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Final

Feasibility Study
Site 21, Bronson Road Landfill

Naval Support Facility, Indian Head
Indian Head, Maryland

Contract Task Order 122

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Prepared by

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Executive Summary

This report presents the Feasibility Study (FS) for Site 21, Bronson Road Landfill, at the Naval Support Facility, Indian Head (NSF-IH) in Indian Head, Maryland. This FS report is prepared by CH2M HILL under the Naval Facilities Engineering Command, Atlantic Division (LANTDIV), Comprehensive Long-Term Environmental Action Navy (CLEAN) II Contract No. N62470-95-D-6007, Contract Task Order (CTO) 0122, for submittal to the United States Navy (Navy), the United States Environmental Protection Agency (USEPA), and the Maryland Department of the Environment (MDE).

This study uses information gathered from various investigations conducted by CH2M HILL at Site 21 to document the analyses and evaluations used to develop remedial action objectives (RAOs) and alternatives for the site. The information presented herein will be used by the Navy and regulatory agencies to select a remedial alternative (RA) for the site that complies with the requirements of the National Contingency Plan (NCP).

Several potential RAs that would be suitable to address the RAOs were selected and evaluated based on the criteria set forth in the NCP to assemble and evaluate technical and policy considerations and to develop the rationale for selecting a remedy for Site 21. The RAs considered for Site 21 are provided in the table below.

TABLE ES-1
Proposed Remedial Action Alternatives
Feasibility Study
Site 21 Bronson Road Landfill
NSF-IH, Indian Head, Maryland

Alternative 1:	No Action: This alternative is required by the NCP as a baseline. Alternative 1 involves no planned actions. NSF-IH is an active Navy installation that has existing institutional controls in place. In addition, to a certain extent, the existing fill material may provide containment of and prevent exposure to waste in the landfill area.
Alternative 2:	Protective Soil Cover, Land Use Controls (LUCs), and Groundwater Monitoring: This alternative involves retrofitting activities for the existing soil cover, including soil cover repair, landscape re-grading for water infiltration and runoff management, in conjunction with LUCs. LUC measures include land-use restrictions and long-term monitoring for shallow groundwater water quality and off-site migration.
Alternative 3:	Resource Conservation and Recovery Act of 1976 (RCRA) C Cap, LUCs, and Groundwater Monitoring: This alternative involves installation of a RCRA Subtitle C Cap in conjunction with LUCs and long-term monitoring program similar to Alternative 2.
Alternative 4:	Excavation and Off-site Disposal: This alternative involves excavation of the solid waste and contaminated soil within the landfill area and off-site disposal.

TABLE ES-2
Comparative Analysis of Remedial Alternatives
Feasibility Study
Site 21 Bronson Road Landfill
NSF-IH, Indian Head, Maryland

Evaluation Criteria	Alternative 1 No Action	Alternative 2 Protective Soil Cover and LUCs	Alternative 3 RCRA Equivalent Cap and LUCs	Alternative 4 Excavation and Off-Site Disposal
Overall Protection of Human Health and the Environment	Not protective of human health and the environment	Adequate protection of human health and the environment. Exposures prevented by cover.	Adequate protection of human health and the environment. Effectively prevent solid waste and COCs from entering potential exposure pathways.	Adequate protection of human health and the environment because solid waste and contaminated soil would be removed from the site.
Compliance With applicable or relevant and appropriate requirement (ARARs)	Non compliant	In compliance with chemical-, location-, and action-specific ARARS, with the exception of Code of Maryland Regulation (COMAR) 26.04.07.21 – Industrial Sanitary Landfill Closure requirements, a state ARAR that requires an impermeable cap to be installed for the closure of an industrial landfill. However, a waiver can be issued if a soil cover is applicable.	Would comply with chemical-specific ARARs within a short amount of time (less than 6 months) and in compliance with location- and action-specific ARARS.	Would comply with chemical-specific ARARs within a short amount of time (less than 6 months) and in compliance with location- and action-specific ARARS.
Long-Term Effectiveness and Permanence	Not effective and permanent alternative. Magnitude of residual risk would remain unchanged. Adequacy and reliability of controls are very poor.	The risk to potential human and ecological receptors from the waste and contaminated soil would be reduced as long as the integrity of the cover is maintained.	The risk to potential human and ecological receptors from the waste and contaminated soil would be eliminated as long as the integrity of the cover is maintained. Provide better long-term adequacy and reliability of controls than Alternative 2 because RCRA cap is more impermeable than a soil cover.	The risk to potential human and ecological receptors from the waste and contaminated soil would be eliminated because the contamination is removed from the site. Therefore, the magnitude of residual risk would diminish significantly within shorter time frame.
Reduction of Toxicity, Mobility, or Volume Through Treatment	None	No reduction in toxicity or volume of contaminants. Adequately reduce the mobility of contaminants through containment.	No reduction in toxicity or volume of contaminants. Adequately reduce the mobility of contaminants through containment.	Reduction of toxicity, mobility, and volume through removal not treatment.
Short-Term Effectiveness	No impact to community, workers, and the environment form remedial activities because this alternative involves no active actions. Will not achieved RAOs.	Impacts to the remediation workers and community during the construction activities (primarily earthwork) are low to moderate can be minimized or potentially eliminated with proper planning and safe practices. RAOs be achieved within 6 months.	Impacts to the remediation workers and community during the construction activities (primarily earthwork) are moderate but can be minimized with proper planning and safe practices. RAOs be achieved within 6 months.	Impacts to the remediation workers and community during the construction activities (primarily earthwork and off-site transportation) are greatest but can be minimize with proper planning and safe practices. RAOs be achieved within 6 months.
Implementability	Has no ability to monitor the effectiveness of this remedy.	Easily implemented but requires long-term administrative commitment.	Easily implemented but requires long-term administrative commitment.	Easily implemented and does not require long-term administrative commitment because long-term monitoring and LUCs would likely not be required. Approval from other agencies is unlikely.
Cost[1]	$0	Capital: $710,000 Lifetime Present Worth Operation and Maintenance (O&M): $449,000 Total Present Worth: $1.15 million.	Capital: $1.5 million Lifetime Present Worth O&M: $639,000 Total Present Worth: $2.1 million	Capital: $14.75 million Lifetime Present Worth O&M: - Total Present Worth: $14.75 million
State and Community Acceptances	To Be Determined	To Be Determined	To Be Determined	To Be Determined
General Comment			Provide a conservative scenario in terms of the protectiveness of human health and the environment and the long-term effectiveness and permanence. However this benefit is marginal compared to Alternative 2 because portions of the solid waste is in contact with groundwater, therefore contribution of leachate to groundwater contamination may be small.	Provide the most conservative worst-case scenario, the benefits in terms of the protectiveness of human health and the environment and the long-term effectiveness and permanence is very marginal compared to Alternatives 2 and 3.

1 Cost estimate was performed in 2004, however for the FS cost comparison purposes, this estimate is still considered adequate.

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Acronyms and Abbreviations

AA	area of attainment
ARAR	applicable or relevant and appropriate requirement
bgs	below ground surface
CAMU	corrective action management unit
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	Code of Federal Regulations
CLEAN	Comprehensive Long-Term Environmental Action Navy
COC	contaminant of concern
COMAR	Code of Maryland Regulation
CTO	contract task order
ER	electric resistivity
FRTR	Federal Remediation Technology Roundtable
FS	feasibility study
GIS	Geographical Information System
HELP	Hydrologic Evaluation of Landfill Performance
HHRA	human health risk assessment
HI	hazard index
HQ	hazard quotients
IC	institutional control
ILCR	incremental lifetime carcinogenic risk
LANTDIV	Atlantic Division (of the Naval Facilities Engineering Command)
LUC	land use control
MCL	Maximum Contaminant Level
MDE	Maryland Department of the Environment
mg/L	milligrams per liter
µg/L	micrograms per liter
NAVFAC	Naval Facilities Engineering Command
NCEA	National Center for Environmental Assessment
NCP	National Contingency Plan
NSF-IH	Naval Support Facility, Indian Head
NOS	Naval Ordnance Station
O&M	operation and maintenance
PRG	preliminary remediation goal

RA	remedial alternative
RAGS	Risk Assessment Guidance for Superfund
RAOs	remedial action objectives
RCRA	Resource Conservation and Recovery Act of 1976
RDA	recommended dietary allowance
RfD	Reference Dose
RI	remedial investigation
RME	reasonable maximum exposure
ROD	record of decision
SARA	Superfund Amendments and Reauthorization Act of 1986
SERA	screening ecological risk assessment
SRG	Site Remediation Goal
SVOC	semivolatile organic compound
TAL	Target Analyte List
TBC	To-Be-Considered
TCL	Target Compound List
TPH	total petroleum hydrocarbon
UCL	upper confidence limit
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound

SECTION 1

Introduction and Background Information

This report presents the Feasibility Study (FS) for surface soil, landfill contents, and groundwater at Site 21, Bronson Road Landfill, at the Naval Support Facility, Indian Head (NSF-IH) in Indian Head, Maryland. This FS report was prepared by CH2M HILL under the Naval Facilities Engineering Command, Atlantic Division (LANTDIV), Comprehensive Long-Term Environmental Action Navy (CLEAN) II Contract No. N62470-95-D-6007, Contract Task Order (CTO) 0122, for submittal to the United States Navy (Navy), the United States Environmental Protection Agency (USEPA), and the Maryland Department of the Environment (MDE).

1.1 Objectives

This FS has been developed in accordance with the Navy's Installation Restoration Program, USEPA guidance (USEPA, 1988), and the National Oil and Hazardous Substance Pollution Contingency Plan (NCP; 40 Code of Federal Regulations [CFR] 300 et seq.).

This report uses information gathered from various investigations, described in Section 1.5. These investigations were used as a basis for developing and evaluating cost-effective alternatives to remediate landfill and soil and groundwater contamination. The remedial alternatives (RAs) developed in this FS address remedial action objectives (RAOs) and risks associated with Site 21. This FS includes a site-specific explanation of how each alternative satisfies the NCP's seven site-specific remedy selection criteria.

This FS documents the analyses and evaluations used to develop remedial action alternatives for Site 21. The information presented herein will be used by the Navy and regulatory agencies to select a RA for Site 21 that complies with the requirements of the NCP. The FS report is not intended to serve as a design document; rather, it gives a conceptual overview of RAs and an assessment of their feasibility. The FS report discusses criteria used to evaluate RAs and to determine the effects of implementing them.

1.2 Report Organization

This FS report is composed of the following sections:

- Section 1—Introduction and Background Information
- Section 2—Remedial Action Objectives, Applicable or Relevant and Appropriate Requirement, Site Remedial Goals, and Area of Attainment
- Section 3—Development of Remedial Alternatives
- Section 4—Detailed Analysis of Remedial Alternatives
- Section 5—Comparative Analysis
- Section 6—References

Figures, tables, and appendixes referenced within the text are provided at the end of each section.

1.3 Base Location and History

NSF-IH was established in 1890 and is the Navy's oldest continuously operating ordnance station. At various times during its operation, NSF-IH has served as a gun and armor proving ground, a powder factory, a propellant plant, and a research facility. The U.S. Government purchased Stump Neck Annex in 1901. The property provided a safety buffer for the testing of larger naval guns, which were tested by firing into the Potomac River and at Stump Neck.

The Indian Head base was enlarged by another 1,160 acres of adjacent land in 1918, during World War I. This expansion included the purchase of Hopewell Farm and Hog Island, which was then an islet in the Mattawoman Creek and has since become attached to the Cornwallis Neck peninsula. When the Dahlgren Naval Proving Ground in Virginia was established as a separate command in 1932, NSF-IH was redesignated the Naval Powder Factory (CH2M HILL, 2004a).

The production of gunpowder and development of new explosives during the onset of World War II resulted in the construction of several new facilities at Indian Head, as well as the construction of Route 210 as a Defense Access Road in 1943. Development and improvements at Indian Head continued throughout the 1950s and 1960s. In 1966, NSF-IH was renamed the Naval Ordnance Station (NOS). Rum Point, an 80-acre promontory in the Mattawoman Creek near Stump Neck, was also acquired in this year. Bullitts Neck was obtained in five small acquisitions between 1965 and 1966 in order to meet safety and security needs arising from explosive magazines at the Indian Head station (CH2M HILL, 2004a).

After the Vietnam conflict, the mission of NSF-IH shifted from primarily production to highly technical engineering support. In 1987, the NOS was established as a Center for Excellence to promote technological excellence in the following specialized fields: energetic chemicals; guns, rockets and missile propulsion; ordnance devices; explosives; safety and environmental protection; and simulators and training (CH2M HILL, 2004a). Current Navy land use includes operations and training; production; maintenance and utilities; research, development, testing and evaluation; explosive storage; supply and non-explosive storage; administration; community facilities and services; housing; and open space.

Forest stands comprise approximately 47 percent, or 1,603 acres, of NSF-IH and include pine, pine-hardwood, and hardwood forest cover types. Recreation areas at Indian Head include approximately 1,150 acres of designated hunting areas, approximately 2 miles of shoreline fishing areas, and 1.5 miles of nature trails.

NSF-IH is generally surrounded by commercial, residential, and State Park land to the east and south of the main installation and Stump Neck Annex. The town of Indian Head is located just northeast of NSF-IH, where most residential developments are located. The Indian Head Highway (Route 210) extends eastward from the NSF-IH main gate, attracting businesses and providing access to residential areas off the main highway. The Potomac River borders the main installation to the north and west and Stump Neck to the west.

Mason Neck National Wildlife Refuge is located across the Potomac River, north of the main installation. The Mattawoman Natural Environment Area is state-owned property located along the southern edge of the Mattawoman Creek, east of the main installation.

The Stump Neck Annex is bordered to the north by the Mattawoman Creek, to the east by General Smallwood State Park and Sweden Point Marina, and to the south by Chicamuxen Creek, agricultural lands, and low-density residential development. The Chicamuxen Wildlife Management Area is located adjacent to and south of the Stump Neck Annex.

More information on the climate, topography and hydrologic characteristics of the site is provided in the Final Remedial Investigation (RI) Report.

1.4 Background and Site Description

Site 21, also known as the Bronson Road Landfill, is located between Bronson Road and Building 602. Figure 1-1 shows the location of the site. The site was originally the location of a 2-acre gravel-mining pit. Circa 1975, the Public Works Department began filling the pit with solid waste generated in the explosives manufacturing area. The landfill was filled by trench excavation and is estimated to contain approximately 1,500 tons of solid waste and unknown quantities of paint sludge, asbestos, and barium sulfate. This practice ended in November 1981 when a 40-cubic-yard dumpster was placed at the north end of the site to act as a transfer station. The dumpster was collected weekly by a private contractor for off-station disposal. The dumpster was removed in 1996, and the area was regraded. The site also accepted sludge from paint spray booths and bagged asbestos until June 1982.

A site reconnaissance in 1982 indicated the landfilled material was partially covered with 6 inches to 1 foot of soil. Uncovered bags of asbestos were observed, as well as several small, dark-brown-colored pools of water that may have been leachate. By 1989, the inactive landfill had been completely covered with a soil cap. Excavation of a sediment pond near the north end of the site in 1996 uncovered plastic, glass, and metal waste. In the past, 20-ft cliffs surrounded three sides of the site; however, placement of fill from other sites on NSF-IH has brought the ground surface nearly up to the elevation of the cliff tops. Currently, additional soil is no longer being placed on the landfill. Figure 1-2 shows the topography of Site 21.

The nearest potable water well is Well 18, located 450 ft north (hydraulically upgradient) of the site.

1.5 Previous Investigations

The results of investigations conducted at Site 21 are summarized in the following documents:

- *Pre-Feasibility Study, Groundwater Sampling Activities, Site 21 (Bronson Road Landfill)* (CH2M HILL, 2002)
- *Investigation of Groundwater Flow and Perchlorate at Site 21* (CH2M HILL, 2003)

- *Final Remedial Investigation Report for Sites 11, 13, 17, 21, and 25* (herein referred to as Final RI Report) (CH2M HILL, 2004a)

A detailed discussion of each investigation is provided in the referenced document. A summary of each investigation is provided below.

1.5.1 Remedial Investigation

The objectives of the RI were to determine the extent of waste at the site and determine whether the waste is a source of soil and groundwater contamination. Field activities were conducted between July 27 and August 4, 2000. The work consisted of surface soil sampling, geophysical surveying, soil boring confirmation, test pit confirmation, monitoring well installation, and groundwater sampling. Figure 1-3 presents the locations of the soil borings, test pits, surface soil samples, and groundwater samples.

Nature and Extent of Contamination

Twenty surface soil samples (IS21SS01 through IS21SS20) were collected on July 26, 2000, and analyzed for Target Compound List (TCL) organics, Target Analyte List (TAL) inorganics, explosives, and total petroleum hydrocarbons (TPHs). Results indicated that volatile and semivolatile organic compounds (VOCs, SVOCs) and explosives were detected in surface soil; however, concentrations of these contaminants were low. Arsenic and iron concentrations exceeded the background 95 percent upper confidence limit (UCL) on the mean of background concentrations. Most high concentrations and frequent detections of metals occurred in the eastern and northern parts of the site. Few explosives were detected at low concentrations.

Groundwater samples were collected from the four monitoring wells (IS21MW01 through IS21MW04) and analyzed for TCL organics, TAL inorganics, explosives, and TPH. VOCs, SVOCs, and explosives were observed in groundwater at two locations; however, detected concentrations were low. Manganese was detected at a maximum concentration of 23,100 micrograms per liter (µg/L) at IS21MW02. It is believed that naturally occurring manganese is being mobilized because of reduction/oxidation (redox) conditions in the subsurface. Groundwater samples collected from IS21MW01 and IS21MW04 (site-specific background well) contained perchlorate at concentrations of 2 µg/L and 2,000 µg/L, respectively. The source of the perchlorate is unknown.

Soil samples were not collected from immediately below the fill to avoid waste penetration. As a result, the effects of waste on the underlying soil are unknown; however, the elevated content of iron, manganese, and other metals compared to the background levels suggested that the underlying groundwater has been impacted. In addition, perchlorate was also detected in two of the four groundwater monitoring wells.

Appendix A.1 presents the detected compounds in surface soil and shallow groundwater samples.

Extent of Solid Waste, Geology, and Hydrogeology

Results of the electromagnetic and electric resistivity (ER) geophysical surveys conducted by Forrest Environmental Services, Inc. in July 2000 were used to initially estimate the lateral and vertical extent of the solid waste at the site. The solid waste is considered to be non-

native material and will be referred to as fill on the cross sections and in the associated text. The geophysical techniques conducted allow for a general, non-intrusive evaluation of the subsurface conditions, although they rely on interpretations of the subsurface material response to applied method. To confirm the geophysical results, seven test pits, previously discussed, were excavated to confirm the lateral extent and five soil borings were installed to confirm the vertical extent of the fill at the site. The fill in the test pits and soil borings was identified based on the occurrence of waste material (such as pieces of brick, slag, metal, and wood) in the soil samples. Appendix A.2 presents the detailed descriptions of the soil borings. Figure 1-4 shows the estimated aerial extent, thickness, and bottom elevation of the fill within the landfill area. The fill material consists of a mixture of solid waste and disturbed soil with a soil cover.

To illustrate the lateral and vertical distributions of the fill and the geologic/hydrogeologic conditions at the site, three cross sections were prepared along the A-A′, B-B′, and C-C′ lines shown on Figure 1-5. Figures 1-6 through 1-8 depict the subsurface conditions along cross sections A-A′, B-B′, and C-C′, respectively. Cross section A-A′ presents information from both boring logs and ER data, cross section B-B′ shows soil boring information, and cross section C-C' shows mostly ER data. The interpolated groundwater elevations shown on Figures 1-6 through 1-8 are based on the groundwater monitoring wells installed around the landfill area. The delineation of fill on these cross sections is based on soil boring/test pit information and is inferred based on geophysical interpretation where soil borings/test pits were not completed. A review of the interpreted lateral extent (Figure 1-4) and vertical extent (Figures 1-6 through 1-8) of fill indicate that the maximum fill thickness is about 45 ft based on an ER survey point and is about 25 ft based on soil boring IS21SB04. Figures 1-6 through 1-8 indicate that the groundwater elevations are above the bottom of the fill. For example, the groundwater elevation near soil borings IS21SB04 and IS21SB02 is interpreted to be about 9 ft and 10 ft, respectively, above the bottom of the fill (Figure 1-7). Similarly, landfill areas that are interpreted to contain fill below an elevation about 30 ft above mean sea level are considered to be below the groundwater table. As such, the thickness of fill below the groundwater table can be as much as 20 to 30 ft (Figure 1-5) in areas of the landfill.

Figures 1-6 and 1-7 also illustrate the subsurface geological conditions at the site based on advancement of soil borings and installation of monitoring wells. The geology at the site consists of unconsolidated sand and gravel deposits with interbedded layers of silts, sands, and clays. As shown on these cross sections, the near-surface gravel deposit and sand deposits appear to have been partially removed during excavation for the landfill area. The total thickness of the unconsolidated deposits was not assessed, although the deposits were encountered to depths of about 48 ft (IS21SB03).

Four groundwater monitoring wells were installed around the landfill area and are shown in Figures 1-9 and 1-10. The monitoring wells were screened in the first-encountered groundwater zone (water table aquifer). Depth to groundwater was measured in these wells on September 8-11, 2000 and December 9, 2002 to assess the groundwater flow conditions. The groundwater depth measurements were converted to elevations using the known monitoring well casing elevations. Groundwater elevation contour maps were constructed using the September 8-11, 2000 and December 9, 2002 groundwater elevations and are shown in Figures 1-19 and 1-10, respectively. These maps show that the groundwater in the

water table aquifer flow to the south-southwest under a hydraulic gradient of about 0.008 to 0.011 ft/ft.

Risk Assessments

This section summarizes the results of the human health risk assessment (HHRA) and ecological risk assessment performed as part of the RI effort. Exposure to both soil and groundwater was evaluated. Groundwater risks were estimated from the sampling results from the three monitoring wells, IS17MW01 through IS17MW03, because well IS17MW04 is considered to be the site-specific background well.

Human Health Risk Assessment A Baseline HHRA was conducted as part of the RI. Human health risks and hazards were assessed for surface soil and shallow groundwater for both current and future land use exposure pathways, including:

Current Land Use

- Trespasser/Visitor (adult and adolescent): incidental ingestion of and dermal contact with surface soil.
- Industrial Worker: incidental ingestion of and dermal contact with surface soil.

Future Land Use

- Resident (adult and child): incidental ingestion of and dermal contact with surface soil, ingestion of and dermal contact with shallow groundwater, and inhalation (adults only) of volatiles from groundwater.
- Construction Worker: dermal contact with and inhalation of volatiles only from shallow groundwater.

Shallow groundwater beneath the site is not used currently as a potable water supply and likely will not be used as a potable water supply in the future. The water table aquifer at Indian Head is not an efficacious source of groundwater. The groundwater encountered in uppermost unconsolidated Quaternary sediments is susceptible to decreased recharge during drought conditions. Hydraulic conductivities and yield generally indicate that the surficial geologic unit across Indian Head is not productive. Background concentrations of naturally occurring and other inorganic constituents will impart unpleasant taste and odor. Extensive use of the surficial aquifer as a potable water supply source is likely to draw in Mattawoman Creek surface water, resulting in further impairment of groundwater quality. Because of these reasons, prospective groundwater users are more likely to draw water from the deeper Patapsco and Patuxent Formations rather than the surficial Quaternary aquifer, and from wells that meet Maryland well regulations regarding well construction and yield. These regulations effectively preclude the use of shallow groundwater at Site 21. However, shallow groundwater beneath the site was evaluated as a worst-case risk estimate for potable groundwater use.

The HHRA concluded that primary risks were associated with future exposure (primarily residential) to surface soil and groundwater. The main human health risks were non-carcinogenic, driven by inorganics, as summarized below.

Surface Soil:

Non-carcinogenic hazard for the future child resident exposed to **arsenic**, **chromium**, **iron**, **manganese**, and **vanadium,** contributing to total hazard index (HI) of 2.5. Arsenic is the primary hazard driver with an HI of 1.0. The remaining metals contribute to hazard indices of greater than 0.1 to the affected individual target organs.

Shallow Groundwater:

Non-carcinogenic hazard for future adult resident associated with exposure to **iron** (HI = 1.5), **manganese** (36), and **thallium** (2.4).

Non-carcinogenic hazard for future child resident associated with exposure to **iron** (HI = 3.5), **manganese** (84), and **thallium** (5.7).

Non-carcinogenic hazard for future construction worker associated with exposure to **manganese** (HI = 2.0).

The National Center for Environmental Assessment recently withdrew the provisional Reference Dose (RfD) for iron. Until (and if) a new RfD is proposed, potential risks associated with exposure to this metal cannot be quantitatively assessed. Therefore, iron does not need to be considered a risk driver, and, therefore, a contaminant of concern (COC) at Site 21. However, there are known safe levels (and recommended for health reasons) of iron, as discussed below.

Iron is an essential human nutrient, with a recommended dietary allowance (RDA) range of iron for children ages 6 months to 10 years (0.36 to 1.11 mg/kg-day) (USEPA, 1999). The estimated reasonable maximum exposure (RME) intake of iron via ingestion of groundwater (1 mg/kg-day) is within the RDA. Therefore, exposure to iron in groundwater by child residents may not be considered a health concern because it is within the range that meets nutritional requirements for healthy individuals.

The estimated RME intake of iron via ingestion of groundwater by adults (0.45 mg/kg-day) slightly exceeds the RDA for adult men (0.13 mg/kg-day) and for women ages 11 to 50 (0.24 to 0.33 mg/kg-day) (USEPA, 1999). It should be noted that the ingestion rate of iron from Site 21 groundwater was calculated conservatively using the maximum detected concentration because only three groundwater samples were available. Exposure to iron in groundwater by adult residents should not be considered a health concern.

In summary, the HHRA indicates that the only human health hazards greater than USEPA target levels are posed to the future RME child and adult resident. Future residential use of the site is not likely. Manganese in the groundwater is the dominant contributor to this health hazard, with additional contributions from iron and thallium. The health hazards posed to the future child and adult residents are also above USEPA's benchmark HI. The concentration of iron and manganese detected in one well was much higher than that detected in the background sample or either of the other two site-related samples. Because of the limited number of samples, these maximum detected concentrations were used as the sample concentrations, which may result in an overestimation of the actual risks. Although the total HI to the child resident associated with exposure to surface soil exceeds 1.0, there are no individual constituents or target organ/effects with HIs above 1.0.

Ecological Risk Assessment. The Screening Ecological Risk Assessment (SERA) concluded that contaminants in the soil posed minimal risk to ecological receptors because: (1) no lowest observed adverse effect level-based hazard quotients (HQs) exceeded 1 for upper trophic level [for the average exposure case]; (2) concentrations of several metals that exceeded screening values were comparable to background conditions; and (3) toxicity evaluations for arsenic and mercury (whose concentrations exceeded screening values and background) suggested that significant impacts to plants and soil invertebrates were unlikely.

1.5.2 Pre-FS Investigation and Perchlorate Investigation

Following the RI, a pre-FS investigation was conducted in July 2002 to confirm the concentration of manganese and perchlorate in groundwater. The results are presented in a technical memorandum entitled *Pre-Feasibility Study Groundwater Sampling Activities Site 21 (Bronson Road Landfill), Indian Head Division-NSWC Indian Head, Maryland* (CH2M HILL, 2002). Perchlorate was detected in monitoring well IS21MW04 at a concentration of 2,900 µg/L. Perchlorate was not detected in any other well at the site. Total manganese was detected at a concentration of 10,900 µg/L in monitoring well IS21MW02, a concentration that is significantly lower than the concentration detected during the September 2000 sampling event (23,100 µg/L).

The pre-FS investigation confirmed the presence of perchlorate in the upgradient well at Site 21. However, the source was not readily identifiable. Additionally, the groundwater flow regime at Site 21 was not well defined. Thus, an additional investigation was conducted to determine if perchlorate in groundwater is associated with the landfill (Site 21). The results are presented in a technical memorandum entitled *Investigation of Groundwater Flow and Perchlorate at Site 21, Indian Head Division-NSWC, Indian Head, Maryland* (CH2M HILL, 2003). The results of this supplemental investigation concluded that the perchlorate detected at well IS21MW04 is not associated with the landfill. Perchlorate will be investigated independently of the landfill because the pre-FS investigation results suggest that it is not associated with the landfill. If, however, perchlorate is deemed to affect the selected remedy in the future, it will be addressed accordingly.

Appendix B presents the compounds detected during the pre-FS and perchlorate investigations. Figure 1-11 shows concentrations of perchlorate during these investigations.

1.6 Summary of Constituents of Concern

In this FS report, COCs are defined as compounds that contribute:

- To a non-carcinogenic hazard of 1.0 or above for individual target organ, or
- Individually to an incremental lifetime carcinogenic risk (ILCR) of 10^{-6} or greater, and
- Cumulatively to ILCR above 10^{-4}.

Figure 1-12 describes the schematic of the COC determination based on the human health risks.

Based on this definition, arsenic is the only COC for surface soil, while manganese and thallium are the only COCs for shallow groundwater. These compounds are the primary

non-carcinogenic risk drivers. No compounds were identified as carcinogenic risk drivers. Therefore, discussions of the COCs in this section will be limited to the primary non-carcinogenic risk drivers.

Although iron meets the definitions above, as previously explained, it is not considered as a COC.

1.6.1 Surface Soil

Arsenic was detected in all surface soil samples. Concentrations in the site samples ranged from 3.4 mg/kg to 51.8 mg/kg. The arithmetic mean concentration is 14.6 mg/kg, which is greater than the background mean of 2.2 mg/kg. Additionally, every sample contained arsenic concentrations greater than the background 95 percent UCL of 2.6 mg/kg. The site-specific background samples contained arsenic at levels similar to most of the site samples (i.e., 3.3 mg/kg to 7.7 mg/kg), but several exceedances of the site-specific background suggest that arsenic is site-related. There is no spatial trend in the data. Concentrations of arsenic are relatively uniform across most of the site, with the highest concentrations detected in sample IS21SS14, located on the eastern side of the sampled area, and sample IS21SS04, located near the northern side of the sampled area. Figure 1-13 shows the concentrations of arsenic in surface soil at Site 21. Manganese and thallium are also shown in this figure because they were identified as COCs in the shallow groundwater.

1.6.2 Shallow Groundwater

Discussion of the primary risk drivers in shallow groundwater is based on the results of the 2000 RI field activities and 2002 pre-FS investigation. All four wells (IS21MW01 through IS21MW04) were sampled and analyzed for total and dissolved metals in 2000. In 2002, unfiltered samples from three wells (IS21MW01, 02, and 04) were analyzed, and filtered samples were only analyzed for two wells (IS21MW01 and 04) because of insufficient yield.

Figure 1-14 shows the concentrations of total and dissolved manganese and thallium in Site 21 shallow groundwater in 2000 and 2002.

Thallium

Total thallium was not detected in any unfiltered samples in 2000. In 2002, only one out of three unfiltered samples contained detectable thallium at 4.9 µg/L (IS21MW02) exceeding its detection limit of 4.2 µg/L. In 2000, dissolved thallium was observed in two wells at 5.5 µg/L (site background well IS21MW04) and 6.2 µg/L (IS21MW01). In 2002, dissolved thallium was not detected in all filtered samples.

Manganese

Manganese was detected in all four unfiltered samples collected from Site 21 monitoring wells during the 2000 RI. Concentrations ranged from 66.5 µg/L to 23,100 µg/L (in IS21MW02). In 2002, manganese was detected in all three unfiltered samples at concentrations ranging from 32.4 µg/L to 10,900 µg/L (in IS21MW02). The dissolved manganese concentrations ranged from 64.6 µg/L to 24,700 µg/L (in IS21MW02) in 2000 and from 17.5 µg/L to 230 µg/L in 2002. Exceedance to the facility background concentration of 824 µg/L was observed in well IS21MW02 in both 2000 and 2002.

Manganese comprises approximately 0.085 percent to 0.095 percent of the earth's crust and is a component of many rock types, particularly those of metamorphic and sedimentary origin (Reimer, 1999). It is associated with iron ores of submarginal concentration; the predominant ores of manganese include pyrosulite (MnO_2), manganite ($Mn_2O_3 \cdot H_2O$), hausmannite (Mn_3O_4), psilomelane and rhodochrosite ($MnCO_3$) (Reimer, 1999).

Manganese occurs in soil as a result of weathering of rock containing manganese during the process of pedogenesis. A broad range of naturally occurring manganese concentrations in soil has been observed. The natural presence of manganese in rock and soil provides a source of manganese that may dissolve in ground and surface waters or may erode and deposit as sediment, with the subsequent potential for dissolution. Manganese accumulated in plant material will also provide a source for dissolution during decomposition. Manganese solubility increases at low pH and under reducing conditions and is most commonly in the 2+ and 4+ oxidation states in aquatic systems. The presence of high concentrations of chlorides, nitrates, and sulfates may increase manganese solubility, increasing both aqueous mobility and uptake by plants (Reimer, 1999). Manganese precipitates out in sediment mainly as Mn^{4+} and re-solubilizes in the water column mainly as Mn^{2+} (Reimer, 1999). Dissolved concentrations of manganese in natural waters that are essentially free of anthropogenic influences range from 10 µg/L to 10,000 µg/L (McNeely, 1979). The groundwater results at Site 21 suggest that the concentrations of the dissolved manganese are within the typical range observed in natural waters, except for IS21MW02 in 2000.

Although dissolved manganese is not known to be toxic, it has undesirable effects on water use. These include staining laundry and ceramic fixtures, such as toilets, where concentrations are greater than 0.05 milligrams per liter (mg/L) (USEPA, 2004). Therefore, USEPA has set a secondary maximum contaminant level, non-enforceable guideline for the level of manganese in drinking water at 0.05 mg/L. Manganese concentrations greater than 50 µg/L impart a bitter, metallic taste[1] without presumptively unacceptable adverse health effects (the risk-based concentration for manganese is 730 µg/L).

Dissolved manganese requiring treatment has been mostly associated with utility's water intakes and effluents and mine water effluents. It should be noted that manganese is one of the most difficult elements to remove from surface waters (USGS, 2004[2]).

As described in the technical memorandum submitted to Indian Head Installation Restoration Team on March 19, 2004 (CH2M HILL, 2004b) included as Appendix C, risks from manganese exposures to future adult and child residents consuming the shallow groundwater summarized in Section 1.5.1.3 likely are overestimated, and the pathway from which these risks derive likely is incomplete. The HHRA calculations assumed that future residents would use groundwater from the surficial aquifer as a potable water supply source and would consume groundwater with manganese concentrations of 23,100 µg/L, the greatest concentration detected. The exposure scenarios are likely incomplete because the use of surficial groundwater from Site 21 as a potable water source is improbable and unrealistic, given insufficient yield, the availability of more productive groundwater sources in the area, well construction requirements, and the generally poor quality of surficial

[1] http://www.epa.gov/safewater/consumer/2ndstandards.html; 03/16/2004

[2] http://energy.er.usgs.gov/products/papers/wvsmdtf/wvkiah.htm, 7/9/2004

groundwater because of natural conditions. Lastly, the effects of the naturally recurring levels of manganese in groundwater, at concentrations below the onset of adverse health effects, such as staining laundry and ceramic fixtures and the bitter metallic taste, would preclude the use of untreated water.

File Path: v:\18gis\indianhead\figures\site_21_revised_fs.apr

LEGEND

- IR Site
- Buildings
- Road
- Wooded Area

N

2000 0 2000 4000 Feet

1" = 4000'

Figure 1-1
Facility Map
Feasibility Study
Site 21, Bronson Road Landfill
NSF- IH, Indian Head, Maryland

CH2MHILL

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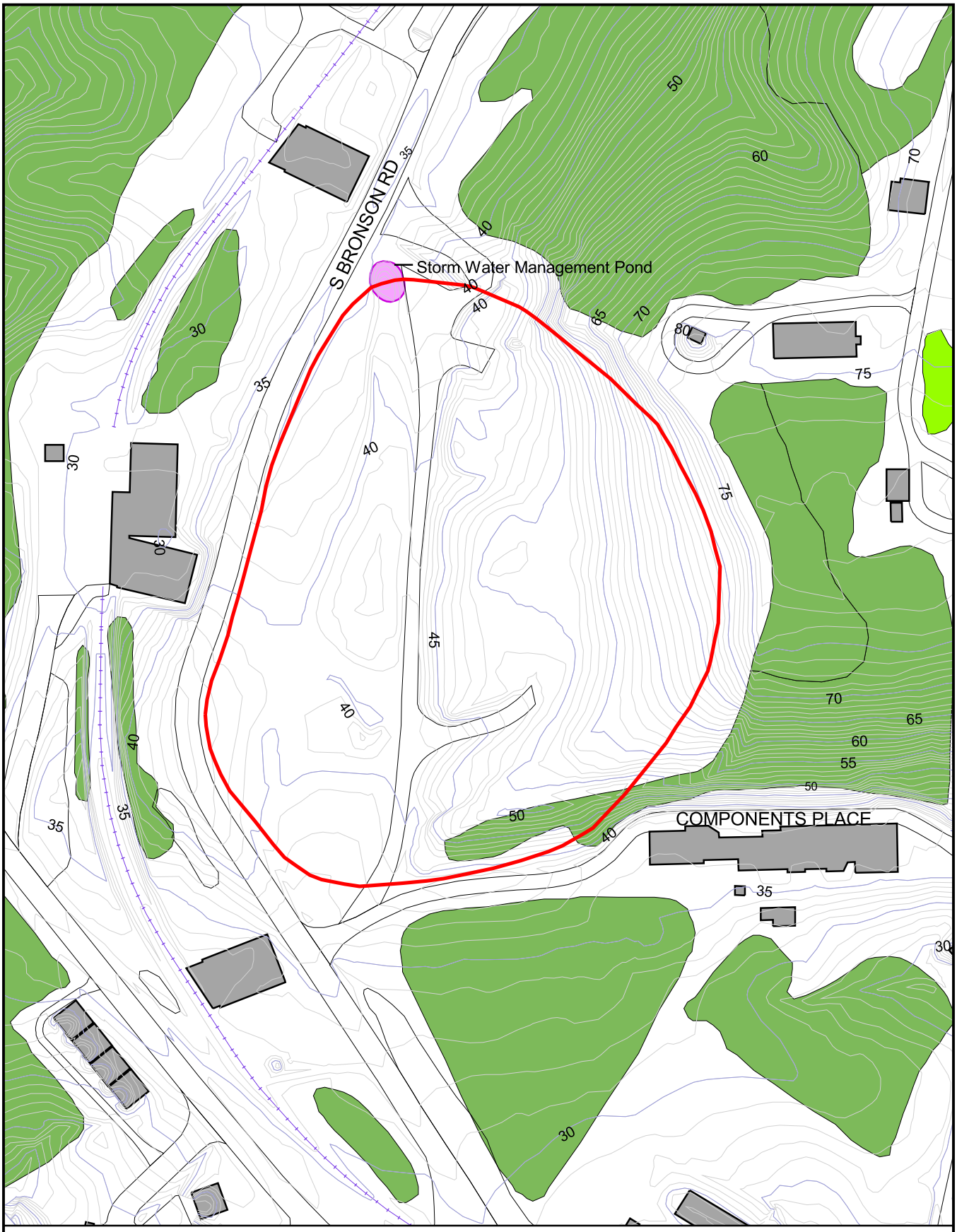


LEGEND

- IR Site
- Buildings
- Railroads
- Road
- Wooded Area
- Topographic Contours (1 foot Intervals)
- Topographic Index Contours (5 foot Intervals)

N

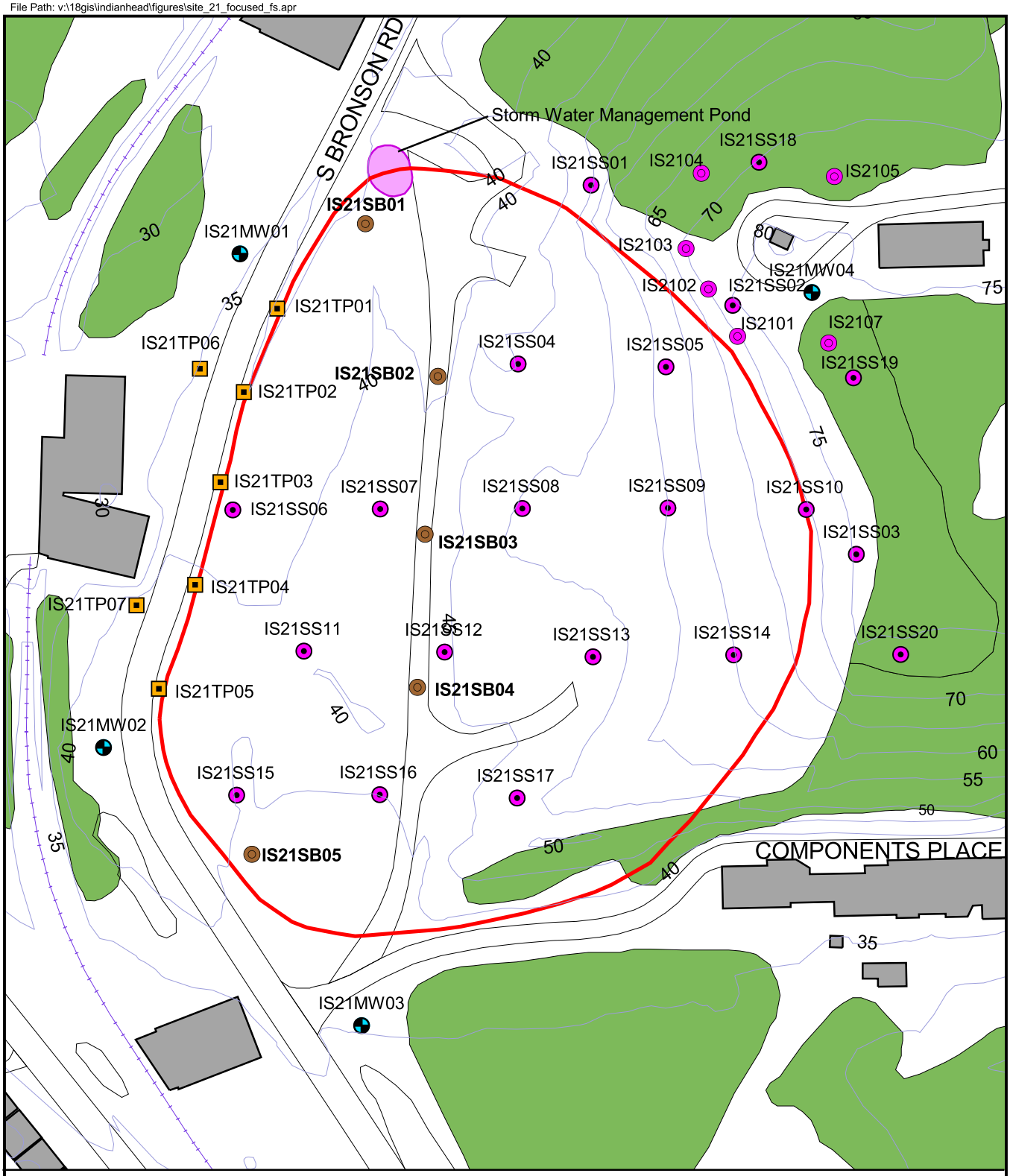
60 0 60 120 Feet

1" = 120'

