] — Cost based on review once every five years for 30 years.
[2] — Lump sum

4.3.2 Alternative 2: Institutional Controls

In the institutional controls alternative, no remedial actions would be taken to contain, remove, or treat soil contamination that exceeds risk-based cleanup goals. Soil would remain in place. Land use restrictions and other necessary controls (e.g., fences, natural barriers) would be implemented to ensure restricted access to contaminated soil.

Institutional Controls: Remedial Elements

No remedial elements are associated with this alternative, except implementation of land use restrictions.

Institutional Controls: Implementability

This alternative is technically feasible. Land use restrictions must be implemented and maintained. Because contaminated soil would remain at Site 15, this alternative is subject to SARA requirements for review and evaluation every five years. As required by CERCLA, the need for remedial action would be reviewed every five years for at least 30 years.

Institutional Controls: Effectiveness

Under current site conditions, surface soil exceeds the industrial-based risk threshold of 1E-06 at 24 sample locations. This alternative would not provide any additional effectiveness for the current use scenario, but would provide long-term effectiveness by restricting future use and access. Current and future industrial workers would be exposed to soil above the 1E-06 industrial risk threshold during activities in which they contact surface soil. This alternative would not reduce contaminant toxicity, mobility, or volume. No risks would be posed during the short-term implementation phase.

Institutional Controls: Cost

Table 4-6 presents costs for the monitoring activities in the institutional controls alternative. Implementing institutional controls is estimated to cost $50,000. There may also be additional costs for fencing or modifying natural barriers. These costs are expected to be minor since they would be implemented at the beginning of the 30-year period and do not require present value calculation. Excluding fencing or other physical restrictions, the present value for Alternative 2 is the cost of Alternative 1, plus $50,000 for land use restrictions for a total of $74,400.

4.3.3 Alternative 3: Limited Excavation to Industrial Scenario and Offsite Disposal

This alternative involves the excavation of surface soil in which contaminants exceed compound-specific RGs and disposing of it offsite. Approximately 580 yd^3 of soil, as depicted in Figure 2-1, and listed in Table 2-2, would be removed from the site. This alternative would remove surface soil that poses a threat to current or future industrial site workers through dermal and ingestion exposure pathways. Since soil removal is based on point risk exceeding 1E-06 industrial risk, institutional controls (the LURA) will be used to ensure that future use remains industrial.

The disposal method will be determined based on the arsenic toxicity test (toxicity characteristic leaching procedure [TCLP]) results. Arsenic TCLP results greater than 5 mg/kg would be classified as hazardous waste and require pretreatment. Although no TCLP data are available for the site, using the TCLP 20 times rule, it can be assumed that concentrations less than 100 mg/kg would not be considered hazardous waste and therefore, would not require treatment. Since the maximum arsenic concentration in Site 15 soil is 66.3 mg/kg, pretreatment of the excavated soil before disposal is not expected.

Limited Excavation to Industrial Scenario and Offsite Disposal: Remedial Elements
Remedial activities would consist of:

- Implement institutional controls (LURA)
- Extent sampling
- Excavation
- Confirmatory sampling
- Backfill
- Transport of excavated material offsite
- Stabilization/treatment (if required)
- Landfilling in a Subtitle D facility

Confirmation sampling of the surface soil surrounding the excavation would be conducted to ensure complete removal of surface soil in which contaminant concentrations exceed RGs. Arsenic will be analyzed to determine the extent of excavation. If analytical results are less than FDEP SCTLs (3.7 mg/kg arsenic), excavation will be complete.

After the contaminated soil is removed, clean backfill would be placed in the excavated areas and graded. TCLP analysis would be conducted to determine if the excavated soil exhibits toxicity characteristics. As previously stated, since concentrations of previously acquired samples have been less than 100 mg/kg, it is expected that excavated soil will be non-hazardous and a Subtitle D facility will be appropriate for disposal without pre-treatment. Approximately 580 yd^3 of soil contaminated with arsenic would require disposal.

Limited Excavation to Industrial Scenario and Offsite Disposal: Implementability

This alternative is both technically and administratively feasible at Site 15. Excavation is performed frequently. It is a reliable method to remove contaminated soil within given boundaries. No technology-specific regulations apply to excavation and offsite disposal (i.e., landfilling) alternatives. Except for implementing land use restrictions, no long-term maintenance or monitoring would be required once soil in which contaminant concentrations exceed RGs has been removed. Based on groundwater elevation data presented in the RI report, groundwater is not expected to pose a problem during excavation.

Excavation and offsite disposal are administratively feasible at Site 15. No capacity limitations are expected at the landfill, given low projected soil volumes. Transportation and disposal of contaminated soil must adhere to U.S. Department of Transportation regulations and requirements. Scheduling would be required to reduce costs for roll-off boxes and downtime while transporting the soil from Site 15 to the disposal facility.

Limited Excavation to Industrial Scenario and Offsite Disposal: Effectiveness

Excavation with offsite disposal would protect the environment at Site 15. This alternative would reduce the quantity of soil in which contaminant concentrations exceed RGs onsite.

Short-term inhalation, ingestion, and contact risks to site workers (excavation crew) would temporarily increase due to excavation and require health and safety practices consistent with working near arsenic-contaminated soil. These risks will be reduced through proper use of PPE and engineering controls. Because no residential areas are adjacent to Site 15, there are no short-term risks to the surrounding community. Short-term risks to site workers are expected to last only until remedial actions are complete. No onsite long-term risks are associated with this alternative because soil in which contaminants exceed the FDEP SCTL industrial threshold would be removed.

Limited Excavation to Industrial Scenario and Offsite Disposal: Cost

Table 4-7 presents the capital costs associated with excavation and offsite disposal at a Subtitle D disposal facility.

4.3.4 Alternative 4: Asphalt Cover with Institutional Controls and Limited Excavation

Installation of an asphalt cover would reduce the risk of site worker contact with areas of exposed contaminated soil, thus eliminating exposure pathways. Institutional controls would be incorporated to restrict future access to contaminated soil. Limited excavation would eliminate risk from isolated areas of contaminated soil.

Asphalt Cover with Institutional Controls and Limited Excavation: Remedial Elements

No remedial activities are associated with institutional controls. Remedial activities for the asphalt cover would consist of:

- Implementing institutional controls (LURA)
- Confirmatory Sampling
- Site Preparation
- Cover Placement
- Surface drainage system installation

Cover construction would consist of a 4- to 8- inch asphalt pavement placed over the contaminated soil areas and a drainage system to divert runoff from the cover surface. Confirmation sampling

Table 4-7
Alternative 3 — Limited Excavation to Industrial Scenario and Offsite Disposal
Soil Costs

Action	Quantity	Cost per Unit	Total Cost
Excavation	580 yd^3	\$20/yd^3	\$11,600
Confirmation Sampling	27 samples (plus 3 QA/QC samples) [a]	\$15/sample	\$450
Backfill	580 yd^3	\$15/yd^3	\$8,700
Subtotal			\$20,750
Subtitle D Disposal Facility			
Transportation	29 trucks (assuming 20 yd^3 each) hauling 30 miles	\$3.50/loaded mile	\$3,045
Soil Disposal	1050 tons	\$36/ton	\$37,800
Engineering/Oversight	LS	20% cost	\$8,200
Contingency/Miscellaneous	LS	25% cost	\$10,200
Subtotal			\$59,245
Institutional Controls (LURA and signs)			\$50,000
Remedial Contractor Cost			\$100,000
Total			**\$230,000**

Note:
a — Samples include four from the large area around Building 2640, three each from the areas northwest of Building 3586, north of Building 2692, and west of building 2640, and two each from the seven small areas represented by a single sample point.

would help delineate the extent of soil in which contaminant concentrations exceed the RG to ensure that all contaminated soil is covered.

Remedial activities for excavation would consist of:

- Excavation
- Confirmatory sampling
- Backfill
- Transport of excavated material offsite

- Stabilization/treatment (if required)
- Landfilling in a Subtitle D facility

Confirmation sampling of the surface soil surrounding the excavation would be conducted to ensure complete removal of surface soil in which contaminant concentrations exceed RGs. Arsenic will be analyzed to determine the extent of excavation. If analytical results are less than FDEP SCTLs (3.7 mg/kg arsenic), excavation will be complete.

After the contaminated soil is removed, clean backfill would be placed in the excavated areas and graded. Approximately 205 yd^3 of soil contaminated with arsenic would require offsite disposal. TCLP analysis would be conducted to determine if the excavated soil exhibits toxicity characteristics. As previously stated, since concentrations of previously acquired samples have been less than 100 mg/kg, it is expected that excavated soil will be non-hazardous and a Subtitle D facility will be appropriate for disposal without pre-treatment.

Asphalt Cover with Institutional Controls and Limited Excavation: Implementability

Cover construction with institutional controls and limited excavation is technically feasible at Site 15. Land use restrictions may be used to implement institutional controls. Site 15 areas that would be covered are shown in Figure 4-5, Proposed Cover Locations and Soil to be Removed. The total area to be covered is approximately 20,000 ft^2. The site is suitable for asphalt or concrete covering to protect site workers from contaminated soil and to control runoff. The cover location was intended to not interfere with the use of the site or access to doors and walkways. The seven isolated areas to be excavated and the associated sampling points are listed in Table 4-8 and shown in Figure 4-5. Excavation implementability is discussed in Section 4.3.3.

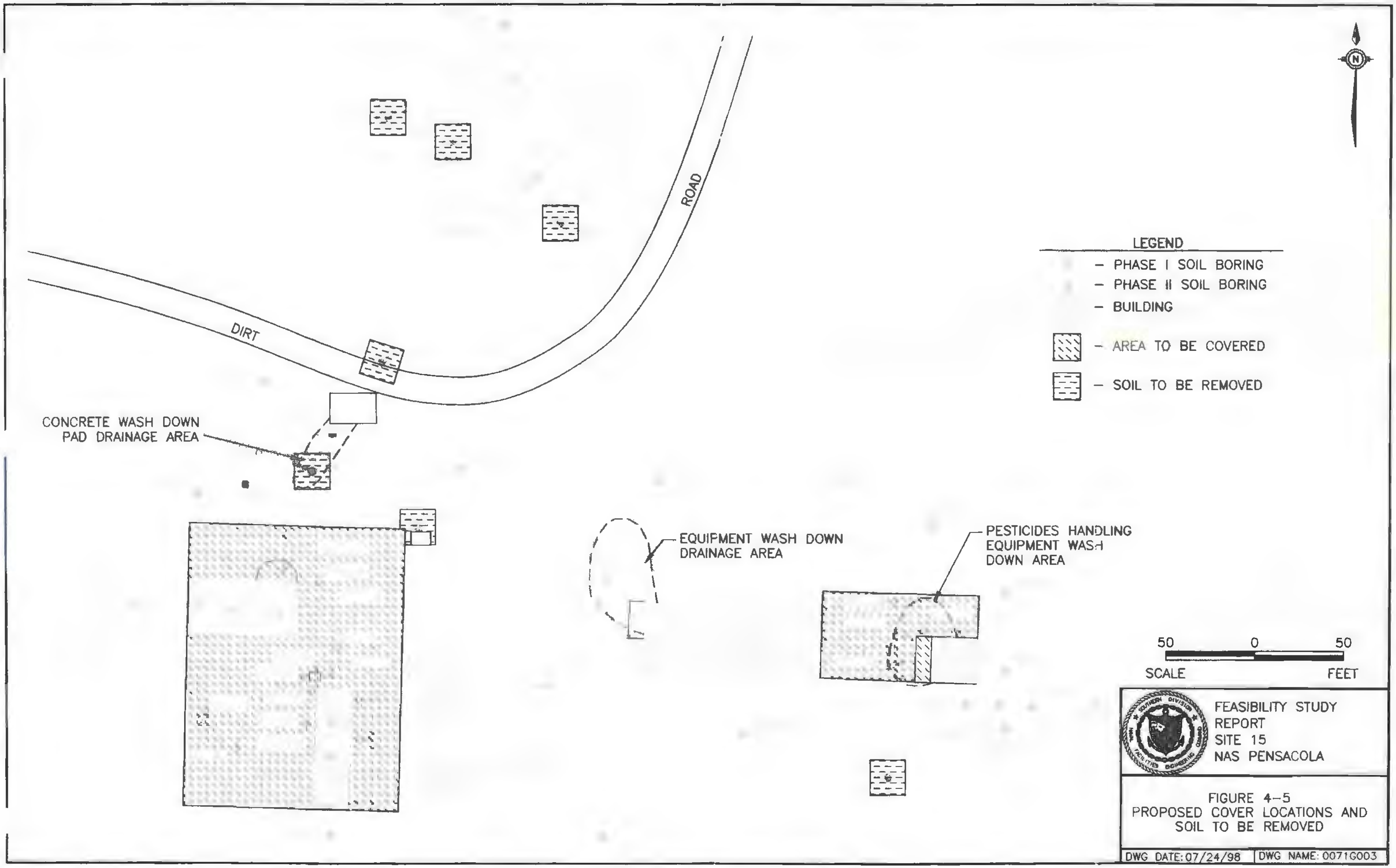

DIRT
ROAD
LEGEND
– PHASE I SOIL BORING
– PHASE II SOIL BORING
– BUILDING
– AREA TO BE COVERED
– SOIL TO BE REMOVED
CONCRETE WASH DOWN PAD DRAINAGE AREA
EQUIPMENT WASH DOWN DRAINAGE AREA
PESTICIDES HANDLING EQUIPMENT WASH DOWN AREA
50 0 50
SCALE FEET
FEASIBILITY STUDY REPORT
SITE 15
NAS PENSACOLA
FIGURE 4–5
PROPOSED COVER LOCATIONS AND SOIL TO BE REMOVED
DWG DATE: 07/24/98
DWG NAME: 0071G003

Table 4-8
Alternative 3 — Site 15 Surface Soil Volume Estimates

Affected Area Designation	Contaminants Exceeding RG	Soil Volume Affected (yd^3)	Basis
15S02	Arsenic	30	Exceeds FDEP SCTL
15S10	Arsenic	30	Exceeds FDEP SCTL
15S45	Arsenic	30	Exceeds FDEP SCTL
15S52	Arsenic	30	Exceeds FDEP SCTL
15S53	Arsenic	30	Exceeds FDEP SCTL
15S55	Arsenic	30	Exceeds FDEP SCTL
15S58	Arsenic	25	Exceeds FDEP SCTL
Total Soil Volume		205	

Asphalt Cover with Institutional Controls and Limited Excavation: Effectiveness

Covers provide reliable protection against dermal contact and ingestion of contaminated soil. They isolate contaminants exceeding risk and guidance concentrations in environmental media, but are not designed to manage solid or hazardous waste. Once the cover is in place, institutional controls would help ensure continued cover effectiveness and regular maintenance would be required. In addition to protecting against existing contamination, the cover drainage system would enhance the current controls for protection against future releases. As operations continue, the drainage system would help prevent additional contamination from releases of herbicides containing arsenic by transporting rinsate and stormwater runoff to the FOTW. These storm water controls would be necessary and be addressed during cover design. Excavation is effective through removal of contaminated soil exceeding RGs.

Asphalt cover with institutional controls and limited excavation: Cost

Table 4-9 presents the capital costs associated with installation of an asphalt cover and institutional controls and limited excavation.

Table 4-9
Alternative 4 — Asphalt Cover with Institutional Controls and Limited Excavation
Soil Costs

Action	Quantity	Cost per Unit	Total Cost
Capital Costs for Asphalt Cover			
Mobilization/Demolization	LS[1]	$250/area	$500
Grading/site preparation	2,200 yd²	$1.50/yd²	$3,300
Drainage System (two systems)	LS[1]	$14,000 $7,000	$21,000
Asphalt/Concrete Surface (8" depth)	19,800 ft²	$1.76/ft²	$34,850
Engineering/Oversight	LS[1]	20% cost	$11,930
Contingency/Miscellaneous	LS[1]	25% cost	$14,900
Subtotal			$86,480
Operation and Maintenance Cost			
Maintain drainage and cover (30 years)	2,200 yd²	$2/yd²	$4,400
Inspection	LS[1]	$500	$500
Subtotal			$4,900
Present value at 6% discount over 30 years			$67,450
Confirmation Sampling	11 samples (plus 2 QA/QC samples)	$15/sample	$195
Institutional Controls (LURA and signs)		LS	$50,000
Capital Cost of Excavation			
Excavation	205 yd³	$20/yd³	$4,100
Confirmation Sampling	14 samples (plus 2 QA/QC samples)	$15/sample	$240
Backfill	205 yd³	$15/yd³	$3,075
Subtotal			$7,415
Subtitle D Disposal Facility			
Transportation	11 trucks (assuming 20 yd³ each) hauling 30 miles	$3.50/loaded mile	$1,155
Soil Disposal	365 tons	$36/ton	$13,140
Engineering/Oversight	LS[1]	20% cost	$2,860
Contingency/Miscellaneous	LS[1]	25%	$3,575
Subtotal			$20,730
Remedial Contractor Cost			$100,000
Total Cost			**$332,300**

Note:
[1] — Lump sum

5.0 DETAILED AND COMPARATIVE ANALYSIS OF ALTERNATIVES

In this section, the remedial alternatives selected in Section 4 are compared to the requirements of CERCLA as amended, the NCP, OSWER Directive 9355.9-19 (*Superfund Selection of Remedy*, Interim, December 24, 1986), and OSWER Directive 9355.3-01 (USEPA, 1988).

5.1 Evaluation Process

Each alternative is first assessed using Directive 9355.3-01, then compared to other alternatives. Assessment results are arrayed to compare the alternatives and identify their key tradeoffs to provide decision makers with enough information to adequately select an appropriate remedy and demonstrate that it satisfies CERCLA's requirements.

Nine evaluation criteria have been developed to address CERCLA requirements and considerations, and the additional technical and policy considerations known to be important in selecting from remedial alternatives. These evaluation criteria are used to analyze alternatives and select an appropriate remedial action. The evaluation criteria are listed below.

Threshold Criteria

- Overall protection of human health and the environment
- Compliance with ARARs

Balancing Criteria

- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume
- Short-term effectiveness
- Implementability
- Cost

Modifying Criteria

- State/support agency acceptance
- Community acceptance

Each remedial alternative is evaluated with respect to the above criteria in the following sections. In Section 6, the statutory factors and criteria listed above are compared for each alternative to assist in selecting a remedy.

5.1.1 Overall Protection of Human Health and the Environment

This evaluation criterion provides a check to assess whether each alternative adequately protects human health and the environment. It draws on the assessments conducted under other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs.

Evaluating the overall protectiveness of an alternative should focus on whether it achieves adequate protection by eliminating, reducing, or controlling the risk posed by each pathway through treatment, engineering, or institutional controls. This evaluation also considers whether an alternative poses any unacceptable short-term or cross-media impacts.

5.1.2 Compliance with ARARs

This evaluation criterion helps determine whether each alternative would meet all the federal and state ARARs identified in previous remedial stages. The detailed analysis should identify which requirements are applicable or relevant and appropriate to an alternative. Chemical-, location-, and action-specific ARARs should be addressed for each alternative during the detailed analysis. The lead agency, the Navy, decides which requirements are applicable or relevant and appropriate by consulting with the support agencies (USEPA and FDEP). Appendix A presents the ARARs.

5.1.3 Long-Term Effectiveness and Permanence

This criterion measures a remedial action's results by the magnitude of the risk remaining after response objectives have been met. This evaluation primarily focuses on the extent and effectiveness of controls that may be required to manage the risk posed by treatment residuals and/or untreated wastes. Residual risk and control adequacy and reliability should be addressed for each alternative.

Magnitude of Residual Risk

This factor assesses residual risk remaining from untreated waste or treatment residuals when remedial activities conclude. The potential for residual risk can be measured by numerical standards such as cancer risk or contaminant's volume or concentrations in waste, media, or treatment residuals remaining onsite.

Control's Adequacy and Reliability

This factor assesses the adequacy and suitability of any controls used to manage treatment residuals or untreated wastes that remain onsite. It may include assessing containment systems and institutional controls to determine if they can ensure that exposure to human and environmental receptors (if any) is within protective levels.

5.1.4 Reduction of Toxicity, Mobility, or Volume

This evaluation criterion addresses the statutory preference for remedial actions using treatment technologies that permanently and significantly reduce the toxicity, mobility, or volume of the hazardous substances. The evaluation should consider the following:

Evaluation Factors

- Treatment processes, the remedies they would use, and the materials they would treat.

- Amount of hazardous materials that would be destroyed or treated, including how principal threats would be addressed.

- Degree of expected reduction in toxicity, mobility, or volume, measured as a reduction percentage (or order of magnitude) when possible.

- Degree to which the treatment would be irreversible.

- Type and quantity of treatment residuals that would remain following treatment.

- Whether the alternative would satisfy the statutory preference for treatment as a principal element.

5.1.5 Short-Term Effectiveness

Short-term effectiveness is evaluated relative to its effect on human health and the environment during remedial action implementation. Short-term effectiveness is based on four key factors:

Assessment Factors

- Risks to the community during remedial action implementation.
- Risks to workers during remedial action implementation.
- Potential for adverse environmental impact as a result of implementing the remedial action.
- Time until remedial response objectives are achieved.

5.1.6 Implementability

Implementability addresses the technical and administrative feasibility of implementing an alternative and the availability of various services and materials required during its implementation. This criterion involves analyzing the factors discussed below.

Technical Feasibility

- **Construction and Operation:** This factor assesses the technical difficulties and unknowns associated with developing and implementing a technology.

- **Reliability of Technology:** Reliability focuses on the likelihood that technical problems associated with implementations would lead to schedule delays.