Figure 1-2
Site 21 Topography
Feasibility Study
Site 21, Bronson Road Lanfill
NSF- IH, Indian Head, Maryland

CH2MHILL

File Path: v:\18gis\indianhead\figures\site_21_focused_fs.apr



LEGEND

- Monitoring Wells (Sampled During RI & Pre-FS)
- Surface Soil (Sampled During RI)
- Soil Boring (Sampled During RI)
- Soil Boring (Sampled During Perchlorate Study)
- Test Pits (Conducted During RI)
- Contours (5 ft)
- IR Site
- Buildings
- Railroads
- Road
- Wooded Area

N

50 0 50 100 Feet

1" = 100'

Figure 1-3
Sampling Locations
Feasibility Study
Site 21, Bronson Road Landfill
NSF- IH, Indian Head, Maryland

Notes:
1. RI was conducted in 2000 (CH2M HILL, 2004)
2. Pre-FS Investigation was conducted in 2002 (CH2M HILL, 2002)
3. Perchlorate Investigation was conducted in 2003 (CH2M HILL, 2003)

CH2MHILL

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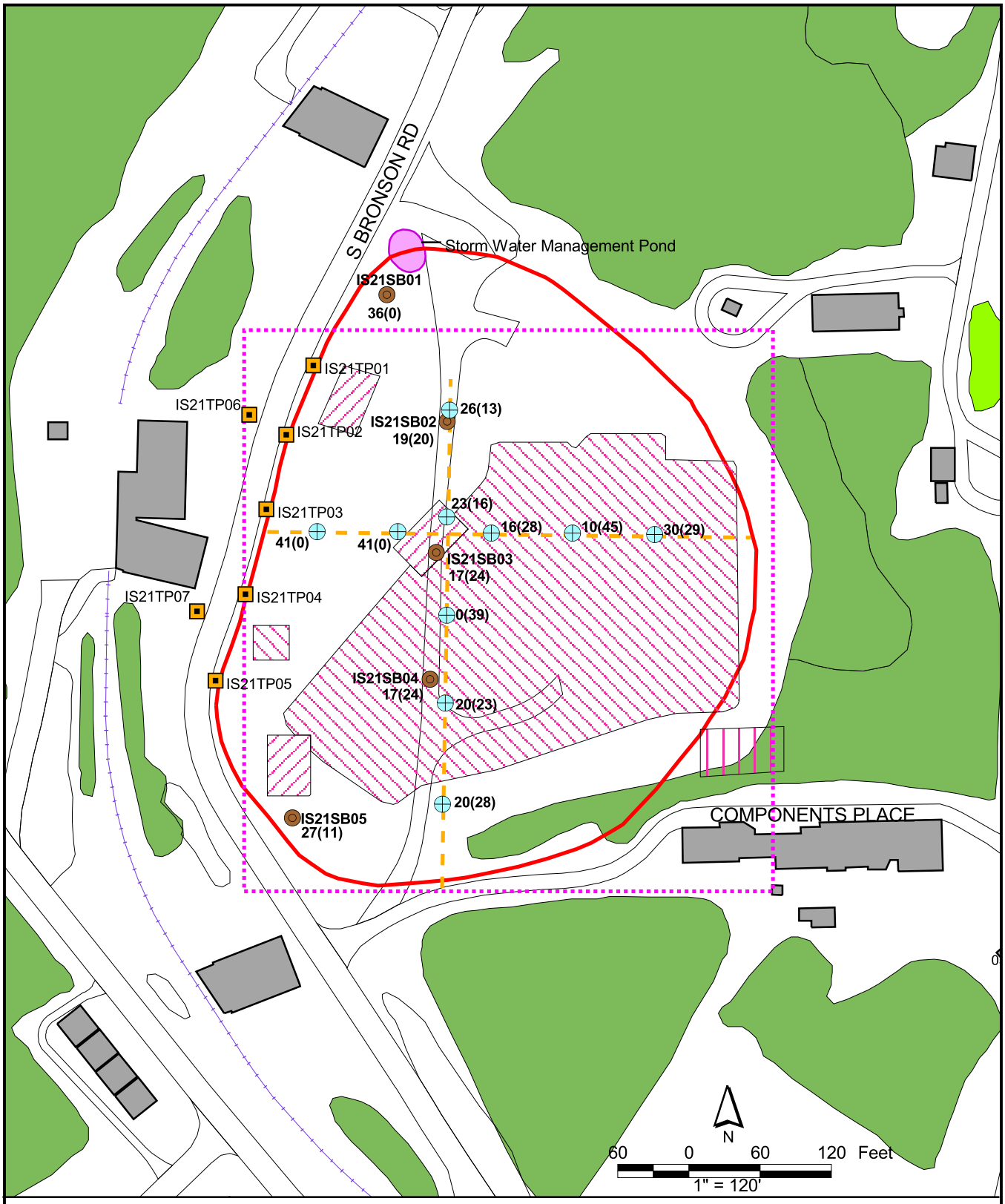


LEGEND

- Soil Boring
- Test Pits
- IR Site
- Buildings
- Railroads
- Road
- Wooded Area
- Extent of EM Survey
- Buried Metal Debris
- Buried Metal and Non-metal Debris
- Surface and Buried Metal Debris
- Electrical Resistivity Profile
- Data Point Along Electrical Resistivity Profile

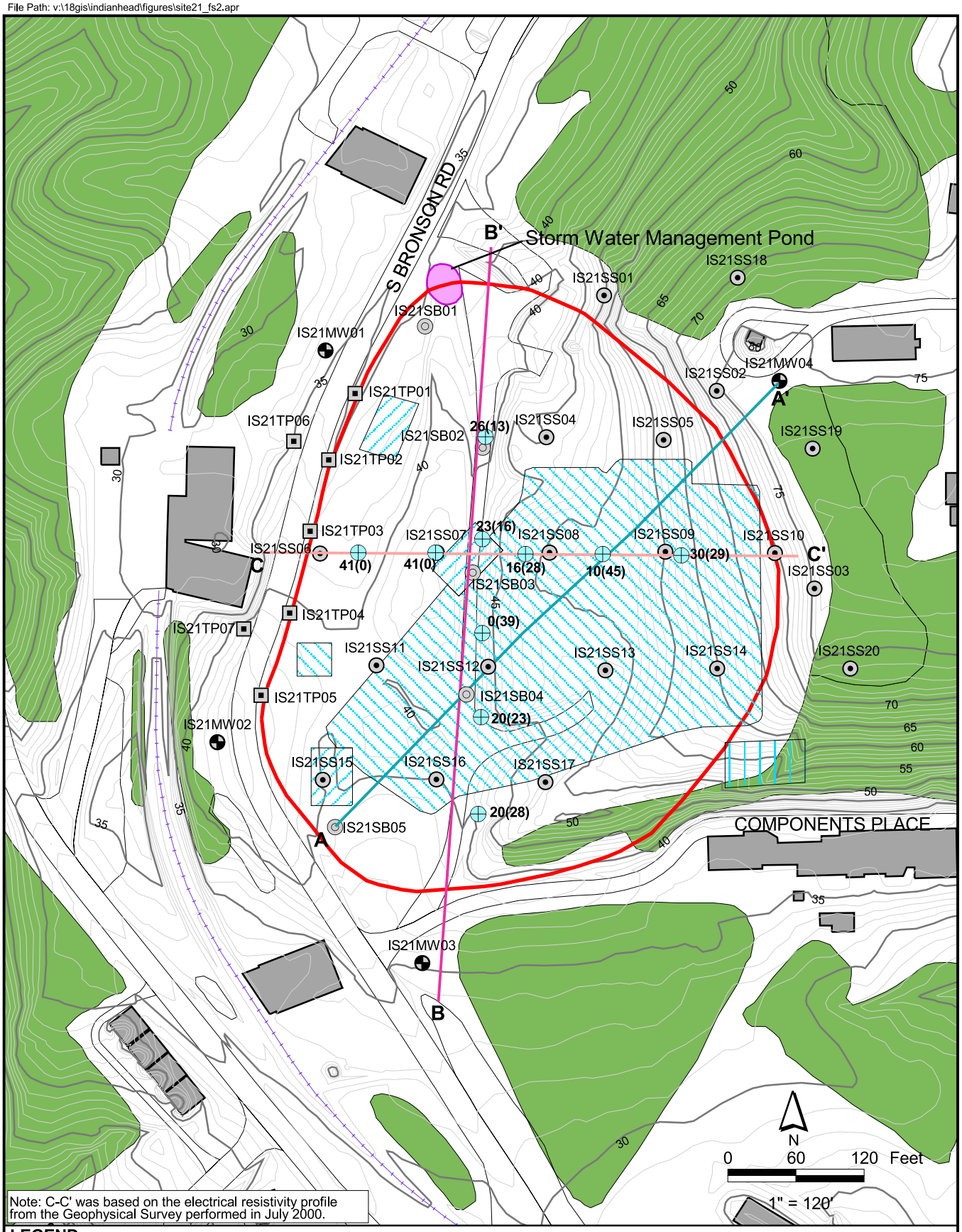
27(11) = Estimated Elevation of Bottom of Fill (ft. above msl) with Estimated Thickness of Fill (ft.)

Notes:
1. Figure is taken from the Final RI Report (CH2M HILL, 2004)
2. Geophysical survey conducted by Forest Environmental Services Inc. on July 18-20, 2000

Figure 1-4
Estimated Areal Extent, Thickness, and Bottom Elevation of the Fill based on the Geophysical Surveys
Feasibility Study
Site 21, Bronson Road Landfill
NSF- IH, Indian Head, Maryland

CH2MHILL

File Path: v:\18gis\indianhead\figures\site21_fs2.apr



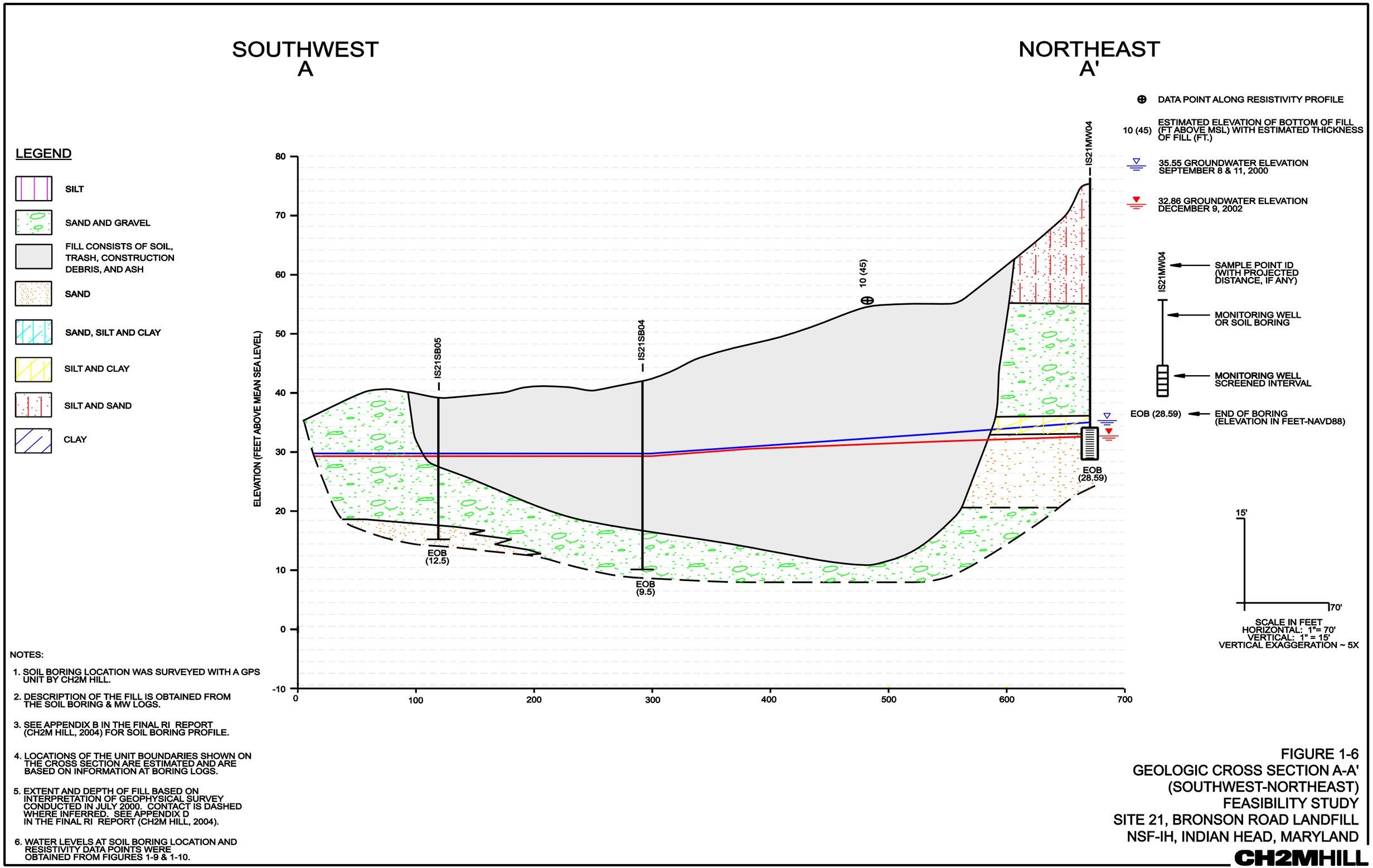
Note: C-C' was based on the electrical resistivity profile from the Geophysical Survey performed in July 2000.

LEGEND

- Monitoring Wells
- Soil
- Soil Boring
- Test Pits
- Approximate Site Boundary
- Buildings
- Road
- Railroads
- Contours (5 ft)
- Contours (1 ft)
- Cross Sections
- Wooded Area
- Buried Metal Debris
- Buried Metal and Non-metal Debris
- Surface and Buried Metal Debris
- Data Point Along Electrical Resistivity Profile
- 27(11) = Estimated Elevation of Bottom of Fill (ft. above msl) with Estimated Thickness of Fill (ft.)

Figure 1-5
Locations of Geologic and Electrical Resistivity Cross Sections
Feasibility Study
Site 21, Bronson Road Landfill
NSF-IH, Indian Head, Maryland

CH2MHILL



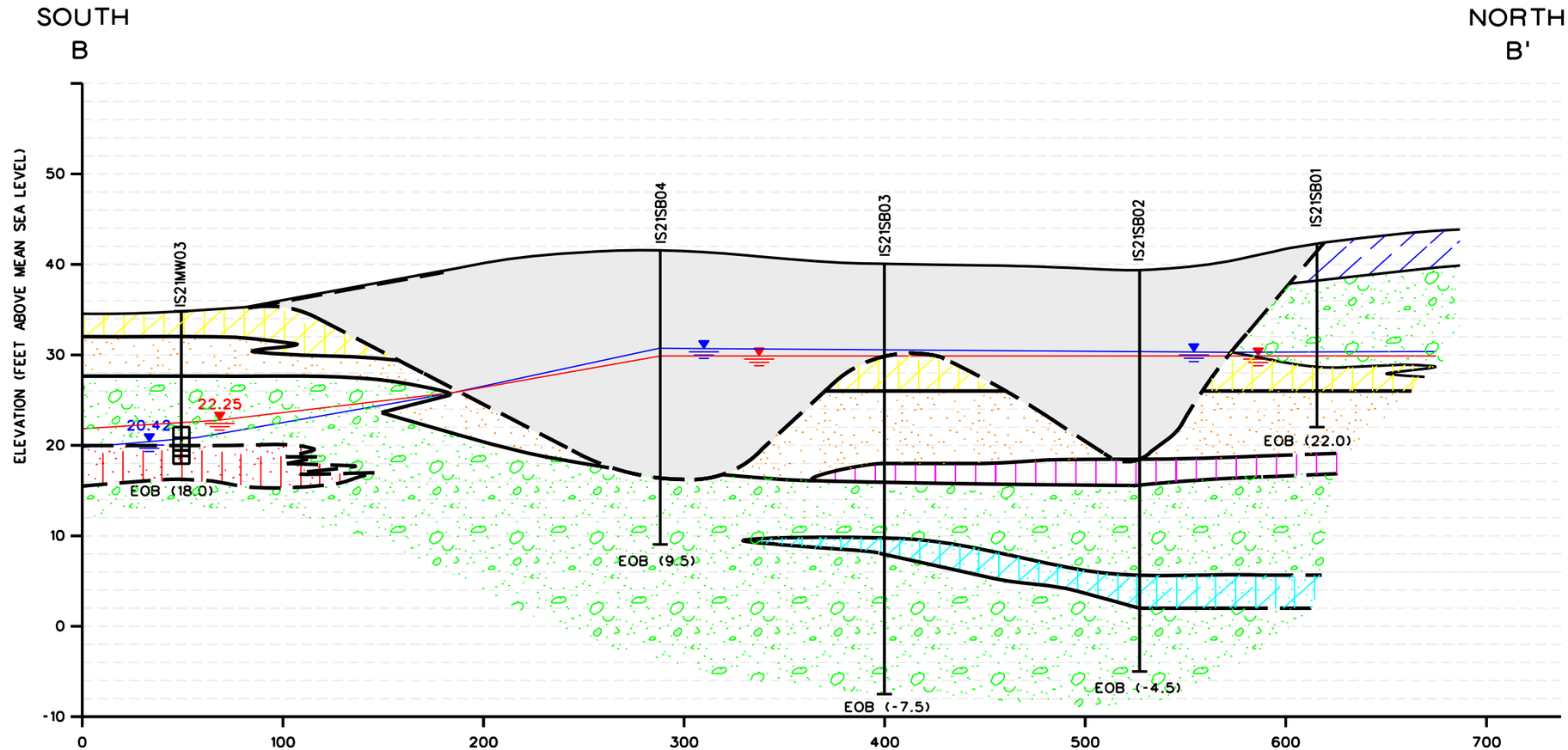
NOTES:

1. SOIL BORING LOCATION WAS SURVEYED WITH A GPS UNIT BY CH2M HILL.
2. DESCRIPTION OF THE FILL IS OBTAINED FROM THE SOIL BORING & MW LOGS.
3. SEE APPENDIX B IN THE FINAL RI REPORT (CH2M HILL, 2004) FOR SOIL BORING PROFILE.
4. LOCATIONS OF THE UNIT BOUNDARIES SHOWN ON THE CROSS SECTION ARE ESTIMATED AND ARE BASED ON INFORMATION AT BORING LOGS.
5. EXTENT AND DEPTH OF FILL BASED ON INTERPRETATION OF GEOPHYSICAL SURVEY CONDUCTED IN JULY 2000. CONTACT IS DASHED WHERE INFERRED. SEE APPENDIX D IN THE FINAL RI REPORT (CH2M HILL, 2004).
6. WATER LEVELS AT SOIL BORING LOCATION AND RESISTIVITY DATA POINTS WERE OBTAINED FROM FIGURES 1-9 & 1-10.

FIGURE 1-6
GEOLOGIC CROSS SECTION A-A'
(SOUTHWEST-NORTHEAST)
FEASIBILITY STUDY
SITE 21, BRONSON ROAD LANDFILL
NSF-IH, INDIAN HEAD, MARYLAND

CH2MHILL

6175f041.dgn



LEGEND

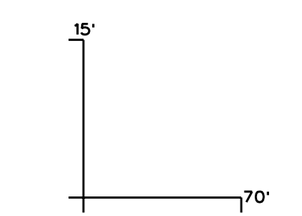
- SILT
- SAND AND GRAVEL
- FILL CONSISTS OF SOIL, TRASH, CONSTRUCTION DEBRIS, AND ASH
- SAND
- SAND, SILT AND CLAY
- SILT AND CLAY
- SILT AND SAND
- CLAY

GROUNDWATER ELEVATION SEPTEMBER 8&11, 2000

GROUNDWATER ELEVATION DECEMBER 9, 2002

NOTES:

1. MONITORING WELLS WERE SURVEYED BY BALDWIN & GREGG IN DECEMBER 2000.
2. SOIL BORING LOCATIONS WERE SURVEYED WITH A GPS UNIT BY CH2M HILL.
3. MONITORING WELL WATER LEVELS WERE MEASURED ON SEPTEMBER 8&11, 2000 AND DECEMBER 9, 2002.
4. DESCRIPTION OF THE FILL IS OBTAINED FROM THE SOIL BORING & MW LOGS.
5. SEE APPENDIX B IN THE FINAL RI REPORT (CH2M HILL, 2004) FOR SOIL BORING & MW PROFILES.
6. LOCATIONS OF THE UNIT BOUNDARIES SHOWN ON THE CROSS SECTION ARE ESTIMATED AND ARE BASED ON INFORMATION AT BORING LOGS AND MW WELLS.
7. WATER LEVELS AT SOIL BORING LOCATIONS OBTAINED FROM FIGURES 1-9 AND 1-10.



SCALE IN FEET
HORIZONTAL: 1" = 70'
VERTICAL: 1" = 15'
VERTICAL EXAGGERATION ~ 5X

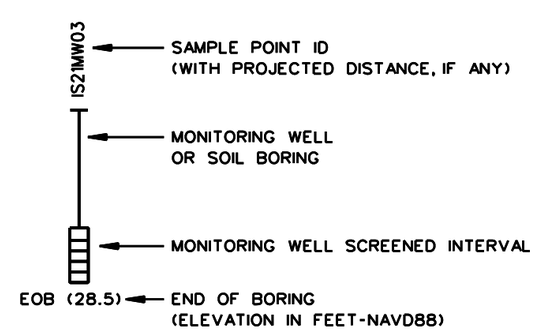
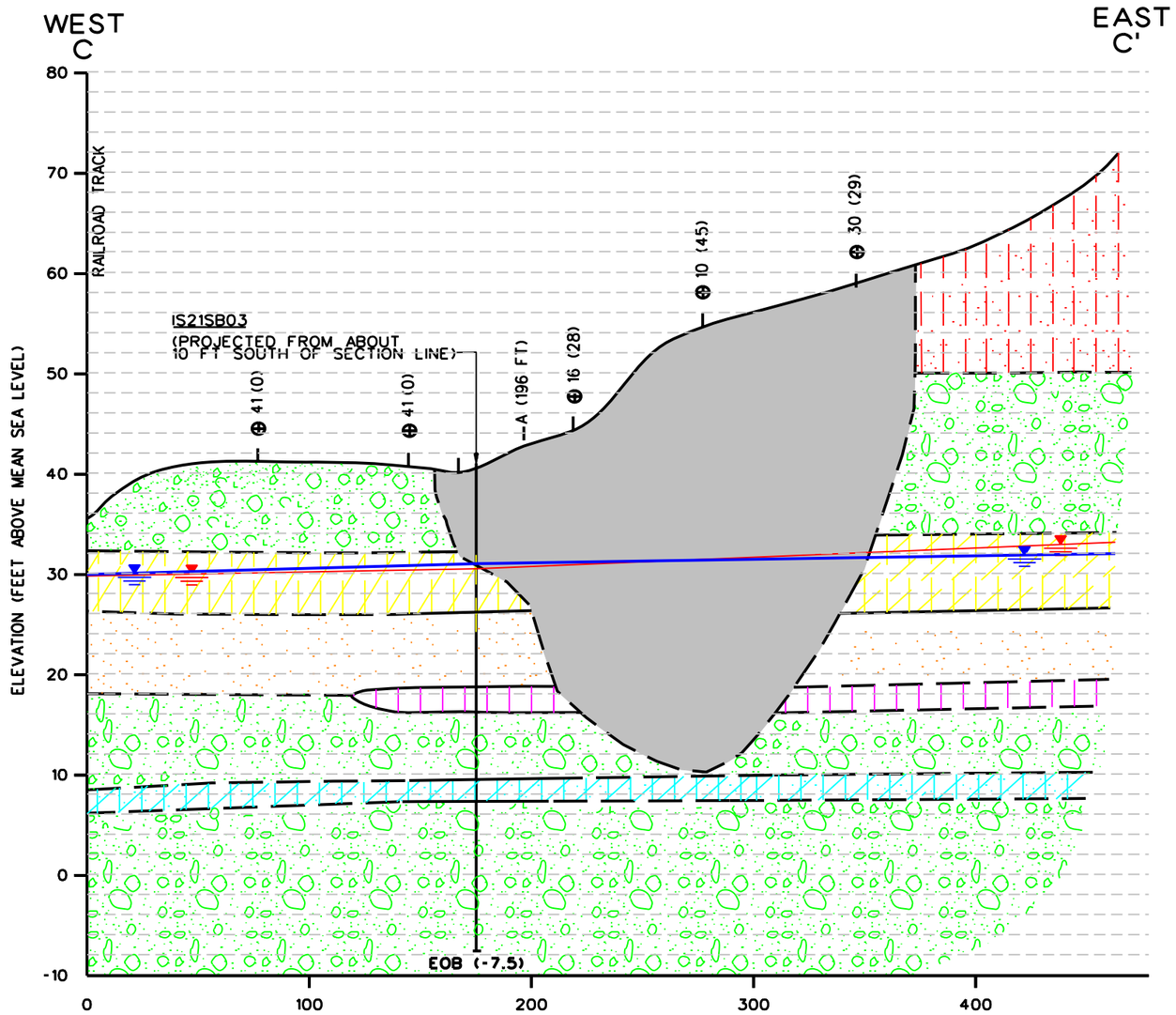


FIGURE 1-7
GEOLOGIC CROSS SECTION B-B'
(SOUTH-NORTH)
FEASIBILITY STUDY
SITE 21, BRONSON ROAD LANDFILL
NSF-IH, INDIAN HEAD, MARYLAND

CH2MHILL

6175F038.DGN



LEGEND

- SILT
- SAND AND GRAVEL
- FILL CONSISTS OF SOIL, TRASH, CONSTRUCTION DEBRIS, AND ASH
- SAND
- SAND, SILT AND CLAY
- SILT AND CLAY
- SILT AND SAND
- CLAY

⊕ DATA POINT ALONG RESISTIVITY PROFILE

30 (29) ESTIMATED ELEVATION OF BOTTOM OF FILL (FT ABOVE MSL) WITH ESTIMATED THICKNESS OF FILL (FT.)

GROUNDWATER ELEVATION DECEMBER 9, 2002

GROUNDWATER ELEVATION SEPTEMBER 8 & 11, 2000

NOTES:

1. SOIL BORING LOCATION WAS SURVEYED WITH A GPS UNIT BY CH2M HILL.
2. DESCRIPTION OF THE FILL IS OBTAINED FROM THE SOIL BORING & MW LOGS.
3. SEE APPENDIX B IN THE FINAL RI REPORT (CH2M HILL, 2004) FOR SOIL BORING PROFILE.
4. LOCATIONS OF THE UNIT BOUNDARIES SHOWN ON THE CROSS SECTION ARE ESTIMATED AND ARE BASED ON INFORMATION AT BORING LOGS.
5. EXTENT AND DEPTH OF FILL BASED ON INTERPRETATION OF GEOPHYSICAL SURVEY CONDUCTED IN JULY 2000. CONTACT IS DASHED WHERE INFERRED. SEE APPENDIX D IN THE FINAL RI REPORT (CH2M HILL, 2004).
6. WATER LEVELS AT SOIL BORING LOCATION AND RESISTIVITY DATA POINTS WERE OBTAINED FROM FIGURES 1-9 & 1-10.

15'

70'

SCALE IN FEET
HORIZONTAL: 1" = 70'
VERTICAL: 1" = 15'
VERTICAL EXAGGERATION ~ 5X

IS21MW03 ← SAMPLE POINT ID (WITH PROJECTED DISTANCE, IF ANY)

MONITORING WELL OR SOIL BORING

MONITORING WELL SCREENED INTERVAL

EOB (28.5) ← END OF BORING (ELEVATION IN FEET-NAVD88)

FIGURE 1-8
GEOLOGIC CROSS SECTION C-C'
(WEST-EAST)
FEASIBILITY STUDY
SITE 21, BRONSON ROAD LANDFILL
NSF-IH, INDIAN HEAD, MARYLAND

CH2MHILL

6175F039.DGN

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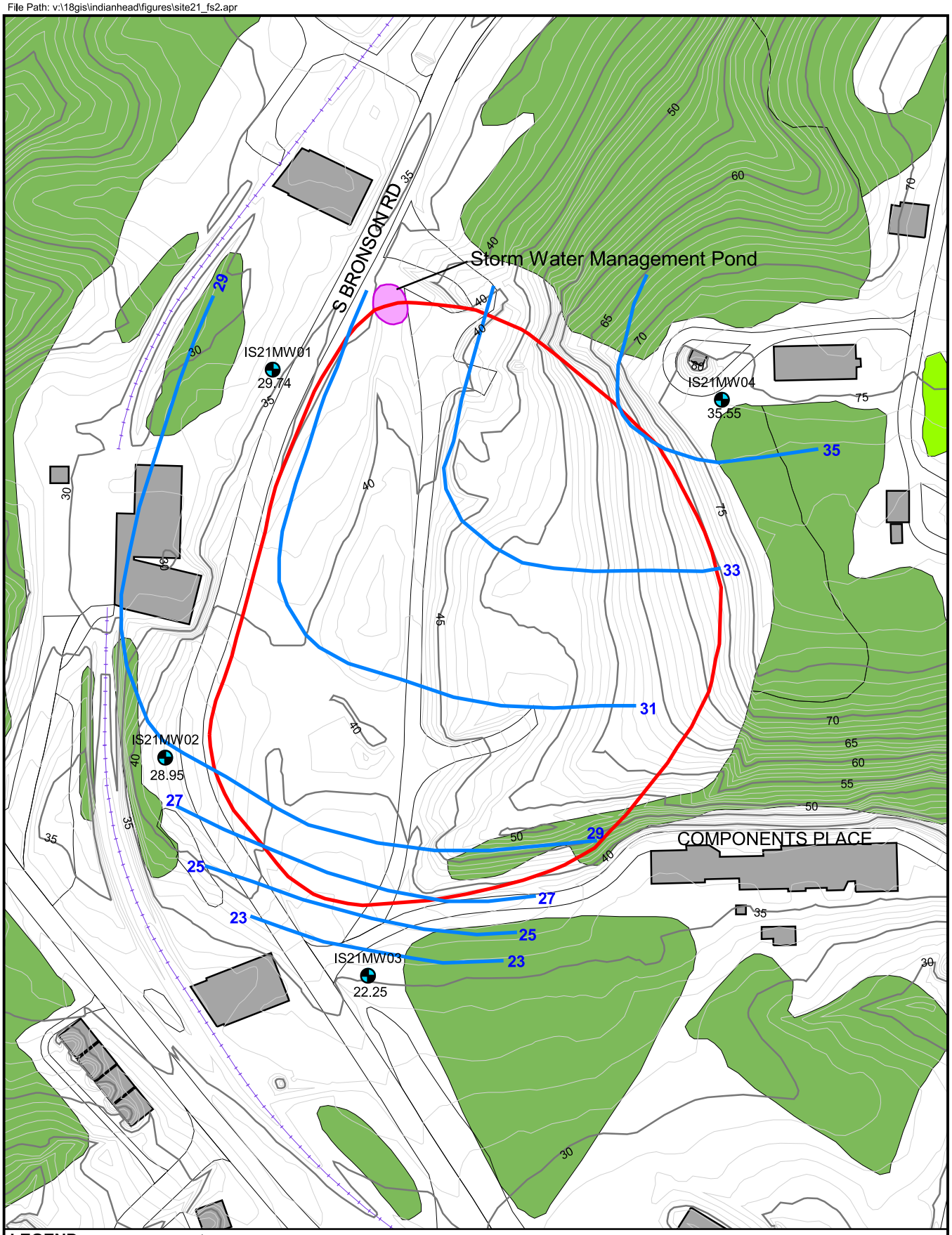

LEGEND

- Monitoring Wells
- Approximate Site Boundary
- Buildings
- Water Table Contours (dashed where inferred; feet above msl)
- Road
- Railroads
- Wooded Area
- Contours (5 ft)
- Contours (1 ft)

N

0 60 120 Feet

1" = 120'

Figure 1-9
Water Table Elevation Contours
September 8-11, 2000
Feasibility Study
Site 21, Bronson Road Landfill
NSF- IH, Indian Head, Maryland

CH2MHILL

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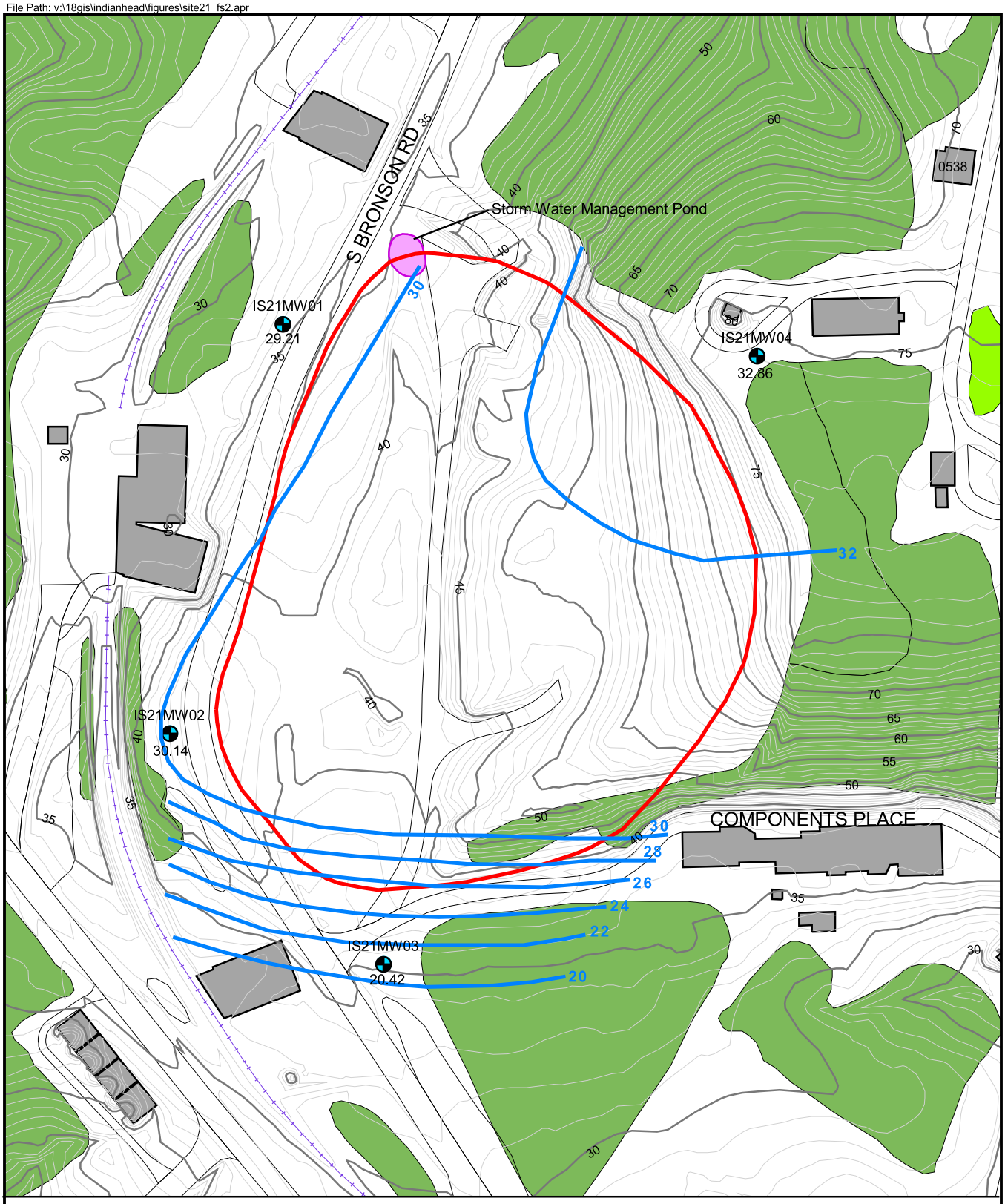

LEGEND

- Monitoring Wells
- Approximate Site Boundary
- Buildings
- Railroads
- Road
- Wooded Area
- Water Table Contours (dashed where inferred; feet above msl)
- Contours (5 ft)
- Contours (1 ft)

N

0 60 120 Feet

1" = 120'

Figure 1-10
Water Table Elevation Contours
December 9, 2002
Feasibility Study
Site 21, Bronson Road Landfill
NSF- IH, Indian Head, Maryland

Notes:
1. RI was conducted in 2000 (CH2M HILL, 2004)
2. Pre-FS Investigation was conducted in 2002 (CH2M HILL, 2002)
3. Perchlorate Investigation was conducted in 2003 (CH2M HILL, 2003)

CH2MHILL

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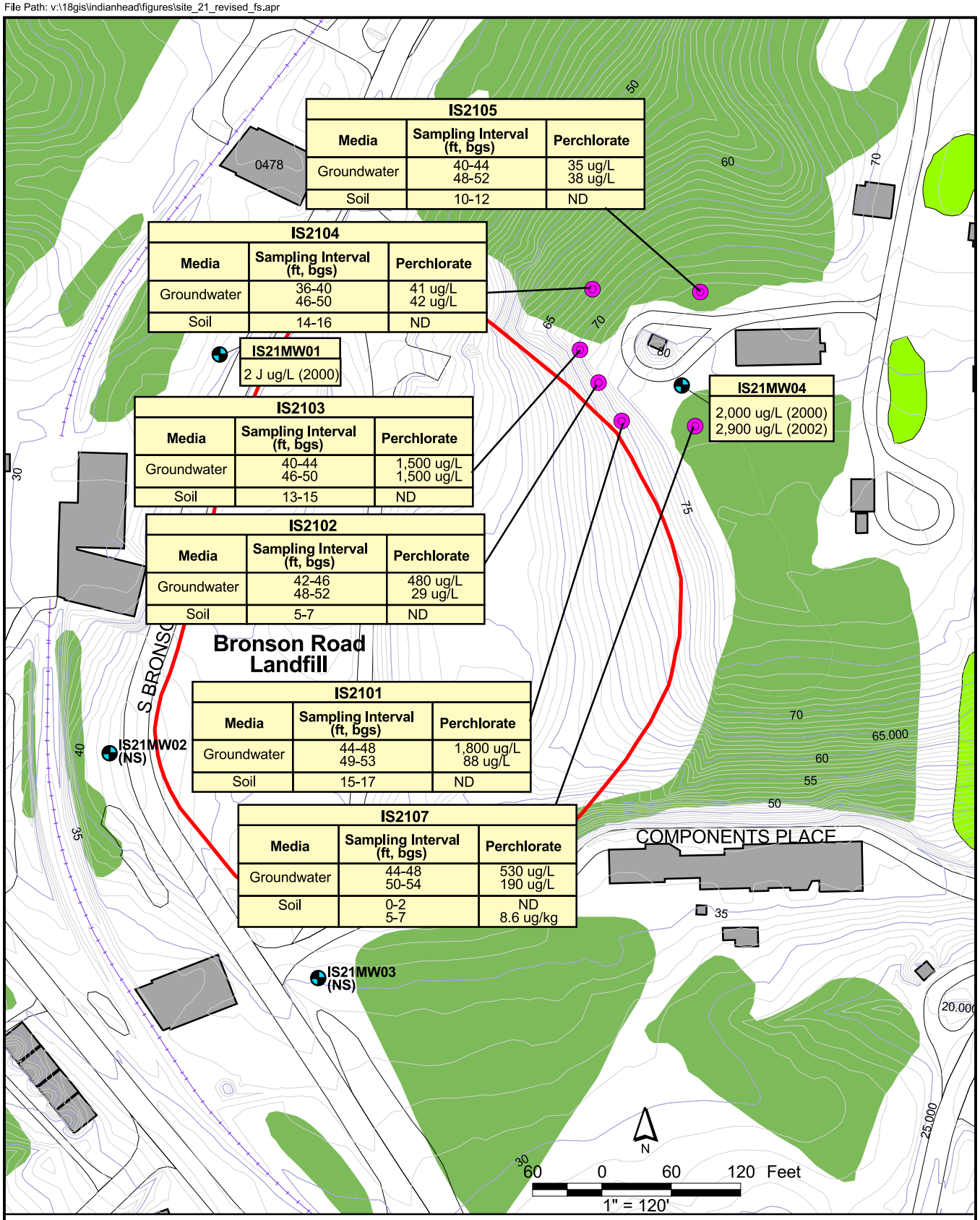

LEGEND

- Monitoring Well Location
- Sampling Locations
- IR Site
- Buildings
- Topographic Contours (1 foot Intervals)
- Topographic Index Contours (5 foot Intervals)

ug/L = micrograms per liter
ND = Not Detected
NS = Not Sampled

Notes:
1. Monitoring Well results are from the 2000 RI and 2002 Pre-FS.
2. Other Groundwater and Soil results are from the 2003 perchlorate investigation.