- **Ease of Undertaking Remedial Actions:** The ease of implementing the remedial action is based on future remedial actions that might need to be undertaken and the difficulty of implementing these actions.

- **Monitoring Considerations:** This consideration addresses the ability to monitor the remedy's effectiveness, including evaluating the exposure risks if monitoring cannot detect a system failure.

Administrative Feasibility

Administrative feasibility involves coordinating with other offices and agencies.

Availability of Services and Materials

- **Offsite Treatment:** Availability of adequate offsite treatment, storage capacity, and disposal services.

- **Equipment and Specialists:** Availability of necessary equipment, specialists, and provisions.

- **Services and Materials:** Availability of services and materials, plus the potential to obtain competitive bids, which may be particularly important for innovative technologies.

- **Prospective Technologies:** Availability of prospective technologies.

5.1.7 Cost

Detailed cost estimates for each remedial alternative are based on engineering analyses, suppliers' estimates of necessary technology, and costs for similar actions such as excavation at other CERCLA and RCRA sites. Cost, one of the primary balancing criteria on which the detailed analysis is based, is expressed in 1998 dollars. The cost estimate for a remedial alternative consists of four principal elements: capital cost, operation and maintenance cost, costs for evaluation reports, and present-worth.

Capital Costs

- ***Direct costs*** for equipment, labor, and materials used to develop, construct, and implement a remedial action.

- ***Indirect costs*** for engineering, financial, and other services that are not actually a part of construction, but required to implement a remedial alternative. The percentage applied to the direct cost varies with the degree of difficulty associated with the alternative's construction and/or implementation. In this FS, indirect costs include health and safety items, permitting and legal fees, bid and scope contingencies, engineering design and services, and other miscellaneous supplies or costs.

- **Annual O&M Costs:** These are the costs needed to ensure a remedial action's continued effectiveness after implementation. They are typically long-term power and material costs such as operating a water treatment plant, equipment replacement, and long-term monitoring.

- **Present-Worth Analysis:** This analysis makes it possible to compare remedial alternatives on the basis of a single cost representing an amount that would be sufficient to cover all costs associated with the remedial action during its planned life if invested in the base year and disbursed as needed. A performance period appropriate to each alternative is assumed for present-worth analyses. Discount rates of 6% are assumed for base calculations. An increase in the discount rate would decrease the alternative's present worth.

Each remedial alternative's cost elements are summarized in the cost analysis section. They are intended to reflect actual costs with an accuracy of minus 30% to plus 50%, in accordance with USEPA guidelines.

5.1.8 State/Support Agency Acceptance

This assessment evaluates technical and administrative issues and concerns the state and USEPA may have regarding each alternative. This criterion is largely satisfied through FDEP and USEPA involvement in the remedial process, including review of the FS. The U.S. Navy, the lead agency, will work with FDEP and USEPA in selecting and implementing the alternative.

5.1.9 Community Acceptance

This assessment evaluates the issues and concerns the public may have regarding each alternatives. As with state/agency acceptance, this criterion will be addressed when FS comments have been received.

5.2 Evaluation of Groundwater Alternatives

The following sections analyze the groundwater remediation alternatives presented in Section 4.

Groundwater Alternatives

- Alternative 1: No action
- Alternative 2: Monitored natural processes/institutional controls
- Alternative 3: Groundwater recovery and discharge
- Alternative 4: Groundwater recovery and ex-situ treatment

Each alternative is evaluated according to the nine criteria discussed in the previous section. Criteria have been divided into the three categories — threshold, balancing, and modifying.

5.2.1 Alternative 1: No Action

The no-action alternative for Site 15 involves no active remedial effort. No actions will be taken to contain, remove, or treat groundwater contamination. Groundwater will remain in place to attenuate according to abiotic, dilution, dispersion, and other natural processes. No engineering or institutional controls will be implemented. The no-action alternative provides a baseline to which other alternatives can be compared.

No Action: Threshold Criteria

Overall Protection of Human Health and the Environment: The no-action alternative provides no additional protection of human health and the environment. Groundwater arsenic concentrations at Site 15 exceed RGs. Under the no-action scenario, these exceedances would remain; it is assumed that current groundwater contamination is "worst case" and attenuating. The Surficial/Sand-and-Gravel Aquifer is not a potable water source in the NAS Pensacola area, so there are no users who would be affected by arsenic in the groundwater. However, there are no controls in place to prevent its use as a potable source.

The no-action alternative does not afford any long-term effectiveness and permanence under an industrial scenario beyond natural degradation of constituents. No short-term impacts are associated with this alternative, which does not reduce contaminants' mobility or volume, but allows them to naturally attenuate. This alternative does not comply with chemical-specific ARARs and TBC criteria because groundwater in which contaminants exceed MCLs could theoretically be consumed. However, groundwater consumption is not likely, as previously mentioned.

Groundwater migration, assuming no easterly flow component, does not indicate a potential risk to Bayou Grande and the tidal pond. Although the potential ecological impacts on these water bodies were not addressed in the RI, based on conservative estimates of Site 15 groundwater contaminant migration rates and the low contaminant concentrations, there are no impacts to Bayou Grande and the tidal pond. This assumption is confirmed by low concentrations or no concentrations of arsenic in the Phase III monitoring wells placed between contamination sources and the two water bodies. Therefore, groundwater discharge from Site 15 is not likely to be a source of contaminants to the Bayou Grande and the tidal pond at concentrations exceeding FSWQS action levels.

Compliance with ARARs

Alternative 1 does not comply with the risk goals developed in Section 2 of this report; risk goals are ARARs under CERCLA. No location- or action-specific ARARs are triggered by the no-action alternative. Contaminated groundwater concentrations would continue to exceed the FPDWS.

No Action: Balancing Criteria

The primary balancing criteria are the technical criteria on which the detailed analysis is based.

Long-term Effectiveness and Permanence: Degradation of site contaminants is left to natural attenuation processes in this alternative, and the long-term effectiveness of the no-action alternative is minimal. Current contaminant concentrations would attenuate slowly. Groundwater volume and concentrations would remain unchanged, except for natural attenuation. The no-action alternative does not reduce the magnitude of residual risk and provides no means for monitoring. This alternative does not provide permanence.

Any site controls currently in place — which include military security and limited access to the site and use of it — would remain. Due to the abundant supply of high quality water in the deeper main producing zone, groundwater from the surficial zone is not currently used as a potable water source in southern Escambia County, nor is it expected to be used for that purpose in the future.

Reduction of Toxicity, Mobility, or Volume Through Treatment

The no-action alternative would not reduce groundwater contaminants' mobility or volume. Toxicity is reduced slowly through natural processes. Contaminants would remain in place onsite; no treatment is effected during remedial actions. However, intrinsic remediation processes would continue. Contaminated groundwater would migrate according to current transport dynamics.

Short-Term Effectiveness

Short-term effectiveness assesses an alternative's effects on human health and the environment while the remedial alternative is being implemented. There are no short-term effects resulting from the no-action alternative.

Implementability

The no-action alternative is technically feasible and easily implemented. No construction, operation, or reliability issues are associated with this alternative. Current access controls — including military security and limited access to personnel — have historically been reliable. No administrative coordination is required for implementation of the no-action alternative. This alternative does not require offsite services, materials, specialists, or innovative technologies. There are no implementation risks associated with Alternative 1.

Cost

Costs associated with the no-action alternative include review and report preparation every five years for 30 years. Each review and reporting event is estimated at $10,000 with a present worth for the 30-year period of $24,400.

No Action: Modifying Criteria

The modifying criteria are assessed formally after the public-comment period. However, the criteria are factored into identifying the preferred alternatives, as far as they are known.

State/Support Agency Acceptance

FDEP and the USEPA will have the opportunity to review and comment on this FS.

Community Acceptance

These criteria are generally not completed until after public comments on the RI/FS report and the proposed plan are received.

5.2.2 Alternative 2: Monitored Natural Processes/Institutional Controls

Under this alternative, contaminated groundwater is left in place. This alternative includes initial assessment and if necessary, may include fate-and-transport modeling to predict expected contaminant concentrations over time. Additional groundwater sampling would be required to support this modeling. A long-term groundwater monitoring program would be implemented to monitor natural processes and to ensure that human health is protected. Institutional controls would be implemented in the form of the Land Use Restriction Agreement (LURA) to limit land to industrial use and restrict use of groundwater beneath and downgradient of the site.

Monitored Natural Processes/Institutional Controls: Threshold Criteria

Overall Protection of Human Health and the Environment: Under an industrial scenario, this alternative addresses long-term effectiveness and permanence by preventing exposure to the contaminant source. Protection of human health is accomplished by restrictions on groundwater use and elimination of the ingestion pathway through institutional controls in the LURA. No short-term impacts would be associated with this alternative.

As previously discussed, no threats to Bayou Grande and the tidal pond have been identified. Ongoing monitoring would verify protection of the two bodies of water and the environment.

Compliance with ARARs: This alternative is intended to comply with chemical-specific groundwater ARARs. It is not known at this time if and when groundwater would reach RGs. Arsenic concentrations would continue to exceed FPDWS in the central portion of the site. Modeling and groundwater sampling are intended to document contaminant migration over time. Even though the FPDWS would be exceeded, MCLs are only intended for potable water sources and based on future land use restrictions, Site 15 surficial groundwater is not expected to be a potable water source. No location or action-specific ARARs would be triggered by groundwater Alternative 2.

Monitored Natural Processes/Institutional Controls: Balancing Criteria

Long-term Effectiveness and Permanence: This alternative eliminates residual risk to site workers by eliminating the groundwater ingestion pathway; Site 15 will be designated as an industrial area and groundwater use restrictions will be implemented. Long-term effectiveness would be minimal. Groundwater would be monitored and contaminated groundwater consumption would be controlled institutionally.

Reduction of Toxicity, Mobility, or Volume Through Treatment: This alternative does not reduce the mobility or volume through treatment. Contaminants would remain in place onsite; no treatment is effected during remedial actions. Contaminated groundwater would migrate according to current transport dynamics.

Short-Term Effectiveness: Protection of the community is accomplished through groundwater restrictions and institutional controls. Protection of workers is accomplished by groundwater restrictions, equipment, and training. This alternative could be executed as soon as land-use restrictions and groundwater restrictions are in place.

Wastes generated from sampling will be managed in a manner that reduces contact with the environment. Wastewater would be stored in 55-gallon drums or other containers and disposed of appropriately. Waste management practices used during the RI could be continued for this alternative.

Implementability: Natural attenuation is technically feasible and easily implemented. Monitoring and modeling intrinsic remediation in groundwater is essential to natural attenuation. Implementation of the initial screening process is both technically and administratively feasible. While natural attenuation is reliable, screening and modeling can determine if natural attenuation can reduce contaminants to RGs in a reasonable time. Groundwater could be monitored using existing monitoring wells, plus two new wells. No other construction, operation, or maintenance would be required initially. However, monitoring well maintenance or other construction might be required during long-term monitoring. Current access controls — including military security and limited access to personnel — have been reliable in the past. Administrative coordination would be required to implement institutional controls. Monitoring, data analysis, and possibly modeling would be required. This alternative would not require offsite treatment services, materials, or innovative technologies. There are no implementation risks associated with Alternative 2.