Figure 1-11
Perchlorate Concentrations in Groundwater and Soil Samples
Feasibility Study
Site 21, Bronson Road Landfill
NSF- IH, Indian Head, Maryland

CH2MHILL

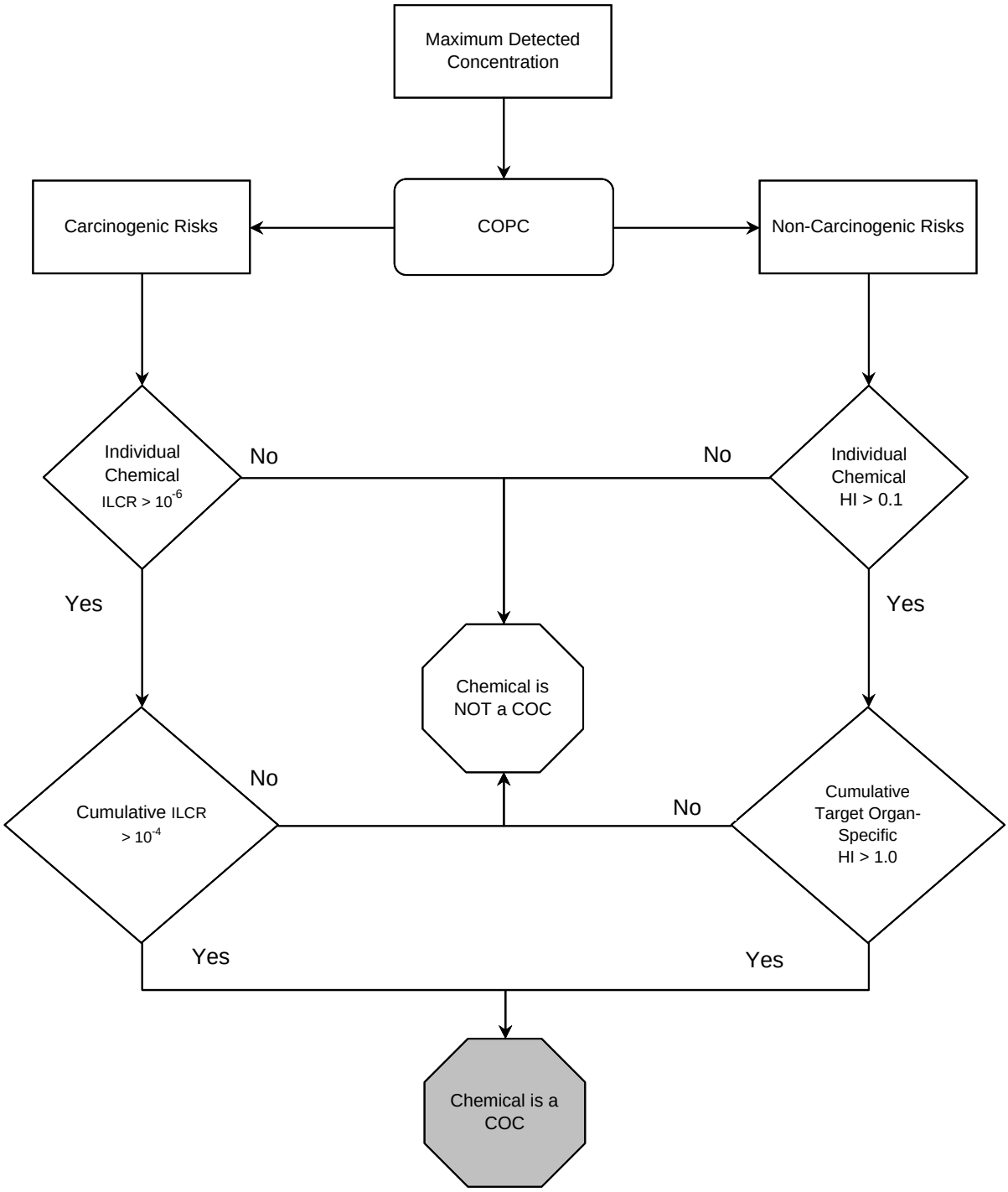

Figure 1-12
Determination of COCs Based on Human Health Risks
Feasibility Study
Site 21, Bronson Road Landfill
NSF-IH, Indian Head, Maryland

CH2M HILL

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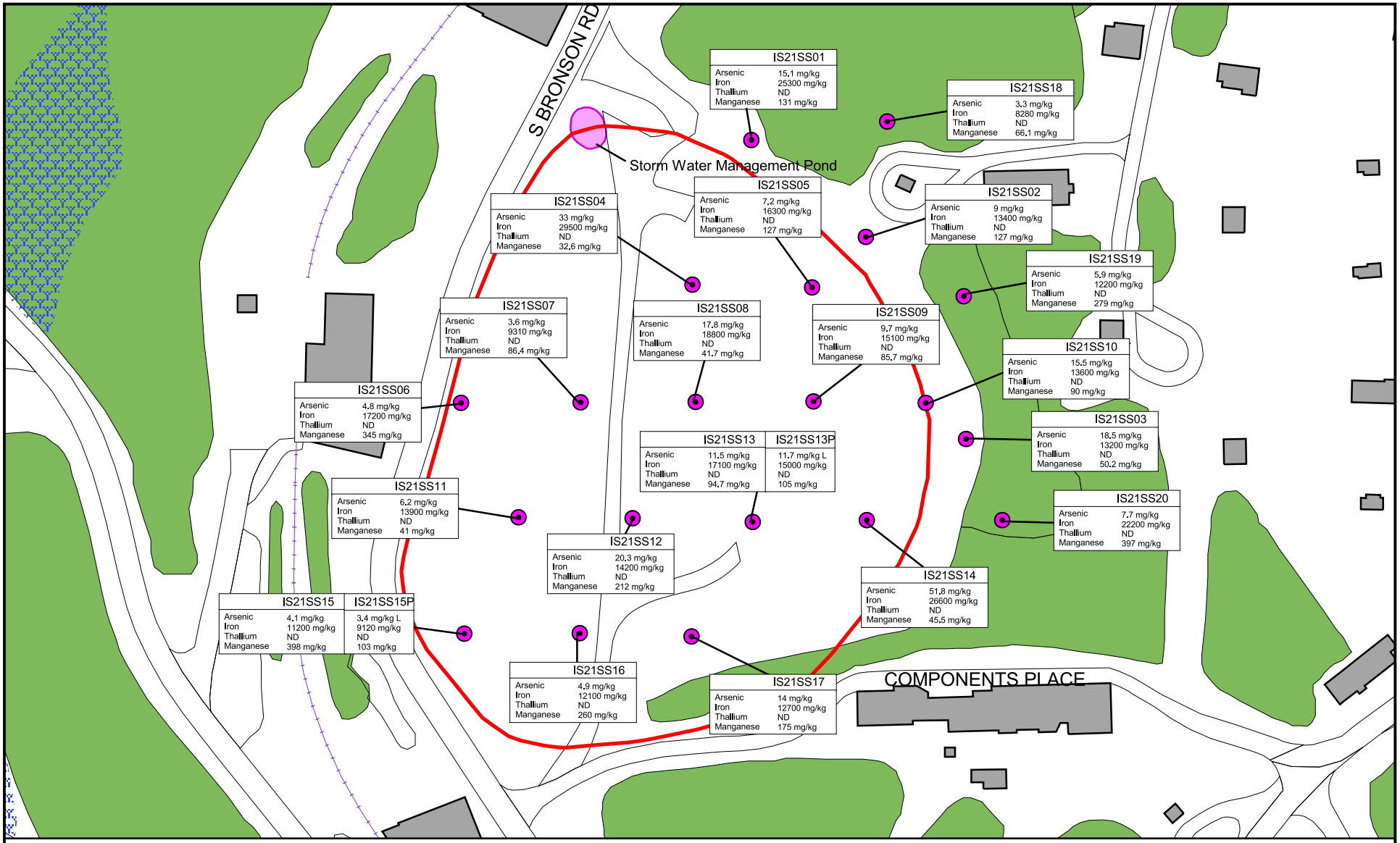


LEGEND

- Surface Soil Sample Location
- IR Site
- Buildings
- Railroad
- Road
- Wooded Area
- L = Biased Low
- ND = Non Detect
- mg/kg = Milligrams per kilogram

N

60 0 60 120 Feet

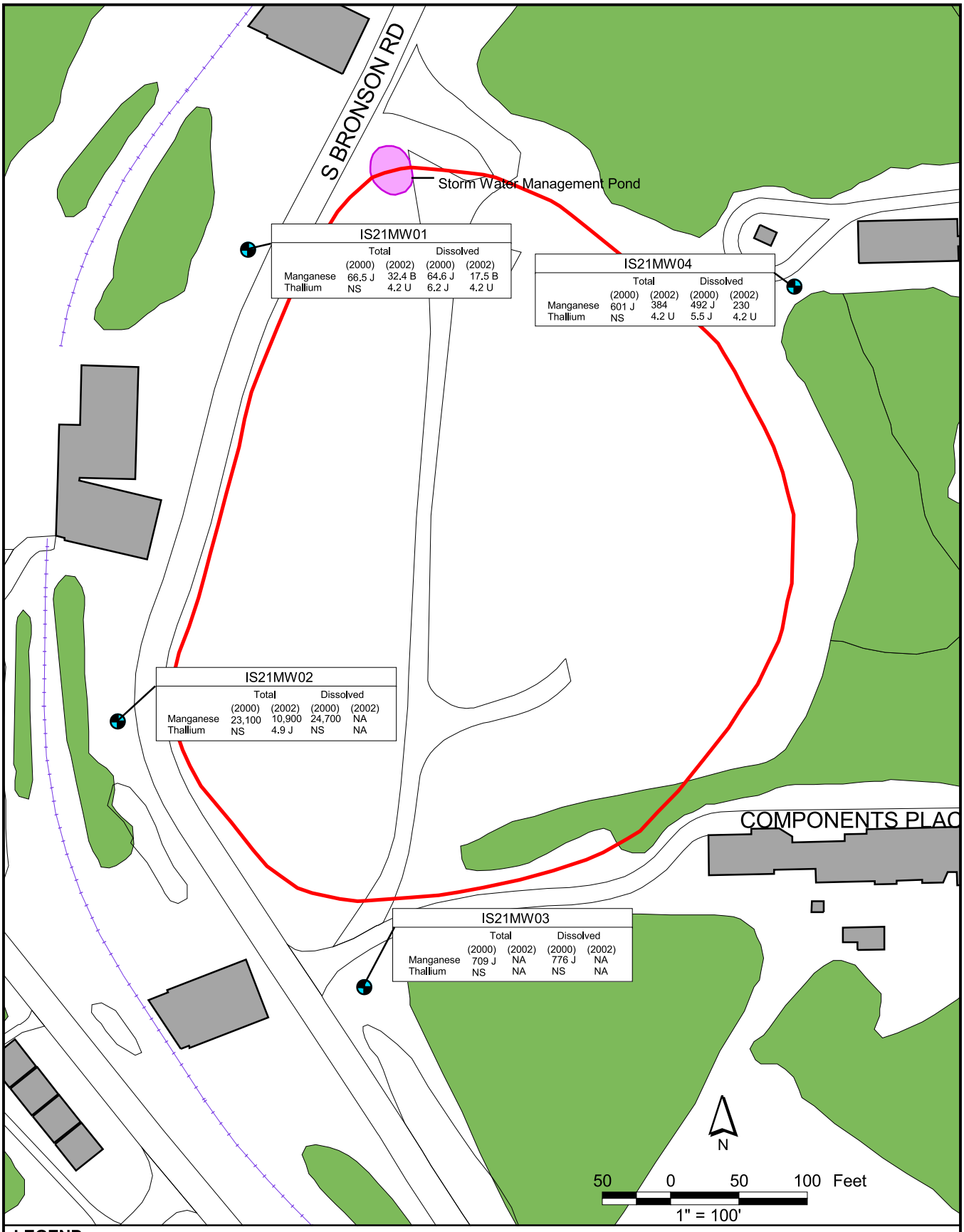
1" = 120'

Note: Soil Samples were collected during the 2000 RI.

Figure 1-13
Metals in Surface Soil
Feasibility Study
Site 21, Bronson Road Landfill
NSF- IH, Indian Head, Maryland

CH2MHILL

File Path: v:\18gis\indianhead\figures\site_21_revised_fs.apr



LEGEND

- Monitoring Wells
- IR Site
- Buildings
- Railroads
- Road
- Wooded Area

NA = Not Analyzed
NS = Not Sampled
ND = Non Detect
B = Analyte not detected above associated blank
J = Estimated Value Below the Detection Limit
U = Analyte not detected
All measurements in µg/l (micrograms per liter)

Note: Data Taken From the Final RI Report and Pre-Feasibility Study

Figure 1-14
Total and Dissolved, Manganese and Thallium in Groundwater
Feasibility Study
Site 21, Bronson Road Landfill
NSF- IH, Indian Head, Maryland

CH2MHILL

SECTION 2

Remedial Action Objectives, Applicable or Relevant and Appropriate Requirements, Site Remedial Goals, and Area of Attainment

This section presents general and site-specific RAOs and identifies corresponding Applicable or Relevant and Appropriate Requirements (ARARs) for Site 21. General RAOs are defined by the NCP and Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) (as amended by the Superfund Amendments and Reauthorization Act of 1986 [SARA]), which are applicable to all Superfund sites. CERCLA defines the statutory requirements for developing remedies.

Site-specific RAOs relate to specific contaminated media and to potential exposure routes. Site-specific RAOs, which require an understanding of the contaminants and the physical properties in their respective media, are based on an evaluation of the risks to public health and to the environment and ARARs.

ARARs and the preliminary facility-wide background concentrations of COCs in soil and shallow groundwater determine the site remediation goals (SRGs). SRGs then determine the area of attainment (AA).

2.1 NCP and CERCLA Objectives

The NCP requires that the selected remedy meet the following objectives:

- Each remedial action selected shall be protective of human health and the environment [40 CFR 300.430 (f)(1)(ii)(A)].
- On-site remedial actions that are selected must attain those ARARs that are identified at the time of the record of decision (ROD) signature [40 CFR 300.430(f)(1)(ii)(B)].
- Each remedial action selected shall be cost-effective, provided that it first satisfies the threshold criteria set forth in 40 CFR 300.430 (f)(1)(ii)(A) and (B). A remedy shall be cost-effective if its costs are proportional to its overall effectiveness [40 CFR 300.430 (f)(1)(ii)(D)].
- Each remedial action shall use permanent solutions and alternative treatment technologies or resource-recovery technology to the maximum extent practicable [40 CFR 300.430 (f)(1)(ii)(E)].

The statutory scope of CERCLA was amended by SARA to include the following general objectives for remedial action at all CERCLA sites:

- Remedial actions "…shall attain a degree of cleanup of hazardous substances, pollutants, and contaminants released into the environment and of control of further

releases at a minimum which assures protection of human health and the environment" [(CERCLA Section 121(d)].

- Remedial actions "…in which treatment that permanently and significantly reduces the volume, toxicity, or mobility of the hazardous substances, pollutants, and contaminants is a principal element" [CERCLA Section 121(b)] are preferred. If the treatment or recovery technologies selected are not a permanent solution, an explanation must be published.
- The least-favored remedial actions are those that include "off-site transport and disposal of hazardous substances or contaminated materials without treatment where practicable treatment technologies are available" [Section 121(b)].
- The selected remedy must comply with or attain the level of any "standard, requirement, criteria, or limitation under any federal environmental law or any promulgated standard, requirement, criteria, or limitation under a State environmental or facility siting law that is more stringent than any federal standard, requirement, criteria, or limitation" [Section 121(d)(2)(A)].

2.2 Site-Specific Remedial Action Objectives

Site-specific RAOs are based on the exposure setting for which protection would be provided (e.g., protection from ingestion of or direct contact with landfill contents). The potential exposure routes and risks for Site 21 were identified in the HHRA presented in the RI Report and summarized in Section 1 of this FS.

2.2.1 Site-Specific Remedial Action Objectives

Both the level of contamination and the potential exposure routes are considered when developing site-specific RAOs for protecting public health and the environment. The future protection of environmental resources and the means of minimizing long-term disruption to existing facility operations are also considered.

The RI, which included a baseline HHRA and is summarized in Section 1.6.1 of this FS report, identified low potential risks to future child resident associated with surface soil and to future child and adult residents associated with the shallow groundwater at Site 21. The RAOs are established to address contamination associated with the contents of the landfill, surface soil, and shallow groundwater. The site-specific RAOs for Site 21 are:

1. Prevent or minimize direct contact of human and ecological receptors with landfill contents.
2. Prevent surface water run-on and control surface water runoff and erosion.
3. Prevent unacceptable risks to human receptors from exposure to contaminants in the shallow groundwater.

2.2.2 Applicable or Relevant and Appropriate Requirements

As required by Section 121 of CERCLA, remedial actions carried out under Section 104 or secured under Section 106 must attain the levels of standards of control for hazardous

substances, pollutants, or contaminants specified by the ARARs of federal and state environmental laws and state facility-siting laws, unless waivers are obtained. According to USEPA guidance, remedial actions also must be based on non-promulgated "to-be-considered (TBC)" criteria or guidelines if the ARARs do not address a particular situation.

EPA distinguishes ARARs as either being applicable to a situation or relevant and appropriate to it. These distinctions are critical to understanding the constraints imposed on RAs by environmental regulations other than CERCLA. The definitions of ARARs below are from USEPA guidance (USEPA, 1988).

"Applicable requirements" are standards and other environmental protection requirements of federal or state law dealing with a hazardous substance, pollutant, or contaminant and its remedial action. For example, the Clean Water Act is "applicable" to a response action for discharging treated effluent. Also, the Corrective Action Management Unit regulations are "applicable" to actions requiring excavation and on-site placement of soil from the site.

"Relevant and appropriate requirements" are standards and environmental protection criteria of federal or state law that, although not "applicable" to a hazardous substance or remedial action, address situations sufficiently similar to those at the CERCLA site that their use is suitable. For example, although Resource Conservation and Recovery Act of 1976 (RCRA) regulations are not applicable to closing a site containing hazardous waste that was disposed of before 1980, the regulations may be relevant and appropriate.

A requirement may be "relevant" to a particular situation but not "appropriate" because of differences in the duration of the regulated activity or the physical characteristics of the affected media. For example, some of the requirements for designing and operating a waste pile that are found in Title 40 CFR Section 264.251, such as using a liner of sufficient strength and thickness to prevent failure caused by pressure gradients, might be considered relevant and appropriate, although the requirement to install a liner to cover all surrounding earth in potential contact with the waste might not be appropriate if the earth already is contaminated, and the eventual remedy is to remove all the contaminated earth.

A requirement that is relevant and appropriate must be met as if it were applicable. Relevant and appropriate requirements that are more stringent than applicable requirements take precedence. However, more discretion is allowed in determining relevant and appropriate requirements than in determining applicable requirements.

Another factor in determining which response or remedial requirements must be met is whether the requirement is substantive or administrative. On-site CERCLA response actions must meet substantive requirements but not administrative requirements. Substantive requirements are those dealing directly with actions or with conditions in the environment. Administrative requirements implement the substantive requirements by prescribing procedures such as fees, permitting, and inspection that make substantive requirements effective. This distinction applies to on-site actions only; off-site response actions are subject to all applicable standards and regulations, including administrative requirements such as permits.

2.2.3 Other Criteria or Guidelines to be Considered

Many federal and state programs have criteria, advisories, guidelines, and proposed standards that provide recommended procedures if no ARARs exist or if existing ARARs are inadequate. In such situations, the "TBC" criteria or guidelines should be used to set remedial action levels. Examples of criteria to be considered are RfDs and potency factors for ingestion of noncarcinogenic and carcinogenic compounds used in the risk assessment.

2.2.4 Determination of ARARs

Federal and state ARARs are summarized in Appendix D. The tables summarize the potential ARARs by classification and the "TBC" criteria, which are included as appropriate for each classification. There are three classifications of ARARs: chemical-specific, location-specific, and action-specific, as further described in this section.

The remedial action alternatives developed in this FS report were analyzed for compliance with federal and state ARARs. The analysis involved identifying potential requirements for each of the alternatives, evaluating their applicability or relevance, and determining if the RAs can achieve the ARARs. Results of that analysis are presented in Section 4 of this report. Any remedial action at the site must meet standards as defined by the ARARs of the USEPA and MDE because Site 21 is located within the state of Maryland. If the ARARs do not address a particular situation, remedial actions must be based on the "TBC" criteria or guidelines.

Chemical-Specific ARARs

Chemical-specific ARARs set health-based concentration limits or discharge limits in various environmental media for specific hazardous substances, pollutants, or contaminants. Examples of federal chemical-specific ARARs for Site 21 are Safe Drinking Water Act Maximum Contaminant Levels (MCLs) and MCL goals that are enforceable standards for drinking water sources and water quality criteria, which set limits for the discharge of water to surface water bodies. TBC criteria would include USEPA Region III risk-based criteria and other site-specific human health and ecological risk-based criteria developed for Site 21 preliminary remediation goals (PRGs) for the soil and shallow groundwater, which were developed based on the chemical-specific ARARs and TBCs, and are discussed in Section 2.2.5. Chemical-specific ARARs and TBCs for Site 21 are presented in Table D-1 in Appendix D.

Location-specific ARARs

Location-specific ARARs are design requirements or activity restrictions that are based on the geographical position of a site. An example is RCRA location requirements that set USEPA policy for carrying out provisions of Executive Order 11988 (Flood Plain Management) and Executive Order 11990 (Protection of Wetlands). Location-specific ARARs for Site 21 are presented in Table D-2 in Appendix D.

Action-specific ARARs

Action-specific ARARs set performance, design, or other standards for particular activities in managing hazardous substances or pollutants. For example, the design requirements for landfilling hazardous waste, established in RCRA 40 CFR Section 264.301, are action-

specific. RCRA contains the greatest number of action-specific ARARs because it regulates hazardous waste management. Action-specific ARARs for Site 21 are presented in Table D-3 in Appendix D.

2.2.5 Determination of Site Remediation Goals

SRGs for Site 21 were determined for all COCs in soil and shallow groundwater. For soil, SRGs are determined based on the greater of the site-specific, risk-based PRGs or background concentrations. For shallow groundwater, SRGs are determined based on the greater of risk-based PRGs, site background concentrations, or Maryland or Federal MCLs. Following is a discussion on the development of the PRGs with subsequent development of the SRGs.

Risk-Based Preliminary Remedial Goals

PRGs for surface soil were calculated for a child resident (Table 2-1) and for groundwater were calculated for a child resident and a construction worker (Table 2-2), although it is unlikely that Site 21 will become a residential area.

The equations presented in the USEPA's Risk Assessment Guidance for Superfund Volume 1, Part B (USEPA, 1991) were combined into a single equation to incorporate the ingestion, dermal absorption, and inhalation pathways (as appropriate) to calculate one PRG that combines all of these pathways, as opposed to individual PRGs. The soil PRG equation combined the ingestion and dermal absorption pathways for the child resident. The groundwater PRG equation combined the ingestion and dermal absorption pathways for the adult and child resident, and only the dermal absorption pathway for the construction worker. None of the COCs selected are considered volatile; therefore, PRG calculations did not include exposure through inhalation. The exposure assumptions used in the PRG calculation equations are the same as those used in the Site 21 HHRA. However, the dermal exposure factors used to calculate the dermally absorbed dose were updated to reflect the values presented in *Risk Assessment Guidance for Superfund (RAGS), Volume 1, Human Health Evaluation Manual, Part E Supplemental Guidance for Dermal Risk Assessment* (USEPA, 2001). Additionally, the absorption factors used to adjust the oral toxicity values for dermal exposure were updated to those presented in RAGS Part E.

The target noncarcinogenic hazard PRG was allocated pro-rata, based on the number of COCs that result in an effect to the same target organ (i.e., nervous system). For example, assuming an acceptable hazard is 1, if two constituents affect the same target, the target noncarcinogenic hazard for each constituent would be 0.5.

Appendix E presents the detailed calculations of the PRGs at Site 21.

Site Remediation Goals

Soil SRGs were determined from the greater of the PRGs and the facility-wide background concentrations.

For shallow groundwater, the PRGs were then compared to the preliminary facility-wide background values and MCLs for all COCs to determine the SRGs. Consistent with the Final RI report, background concentrations presented in the summary Tables 2-3 and 2-4 are based on the 95 percent UCL presented in the *Background Soil Investigation Report for Indian*

Head and Stump Neck Annex (Tetra Tech NUS, Inc., 2002) and provided as Appendix E in the Final RI report (CH2M HILL, 2004a). The greater concentration among the PRG, background concentration, and MCL was selected as the SRG for each COC.

Tables 2-3 and 2-4 present the recommended SRGs for soil and groundwater, respectively. The shaded values in these tables are the recommended SRGs.

2.2.6 Determination of COCs Requiring Remediation

Thallium exceeded its SRG in one filtered groundwater sample. The exceedance was based on J-qualified data, indicating that these reported concentrations were estimated below practical quantitation limits (e.g., reporting limits). The USEPA has called into question some low-level detections of metals using the Inductively Coupled Plasma analytical methods at sites in USEPA Region IV, particularly involving arsenic, lead, and thallium. Elevated iron concentrations produce many secondary peaks, some of which may interfere with thallium results, generating potential false positives (USEPA, 2001). In addition, one of the thallium exceedances occurred in the site-specific background well. The low-level detections of thallium at Site 21 may not be representative of true site conditions. Therefore, thallium will not be considered as a COC requiring remediation.

As described in Section 1.5.1.3, manganese was identified as a risk driver to the future adult and child residents drinking the shallow groundwater. Section 1.6.2.2 presents a summary of the manganese detections and risk assessment, and a discussion of manganese in the natural environment. To reiterate some of the information presented in Section 1.6.2.2, the risk from manganese is likely overestimated, and the pathway from which this risk is derived is likely incomplete; this is further explained in Appendix C. Furthermore, manganese exceeds the SRG at only well IS21MW02, which results in an uncertainty with the provenance of the manganese. It is uncertain if the manganese is from the landfill; however, as stated in Section 1.6.2.2, the groundwater monitoring results, in general, suggest that the concentrations of the dissolved manganese are within the typical range observed in natural waters.

For the reasons discussed above, a separate RA evaluation for the shallow groundwater will not be performed in this FS because of the lack of need to actively treat the groundwater. The shallow groundwater will be indirectly addressed in the RAs for soil and the solid waste in the landfill because a long-term groundwater monitoring is an integral part of the soil and solid waste remedy to closely assess the effectiveness of the remedy, as well as the behavior of the COCs in the shallow groundwater.

Arsenic is the only COC requiring remediation in the surface soil at Site 21.

2.3 Area of Attainment

The AA is defined as the area over which RAOs and, therefore, SRGs are to be met. The AA may not necessarily become the area of remediation, depending on the effectiveness, implementability, and cost for a particular RA.

For soil, the AA consists of the areas where the surface and buried metal and non-metal debris were identified during the geophysical survey and the area where concentration of

arsenic exceeds its SRG of 22 mg/kg. The soil AA encompasses an area of approximately 150,000 square feet or 3.5 acres. Figure 2-1 shows the AA for the solid waste and soil.

TABLE 2-1
Summary of Surface Soil Risk-Based PRGs
Feasibility Study
Site 21, Bronson Road Landfill
NSF-IH, Indian Head, Maryland

COC	Risk-Based PRG (mg/kg)	Basis for PRG
Residential Scenario		
Arsenic	22	Target hazard = 1, Child resident

TABLE 2-2
Summary of Shallow Groundwater Risk-Based PRGs
Feasibility Study
Site 21, Bronson Road Landfill
NSF-IH, Indian Head, Maryland

COC	Risk-Based PRG (µg/L)	Basis for PRG
Residential Scenario		
Manganese	290	Target hazard = 1, Child resident
Thallium	0.55	Target hazard = 1, Child resident
Construction Worker Scenario		
Manganese	11,000	Target hazard = 1, Construction worker

TABLE 2-3
Summary of SRGs for Site 21 Soil
Feasibility Study
Site 21, Bronson Road Landfill
NSF-IH, Indian Head, Maryland

COC	Facility Background 95% UCL (mg/kg)	Applicable Residential Soil PRG (mg/kg)	Maximum Detected Concentration (mg/kg)	Basis for PRG
Arsenic	2.56	22	51.8	Target hazard = 1, Child resident

Notes: 95% UCL—95 percent UCL
mg/kg—milligrams per kilogram
Shaded value represents SRG

TABLE 2-4
Summary of SRGs for Site 21 Shallow Groundwater
Feasibility Study
Site 21,Bronson Road Landfill
NSF-IH, Indian Head, Maryland

COC	Facility Background (μg/L)	Construction and Residential PRG (μg/L)	Maximum Detected Concentration (μg/L)	MCL (μg/L)	Basis for PRG
Manganese	824	290	24,700 (filtered)	NA	Target hazard = 1,Child resident
	824	11,000	23,100 (unfiltered)		Target hazard = 1,Construction Worker
Thallium	NA	0.55	6.20	2	Target hazard = 1,Child resident

Notes: NA—Not available
μg/L—micrograms per liter
Shaded value represents SRG
Construction worker risk-based PRG was not used in the PRG selection because it was less conservative than child resident scenario.

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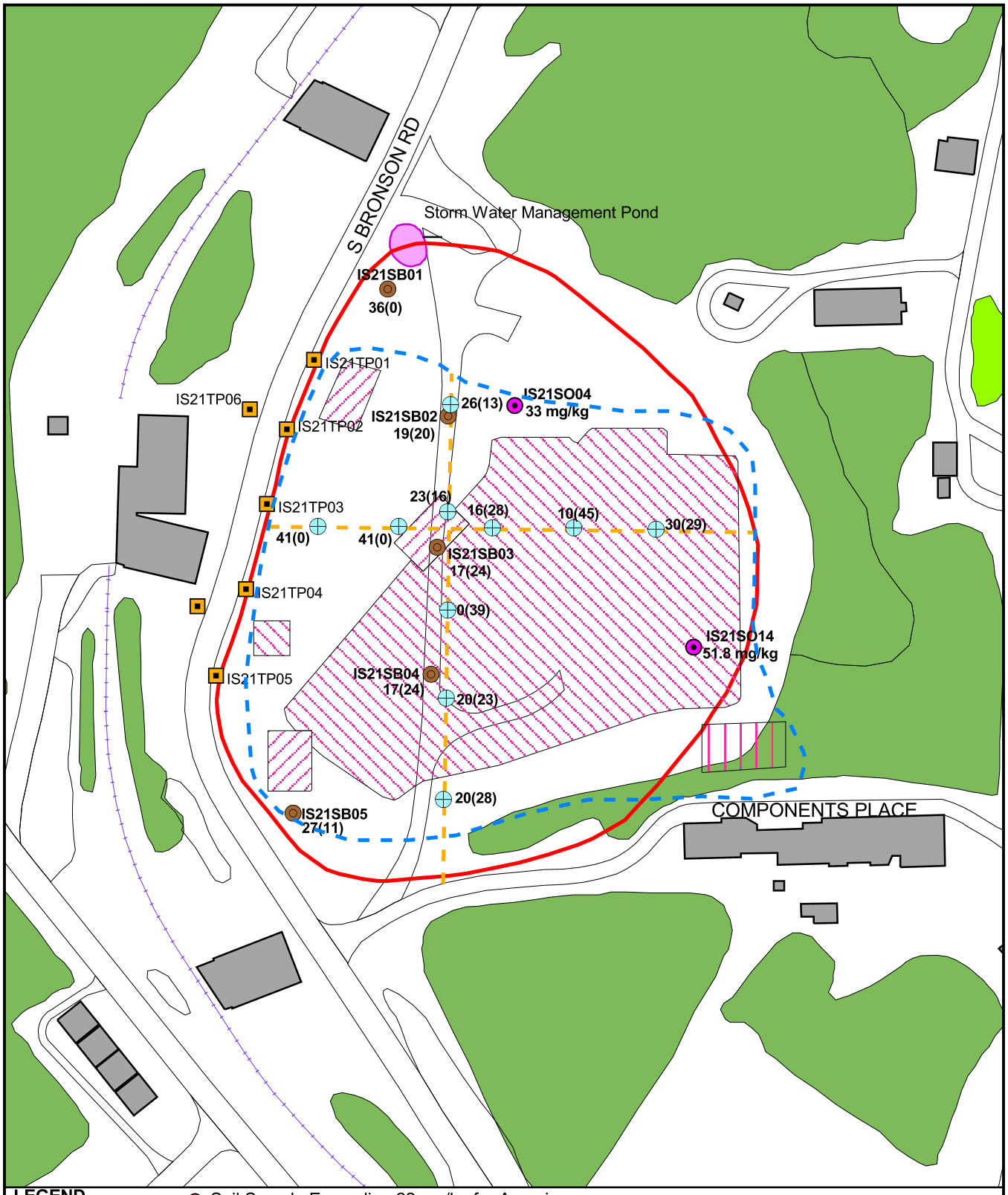

LEGEND

- Soil Boring
- Test Pits
- IR Site
- Buildings
- Railroads
- Road
- Wooded Area
- Soil Sample Exceeding 22 mg/kg for Arsenic
  51.8 mg/kg
- Buried Metal Debris
- Buried Metal and Non-metal Debris
- Surface and Buried Metal Debris
- Approximate Area of Attainment
- Electrical Resistivity Profile
- Data Point Along Electrical Resistivity Profile

27(11) = Estimated Elevation of Bottom of Fill (ft. above msl) with Estimated Thickness of Fill (ft.)

Notes:
1. Figure is taken from the Final RI Report (CH2M HILL, 2004)
2. The area of attainment boundary is approximate and is determined based on the geophysical survey conducted as part of the RI, test pit and soil boring information, and soil analytical results.

Figure 2-1
Soil Area of Attainment
Feasibility Study
Site 21, Bronson Road Landfill
NSF- IH, Indian Head, Maryland

N

60 0 60 120 Feet

1" = 120'

CH2MHILL

SECTION 3

Development of Remedial Alternatives

This section discusses the RAs developed to address the RAOs presented in Section 2. Potential remedial technologies and specific process options are identified and described for each response action. A preliminary screening assesses the suitability of these technologies and process options as part of a RA.

3.1 General Response Actions

General response actions are broad classes of responses or remedies developed to meet the site-specific RAOs defined for Site 21. Each action is intended to address specific constituents and the possible migration pathways and exposure routes in each medium. Although an action may be capable of meeting an objective, combinations of actions may be more cost effective in meeting all the objectives.

The general response actions listed below have been identified as being potentially applicable for the landfill and soil, and shallow groundwater:

- No action
- Institutional Controls (ICs)
- Containment
- *In situ* treatment
- Removal and off-site disposal

No action response is included because the NCP requires that a no action alternative be developed as a baseline for evaluating the RAs.

Institutional controls response action is a category of alternatives that can be used independently or as part of another response action. ICs include land use controls (LUCs), deed restrictions, or access restrictions, which prevent exposure to contaminated media. With respect to groundwater use, LUCs and deed restrictions often include groundwater monitoring. However, the efficacy of ICs as a groundwater remedy is receptor and pathway dependent. Not all exposures to groundwater can be prevented by ICs.

Containment response actions involve constructing a physical barrier that breaks the contact exposure pathway to the waste and reduces water infiltration through the waste. Containment is necessary when contaminated materials are left in place at a site. Containment offers quick installation times and typically low to moderate costs. Containment requires periodic inspections and maintenance for settlement, ponding of liquids, erosion, and naturally occurring invasion by deep-rooted vegetation. Additionally, groundwater monitoring wells need to be periodically sampled and maintained. Even with these long-term requirements, containment remedies usually are considerably more economical than excavation and removal.

In situ treatment response actions allow soil to be treated without being excavated and transported, resulting in potentially significant cost savings. However, *in situ* treatment generally requires longer time periods, with less certainty about the uniformity of treatment because of the variability in soil and because the efficacy of the process is more difficult to verify.

Removal and off-site disposal response actions include excavation of landfill content and contaminated soil and off-site disposal of the excavated material to an appropriately permitted landfill.

3.2 Identification and Screening of Remedial Technologies and Process Options

The next step in the FS process is to identify remedial technologies and process options for each general response action. *Remedial technologies* are general categories of technologies such as chemical treatment, thermal destruction, or immobilization. *Process options* are specific processes within each technology type. For example, the chemical treatment remedial technology includes process options such as precipitation, ion exchange, and oxidation/reduction.

The Technology Screening Matrix developed by the Federal Remediation Technologies Roundtable (FRTR) [at the FRTR Web site[3] and the Naval Facilities Engineering Command (NAVFAC) Environmental Restoration and Base Realignment and Closure Technology Web site[4]] and other sources are used in the preliminary identification of technologies and process options.

Technologies and process options that potentially apply to Site 21 were screened on the basis of their effectiveness, implementability, and relative cost for treating the COCs. Specific remedial technologies or process options were evaluated on the basis of their potential performance relative to other remedial technologies and process options within the same general response action.

In the screening process, *effectiveness* includes:

- The capability of the technology to attain RAOs
- The capability of a remedial technology to handle the estimated areas or volumes of remediation target and to prevent or minimize the release of hazardous substances to potential receptors
- The degree of protection afforded to human health and the environment during construction and implementation of the remedial technology
- The reliability and performance of the technology with respect to the site conditions

[3] **http://www.frtr.gov**

[4] http://enviro.nfesc.navy.mil/scripts/WebObjects.dll/erbweb

Implementability includes:

- The availability and capacity of treatment, storage, and disposal services
- The constructability of the remedial technology under facility conditions
- The time needed to implement the remedial technology, to achieve beneficial results, and to satisfy the RAOs

Relative cost screening considers the general capital and operation and maintenance (O&M) costs associated with the process options. During the screening phase, detailed, site-specific cost estimates were not developed. The relative cost of process options was considered only if the cost of an option was believed to be significantly higher than the cost for other process options comparably effective or implementable.

Table 3-1 presents the retained process options following technology screening. Where possible, a single process option was selected as representative of a general response action. In some cases, more than one process option was selected because the options could not be differentiated in terms of effectiveness, implementability, or relative cost. In addition to no action, the retained technologies are:

- LUCs and groundwater monitoring
- RCRA Subtitle C cap
- Protective soil cover
- Excavation and off-site disposal

3.3 Remedial Alternatives

The remedial technologies and process options that passed the initial screening process were assembled into RAs. Table 3-2 presents the RAs for Site 21.

TABLE 3-1
Screening of Remedial Process Options
Feasibility Study
Site 21, Bronson Road Landfill
NSF-IH, Indian Head, Maryland

General Response Action	Remedial Action or Technology	Process Options	Effectiveness	Implementability	Relative Cost	Evaluation Action		Screening Comments
						Retain	Reject	
No Action	None	Not applicable	Does not protect human health or the environment. Does not satisfy RAOs.	Easily implemented.	Low	X		Retain as baseline alternative.
Institutional Controls	Administrative restrictions	Land use restrictions (access and groundwater use)	Effectiveness depends on continued future implementation regardless of property use or ownership. Does not reduce contaminant levels but effective in minimizing human exposures.	Easily implemented on NSF-IH property.	Low	X		Could be used with other RA(s) until RAOs are met.
	Monitoring	Groundwater Monitoring	Effective in tracking contaminant migration and reduction. Does not satisfy RAOs.	Easily implemented. Existing monitoring wells may be used in the groundwater monitoring program.	Low capital, low O&M	X		Will likely be used with other remedial alternative(s) until RAOs are met and required under capping approach.
Containment	Capping	RCRA Subtitle C Cap	Highly effective minimizing human exposures and in preventing migration of the solid waste and contamination from the site as long as the integrity of the cap is maintained.	Easily implemented	High capital Moderate O&M	X		Conservative alternative since the solid waste within the landfill has not been fully characterized.
		Protective Soil Cap/Cover	Adequate effectiveness in minimizing human exposures and in preventing migration of contamination from the site as long as the integrity of the cover is maintained.	Easily implemented	Moderate capital Low to Moderate O&M	X	-	Demonstrated effectiveness under existing conditions. Risks can be managed effectively through ICs.
In situ Treatment	Physical/Chemical Treatment	Solidification/Stabilization	Will not be effective for heterogeneous landfill content, primarily large pieces of debris.	Implementable, though will likely require bench and pilot scale testing.	High to very high capital, low O&M		X	Difficult to verify its effectiveness because of the varied characteristics of the waste. Likely to be very high cost.
Removal and Off-site Disposal	Excavation and Off-site landfill Disposal	Excavation and Off-site landfill Disposal	Highly effective, waste and contaminated soil will be removed and disposed of at a permitted off-site landfill.	Implementable.	Very high due to transportation and disposal costs. Zero O&M.	X		Retain to depict worst-case scenario

Note: Shaded area indicates eliminated technology.

TABLE 3-2
Proposed Remedial Action Alternatives
Feasibility Study
Site 21, Bronson Road Landfill
NSF-IH, Indian Head, Maryland

Alternative 1:	No Action: This alternative is required by the NCP as a baseline. Alternative 1 involves no planned actions. NSF-IH is an active Navy installation that has certain existing ICs in place. In addition, the existing fill material may provide containment of and prevent exposure to waste in the landfill area.
Alternative 2:	Protective Soil Cover, LUCs, and Groundwater Monitoring: This alternative involves retrofitting activities for the existing soil cover, including soil cover repair, landscape re-grading for water infiltration and runoff management, in conjunction with LUCs. LUC measures include land-use restrictions and long-term monitoring for groundwater water quality and off-site migration.
Alternative 3:	RCRA Subtitle C Cap, LUCs, and Groundwater Monitoring: This alternative involves installation of a RCRA Subtitle C Cap in conjunction with LUCs and long-term monitoring program similar to Alternative 2.
Alternative 4:	Excavation and Off-site Disposal: This alternative involves excavation of the solid waste and contaminated soil within the landfill area and off-site disposal.

SECTION 4

Detailed Analysis of Remedial Alternatives

The RAs developed in Section 3 are further described and evaluated both individually and comparatively in this section. Additional screening of RAs was not necessary because of the limited number of technologies remaining following the technology screening in Section 3.

4.1 Descriptions of Remedial Alternatives

This section describes four RAs in further detail. Under all alternatives, a contingency plan would be developed and implemented in the event the contaminant migrated out of the AA. The costs associated with the development of contingency plans are not included. In addition, CERCLA statutory 5-year reviews[5] would be conducted under all alternatives, except the no action alternative.

4.1.1 Alternative 1—No Action

The no action alternative is required by the NCP and serves as the baseline alternative. All other remedial action alternatives are judged against the no action alternative. Under this alternative, no controls or remedial technologies will be implemented.

4.1.2 Alternative 2—Protective Soil Cover, LUCs, and Groundwater Monitoring

This alternative involves retrofitting activities for the existing soil cover, including soil cover repair, landscape re-grading for water infiltration and runoff management, in conjunction with LUCs, and groundwater monitoring. LUC measures include land- and groundwater-use restrictions. Groundwater monitoring includes long-term monitoring of groundwater at specified locations to monitor the transport and concentrations over time. Components of the alternative are described in more detail below.

Soil Cover

As previously described in Section 1.0, soil cover exists at the site. Based on the RI and the geophysical survey conducted at Site 21, the thickness of the existing soil cover is estimated to range from 5 to 10 feet. The soil and test pit borings, however, indicated that waste was exposed in some areas. For cost-estimating purposes, it is assumed that 100 percent of the soil cover area needs to be repaired by adding 24 inches of soil cover. The soil cover area is the AA, which covers an area of 150,000 square feet or 3.5 acres. This assumption has been made to ensure that all potentially contaminated soil is appropriately covered at Site 21 because exposed waste exists and the limits of contamination are unknown. A minimum soil cover of 24 inches will cover the entire AA.

[5] CERCLA (Section 121(c)), as amended by SARA (1986, requires that the site be reviewed every 5 years as long as contamination remains above levels that prevent unrestricted use.

The cover will be retrofitted to meet the following specifications:

- An 18-inch layer of earthen material.
- A 6-inch layer of earthen material capable of sustaining native plant growth.

Land- and Groundwater-Use Restrictions Under Alternative 2, the site would be designated as a "restricted use" area in the base Geographical Information System (GIS). This designation would prohibit intrusive activities at the site that may disrupt the integrity of the soil cover and potable use of groundwater. Records of the groundwater contamination would also be kept in the base GIS/environmental database. The restricted use designation would remain in place so long as the soil cover is in place.

Long-Term Groundwater Monitoring For cost-estimating purposes, groundwater monitoring would be performed for 30 years. Under this alternative, two additional hydraulically downgradient monitoring wells would be installed for further characterization of manganese SRG exceedance previously observed in well IS21MW02. All four existing groundwater monitoring wells, as well as the two additional downgradient monitoring wells would be sampled quarterly for the first year and annually for the remaining years. Unfiltered and filtered samples would be analyzed for TAL metals. As part of the LTM, geochemical data such as oxidation reduction potential, pH, dissolved oxygen, sulfate, iron (II), nitrate, and methane-ethane-ethene (MEE) will be collected and evaluated to assess manganese mobilization in the shallow groundwater. The frequency, duration and parameters analyzed for the long-term monitoring may be altered based on the results of the 5-year reviews. Detailed description of the monitoring program will be included in the long-term monitoring plan, prepared after the ROD is signed.

Other Design and O&M Requirements
A pre-design survey will be conducted to assess the condition and thickness of the existing cover. In addition, the costs will also cover the efforts associated with the design and planning of the cover. In addition, measures for surface water control, such as grading, ditches, dikes, berm, and revegetation will also be implemented, because these structures are designed to accept rainwater drainage from the cover.

For cost-estimating purposes, the design lifetime of the cover is assumed to be 30 years. Throughout this period of time, groundwater quality will be monitored and LUCs will be maintained. Biannual field inspections and mowing will be conducted throughout the 30-year period. The cover will be inspected on a 5-year schedule and will be repaired to the extent necessary.