Cost: Costs for monitored natural processes with institutional controls include:

- Monitoring well construction
- Groundwater sampling and analysis
- Initial natural attenuation assessment
- Engineering, institutional controls, and report compilation

Costs for this alternative are detailed in Section 4. Capital costs for Alternative 2 initial screening and startup and implementation of institutional controls are approximately $103,000, including direct, indirect and incidentals. Annual operating and maintenance costs for long-term monitoring are $39,000 and remedial action contractor costs are $100,000. The total present value for Alternative 2 is $740,000 (assuming a 6% discount rate over 30 years for monitoring costs).

Monitored Natural Processes/Institutional Controls: Modifying Criteria

State/Support Agency Acceptance: FDEP and the USEPA will have the opportunity to review and comment on this FS.

Community Acceptance: These criteria are generally not completed until after public comments on the RI/FS report and the proposed plan are received. Education of the public on the difference between monitored natural processes/institutional controls and no action might be required, if monitored natural processes/institutional controls is selected as the remedial alternative.

5.2.3 Alternative 3: Groundwater Recovery and Discharge

This alternative involves recovering groundwater by well extraction. Extracted groundwater is then discharged to the FOTW. Mass removal in this area would eliminate a potential source of downgradient contamination. Alternative 3 would provide containment of both plumes using two proposed recovery wells. Institutional controls would also be implemented in the LURA as in Alternative 2.

Groundwater Recovery and Discharge: Threshold Criteria

Overall Protection of Human Health and the Environment: Protection of human health is accomplished by containing contaminated groundwater in which arsenic exceeds FPDWS, thus preventing migration of contaminants beyond the source area and effecting mass removal in contaminated zones.

Extracted groundwater would discharge to the FOTW. Institutional controls (the LURA) would prohibit domestic use of groundwater.

Compliance with ARARs: Groundwater extraction complies with the chemical-specific ARARs developed in Section 2. The contaminated groundwater would be captured by extraction wells, thereby removing groundwater in which arsenic exceeds FPDWS. Removal of groundwater from Site 15 is intended to reduce the mass of contaminants in the aquifer and contain the two contaminant plumes.

The FOTW is subject to NPDES requirements and FOTW effluent discharges must meet permit requirements. ARARs are presented in Appendix A.

Groundwater Recovery and Discharge: Balancing Criteria

Long-term Effectiveness and Permanence: Groundwater extraction would contain contaminants and reduce groundwater contamination by mass removal. Groundwater migration is expected to be arrested by the containment system. Alternative 3 reduces risk through mass removal and offers protection by containment of the source. Groundwater monitoring effectively documents changes in groundwater concentrations.

Groundwater extraction removes contaminants from the surficial zone and contains the two plumes. This alternative is effective for contaminant mass removal.

For the purpose of the FS, the projected remedial time to withdraw five pore volumes is five years. Risks to human health and the environment onsite are expected to decrease with time as constituents are removed. Saline intrusion from groundwater extraction is not likely.

Reduction of Toxicity, Mobility, or Volume Through Treatment: This alternative is a mass removal/containment alternative. Groundwater removal at Site 15 would reduce toxicity of groundwater, and reduce the volume of contaminants. The process of groundwater containment eliminates contaminant migration. This alternative reduces mobility or volume through mass removal process.

Over five years, Alternative 3 would extract an estimated 62.5 million gallons of groundwater. Assuming no requirement for pretreatment, this water would be collected and discharged to the FOTW. Flow rates are estimated, to be 30 gpm for each well, based on preliminary modeling. Mass removal of non-naturally occurring arsenic in the surficial aquifer is expected to be permanent.

Short-Term Effectiveness: Adverse impacts to the surrounding environment are not anticipated during groundwater recovery system construction. Discharge acceptance to the FOTW needs to be completed before implementation. After design plans are approved and testing is complete, the groundwater collection system would be constructed. Collection of five pore volumes is estimated to take five years.

Workers should be trained according to OSHA standards as required by 29 CFR 1910.120 to protect and mitigate risks during remedial construction. Field personnel contact with site contaminants would be minimal during construction (pump installation, control panel installation, and sanitary sewer connections). Worker protection could be managed through appropriate PPE. Compliance with RGs can be determined by monitoring site wells. System performance and mass removal can be evaluated by effluent monitoring. Alternative 3 would be compatible with any additional remedial actions, if required.

Implementability: Extracting contaminated groundwater beneath the site is both technically and administratively feasible. This alternative would not require any extraordinary services, materials, specialists, or innovative technologies. Construction and operation could be achieved with minimal difficulty. Implementation could begin immediately.

Cost: Direct and indirect costs associated with groundwater extraction Alternative 3 are $98,000. Annual operation, maintenance, and FOTW costs are expected to be $84,300 (including groundwater monitoring). The total present value cost of Alternative 3 including implementing institutional controls and the costs for the corrective action contractor, is estimated to be $603,000 (assuming a 6% discount rate over five years).

Groundwater Recovery and Discharge: Modifying Criteria

State/Support Agency Acceptance: FDEP and the USEPA will have the opportunity to review and comment on this FS.

Community Acceptance: These criteria are generally not completed until after public comments on the RI/FS report and the proposed plan are received.

5.2.4 Alternative 4: Groundwater Recovery and Ex-Situ Treatment

This alternative involves recovering groundwater by well extraction. Extracted groundwater is then treated onsite and discharged to the FOTW. The treatments identified for groundwater are chemical/physical processes for arsenic. Area remediation would remove a potential source of downgradient contamination, and permit natural flushing and attenuation of contaminated plumes. Two treatment systems have been evaluated: a) coagulation/precipitation and solids separation, and b) ion exchange.

Groundwater Recovery and Ex-situ Treatment: Threshold Criteria

Overall Protection of Human Health and the Environment: Human health is protected by extracting, containing, and treating contaminated groundwater in which arsenic exceeds FPDWS, thus preventing migration of contaminants beyond the source area and effecting mass removal in contaminated zones. Extracted groundwater would be treated before discharge to the FOTW. Institutional controls (the LURA) would prohibit domestic groundwater use.

Compliance with ARARs: Groundwater extraction and treatment complies with the chemical-specific ARARs developed in Section 2. The contaminated groundwater would be captured by extraction wells and treated, thereby removing groundwater exceeding arsenic's FPDWS. Groundwater removal from Site 15 is intended to reduce the mass of contaminants in the aquifer and contain the two contaminant plumes. The FOTW is subject to NPDES requirements and all FOTW effluent must meet these requirements.

Waste disposal standards for waste generated from the filtration system would be required; specific waste disposal ARARs depend on sludge characteristics. Both federal and Florida action-specific ARARs would be met by Alternative 4. Hazardous materials may be treated or stored onsite as a result of remedial activity and proper management of these materials in accordance with Florida Hazardous Waste Rules would be required. ARARs are presented in Appendix A.

Groundwater Recovery and Ex-Situ Treatment: Balancing Criteria

Long-term Effectiveness and Permanence: Groundwater extraction and treatment would contain contaminants and reduce arsenic concentrations through mass removal. Groundwater migration is expected to be arrested by the containment system. Groundwater extraction removes contaminants from the surficial zone and contains plume areas. This alternative effectively removes contaminant mass. Ex-situ groundwater treatment removes contaminants. Groundwater monitoring effectively documents changes in groundwater concentrations.

The projected remedial time to withdraw five pore volumes is five years. Risks to human health and the environment onsite are expected to decrease with time, as constituents are removed and treated. Extraction of arsenic contaminants from extracted groundwater is reliable and expected to be permanent. Saline intrusion resulting from groundwater extraction is not likely.

Reduction of Toxicity, Mobility, or Volume Through Treatment: This alternative removes/contains mass. Groundwater removal at Site 15 would reduce its toxicity and reduce the volume of contaminants.

Chemical and physical treatment are established technologies for removing arsenic contaminants through coagulation/precipitation and solids separation or ionic exchange. The arsenic contaminants would be separated in a sludge or concentrated liquid and disposed of offsite. Groundwater containment eliminates contaminant migration. This alternative reduces toxicity, mobility, or volume through treatment, and satisfies the statutory preference for treatment as a principal element. Additional treatment is also provided by the FOTW.

Over five years, Alternative 4 would extract an estimated 62.5 million gallons of groundwater which would be collected and discharged to the FOTW. Flow rate estimates, based on preliminary modeling, are 30 gpm for each of the two wells. Mass removal of non-naturally occurring arsenic in the surficial aquifer is expected to be permanent.

Short-Term Effectiveness: Adverse impacts to the surrounding environment are not anticipated during groundwater recovery and treatment system construction. The FOTW needs to accept discharge before implementation. After design plans are approved and testing is complete, the groundwater collection system would be constructed. Collection of five pore volumes is estimated to take five years.

Workers should be trained according to OSHA standards as required by 29 CFR 1910.120 to protect and mitigate risks during remedial construction. Field personnel contact with site contaminants would be minimal during construction (pump installation, control panel installation, and sanitary sewer connections.) Worker protection could be managed through use of appropriate PPE.

Compliance with RGs can be determined by monitoring site wells. System performance and mass removal can be evaluated by effluent monitoring. Alternative 4 would be compatible with any additional remedial actions, if required.

Implementability: Extracting contaminated groundwater from beneath the site and providing treatment is both technically and administratively feasible. This alternative would not require any extraordinary services, materials, specialists, or innovative technologies. Construction and operation could be achieved with minimal difficulty. Offsite disposal would be required for solids or concentrated liquids generated by ether arsenic treatment process. Implementation could begin immediately.

Cost:

Alternative 4 Groundwater Recovery

Direct and indirect costs associated with groundwater extraction for Alterative 4a and 4b are $98,000. Annual maintenance costs are expected to be $392,700 (including groundwater monitoring and FOTW discharge costs).

Alternative 4a Coagulation/Precipitation and Solids Septation Treatment

Direct and indirect capital costs for the physical/chemical treatment for Alterative 4a are $1,047,800. Annual operating costs are expected to be $207,500 with Subtitle D disposal, or $217,700 with Subtitle C disposal. The total present value of coagulation/precipitation and solids separation is $1,922,000 with Subtitle D disposal or $1,965,000 with Subtitle C disposal (assuming a 6% discount rate over five years).

The total present value cost of Alternative 4a is estimated to be $3,824,000 (including groundwater recovery, institutional controls, and the remedial action contractor cost) with Subtitle D disposal and $3,867,000 with Subtitle C Disposal.

Alternative 4b Ionic Exchange Treatment

Direct and indirect capital costs for the physical/chemical treatment for Alterative 4b are $551,000. Annual operating costs for treatment and disposal are expected to be $154,600. The total present value of ionic exchange including disposal is $1,218,200 (assuming a 6% discount rate over five years).