4.1.3 Alternative 3—RCRA Subtitle C Cap, LUCs, and Groundwater Monitoring

This alternative involves the installation of a RCRA C cap in conjunction with LUCs and long-term monitoring of groundwater, similar to Alternative 2.

RCRA capping works by maintaining a multi-layer, low-permeability cover over the waste to stabilize surface soil and reduce surface water infiltration. The RCRA Subtitle C multi-layered landfill cap is a baseline design that is suggested for use in RCRA hazardous waste applications. These caps generally consist of an upper vegetative and protective (24-inch-thick earthen material) layer, a drainage layer (a 12-inch-thick sand—permeability > $1x10^{-2}$ centimeters per second [cm/sec]), and a low permeability layer, which consists of a

synthetic liner (>20 mil thickness) over 2 feet of compacted clay (permeability < $1x10^{-7}$ cm/sec).

Similar to Alternative 2, long-term groundwater monitoring and surface water control will be implemented in conjunction with this alternative. Under this alternative, a pre-design survey will be conducted to further assess the condition and thickness of the existing cover. In addition, the costs will also cover the efforts associated with the design and planning of the cap.

For cost-estimating purposes, the design lifetime of the cap is assumed to be 30 years. Throughout this period, biannual field inspections and mowing will be performed. The cap is assumed to require repair every 5 years.

4.1.4 Alternative 4—Excavation and Off-Site Disposal

Alternative 4 involves excavation of all waste material; metallic, non-metallic surface and buried debris; and contaminated soil within the soil AA for offsite disposal at a permitted landfill. Excavated material will be segregated and staged on site. Metallic debris, waste, and contaminated soil will be disposed of to an off-site landfill, and clean excavated material will be reused as backfill material in addition to the imported backfill material.

With the assumption that the average thickness of the waste material is approximately 20 feet (based on the results of the geophysical survey, soil borings, and test pit logs) and the excavation area is 150,000 square feet, the volume of excavated waste/debris is approximately 111,000 cubic yards. Portions of the excavated soil from Site 21 may be reused as backfill because over the years, clean soil from the water leak repairs has been stored at this site. However, to be conservative, for costing purposes, it is assumed that all of the excavated soil will be disposed off-site

4.2 Evaluation Criteria

The detailed alternative analysis is the means for assembling and evaluating technical and policy considerations to develop the rationale for selecting a remedy. Each alternative was developed to address potential threats to human health and the environment posed by contaminated groundwater. The NCP requires RAs be evaluated against the nine criteria listed below.

<u>Threshold Criteria</u>

- Protection of human health and the environment
- Compliance with ARARs

<u>Balancing Criteria</u>

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

Modifying Criteria

- State acceptance
- Community acceptance

The first two criteria are requirements that must be met unless specific ARARs are waived. The first seven criteria are addressed in this FS. The last two criteria will be addressed in the Proposed Plan and ROD. Figure 4-1 summarizes the NCP criteria.

The following paragraphs define and detail each of the nine criteria.

4.2.1 Overall Protection of Human Health and the Environment

This evaluation criterion is an assessment of whether each alternative achieves and maintains adequate protection of human health and the environment. The overall appraisal of protection draws on the assessments conducted under other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs. Another consideration is the statutory preference for on-site remedial actions.

4.2.2 Compliance with ARARs

This evaluation criterion is used to determine whether an alternative would meet all federal, state, and local ARARs that have been previously identified. Significant ARARs would be identified for each alternative, and descriptions on how they are met would be given. When an ARAR is not met, the basis for justifying one of the six waivers allowed under CERCLA would be discussed. A discussion of the compliance of each alternative with chemical-, location-, and action-specific ARARs and TBC guidance is included.

4.2.3 Long-Term Effectiveness and Permanence

Under this criterion the results of a RA are evaluated in terms of the risk remaining at the site after response objectives have been met. The primary focus of this evaluation is the extent and effectiveness of the actions or controls that may be required to manage the risk posed by treatment residuals or untreated wastes. Factors to be considered and addressed are magnitude of residual risk, adequacy of controls, and reliability of controls. Magnitude of residual risk is the assessment of the risk remaining from untreated waste or treatment residuals after remediation. Adequacy and reliability of controls is the evaluation of the controls that can be used to manage treatment residuals or untreated wastes that remain at the facility. The evaluation may include an assessment of containment systems and ICs to determine whether they are sufficient to ensure that any exposure to human and environmental receptors is within protective levels.

This FS also include results of the preliminary runs from the Hydrologic Evaluation of Landfill Performance (HELP) model to assess the effectiveness of the capping alternatives in the reduction of water infiltration into groundwater. However, because most of the waste is likely located below the water table, the percentages of water infiltration are presented for comparison only and will not be used to determine whether the alternative is effective and permanent.

4.2.4 Reduction of Toxicity, Mobility, and Volume

This evaluation criterion addresses the statutory preference for selecting remedial actions that, as their principal element, use technologies that permanently remediate and significantly reduce the toxicity, mobility, or volume of the hazardous substances. This preference is satisfied when treatment is used to reduce the principal threats at a site through destruction of toxic contaminants, reduction of the total mass of toxic contaminants, irreversible reduction of contaminant mobility, or reduction of total volume of contaminated media. When evaluating this criterion, an assessment is made as to whether remediation is used to reduce principal threats, including the extent to which toxicity, mobility, or volume are reduced either separately or in combination with one another. Factors that would be focused on include:

- Remediation processes employed by the remedy
- Amount of hazardous materials that would be remediated
- Degree of expected reduction in toxicity, mobility, or volume measured as a percentage of reduction
- Degree to which the remediation would be irreversible
- Type and quantity of treatment residuals that would remain following remediation
- Whether the alternative would satisfy the statutory preference for treatment as a principal element

4.2.5 Short-Term Effectiveness

This evaluation criterion addresses the effects of the alternative during the construction and implementation phase until RAOs are met. Alternatives would be evaluated with respect to their effects on human health and the environment during implementation of the remedial action. The following factors' RAOs would be addressed for each alternative:

- Protection of the community during remedial actions
- Protection of workers during remedial actions
- Environmental impacts during remedial actions
- Time until RAOs are achieved

4.2.6 Implementability

The implementability criterion addresses the technical and administrative feasibility of executing an alternative and the availability of various services and materials required during its implementation. Technical feasibility includes construction, operation, reliability of technology, ease of undertaking additional remedial action, and monitoring. Administrative feasibility refers to the activities needed to coordinate with other offices and agencies (e.g., local permits). Availability of services and materials includes availability of adequate off-facility treatment, storage capacity, and disposal services; necessary equipment and specialists; services and materials; and prospective technologies.

4.2.7 Cost

For the cost analysis of alternatives, the expenditures required to complete each remedial action are estimated in terms of both capital and annual O&M costs. Using these values, a present-worth calculation for each alternative can then be made for comparison.

Capital costs consist of direct and indirect costs. Direct costs include the cost of construction, equipment, land and site development, treatment, transportation, and disposal. Indirect costs include engineering expenses, license or permit costs, and contingency allowances.

Annual O&M costs are the post-construction costs required to ensure the continued effectiveness of the remedial action. Components of annual O&M cost include the cost of operating labor, maintenance materials and labor, auxiliary materials and energy, residue disposal, purchased services, administration, insurance, taxes, licensing, maintenance reserve and contingency funds, rehabilitation, monitoring, and periodic site reviews.

Expenditures that occur over a time period are analyzed using present worth, which discounts all future costs to a common base year. Present-worth analysis allows the cost of remedial action alternatives to be compared on the basis of a single figure representing the amount of money that, if invested in the base year and disbursed as needed, would be sufficient to cover all costs associated with the life of the remedial project. Assumptions associated with the present-worth calculations include a discount rate of 3 percent (OMB Circular No. A-94, Appendix C, revised January 1999), cost estimates in the planning years in constant dollars, and a period of performance that would vary depending on the activity, but would not exceed 30 years.

It should be noted that the cost estimates presented in this FS only provide an accuracy of +50 percent to -30 percent. The alternative cost estimates are in 2004 dollars and are based on conceptual design from information available at the time of this study. The actual cost of the project would depend on the final scope and design of the selected remedial action, the schedule of implementation, competitive market conditions, and other variables. Most of these factors are not expected to affect the relative cost differences between alternatives. The cost estimates were prepared in general conformance with "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study" (USEPA, 2000).

Expenditures that occur over different time periods are returned to present worth, which discounts all future costs to a common base year. Present-worth analysis allows the cost of remedial action alternatives to be compared on the basis of a single figure representing the amount of money that, if invested in the base year and disbursed as needed, would be sufficient to cover all costs associated with the life of the remedial project. Assumptions associated with the present-worth calculations include a discount rate of 5.5 percent for 30-year time frame (OMB, 2004), cost estimates in the planning years in constant dollars, and a period of performance that would vary depending on the activity, but would not exceed 30 years. Appendix F presents the detailed cost estimates for the RAs. This FS cost estimate was performed in 2004. However, for the cost comparison purposes, the cost estimate is still considered adequate.

4.2.8 State Acceptance

This assessment evaluates the technical and administrative issues and concerns that the State of Maryland may have regarding each of the alternatives. This criterion is not discussed in this report, but would be addressed in the ROD.

4.2.9 Community Acceptance

This assessment evaluates the issues and concerns the public may have regarding each of the alternatives. As with state acceptance, this criterion is not discussed in this report, but would be addressed in the ROD.

4.3 Detailed Evaluation of Remedial Alternatives

This section evaluates the four RAs against the seven criteria.

4.3.1 Alternative 1—No Action

Consideration of this alternative is required under the NCP, and serves as the baseline against which the effectiveness of other alternatives is judged. Under this alternative, no further effort or resources would be expended at Site 21 to address the landfill or soil contamination.

Overall Protection of Human Health and the Environment

Implementation of Alternative 1 would not protect human health or the environment. The risk posed by the landfill contents and surface soil would not be decreased because the risk of potential exposure by human and ecological receptors, and the potential for leaching of contaminants to the groundwater, would remain. Residual risks are identical to those identified in the baseline risk assessment.

Alternative 1 would partially achieve the RAOs for the shallow groundwater. As described in Section 2.4.2, risks from the exposures to manganese in the shallow groundwater by future adult and child residents are overestimated and the pathways are likely incomplete. As a result, this alternative would likely be protective of human health. However, because there are no planned activities, this alternative is not capable of achieving the second RAO for the shallow groundwater, "Returning the shallow groundwater to its beneficial use to the extent practicable."

Compliance with ARARs

There are no chemical-specific ARARs for landfill contents, surface soil, or shallow groundwater. Instead, SRGs have been developed for evaluation of the RAs. This alternative does not assist with meeting the SRGs. Similarly, there are no applicable location-specific ARARs for this alternative because no remedial actions will be undertaken. The alternative does not meet state regulations for solid waste landfills.

Long-Term Effectiveness and Permanence

Alternative 1 does not provide long-term effectiveness and permanence. The risk currently associated with the site would not be decreased and may be increased through continued

erosion and migration of landfill contaminants to groundwater. This alternative affords no measures to assess the long-term behavior of the COCs and the impact of the landfill to groundwater quality. Long-term and potential future risks posed by the site are described in the baseline risk assessment. Because contaminants are left at the site, a review of site conditions would be required every 5 years.

Reduction of Toxicity, Mobility, and Volume

This alternative would not provide any reduction in toxicity, mobility, or volume of the landfill contents.

Short-Term Effectiveness

No immediate increased risk to the surrounding community would be realized by implementation of this alternative. Because no action would be undertaken, the level of risk to human health and the environment would remain the same to those described in the baseline risk assessment.

Implementability

Evaluation of implementability includes technical feasibility, administrative feasibility, and availability of services and materials. Of these three issues, Alternative 1 only has administrative feasibility associated with its implementation. Contaminated material would remain at the site under this alternative. This would require that long-term administrative resources be provided to conduct the 5-year site reviews.

Cost

Taking no action would require no expenditure of money for both capital and O&M investments.

4.3.2 Alternative 2 —Protective Soil Cover, LUCs and Alternative 3—RCRA-Subtitle C Cap and LUCs

Because of the similar components of Alternatives 2 and 3, the detailed analyses of these alternatives are combined in this section.

Overall Protection of Human Health and Environment

Both alternatives would be protective of human health and environment. Although contaminants would remain on site, they would be prevented from entering potential exposure pathways by the presence of the soil cover or cap and LUCs. Groundwater use restrictions as a component of LUCs would prevent or minimize future exposure, while groundwater monitoring provides a mechanism to assess the long-term behavior of manganese in shallow groundwater and any potential impacts of the landfill to groundwater quality.

The benefit of an engineered cap may be marginal because significant portions of solid waste are in contact with the groundwater.

Compliance with ARARs and TBCs

Both alternatives will comply with the location-, action-, and chemical-specific ARARs identified in Section 2.0. Compliance would be met through elimination of the exposure pathways. However, implementation of Alternative 2 will require a waiver because of the incompliance with Code of Maryland Regulation (COMAR) 26.04.07.21 – Industrial Sanitary Landfill Closure requirements, a state ARAR that requires an impermeable cap to be installed for the closure of an industrial landfill, a category that was likely a best fit for the landfill at Site 21. Because significant portions of the solid waste volume lies below the water table, as shown in Figures 1-6 through 1-8, reduction of water infiltration may not be a critical criterion to be achieved, and therefore, soil cover may be adequate for Site 21.

Long-Term Effectiveness and Permanence

The risks to potential human and ecological receptors from the waste, contaminated soil, and shallow groundwater would be decreased to levels typically considered acceptable as long as the soil cover or cap is maintained and LUCs are properly and continuously implemented and enforced. However, if items in the waste/debris deteriorate or otherwise break down, contaminants may be released to the environment. Potential releases will be detected by sampling groundwater. The preliminary assessment using the HELP model predicted that no infiltration reduction would be achieved compared to the existing condition through the implementation of Alternative 2. However, this may not present as a drawback for Alternative 2 because most of the solid waste are already in contact with the shallow groundwater.

A RCRA Subtitle C Cap under Alternative 3 would likely reduce the water infiltration rate by 99.8 percent compared to the existing condition. The benefit of the reduced infiltration rate may be considered marginal because the majority of the solid waste volume is likely in contact with the shallow groundwater.

Reduction of Toxicity, Mobility, and Volume Through Treatment

There would be no reduction in toxicity or volume in this alternative. Both alternatives serve to reduce the potential for contact with the waste and contaminated soil. They also reduce the potential for infiltrating water to reach the waste and contaminated soil and limit the mobility of potential contaminants associated with the landfill. Greater reduction of the infiltration, however, would be achieved through the implementation of Alternative 3. Although these alternatives would not meet the statutory preference for treatment, they are expected to adequately meet RAOs for this site shortly after the soil cover or cap is installed.

Reduction of the water infiltration afforded under Alternative 3 may indirectly mitigate the mobilization of manganese in the shallow groundwater due to the reduced leachate or may exacerbate the mobilization of manganese by further exerting the reducing conditions in the shallow aquifer. Although the later case may be the likely outcome because most of the solid waste volume is already in contact with the shallow groundwater.

Implementability

Both alternatives would be implementable. Material and services for the technologies are available.

Short-Term Effectiveness

On-site exposure of construction workers to contaminants during placement of the cap would be minimal. Remedial action duration would be approximately 4 to 6 months. RAOs can be achieved shortly following the completion of the soil cover or cap.

Cost

The capital costs of Alternatives 2 and 3 are approximately $710,000 and $1.5 million, respectively. The total lifetime O&M costs in 2004 dollars are estimated at $940,000 and $1.3 million for Alternatives 2 and 3, respectively, resulting in the present worth costs for both alternatives of $1.155 million and $2.1 million.

4.3.3 Alternative 4—Excavation and Off-Site Disposal

Overall Protection of Human Health and the Environment

This alternative satisfies this criterion because waste and contaminated soil that may represent a potential source of contamination will be removed from the site, minimizing the residual contamination and therefore, minimizing the potential human and ecological receptors exposures to the landfill content.

Compliance with ARARs and TBCs

This alternative will comply with the location-, action-, and chemical-specific ARARs identified in Appendix D.

Long-Term Effectiveness and Permanence

Because the potential sources of contamination will be permanently removed from the site, Alternative 4 affords an adequate compliance with the long-term effectiveness and permanence.

Reduction of Toxicity, Mobility, or Volume Through Treatment

Reduction of toxicity, mobility, and volume of contaminant at Site 21 will be achieved through the removal of the potential sources of contamination but not through treatment.

Short-Term Effectiveness

Short-term impacts to the remediation workers resulting from the implementation of this alternative will be minimized through the implementation of good health and safety practices. OSHA-trained personnel will be required for all the site-related activities. Therefore, short-term hazards to the remediation workers will be minimized as much as possible. Also, erosion control measures will be used to prevent any discharge of waste from Site 21 to surface water during excavation.

Implementability

Excavation and landfill disposal are technically and administratively feasible because the technologies have become standard practices.

Cost

This alternative has an approximate capital cost of $14.75 million, with the majority of the costs expended for earthwork ($1 million) and off-site transportation and disposal fee ($9.2 million). No O&M costs are associated with this alternative.

THRESHOLD CRITERIA

OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

- How Alternatives Provide Human Health and Environmental Protection

COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)

- Compliance With Chemical-Specific ARARs
- Compliance With Action-Specific ARARs
- Compliance With Location-Specific ARARs
- Compliance With Other Criteria, Advisories, and Guidance (To-Be-Considered Guidance)

BALANCING CRITERIA

LONG-TERM EFFECTIVENESS AND PERMANENCE

- Magnitude of Residual Risk
- Adequacy and Reliability of Controls

REDUCTION OF TOXICITY, MOBILITY, AND VOLUME THROUGH TREATMENT

- Treatment Process Used and Materials Treated
- Amount of Hazardous Materials Destroyed or Treated
- Degree of Expected Reductions in Toxicity, Mobility, and Volume
- Degree to Which Treatment is Irreversible
- Type and Quantity of Residuals Remaining After Treatment

SHORT-TERM EFFECTIVENESS

- Protection of Community During Remedial Construction
- Protection of Workers During Remedial Construction
- Environmental Impacts
- Time Until Remedial Action Objectives Are Achieved

IMPLEMENTABILITY

- Ability to Construct and Operate the Technology
- Reliability of the Technology
- Ease of Undertaking Additional Remedial Action, if Necessary
- Ability to Monitor Effectiveness of Remedy
- Ability to Obtain Approvals From Other Agencies
- Coordination With Other Agencies
- Availability of Off-site Treatment, Storage, and Disposal Services and Capacity
- Availability of Necessary Equipment, Materials, and Personnel
- Availability of Prospective Technologies

COST

- Capital Costs
- Operating and Maintenance Costs
- Present Worth Cost

MODIFYING CRITERIA

STATE [1] ACCEPTANCE

COMMUNITY [1] ACCEPTANCE

1 These criteria are assessed following comment on the FS and the Proposed Plan.

FIGURE 4-1
Detailed Evaluation Criteria
Feasibility Study
Site 21, Bronson Road Landfill
NSF-IH, Indian Head, Maryland

SECTION 5

Comparative Analysis of Remedial Alternatives

In the following analysis, the RAs are evaluated in relation to one another for each of the seven NCP criteria. The purpose of this analysis is to identify the relative advantages and disadvantages of each alternative. Comparative analyses of RAs are documented below and further summarized in Tables 5-1.

5.1 Protection of Human Health and the Environment

All alternatives, except Alternative 1, are protective of human health and the environment. Alternative 1 does not protect human health and the environment because no action would be taken to mitigate unacceptable risk. Alternative 4 would achieve the greatest extent of protectiveness because the contaminated media would be removed from the site.

5.2 Compliance with ARARs

All alternatives, except Alternative 1, would comply with the ARARs and TBCs. However, unlike Alternative 4, the compliance with ARARs and TBCs under Alternatives 2 and 3 depends on the continuous enforcement of the LUCs and maintenance of the cap's or cover's integrity. Implementation of Alternative 2 will require a waiver because of the incompliance with COMAR 26.04.07.21 – Industrial Sanitary Landfill Closure requirements, a state ARAR that requires an impermeable cap to be installed for the closure of an industrial landfill, a category that was likely a best fit for the landfill at Site 21.

5.3 Long-Term Effectiveness and Permanence

Alternatives 2, 3, and 4 will achieve long-term effectiveness and permanence. Alternative 4, however, would achieve the greatest reduction of residual risk and the greatest adequacy and reliability of controls because contaminated media would be removed from the site compared to Alternatives 2 and 3. Alternatives 2 and 3 are permanent only to the extent that the cap or cover is maintained; both alternatives require continued maintenance to preserve risk reduction.

Although Alternative 3 affords a much greater reduction in water infiltration, the benefit to the groundwater contamination mitigation may be marginal because significant portions of solid waste are already in contact with the shallow groundwater. Therefore, the contribution of waste leachate to groundwater contamination may be small.

5.4 Reduction in Toxicity, Mobility, and Volume through Treatment

None of the alternatives would reduce the toxicity, mobility, or volume of contaminants through treatment. However, Alternative 4 would afford the greatest extent of mobility reduction through removal and disposal in an appropriately designed and permitted facility, followed by Alternatives 3 and 4 through on-site containment. Similarly, because of the removal of the contaminated media, Alternative 4 would leave a minimal quantity of residuals after removal and backfill. Because neither treatment nor removal would be associated with Alternatives 2 and 3, these alternatives afford no reduction in the quantity of residuals.

5.5 Short-Term Effectiveness

Alternative 4 would have the greatest potential impact to both the community and the workers during the removal action, as well as environmental impacts. This alternative, however, would achieve the RAOs within the shortest time frame. Alternatives 2 and 3 would take longer to achieve RAOs and risk reduction compared to Alternative 4. However, the potential impacts to the community would be minimal and the impacts to the remediation workers could be mitigated with safe practices for all alternatives.

5.6 Implementability

All alternatives involving active remedies would be readily implementable because the technologies contained in these alternatives are all well-accepted, conventional, and have been used successfully at numerous other NPL sites. Alternatives 2 and 3 would require approvals from more State agencies than Alternative 4, given State guidance and regulations on landfill cover design. Alternative 4 requires identifying an appropriate disposal facility with sufficient capacity for this waste stream.

5.7 Cost

On a present worth basis, Alternative 2 is less costly ($1.15 million) than Alternatives 3 ($2.1 million) and 4 ($14.75 million). All costs are within the degree of accuracy associated with conceptual level cost estimates (+50 percent to -30 percent degree of accuracy), in accordance with FS guidance (USEPA, 1988). The cost estimate is provided in Appendix F.

5.8 Uncertainty

As indicated in Section 2.0, groundwater will be addressed as part of the landfill remedy, which will be selected in the proposed plan. The RI identified manganese as a risk driver to the future child resident based on the concentration of manganese in one monitoring well, IS21MW02. Because of the uncertainty associated with the result from one well in selecting a remedy, an additional investigation of manganese downgradient of this well was conducted by CH2M HILL in 2006.

The results of the investigation indicated that except for the area west of IS21MW02, the extent of manganese in the other geographic directions has been characterized. The area to the west was not delineated to background because of the presence of several features, which limited access to the area with a direct-push rig. These features include a fence on the west side of Atkins Road, a hill, and a wetland area. The results of this investigation also indicate that the area of elevated manganese concentration is not isolated at or around IS21MW02. Appendix G presents the rationale and findings of this investigation. These results will be used in the remedy selection in the proposed plan for Site 21.

TABLE 5-1
Comparative Analysis of Remedial Alternatives Summary
Feasibility Study
Site 21, Bronson Road Landfill
NSF-IH, Indian Head, Maryland

Evaluation Criteria	Alternative 1 No Action	Alternative 2 Protective Soil Cover and LUCs	Alternative 3 RCRA Equivalent Cap and LUCs	Alternative 4 Excavation and Off-Site Disposal
Overall Protection of Human Health and the Environment	Not protective of human health and the environment	Adequate protection of human health and the environment. Exposures prevented by cover.	Adequate protection of human health and the environment. Effectively prevent solid waste and COCs from entering potential exposure pathways.	Adequate protection of human health and the environment because solid waste and contaminated soil would be removed from the site.
Compliance With ARARs	Non compliant	In compliance with chemical-, location-, and action-specific ARARS, with the exception of COMAR 26.04.07.21 – Industrial Sanitary Landfill Closure requirements, a state ARAR that requires an impermeable cap to be installed for the closure of an industrial landfill. However, a waiver can be issued if a soil cover is applicable.	Would comply with chemical-specific ARARs within a short amount of time (less than 6 months) and in compliance with location- and action-specific ARARS.	Would comply with chemical-specific ARARs within a short amount of time (less than 6 months) and in compliance with location- and action-specific ARARS.
Long-Term Effectiveness and Permanence	Not effective and permanent alternative. Magnitude of residual risk would remain unchanged. Adequacy and reliability of controls are very poor.	The risk to potential human and ecological receptors from the waste and contaminated soil would be reduced as long as the integrity of the cover is maintained.	The risk to potential human and ecological receptors from the waste and contaminated soil would be eliminated as long as the integrity of the cover is maintained. Provide better long-term adequacy and reliability of controls than Alternative 2 because RCRA cap is more impermeable than a soil cover.	The risk to potential human and ecological receptors from the waste and contaminated soil would be eliminated because the contamination is removed from the site. Therefore, the magnitude of residual risk would diminish significantly within shorter time frame.
Reduction of Toxicity, Mobility, or Volume Through Treatment	None	No reduction in toxicity or volume of contaminants. Adequately reduce the mobility of contaminants through containment.	No reduction in toxicity or volume of contaminants. Adequately reduce the mobility of contaminants through containment.	Reduction of toxicity, mobility, and volume through removal not treatment.
Short-Term Effectiveness	No impact to community, workers, and the environment form remedial activities because this alternative involves no active actions. Will not achieved RAOs.	Impacts to the remediation workers and community during the construction activities (primarily earthwork) are low to moderate can be minimized or potentially eliminated with proper planning and safe practices. RAOs be achieved within 6 months.	Impacts to the remediation workers and community during the construction activities (primarily earthwork) are moderate but can be minimized with proper planning and safe practices. RAOs be achieved within 6 months.	Impacts to the remediation workers and community during the construction activities (primarily earthwork and off-site transportation) are greatest but can be minimize with proper planning and safe practices. RAOs be achieved within 6 months.
Implementability	Has no ability to monitor the effectiveness of this remedy.	Easily implemented but requires long-term administrative commitment.	Easily implemented but requires long-term administrative commitment.	Easily implemented and does not require long-term administrative commitment because long-term monitoring and LUCs would likely not be required. Approval from other agencies is unlikely.
Cost[1]	$0	Capital: $710,000 Lifetime Present Worth O&M: $449,000 Total Present Worth: $1.15 million.	Capital: $1.5 million Lifetime Present Worth O&M: $639,000 Total Present Worth: $2.1 million	Capital: $14.75 million Lifetime Present Worth O&M: - Total Present Worth: $14.75 million
State and Community Acceptances	To Be Determined	To Be Determined	To Be Determined	To Be Determined
General Comment			Provide a conservative scenario in terms of the protectiveness of human health and the environment and the long-term effectiveness and permanence. However this benefit is marginal compared to Alternative 2 because portions of the solid waste is in contact with groundwater, therefore contribution of leachate to groundwater contamination may be small.	Provide the most conservative worst-case scenario, the benefits in terms of the protectiveness of human health and the environment and the long-term effectiveness and permanence is very marginal compared to Alternatives 2 and 3.

1 cost estimate was performed in 2004, however for the FS cost comparison purposes, this estimate is still considered adequate.

SECTION 6

References

CH2M HILL, 2002. *Pre-Feasibility Study Groundwater Sampling Activities Site 21 (Bronson Rod Landfill, Indian Head Division–NSWC.* Indian Head, Maryland. Technical Memorandum dated October 8.

CH2M HILL, 2003. *Investigation of Groundwater Flow and Perchlorate at Site 21, Indian Head Division–NSWC.* Indian Head, Maryland. Technical Memorandum dated March 14.

CH2M HILL. 2004a. *Final Remedial Investigation Report, Sites 11, 13, 17, 21, and 25, Indian Head Division–NSWC,* Indian Head, Maryland. April.

CH2M HILL. 2004b. *Manganese in Groundwater at Site 21, NDW-Indian, a Technical Memorandum submitted to the Indian Head Installation Restoration Team.* March 19.

McNeely and others. 1979. *Water Quality Sourcebook, A Guide to Water Quality Parameters.* Environment Canada. Inland Waters Directorate.

Moore, J.W. 1991. *Inorganic Contaminants in Surface Water: Research and Monitoring Priorities.* Springer-Verlag. New York.

Office of Management and Budget (OMB). 2004. OMB Circular No. A-94, Appendix C. February.

Reimer, P.S. 1999. *Environmental Effect of Manganese and Proposed Freshwater Guidelines to Protect Aquatic Life in British Columbia.* A Master of Science Thesis. April.

Tetra Tech NUS. 2002. *Background Soil Investigation Report for Indian Head and Stump Neck Annex*, Naval Surface Warfare Center, Indian Head Maryland. October.

U.S. Environmental Protection Agency (USEPA). 1988. Interim Final, Guidance for Conducting RI and FS under CERCLA. October.

USEPA. 1988. Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA, Interim Final, EPA/540/G-89/004, October.

USEPA. 1991. Risk Assessment Guidance for Superfund: Volume I (Human Health Evaluation Manual) Part B (Development of Risk-Based Preliminary Remediation Goals),EPA/540/R-92/003. December.

USEPA. 1999. Risk Assessment Issue Paper, Derivation of a Provisional RfD for Iron (CASRN 7439-89-6). National Center for Environmental Assessment. January.

USEPA. 2000. *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study*, EPA 540-R-00-002, OSWER 9355.0-75. July.

USEPA. 2001. *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual, Part E, Supplemental Guidance for Dermal Risk Assessment*, EPA/540/R/99/005, OSWER 9285.7-02EP, September.

USEPA. 2004. Drinking Water Health Advisory for Manganese, EPA/822/R/04/003, January

U.S. Geological Survey (USGS). http://energy.er.usgs.gov/products/papers/wvsmdtf/wvkiah.htm. Viewed in July 2004.

Appendix A
RI Surface Soil and Groundwater Analytical Results and Soil Boring Logs

Appendix A.1
RI Surface Soil and Groundwater Analytical Results

Table A.1.1
Detected Constituents in Groundwater
Feasibility Study, Site 21, Bronson Road Landfill
NSF-IH, Indian Head, Maryland

Station ID	IS21MW01		IS21MW02		IS21MW03				IS21MW04	
Sample ID	IS21MW010900		IS21MW020900		IS21MW030900P		IS21MW030900		IS21MW040900	
Sample Date	09/07/00		09/11/00		09/08/00		09/08/00		09/08/00	
Chemical Name										
Volatile Organic Compounds (UG/L)										
1,4-Dichlorobenzene			1.3	J						
Acetone	2.7	J								
Chlorobenzene			2.2	J						
Toluene			1.4	J						
Explosives (UG/L)										
1,3,5-Trinitrobenzene			0.19	J						
1,3-Dinitrobenzene	0.053	J							0.049	J
2,4-Dinitrotoluene			0.13	J			0.098	J		
Ammonium perchlorate	2	J							2,000	
Total Metals (UG/L)										
Aluminum	190	J	2,060		2,100		5,180		729	
Arsenic							3.6	J		
Barium	35.2	J	108	J	41	J	50.9	J	32.4	J
Cadmium					0.57	J	0.76	J	0.47	J
Calcium	1,720	J	29,700		22,100	J	23,200	J	3,380	J
Chromium			103		58.4		83.2		3.9	J
Cobalt	9.5	J	161		25.7	J	27.5	J	42.9	J
Copper	5.3	J	27.9		38.3		47.5		6.4	J
Cyanide			1.7	L			1.7	L		
Iron	97.3	J	24,200		2,820		6,820		1,790	
Lead			3.9		6.7		9		2.1	J
Magnesium	1,090	J	18,000		29,900		31,100		1,200	J
Manganese	66.5	J	23,100		682	J	709	J	601	J
Mercury			0.1		0.12	J				
Nickel	6.8	J	85.7		71.5		84.4			
Potassium	2,120	J	7,590		4,110	J	4,400	J	1,120	J
Silver			1.3	J						
Sodium	12,400		72,700		58,200		59,400		74,900	
Vanadium			6.5	J	4.9	J	12.5	J	5.2	J

J - Estimated Value
K - Biased high
L - Biased low

Table A.1.1
Detected Constituents in Groundwater
Feasibility Study, Site 21, Bronson Road Landfill
NSF-IH, Indian Head, Maryland

Station ID	IS21MW01		IS21MW02		IS21MW03				IS21MW04	
Sample ID	IS21MW010900		IS21MW020900		IS21MW030900P		IS21MW030900		IS21MW040900	
Sample Date	09/07/00		09/11/00		09/08/00		09/08/00		09/08/00	
Chemical Name										
Zinc	30.7	J	164		77.3	J	87.1	J	19.9	J
Dissolved Metals (UG/L)										
Aluminum					705		667			
Barium	33.3	J	113	J	37.7	J	36.5	J	11.9	J
Cadmium					0.59	J	0.74	J		
Calcium	1,890	J	34,400		25,700	J	24,800	J	2,930	J
Chromium					5.8	J	7	J		
Cobalt	8.9	J	179		29.1	J	29.2	J	33.6	J
Copper	7.3	J	7.8	J	28.9		26.3			
Iron			16,300		180		335		331	
Lead					4		3.7			
Magnesium	1,050	J	20,900		34,600		33,000		1,050	J
Manganese	64.6	J	24,700		776	J	748	J	492	J
Nickel			46.9		48.9		67.5			
Potassium	2,080	J	8,460		4,190	J	3,970	J	1,140	J
Silver			2.4	J						
Sodium	12,100		82,600		65,900		62,300		87,800	
Thallium	6.2	J							5.5	J
Zinc	49.9	J	209		69.9	J	69.5	J	26.6	J

J - Estimated Value
K - Biased high
L - Biased low

Table A.1.2
Raw Analytical Results for Surface Soil
Feasibility Study, Site 21, Bronson Road Landfill
NSF-IH, Indian Head, Maryland

	IS21SS010001		IS21SS020001		IS21SS030001		IS21SS040001		IS21SS050001		IS21SS060001		IS21SS070001		IS21SS080001		IS21SS090001	
Sample Date																		
Chemical Name																		
Volatile Organic Compounds (UG/KG)																		
1,1,1-Trichloroethane	18	U	11	U	12	U	13	U	11	U	11	U	13	R	12	U	12	U
1,1,2,2-Tetrachloroethane	18	U	11	U	12	U	13	U	11	U	11	U	13	UJ	12	U	12	U
1,1,2-Trichloro-1,2,2- trifluoroethane	18	U	11	U	12	U	13	U	11	U	11	U	13	R	12	U	12	U
1,1,2-Trichloroethane	18	U	11	U	12	U	13	U	11	U	11	U	13	R	12	U	12	U
1,1-Dichloroethane	18	U	11	U	12	U	13	U	11	U	11	U	13	R	12	U	12	U
1,1-Dichloroethene	18	U	11	U	12	U	13	U	11	U	11	U	13	U	12	U	12	U
1,2,4-Trichlorobenzene	18	U	11	U	12	U	13	U	11	U	11	U	13	UJ	12	U	12	U
1,2-Dibromo-3-chloropropane	18	U	11	U	12	U	13	U	11	U	11	U	13	UJ	12	U	12	U
1,2-Dibromoethane	18	U	11	U	12	U	13	U	11	U	11	U	13	UJ	12	U	12	U
1,2-Dichlorobenzene	18	U	11	U	12	U	13	U	11	U	11	U	13	R	12	U	12	U
1,2-Dichloroethane	18	U	11	U	12	U	13	U	11	U	11	U	13	UJ	12	U	12	U
1,2-Dichloroethene (total)	NS		NS		NS		NS		NS		NS		NS		NS		NS	
1,2-Dichloropropane	18	U	11	U	12	U	13	U	11	U	11	U	13	R	12	U	12	U
1,3-Dichlorobenzene	18	U	11	U	12	U	13	U	11	U	11	U	13	UJ	12	U	12	U
1,4-Dichlorobenzene	18	U	11	U	12	U	13	U	11	U	11	U	13	UJ	12	U	12	U
2-Butanone	18	U	11	U	12	U	13	U	11	U	11	U	13	R	12	U	12	U
2-Hexanone	18	U	11	U	12	U	13	U	11	U	11	U	13	UJ	12	U	12	U
4-Methyl-2-pentanone	18	U	11	U	12	U	13	U	11	U	11	U	13	UJ	12	U	12	U
Acetone	1.8	B	11	U	1.4	B	1.7	B	11	U	1.8	B	13	R	2	B	2.7	B
Benzene	18	U	11	U	12	U	13	U	11	U	11	U	13	R	12	U	12	U
Bromodichloromethane	18	U	11	U	12	U	13	U	11	U	11	U	13	R	12	U	12	U
Bromoform	18	U	11	U	12	U	13	U	11	U	11	U	13	R	12	U	12	U
Bromomethane	18	U	11	U	12	U	13	U	11	U	11	U	13	R	12	U	12	U
Carbon disulfide	18	U	11	U	12	U	13	U	11	U	11	U	13	R	12	U	12	U
Carbon tetrachloride	18	U	11	U	12	U	13	U	11	U	11	U	13	R	12	U	12	U
Chlorobenzene	18	U	11	U	12	U	13	U	11	U	11	U	13	R	12	U	12	U
Chloroethane	18	U	11	U	12	U	13	U	11	U	11	U	13	R	12	U	12	U
Chloroform	18	U	11	U	12	U	13	U	11	U	11	U	13	R	12	U	12	U
Chloromethane	18	U	11	U	12	U	13	U	11	U	11	U	13	R	12	U	12	U
Cumene	18	U	11	U	12	U	13	U	11	U	11	U	13	R	12	U	12	U
Cyclohexane	18	U	11	U	12	U	13	U	11	U	11	U	13	R	12	U	12	U
Dibromochloromethane	18	U	11	U	12	U	13	U	11	U	11	U	13	R	12	U	12	U
Dichlorodifluoromethane	18	U	11	U	12	U	13	U	11	U	11	U	13	R	12	U	12	U
Ethylbenzene	18	U	11	U	12	U	13	U	11	U	11	U	13	R	12	U	12	U

NS - Not sampled
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J - Reported value is estimated
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L - Reported value may be biased low
R - Unreliable result
U - Analyte not detected

Table A.1.2
Raw Analytical Results for Surface Soil
Feasibility Study, Site 21, Bronson Road Landfill
NSF-IH, Indian Head, Maryland

	IS21SS010001		IS21SS020001		IS21SS030001		IS21SS040001		IS21SS050001		IS21SS060001		IS21SS070001		IS21SS080001		IS21SS090001	
Sample Date																		
Chemical Name																		
Methyl acetate	18	U	11	U	12	U	13	U	11	U	11	U	13	R	12	U	12	U
Methyl-tert-butyl ether (MTBE)	18	U	11	U	12	U	13	U	11	U	11	U	13	J	12	U	12	U
Methylcyclohexane	18	U	11	U	12	U	13	U	11	U	11	U	13	R	12	U	12	U
Methylene chloride	18	U	11	U	12	U	13	U	1.2	B	11	U	13	R	12	U	12	U
Styrene	18	U	11	U	12	U	1.5	J	11	U	11	U	13	R	12	U	12	U
Tetrachloroethene	18	U	11	U	12	U	13	U	11	U	11	U	13	UJ	12	U	12	U
Toluene	18	U	11	U	12	U	13	U	11	U	11	U	13	R	12	U	6.3	J
Trichloroethene	18	U	11	U	12	U	13	U	11	U	11	U	13	UJ	12	U	12	U
Trichlorofluoromethane	18	U	11	U	12	U	13	U	11	U	11	U	13	R	12	U	12	U
Vinyl chloride	18	U	11	U	12	U	13	U	11	U	11	U	13	R	12	U	12	U
Xylene, total	18	U	11	U	12	U	13	U	11	U	11	U	13	R	12	B	12	B
cis-1,2-Dichloroethene	18	U	11	U	12	U	13	U	11	U	11	U	13	R	12	U	12	U
cis-1,3-Dichloropropene	18	U	11	U	12	U	13	U	11	U	11	U	13	R	12	U	12	U
trans-1,2-Dichloroethene	18	U	11	U	12	U	13	U	11	U	11	U	13	R	12	U	12	U
trans-1,3-Dichloropropene	18	U	11	U	12	U	13	U	11	U	11	U	13	R	12	U	12	U
Semi-volatile Organic Compounds (UG/KG)																		
1,1-Biphenyl	580	U	380	U	400	U	420	U	380	U	370	U	410	U	400	U	400	U
2,2'-Oxybis(1-chloropropane)	580	U	380	U	400	U	420	U	380	U	370	U	410	U	400	U	400	U
2,4,5-Trichlorophenol	1,500	U	940	U	1,000	U	1,100	U	950	U	940	U	1,000	U	1,000	U	1,000	U
2,4,6-Trichlorophenol	580	U	380	U	400	U	420	U	380	U	370	U	410	U	400	U	400	U
2,4-Dichlorophenol	580	U	380	U	400	U	420	U	380	U	370	U	410	U	400	U	400	U
2,4-Dimethylphenol	580	U	380	U	400	U	420	U	380	U	370	U	410	U	400	U	400	U
2,4-Dinitrophenol	1,500	U	940	U	1,000	U	1,100	U	950	U	940	U	1,000	U	1,000	U	1,000	U
2-Chloronaphthalene	580	U	380	U	400	U	420	U	380	U	370	U	410	U	400	U	400	U
2-Chlorophenol	580	U	380	U	400	U	420	U	380	U	370	U	410	U	400	U	400	U
2-Methylnaphthalene	580	U	380	U	400	U	420	U	380	U	370	U	410	U	400	U	400	U
2-Methylphenol	580	U	380	U	400	U	420	U	380	U	370	U	410	U	400	U	400	U
2-Nitroaniline	1,500	U	940	U	1,000	U	1,100	U	950	U	940	U	1,000	U	1,000	U	1,000	U
2-Nitrophenol	580	U	380	U	400	U	420	U	380	U	370	U	410	U	400	U	400	U
3,3'-Dichlorobenzidine	580	U	380	U	400	U	420	U	380	U	370	U	410	U	400	U	400	U
3-Nitroaniline	1,500	U	940	U	1,000	U	1,100	U	950	U	940	U	1,000	U	1,000	U	1,000	U
4,6-Dinitro-2-methylphenol	1,500	U	940	U	1,000	U	1,100	U	950	U	940	U	1,000	U	1,000	U	1,000	U
4-Bromophenyl-phenylether	580	U	380	U	400	U	420	U	380	U	370	U	410	U	400	U	400	U
4-Chloro-3-methylphenol	580	U	380	U	400	U	420	U	380	U	370	U	410	U	400	U	400	U

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Table A.1.2
Raw Analytical Results for Surface Soil
Feasibility Study, Site 21, Bronson Road Landfill
NSF-IH, Indian Head, Maryland

	IS21SS010001		IS21SS020001		IS21SS030001		IS21SS040001		IS21SS050001		IS21SS060001		IS21SS070001		IS21SS080001		IS21SS090001	
Sample Date																		
Chemical Name																		
4-Chloroaniline	580	U	380	U	400	U	420	U	380	U	370	U	410	U	400	U	400	U
4-Chlorophenyl-phenylether	580	U	380	U	400	U	420	U	380	U	370	U	410	U	400	U	400	U
4-Methylphenol	580	U	380	U	400	U	420	U	380	U	370	U	410	U	400	U	400	U
4-Nitroaniline	1,500	U	940	U	1,000	U	1,100	U	950	U	940	U	1,000	U	1,000	U	1,000	U
4-Nitrophenol	1,500	U	940	U	1,000	U	1,100	U	950	U	940	U	1,000	U	1,000	U	1,000	U
Acenaphthene	580	U	380	U	400	U	420	U	380	U	370	U	410	U	400	U	400	U
Acenaphthylene	580	U	380	U	400	U	420	U	380	U	370	U	410	U	400	U	400	U
Acetophenone	580	U	380	U	400	U	420	U	380	U	370	U	410	U	400	U	400	U
Anthracene	580	U	380	U	400	U	420	U	45	J	370	U	410	U	400	U	400	U
Atrazine	580	U	380	U	400	U	420	U	380	U	370	U	410	U	400	U	400	U
Benzaldehyde	580	U	380	U	400	U	420	U	380	U	370	U	410	U	400	U	400	U
Benzo(a)anthracene	81	J	83	J	400	U	170	J	260	J	370	U	120	J	190	J	72	J
Benzo(a)pyrene	580	U	380	U	400	U	46	J	81	J	61	J	45	J	49	J	400	U
Benzo(b)fluoranthene	130	J	130	J	400	U	250	J	350	J	370	U	200	J	270	J	110	J
Benzo(g,h,i)perylene	580	U	380	U	400	U	420	U	380	U	370	U	410	U	400	U	400	U
Benzo(k)fluoranthene	62	J	42	J	400	U	100	J	170	J	370	U	79	J	140	J	400	U
Butylbenzylphthalate	580	U	380	U	400	U	420	U	380	U	370	U	410	U	400	U	400	U
Caprolactam	580	U	380	U	400	U	420	U	380	U	370	U	410	U	400	U	400	U
Carbazole	580	U	380	U	400	U	420	U	380	U	370	U	410	U	400	U	400	U
Chrysene	100	J	100	J	400	U	190	J	290	J	370	U	140	J	230	J	87	J
Di-n-butylphthalate	580	U	380	U	400	U	420	U	380	U	370	U	410	U	400	U	400	U
Di-n-octylphthalate	580	U	380	U	400	U	420	U	380	U	370	U	410	U	400	U	400	U
Dibenz(a,h)anthracene	580	U	380	U	400	U	420	U	41	J	370	U	410	U	400	U	400	U
Dibenzofuran	580	U	380	U	400	U	420	U	380	U	370	U	410	U	400	U	400	U
Diethylphthalate	390	B	72	B	400	U	84	B	380	U	370	U	410	U	400	U	250	B
Dimethyl phthalate	580	U	380	U	400	U	420	U	380	U	370	U	410	U	400	U	400	U
Fluoranthene	140	J	160	J	400	U	320	J	530		370	U	190	J	340	J	130	J
Fluorene	580	U	380	U	400	U	420	U	380	U	370	U	410	U	400	U	400	U
Hexachlorobenzene	580	U	380	U	400	U	420	U	380	U	370	U	410	U	400	U	400	U
Hexachlorobutadiene	580	U	380	U	400	U	420	U	380	U	370	U	410	U	400	U	400	U
Hexachlorocyclopentadiene	580	U	380	U	400	U	420	U	380	U	370	U	410	U	400	U	400	U
Hexachloroethane	580	U	380	U	400	U	420	U	380	U	370	U	410	U	400	U	400	U
Indeno(1,2,3-cd)pyrene	580	U	380	U	400	U	61	J	77	J	52	J	410	U	57	J	400	U
Isophorone	580	U	380	U	400	U	420	U	380	U	370	U	410	U	400	U	400	U
Naphthalene	580	U	380	U	400	U	420	U	380	U	370	U	410	U	400	U	400	U

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Table A.1.2
Raw Analytical Results for Surface Soil
Feasibility Study, Site 21, Bronson Road Landfill
NSF-IH, Indian Head, Maryland

	IS21SS010001		IS21SS020001		IS21SS030001		IS21SS040001		IS21SS050001		IS21SS060001		IS21SS070001		IS21SS080001		IS21SS090001	
Sample Date																		
Chemical Name																		
Pentachlorophenol	1,400	U	910	U	970	U	1,000	U	910	U	900	U	1,000	U	960	U	970	U
Phenanthrene	580	U	63	J	400	U	110	J	230	J	370	U	66	J	120	J	63	J
Phenol	580	U	380	U	400	U	420	U	380	U	370	U	410	U	400	U	400	U
Pyrene	580	U	73	J	400	U	130	J	220	J	59	J	120	J	170	J	85	J
bis(2-Chloroethoxy)methane	580	U	380	U	400	U	420	U	380	U	370	U	410	U	400	U	400	U
bis(2-Chloroethyl)ether	580	U	380	U	400	U	420	U	380	U	370	U	410	U	400	U	400	U
bis(2-Ethylhexyl)phthalate	76	J	380	U	45	J	48	J	48	J	370	U	45	J	400	U	45	J
n-Nitroso-di-n-propylamine	580	U	380	U	400	U	420	U	380	U	370	U	410	U	400	U	400	U
n-Nitrosodiphenylamine	580	U	380	U	400	U	420	U	380	U	370	U	410	U	400	U	400	U
Explosives (MG/KG)																		
1,3,5-Trinitrobenzene	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U
1,3-Dinitrobenzene	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U
2,4,6-Trinitrotoluene	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U
2,4-Dinitrotoluene	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U
2,6-Dinitrotoluene	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U
2-Amino-4,6-dinitrotoluene	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U
2-Nitrotoluene	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U
3-Nitrotoluene	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U
4-Amino-2,6-dinitrotoluene	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U
4-Nitrotoluene	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U
Ammonium perchlorate	0.097	U	0.092	U	0.097	U	0.1	U	0.098	U	0.089	U	0.089	U	0.098	U	0.099	U
HMX	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.19	J	0.5	U	0.5	U	0.5	U
Nitrobenzene	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U
Nitroglycerin	1.7	U	1.2	U	1.3	U	1.3	U	1.1	U	1.1	U	1.1	U	1.1	U	1.1	U
Nitroguanidine	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.068	J	0.1	U	0.1	U	0.1	U
PETN	2.5	U	2.5	U	2.5	U	2.5	U	2.5	U	2.5	U	2.5	U	2.5	U	2.5	U
RDX	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Tetryl	0.65	U	0.65	U	0.65	U	0.65	U	0.65	U	0.65	U	0.65	U	0.65	U	0.65	U
Total Metals (MG/KG)																		
Aluminum	9,830		5,240		6,440		6,780		7,230		7,340		4,130		6,070		5,760	
Antimony	1.5	UL	0.98	UL	1	UL	1.1	UL	0.98	UL	0.97	UL	1.1	UL	1	UL	1	UL
Arsenic	15.1		9		18.5		33		7.2		4.8		3.6		17.8		9.7	
Barium	67.6	J	35.9	J	28.5	J	51.1		41.5	J	34.2	J	24.8	J	38.5	J	39	J

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Table A.1.2
Raw Analytical Results for Surface Soil
Feasibility Study, Site 21, Bronson Road Landfill
NSF-IH, Indian Head, Maryland

	IS21SS010001		IS21SS020001		IS21SS030001		IS21SS040001		IS21SS050001		IS21SS060001		IS21SS070001		IS21SS080001		IS21SS090001	
Sample Date																		
Chemical Name																		
Beryllium	0.42	B	0.15	B	0.059	B	0.051	U	0.3	B	0.12	B	0.078	B	0.068	B	0.094	B
Cadmium	0.92	J	1.5		0.097	U	0.1	U	0.091	U	0.09	U	0.52	J	0.096	U	0.097	U
Calcium	2,640		1,160		277	J	305	J	4,870		208	J	3,290		453	J	902	J
Chromium	18.8		16.5		36.6		15.3		16.3		11.9		13.8		12.2		12.7	
Cobalt	7.9	J	4.5	J	2.3	J	2.2	J	4	J	3.7	J	3.1	J	2.5	J	4.5	J
Copper	22	K	14.9	K	26.4	K	13.4	K	9.4	K	9.8	K	7.2	K	10.2	K	7.8	K
Cyanide	0.18		0.075	B	0.61		0.64		0.57		0.12	B	0.12	B	0.6		0.6	
Iron	25,300		13,400		13,200		29,500		16,300		17,200		9,310		18,800		15,100	
Lead	57.1		35.9		18.5		31.4		16.2		16.8		22.7		21.6		25.6	
Magnesium	1,370	J	936	J	534	J	559	J	1,630		560	J	1,260		592	J	560	J
Manganese	131		127		50.2		32.6		127		345		86.4		41.7		85.7	
Mercury	0.19		0.085	J	0.082	J	0.29		0.06	J	1.5		0.063	U	0.34		0.14	
Nickel	18.5		13.4		5.2	J	7.2	J	11		6.1	J	17.2		8.9	J	7.3	J
Potassium	650	J	393	J	352	J	720	J	441	J	491	J	473	J	528	J	357	J
Selenium	1.5	UL	0.98	UL	1.1	L	1.1	UL	0.98	UL	0.97	UL	1.1	UL	1	UL	1	UL
Silver	1.1	U	0.71	U	0.75	U	0.79	U	0.71	U	0.7	U	0.78	U	0.75	U	0.75	U
Sodium	155	U	99.9	U	107	U	208	J	117	J	98.9	U	110	U	106	U	106	U
Thallium	1.9	U	1.2	U	1.3	U	1.4	U	1.2	U	1.2	U	1.3	U	1.3	U	1.3	U
Vanadium	45.3		22.1		21.9		33.5		21.6		29.2		32.2		36.5		20	
Zinc	81.7	J	60.9	J	17.3	J	19.1	J	30.2	J	49.4	J	26.9	J	20.2	J	24.6	J
Wet Chemistry (MG/KG)																		
% Moisture	43.2		12.1		17.7		21.4		12.5		11.3		20.1		17		17.2	
%Solids	58.7		88.1		81.5		84.4		78.5		92.5		83		83.8		84.8	
Total organic carbon (TOC)	16,400		10,600		12,700		3,460		3,460		5,150		31,700		15,500		7,750	
pH	6.6		6.7		5.6		4.3		7.1		5.3		7.4		5.4		5.6	

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Feasibility Study, Site 21, Bronson Road Landfill
NSF-IH, Indian Head, Maryland

	IS21SS100001		IS21SS110001		IS21SS120001		IS21SS130001		IS21SS130001P		IS21SS140001		IS21SS150001		IS21SS150001P		IS21SS160001	
Sample Date																		
Chemical Name																		
Volatile Organic Compounds (UG/KG)																		
1,1,1-Trichloroethane	12	U	13	U	12	U	12	U	12	U	11	U	13	U	13	U	12	U
1,1,2,2-Tetrachloroethane	12	U	13	U	12	U	12	U	12	U	11	U	13	U	13	U	12	U
1,1,2-Trichloro-1,2,2- trifluoroethane	12	U	13	U	12	U	12	U	12	U	11	U	13	U	13	U	12	U
1,1,2-Trichloroethane	12	U	13	U	12	U	12	U	12	U	11	U	13	U	13	U	12	U
1,1-Dichloroethane	12	U	13	U	12	U	12	U	12	U	11	U	13	U	13	U	12	U
1,1-Dichloroethene	12	U	13	U	12	U	12	U	12	U	11	U	13	U	13	U	12	U
1,2,4-Trichlorobenzene	12	U	13	U	12	U	12	U	12	U	11	U	13	U	13	U	12	U
1,2-Dibromo-3-chloropropane	12	U	13	U	12	U	12	U	12	U	11	U	13	U	13	U	12	U
1,2-Dibromoethane	12	U	13	U	12	U	12	U	12	U	11	U	13	U	13	U	12	U
1,2-Dichlorobenzene	12	U	13	U	12	U	12	U	12	U	11	U	13	U	13	U	12	U
1,2-Dichloroethane	12	U	13	U	12	U	12	U	12	U	11	U	13	U	13	U	12	U
1,2-Dichloroethene (total)	NS		NS		NS		12	U	NS		NS		NS		NS		NS	
1,2-Dichloropropane	12	U	13	U	12	U	12	U	12	U	11	U	13	U	13	U	12	U
1,3-Dichlorobenzene	12	U	13	U	12	U	12	U	12	U	11	U	13	U	13	U	12	U
1,4-Dichlorobenzene	12	U	13	U	12	U	12	U	12	U	11	U	13	U	13	U	12	U
2-Butanone	12	U	13	U	12	U	12	U	12	U	11	U	13	U	13	U	12	U
2-Hexanone	12	U	13	U	12	U	12	U	12	U	11	U	13	U	13	U	12	U
4-Methyl-2-pentanone	12	U	13	U	12	U	12	U	12	U	11	U	13	U	13	U	12	U
Acetone	1.9	B	2.4	B	1.3	B	1.6	B	12	U	1.7	B	13	U	13	U	12	U
Benzene	12	U	13	U	12	U	12	U	12	U	11	U	13	U	13	U	12	U
Bromodichloromethane	12	U	13	U	12	U	12	U	12	U	11	U	13	U	13	U	12	U
Bromoform	12	U	13	U	12	U	12	U	12	U	11	U	13	U	13	U	12	U
Bromomethane	12	U	13	U	12	U	12	U	12	U	11	U	13	U	13	U	12	U
Carbon disulfide	12	U	13	U	12	U	12	U	12	U	11	U	13	U	13	U	12	U
Carbon tetrachloride	12	U	13	U	12	U	12	U	12	U	11	U	13	U	13	U	12	U
Chlorobenzene	12	U	13	U	12	U	12	U	12	U	11	U	13	U	13	U	12	U
Chloroethane	12	U	13	U	12	U	12	U	12	U	11	U	13	U	13	U	12	U
Chloroform	12	U	13	U	12	U	12	U	12	U	11	U	13	U	13	U	12	U
Chloromethane	12	U	13	U	12	U	12	U	12	U	11	U	13	U	13	U	12	U
Cumene	12	U	13	U	12	U	12	U	12	U	11	U	13	U	13	U	12	U
Cyclohexane	12	U	13	U	12	U	12	U	12	U	11	U	13	U	13	U	12	U
Dibromochloromethane	12	U	13	U	12	U	12	U	12	U	11	U	13	U	13	U	12	U
Dichlorodifluoromethane	12	U	13	U	12	U	12	U	12	U	11	U	13	U	13	U	12	U
Ethylbenzene	12	U	13	U	12	U	12	U	12	U	11	U	13	U	13	U	12	U

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Feasibility Study, Site 21, Bronson Road Landfill
NSF-IH, Indian Head, Maryland

	IS21SS100001		IS21SS110001		IS21SS120001		IS21SS130001		IS21SS130001P		IS21SS140001		IS21SS150001		IS21SS150001P		IS21SS160001	
Sample Date																		
Chemical Name																		
Methyl acetate	12	U	13	U	12	U	12	U	12	U	11	U	13	U	13	U	12	U
Methyl-tert-butyl ether (MTBE)	12	U	13	U	12	U	12	U	12	U	11	U	13	U	13	U	12	U
Methylcyclohexane	12	U	13	U	12	U	12	U	12	U	11	U	13	U	13	U	12	U
Methylene chloride	12	U	13	U	1.5	B	12	U	12	U	1.5	B	1.4	B	13	U	12	U
Styrene	12	U	13	U	12	U	12	U	12	U	11	U	13	U	13	U	12	U
Tetrachloroethene	12	U	13	U	12	U	12	U	12	U	11	U	13	U	13	U	12	U
Toluene	12	U	13	U	12	U	12	U	12	U	11	U	13	U	13	U	12	U
Trichloroethene	12	U	13	U	12	U	12	U	12	U	11	U	13	U	13	U	12	U
Trichlorofluoromethane	12	U	13	U	12	U	12	U	12	U	11	U	13	U	13	U	12	U
Vinyl chloride	12	U	13	U	12	U	12	U	12	U	11	U	13	U	13	U	12	U
Xylene, total	12	U	1.8	J	12	U	12	U	12	U	11	U	13	U	13	U	12	U
cis-1,2-Dichloroethene	12	U	13	U	12	U	12	U	12	U	11	U	13	U	13	U	12	U
cis-1,3-Dichloropropene	12	U	13	U	12	U	12	U	12	U	11	U	13	U	13	U	12	U
trans-1,2-Dichloroethene	12	U	13	U	12	U	12	U	12	U	11	U	13	U	13	U	12	U
trans-1,3-Dichloropropene	12	U	13	U	12	U	12	U	12	U	11	U	13	U	13	U	12	U
Semi-volatile Organic Compounds (UG/KG)																		
1,1-Biphenyl	400	U	430	U	400	U	390	U	410	U	370	U	430	U	430	U	390	U
2,2'-Oxybis(1-chloropropane)	400	U	430	U	400	U	390	U	410	U	370	U	430	U	430	U	390	U
2,4,5-Trichlorophenol	1,000	U	1,100	U	1,000	U	970	U	1,000	U	940	U	1,100	U	1,100	U	980	U
2,4,6-Trichlorophenol	400	U	430	U	400	U	390	U	410	U	370	U	430	U	430	U	390	U
2,4-Dichlorophenol	400	U	430	U	400	U	390	U	410	U	370	U	430	U	430	U	390	U
2,4-Dimethylphenol	400	U	430	U	400	U	390	U	410	U	370	U	430	U	430	U	390	U
2,4-Dinitrophenol	1,000	U	1,100	U	1,000	U	970	U	1,000	U	940	U	1,100	U	1,100	U	980	U
2-Chloronaphthalene	400	U	430	U	400	U	390	U	410	U	370	U	430	U	430	U	390	U
2-Chlorophenol	400	U	430	U	400	U	390	U	410	U	370	U	430	U	430	U	390	U
2-Methylnaphthalene	400	U	430	U	400	U	390	U	410	U	370	U	430	U	430	U	390	U
2-Methylphenol	400	U	430	U	400	U	390	U	410	U	370	U	430	U	430	U	390	U
2-Nitroaniline	1,000	U	1,100	U	1,000	U	970	U	1,000	U	940	U	1,100	U	1,100	U	980	U
2-Nitrophenol	400	U	430	U	400	U	390	U	410	U	370	U	430	U	430	U	390	U
3,3'-Dichlorobenzidine	400	U	430	U	400	U	390	U	410	U	370	U	430	U	430	U	390	U
3-Nitroaniline	1,000	U	1,100	U	1,000	U	970	U	1,000	U	940	U	1,100	U	1,100	U	980	U
4,6-Dinitro-2-methylphenol	1,000	U	1,100	U	1,000	U	970	U	1,000	U	940	U	1,100	U	1,100	U	980	U
4-Bromophenyl-phenylether	400	U	430	U	400	U	390	U	410	U	370	U	430	U	430	U	390	U
4-Chloro-3-methylphenol	400	U	430	U	400	U	390	U	410	U	370	U	430	U	430	U	390	U

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Feasibility Study, Site 21, Bronson Road Landfill
NSF-IH, Indian Head, Maryland

	IS21SS100001		IS21SS110001		IS21SS120001		IS21SS130001		IS21SS130001P		IS21SS140001		IS21SS150001		IS21SS150001P		IS21SS160001	
Sample Date																		
Chemical Name																		
4-Chloroaniline	400	U	430	U	400	U	390	U	410	U	370	U	430	U	430	U	390	U
4-Chlorophenyl-phenylether	400	U	430	U	400	U	390	U	410	U	370	U	430	U	430	U	390	U
4-Methylphenol	400	U	430	U	400	U	390	U	410	U	370	U	430	U	430	U	390	U
4-Nitroaniline	1,000	U	1,100	U	1,000	U	970	U	1,000	U	940	U	1,100	U	1,100	U	980	U
4-Nitrophenol	1,000	U	1,100	U	1,000	U	970	U	1,000	U	940	U	1,100	U	1,100	U	980	U
Acenaphthene	400	U	430	U	400	U	390	U	410	U	370	U	430	U	430	U	390	U
Acenaphthylene	400	U	430	U	400	U	390	U	410	U	370	U	430	U	430	U	390	U
Acetophenone	400	U	430	U	400	U	390	U	410	U	370	U	430	U	430	U	390	U
Anthracene	400	U	430	U	400	U	390	U	410	U	370	U	430	U	430	U	390	U
Atrazine	400	U	430	U	400	U	390	U	410	U	370	U	430	U	430	U	390	U
Benzaldehyde	400	U	430	U	400	U	390	U	410	U	370	U	430	U	430	U	390	U
Benzo(a)anthracene	160	J	430	U	220	J	110	J	51	J	150	J	430	U	430	U	390	U
Benzo(a)pyrene	45	J	430	U	60	J	390	U	410	U	370	U	430	U	430	U	390	U
Benzo(b)fluoranthene	250	J	430	U	380	J	150	J	64	J	250	J	430	U	430	U	49	J
Benzo(g,h,i)perylene	400	U	430	U	400	U	390	U	410	U	370	U	430	U	430	U	390	U
Benzo(k)fluoranthene	120	J	430	U	130	J	84	J	410	U	99	J	430	U	430	U	390	U
Butylbenzylphthalate	400	U	430	U	400	U	390	U	410	U	370	U	430	U	430	U	390	U
Caprolactam	400	U	430	U	400	U	390	U	410	U	370	U	430	U	430	U	390	U
Carbazole	400	U	430	U	400	U	390	U	410	U	370	U	430	U	430	U	390	U
Chrysene	180	J	430	U	330	J	140	J	55	J	190	J	430	U	430	U	390	U
Di-n-butylphthalate	400	U	430	U	400	U	390	U	410	U	370	U	430	U	430	U	390	U
Di-n-octylphthalate	400	U	430	U	400	U	390	U	410	U	370	U	430	U	430	U	390	U
Dibenz(a,h)anthracene	400	U	430	U	48	J	390	U	410	U	370	U	430	U	430	U	390	U
Dibenzofuran	400	U	430	U	400	U	390	U	410	U	370	U	430	U	430	U	390	U
Diethylphthalate	220	B	430	U	1,200		260	B	410	U	310	B	110	B	76	J	320	B
Dimethyl phthalate	400	U	430	U	400	U	390	U	410	U	370	U	430	U	430	U	390	U
Fluoranthene	190	J	430	U	490		300	J	100	J	350	J	430	U	430	U	63	J
Fluorene	400	U	430	U	400	U	390	U	410	U	370	U	430	U	430	U	390	U
Hexachlorobenzene	400	U	430	U	400	U	390	U	410	U	370	U	430	U	430	U	390	U
Hexachlorobutadiene	400	U	430	U	400	U	390	U	410	U	370	U	430	U	430	U	390	U
Hexachlorocyclopentadiene	400	U	430	U	400	U	390	U	410	U	370	U	430	U	430	U	390	U
Hexachloroethane	400	U	430	U	400	U	390	U	410	U	370	U	430	U	430	U	390	U
Indeno(1,2,3-cd)pyrene	47	J	430	U	81	J	390	U	410	U	370	U	430	U	430	U	390	U
Isophorone	400	U	430	U	400	U	390	U	410	U	370	U	430	U	430	U	390	U
Naphthalene	400	U	430	U	400	U	390	U	410	U	370	U	430	U	430	U	390	U

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NSF-IH, Indian Head, Maryland

	IS21SS100001		IS21SS110001		IS21SS120001		IS21SS130001		IS21SS130001P		IS21SS140001		IS21SS150001		IS21SS150001P		IS21SS160001	
Sample Date																		
Chemical Name																		
Pentachlorophenol	970	U	1,000	U	980	U	930	U	990	U	910	U	1,100	U	1,000	U	940	U
Phenanthrene	63	J	430	U	340	J	200	J	50	J	220	J	430	U	430	U	390	U
Phenol	400	U	430	U	400	U	390	U	410	U	370	U	430	U	430	U	390	U
Pyrene	110	J	430	U	280	J	150	B	45	B	220	J	430	U	430	U	65	J
bis(2-Chloroethoxy)methane	400	U	430	U	400	U	390	U	410	U	370	U	430	U	430	U	390	U
bis(2-Chloroethyl)ether	400	U	430	U	400	U	390	U	410	U	370	U	430	U	430	U	390	U
bis(2-Ethylhexyl)phthalate	51	J	430	U	49	J	43	J	43	B	67	J	64	B	59	J B	43	J
n-Nitroso-di-n-propylamine	400	U	430	U	400	U	390	U	410	U	370	U	430	U	430	U	390	U
n-Nitrosodiphenylamine	400	U	430	U	400	U	390	U	410	U	370	U	430	U	430	U	390	U
Explosives (MG/KG)																		
1,3,5-Trinitrobenzene	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U
1,3-Dinitrobenzene	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U
2,4,6-Trinitrotoluene	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U
2,4-Dinitrotoluene	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U
2,6-Dinitrotoluene	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U
2-Amino-4,6-dinitrotoluene	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U
2-Nitrotoluene	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U
3-Nitrotoluene	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U
4-Amino-2,6-dinitrotoluene	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U
4-Nitrotoluene	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U
Ammonium perchlorate	0.092	U	0.097	U	0.1	U	0.091	U	0.081	J	0.088	U	0.094	U	0.13	U	0.097	U
HMX	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Nitrobenzene	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U	0.25	U
Nitroglycerin	1.3	U	1.2	U	1.3	U	1.1	U	1.3	U	1.1	U	1.2	U	NS		1.2	U
Nitroguanidine	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U
PETN	2.5	U	2.5	U	2.5	U	2.5	U	2.5	U	2.5	U	2.5	U	2.5	U	2.5	U
RDX	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Tetryl	0.65	U	0.65	U	0.65	U	0.65	U	0.65	U	0.65	U	0.65	U	0.65	U	0.65	U
Total Metals (MG/KG)																		
Aluminum	5,680		5,320		5,070		7,100		7,270		5,260		3,820		3,120		5,620	
Antimony	1	UL	1.1	UL	1.1	UL	1	UL	1.1	UL	0.97	UL	1.1	UL	1.1	UL	1	UL
Arsenic	15.5		6.2		20.6		11.5		11.7	L	51.8		4.1		3.4	L	4.9	
Barium	28.3	J	32.2	J	34.1	J	36.7	J	39.7	J	45.5		41.5	J	22.6	J	31.2	J

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Table A.1.2
Raw Analytical Results for Surface Soil
Feasibility Study, Site 21, Bronson Road Landfill
NSF-IH, Indian Head, Maryland

	IS21SS100001		IS21SS110001		IS21SS120001		IS21SS130001		IS21SS130001P		IS21SS140001		IS21SS150001		IS21SS150001P		IS21SS160001	
Sample Date																		
Chemical Name																		
Beryllium	0.23	B	0.052	U	0.12	B	0.076	B	0.066	J	0.045	U	0.053	U	0.052	U	0.047	U
Cadmium	0.097	U	0.15	J	0.6	J	0.093	U	0.15	J	0.37	J	0.54	J	0.22	J	0.2	J
Calcium	1,490		614	J	2,280		1,420		1,770		3,220		722	J	868	J	651	J
Chromium	11.2		11.6		12.5		12.3		12.6		13.8		10.7		9.2		10.4	
Cobalt	4.2	J	2.5	J	4.7	J	4.2	J	4.3	J	3	J	5.8	J	3.8	J	5.2	J
Copper	24.6	K	10.7	K	14.4	K	48.1	K	48	K	32.7	K	8.5	K	8.2	K	7.1	K
Cyanide	0.61		0.65		0.11	B	0.58		0.62		0.57		0.66		0.64		0.4	B
Iron	13,600		13,900		14,200		17,100		15,000		26,600		11,200		9,120		12,100	
Lead	32.3		13.2		29.9	L	41.6		37.2		49.1		15.5		15.3		10.5	
Magnesium	1,050	J	535	J	747	J	811	J	884	J	1,000	J	943	J	1,070	J	591	J
Manganese	90		41		212		94.7		105		45.5		398		103		260	
Mercury	0.061	U	0.067	J	0.14		0.13		0.073	J	0.56		0.066	U	0.12	J	0.059	U
Nickel	12		5.2	J	12.6		9	J	8.6	J	19.2		13.1		13.3		6.2	J
Potassium	357	J	403	J	500	J	495	J	450	J	520	J	317	J	262	J	499	J
Selenium	1	UL	1.1	UL	1.6	L	1	UL	1.1	UL	2.7	L	1.1	UL	1.1	UL	1	UL
Silver	0.75	U	0.81	U	0.76	U	0.72	U	0.77	U	16.5		0.81	U	0.8	U	0.73	U
Sodium	107	J	115	U	108	U	103	U	109	U	166	J	115	U	113	U	103	U
Thallium	1.3	U	1.4	U	1.3	U	1.2	U	1.3	U	1.2	U	1.4	U	1.4	U	1.3	U
Vanadium	20.7		26.4		29.4		21.3		21.8		65.1		25.1		21.6		18.7	
Zinc	134	J	15.5	J	40.7	J	64.2	J	61.2	J	26.3	J	23.5	J	24.6	J	18.8	J
Wet Chemistry (MG/KG)																		
% Moisture	17.4		23.6		18.4		14.3		19.3		11.7		23.8		22.4		14.9	
%Solids	89		77.6		78.2		86.2		87.1		90.3		80.9		78.6		81.8	
Total organic carbon (TOC)	5,970		10,400		43,800		7,010		4,970		23,100		10,900		12,800		16,400	
pH	7.7		4.7		7.6		7.2		7.6		3.7		6.6		6.5		6.2	

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Table A.1.2
Raw Analytical Results for Surface Soil
Feasibility Study, Site 21, Bronson Road Landfill
NSF-IH, Indian Head, Maryland

	IS21SS170001		IS21SS180001		IS21SS190001		IS21SS200001	
Sample Date								
Chemical Name								
Volatile Organic Compounds (UG/KG)								
1,1,1-Trichloroethane	13	U	12	R	15	U	13	U
1,1,2,2-Tetrachloroethane	13	U	12	R	15	U	13	U
1,1,2-Trichloro-1,2,2- trifluoroethane	13	U	12	UJ	15	U	13	U
1,1,2-Trichloroethane	13	U	12	R	15	U	13	U
1,1-Dichloroethane	13	U	12	R	15	U	13	U
1,1-Dichloroethene	13	U	12	R	15	U	13	U
1,2,4-Trichlorobenzene	13	U	12	R	15	U	13	U
1,2-Dibromo-3-chloropropane	13	U	12	R	15	U	13	U
1,2-Dibromoethane	13	U	12	R	15	U	13	U
1,2-Dichlorobenzene	13	U	12	R	15	U	13	U
1,2-Dichloroethane	13	U	12	R	15	U	13	U
1,2-Dichloroethene (total)	NS		NS		NS		NS	
1,2-Dichloropropane	13	U	12	R	15	U	13	U
1,3-Dichlorobenzene	13	U	12	R	15	U	13	U
1,4-Dichlorobenzene	13	U	12	R	15	U	13	U
2-Butanone	13	U	12	R	15	U	13	U
2-Hexanone	13	U	12	R	15	U	13	U
4-Methyl-2-pentanone	13	U	12	R	15	U	13	U
Acetone	13	U	3.3	R	3	B	2	B
Benzene	13	U	12	R	15	U	13	U
Bromodichloromethane	13	U	12	R	15	U	13	U
Bromoform	13	U	12	R	15	U	13	U
Bromomethane	13	U	12	R	15	U	13	U
Carbon disulfide	13	U	12	R	15	U	13	U
Carbon tetrachloride	13	U	12	R	15	U	13	U
Chlorobenzene	13	U	12	R	15	U	13	U
Chloroethane	13	U	12	R	15	U	13	U
Chloroform	13	U	12	R	15	U	13	U
Chloromethane	13	U	12	R	15	U	13	U
Cumene	13	U	12	U	15	U	13	U
Cyclohexane	13	U	12	R	15	U	13	U
Dibromochloromethane	13	U	12	R	15	U	13	U
Dichlorodifluoromethane	13	U	12	R	15	U	13	U
Ethylbenzene	13	U	12	R	15	U	13	U

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Raw Analytical Results for Surface Soil
Feasibility Study, Site 21, Bronson Road Landfill
NSF-IH, Indian Head, Maryland

	IS21SS170001		IS21SS180001		IS21SS190001		IS21SS200001	
Sample Date								
Chemical Name								
Methyl acetate	13	U	12	R	15	U	13	U
Methyl-tert-butyl ether (MTBE)	13	U	12	R	15	U	13	U
Methylcyclohexane	13	U	12	R	15	U	13	U
Methylene chloride	13	U	1.6	R	1.6	B	1.6	B
Styrene	13	U	12	R	15	U	13	U
Tetrachloroethene	13	U	12	R	15	U	13	U
Toluene	13	U	12	R	15	U	13	U
Trichloroethene	13	U	12	R	15	U	13	U
Trichlorofluoromethane	13	U	12	R	15	U	13	U
Vinyl chloride	13	U	12	R	15	U	13	U
Xylene, total	13	U	12	R	15	U	13	U
cis-1,2-Dichloroethene	13	U	12	R	15	U	13	U
cis-1,3-Dichloropropene	13	U	12	R	15	U	13	U
trans-1,2-Dichloroethene	13	U	12	R	15	U	13	U
trans-1,3-Dichloropropene	13	U	12	R	15	U	13	U
Semi-volatile Organic Compounds (UG/KG)								
1,1-Biphenyl	430	U	390	U	480	U	430	R
2,2'-Oxybis(1-chloropropane)	430	U	390	U	480	U	430	R
2,4,5-Trichlorophenol	1,100	U	970	U	1,200	U	1,100	R
2,4,6-Trichlorophenol	430	U	390	U	480	U	430	R
2,4-Dichlorophenol	430	U	390	U	480	U	430	U
2,4-Dimethylphenol	430	U	390	U	480	U	430	R
2,4-Dinitrophenol	1,100	U	970	U	1,200	U	1,100	R
2-Chloronaphthalene	430	U	390	U	480	U	430	R
2-Chlorophenol	430	U	390	U	480	U	430	R
2-Methylnaphthalene	430	U	390	U	480	U	430	R
2-Methylphenol	430	U	390	U	480	U	430	R
2-Nitroaniline	1,100	U	970	U	1,200	U	1,100	R
2-Nitrophenol	430	U	390	U	480	U	430	R
3,3'-Dichlorobenzidine	430	U	390	U	480	U	430	R
3-Nitroaniline	1,100	U	970	U	1,200	U	1,100	R
4,6-Dinitro-2-methylphenol	1,100	U	970	U	1,200	U	1,100	R
4-Bromophenyl-phenylether	430	U	390	U	480	U	430	R
4-Chloro-3-methylphenol	430	U	390	U	480	U	430	R

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Table A.1.2
Raw Analytical Results for Surface Soil
Feasibility Study, Site 21, Bronson Road Landfill
NSF-IH, Indian Head, Maryland

	IS21SS170001		IS21SS180001		IS21SS190001		IS21SS200001	
Sample Date								
Chemical Name								
4-Chloroaniline	430	U	390	U	480	U	430	R
4-Chlorophenyl-phenylether	430	U	390	U	480	U	430	R
4-Methylphenol	430	U	390	U	480	U	430	R
4-Nitroaniline	1,100	U	970	U	1,200	U	1,100	R
4-Nitrophenol	1,100	U	970	U	1,200	U	1,100	R
Acenaphthene	430	U	390	U	480	U	430	R
Acenaphthylene	430	U	390	U	480	U	430	R
Acetophenone	430	U	390	U	63	J	430	R
Anthracene	430	U	390	U	480	U	430	R
Atrazine	430	U	390	U	480	U	430	R
Benzaldehyde	430	U	390	U	480	U	430	R
Benzo(a)anthracene	430	U	390	U	480	U	430	R
Benzo(a)pyrene	430	U	390	U	480	U	430	R
Benzo(b)fluoranthene	430	U	390	U	480	U	430	R
Benzo(g,h,i)perylene	430	U	390	U	480	U	430	R
Benzo(k)fluoranthene	430	U	390	U	480	U	430	R
Butylbenzylphthalate	430	U	390	U	480	U	430	R
Caprolactam	430	U	390	U	480	U	430	R
Carbazole	430	U	390	U	480	U	430	R
Chrysene	430	U	390	U	480	U	430	R
Di-n-butylphthalate	430	U	390	U	480	U	430	R
Di-n-octylphthalate	430	U	390	U	480	U	430	R
Dibenz(a,h)anthracene	430	U	390	U	480	U	430	R
Dibenzofuran	430	U	390	U	480	U	430	R
Diethylphthalate	310	B	490	B	480	U	430	R
Dimethyl phthalate	430	U	390	U	480	U	430	R
Fluoranthene	46	J	390	U	480	U	430	R
Fluorene	430	U	390	U	480	U	430	R
Hexachlorobenzene	430	U	390	U	480	U	430	R
Hexachlorobutadiene	430	U	390	U	480	U	430	R
Hexachlorocyclopentadiene	430	U	390	U	480	U	430	R
Hexachloroethane	430	U	390	U	480	U	430	R
Indeno(1,2,3-cd)pyrene	430	U	390	U	480	U	430	R
Isophorone	430	U	390	U	480	U	430	R
Naphthalene	430	U	390	U	480	U	110	L

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Raw Analytical Results for Surface Soil
Feasibility Study, Site 21, Bronson Road Landfill
NSF-IH, Indian Head, Maryland

	IS21SS170001		IS21SS180001		IS21SS190001		IS21SS200001	
Sample Date								
Chemical Name								
Pentachlorophenol	1,000	U	940	U	1,200	U	1,000	R
Phenanthrene	430	U	390	U	480	U	430	R
Phenol	430	U	390	U	480	U	430	R
Pyrene	430	U	390	U	480	U	430	R
bis(2-Chloroethoxy)methane	430	U	390	U	480	U	430	R
bis(2-Chloroethyl)ether	430	U	390	U	480	U	430	R
bis(2-Ethylhexyl)phthalate	430	U	390	U	67	B	55	R
n-Nitroso-di-n-propylamine	430	U	390	U	480	U	430	R
n-Nitrosodiphenylamine	430	U	390	U	480	U	430	R
Explosives (MG/KG)								
1,3,5-Trinitrobenzene	0.25	U	0.25	U	0.25	U	0.25	U
1,3-Dinitrobenzene	0.25	U	0.25	U	0.25	U	0.25	U
2,4,6-Trinitrotoluene	0.25	U	0.25	U	0.25	U	0.25	U
2,4-Dinitrotoluene	0.25	U	0.25	U	0.25	U	0.25	U
2,6-Dinitrotoluene	0.25	U	0.25	U	0.25	U	0.25	U
2-Amino-4,6-dinitrotoluene	0.25	U	0.25	U	0.25	U	0.25	U
2-Nitrotoluene	0.25	U	0.25	U	0.25	U	0.25	U
3-Nitrotoluene	0.25	U	0.25	U	0.25	U	0.25	U
4-Amino-2,6-dinitrotoluene	0.25	U	0.25	U	0.25	U	0.25	U
4-Nitrotoluene	0.25	U	0.25	U	0.25	U	0.25	U
Ammonium perchlorate	0.11	U	0.1	U	0.11	U	0.1	U
HMX	0.5	U	0.5	U	0.5	U	0.5	U
Nitrobenzene	0.25	U	0.25	U	0.25	U	0.25	U
Nitroglycerin	1.4	U	1.2	U	1.3	U	1.3	U
Nitroguanidine	0.1	U	0.1	U	0.1	U	0.1	U
PETN	2.5	U	2.5	U	2.5	U	2.5	U
RDX	0.5	U	0.5	U	0.5	U	0.5	U
Tetryl	0.65	U	0.65	U	0.65	U	0.65	U
Total Metals (MG/KG)								
Aluminum	8,850		4,510		5,940		10,100	
Antimony	1.1	UL	1	UL	1.3	UL	1.1	UL
Arsenic	14		3.3		5.9		7.7	
Barium	58.4		17.4	J	45.3	J	42.2	J

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Raw Analytical Results for Surface Soil
Feasibility Study, Site 21, Bronson Road Landfill
NSF-IH, Indian Head, Maryland

	IS21SS170001		IS21SS180001		IS21SS190001		IS21SS200001	
Sample Date								
Chemical Name								
Beryllium	0.17	B	0.047	U	0.058	U	0.052	U
Cadmium	0.21	J	0.094	U	0.12	U	0.16	J
Calcium	1,460		83.9	J	235	J	609	J
Chromium	13		8.9		16.1		19.6	
Cobalt	4.6	J	1.8	J	4.7	J	3.9	J
Copper	9.9	K	3.8	K	4.9	K	9.7	K
Cyanide	0.65		0.59		0.73		0.65	
Iron	12,700		8,280		12,200		22,200	
Lead	27.5		17.1		25.7		16.8	
Magnesium	1,040	J	353	J	582	J	390	J
Manganese	175		66.1		279		397	
Mercury	0.11	J	0.076	J	0.073	U	0.12	J
Nickel	10.7		3.2	J	7	J	4.5	J
Potassium	394	J	236	J	324	J	636	J
Selenium	1.1	UL	1	UL	1.3	UL	1.1	UL
Silver	0.8	U	0.73	U	0.9	U	0.81	U
Sodium	271	J	103	U	128	U	115	U
Thallium	1.4	U	1.2	U	1.6	U	1.4	U
Vanadium	28.3		18.3		29		36.4	
Zinc	25.9	J	8.8	J	19	J	22.9	J
Wet Chemistry (MG/KG)								
% Moisture	22.6		14.6		31.4		23.4	
%Solids	82.1		78		77.9		73.1	
Total organic carbon (TOC)	10,700		26,000		31,000		37,600	
pH	7.4		5.2		4.5		5.4	

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Appendix A.2
Soil Boring Logs

PROJECT NUMBER	BORING NUMBER	
156175.FI.FI	IS21MW01	SHEET 1 OF 1

SOIL BORING LOG

PROJECT : NDWIH — LOCATION : Site 21 along Bronson Road

ELEVATION : See survey report — DRILLING CONTRACTOR : Parratt-Wolff Inc.