The total present value cost of Alternative 4b is estimated to be $3,105,000 (including groundwater recovery, institutional controls, and the remedial action contractor cost).

Groundwater Recovery and Ex-Situ Treatment: Modifying Criteria

State/Support Agency Acceptance: FDEP and the USEPA will have the opportunity to review and comment on this FS.

Community Acceptance: These criteria are generally not completed until after public comments on the RI/FS report and the proposed plan are received.

5.3 Evaluation of Soil Alternatives

The following sections present a detailed analysis of the soil alternatives presented in Section 4:

Soil Alternatives

Alternative 1: No Action
Alternative 2: Institutional Controls
Alternative 3: Limited Excavation to Industrial Scenario and Offsite Disposal
Alternative 4: Asphalt Cover with Institutional Controls and Limited Excavation

Each alternative is evaluated according to the nine criteria discussed in the previous section. Criteria have been divided into the three categories — threshold, balancing, and modifying.

5.3.1 Alternative 1: No Action

The no-action alternative for Site 15 involves no active remedial effort. No actions will be taken to contain, remove, or treat soil contamination that exceeds RGs. Soil will remain in place. No engineering or institutional controls will be implemented. The no-action alternative provides a baseline to which other alternatives can be compared.

No Action: Threshold Criteria

Overall Protection of Human Health and the Environment: The no-action alternative provides no additional protection of human health and the environment. Site 15 soil arsenic concentrations exceed RGs at 24 sample locations. Under the no-action scenario, these exceedances would remain.

Compliance with ARARs: Alternative 1 does not comply with the risk goals developed in Section 2 of this report; risk goals are ARARs under CERCLA. No location- or action-specific ARARs are triggered by the no-action alternative. Contaminated soil that exceed RGs would remain.

No Action: Balancing Criteria

The primary balancing criteria are the technical criteria on which the detailed analysis is based.

Long-term Effectiveness and Permanence: Long-term effectiveness of no-action is minimal. Soil volume and concentrations would remain unchanged. In addition, the no-action alternative does not reduce the magnitude of residual risk. This alternative lacks treatment actions that would provide permanence.

Any controls currently in place at the site — military security and limited access to the site and use of it — would remain. If use were unrestricted, no controls would be in place to protect potential receptor groups (i.e., residents).

Reduction of Toxicity, Mobility, or Volume Through Treatment: The no-action alternative would not reduce soil contaminant mobility, toxicity, or volume. Contaminants would remain untreated and in place.

Short-Term Effectiveness: Short-term effectiveness assesses an alternative's effect on human health and the environment while it is being implemented. There are no effects resulting from the no-action alternative

Implementability: The no-action alternative is technically feasible and easily implemented. No construction, operation, or reliability issues are associated with this alternative. Current access controls — including military security and limited personnel access to the site — have historically been reliable. No administrative coordination is required for the no-action alternative. Offsite services, materials, specialists, or innovative technologies are not required. There are no implementation risks associated with Alternative 1.

Cost: Costs associated with the no-action alternative include a review and report preparation every five years for 30 years. Each review and report are estimated to cost $10,000 with a present worth for the 30-year period of $24,400.

No Action: Modifying Criteria

The modifying criteria are assessed formally after the public-comment period. However, the criteria are factored into identifying the preferred alternatives, as far as they are known.

State/Support Agency Acceptance: FDEP and the USEPA will have the opportunity to review and comment on this FS.

Community Acceptance: These criteria are generally not completed until after public comments on the RI/FS report and the proposed plan are received.

5.3.2 Alternative 2: Institutional Controls

The institutional controls alternative for Site 15 involves no active remedial effort. No actions will be taken to contain, remove, or treat soil contamination that exceeds RGs. Soil would remain in place and institutional controls would be incorporated in the LURA to ensure Site 15 remains an industrial use area.

Institutional Controls: Threshold Criteria

Overall Protection of Human Health and the Environment: The institutional controls alternative provides additional protection of human health and the environment by reducing the potential for ingestion or contact with soil through institutional controls. However, soil arsenic concentrations at Site 15 exceed RGs. Under the institutional controls scenario, this soil would remain, but risks would be reduced by elimination of dermal contact and ingestion pathways that exist with uncontrolled access.

Compliance with ARARs: Alternative 2 does not comply with the risk goals developed in Section 2 of this report; risk goals are ARARs under CERCLA. No location- or action-specific ARARs are triggered by the institutional controls alternative. Contaminated soil would remain above the RGs.

Institutional Controls: Balancing Criteria

The primary balancing criteria are the technical criteria on which the detailed analysis is based.

Long-Term Effectiveness and Permanence: The long-term effectiveness of institutional controls is limited to the ability to control access to contaminated soil. The volume and concentrations of soil would remain unchanged. This alternative lacks treatment actions that would provide permanence.

Reduction of Toxicity, Mobility, or Volume Through Treatment: The institutional controls alternative would not reduce the mobility, toxicity, or volume of soil contaminants. Contaminants would remain untreated and in place onsite.

Short-Term Effectiveness: Short-term effectiveness assesses an alternative's effect on human health and the environment while it is being implemented. There are no short-term effects resulting from the institutional controls alternatives.

Implementability: The institutional controls alternative is technically feasible and easily implemented. No construction issues are associated with this alternative. Current access controls — including military security and limited personnel access to the site — have historically been reliable and will be supplemented through land use restrictions. Administrative coordination is required to implement institutional controls. Offsite services, materials, specialists, or innovative technologies would not be required. There are no implementation risks with Alternative 2.

Cost: Costs associated with institutional controls include soil monitoring and report preparation every five years for 30 years and the cost of establishing the institutional controls. Each sampling and reporting event is estimated to cost $10,000, with a present worth for the 30-year period of $24,400. Providing the necessary institutional controls is estimated to be a one-time cost of $50,000, for a total Alternative 2 cost of $74,400.

Institutional Controls: Modifying Criteria

The modifying criteria are assessed formally after the public-comment period. However, the criteria are factored into identifying the preferred alternatives, as far as they are known.

State/Support Agency Acceptance: FDEP and the USEPA will have the opportunity to review and comment on this FS.

Community Acceptance: These criteria are generally not completed until after public comments on the RI/FS report and the proposed plan are received.

5.3.3 Alternative 3: Limited Excavation to Industrial Scenario and Offsite Disposal

The primary element of this alternative is the excavation of soil contaminated above RGs from the site with disposal in an approved landfill. Land use is restricted to industrial to minimize uncontrolled exposure.

Limited Excavation to Industrial Scenario and Offsite Disposal: Threshold Criteria

Overall Protection of Human Health and the Environment: Excavation and offsite disposal protects human health and the environment by removing contaminated soil posing a risk above RGs. Risk to human health and the environment from contaminants exceeding the FDEP SCTL industrial threshold would be eliminated. Short-term risks from inhalation and dermal contact during implementation would be minimal, and could be controlled using common engineering techniques and use of PPE.

Excavation with offsite landfilling is one of two aggressive remedial actions proposed in this FS. The alternative could be easily implemented and protective of current and future site workers and the environment.

Compliance with ARARs: The excavation alternative would meet chemical-specific ARARs for the associated RGs which protect future industrial site workers. No location-specific ARARs would be triggered by this alternative.

Limited Excavation to Industrial Scenario and Offsite Disposal: Balancing Criteria

Long-Term Effectiveness and Permanence: The excavation alternative would remove the contaminated soil from the site and dispose of it in a permitted Subtitle D disposal facility. This alternative would eliminate risk from contaminants exceeding the FDEP SCTL industrial threshold. Soil remaining onsite would not threaten human health.

Excavation with disposal in an offsite landfill is a particularly reliable option, because soil would be removed from the site and onsite risks exceeding RGs would be eliminated. Some future liability might be incurred through disposal at a landfill.

Reduction of Toxicity, Mobility, or Volume Through Treatment: The excavation with disposal at an offsite landfill alternative would not satisfy this preference for treatment. Although it is anticipated that excavated soil is non-hazardous, TCLP analysis will be performed for verification.

Excavation would eliminate the source area and therefore, eliminate contaminants exceeding RGs. This alternative includes the removal of approximately 580 yd^3 of soil from the site which would be isolated in a secure landfill. Because the source would no longer remain onsite, excavation is considered permanent. Mobility, toxicity and volume would not be reduced and the preference for treatment would not be satisfied.

Short-Term Effectiveness: Excavation would be sufficiently removed from the public to reduce health and safety concerns associated with soil removal. Excavation workers would be exposed to increased particulate emissions and might also have more dermal contact with hazardous constituents. However, worker risks can be reduced by implementing dust control technologies and a site-specific health and safety plan that specifies PPE, respiratory protection, etc.

Implementability: Excavation with offsite landfilling is technically and administratively feasible at Site 15. Removal and offsite disposal have been commonly applied at previous sites. The only potential technical problems that might slow down removal activities are materials handling and disposal (standby time between confirmatory sampling and disposal). The soil volumes are relatively small (580 yd^3) and removal activities are anticipated to be easily implemented. Areas to be excavated are readily accessible. No future remedial actions would be required after this alternative is completed.

The excavation with disposal at an offsite landfill alternative would not require any extraordinary services or materials. The Perdido Landfill in Escambia County is a Class D facility and has accepted nonhazardous soil from interim removal actions on the base.

Cost: Detailed costs associated with Alternative 3 are presented in Section 4.3.3. Total direct costs for excavation and disposal at a Subtitle D facility are estimated to be $63,965. Indirect costs, including engineering and design (20%) and contingencies (25%), institutional controls ($50,000), and remedial action contractor costs ($100,000) are expected to increase total costs to $230,000. No O&M costs are associated with this alternative.

Limited Excavation to Industrial Scenario and Offsite Disposal: Modifying Criteria

State/Support Agency Acceptance: FDEP and the USEPA will have the opportunity to review and comment on this FS.

Community Acceptance: These criteria are generally not completed until after public comments on the RI/FS report and the proposed plan are received.

5.3.4 Alternative 4: Asphalt Cover with Institutional Controls and Limited Excavation

This alternative uses a physical barrier to cover the two large areas of contaminated soil to eliminate dermal and ingestion pathways. Land use is restricted to industrial to minimize uncontrolled exposure. Isolated areas of contamination will be excavated to eliminate the source.

Asphalt Cover with Institutional Controls and Limited Excavation: Threshold Criteria

Overall Protection of Human Health and the Environment: The asphalt cover would eliminate the threat of dermal and ingestive contact for current and future site workers. Contaminated soil would be left onsite indefinitely and the cover will be maintained to ensure adequate protection. Excavation and offsite disposal protects human health and the environment by removing contaminated soil.

This alternative would protect human health and the environment by physically eliminating receptor pathways and controlling access through land use restrictions. Cover construction and maintenance would be easily implemented and current site controls (site security, access control, and fencing) and the LURA would be adequate to ensure minimal disturbance of onsite covers. Short-term risks from inhalation and dermal contact during implementation would be minimal, and could be controlled using common engineering techniques and use of PPE.

Compliance with ARARs: The asphalt cover with institutional controls and limited excavation alternative would comply with the chemical-specific ARAR proposed as an RG for future industrial workers to protect human health. The potential for contact with soil in which contaminants exceed the FDEP SCTL industrial threshold is eliminated by removing the primary pathways and sources.

The cover would isolate or eliminate contaminants exceeding RGs in environmental media, but not manage solid or hazardous waste. Site grading would need to comply with federal, state, and local air emissions and storm water control regulations. The asphalt cover and limited excavation would not trigger any location-specific ARARs.

Asphalt Cover with Institutional Controls and Limited Excavation: Balancing Criteria

Long-Term Effectiveness and Permanence: An asphalt cover would effectively reduce site worker dermal or ingestive contact with contaminated soil. It would require observation and maintenance; soil covers are generally reliable containment controls. If the soil cover failed, site workers could be exposed; however, repairs could be made to re-establish the cover's integrity. Excavation would remove contaminated soil and eliminate risk exceeding the FDEP SCTL industrial threshold.

This alternative eliminates residual risk to site workers by managing Site 15 as an industrial site and restricting land use. The use of these covered soil areas would be controlled institutionally.

Excavation eliminates risk through contaminated source removal. Some future liability might be incurred through disposal at a landfill.

Reduction of Toxicity, Mobility, or Volume Through Treatment: Constructing an asphalt cover at Site 15 would not remove, treat, or remediate the contaminated soil; it provides containment only. Excavation would remove contaminated soil but would not provide treatment. The asphalt cover is considered reversible, because contaminants exceeding RGs under the asphalt cover would remain onsite; if the cover fails because of poor maintenance, contaminants may be exposed. Excavation is considered permanent since the source does not remain onsite. This alternative would not reduce toxicity, mobility, or volume through treatment, nor would it satisfy the statutory preference for treatment.

Short-Term Effectiveness: Adverse impacts to the surrounding environment are not anticipated during cover construction; engineering controls would be applied to manage storm water runoff and siltation. Once design plans are approved, actual cover construction would be expected to take less than one month. During construction of the two covers, there would be a risk of dermal or ingestive contact to construction workers; however, this risk would be reduced by proper removal practices and use of PPE. During excavation, workers would be exposed to increased particulate emissions and might have more dermal contact with hazardous constituents. However, worker risks can be controlled through the use of dust control technologies and PPE.

Implementability: An asphalt cover with institutional controls and limited excavation is technically and administratively feasible. This alternative could be readily applied at the site, given that the proposed areas to be covered or excavated are easily accessible to site workers and current access controls have been reliable and will be supplemented through the LURA. Thus, implementing this alternative would merely involve placement of the cover, implementation of the LURA, and excavation and soil removal. Future monitoring and maintenance would involve visually inspecting the cover periodically and repairing any damage or degradation. However, repairs are easily implemented. Soil covering would not require any extraordinary services or materials. Offsite disposal would be required for excavated soil.

Cost: Costs associated with this alternative are detailed in Section 4.3.4. The cost of constructing the cover is $86,480 including 20% for engineering and design costs and an additional 25% for contingencies. Annual inspection and maintenance costs are $4,900 each year. The estimated present worth for 30 years of inspections and maintenance, is $67,450, with a discount rate of 6%. Costs associated with institutional controls are $50,000 and excavation and disposal costs are estimated at $28,145. The total cost for Alternative 4 including the cover, institutional controls, excavation, and corrective active contractor costs is $332,300.

Asphalt Cover with Institutional Controls and Limited Excavation: Modifying Criteria
State/Support Agency Acceptance: FDEP and the USEPA will have the opportunity to review and comment on this FS.

Community Acceptance: These criteria are generally not completed until after public comments on the RI/FS report and the proposed plan are received.

6.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

Once the alternatives have been fully described and individually assessed against the nine criteria, each alternative's performance relative to the evaluation criteria is assessed. This section highlights differences between alternatives for each of the criteria, especially the balancing criteria. The focus should help determine which options are cost-effective and which remedy uses permanent solutions and treatment to the maximum extent practicable. Groundwater alternatives are assessed separately from soil alternatives, consistent with previous sections of this FS.

6.1 Comparative Analysis of Groundwater Alternatives

The comparative analysis examines potential advantages and disadvantages of each alternative according to the nine criteria. All the alternatives evaluated in Section 5.2 are implementable and have been developed and used at other sites. All alternatives, except no action, are protective of human health and the environment. State and community acceptance will be determined in the same manner for each alternative. The key criteria that distinguish the alternatives focus on long- and short-term effectiveness, cost, compliance with ARARs, and reduction of mobility, toxicity, and volume.

6.1.1 Threshold Criteria

Alternatives considered for selection must comply with the threshold criteria, overall protection of human health and the environment, and compliance with ARARs.

Overall Protection of Human Health and the Environment

This criterion evaluates the overall degree of protectiveness afforded to human health and the environment. It assesses the overall adequacy of each alternative.

Protection of Human Health: As discussed in Section 5.2, groundwater contaminants exceeded federal and state drinking water standards, posing a potential risk to future receptors. Because site groundwater is not used as a potable source, no current pathways exist. Potential for future groundwater consumption exists, but is unlikely.

If the Sand-and-Gravel Aquifer were tapped as a potable source, Alternative 1, no action, does not protect future site workers. Exposure to shallow/intermediate groundwater presents a potential risk and hazard by the ingestion of groundwater in which arsenic exceeded FPDWS.

Alternative 2, monitoring natural processes/institutional controls, protects future site workers through institutional controls. In this alternative, groundwater degrades under natural processes and FPDWS can be attained. Also, in this alternative ingestion exposure is unlikely because future exposure will be eliminated through institutional controls.

Alternative 3, groundwater recovery and discharge to the FOTW, and Alternative 4, groundwater recovery and ex-situ treatment, prevent potential groundwater migration through containment. In these alternatives, attainment of groundwater FPDWS is possible. Alternatives 3 and 4 would protect human health by containment and contaminant mass removal. Institutional controls would eliminate the groundwater consumption pathway.

Protection of the Environment: In the ecological risk assessment for Site 15's Final Remedial Investigation Report, no receptor species of special concern were found within the area of Site 15. Also, transport of groundwater contaminants to surface water receptors is negligible and concentrations detected during the RI are lower than established effects levels.

Compliance with ARARs

There are no remediation processes in Alternatives 1 and 2 other than natural mechanisms; final compliance with ARARs is possible, but remedial time frames are not quantifiable at this time. Alternative 2 evaluates compliance feasibility. Alternatives 3 and 4 actively address groundwater exceeding FPDWS and attempt to meet FPDWS through mass removal and containment. Compliance with action- and location-specific ARARs for the four alternatives is anticipated.

6.1.2 Primary Balancing Criteria

Five primary balancing criteria typically highlight the major differences between alternatives. These criteria include: long-term effectiveness and permanence; reduction of toxicity, mobility, and volume through treatment; short-term effectiveness; implementability; and cost.

Long-Term Effectiveness and Permanence

The long-term effectiveness and permanence criterion assesses the results of a remedial action by the risk remaining onsite, particularly the magnitude of remedial risk and the adequacy and reliability of controls.

Magnitude of Residual Risk: Long-term effectiveness for Alternatives 1 and 2 is based on natural processes, which may or may not achieve FPDWS. The actual site risks are minimal for Alternative 1 because the aquifer is not used as a drinking water source. Site contaminants would naturally dissipate; these mechanisms are permanent. Land use restrictions in Alternative 2, 3 and 4 eliminate the potential for use of the aquifer as a drinking water source. Alternatives 3 and 4 contain groundwater and would remove bulk groundwater contamination; groundwater contamination is mitigated by attempting to remove contaminant mass, and thus reduce residual risk.

Adequacy and Reliability of Controls: Controls inherent to Site 15 include limited access, security provided by military personnel, and institutional controls. If Site 15 remains a part of NAS Pensacola, these controls will remain. With institutional controls in alternatives 2, 3, and 4, Site 15 is expected to remain an industrial facility and would require no further action to protect human health.

Alternatives 3 and 4 provide more reliable controls than no-action and monitored natural processes. Groundwater extraction and treatment would reduce the threat to current and future workers by containment and mass removal.

Reduction of Toxicity, Mobility, and Volume through Treatment

Alternatives 1 and 2 do not reduce contaminant toxicity, mobility, or volume through treatment other than by natural mechanisms. Alternative 3 and 4 reduce contaminant mobility and volume through extraction and reduce extracted groundwater toxicity by treatment.

Short-Term Effectiveness

No short-term effectiveness issues are associated with Alternatives 1 or 2, except for the ability to implement groundwater use restrictions. Alternatives 3 and 4's short-term issues include exposure to workers, which can be controlled using engineering controls, and use of correct PPE during well installation or treatment system operations. Duration of field activities for these alternatives is relatively short (less than 6 months).

Remedial time frames for Alternatives 1 and 2 are essentially none since remedial actions are not included. Groundwater removal in Alternatives 3 and 4 is estimated to take approximately 5 years.

Implementability

All four alternatives are implementable at Site 15. Each alternative is administratively feasible. Discharge permitting with the FOTW will need to be completed before Alternatives 3 and 4 can be implemented. Each alternative is technically feasible.

Cost

Capital (direct and indirect), O&M, and net present worth costs for all four alternatives are presented in Table 6-1, Groundwater Alternatives Cost Comparison. Alternatives range in cost from $24,400 to almost $3,900,000 for treatment and disposal.

6.1.3 Modifying Criteria

These criteria, which will be evaluated in detail following comments on the FS report and the proposed plan, will be addressed when a final decision is being made and the record of decision (ROD) is being proposed.

6.2 Comparative Analysis of Soil Alternatives

This section compares soil remedial alternatives, examining potential advantages and disadvantages according to each of the nine criteria. The alternatives evaluated in Section 5.3 are technically feasible, implementable, and have been developed and used at other sites. The alternatives generally protect human health and, except no action, protect the environment. State and community acceptance will be determined in the same manner for each alternative. The key criteria that distinguish among the soil alternatives are long-term effectiveness, short-term effectiveness, reduction of mobility, toxicity, and volume, cost, and compliance with ARARs. Impacts to adjacent wetlands, Bayou Grande, and the tidal pond will be assessed in the Site 41 study.

6.2.1 Threshold Criteria

All alternatives considered for selection must comply with the threshold criteria, overall protection of human health and the environment, and compliance with ARARs.