DRILLING METHOD AND EQUIPMENT USED : ATV Rotary Drill Rig, CME 850, 8" hollow stem augers, 2' split spoon sampling

WATER LEVELS : First encountered at 14' START : 8/3/00 END : 8/3/00 LOGGER : David Kinney

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (FT)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.
		0/2	SS01	7-11-11-4 (22)	2" Organic Topsoil **Sandy Gravel w/ Silt (GM)** orange, moist	@0' OVM=0ppm @2-4' log based on slough from SS03
		0/2	SS02	5-5-3-2 (8)	@2' **Sandy Silt w/ Gravel (ML)** , yellowish - red (5YR 4/6), fine sand with well-rounded gravel to 1/2"	@4' OVM=0ppm
5		2/2	SS03	3-3-6-11 (10)	@4' **Silty Sand (SM)**, light brownish gray (2.5Y 6/2), 20-30% fines, 70-80% fine sand, 5-10%fine gravel, loose moist	@6' OVM=0ppm
		1/2	SS04	6-5-6-9 (11)		@8' OVM=0ppm
		2/2	SS05	7-10-21-15 (31)	@8.5' **Clayey Silt (ML)**, light gray (10YR 7/2), moist, very stiff	
10		1.5/2	SS06	6-11-11-8 (22)	@9.5' **Silty Sand (SM)**, light brownish gray (2.5Y 6/2), 40% low plasticity fines, 60% fine sand, iron oxide staining, loose @11' **Lean Clay (CL)**, light gray (10YR 7/1), slightly plastic, very stiff, trace very fine sand, iron oxide staining	@10' OVM=0ppm @12' OVM=0ppm
		2/2	SS07	12-12-16-13 (28)		@14' OVM=0ppm; First encountered water.
15		1.5/2	SS08	2-3-5-5 (8)	@14' **Poorly Graded Sand (SP)**, light gray (10YR 7/1), loose, wet, fine sand, 5-10% fines @15.5' **Well Graded Sand (SW)**, as above except fine-coarse sand, trace fine gravel	@16' OVM=0ppm
		2/2	SS09	14-15-18-14 (32)		@18' OVM=0ppm
20					Boring terminated at 18' bgs. Monitoring well installed.	First encountered water at 14'bgs; monitoring well screened from 13-18' bgs. See Monitoring Well Completion Diagrams for additional details.
25						

PROJECT NUMBER	BORING NUMBER	
156175.FI.FI	IS21MW02	SHEET 1 OF 1

SOIL BORING LOG

PROJECT : NDWIH — LOCATION : Site 21 along Bronson Road

ELEVATION : See survey report — DRILLING CONTRACTOR : Parratt-Wolff Inc.

DRILLING METHOD AND EQUIPMENT USED : ATV Rotary Drill Rig, CME 850, 8" hollow stem augers, 2' split spoon sampling

WATER LEVELS : First encountered at 16' START : 8/3/00 END : 8/4/00 LOGGER : David Kinney

DEPTH BELOW SURFACE (FT)	INTERVAL	RECOVERY (FT)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.
		1.5/2	SS01	3-3-4-4 (7)	2" Organic Topsoil **Sandy Silt w/ Gravel (ML)** , yellowish - red (5YR 4/6), fine sand with well-rounded coarse gravel (10%)	Large subsurface cobbles in this area as large as 2' in diameter based on IS21TP06 @2' OVM=0ppm
		1.5/2	SS02	10-13-12-15 (25)	@3' **Silty Gravel w/ Sand (GM)**, as above with 75% angular quartz gravel to 1" diameter @3.5-3.8' green quartz sandstone, probably cobble cored w/ split spoon	@4' OVM=0ppm
5		1.5/2	SS03	11-17-18-21 (35)		@6' OVM=0ppm
		1.5/2	SS04	22-18-22-11 (40)	@6' **Sandy Gravel w/ Silt (GM),** yellowish-red (5YR 4/6), well graded sand with angular quartz gravel	@8' OVM=0ppm
		1.5/2	SS05	8-9-40-26 (49)		
10		1.5/2	SS06	8-11-26-16 (37)	@10' color to dark brown/black @10.5' color back to yellowish-red (5YR 4/6)	@10' OVM=0ppm @12' OVM=0ppm
		1.5/2	SS07	19-30-25-19 (55)		@14' OVM=0ppm
15		1/2	SS08	21-29-24-11 (53)	@15' **Silty Sand (SM)**, strong brown (7.5Y 5/6), moist to wet, loose, fine-coarse sand	@16' OVM=0ppm; First encountered water.
		1/2	SS09	21-22-31-40 (54)	@15.5' **Sandy Gravel w/ Silt (GM),** yellowish-red (5YR 4/6), well graded sand with angular quartz gravel	@18' OVM=0ppm
		1/2	SS10	10-10-11-10 (21)		
20					Boring terminated at 20' bgs. Monitoring well installed.	First encountered water at 16'bgs; monitoring well screened from 15-20' bgs. See Monitoring Well Completion Diagrams for additional details.
25						

PROJECT NUMBER	BORING NUMBER	
156175.FI.FI	IS21MW03	SHEET 1 OF 1

SOIL BORING LOG

PROJECT : NDWIH — LOCATION : SW corner of Site 21

ELEVATION : See survey report — DRILLING CONTRACTOR : Parratt-Wolff Inc.

DRILLING METHOD AND EQUIPMENT USED : ATV Rotary Drill Rig, CME 850, 8" hollow stem augers, 2' split spoon sampling

WATER LEVELS : First encountered at 14' START : 8/4/00 END : 8/4/00 LOGGER : David Kinney

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (FT)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.
		1/2	SS01	5-5-4-4 (9)	2" Organic Topsoil **Silt (ML)**, dark yellowish brown (10YR 4/4), moist, roots, trace fine sand	@0' OVM=0ppm
		1.5/2	SS02	5-7-6-9 (13)	@2' **Clayey Silt (ML)**, light olive brown (2.5Y 5/4), slightly plastic, firm, iron staining, trace fine gravel	@2' OVM=0ppm
5		2/2	SS03	8-9-11-13 (20)	@4' color to light gray (2.5Y 7/2), ancient roots	@4' OVM=0ppm
		2/2	SS04	12-12-17-40 (29)		@6' OVM=0ppm
		1.5/2	SS05	11-26-50-50 (76)	@7' **Silty Sand w/ Gravel (SM)**, light gray (2.5Y 7/2), 20% fines, 70% fine-medium sand, 10% quartz gravel @7.5' **Sandy Gravel w/ Silt (GM)**, yellowish red (5YR 4/6), angular quartz gravel > 1" diameter (75%), fine-medium sand (15%), fines (10%)	@8' OVM=0ppm
10		2/2	SS06	22-30-50/4		@10' OVM=0ppm
		1.5/2	SS07	12-30-50/4		@12' OVM=0ppm
15		1/2	SS08	18-24-12-6 (36)	@13.5' a 3" thick band of silty sand @14' wet	@14' OVM=0ppm; First encountered water, could be as high as 13.5 bgs.
		1/2	SS09	7-8-10-8 (18)	@15.5' **Silty Sand (SM)**, pinkish gray (7.5YR 7/2), 30% low plasticity fines, 65% fine-medium sand, 5% quartz gravel	@16' OVM=0ppm @18' OVM=0ppm
20					Boring terminated at 18' bgs. Monitoring well installed.	First encountered water at 14'bgs; monitoring well screened from 13-18' bgs. See Monitoring Well Completion Diagrams for additional details.
25						

PROJECT NUMBER	BORING NUMBER	
156175.FI.FI	IS21MW04	SHEET 1 OF 2

SOIL BORING LOG

PROJECT : NDWIH — LOCATION : Site 21 near Bld 554

ELEVATION : See survey report — DRILLING CONTRACTOR : Parratt-Wolff Inc.

DRILLING METHOD AND EQUIPMENT USED : ATV Rotary Drill Rig, CME 850, 8" hollow stem augers, 2' split spoon sampling

WATER LEVELS : First encountered at 44' START : 8/2/00 END : 8/3/00 LOGGER : David Kinney

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (FT)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.
		2/2	SS01	2-3-3-4 (6)	0-1' Organic Topsoil with gravel **@1' Gravelly Silt w/ Sand (ML)**, brown (7.5YR 4/4), moist, firm, slightly plastic	Although some of the soils are indistinguishable from fill, entire boring appears to be native materials transported via fluvial processes. @2' OVM=0ppm
		2/2	SS02	4-4-5-6 (9)		@4' OVM=0ppm
5		2/2	SS03	5-12-11-11 (23)	@5' **Sandy Silt w/ Gravel (ML)**, yellowish-red (5YR 4/6), quartz sandstone angular gravel to 1", moist, firm, 10% fine sand	@6' OVM=0ppm
		2/2	SS04	8-8-10-11 (18)	@6' **Sandy Silt (ML)**, yellowish-red (5YR 4/6), medium to coarse sand, not plastic, moist	@8' OVM=0ppm
		2/2	SS05	4-4-5-5 (9)		
10		1.5/2	SS06	5-5-8-10 (13)	@10' as above, color to brown (7.5YR 4/4)	@10' OVM=0ppm
		1/2	SS07	10-12-11-9 (23)	@12' sand content increases to 20%	@12' OVM=0ppm; possible cobble preventing recovery @14' OVM=0ppm
15		2/2	SS08	4-4-6-6 (10)	@14' sand content increases to 40%	@16' OVM=0ppm
		2/2	SS09	6-8-8-7 (16)		@18' OVM=0ppm
20		2/2	SS10	4-5-5-7 (10)	@18' **Silty Sand (SM)**, yellowish red (5YR 4/6), 20% low plasticity fines, 80% fine sand, loose, moist	@20' OVM=0ppm
		1/2	SS11	4-5-5-5 (10)	@21' seams 1-2" thick of fine to medium sand	@22' OVM=0ppm
		2/2	SS12	6-9-7-6 (16)	@22.5' **Sandy Silt (ML)**, brown (7.5YR 4/4) medium to coarse sand, not plastic, moist @23' **Silty Sand (SM)**, yellowish red (5YR 4/6), 20% low plasticity fines, 80% fine sand, loose, moist	@24' OVM=0ppm
25		1/2	SS13	11-25-50/4	@24' **Sandy Gravel (GW)**, tan to orange, gravel >1" diameter, semi-angular to semi-rounded gravel, fine-coarse sand	@26' OVM=0ppm
		1/2	SS14	19-22-50/3		@28' OVM=0ppm
		0.5/2	SS15	32-50/3	@28' reddish sandstone gravel	@30' OVM=0ppm

PROJECT NUMBER	BORING NUMBER	
156175.FI.FI	IS21MW04	SHEET 2 OF 2

SOIL BORING LOG

PROJECT : NDWIH — LOCATION : Site 21 near Bld 554

ELEVATION : See survey report — DRILLING CONTRACTOR : Parratt-Wolff Inc.

DRILLING METHOD AND EQUIPMENT USED : ATV Rotary Drill Rig, CME 850, 8" hollow stem augers, 2' split spoon sampling

WATER LEVELS : First encountered at 44' START : 8/2/00 END : 8/3/00 LOGGER : David Kinney

DEPTH BELOW SURFACE (FT)	INTERVAL (FT) / RECOVERY (FT)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.
				@30' as above	
	1/2	SS16	20-29-30-37 (59)		
					@32' OVM=0ppm
	1/2	SS17	40-50/3		
					@34' OVM=0ppm
35	0.5/2	SS18	32-32-34-38 (66)		
					@36' OVM=0ppm
				@36' end of reddish sandstone gravel, moist	
	1.5/2	SS19	20-22-27-25 (49)		
					@38' OVM=0ppm
	1/2	SS20	25-31-20-16 (51)		
40					@40' OVM=0ppm
				@40' **Lean Clay (CL)**, yellowish brown (10YR 5/6) slightly plastic, trace fine sand, firm, moist	
	2/2	SS21	5-5-9-8 (14)		
					@42' OVM=0ppm
				@42' fine laminations of **Silty Sand (SM)** to **Sandy Silt (ML)**, color as above, moist to wet	Water level is 42.5' with augers at 48'
	2/2	SS22	6-5-6-7 (11)		
					@44' OVM=0ppm; First encountered water.
				@44' **Sand (SP)**, fine to medium, iron oxide stained white quartz sand, wet	
45	1/2	SS23	10-10-22-10 (32)		
					@46' OVM=0ppm
	1/2	SS24	10-11-15-16 (26)		
					@48' OVM=0ppm
				Boring terminated at 48' bgs. Monitoring well installed.	Appears to be confined conditions below 42' (the gravels above 40' appeared moist not wet). Monitoring well screened from 42-47' bgs. See Monitoring Well Completion Diagrams for additional details.
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PROJECT NUMBER	BORING NUMBER	
156175.FI.SS	IS21SB01	SHEET 1 OF 1

SOIL BORING LOG

PROJECT : NDWIH LOCATION : Site 21

ELEVATION : See survey report DRILLING CONTRACTOR : Parratt-Wolff Inc.

DRILLING METHOD AND EQUIPMENT USED : ATV Rotary Drill Rig, CME 850, 2 3/4" hollow stem augers, 2' split spoon sampling

WATER LEVELS : First encountered at 20' START : 7/27/00 END : 7/27/00 LOGGER : Chip Cates (edits by DK)

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (FT)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.
					Grass/Gravel	
			SS01	5-5-6-4 (11)	@0.5' **Sandy Clay (CL)**, light brown	@0' OVM=0 ppm
						@2' OVM=0ppm
			SS02	7-5-5-4 (10)	@2' color to gray, soft	
						@4' OVM=0ppm
5			SS03	4-4-6-4 (10)	@4' moist	
						@6' OVM=0ppm
			SS04	4-4-6-5 (10)	@6' **Clayey Sand w/ Gravel (SP)**, light brown	
						@8' OVM=0ppm
			SS05	2-3-2-2 (5)		
10						@10' OVM=0ppm
			SS06	5-6-12-12 (18)	@10' **Silty Sand and Gravel (SM-GM)**, orange, coarse sand, moist	
						@12' OVM=0ppm
			SS07	17-15-17-18 (32)		
						@14' OVM=0ppm
15			SS08	8-13-15-13 (28)		
					@15.5' silt content increases	@16' OVM=0ppm
			SS09	40-40-12-15 (52)	@16' **Lean Clay (CL)** laminations with silt and sand, damp	
						@18' OVM=0ppm
			SS10	14-18-20-15 (38)	@18' **Sand (SP)** with clay laminations, light gray, moist, medium sand	
20						@20' OVM=0ppm
			SS11	4-8-8-12 (16)	@20' **Sand (SP)**, white, medium sand, wet	
					Boring terminated at 22' bgs. Monitoring well installed.	First encountered water at 20' bgs. Backfilled with cuttings. It was difficult to determine whether the gravelly soils to 15' were native or fill, they appeared native.
25						

PROJECT NUMBER	BORING NUMBER	
156175.FI.SS	IS21SB02	SHEET 1 OF 2

SOIL BORING LOG

PROJECT : NDWIH — LOCATION : Site 21

ELEVATION : See survey report — DRILLING CONTRACTOR : Parratt-Wolff Inc.

DRILLING METHOD AND EQUIPMENT USED : ATV Rotary Drill Rig, CME 850, 2 3/4" hollow stem augers, 2' split spoon sampling

WATER LEVELS : First encountered at 40' START : 7/28/00 END : 7/28/00 LOGGER : Ben Francisco (edits by DK)

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (FT)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.
		1.75/2	SS01	4-6-6 (12)	**FILL - Gravelly Silt w/ Sand (ML)**, brown moist, firm, coal and wood fragments	
						@2' OVM=0ppm
		1.75/2	SS02	4-6-8 (14)	@2.5' **FILL - Gravelly Clay (CL)**, orange-brown, trace sand, moist, firm	
						@4' OVM=0ppm
5		2/2	SS03	3-4-5 (9)	@4' **FILL - Sandy Silt w/ Gravel (ML)**, tan, rounded quartz gravel, moist, firm	
						@6' OVM=0ppm
		1/2	SS04	3-3-4 (7)	@6' black staining, coal fragment, probable fill	
						@8' OVM=0ppm
		1/2	SS05	1-3-5 (8)	@9' organic material	
10						@10' OVM=0ppm
		1.75/2	SS06	2-2-2 (4)	@10' **FILL - Sandy Silt w/ Gravel (ML)**, dark brown, rounded quartz gravel, moist, soft, organic staining	
						@12' OVM=0ppm
		2/2	SS07	3-3-3 (6)		
						@14' OVM=0ppm
15		1/2	SS08	Weight of Hammer	@15' **FILL - Gravelly Sand w/ Silt (SM)**, black, damp, tight, wood fragments	
						@16' OVM=0ppm
		1/2	SS09	3-6-6 (12)		
						@18' OVM=0ppm
		1.25/2	SS10	4-6-6 (12)		
20						@20' OVM=0ppm
					@ 20' glass, wood, and paper fragments	
		1/2	SS11	2-2-2 (4)	@21' **Silt (ML)**, pink, trace sand, moist, firm, appears native (probable contact)	@21' probably contact fill/native
						@22' OVM=0ppm
		1/2	SS12	2-50/4	@22' **Gravelly Sand (SW)**, tan, fine to coarse grained sand, fine gravel, trace silt, moist, tight	
						@24' OVM=0ppm
25		1.25/2	SS13	31-50/3	@24' **Sandy Gravel (GP)**, tan to orange, trace silt, fine to coarse sand, rounded quartz gravel, moist, tight	
						@26' OVM=0ppm
		1.75/2	SS14	42-37-27 (64)		
						@28' OVM=0ppm
		1/2	SS15	18-17-14 (31)		
						@30' OVM=0ppm

PROJECT NUMBER	BORING NUMBER	
156175.FI.SS	IS21SB02	SHEET 2 OF 2

SOIL BORING LOG

PROJECT : NDWIH LOCATION : Site 21

ELEVATION : See survey report DRILLING CONTRACTOR : Parratt-Wolff Inc.

DRILLING METHOD AND EQUIPMENT USED : ATV Rotary Drill Rig, CME 850, 2 3/4" hollow stem augers, 2' split spoon sampling

WATER LEVELS : First encountered at 40' START : 7/28/00 END : 7/28/00 LOGGER : Ben Francisco (edits by DK)

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (FT)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.
			SS16	16-17-16 (33)	as above, **Sandy Gravel (GP)**	
						@32' OVM=0ppm
			SS17	21-19-11 (30)		
						@34' OVM=0ppm
35			SS18	15-26-17 (43)	@35' very moist	
						@36' OVM=0ppm
			SS19	17-23-29 (52)	@36' **Sandy Clay (CL)**, tan, fine grained sand, moist, soft	
						@38' OVM=0ppm
			SS20	3-2-4 (6)		
40						@40' OVM=0ppm; First encountered water.
			SS21	44-26-18 (44)	@40' **Clayey Sand (SC)**, tan to orange, loose, wet	
						@42' OVM=0ppm
			SS22	15-10-10 (20)	@42' **Sandy Gravel w/ Silt (GM)**, orange, loose, wet	
						@44' OVM=0ppm
45			SS23	7-12-15 (27)	@45' **Sand (SP)**, mottled white and tan, medium to coarse sand, trace silt, wet, tight	
						@46' OVM=0ppm
					Boring terminated at 46' bgs.	First encountered water at 40' bgs. Backfilled with cuttings.
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PROJECT NUMBER	BORING NUMBER	
156175.FI.SS	IS21SB03	SHEET 1 OF 2

SOIL BORING LOG

PROJECT : NDWIH — LOCATION : Site 21

ELEVATION : See survey report — DRILLING CONTRACTOR : Parratt-Wolff Inc.

DRILLING METHOD AND EQUIPMENT USED : ATV Rotary Drill Rig, CME 850, 2 3/4" hollow stem augers, 2' split spoon sampling

WATER LEVELS : First encountered at 40' START : 7/30/00 END : 7/31/00 LOGGER : Ben Francisco (edits by DK)

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (FT)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.
		1.5/2	SS01	4-3-5 (8)	**FILL - Silty Clay w/ Sand & Gravel (CL),** orange-brown, coal fragments, firm	@2' OVM=0ppm
		1.5/2	SS02	5-4-3 (7)	@4' wood and coal fragments	@4' OVM=0ppm
5		1.5/2	SS03	4-4-3 (7)	@5' birck and coal fragments	@6' OVM=0ppm
		1/2	SS04	3-3-5 (8)	@6' **FILL - Clayey Silt w/ Sand (SC)**, brown, trace gravel, moist, soft, coal and wood fragments	@8' OVM=0ppm
		1/2	SS05	1-1-1 (2)	@9' **Sandy Silt (ML)**, black,	@9' probably contact fill/native
10		1/2	SS06	1-2-2 (4)	moist, soft, appears native (probable contact), wood fragments (peat?)	@10' OVM=0ppm; chlorinated odor? possibly organic odor
		1/2	SS07	2-3-3 (6)	@12' **Clayey Silt (ML)**, brown, with trace sand, moist, soft	@12' OVM=0ppm
15		1.5/2	SS08	2-2-2 (4)	@15' **Silty Sand (SM)**, black, fine sand, damp, tight	@14' OVM=0ppm
		1/2	SS09	1-1-1 (2)	@16' **Sand (SP)**, pink, trace clay, damp, tight	@16' OVM=0ppm
		1/2	SS10	1-1-1 (2)		@18' OVM=0ppm
20		1/2	SS11	2-2-2 (4)	@20' **Clayey Sand (SC)**, pink, moist, tight, clay nodules, trace gravel	@20' OVM=0ppm
		0.75/2	SS12	1-3-4 (7)	@22.5' **Sandy Silt (ML)**, brown, moist, trace gravel, moist, soft	@22' OVM=0ppm
25		1.5/2	SS13	25-28-37 (65)	@23.5' **Gravelly Sand w/ Silt (SM)**, yellow-brown, fine sand, damp, tight @25' **Sandy Gravel w/ Silt (GM)**, mottled tan and white, low silt content, gravel from 0.5 to 1" in diameter, rounded quartz gravel	@24' OVM=0ppm @26' OVM=0ppm
		1.75/2	SS14	37-39-34 (73)		@28' OVM=0ppm
		0.25/2	SS15	35-50/4		@29' split spoon refusal @30' OVM=0ppm

PROJECT NUMBER	BORING NUMBER	
156175.FI.SS	IS21SB03	SHEET 2 OF 2

SOIL BORING LOG

PROJECT : NDWIH LOCATION : Site 21

ELEVATION : See survey report DRILLING CONTRACTOR : Parratt-Wolff Inc.

DRILLING METHOD AND EQUIPMENT USED : ATV Rotary Drill Rig, CME 850, 2 3/4" hollow stem augers, 2' split spoon sampling

WATER LEVELS : First encountered at 40' START : 7/30/00 END : 7/31/00 LOGGER : Ben Francisco (edits by DK)

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (FT)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.
		1.5/2	SS16	44-10-9 (19)	as above, **Sandy Gravel w/ Silt (GM)** @31' **Sandy Silt (ML)**, brown, moist, firm	@32' OVM=0ppm
		1.75/2	SS17	12-10-11 (21)	@32.2' a 2" thick layer of quartz gravel @32.5' **Clayey Sand (SC)**, brown, fine to medium grained sand, moist, tight, clay content increases w/ depth	@34' OVM=0ppm
35		1/2	SS18	50/3	@34' **Sandy Gravel (GP)**, brown to orange, trace silt, rounded quart gravel to 1.5" in diameter, fine to medium grained sand, moist, tight	@36' OVM=0ppm
		1.25/2	SS19	22-50/5		@38' OVM=0ppm
		1/2	SS20	36-50/5		
40		1.25/2	SS21	18-12-26 (38)		@40' OVM=0ppm
		1/2	SS22	23-24-24 (48)		@42' OVM=0ppm
45		1.75/2	SS23	23-39-50/1		@44' OVM=0ppm
		1.25/2	SS24	20-15-10 (25)	@47' wet	@46' OVM=0ppm @47' First encountered water. @48' OVM=0ppm
			SS25	48-50/2		
50					Boring terminated at 49' bgs.	First encountered water at 47' bgs. Backfilled with cuttings.
55						

PROJECT NUMBER	BORING NUMBER	
156175.FI.SS	IS21SB04	SHEET 1 OF 2

SOIL BORING LOG

PROJECT : NDWIH LOCATION : Site 21

ELEVATION : See survey report DRILLING CONTRACTOR : Parratt-Wolff Inc.

DRILLING METHOD AND EQUIPMENT USED : ATV Rotary Drill Rig, CME 850, 2 3/4" hollow stem augers, 2' split spoon sampling

WATER LEVELS : First encountered at 30' START : 8/1/00 END : 8/1/00 LOGGER : Ben Francisco (edits by DK)

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (FT)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.
		1/2	SS01	2-3-4 (7)	**FILL - Sandy Silty w/ Gravel (ML),** brown, moist firm, coal fragments	The contact between fill and native soil is estimated to be at 25' bgs, however, the native soil are difficult to distinguish from the clean fill (or re-worked) deposits.
		1.25/2	SS02	4-3-6 (9)	@3' **FILL - Sandy Silt (ML)**, black, moist, soft	@2' OVM=0ppm @3' unusual odor, organic?; OVM=0ppm @4' OVM=0ppm
5		1.75/2	SS03	4-4-4 (8)	@4' **FILL - Clayey Sand w/ Gravel (SC)**, grey brown, fine to medium grained sands, moist, firm	@6' OVM=0ppm
		1.25/2	SS04	4-5-5 (10)	@7' black staining	@8' OVM=0ppm
10		2/2	SS05	2-1-2 (3)	@9' coal fragments	@10' OVM=0ppm
		1.75/2	SS06	4-6-7 (13)	@10.5' **FILL - Sandy Silt w/ Gravel (ML)**, grey brown, moist, firm, wood fragments	@12' OVM=0ppm
		1.5/2	SS07	4-6-6 (12)		@14' OVM=0ppm
15		1.75/2	SS08	6-7-6 (13)	@15' **FILL - Silty Sand w/ Gravel (SM)**, pink, moist, firm	@16' OVM=0ppm @16.4' split spoon refusal
		0.4/2	SS09	50/4		@18' OVM=0ppm
		1/2	SS10	7-7-7 (14)	@18' **FILL - Gravelly Sand w/ Silt (SM)**, brown, angular gravel, moist, tight	
20		1.5/2	SS11	2-3-2 (5)	@21' organic material	@20' OVM=0ppm @22' OVM=0ppm
		1/2	SS12	2-3-5 (8)	@23' **FILL - Sandy Gravel w/ Silt (GM)**, moist, loose, gravel is 0.5-1" in diameter, wood fragments	@24' OVM=0ppm
25		2/2	SS13	12-23-20 (43)	@25' **Gravelly Sand (SP)**, orange, trace silt, moist, tight, appears native (probable contact),	@25' probably contact fill/native @26' OVM=0ppm
		1/2	SS14	38-50/3		@28' OVM=0ppm
		1.75/2	SS15	33-43-40 (83)	@28' **Sandy Gravel w/ Silt (GM)**, orange-brown, moist, very tight	@30' OVM=0ppm; First encountered water.

PROJECT NUMBER	BORING NUMBER	
156175.FI.SS	IS21SB04	SHEET 2 OF 2

SOIL BORING LOG

PROJECT : NDWIH LOCATION : Site 21

ELEVATION : See survey report DRILLING CONTRACTOR : Parratt-Wolff Inc.

DRILLING METHOD AND EQUIPMENT USED : ATV Rotary Drill Rig, CME 850, 2 3/4" hollow stem augers, 2' split spoon sampling

WATER LEVELS : First encountered at 30' START : 8/1/00 END : 8/1/00 LOGGER : Ben Francisco (edits by DK)

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (FT)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.
		1.75/2	SS16	21-23-11 (34)	@30' wet	
						@32' OVM=0ppm
		2/2	SS17	30-33-39 (69)	@32' **Gravelly Sand (SP)**, tan, medium to coarse sand, trace silt, wet, tight	
						@34' OVM=0ppm
35					Boring terminated at 34' bgs.	First encountered water at 30' bgs. Backfilled with cuttings.
40						
45						
50						
55						

PROJECT NUMBER	BORING NUMBER	
156175.FI.SS	IS21SB05	SHEET 1 OF 1

SOIL BORING LOG

PROJECT : NDWIH LOCATION : Site 21

ELEVATION : See survey report DRILLING CONTRACTOR : Parratt-Wolff Inc.

DRILLING METHOD AND EQUIPMENT USED : ATV Rotary Drill Rig, CME 850, 2 3/4" hollow stem augers, 2' split spoon sampling

WATER LEVELS : First encountered at 22' START : 7/27/00 END : 7/28/00 LOGGER : Francisco/Cates (edits by DK)

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (FT)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.
			SS01	6-5-5-4 (10)	**FILL - Clayey Sand and Gravel (GC),** orange-red	The contact between fill and native soil is estimated to be at 12' bgs, however, the native soil are difficult to distinguish from the clean fill (or re-worked) deposits. Contact possibly at 22' bgs)
			SS02	2-3-2-3 (5)		@4' OVM=0ppm
5			SS03	Weight of Hammer	@4' **FILL - Sandy Clay (CL),** dark brown, moist, soft, leaves	@6' OVM=0ppm
			SS04	3-5-7-8 (12)	@6' **FILL - Sandy Clay (CL),** dark brown, damp, soft, some debris	@8' OVM=0ppm
			SS05	20-25-30-27 (55)	@8' **FILL - Sandy Clay (CL),** dark brown, fine sand, wood and metal debris	
10		0/2	SS06	16-30-46-35 (76)	@10' **FILL - trash and metal debris**	@10' OVM=0ppm
			SS07	38-30-37-50/3 (67)	@12' **Gravelly Sand (SP),** light orange, medium sand	@12' OVM=0ppm; probably contact fill/native
15			SS08	14-17-18-14 (33)	@14' color to orange	@14' OVM=0ppm
		2/2	SS09	11-17-18-11 (35)	@16' **Gravelly Sand w/ Silt (SM),** orange-brown, moist, loose	@16' OVM=0ppm
		1/2	SS10	10-10-21-32 (21)	@19' **Sandy Gravel w/ Silt (GM),** orange-brown, very moist, loose	@18' OVM=0ppm
20		1/2	SS11	44-32-30-34 (62)		@20' OVM=0ppm
		1/2	SS12	13-15-12-10 (27)	@22' **Sand (SP),** mottled white and tan, medium to coarse sand, trace silt, saturated, tight, bedding of sand layers visible	@22' OVM=0ppm; first encountered water @24' OVM=0ppm
25					Boring terminated at 24' bgs.	First encountered water at 22' bgs. Backfilled with cuttings.

Appendix B
Pre-FS and Supplemental Perchlorate Investigations Analytical Results

Table B.1
Pre-FS and Supplemental Perchlorate Investigations Analytical Results
Site 21Feasibility Study
NSF-IH, Indian Head, Maryland

Station ID	IS21MW01		IS21MW04	
Sample ID	IS21MW01071602		IS21MW04071602	
Sample Date	07/16/02		07/16/02	
Chemical Name				
Explosives (UG/L)				
Perchlorate	4	U	2,900	
Total Metals (UG/L)				
Aluminum	5,920		18,300	
Arsenic	3.5	U	6.6	J
Barium	52.3	J	71.4	J
Chromium	21.4		167	
Cobalt	6	J	32.4	J
Copper	33.3		31.2	B
Iron	3,940		35,600	
Lead	9.8	J	20.2	
Manganese	32.4	B	384	
Mercury	0.1	U	0.26	
Nickel	16.5	J	92.5	
Sodium	12,700	B	96,200	
Vanadium	13.7	J	52.6	
Dissolved Metals (UG/L)				
Aluminum	62.7	B	895	
Barium	31.9	J	17.1	J
Chromium	0.8	J	4.7	B
Cobalt	5.1	J	14.9	J
Iron	46.5	B	1,510	
Lead	2.3	J	1.5	U
Manganese	17.5	B	230	
Sodium	12,900	B	94,600	
Wet Chemistry (MG/L)				
Sulfate	4.5		83	

NA - Not analyzed
B - Blank contamination
J - Estimated
U - Undetected

Table B.2
Pre-FS and Supplemental Perchlorate Investigations - Analytical Results
Site 21 Feasibility Study
NSF-IH, Indian Head, Maryland

Soil

Station ID	Sampling Interval (ft, bgs)	Perchlorate (mg/Kg)	Comments
IS2101	15-17	9.5	Primary sample conc is 9.5 and duplicate is 9.2.
IS2102	5-7	9.3	
IS2103	13-15	9.5	
IS2104	14-16	9.3	
IS2105	12-Oct	8.9	
IS2106	not collected		
IS2107	0-2	9.4	
	5-7	8.6	

Direct Push Groundwater

Station ID	Sampling Interval (ft, bgs)	Perchlorate (µg/L)	Comments
IS2101	44-48	1,800	
	49-53	88	
IS2102	42-46	480	Primary sample conc is 480 and duplicate is 480.
	48-52	29	
IS2103	40-44	1,500	
	46-50	1,500	
IS2104	36-40	41	
	46-50	42	
IS2105	40-44	35	
	48-52	38	Primary sample conc is 38 and duplicate is 35.
IS2106	not collected		
	not collected		
IS2107	44-48	530	
	50-54	190	

Appendix C
Manganese in Groundwater at Site 21, NSF-Indian Head, CH2M HILL Technical Memo

Manganese in Groundwater at Site 21, NDW-Indian Head

PREPARED FOR: Indian Head Installation Restoration Team

PREPARED BY: Gene Peters/ CH2M HILL

COPIES: Margaret Kasim/CH2M HILL
Roni Warren/CH2M HILL
Ed Corack/ CH2M HILL
Anne Estabrook/ CH2M HILL

DATE: March 19, 2004

One of the exposure scenarios evaluated in the Site 21 Remedial Investigation (RI) was based on residential development and potable use of the surficial aquifer in the immediate vicinity of the Bronson Road Landfill. The human health risk assessment calculations assumed that future residents would use groundwater from the surficial aquifer as a potable water supply source and would consume groundwater with manganese concentrations of 23,100 µg/L, the greatest concentration detected. This exposure scenario resulted in presumptively unacceptable risks to future adult and child residents consuming this groundwater. After a more detailed review of site-specific hydrogeologic and future land use considerations, we believe that exposure to elevated manganese concentrations through potable use is unlikely and that this pathway is not complete.

We are not trying to demonstrate that the groundwater quality in this areas is not affected by landfilled materials, but that the risks from this impairment are over-estimates and that the pathway from which these risks derive likely is incomplete.

Surficial groundwater: The manganese concentrations driving risk are from samples taken from the shallow water table unit. Use of the first groundwater (i.e., water table) for potable use is not realistic given hydrogeologic and legal constraints.

> **Insufficient yield:** The water table aquifer at Indian Head is not an efficacious source of groundwater. The groundwater encountered in uppermost unconsolidated Quaternary sediments is susceptible to decreased recharge during drought conditions[1]. Hydraulic conductivities and yield during groundwater sampling activities generally indicate that the surficial unit across Indian Head[2] is not a productive source of groundwater. The interval sampled during the RI likely is isolated from underlying units and recharge by one or more clay and silt layers that have been encountered throughout the Indian Head peninsula at depths less than 30 feet below ground surface (at Sites 5, 11, 12, 17, 21, 25, 28, 39/40, 45, and 47).

[1] Periods of low water levels have been encountered at Indian Head during field investigations conducted during drought events.

[2] See, for example, hydraulic conductivity estimates from laboratory permeability tests and field slug tests at Sites 28 and 47.

Therefore, the only recharge to the surficial water-bearing units is from precipitation. Future groundwater users are not likely to rely on an aquifer unit susceptible to drought.

More productive groundwater sources are available: Less than 40% of residents of Maryland use groundwater as a potable water supply source[3]. Those that do use groundwater are required to use public water supply sources where available and to connect within 1 year of public water becoming available in the future (Code of Maryland Regulations [COMAR] Section 26.03.01.05.A). Absent public water, an interim individual water supply is permissible, subject to restrictions on well construction, minimum lot size, etc. However, prospective groundwater users are more likely to draw water from the deeper Patapsco and Patuxent Formations rather than the surficial Quaternary aquifer[4]. In addition, large-scale residential development on the Indian Head peninsula likely would result in use of the current facility production wells, which are screened in the deeper Potomac Group (Patuxent and Patapsco Fms) and, depending on the number of residents served, be subject to regulation under the Federal Safe Drinking Water Act and Maryland Water Supply Regulations.

Well construction: Hypothetical future residents wishing to install an individual private water supply well are unlikely to use solely the water table aquifer. Maryland water well construction regulations require a minimum of 20 feet of vertical separation between the ground surface and the top of screen (COMAR 26.04.04.07.D.3.c). The monitoring well from which the maximum manganese concentration was collected does not meet this criterion and is not representative of potable groundwater.

In addition, the well must be capable of a sustained yield of at least 1 gallon per minute and be able to produce 500 gallons in a 2-hour period at least once per 24-hour period (COMAR 26.04.04.07.J.P). Aquifers not capable of sustained 4 gpm (500 gallons/120 minutes) production must make up the difference in casing storage, which translates to very long well screens[5] that will dilute greatly the manganese concentrations attributable to potential releases from the Site.

Further, if public water supply is not available, public sewerage likely is not available, requiring residential septic systems. Maryland regulations require a minimum of 100 feet of horizontal separation between septic systems and wells and, as a practical matter, most water users are not likely to want to use the first groundwater below a septic system.

Surface water contamination: Extensive use of the surficial aquifer as a potable water supply source is likely to draw in Mattawoman Creek surface water, which is approximately 500 feet downgradient, impairing groundwater quality.

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[3] GAO (2003), Figure 16

[4] Hiortdahl (1990): "…most withdrawals were from the Patapsco…aquifers." (citing Wheeler and Wilde, 1989).

[5] For example, a 1 gpm well, 6 inches in diameter, can produce 120 gallons in a 2-hour period. The remaining 380 gallons must come from casing storage, which means that for a 6-inch well, the screen length must be 255 feet long.

Aesthetic quality of water: Future residents are unlikely to use water with even relatively minor loads of dissolved metals and other solids, regardless of health effects. For example, manganese concentrations greater than 50 µg/L impart a bitter, metallic taste[6] without presumptively unacceptable adverse health effects (the risk-based concentration [RBC] for manganese is 730 µg/L). Therefore, even with manganese concentrations less than the RBC but greater than 50 µg/L, potential groundwater users are likely to seek treatment or alternative water supply sources.

Use of metals data from unfiltered samples: The risk calculations used metals concentrations from unfiltered samples, which are generally greater than the concentrations in corresponding filtered samples. Metals concentrations in unfiltered samples represent both the dissolved and suspended fractions of the total metals content. Potable use, in which a well is installed in accordance with State well construction regulations, is more likely to result in exposures to groundwater in which measures have been taken to minimize the suspended load for practical and aesthetic purposes. For example, private wells must be constructed and developed so as to results in water with turbidity of less than 10 nephelometric turbidity units [COMAR 26.04.04.07.J.2.b]. Therefore, use of unfiltered metals data likely result in unrealistic overestimates of EPCs and risk for potable use.

Conclusions:

The original risk assessment concluded that manganese concentrations in groundwater present a potentially unacceptable risk to future residential users of groundwater for potable purposes. After a more detailed review of site-specific hydrogeologic and future land use considerations, we believe that exposure to elevated manganese concentrations through potable use is unlikely and that this pathway is not complete. Accordingly, we recommend no further action for groundwater at Site. This conclusion does not affect the need for completion of the CERCLA process at the Bronson Road Landfill, which likely will require institutional and engineering controls that will further restrict groundwater use.

References:

Hiortdahl, S.N. 1990. Geologic framework, hydrogeology, and groundwater quality of the Potomac Group aquifer system, northwestern Charles County, Maryland. U.S. Geological Survey Water Resources Investigation Report 91-4059.

U.S. Environmental Protection Agency (USEPA). 1989. Risk Assessment Guidance for Superfund -- Volume I: Human Health Evaluation Manual (Part A) Interim Final. EPA/540/1-89/002. December

U.S. Environmental Protection Agency (USEPA). 1991. Exposure point concentrations in groundwater. Region III Technical Guidance Manual. EPA/903-8-91/002. November

U.S. Environmental Protection Agency (USEPA). 2002. Calculating upper confidence limits for exposure point concentrations at hazardous waste sites. OSWER Directive OSWER 9285.6-10. December.

[6] http://www.epa.gov/safewater/consumer/2ndstandards.html; 03/16/2004

Government Accounting Office (GAO). 2003. Freshwater Supply: States Views of How Federal Agencies Could Help Them Meet the Challenges of Expected Shortages. GAO-03-514

Selected excerpts from Maryland Regulations (emphasis added):

[COMAR 26.03.01.05.A] An **individual water supply** or individual sewerage system **may not be permitted to be** installed **where an adequate community water** or sewerage facility **is available**. If an existing community water or sewerage facility is inadequate or is not available, an interim individual water and sewerage system may be used as set forth in…below…. (i)nterim individual water supply and sewerage systems may be permitted to be installed in any portion of the county, except where otherwise prohibited,…provided that…(p)ermits for the interim systems shall bear a notice regarding the interim nature of the permit and stating that connection to a future community system shall be made within 1 year or less after the system becomes available

[COMAR 26.04.04.07.D.3.c] **Less than 20 feet of casing may not be used** in any area except as provided in § M(2)(b). A minimum of 8 inches of the casing length shall extend above ground level after final grading.

[COMAR 26.04.04.07.J.2.b] **Have a turbidity of less than 10** as determined by methods designated in the National Interim Primary Drinking Water Standards, 40 CFR Part 141.22(a), except that when the turbidity is due to the oxidation of dissolved iron or manganese naturally occurring in the water, the well may be put into service if it is not reasonably possible to produce conforming water from another aquifer, and treatment is not legally or technically possible.

[COMAR 26.04.04.07.P] Domestic Water Supply System Standard.

1. A well or double well system shall produce **at least 1 gallon per minute**.
2. **The water supply system shall produce not less than 500 gallons of water in a 2-hour period, at least once each day**.
3. **If the sustained yield of the well is not capable of meeting the total water supply standard, sufficient storage shall be provided.**
4. Well Storage.
    a. If well storage is selected, the amount of storage is calculated by subtracting the well yield, as determined in § P(2), above, over a 2-hour period, from 500 gallons.
    b. The quantity of water in storage in the well is equal to the number of feet between the static water level and the level of drawdown as determined in the pump test, multiplied times 1.5 gallons per foot for a 6 inch well or 0.65 gallons per foot for a 4 inch well.
    c. Example of Determining Required Storage. If a 6 inch well produces a constant 1 gallon per minute, it will produce 120 gallons in a 2 hour period. The well storage, therefore, shall provide 380 gallons (500 gallons - 120

gallons - 380 gallons). To provide this quantity the well shall contain 253 feet of water in storage (380 gallons / 1.5 gallons per foot = 253).

d. Table 4 has been provided to assist in determining the number of feet of water contained in well storage that is required to meet the well water supply standard.

Nominal Well Size--Inches

GPM↓ \DIA→	2	3	4	5	6	7	8
1.0	---	---	---	375	255	190	150
1.5	---	---	---	315	220	160	125
2.0	---	---	400	255	180	130	100
2.5	---	---	310	200	140	100	80
3.0	---	380	220	140	95	70	55
3.5	---	220	125	80	55	40	35
4.0	125	53	35	15	15	10	10

Appendix D
ARARs

Table D-1
Chemical-Specific ARARs
Site 21 Feasibility Study
NSF-IH, Indian Head, Maryland

Chemicals & Relevant Media	Requirement	Prerequisites	Citation	ARAR or TBC	Comments
Groundwater, residential water supplies	Meet National Primary Standards for maximum contaminant levels (MCLs).	Drinking water source or potential source	Safe Drinking Water Act (SDWA): 40 CFR 141 National Primary Drinking Water Regulations, CERCLA, RCRA	Relevant and appropriate	Regulation does not apply where groundwater quality has concentrations of total dissolved solids (TDS) greater than 2,500 mg/L. In these instances, the Medium-Specific Concentration for groundwater may be multiplied by 100. MCLs are considered in the determination of SRGs for Site 21 groundwater.
Surface waters of the State	Protect and maintain the quality of surface water in the State of Maryland. Criteria and standards for discharges. Limitations and policy for antidegradation of the State's surface water.	Activities that will pollute the State's surface waters	COMAR 26.08, chapters 1 through 7	Applicable	This regulation is applicable for remedial actions that may affect surface water quality in the State of Maryland.
Soil as a source of groundwater contamination	Regulated substances are not to exceed the soil-to-groundwater pathway numeric value throughout the soil column.	Potential exposure to groundwater	CERCLA, EPA Region III RBC tables, and EPA soil-screening guidance (EPA/540/R-94/101)	TBC	Potentially applies at Site 21 where contaminants in soil are also present in groundwater at concentrations above PRGs. Used to define soil PRGs for Site 21.
Carcinogens in groundwater	Not to exceed media-specific concentration that causes a lifetime cancer risk of between 1 in 10,000 and 1 in 100,000.	Potential exposure	CERCLA, RCRA	TBC	Use to calculate site-specific PRGs for Site 21 groundwater.
Systemic toxicants in groundwater	Not to exceed media-specific levels where people could be exposed by direct ingestion or inhalation on a daily basis without appreciable risk of deleterious effects.	Potential exposure	CERCLA, RCRA	TBC	Use to calculate site-specific PRGs for Site 21 groundwater.