Table 6-1
Groundwater Alternatives Cost Comparison

Cost Element	Alternative 1	Alternative 2	Alternative 3	Alternative 4a Subtitle D	Alternative 4a Subtitle C	Alternative 4b
Capital	None	$103,000	$98,000	$1,296,000	$1,296,000	$799,000
Annual O&M	$ 10,000 (every 5 years)	$39,000 (every year for 30 years)	$84,300 (for 5 years)	$600,300 (for 5 years)	$610,500 (for 5 years)	$547,340 (for 5 years)
Net Present Worth	$24,400	$740,000	$603,000	$3,824,000	$3,867,000	$3,105,000

Overall Protection of Human Health and the Environment

This criterion evaluates the overall degree of protectiveness afforded to human health and the environment. It assesses the overall adequacy of each alternative.

Protection of Human Health: As discussed in Section 5.3, risk and/or hazard to human health exists at certain areas of surface soil at Site 15. These areas are not covered and create a potential exposure pathway to site workers by dermal contact and ingestion.

Alternative 1, no action, does not provide adequate protection of human health. Exposure to surface soil presents an unacceptable risk and hazard via the dermal and ingestion exposure pathways with uncontrolled land use. Alternative 2, institutional controls, protects residential receptors by preventing residential land use. Both alternatives leave soil exceeding RGs on site.

Alternative 3 protects human health through the removal of affected soil media. The cap in Alternative 4 protects human health through containment and land-use restrictions and prevents completion of dermal and ingestion pathways. Isolated "hot spots" are removed in Alternative 4.

Protection of the Environment: According to the ERA conclusions, there are no ecological risks at Site 15 and no species or habitats are threatened by soil contamination.

Compliance with ARARs

Alternatives 1 and 2 do not comply with RGs for protection of human health and the environment. However, Alternative 3 removes affected surface soil. Alternative 4 complies with RGs for protection of human health and environment because the risk pathway is eliminated by a cap or affected soil is removed. Compliance with action- and location- specific ARARs for Alternatives 3 and 4 is anticipated.

6.2.2 Primary Balancing Criteria

Five primary balancing criteria typically highlight the major differences between alternatives. These criteria include: long-term effectiveness and permanence; reduction of toxicity, mobility, and volume through treatment; short-term effectiveness; implementability; and cost.

Long-Term Effectiveness and Permanence

The long-term effectiveness and permanence criterion assesses the results of a remedial action in risk remaining onsite, particularly the magnitude of remedial risk, and the adequacy and reliability of controls.

Magnitude of Residual Risk: Risk above RGs remain in both Alternatives 1 and 2. Alternatives 3 and 4 eliminate site risk above RGs through removing contaminated soil and/or eliminating pathways to receptors.

Adequacy and Reliability of Controls: Controls inherent to Site 15 include limited access, security provided by military personnel, and institutional controls. Site 15 is expected to remain a part of NAS Pensacola and these controls will remain. In Alternatives 2, 3, and 4, Site 15 is expected to remain an industrial facility in accordance with the LURA and would require no further action to protect human health.

Alternatives 3 and 4 provide more reliable controls than the no-action and institutional controls alternatives. In addition to eliminating residential risk through institutional controls, soil removal and disposal (Alternative 3) would reduce the threat to future workers by mass removal and an asphalt cover with limited soil removal (Alternative 4) would reduce the threat to future workers by elimination of exposure routes and mass removal.

Reduction of Toxicity, Mobility, and Volume through Treatment

Alternatives 1 and 2 do not reduce the toxicity, mobility, or volume of contaminants through treatment. Alternative 3 and the "hot spot" excavation of Alternative 4 reduce toxicity, mobility, and volume of contaminants through mass removal.

Short-Term Effectiveness

No short-term effectiveness issues are associated with Alternatives 1 or 2. Alternatives 3 and 4 short-term issues include exposure to workers, which can be controlled using engineering controls and correct PPE during excavation or cap installation. Remedial time frames for these alternatives is relatively short (less than six months).

Implementability

All four alternatives are implementable at Site 15 and are technically and administratively feasible.

Cost

Capital (direct and indirect), O&M, and net present worth for all four alternatives are presented in Table 6-2, Soil Alternatives Cost Comparison. Alternatives range in cost from less than $24,400 for reviews associated with the no-action alternative to over $330,000 for a cover, institutional controls, and limited excavation.

Table 6-2
Soil Alternatives Cost Comparison

Cost Element	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Capital	None	$50,000	$230,000	$264,800
Annual O&M	$10,000 (every 5 years)	$10,000 (every 5 years)	None	$4,900 (every year for 30 years)
Net Present Worth	$24,400	$74,400	$230,000	$332,300

6.2.3 Modifying Criteria

These criteria, which will be evaluated in detail following comments on the FS report and the proposed plan, will be addressed when a final decision is being made and the ROD is being proposed.

7.0 REFERENCES

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8.0 FLORIDA PROFESSIONAL GEOLOGIST SEAL

I have read and approve of this Feasibility Study Report at NAS Pensacola Site 15 and seal it in accordance with Chapter 492 of the Florida Statutes. In sealing this document, I certify the geological information contained in it is true to the best of my knowledge and the geological methods and procedures included herein are consistent with currently accepted geological practices.

Name:	Brian E. Caldwell
License Number:	#1330
State:	Florida
Expiration Date:	July 31. 2000

Brian E. Caldwell

Date

9.0 FLORIDA PROFESSIONAL ENGINEER'S SEAL

I am registered to practice engineering by the Florida State Board of Professional Examiners (License No. 50413). I certify, under penalty of law, that the Feasibility Study for Naval Air Station Pensacola Site 15 was performed in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. To the best of my knowledge and belief, the information submitted is true, accurate, and complete; and the contents of this document are consistent with currently accepted engineering practices. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Elizabeth Claire Barnett
Elizabeth Claire Barnett

8-10-98
Date
License Expires February 28, 1999

Appendix A

Applicable or Relevant and Appropriate Requirements

Table A-1
Summary of Potential Chemical-Specific ARARs
NAS Pensacola Site 15

Requirements	Status	Requirement Synopsis	Application to the RI/FS
Federal Requirements			
Safe Drinking Water Act MCLs 40 CFR 141.11 - 141.16	Relevant and Appropriate	MCLs have been set for toxic compounds as enforceable standards for public drinking water systems. SMCLs are unenforceable goals regulating the aesthetic quality of drinking water.	The surficial zone of the Sand-and-Gravel-Aquifer is a potential, although unlikely, source of drinking water. Some contaminants in the plume below Site 15 are above MCLs and SMCLs.
Safe Drinking Water Act MCLGs 40 CFR 141.50-141.51	Relevant and Appropriate	MCLGs are unenforceable goals under the SDWA.	The surficial zone of the Sand-and-Gravel-Aquifer is a potential, although unlikely, source of drinking water. Some contaminants in the plume below Site 15 are above MCLGs.
State Requirements			
Florida Drinking Water Standards, Monitoring, and Reporting Title 62 Chapter 62-550	Relevant and Appropriate	Establishes Primary and Secondary MCLs for drinking water.	The surficial zone of the Sand-and-Gravel-Aquifer is a potential, although unlikely, source of drinking water. Some contaminants in the plume below Site 15 are above the state MCLs and SMCLs.
Florida Soil Cleanup Goals (09-25-95, updated 01-19-96)	To Be Considered	Establishes soil cleanup limits for Florida	Should be considered when setting remediation objectives. The goals are not promulgated.
Florida Ground Water Classes, Standards and Exemptions, Title 62, Chapter 62-520	Applicable	Establishes drinking water standards for drinking water aquifers	The surficial zone of the Sand-and-Gravel-Aquifer is a potential, although unlikely, source of drinking water. Some contaminants in the plume below Site 15 are above the state MCLs and SMCLs

Table A-2
Summary of Potential Location Specific ARARs
NAS Pensacola Site 15

Requirements	Status	Requirement Synopsis	Application to the RI/FS
Federal Requirements			
Executive Order 11988 Floodplain Management Policy	To Be Considered	Establishes guidelines for activities conducted within a 100-year floodplain.	Site 15 is located within a 100-year floodplain.
Procedures for Implementing the Requirements of the National Environmental Policy Act 40 CFR Part 6, Appendix A	Applicable	Sets forth EPA policy carrying out the provisions of Executive Order 11988, Floodplain Management Policy, and Executive Order 11990, Wetlands Protection Policy.	Site 15 is located within a 100-year floodplain. Remediation activities may disturb these areas.
RCRA Location Requirements 40 CFR 264.18	Relevant and Appropriate	Sets forth minimum requirements for design, construction, and operation of a facility where treatment, storage, or disposal of hazardous waste will be within a 100-year floodplain.	Treatment, disposal, and storage of hazardous materials may occur during groundwater treatment Alternative 4.
Executive Order 11988 Floodplain Management Policy	To Be Considered	Establishes guidelines for activities conducted within a 100-year floodplain.	Site 15 is within a 100-year floodplain.
National Environmental Policy Act 40 CFR Part 6, Appendix A	Applicable	Sets forth EPA policy carrying out the provisions of Executive Order 11988, Floodplain Management Policy, and Executive Order 11990, Wetlands Protection Policy.	Site 15 is within a 100-year flood. Remediation activities may disturb these areas.
Fish and Wildlife Coordination Act (16 U.S.C. 661 et seq.) 40 CFR 6.302	Applicable	Requires actions to protect fish and wildlife from actions modifying streams or areas affecting streams including floodplain areas.	Site 15 is located within a 100-year flood. Remediation activities may disturb these areas.
State Requirements			
Florida Hazardous Waste Rules Title 62 Chapter 62-730	Relevant and Appropriate	Sets forth minimum requirements for design, construction, and operation of a facility where treatment, storage, or disposal of hazardous waste will be within a 100-year floodplain	Treatment, disposal, and storage of hazardous wastes may occur during groundwater treatment Alternative 4. Site 15 is in the 100-year floodplain.

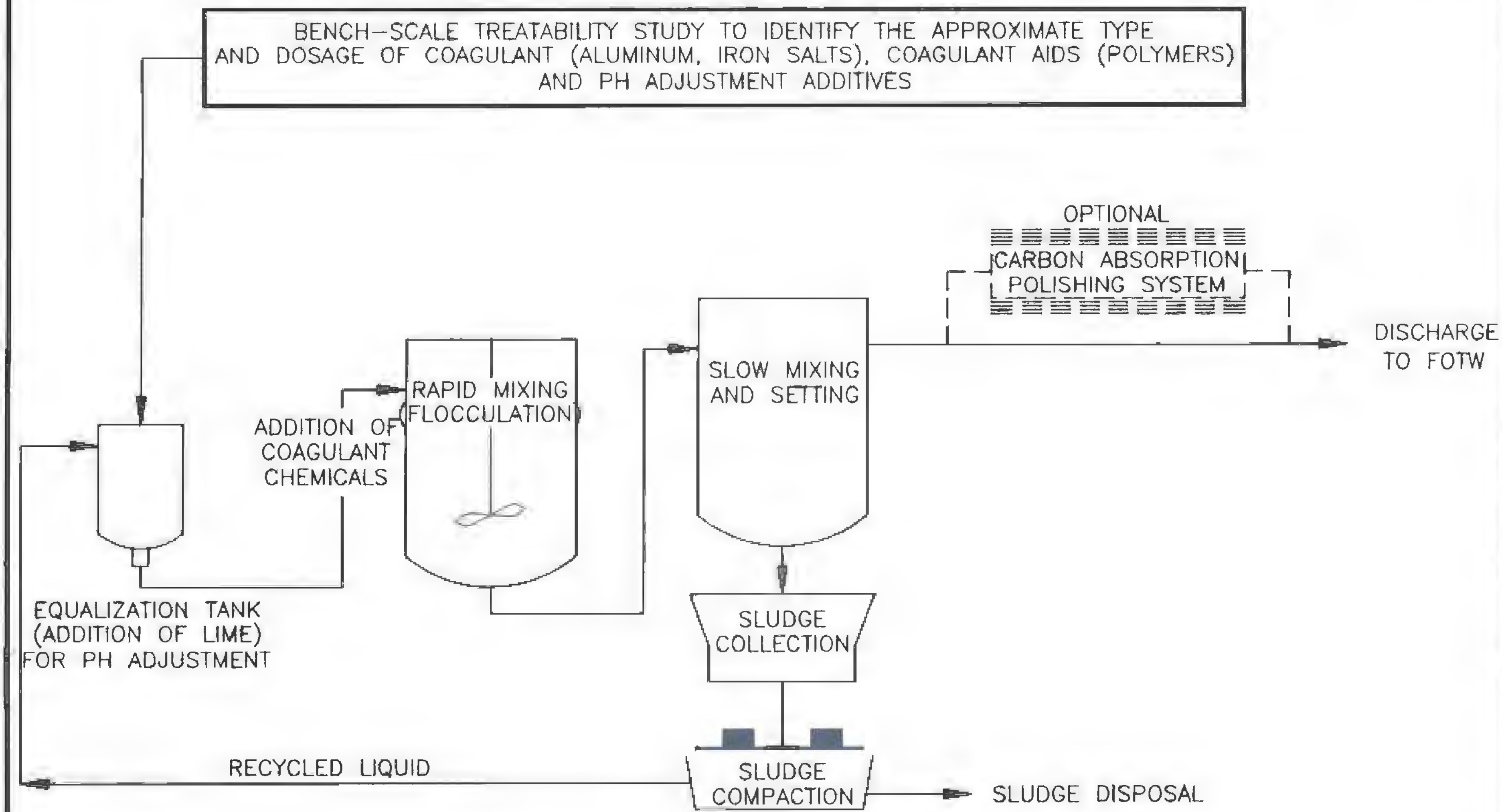
Table A-3
Summary of Potential Action Specific ARARs
NAS Pensacola Site 15

Requirements	Status	Requirement Synopsis	Application to the RI/FS
Federal Requirements			
Clean Water Act National Pollutant Discharge Elimination System (NPDES) 40 CFR 122, 125, 129, 136	Applicable	Prohibits unpermitted discharge of any pollutant or combination of pollutants. Standards and limitations are established for discharges to waters of the U.S. from any point source. Requirements for best available technology (BAT) to control toxic pollutants, best conventional pollution control technology (BCT) for conventional pollutants, and best management practices (BMP) to prevent releases of toxic pollutants are established.	Remedial actions may include the discharge of treated groundwater, storm water runoff, or other flows to a surface water. If required, groundwater will be discharged to the FOTW, which operates under an NPDES permit.
Clean Water Act General Pretreatment Regulations for Existing and New Sources of Pollution 40 CFR 403	Relevant and Appropriate	Establishes the limits for the discharge of pollutants to publicly owned treatment works and the requirement for pretreatment if applicable.	Remedial actions may include the discharge of treated groundwater, runoff, or other flows to a POTW The FOTW may establish pretreatment limits.
Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) of 1972, 7 U.S.C. 136 (1972), as amended by Act of August 3, 1996.	Applicable	Establishes requirement for use of treatment chemicals for grass treatment and pest control.	Applicable to all site actions.
State Requirements			
Florida Rules on Permits Title 62 Chapter 62-4	Relevant and Appropriate	Establishes requirements and procedures for all permitting required by the FDEP, and defines anti-degradation requirements.	Requirements may be relevant and appropriate to site depending upon remedial actions and discharge options selected.
Florida Stormwater Discharge Regulations Title 62 Chapter 62-25	Applicable	Establishes design and performance standards and permit requirements for stormwater discharge facilities.	Remedial actions may impact stormwater discharge patterns at Site 15.
Florida Hazardous Waste Rules Title 62 Chapter 62-730	Applicable	Establishes standards applicable to owners and operators of hazardous waste treatment, storage and disposal facilities.	May apply to groundwater sludge handling

Table A-3
Summary of Potential Action Specific ARARs
NAS Pensacola Site 15

Requirements	Status	Requirement Synopsis	Application to the RI/FS
State Requirements (Continued)			
Florida Water Well Permitting and Construction Title 62 Chapter 62-532	Applicable	Establishes local criteria for design and installation of monitoring wells.	Installation of monitoring wells may be a necessary part of site remediation given any alternative
Florida Hazardous Substance Release Notification Rules Title 62 Chapter 62-150	Applicable	Establishes notification requirements in the event of a hazardous substance release	May be applicable if a hazardous substance is released in conjunction with remedial activities.
Florida Industrial Waste Water Facilities Title 62 Chapter 62-660	To Be Considered	Establishes the policy to encourage an applicant to study and evaluate treatment alternative techniques and to discuss alternatives with the FDEP	Applicable if remedial actions generate waste waters to be treated on site prior to discharge to the navigable water ways of the U.S. by an NPDES permit.
Florida Water Quality Based Effluent Limitations Title 62 Chapter 62-650	Relevant and Appropriate	Establishes the requirements for the characterization of the effluent to be discharged from by an effected discharger.	Applicable if remedial actions generate waste waters to be treated on site prior to discharge to the navigable water ways of the U.S. by an NPDES permit.
Florida Pretreatment Requirements for Existing and New Sources of Pollution Title 62 Chapter 62-625	Relevant and Appropriate	Establishes the requirements for pretreatment of waste waters prior to discharge to a publicly owned treatment works (POTW).	The FOTW may establish pretreatment limits
Florida Waste Water Facility Permitting Title 62 Chapter 62-620	Applicable	Establishes the procedure to obtain a permit to construct, modify, or operate a domestic or industrial waste water facility.	Applicable if remedial actions generate waste waters to be treated on site prior to discharge to the navigable water ways of the U.S.

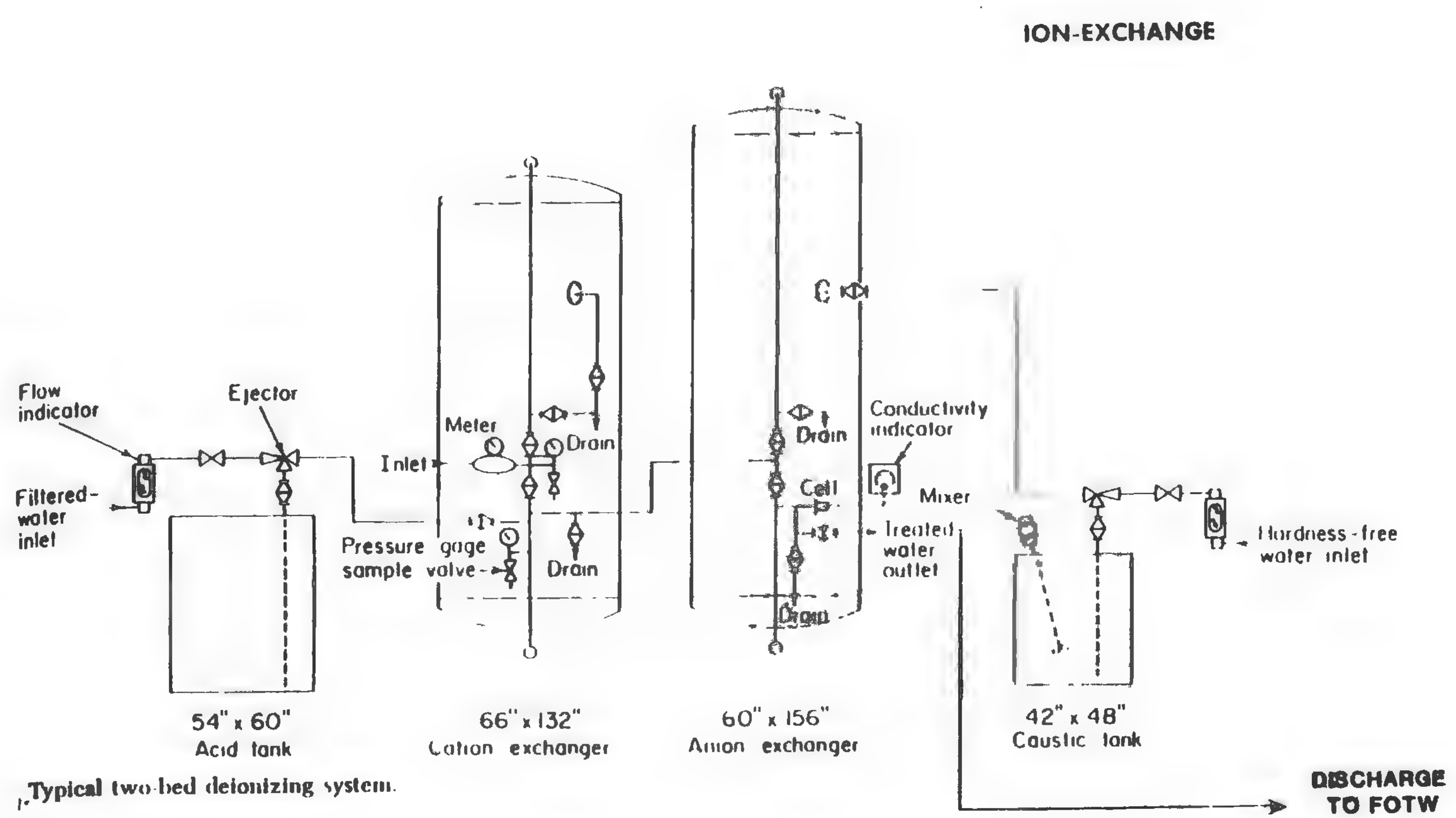
Appendix B
Process Flow Diagrams



FEASIBILITY STUDY REPORT
SITE 15
NAS PENSACOLA

FIGURE B-1
COAGULATION/PRECIPITATION
CONCEPTUAL PROCESS FLOW DIAGRAM

DWG DATE: 04/09/98 | DWG NAME: 0071T001



FEASIBILITY STUDY REPORT
SITE 15
NAS PENSACOLA

FIGURE B–2
IONIC EXCHANGE
CONCEPTUAL PROCESS FLOW DIAGRAM

DWG DATE: 04/09/98 | DWG NAME: 0071T002