ARAR - Applicable or relevant and appropriate requirement
RCRA - Resource Conservation and Recovery Act
CFR - Code for Federal Regulations
CWA - Clean Water Act
EPA - U.S. Environmental Protection Agency
OSHA - Occupational Safety and Health Administration
CERCLA - Comprehensive Environmental Response, Compensation, and Liability Act
SDWA - Safe Drinking Water Act
SMCLs - Secondary Maximum Contaminant Levels
TBC - To be considered

Table D-2
Location-Specific ARARs
Site 21 Feasibility Study
NSF-IH, Indian Head, Maryland

Location	Requirement	Prerequisite	Citation	Applicability Determination	Comments
Federal Location-Specific ARARs					
Historic Sites, Buildings, and Antiquities Act					
Historic sites	Avoid undesirable impacts on landmarks.	Areas designated as historic sites.	16 USC 461-467; 40 CFR 6.301 (a)	Relevant and Appropriate	There are no records of historic landmarks at Site 21. These regulations are applicable only if this situation changes.
Endangered Species Act of 1973					
Critical habitat upon which endangered species or threatened species depend.	Action to conserve endangered species or threatened species, including consultation with the Department of the Interior. Reasonable mitigation and enhancement measures must be taken, including live propagation, transplantation, and habitat acquisition and improvement.	Determination of effect upon endangered or threatened species or their habitat by conducting biological assessments.	16 USC 1531; 16 USC 1536(a); 50 CFR 81, 225, 402	Potentially applicable	There are no records of federal endangered plant and animal species located at NDWIH. These regulations are applicable only if this situation changes.
Fish and Wildlife Coordination Act, Fish and Wildlife Improvement Act of 1978, Fish and Wildlife Conservation Act of 1980					
Area affecting streams or other water body	Provides protection for actions that would affect streams, wetlands, other water bodies or protected habitats. Any action taken should protect fish or wildlife.	Diversion, channeling or other activity that modifies a stream or other water body and affects fish or wildlife.	16 USC 661; 16 USC 662; 16 USC 742a; 16 USC 2901; 50 CFR 83	Applicable	Response actions will incorporate protection against any area water body, wetlands, or protected habitats.
Procedures for Implementing the Requirements of the Council on Environmental Quality on the National Environmental Policy Act and Executive Order 11990, Protection of Wetlands					
Wetland	Action to minimize the destruction, loss, or degradation of wetlands. Wetlands of primary ecological significance must not be altered so that ecological systems in the wetlands are unreasonably disturbed.	Wetlands as defined by Executive Order 11990 Section 7.	40 CFR 6, Appendix A, excluding Sections 6(a)(2), 6(a)(4), 6(a)(6); 40 CFR 6.302	Applicable	This regulation may be an ARAR for activities occurring in areas that meet the definition of a wetland. Remedial activities must minimize the destruction, loss, or degradation of the wetlands.
Clean Water Act, Section 404					
Wetland	The degradation Section requires degradation or destruction of wetlands and other aquatic sites be avoided to the extent possible. Dredged or fill material must not be discharged to navigable waters if the activity: contributes to the violation of Maryland water quality standards; CWA Sec. 307; jeopardizes endangered or threatened species; or violates requirements of the Title III of the Marine Protection, Research, and Sanctuaries Act of 1972.	Wetland as defined by Executive Order 11990 Section 7.	40 CFR 230.10; 40 CFR 231 (231.1, 231.2, 231.7, 231.8)	Applicable	Wetlands and navigable waters are present in the vicinity of Site 21. Remedial activities will comply with the requirements of this section of the Clean Water Act.
Surface Water	Ambient Water Quality Criteria established to protect aquatic life and human consumers of water aquatic life.	Activities that affect or may affect the surface water onsite	40 CFR 129	Applicable	
Hazardous Waste Control Act (HWCA)					
Within 100-year floodplain	Facility must be designed, constructed, operated, and maintained to avoid washout.	RCRA hazardous waste; treatment, storage, or disposal of hazardous waste.	40 CFR 264.18 (b)	TBC	Portions of Site 21 are within the 100-year flood zones. However, actions are not expected to involve hazardous waste. This would be TBC for nonhazardous waste.
Executive Order 11988, Protection of Floodplains					
Within floodplain	Actions taken should avoid adverse effects, minimize potential harm, restore and preserve natural and beneficial values.	Action that will occur in a floodplain, i.e., lowlands, and relatively flat areas adjoining inland and coastal waters and other flood-prone areas.	40 CFR 6, Appendix A; excluding Sections 6(a)(2), 6(a)(4), 6(a)(6); 40 CFR 6.302	Applicable	Portions of Site 21 are within the 100-year flood zones, therefore the requirements of this regulation are applicable for any response actions that might involve the use of these areas.
State Location-Specific ARARs					
Threatened and Endangered Species					
Critical habitat upon which endangered species or threatened species depend.	Requires action to conserve endangered or threatened fish species and the critical habitats they depend on. May not reduce the likelihood of either the survival or recovery of a listed species in the wild by reducing the reproduction, numbers or distribution of a listed species or otherwise adversely affect the species.	Determination of effect upon endangered or threatened species or its habitat.	COMAR 08.03.08	Potentially applicable	There are no records of state or federal endangered or threatened plant and animal species located within NDWIH, based on inquiries to the Maryland DNR. These regulations are applicable if this situation changes.

Table D-2
Location-Specific ARARs
Site 21 Feasibility Study
NSF-IH, Indian Head, Maryland

Location	Requirement	Prerequisite	Citation	Applicability Determination	Comments
Threatened and Endangered Fish Species					
Critical habitat upon which endangered or threatened fish species depend.	Requires action to conserve endangered or threatened fish species and the critical habitats they depend on.	Determination of effect upon endangered or threatened fish species or its habitat.	COMAR 08.02.12	Potentially applicable	These regulations are applicable if remedial actions may jeopardize endangered or threatened fish species. Currently, there are no federal or state endangered fish species at NDWIH.
Fish and Fisheries					
Fisheries, locations where species of fish exist	Requirements to conserve species of fish for human enjoyment, for scientific purposes and to ensure their perpetuation as viable components of their ecosystems.	Determination of effect upon fish species or its habitat.	Annotated Code of Maryland Title 4	Applicable	Fish species inhabit Mattawoman Creek. If response actions affect these species, the requirements of this title are applicable.
Wildlife					
Areas inhabited by wildlife	Requirements to conserve species of wildlife for human enjoyment, for scientific purposes and to ensure their perpetuation as viable components of their ecosystems.	Determination of effect upon wildlife species or its habitat.	Annotated Code of Maryland Title 10	Applicable	Wildlife species are present at NDWIH. If response actions may affect these species, the requirements of this title are applicable.
Nontidal Wetlands Protection Act, Maryland Nontidal Wetlands Regulations					
Wetland	Provides regulations for activities on or near nontidal wetlands (an area that is inundated or saturated by surface water or ground water at a frequency and duration sufficient to support, and that under normal circumstances does support, a prevalence of vegetation typically adapted for life in saturated soil conditions). Must obtain a permit from the State in order to conduct certain regulated activities in a nontidal wetland, or within a buffer or an expanded buffer.	Activities that will occur on or near nontidal wetlands.	COMAR 26.23; Annotated Code of Maryland, Title 5; Code of MD, Title 8-1201;	Applicable	Nontidal wetlands are present at White Oak. A permit or letter of exemption from the Department of Natural Resources is required if remedial activities involve activities on or in nontidal wetlands.
Wetlands and Riparian Rights					
Wetlands	Requirements to preserve wetlands and prevent their destruction; requires a license for dredging or filling of wetlands.	Activities that can affect the integrity of wetlands, such as dredging or filling.	Annotated Code of Maryland Title 16	Applicable	Wetlands (tidal and nontidal) are present at White Oak. The requirements of this title are applicable for any response actions that may affect the integrity of these wetlands.
Construction on Nontidal Waters and Floodplains					
Nontidal waters and floodplains	Protect and maintain nontidal waterways and/or state of Maryland floodplains must follow these regulations	Activities that affect nontidal waterways and floodplains	COMAR 08.05.03	Potentially Applicable	Any remedial actions involving alteration to the streams bounding OU-1 or floodplains (including temporary construction) are subject to these requirements.
Water Pollution Control Law					
Waters of the State	Establishes effective programs and provides additional and cumulative remedies to prevent, abate, and control pollution of the waters in the state.	Activities that will pollute the waters in the state.	COMAR 9, Parts 301-351	Applicable	This regulation is applicable for remedial actions that may affect water quality in the streams around OU-1.
Maryland Water Pollution Control Regulations					
Surface waters of the State	Protect and maintain the quality of surface water in the State of Maryland. Criteria and standards for discharges limitations and policy for antidegradation of the State's limitations and policy for antidegradation of the State's surface water.	Activities that will pollute the surface waters of the state.	COMAR 26.08, Chapters 01-07	Applicable	This regulation is applicable for remedial actions that may affect surface water quality in the State of Maryland.

Table D-2
Location-Specific ARARs
Site 21 Feasibility Study
NSF-IH, Indian Head, Maryland

Location	Requirement	Prerequisite	Citation	Applicability Determination	Comments
Water Management					
Water resources of the State	Provides for the conservation and protection of the water resources of the State by requiring that any land-clearing, grading, or other earth disturbances require an erosion- and sediment-control plan. Also provides that stormwater must be managed to prevent offsite sedimentation and maintain current site conditions.	Activities that affect the water resources of the State.	COMAR 26.17.01 COMAR 26.17.02, Annotated Code of Maryland Title 4	Applicable	The design for the remedial actions will incorporate the requirements of this regulation.

ARARs - Applicable or relevant and appropriate requirements.
RCRA - Resource Conservation and Recovery Act.
CFR - Code of Federal Regulations.
CWA- Clean Water Act.
DON - Department of Navy.
EO - Executive Order
FR - Federal Register.
HWCA - Hazardous Waste Control Act.
USC - United States Code.
TBC - To Be Considered.

Table D-3
Action-Specific ARARs
Site 21 Feasibility Study
NSF-IH, Indian Head, Maryland

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
Federal Action-Specific ARARs					
Resource Conservation and Recovery Act (RCRA) 42 USC 6901 et seq.*					
Onsite waste generation	Waste generator shall determine if waste is hazardous waste.	Generator of hazardous waste.	40 CFR 262.10 (a), 262.11	Applicable	Applicable for any operation where waste is generated. Remedial alternatives for Site 21 may generate contaminated wastes.
Hazardous waste accumulation	Generator may accumulate waste on site for 90 days or less or must comply with requirements for operating a storage facility.	Accumulate hazardous waste.	40 CFR 262.34	Potentially applicable	If waste generated at NDWIH is determined to be hazardous, any storage of the hazardous waste will not exceed 90 days. Accumulation of hazardous wastes onsite for longer than 90 days would be subject to the substantive RCRA requirements for storage facilities.
Recordkeeping	Generator must keep records.	Generate hazardous waste.	40 CFR 262.40	Potentially applicable	Administrative requirements are not ARARs for onsite CERCLA actions.
Excavation	Movement of excavated materials to new location and placement in or on land will trigger land disposal restrictions for the excavated waste or closure requirements for the unit in which the waste is being placed.	Materials containing RCRA hazardous wastes subject to land disposal restrictions are placed in another unit.	40 CFR 268.40	Potentially applicable	Applicable to disposal of soil to a new location and placement in or on land containing land-disposal-restricted RCRA hazardous waste. The wastes generated from response actions at Site 21 NDWIH may be RCRA hazardous wastes.
Safe Drinking Water Act					
Actions that affect drinking water supply	Promulgates National Primary Drinking Water Standard Maximum Contaminant Levels (MCLs)	Actions that affect drinking water supply	40 CFR 141	Relevant and appropriate	These regulations are ARARs for remedial actions at Site 21 that affect the groundwater.
U.S. Department of Transportation, 49 USC 1802, et seq.*					
Hazardous Materials Transportation	No person shall represent that a container or package is safe unless it meets the requirements of 49 USC 1802, et seq. or represent that a hazardous material is present in a package or motor vehicle if it is not.	Interstate carriers transporting hazardous waste and substances by motor vehicle. Transportation of hazardous material under contract with any department of the executive branch of the Federal Government.	49 CFR 171.2(f)	Potentially applicable	Offsite transport of hazardous materials must comply with both substantive and administrative requirements.
	No person shall unlawfully alter or deface labels, placards, or descriptions, packages, containers, or motor vehicles used for transportation of hazardous materials.		49 CFR 171.2(g)	Potentially applicable	
Hazardous Materials Marking, Labeling, and Placarding	Each person who offers hazardous material for transportation or each carrier that transports it shall mark each package, container, and vehicle in the manner required.	Person who offers hazardous material for transportation; carries hazardous material; or packages, labels, or placards hazardous material.	49 CFR 172.300	Potentially applicable	To be determined. Offsite transport of hazardous materials must comply with both substantive and administrative requirements.
	Each person offering non-bulk hazardous materials for transportation shall mark the proper shipping name and identification number (technical name) and consignee's name and address.		49 CFR 172.301	Potentially applicable	

Table D-3
Action-Specific ARARs
Site 21 Feasibility Study
NSF-IH, Indian Head, Maryland

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
Hazardous Materials Marking, Labeling, and Placarding (cont.)	Hazardous materials for transportation in bulk packages must be labeled with proper identification (ID) number, specified in 49 CFR 172.101 table, with required size of print. Packages must remain marked until cleaned or refilled with material requiring other marking.	Person who offers hazardous material for transportation; carries hazardous material; or packages, labels, or placards hazardous material.	49 CFR 172.302	Potentially applicable	
	No package marked with a proper shipping name or ID number may be offered for transport or transported unless the package contains the identified hazardous material or its residue.		49 CFR 172.303	Potentially applicable	To be determined. Offsite transport of hazardous materials must comply with both substantive and administrative requirements.
	The marking must be durable, in English, in contrasting colors, unobscured, and away from other markings.		49 CFR 172.304	Potentially applicable	
	Labeling of hazardous material packages shall be as specified in the list.	Person who offers hazardous material for transportation; carries hazardous material; or packages, labels, or placards hazardous material.	49 CFR 172.400	Potentially applicable	
	Non-bulk combination packages containing liquid hazardous materials must be packed with closures upward, and marked with arrows pointing upward.		49 CFR 172.312	Potentially applicable	
	Each bulk packaging or transport vehicle containing any quantity of hazardous material must be placarded on each side and each end with the type of placards listed in Tables 1 and 2 of 49 CFR 172.504.		49 CFR 172.504	Potentially applicable	
Occupational Safety and Health Administration (OSHA)					
Hazardous waste work	Requirements for hazardous waste workers such as training, personal protective equipment (PPE), and clothing must be met.	Hazardous waste work.	29 CFR 1904, 29 CFR 1910, 29 CFR 1926	Applicable	Remedial action activities at NDWIH Site 21 will involve hazardous waste workers; therefore the requirements of OSHA must be met.
State Action-Specific ARARs					
Maryland Hazardous Waste Regulations					
Storage, treatment or disposal, and transportation of hazardous waste	Regulations and procedures for the identifications, listing, transportation, treatment, storage, and disposal of hazardous wastes must be met.	Handling of hazardous wastes	COMAR 26.13.01 through COMAR 26.13.04, Annotated Code of Maryland Title 7	Potentially Applicable	Any hazardous waste found during site remediation will be disposed of according to regulations. Any residues or by-products from treatment systems that are hazardous must be disposed of properly.
Solid Waste and Water Supply Regulations					
Well Construction and Abandonment	Specifications for well construction and abandonment must be met. Also provides a mechanism to provide the State of Maryland with a database of existing and abandoned wells. Permits are required for well construction.		COMAR 26.04.03 (A&D); COMAR 26.04.04	Applicable	The requirements of this regulation are applicable to the response actions at Site 21 if monitoring wells have to be installed or abandoned.

Table D-3
Action-Specific ARARs
Site 21 Feasibility Study
NSF-IH, Indian Head, Maryland

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
Solid Waste Management - Landfill Closure					
Sanitary Landfill Closure	Requirments for landfill closure	Design specifications of various closure caps	COMAR 26.04.07.21	Applicable	The requirements of this regulation is applicable for the design of soil cover and the impermeable cap to address the solid waste and soil at Site 21.
Stormwater Management					
Design and construction	Regulations require the design and construction of a system necessary to control stormwater.	Design and construction activities	COMAR 26.17.02	Applicable	The remedial action will incorporate measures to control and manage stormwater as necessary.
Erosion and Sediment Control					
Land clearing, grading, and earth disturbances	Regulations require the preparation and implementation of a plan to control erosion and sediment for activities involving land clearing, and grading and earth disturbances. Erosion and sediment control criteria are also established.	Land clearing, grading, and earth disturbances	COMAR 26.17.01	Applicable	The remedial action will incorporate the standards required for clearing, grading, and other earth disturbances, including compliance with county and municipal erosion and sediment control ordinances, and the Commission's erosion- and sedimentation-control regulations.
Maryland Drinking Water Law					
Actions that affect state drinking water	Ensures that the State has the primary enforcement responsibility for drinking water standards under the Federal Safe Drinking Water Act.	Action causing pollution of drinking water supply	COMAR 9.04, Parts 401-413	Applicable	This regulation may be an ARAR for Site 21 if activities that affect water quality are conducted.
Occupational, Industrial, and Residential Hazards					
Action that will generate noise	Limits set on the levels of noise must be met; these limits are protective of the health, welfare, and property of the people in the State of Maryland. The maximum permitted levels for construction activities may not exceed 90 dBA during the day and 75 dBA during night.	Action that will generate noise	COMAR 26.02.03.02A (2) and B(2), COMAR 26.02.03.02.03A, Annotated Code of Maryland Title 3	Applicable	During site remediation work, the maximum allowable noise levels will not be exceeded at site boundaries.
Air Quality					
Actions that involve emissions to air	Provides ambient air quality standards, general emissions standards, and restrictions for air emissions from construction activities, vents, and treatment technologies such as incinerators. Also includes nuisance and odor control. Construction activities may emit particulate matter into the ambient air. Remedial activities must follow regulations.	Actions that involve emissions to air above specific limits.	COMAR 26.11	Applicable	May apply to earthwork activities that potentially generate particulate emissions.

Statutes and policies, and their citations, are provided as headings to identify general categories of potential ARARs. Specific potential ARARs are addressed in the table below each heading.
Acronyms used in the table:

ARAR - Applicable or relevant and appropriate requirement
CAA - Clean Air Act
RCRA - Resource Conservation and Recovery Act
CFR - Code for Federal Regulations
CWA - Clean Water Act
DOT - U.S. Department of Transportation
EPA - U.S. Environmental Protection Agency
NPDES - National Pollutant Discharge Elimination System.
OSHA - Occupational Safety and Health Administration
CERCLA - Comprehensive Environmental Response, Compensation, and Liability Act
SDWA - Safe Drinking Water Act
SMCLs - Secondary Maximum Contaminant Levels
TBC - To be considered
USC - United States Code

Appendix E
Determination of Risk-Based PRGs

Table E.1
Preliminary Remediation Goals - Soil, Child Residential Scenario
Site 21 Feasibility Study
NSF-IH, Indian Head, Maryland

Chemical	Chronic Oral RfD (RfDo) (mg/kg-day)	Chronic Dermal RfD (RfDd) (mg/kg-day)	Target Organ	Absorption Factor (ABS)	An	Bn	Noncarcinogen PRG HQ = 0.1 (mg/kg)	HQ = 0.5 (mg/kg)	HQ = 1 (mg/kg)	PRG (mg/kg)	Target HQ[1] (mg/kg)
Arsenic	3.00E-04	3.00E-04	Skin, Vascular	3.00E-02	6.7E-01	3.7E-02	2.2E+00	1.1E+01	2.2E+01	**2.2E+01**	1
Chromium	3.00E-03	7.50E-05	See Note 2 below	1.00E-02	6.7E-02	5.0E-02	1.3E+01	6.7E+01	1.3E+02	**1.3E+02**	1
Iron	3.00E-01	3.00E-01	Blood, GI, Liver	1.00E-02	6.7E-04	1.2E-05	2.3E+03	1.2E+04	2.3E+04	**2.3E+04**	1
Manganese	2.00E-02	8.00E-04	CNS	1.00E-02	1.0E-02	4.7E-03	1.1E+02	5.3E+02	1.1E+03	**1.1E+03**	1
Vanadium	1.00E-03	2.60E-05	Kidney	1.00E-02	2.0E-01	1.4E-01	4.5E+00	2.3E+01	4.5E+01	**4.5E+01**	1

Noncarcinogenic calculations:

$$\textbf{Soil PRG (mg/kg)} = \frac{\text{Target HQ} \times BW \times AT_n}{EF \times ED \times (An + Bn)}$$

An = $1/RfDo \times IRS/10^6$ mg/kg

Bn = $1/RfDd \times SA \times AF \times ABS \times 1/10^6$ mg/kg

EXPOSURE ASSUMPTIONS	
BW - Body weight (kilograms)	15
ATnc - Averaging time for noncarcinogens (days)	2,190
ATc - Averaging time for carcinogens (days)	25,550
EF - Exposure frequency (days/year)	350
ED - Exposure duration (year)	6
IRS - Ingestion rate (mg/day)	200
SA - Skin surface area (cm^2)	3,400
AF - Soil to Skin Adherence Factor (mg/cm^2-day)	0.11
ABS - Absorption Factor (unitless)	chemical specific

1 Target HQ calculated so that total HQ for a target organ does not exceed 1.

2. USEPA did not specify the target organ for the chromium toxicity study. Therefore, the reference dose for chromium was derived based on the NOAEL value.

Table E.2
Preliminary Remediation Goals - Groundwater, Adult Residential Scenario
Site 21 Feasibility Study
NSF-IH, Indian Head, Maryland

Chemical	Chronic Oral RfD (RfDo) (mg/kg-day)	Chronic Dermal RfD (RfDd) (mg/kg-day)	Chronic Inhalation RfD (RfDi) (mg/kg-day)	Target Organ	DAevent (L/cm^2-day)	Shower Exposure (L/day)	Noncarcinogen Groundwater PRG HQ = 0.1 (mg/L)	HQ = 0.5 (mg/L)	HQ = 1 (mg/L)	Applicable HQ[1] (mg/L)	Applicable PRG (mg/L)
Explosives											
Ammonium Perchlorate	N/A	N/A	N/A				N/A	N/A	N/A		N/A
Inorganics											
Manganese	2.0E-02	8.0E-04	N/A	CNS	2.0E-07		7.0E-02	3.5E-01	7.0E-01	1	7.0E-01
Thallium	7.0E-05	N/A	N/A	Liver, Blood, Hair	2.0E-07		2.6E-04	1.3E-03	2.6E-03	0.5	1.3E-03

Noncarcinogenic calculations:

$$\textbf{Groundwater RBC (mg/L)} = \frac{THQ \times BW \times AT_{nc}}{EF \times ED \times (An + Bn + Cn)}$$

An = 1/RfDo x IR

Bn = 1/RfDd x SA x DAevent

Cn = 1/RfDi x Shower Exposure

EXPOSURE ASSUMPTIONS	
BW - Body weight (kilograms)	70
ATnc - Averaging time for noncarcinogens (days)	8760
ATc - Averaging time for carcinogens (days)	25,550
EF - Exposure frequency (days/year)	350
ED - Exposure duration (year)	24
IR - Ingestion rate (L/day)	2
SA - Skin surface area (cm^2)	20,000

N/A = Not available or applicable

Table E.2a
Calculation of DAevent (Adult) - Groundwater
Site 21 Feasibility Study
NSF-IH, Indian Head, Maryland

Chemical of Potential Concern	Permeability Constant (PC) (cm/hr)	Lag Time (t) (hr)	Duration of Event (ET) (hr)	t* (hr)	B (dimensionless)	DAevent (L/cm^2-day)	Eq
Manganese	1.0E-03	N/A	2.0E-01	N/A	N/A	2.0E-07	1
Thallium	1.0E-03	N/A	2.0E-01	N/A	N/A	2.0E-07	1

Inorganics: DAevent (mg/cm2-event) =

PC x ET x CF2 (eq 1)

Organics: DAevent (mg/cm2-event) =

ET<t*: DAevent (mg/cm2-event) =
2 x PC x (sqrt((6 x t x ET)/3.1415))
x CF2 (eq 2)

Notes:
Permeability constants from EPA 2001, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment - Interim).* EPA/540/R/99/005. The default value of 0.001 was assigned to inorganics not listed in this document.
N/A - not applicable.
[1] values for Dichloroethene-1,2 trans used as a surrogate.

Table E.3
Preliminary Remediation Goals - Groundwater, Child Residential Scenario
Site 21 Feasibility Study
NSF-IH, Indian Head, Maryland

Chemical	Chronic Oral RfD (RfDo) (mg/kg-day)	Chronic Dermal RfD (RfDd) (mg/kg-day)	Target Organ	DAevent (L/cm^2-day)	Noncarcinogen				
					Groundwater PRG			Applicable HQ[1] (mg/L)	Applicable PRG (mg/L)
					HQ = 0.1 (mg/L)	HQ = 0.5 (mg/L)	HQ = 1 (mg/L)		
Explosives									
Ammonium Perchlorate	N/A	N/A			N/A	N/A	N/A		N/A
Inorganics									
Manganese	2.0E-02	8.0E-04	CNS	3.3E-07	2.9E-02	1.5E-01	2.9E-01	1	2.9E-01
Thallium	7.0E-05	N/A	Liver, Blood, Hair	3.3E-07	1.1E-04	5.5E-04	1.1E-03	0.5	5.5E-04

Noncarcinogenic calculations:

$$\textbf{Groundwater RBC (mg/L)} = \frac{THQ \times BW \times AT_{nc}}{EF \times ED \times (An + Bn)}$$

An = 1/RfDo x IR

Bn = 1/RfDd x SA x DAevent

EXPOSURE ASSUMPTIONS	
BW - Body weight (kilograms)	15
ATnc - Averaging time for noncarcinogens (days)	2190
ATc - Averaging time for carcinogens (days)	25,550
EF - Exposure frequency (days/year)	350
ED - Exposure duration (year)	6
IR - Ingestion rate (L/day)	1
SA - Skin surface area (cm^2)	7,500

N/A = Not available or applicable

Table E.3a
Calculation of DAevent (Child) - Groundwater
Site 21 Feasibility Study
NSF-IH, Indian Head, Maryland

Chemical of Potential Concern	Permeability Constant (PC) (cm/hr)	Lag Time (t) (hr)	Duration of Event (ET) (hr)	t* (hr)	B (dimensionless)	DAevent (L/cm^2-day)	Eq
Manganese	1.0E-03	N/A	3.3E-01	N/A	N/A	3.3E-07	1
Vanadium	1.0E-03	N/A	3.3E-01	N/A	N/A	3.3E-07	1

Inorganics: DAevent (mg/cm2-event) =

PC x ET x CF2 (eq 1)

Organics: DAevent (mg/cm2-event) =

ET<t*: DAevent (mg/cm2-event) =
2 x PC x (sqrt((6 x t x ET)/3.1415))
x CF2 (eq 2)

Notes:
Permeability constants from EPA 2001, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment - Interim).* EPA/540/R/99/005. The default value of 0.001 was assigned to inorganics not listed in this document.
N/A - not applicable.
[1] values for Dichloroethene-1,2 trans used as a surrogate.

Table E.4
Preliminary Remediation Goals - Groundwater, Construction Worker Scenario
Site 21 Feasibility Study
NSF-IH, Indian Head, Maryland

Chemical	Subchronic Dermal RfD (RfDd) (mg/kg-day)	Target Organ	DAevent (L/cm^2-day)	An (kg-L/mg)	Bn (kg-L/mg)	Noncarcinogen Applicable HQ[1] (mg/L)	Noncarcinogen Applicable PRG (mg/L)
Inorganics							
Manganese	8.00E-04	CNS	8.00E-06	5.3E+01		5.0E-01	1.1E+01

Noncarcinogenic calculations:

$$\textbf{Groundwater RBC (mg/L)} = \frac{THQ \times BW \times AT_n}{EF \times ED \times (An + Bn)}$$

An = 1/RfDd x SA x DAevent

Bn = 1/RfDi x Ca x IN x ET

EXPOSURE ASSUMPTIONS	
BW - Body weight (kilograms)	70
ATn - Averaging time for noncarcinogens (days)	365
ATc - Averaging time for carcinogens (days)	25,550
EF - Exposure frequency (days/year)	42
ED - Exposure duration (year)	1
ET - Exposure Time (hours/day)	8
IN - Inhalation Rate (m^3/hour)	1.7
SA - Skin surface area (cm^2)	5,300

Subchronic RfDs used if available, if not chronic RfD used.

N/A = Not available or applicable

1 Applicable HQ calculated so that total HQ for a target organ does not exceed 1.

Table E.4a
Calculation of DAevent (Construction Worker) - Groundwater
Site 21 Feasibility Study
NSF-IH, Indian Head, Maryland

Chemical of Potential Concern	Permeability Constant (PC) (cm/hr)	Lag Time (t) (hr)	Duration of Event (ET) (hr)	t* (hr)	B (dimensionless)	DAevent (L/cm^2-day)	Eq
Aluminum	1.0E-03	N/A	8.0E+00	N/A	N/A	8.0E-06	1
Arsenic	1.0E-03	N/A	8.0E+00	N/A	N/A	8.0E-06	1
Chromium	2.0E-03	N/A	8.0E+00	N/A	N/A	1.6E-05	1
Manganese	1.0E-03	N/A	8.0E+00	N/A	N/A	8.0E-06	1
Nickel	2.0E-04	N/A	8.0E+00	N/A	N/A	1.6E-06	1
Vanadium	1.0E-03	N/A	8.0E+00	N/A	N/A	8.0E-06	1

Inorganics: DAevent (mg/cm2-event) =

PC x ET x CF2 (eq 1)

Organics: DAevent (mg/cm2-event) =

ET<t*: DAevent (mg/cm2-event) =
2 x PC x (sqrt((6 x t x ET)/3.1415))
x CF2 (eq 2)

ET>t*: DAevent (mg/cm2-event) =
PC x (ET/(1+B) + 2 x t x ((1 + 3xB)/(1+B)) x CF2 (eq 3)

Notes:
[1] Used permeability constant and lag time values for trans-1,2-dichloroethene.
N/A - not applicable.
Permeability constants from EPA 1992, Dermal Exposure Assessment: Principals and Applications.
ORD, EPA/600/8-91/001B. Default value of 0.001 cm/hour used for inorganics without published values.

Appendix F
Detailed Cost Estimate

Remedial Alternatives	Construction Time (weeks)	Operation Time (years)	2004 Capital Cost	2004 Lifetime O&M	Lifetime Present Worth O&M*	Total Present Worth
2 Existing Soil Cover Repair and Retrofit and LUCs	15.6	30	$705,750.37	$940,865.84	$449,454.88	**$1,155,205.25**
3 RCRA C Cap and LUCs	27	30	$1,475,501.34	$1,305,687.57	$638,929.18	**$2,114,430.52**
4 Excavation and Off-Site Disposal	55	NA	$14,746,662.28	$0.00	$0.00	**$14,746,662.28**

* Assumes a 20% contingency on O&M

REMEDIAL ALTERNATIVE 2 Protective Soil Cover, LUCs, and Groundwater Monitoring	LOCATION: Site 21, Bronson Road Landfill NSF-IH, Indian Head, Maryland	MEDIA: Solid Waste, Contaminated Soil, and Shallow Groundwater	Construction time: 15.6 weeks Operation time: 30 years Post Remediation Monitoring: 30 years

DESCRIPTION OF ALTERNATIVE:

Existing cover repair and retrofit where necessary. The cover shall have a minimum 24-inch thickness of soil. Implementation of operation and maintenance and LUCs for 30 years, including biannual field inspection and mowing, five-yearly cover repair, and five-year reviews. LUC measures are in the forms of land- and groundwater-use restrictions and long-term groundwater monitoring.

ASSUMPTIONS:

1) The soil cover area is approx. 150000 SF 3.44 acres

2) The RI indicated that the existing thickness of soil cover likely ranges from 5 to 10 ft. No study/investigations have confirmed this statement. The soil and test pits boring indicated that the wastes were exposed in some areas. Therefore, for cost estimating purposes, it is assumed that the percentage of the soil cover area needing a 24-inch soil cover is 100%

3) Perimeter of the soil cover area is approx. 1550 ft

4) Required soil fill material to improve the slope of the existing soil cover is approx. (in CY) 4270 (see the calculation at the end of this appendix)

5) Surface water management would be accomplished through rip rap ditches along the perimeter of the cover.

6) Installation of 2 additional downgradient groundwater monitoring wells.

7) Quaterly sampling for the first year and annual sampling of groundwater for total and dissolved metals and geochemical parameters for 30 years from all four existing wells and 2 additional wells.
8) All samples would be analyzed for TAL Metals/Cyanide, chlorides, nitrates, and sulphates. In addition field measurements such as DO, ORP, pH, and temperature would also be collected.
9) Data interpretation and report would be prepared following a sampling event.

10) Sources of costs are 2004 RS Means Site Work & Landscape Cost Data, RS Means Environmental Remediation Cost Data - Unit Price, vendor quotes, and professional judgment based on similar projects.

11) All soil volumes are in-place

Cost Component	Qty	Unit	Cost Source/Assumptions	Estimated Activity Duration (day)	Labor Unit Cost	Labor Total Cost	Equipment Unit Cost	Equipment Total Cost	Material Unit Cost	Material Total Cost	Subcontractor	Total Cost
CAPITAL COSTS												
Institutional Controls/Planning												**$5,000.00**
Site-Specific LUC	1	lump sum	Allowance		$5,000.00	$5,000.00	$0.00	$0.00	$0.00	$0.00	$0.00	$5,000.00
Permitting, Planning, and Reporting												**$7,500.00**
Health and Safety Plan	1	lump sum	Professional Judgment		$2,500.00	$2,500.00	$0.00	$0.00	$0.00	$0.00	$0.00	$2,500.00
FSP, QAPP, and DQOs	1	lump sum	Professional Judgment		$5,000.00	$5,000.00	$0.00	$0.00	$0.00	$0.00	$0.00	$5,000.00
Site Preparation				**12**								**$9,957.22**
Site clearing (dozer light)	3.44	acre	M 022030 200 0500	6	$239.00	$823.00	$430.00	$1,480.72	$0.00	$0.00	$0.00	$2,303.72
Site demolition (road demolition - assume asphalt paved)	2000	SY	M 02220 250 5010	3	$1.69	$3,380.00	$1.17	$2,340.00	$0.00	$0.00	$0.00	$5,720.00
Survey	3	days	M 01103 700 1100	3	$585.00	$1,755.00	$59.50	$178.50	$0.00	$0.00	$0.00	$1,933.50

REMEDIAL ALTERNATIVE 2 Protective Soil Cover, LUCs, and Groundwater Monitoring	LOCATION: Site 21, Bronson Road Landfill NSF-IH, Indian Head, Maryland	MEDIA: Solid Waste, Contaminated Soil, and Shallow Groundwater	Construction time: 15.6 weeks Operation time: 30 years Post Remediation Monitoring: 30 years

Earthwork				**53**									**$251,774.17**
Borrow, loading, and spreading - common earth, shovel, 1CY bucket (18" thick)	11053	CY	M 02315 210 4000	14	$0.61	$6,742.53	$1.01	$11,163.87	$7.15	$79,031.33	$0.00	$96,937.73
Borrow, loading, and spreading - top soil, shovel, 1CY bucket (6" thick)	5556	CY	M 02055 150 0800	10	$1.33	$7,388.89	$3.03	$16,833.33	$20.00	$111,111.11	$0.00	$135,333.33
Grading - large area	16667	SY	M 02300 100 0100	9	$0.24	$4,000.00	$0.22	$3,666.67	$0.00	$0.00	$0.00	$7,666.67
Compaction - sheepsfoot, 12" lifts, 4 passes	11053	CY	M 02315 310 5640	9	$0.14	$1,547.47	$0.29	$3,205.47	$0.00	$0.00	$0.00	$4,752.93
Trenching for dikes and ditches- 1-4' deep, 1/8 CY backhoe	1550	CY	M 02315 610 0050	11	$3.18	$4,929.00	$1.39	$2,154.50	$0.00	$0.00	$0.00	$7,083.50
Site Restoration and Surface Water Management				**10**								**$56,429.00**
Rip rap , 3' bottom, 3' deep, 2:1 side slope	1550	LF	E 33 05 0804	8	$3.14	$4,867.00	$2.02	$3,131.00	$26.77	$41,493.50	$0.00	$49,491.50
Hydroseeding	150	M.SF	M 02920 320 2400	2	$8.60	$1,290.00	$5.15	$772.50	$32.50	$4,875.00	$0.00	$6,937.50
Installation of New Groundwater Monitoring Wells				**3**								**$2,627.54**
2" MW constructions (Total of 50 feet)	50	LF	2005 BOA Rates	2	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$598.00	$598.00
Stickup covers with bollards	2	ea	2005 BOA Rates	0	$0.14	$0.28	$0.29	$0.58	$0.00	$0.00	$1,191.48	$1,192.34
Well development	8	hrs	2005 BOA Rates	1	$3.18	$25.44	$1.39	$11.12	$0.00	$0.00	$800.64	$837.20
Construction Oversight												**$66,424.80**
Engineer	16	weeks	E 99 11 0403		$1,096.00	$17,097.60	$0.00	$0.00	$0.00	$0.00	$0.00	$17,097.60
Site Health and Safety	16	weeks	E 99 11 0703		$1,492.00	$23,275.20	$0.00	$0.00	$0.00	$0.00	$0.00	$23,275.20
Superintendent	16	weeks	E 99 11 0203		$1,670.00	$26,052.00	$0.00	$0.00	$0.00	$0.00	$0.00	$26,052.00
Preconstruction Submittals												**$47,724.06**
Preconstruction survey, design basis, pre-draft, draft, and final design, specifications, and H&S plans	1	lump sum	15% of total construction cost		$47,724.06	$47,724.06	$0.00	$0.00	$0.00	$0.00	$0.00	$47,724.06
General Conditions												**$31,816.04**
Decontamination, temp. facilities, sed. & erosion control, temp. fence, etc.	1	lump sum	10% of total construction cost		$31,816.04	$31,816.04	$0.00	$0.00	$0.00	$0.00	$0.00	$31,816.04
Contractor Overhead and Profit												**$47,724.06**
Home office cost, etc.	1	lump sum	15% of total construction cost		$47,724.06	$47,724.06	$0.00	$0.00	$0.00	$0.00	$0.00	$47,724.06

REMEDIAL ALTERNATIVE 2 Protective Soil Cover, LUCs, and Groundwater Monitoring	LOCATION: Site 21, Bronson Road Landfill NSF-IH, Indian Head, Maryland	MEDIA: Solid Waste, Contaminated Soil, and Shallow Groundwater	Construction time: 15.6 weeks Operation time: 30 years Post Remediation Monitoring: 30 years

Mob/Demob												**$15,908.02**
Mob & demob of equip & personnel	1	lump sum	5% of total construction cost		$15,908.02	$15,908.02	$0.00	$0.00	$0.00	$0.00	$0.00	$15,908.02
SUBTOTAL CAPITAL COST						**$258,845.59**		**$44,938.25**		**$236,510.94**	**$2,590.12**	**$542,884.90**
Scope Contingency	20%											**$108,576.98**
Bid Contingency	10%											**$54,288.49**
TOTAL CAPITAL COST												**$705,750.37**
OPERATION & MAINTENANCE AND PERIODIC ACTIVITIES - PER EVENT COST												
Cover Maintenance												**$3,952.50**
Biannual mowing - tractor with rotary mower	150	M.SF	M 02935 300 1660		$12.25	$1,837.50	$10.10	$1,515.00	$0.00	$0.00	$0.00	$3,352.50
Biannual inspection	8	hrs	E 99 11 0403		$75.00	$600.00	$0.00	$0.00	$0.00	$0.00	$0.00	$600.00
Cover Repair - every five year												**$14,115.01**
Assume 2% of total capital cost	1	lump sum	Professional Judgment		$14,115.01	$14,115.01	$0.00		$0.00	$0.00	$0.00	$14,115.01
Sampling and Analysis												
Sample Collection												**$3,932.04**
Sample collection - 2 crew, 10 hrs/day, $50/hr	3	days	Professional Judgment		$1,000.00	$3,000.00	$0.00	$0.00	$0.00	$0.00	$0.00	$3,000.00
Disposable and decon materials per sample	10	samples	E 33 02 0401, 33 02 0402, 33 02 0561		$0.00	$0.00	$0.00	$0.00	$24.90	$249.00	$0.00	$249.00
Equipment Rental	3	days	E 33 02 0573, 33 02 0578		$0.00	$0.00	$227.68	$683.04	$0.00	$0.00	$0.00	$683.04
Lab Analysis												**$2,220.00**
Metals	10	samples	BOA Rates		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$1,570.00	$1,570.00
Chloride, nitrite/nitrate, sulfate	10	samples	BOA Rates		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$650.00	$650.00
Data Interpretation												**$7,500.00**
Report	1	lump sum	Professional Judgment		$7,500.00	$7,500.00	$0.00		$0.00	$0.00	$0.00	$7,500.00
Five-Year Review												**$4,500.00**
Report - Engineer	60	hrs	E 99 11 0403		$75.00	$4,500.00	$0.00	$0.00	$0.00	$0.00	$0.00	$4,500.00
Site Closure												**$15,000.00**
Report development	1	lump sum	Allowance		$15,000.00	$15,000.00	$0.00		$0.00	$0.00	$0.00	$15,000.00

PRESENT WORTH CALCULATION REMEDIAL ALTERNATIVE 2

Discount Rate: 5.5% **O&M and Period Cost Contingency:** 20%

Year	Real Cost Incurred	Cost Description	Cost Type	Discount Factor	Present Worth
0	$705,750	Capital costs	Capital	1.00	$705,750
1	$75,016	Two biannual field inspections and mowings and four quarterly groundwater sampling events	O&M	1.06	$71,105
2	$24,287	Two biannual field inspections and mowings and an annual groundwater sampling event	O&M	1.11	$21,821
3	$24,287	Two biannual field inspections and mowings and an annual groundwater sampling event	O&M	1.17	$20,684
4	$24,287	Two biannual field inspections and mowings and an annual groundwater sampling event	O&M	1.24	$19,605
5	$48,206	Two biannual field inspections and mowings; an annual groundwater monitoring event; cover repair; and five-year review	O&M, Periodic	1.31	$36,884
6	$24,287	Two biannual field inspections and mowings and an annual groundwater sampling event	O&M	1.38	$17,614
7	$24,287	Two biannual field inspections and mowings and an annual groundwater sampling event	O&M	1.45	$16,696
8	$24,287	Two biannual field inspections and mowings and an annual groundwater sampling event	O&M	1.53	$15,826
9	$24,287	Two biannual field inspections and mowings and an annual groundwater sampling event	O&M	1.62	$15,001
10	$48,206	Two biannual field inspections and mowings; an annual groundwater monitoring event; cover repair; and five-year review	O&M	1.71	$28,222
11	$24,287	Two biannual field inspections and mowings and an annual groundwater sampling event	O&M, Periodic	1.80	$13,477
12	$24,287	Two biannual field inspections and mowings and an annual groundwater sampling event	O&M	1.90	$12,775
13	$24,287	Two biannual field inspections and mowings and an annual groundwater sampling event	O&M	2.01	$12,109
14	$24,287	Two biannual field inspections and mowings and an annual groundwater sampling event	O&M, Periodic	2.12	$11,478
15	$48,206	Two biannual field inspections and mowings; an annual groundwater monitoring event; cover repair; and five-year review			
16	$24,287	Two biannual field inspections and mowings and an annual groundwater sampling event	O&M	2.36	$10,312
17	$24,287	Two biannual field inspections and mowings and an annual groundwater sampling event	O&M	2.48	$9,774

PRESENT WORTH CALCULATION REMEDIAL ALTERNATIVE 2

Discount Rate: 5.5% **O&M and Period Cost Contingency:** 20%

Year	Real Cost Incurred	Cost Description	Cost Type	Discount Factor	Present Worth
18	$24,287	Two biannual field inspections and mowings and an annual groundwater sampling event	O&M	2.62	$9,265
19	$24,287	Two biannual field inspections and mowings and an annual groundwater sampling event	O&M	2.77	$8,782
20	$48,206	Two biannual field inspections and mowings; an annual groundwater monitoring event; cover repair; and five-year review	O&M, Periodic	2.92	$16,522
21	$24,287	Two biannual field inspections and mowings and an annual groundwater sampling event	O&M	3.08	$7,890
22	$24,287	Two biannual field inspections and mowings and an annual groundwater sampling event	O&M	3.25	$7,479
23	$24,287	Two biannual field inspections and mowings and an annual groundwater sampling event	O&M	3.43	$7,089
24	$24,287	Two biannual field inspections and mowings and an annual groundwater sampling event	O&M	3.61	$6,719
25	$48,206	Two biannual field inspections and mowings; an annual groundwater monitoring event; cover repair; and five-year review	O&M, Periodic	3.81	$12,641
26	$24,287	Two biannual field inspections and mowings and an annual groundwater sampling event	O&M	4.02	$6,037
27	$24,287	Two biannual field inspections and mowings and an annual groundwater sampling event	O&M	4.24	$5,722
28	$24,287	Two biannual field inspections and mowings and an annual groundwater sampling event	O&M	4.48	$5,424
29	$24,287	Two biannual field inspections and mowings and an annual groundwater sampling event	O&M	4.72	$5,141
30	$66,206	Two biannual field inspections and mowings; an annual groundwater monitoring event; cover repair; five-year review; and site closure.	O&M, Periodic, Site Closure	3.81	$17,362
CAPITAL COST	**$705,750**				
2004 Dollar LIFETIME O&M	**$940,866**		**Lifetime Present Worth O&M**		**$449,455**
TOTAL IMPLEMENTATION COST	**$1,646,616**		**TOTAL PRESENT WORTH**		**$1,155,205**

REMEDIAL ALTERNATIVE 3 RCRA C Cap, LUCs, and Groundwater Monitoring	LOCATION: Site 21, Bronson Road Landfill NSF-IH, Indian Head, Maryland	MEDIA: Solid Waste, Contaminated Soil, and Shallow Groundwater	Construction time: 27 weeks Operation time: 30 years Post Remediation Monitoring: 30 years

DESCRIPTION OF ALTERNATIVE:

RCRA C Cap and implementation of operation and maintenance and LUCs for 30 years, including biannual field inspection and mowing, five-yearly cover repair, and five-year reviews. LUC measures are in the forms of land- and groundwater-use restrictions and long-term groundwater monitoring.

ASSUMPTIONS:

1) The soil cap area is approx. 150000 SF

2) The layers consist of a 24-inch thick soil layer, a 12-inch thick sand layer, >20 mil thick synthetic membrane layer, and a 24-inch thick low permeability clay layer.

3) Perimeter of the soil cover area is approx. 1550 ft

4) Required soil fill material to improve the slope of the existing soil cover is approx. (Cubic Yard) 4270 (see the calculation at the end of this appendix)

5) Surface water management would be accomplished through rip rap ditches along the perimeter of the cover.

6) Installation of 2 additional downgradient groundwater monitoring wells.

7) Quaterly sampling for the first year and annual sampling of groundwater for total and dissolved metals and geochemical parameters for 30 years from all four existing wells and 2 additional wells.
8) All samples would be analyzed for TAL Metals/Cyanide, chlorides, nitrates, and sulphates. In addition field measurements such as DO, ORP, pH, and temperature would also be collected.
9) Data interpretation and report would be prepared following a sampling event.

10) Sources of costs are 2004 RS Means Site Work & Landscape Cost Data, RS Means Environmental Remediation Cost Data - Unit Price, vendor quotes, and professional judgment based on similar projects.

11) All soil volumes are in-place

Cost Component	Qty	Unit	Cost Source	Estimated Activity Duration (day)	Labor Unit Cost	Labor Total Cost	Equipment Unit Cost	Equipment Total Cost	Material Unit Cost	Material Total Cost	Subcontractor	Total Cost
CAPITAL COSTS												
Institutional Controls/Planning												**$5,000.00**
Site-Specific LUC	1	lump sum	Professional Judgment		$5,000.00	$5,000.00	$0.00	$0.00	$0.00	$0.00	$0.00	$5,000.00
Permitting, Planning, and Reporting												**$7,500.00**
Health and Safety Plan	1	lump sum	Professional Judgment		$2,500.00	$2,500.00	$0.00	$0.00	$0.00	$0.00	$0.00	$2,500.00
FSP, QAPP, and DQOs	1	lump sum	Professional Judgment		$5,000.00	$5,000.00	$0.00	$0.00	$0.00	$0.00	$0.00	$5,000.00
Site Preparation				**12**								**$9,957.22**
Site clearing (dozer light)	3.44	acre	M 022030 200 0500	6	$239.00	$823.00	$430.00	$1,480.72	$0.00	$0.00	$0.00	$2,303.72
Site demolition (road demolition - assume asphalt paved)	2000	SY	M 02220 250 5010	3	$1.69	$3,380.00	$1.17	$2,340.00	$0.00	$0.00	$0.00	$5,720.00
Survey	3	days	M 01103 700 1100	3	$585.00	$1,755.00	$59.50	$178.50	$0.00	$0.00	$0.00	$1,933.50

REMEDIAL ALTERNATIVE 3 RCRA C Cap, LUCs, and Groundwater Monitoring		LOCATION: Site 21, Bronson Road Landfill NSF-IH, Indian Head, Maryland					MEDIA: Solid Waste, Contaminated Soil, and Shallow Groundwater		Construction time: 27 weeks Operation time: 30 years Post Remediation Monitoring: 30 years			
Earthwork				**113**								**$577,788.43**
Vegetative and Protective Layer - 18" common earth 6" top soil												
Borrow, loading, and spreading - top soil, shovel, 1CY bucket (6" thick)	2778	CY	M 02055 150 0800	5	$1.33	$3,694.44	$3.03	$8,416.67	$20.00	$55,555.56	$0.00	$67,666.67
Borrow, loading, and spreading - common earth, shovel, 1CY bucket (18" thick)	11053	CY	M 02315 210 4000	14	$0.61	$6,742.53	$1.01	$11,163.87	$10.38	$114,733.60	$0.00	$132,640.00
Grading - large area	16667	SY	M 02300 100 0100	9	$0.24	$4,000.00	$0.22	$3,666.67	$0.00	$0.00	$0.00	$7,666.67
Compaction - sheepsfoot, 12" lifts, 4 passes	11053	CY	M 02315 310 5640	9	$0.14	$1,547.47	$0.29	$3,205.47	$0.00	$0.00	$0.00	$4,752.93
Trenching for dikes and ditches-1-4' deep, 1/8 CY backhoe	1550	CY	M 02315 610 0050	11	$3.18	$4,929.00	$1.39	$2,154.50	$0.00	$0.00	$0.00	$7,083.50
Drainage Layer - 12" thick												
Borrow and spread bank sand, 5 mile haul	5556	CY	M 02060 0500 & 0900, M 04055 750 0010	28	$3.18	$17,666.67	$1.39	$7,722.22	$12.80	$71,111.11	$0.00	$96,500.00
Compaction - riding vibrating roller 12" lifts, 2 passes	5556	CY	M 02315 310 5060	2	$0.12	$666.67	$0.11	$611.11	$0.00	$0.00	$0.00	$1,277.78
Synthetic barrier	150000	SF	Current cost of 40-mil HDPE	24	$0.09	$13,500.00	$0.07	$10,500.00	$0.40	$60,000.00	$0.00	$84,000.00
Clay Liner 10E-7, 6" lifts, Off-site	11311	CY	E 33 08 0507	16	$5.19	$58,704.67	$8.86	$100,216.44	$7.51	$84,946.44	$0.00	$243,867.56
Site Restoration and Surface Water Management				**10**								**$56,429.00**
Rip rap , 3' bottom, 3' deep, 2:1 side slope	1550	LF	E 33 05 0804	8	$3.14	$4,867.00	$2.02	$3,131.00	$26.77	$41,493.50	$0.00	$49,491.50
Hydroseeding	150	M.SF	M 02920 320 2400	2	$8.60	$1,290.00	$5.15	$772.50	$32.50	$4,875.00	$0.00	$6,937.50
Installation of New Groundwater Monitoring Wells				**3**								**$2,627.54**
2" MW constructions (Total of 50 feet)	50	LF	2005 BOA Rates	2	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$598.00	$598.00
Stickup covers with bollards	2	ea	2005 BOA Rates	0	$0.14	$0.28	$0.29	$0.58	$0.00	$0.00	$1,191.48	$1,192.34
Well development	8	hrs	2005 BOA Rates	1	$3.18	$25.44	$1.39	$11.12	$0.00	$0.00	$800.64	$837.20

REMEDIAL ALTERNATIVE 3 RCRA C Cap, LUCs, and Groundwater Monitoring		LOCATION: Site 21, Bronson Road Landfill NSF-IH, Indian Head, Maryland					MEDIA: Solid Waste, Contaminated Soil, and Shallow Groundwater		Construction time: 27 weeks Operation time: 30 years Post Remediation Monitoring: 30 years			
Construction Oversight												**$114,966.00**
Engineer	27	weeks	E 99 11 0403		$1,096.00	$29,592.00	$0.00	$0.00	$0.00	$0.00	$0.00	$29,592.00
Site Health and Safety	27	weeks	E 99 11 0703		$1,492.00	$40,284.00	$0.00	$0.00	$0.00	$0.00	$0.00	$40,284.00
Superintendent	27	weeks	E 99 11 0203		$1,670.00	$45,090.00	$0.00	$0.00	$0.00	$0.00	$0.00	$45,090.00
Preconstruction Submittals												**$97,688.72**
Preconstruction survey, design basis, pre-draft, draft, and final design,	1	lump sum	15% of total construction cost		$97,688.72	$97,688.72	$0.00	$0.00	$0.00	$0.00	$0.00	$97,688.72
General Conditions												**$65,125.82**
Decontamination, temp. facilities, sed. & erosion control, temp. fence,	1	lump sum	10% of total construction cost		$65,125.82	$65,125.82	$0.00	$0.00	$0.00	$0.00	$0.00	$65,125.82
Contractor Overhead and Profit												**$97,688.72**
Home office cost, etc.	1	lump sum	15% of total construction cost		$97,688.72	$97,688.72	$0.00	$0.00	$0.00	$0.00	$0.00	$97,688.72
Mob/Demob												**$32,562.91**
Mob & demob of equip & personnel	1	lump sum	5% of total construction cost		$32,562.91	$32,562.91	$0.00	$0.00	$0.00	$0.00	$0.00	$32,562.91
SUBTOTAL CAPITAL COST						**$544,124.34**		**$155,571.36**		**$432,715.21**	**$2,590.12**	**$1,135,001.03**
Scope Contingency	20%											**$227,000.21**
Bid Contingency	10%											**$113,500.10**
TOTAL CAPITAL COST												**$1,475,501.34**
OPERATION & MAINTENANCE AND PERIODIC ACTIVITIES - PER EVENT COST												
Cover Maintenance												**$3,952.50**
Biannual mowing - tractor with rotary	150	M.SF	M 02935 300 1660		$12.25	$1,837.50	$10.10	$1,515.00	$0.00	$0.00	$0.00	$3,352.50
Biannual inspection	8	hrs	E 99 11 0403		$75.00	$600.00	$0.00	$0.00	$0.00	$0.00	$0.00	$600.00
Cover Repair - every five year												**$29,510.03**
Assume 2% of total capital cost	1	lump sum	Professional Judgment		$29,510.03	$29,510.03	$0.00		$0.00	$0.00	$0.00	$29,510.03
Sampling and Analysis												
Sample Collection												**$3,932.04**
Sample collection - 2 crew, 10 hrs/day, $50/hr	3	days	Professional Judgment		$1,000.00	$3,000.00	$0.00	$0.00	$0.00	$0.00	$0.00	$3,000.00
Disposable and decon materials per sample	10	samples	E 33 02 0401, 33 02 0402, 33 02 0561		$0.00	$0.00	$0.00	$0.00	$24.90	$249.00	$0.00	$249.00
Equipment Rental	3	days	E 33 02 0573, 33 02 0578		$0.00	$0.00	$227.68	$683.04	$0.00	$0.00	$0.00	$683.04
Lab Analysis												**$2,220.00**
Metals	10	samples	BOA Rates		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$1,570.00	$1,570.00
Chloride, nitrite/nitrate, sulfate	10	samples	BOA Rates		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$650.00	$650.00
Data Interpretation												**$7,500.00**
Report	1	lump sum	Professional Judgment		$7,500.00	$7,500.00	$0.00		$0.00	$0.00	$0.00	$7,500.00
Five-Year Review												**$4,500.00**
Report - Engineer	60	hrs	E 99 11 0403		$75.00	$4,500.00	$0.00	$0.00	$0.00	$0.00	$0.00	$4,500.00
Site Closure												**$15,000.00**
Report development	1	lump sum	Professional Judgment		$15,000.00	$15,000.00	$0.00		$0.00	$0.00	$0.00	$15,000.00

PRESENT WORTH CALCULATION REMEDIAL ALTERNATIVE 3

Discount Rate: 5.5% **O&M and Period Cost Contingency:** 20%

Year	Real Cost Incurred	Cost Description	Cost Type	Discount Factor	Present Worth
0	$1,475,501	Capital costs	Capital	1.00	$1,475,501
1	$75,016	Two biannual field inspections and mowings and four quarterly groundwater sampling events	O&M	1.06	$71,105
2	$25,868	Two biannual field inspections and mowings and an annual groundwater sampling event	O&M	1.11	$23,242
3	$25,868	Two biannual field inspections and mowings and an annual groundwater sampling event	O&M	1.17	$22,030
4	$25,868	Two biannual field inspections and mowings and an annual groundwater sampling event	O&M	1.24	$20,881
5	$66,680	Two biannual field inspections and mowings; an annual groundwater monitoring event; cover repair; and five-year review	O&M, Periodic	1.31	$51,020
6	$25,868	Two biannual field inspections and mowings and an annual groundwater sampling event	O&M	1.38	$18,761
7	$25,868	Two biannual field inspections and mowings and an annual groundwater sampling event	O&M	1.45	$17,783
8	$25,868	Two biannual field inspections and mowings and an annual groundwater sampling event	O&M	1.53	$16,856
9	$25,868	Two biannual field inspections and mowings and an annual groundwater sampling event	O&M	1.62	$15,977
10	$66,680	Two biannual field inspections and mowings; an annual groundwater monitoring event; cover repair; and five-year review	O&M, Periodic	1.71	$39,037
11	$25,868	Two biannual field inspections and mowings and an annual groundwater sampling event	O&M	1.80	$14,355
12	$25,868	Two biannual field inspections and mowings and an annual groundwater sampling event	O&M	1.90	$13,606
13	$25,868	Two biannual field inspections and mowings and an annual groundwater sampling event	O&M	2.01	$12,897
14	$25,868	Two biannual field inspections and mowings and an annual groundwater sampling event	O&M	2.12	$12,225
15	$66,680	Two biannual field inspections and mowings; an annual groundwater monitoring event; cover repair; and five-year review	O&M, Periodic	2.23	$29,868
16	$25,868	Two biannual field inspections and mowings and an annual groundwater sampling event	O&M	2.36	$10,983
17	$25,868	Two biannual field inspections and mowings and an annual groundwater sampling event	O&M	2.48	$10,411

PRESENT WORTH CALCULATION REMEDIAL ALTERNATIVE 3

Discount Rate: 5.5% **O&M and Period Cost Contingency:** 20%

Year	Real Cost Incurred	Cost Description	Cost Type	Discount Factor	Present Worth
18	$25,868	Two biannual field inspections and mowings and an annual groundwater sampling event	O&M	2.62	$9,868
19	$25,868	Two biannual field inspections and mowings and an annual groundwater sampling event	O&M	2.77	$9,353
20	$66,680	Two biannual field inspections and mowings; an annual groundwater monitoring event; cover repair; and five-year review	O&M, Periodic	2.92	$22,853
21	$25,868	Two biannual field inspections and mowings and an annual groundwater sampling event	O&M	3.08	$8,404
22	$25,868	Two biannual field inspections and mowings and an annual groundwater sampling event	O&M	3.25	$7,966
23	$25,868	Two biannual field inspections and mowings and an annual groundwater sampling event	O&M	3.43	$7,550
24	$25,868	Two biannual field inspections and mowings and an annual groundwater sampling event	O&M	3.61	$7,157
25	$66,680	Two biannual field inspections and mowings; an annual groundwater monitoring event; cover repair; and five-year review	O&M, Periodic	3.81	$17,486
26	$25,868	Two biannual field inspections and mowings and an annual groundwater sampling event	O&M	4.02	$6,430
27	$25,868	Two biannual field inspections and mowings and an annual groundwater sampling event	O&M	4.24	$6,095
28	$25,868	Two biannual field inspections and mowings and an annual groundwater sampling event	O&M	4.48	$5,777
29	$25,868	Two biannual field inspections and mowings and an annual groundwater sampling event	O&M	4.72	$5,476
30	$84,680	Two biannual field inspections and mowings; an annual groundwater monitoring event; cover repair; five-year review; and site closure.	O&M, Periodic, Site Closure	4.98	$16,991
CAPITAL COST	**$1,475,501**				
2004 Dollar LIFETIME O&M	**$1,305,688**		**Lifetime Present Worth O&M**		**$638,929**
TOTAL IMPLEMENTATION COST	**$2,781,189**		**TOTAL PRESENT WORTH**		**$2,114,431**

REMEDIAL ALTERNATIVE 4 Excavation and Off-site Disposal	LOCATION: Site 21, Bronson Road Landfill NSF-IH, Indian Head, Maryland	MEDIA: Solid Waste, Contaminated Soil, and Shallow Groundwater	Construction time: 55 weeks Operation time: NA Post Remediation Monitoring: none

DESCRIPTION OF ALTERNATIVE:

Excavation of soil area of attainment containing surface and buried metal debris, buried non metal debris, and arsenic contaminated soil; off-site disposal of the excavated material to a permitted landfill; and, backfill and site restoration of the excavation area.

3) Total excavated volume (in place): **3,000,000** CF or **111,111** CY

Road demolition: **200** CY

4) Percentage of the excavated material that can be used as backfill: 0% or **0** CY

5) Swelling factor: 10%

6) Sources of costs are 2004 RS Means Site Work & Landscape Cost Data, RS Means Environmental Remediation Cost Data - Unit Price, vendor quotes, and professional judgment based on similar projects.

ASSUMPTIONS:

1) The AA is approx. 150000 SF

2) Average thickness of the AA: 20 ft (based on the results of geophysical survey, boring and test pit logs)

Cost Component	Qty	Unit	Cost Source	Estimated Activity Duration (day)	Labor Unit Cost	Labor Total Cost	Equipment Unit Cost	Equipment Total Cost	Material Unit Cost	Material Total Cost	Subcontractor	Total Cost
CAPITAL COSTS												
Site Preparation				**12**								**$9,660.50**
Site clearing (dozer light)	3	acre	M 022030 200 0500	6	$239.00	$717.00	$430.00	$1,290.00	$0.00	$0.00	$0.00	$2,007.00
Site demolition (road demolition - assume asphalt paved)	2000	SY	M 02220 250 5010	3	$1.69	$3,380.00	$1.17	$2,340.00	$0.00	$0.00	$0.00	$5,720.00
Survey	3	days	M 01103 700 1100	3	$585.00	$1,755.00	$59.50	$178.50	$0.00	$0.00	$0.00	$1,933.50
Earthwork				**252**								**$1,175,004.56**
Excavation, bulk, dozer, piled, 300 HP 50' haul common earth	111311	CY	M 2315 432 5020	68	$0.23	$25,601.56	$0.67	$74,578.44	$0.00	$0.00	$0.00	$100,180.00
Borrow, loading, and spreading - common earth, shovel, 1CY bucket	119387	CY	M 02315 210 4000	143	$0.61	$72,825.87	$1.01	$120,580.53	$7.15	$853,614.67	$0.00	$1,047,021.07
Borrow, loading, and spreading - top soil, shovel, 1CY bucket (6" thick)	2778	CY	M 02055 150 0800	5	$1.33	$3,694.44	$3.03	$8,416.67	$20.00	$55,555.56	$0.00	$67,666.67
Grading - large area	16667	SY	M 02300 100 0100	9	$0.24	$4,000.00	$0.22	$3,666.67	$0.00	$0.00	$0.00	$7,666.67
Compaction - sheepsfoot, 12" lifts, 4 passes	122442	CY	M 02315 310 5640	95	$0.14	$17,141.91	$0.29	$35,508.24	$0.00	$0.00	$0.00	$52,650.16

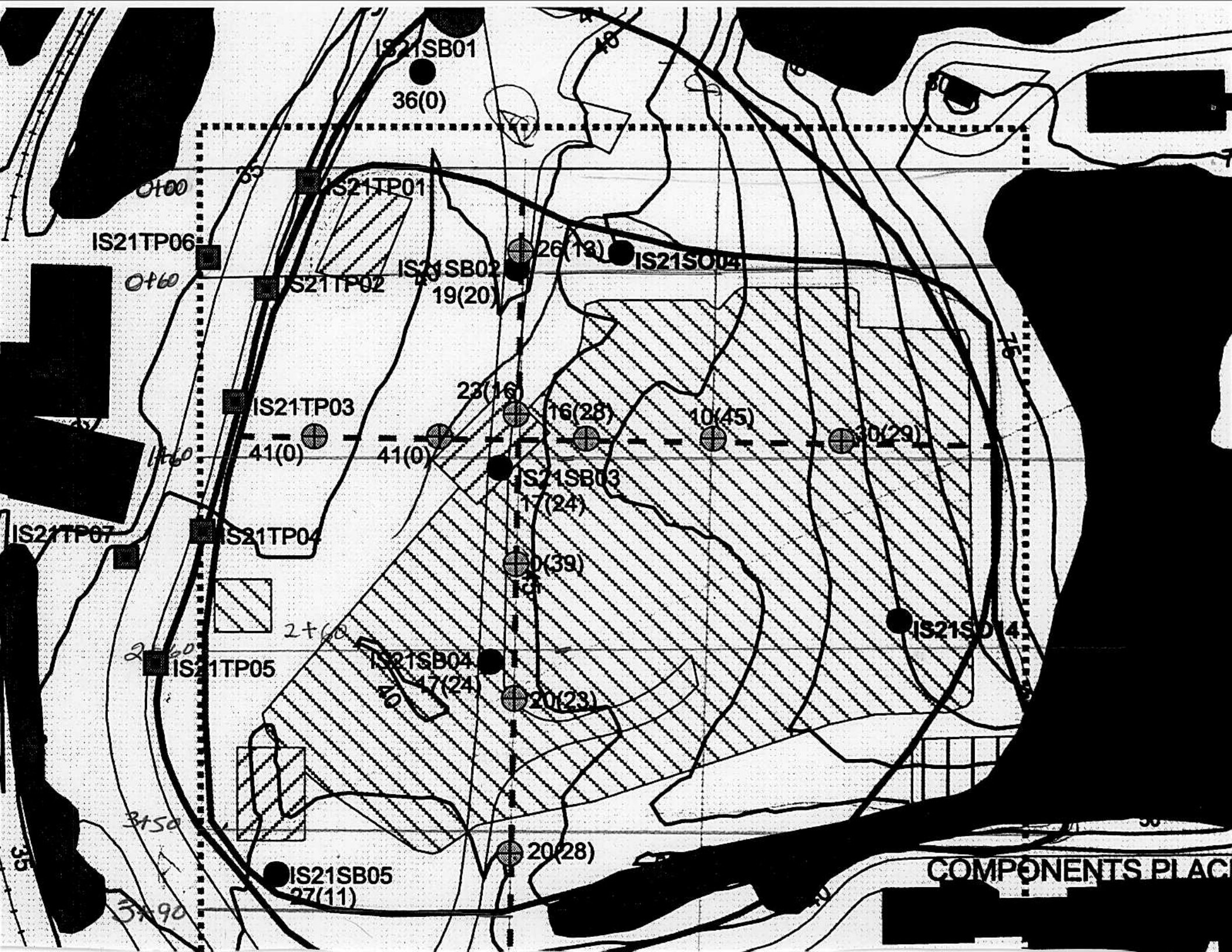
REMEDIAL ALTERNATIVE 4 Excavation and Off-site Disposal		LOCATION: Site 21, Bronson Road Landfill NSF-IH, Indian Head, Maryland					MEDIA: Solid Waste, Contaminated Soil, and Shallow Groundwater		Construction time: 55 weeks Operation time: NA Post Remediation Monitoring: none			
Off-site Transportation and Disposal												**$9,183,166.67**
Transporation	122442	CY	Clean Earth		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$3,061,055.56	$3,061,055.56
Disposal fee	122442	CY	Clean Earth		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$6,122,111.11	$6,122,111.11
Site Restoration and Surface Water Management				**10**								**$58,025.50**
Rip rap , 3' bottom, 3' deep, 2:1 side slope	1600	LF	E 33 05 0804	8	$3.14	$5,024.00	$2.02	$3,232.00	$26.77	$42,832.00	$0.00	$51,088.00
Hydroseeding	150	M.SF	M 02920 320 2400	2	$8.60	$1,290.00	$5.15	$772.50	$32.50	$4,875.00	$0.00	$6,937.50
Construction Oversight												**$233,338.40**
Engineer	55	weeks	E 99 11 0403		$1,096.00	$60,060.80	$0.00	$0.00	$0.00	$0.00	$0.00	$60,060.80
Site Health and Safety	55	weeks	E 99 11 0703		$1,492.00	$81,761.60	$0.00	$0.00	$0.00	$0.00	$0.00	$81,761.60
Superintendent	55	weeks	E 99 11 0203		$1,670.00	$91,516.00	$0.00	$0.00	$0.00	$0.00	$0.00	$91,516.00
Preconstruction Submittals												**$186,403.58**
Preconstruction survey, design basis, pre-draft, draft, and final design, specifications, and H&S plans	1	lump sum	15% of total construction cost		$186,403.58	$186,403.58	$0.00	$0.00	$0.00	$0.00	$0.00	$186,403.58
General Conditions												**$124,269.06**
Decontamination, temp. facilities, sed. & erosion control, temp. fence, etc.	1	lump sum	10% of total construction cost		$124,269.06	$124,269.06	$0.00	$0.00	$0.00	$0.00	$0.00	$124,269.06
Contractor Overhead and Profit												**$186,403.58**
Home office cost, etc.	1	lump sum	15% of total construction cost		$186,403.58	$186,403.58	$0.00	$0.00	$0.00	$0.00	$0.00	$186,403.58
Mob/Demob												**$62,134.53**
Mob & demob of equip & personnel	1	lump sum	5% of total construction cost		$62,134.53	$62,134.53	$0.00	$0.00	$0.00	$0.00	$0.00	$62,134.53
Site Closure												**$25,000.00**
Report development	1	lump sum	Professional Judgment		$25,000.00	$25,000.00	$0.00		$0.00	$0.00	$0.00	$25,000.00
SUBTOTAL CAPITAL COST						**$927,978.93**		**$250,563.56**		**$956,877.22**	**$9,183,166.67**	**$11,343,586.37**
Scope Contingency	20%											**$2,268,717.27**
Bid Contingency	10%											**$1,134,358.64**
TOTAL CAPITAL COST												**$14,746,662.28**

Supplemental Information to the Detailed Cost Estimate

Alternatives 2 and 3

Calculation of Estimated Fill Requirement

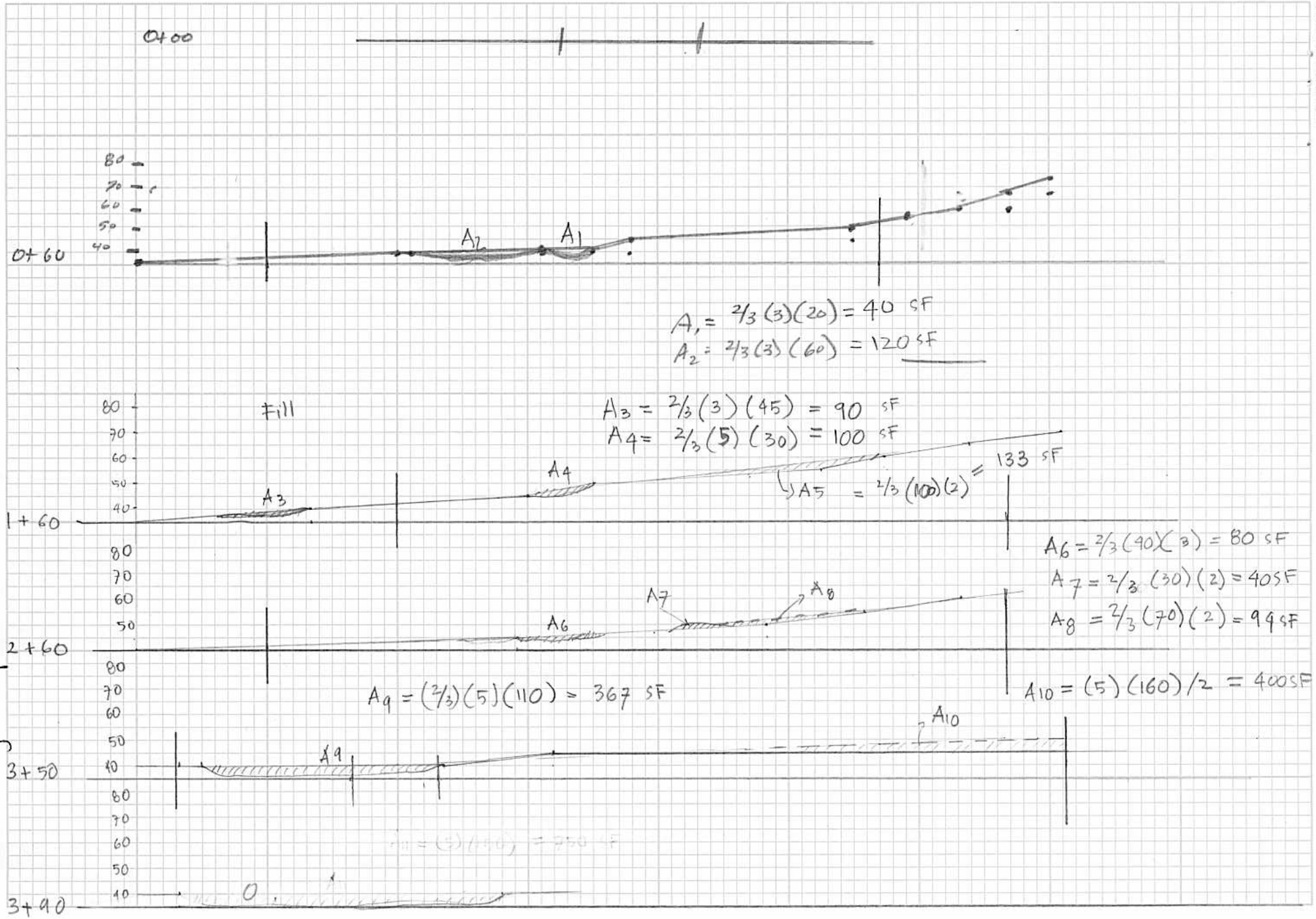
To Create 3:1 Slope to the Existing Landfill Grade


IS21SB01
36(0)
IS21TP01
IS21TP06
IS21TP02
IS21SB02
19(20)
26(13)
IS21SO04
IS21TP03
23(16)
16(28)
10(45)
30(29)
41(0)
41(0)
IS21SB03
17(24)
IS21TP07
IS21TP04
0(39)
IS21SO14
IS21TP05
IS21SB04
17(24)
20(23)
20(28)
IS21SB05
27(11)
COMPONENTS PLAC
0+00
0+60
1+60
2+60
2+60
3+50
3+90

SHEET NO. 2 of 3 DATE 7/7/04

PROJECT NO.

to create 3:1 Slope to the ex's
ting surface/cover



REV 9/93 FORM 18B

STATION	Area (SF)	Average Area (SF)	Distance (ft)	Volume (CF)	Vol (CY)
0+00	0				
0+60	160	80	60	4,800	178
1+60	323	241.5	100	24,150	894
2+60	214	268.5	100	26,850	994
3+50	767	490.5	90	44,145	1,635
3+90	0	383.5	40	15,340	568
				115,285	4,270

¢5 / SF grading.

Appendix G
Additional Manganese Investigation Results

Site 21 Manganese Investigation Results NSF-IH, Indian Head, Maryland

PREPARED FOR: Jeff Morris/NAVFAC Washington
Joe Rail/NAVFAC Washington
Shawn Jorgensen/NSF-IH
Dennis Orenshaw/EPA Region III
Curtis DeTore/MDE

PREPARED BY: Rebecca Calimer/CH2M HILL
Gunarti Coghlan/CH2M HILL

COPIES: Margaret Kasim/CH2M HILL
John Mason/CH2M HILL
Scott Saroff/CH2M HILL

DATE: September 15, 2006

Introduction

This technical memorandum presents the results of the direct-push technology (DPT) groundwater sampling at Site 21, Bronson Road Landfill, at the Naval Support Facility, Indian Head (NSF-IH), Indian Head, Maryland. The rationale for this investigation is presented in two versions of an electronic work plan provided in Attachment A. To reduce duplication of material, background information and site history will not be repeated in this technical memorandum because that material is presented in the report entitled *Final Remedial Investigation Report for Sites 11, 13, 17, 21, and 25, Naval District Washington, Indian Head, Indian Head, Maryland (Volume 1)* (CH2H HILL, 2004).

The primary objective of this investigation was to characterize the extent of manganese in shallow groundwater downgradient of monitoring well IS21MW02. For the most part, delineation was considered complete if manganese concentrations in groundwater were equal or less than the facility-wide background concentration of 824 µg/L. The objective of the groundwater sampling was accomplished through a triad-like approach. Attachment B provides selected correspondence with the Indian Head Installation Restoration Team (IHIRT) showing how the triad approach was used for this investigation.

Field Activities

Utility clearance was performed by Earth Resource Technology, Inc. at the direct-push technology (DPT) locations before initiating intrusive work. Below is a chronology of field events.

Tier 1 Sampling

Tier 1 sampling was conducted on June 20, 2006. With the exception of location IS21DP02, DPT groundwater samples were collected from locations IS21DP01 and IS21DP03 through IS21DP05. At IS21DP02, a groundwater sample was collected from a piezometer with a 20-

foot screen because of difficulty in collecting water as a result of low groundwater recharge. Groundwater samples were collected from one depth interval at the DPT locations except IS21DP05, where samples were collected from two depth intervals. A total of six samples were sent to the laboratory for dissolved manganese analysis.

The work plan called for collection of groundwater samples at approximately 4, 8, and 12 feet below the water table. Based on field observations and difficulty in collecting groundwater samples during the June 20, 2006 sampling, it was speculated that the water-bearing unit is thin in this area. Consequently, on June 28, 2006, macro-core sampling was performed at location IS21DP06 for lithological information. A macro-core sampler was advanced at 4-foot intervals from ground surface to 20 feet below ground surface. Soil samples were retrieved from an acetate liner and visually classified to assess the presence and thickness of permeable lenses in the saturated zone. Lithological information was considered necessary for making a decision on the number of depth intervals that could be sampled at each borehole. The presence of a thin water-bearing unit was confirmed through the lithology descriptions from the macro-core samples from IS21DP06.

Groundwater grab samples were collected with a direct-push rig, which advanced a macro-core rod fitted with a retractable screen. The sampling apparatus was advanced 4 feet below the anticipated groundwater table; the barrel was then retracted to expose a stainless steel screen for 30 to 60 minutes for groundwater to infiltrate. A groundwater sample was then collected via a peristaltic pump. If an insufficient volume of groundwater was present at the first sampling interval, the drill rod was advanced an additional four feet, and the process was repeated. At some sampling locations, a groundwater sample could not be extracted from the boring using this method; for these instances, either the retractable screen was left in place overnight, or a 1-inch diameter, 0.010 inch (10 slot) piezometer was installed to allow groundwater to infiltrate the borehole overnight.

Tiers 2 and 3 Sampling

From June 28 to June 30, 2006, groundwater samples were collected from seven Tier 2 locations (IS21DP06 through IS21DP12) and three Tier 3 locations (IS21DP13 through IS21DP15). Because the sample holding time for manganese analysis is 14 days, Tier 3 samples were collected concurrently with Tier 2 samples to minimize the extra field effort. Based on the results of the macro-core sampling, one depth interval was sampled from each borehole. A groundwater sample from IS21DP11 was collected using a 10-foot screen piezometer after an overnight recharge because of the low groundwater recharge at this location. Locations IS21DP16 and IS21DP17 were not sampled because water was not encountered even though several attempts were made at several locations and various depth intervals at each location. Samples from IS21DP13 and IS21DP14 were not analyzed because the manganese concentrations from locations IS21DP11 and IS21DP12 were below the facility-wide background concentration. A total of eight samples were sent to the laboratory for dissolved manganese analysis.

Tier 4 Sampling

Tier 4 sampling was conducted from July 31 to August 2, 2006. DPT groundwater samples were collected from locations IS21DP18 through IS21DP22. A sample was collected from one depth interval at each location. A total of five samples were sent to the laboratory for dissolved manganese analysis.

The groundwater samples were filtered using a 0.45-micron filter and were analyzed for dissolved manganese according to the U.S. Environmental Protection Agency (EPA) Method SW-846 6010B on a 24-hour turn-around time. The analysis was performed by GPL Laboratories of Frederick, Maryland.

Parallel with the manganese investigation, another investigation was conducted to collect data for geochemical modeling and water balance calculations. The collected data consisted of groundwater samples from the existing four monitoring wells (IS21MW01 through IS21MW04) at the site and analyzing them for total and dissolved manganese, as well as other parameters. The results are presented in this technical memorandum to show the most recent dissolved manganese results for the monitoring wells.

Results

Table 1 shows the analytical results, depth interval where each sample was taken; sample collection date and comments, if any, associated with each sample; and exceedances of the facility-wide background concentration. Figure 1 shows the locations and manganese concentration results associated with each sample. Laboratory reports are presented in Attachment C.

Manganese was detected in the 19 groundwater samples at concentrations that ranged from 72 µg/L to 5,710 µg/L, with 10 of the 19 samples exceeding the background level of 824 µg/L (Figure 1). The maximum concentration of 5,710 µg/L was detected in the groundwater sample collected from location IS21DP07, and the minimum concentration of 72 µg/L was observed in the deeper depth interval sample from IS21DP18.

Manganese concentrations in six Tier 1 samples ranged from 78 µg/L to 3,650 µg/L, with three samples exceeding the facility-wide background concentration. At location IS21DP05, the manganese concentration was reduced from 3,650 µg/L in the shallow depth interval (8 to 12 feet bgs) to 78 µg/L in the deep depth interval (16 to 20 feet bgs). These results indicated that further sampling was necessary because concentrations were not adequately delineated to background in all areas downgradient of well IS21MW02.

Manganese concentrations in seven Tier 2 samples ranged from 85 µg/L to 5,710 µg/L, with four samples exceeding the facility-wide background concentration. The only Tier 3 sample analyzed (IS21DP15) indicated a concentration of 296 µg/L, well below the facility-wide background concentration of 824 µg/L. Based on the results, Tiers 2 and 3 samples have adequately delineated the extent of the manganese concentrations in the south and southwest downgradient area of well IS21MW02. Further sampling was necessary to adequately delineate the concentration extent in the area west and north of monitoring well IS21MW02.

Manganese concentrations in five Tier 4 samples ranged from 72 µg/L to 4,300, with three samples exceeding the facility-wide background concentration. The results indicate that the extent of manganese concentrations have been adequately delineated to the background level in the area of north of well IS21MW02. Adequate delineation to background has not been achieved in the area west of well IS21MW02.

In the monitoring wells, manganese concentrations in groundwater were detected below the facility-wide background concentration of 824 µg/L. These results are consistent with the

previous groundwater sampling events for the monitoring wells, with the exception of monitoring well IS21MW02. Manganese levels in monitoring well IS21MW02 are decreased from 23,000 µg/L in 2000 to 10,900 µg/L in 2002, and are currently 713 µg/L in 2006.

The results and primary findings of the manganese investigation were communicated to the IHIRT via e-mail on August 14, 2006 (Attachment B).

Conclusion

The objective of this investigation was to characterize the extent of manganese in the shallow groundwater to the background level of 824 µg/L in the area downgradient of well IS21MW02. Except for the area west of IS21MW02, the extent of manganese in the other geographic directions has been characterized. The area to the west was not delineated to background because of the presence of several features, which limited access to the area with a direct-push rig. These features include a fence on the west side of Atkins Road, a hill, and a wetland area. The results of this investigation also indicate that the area of elevated manganese concentration is not isolated at or around IS21MW02.

The DPT results show that there may be a manganese plume migrating to the west, as shown in Figure 1. However, these results may not be representative of the dissolved manganese concentration migrating in the groundwater and, because they are not repeatable, the results may be anomalously high. To collect a more representative groundwater sample to assess the migration of dissolved manganese, a groundwater monitoring well should be installed and incorporated into a groundwater sampling program as part of the long-term monitoring. This method would allow for the on-going monitoring of the manganese and would further assess the dissolved manganese concentration in groundwater.

Reference

CH2M HILL. 2004. *Final Remedial Investigation Report, Sites 11, 13, 17, 21, and 25, Indian Head Division–NSWC, Indian Head, Maryland*.

Attachment A
Work Plan

Kasim, Margaret/WDC

From: Kasim, Margaret/WDC

Sent: Tuesday, January 10, 2006 2:27 PM

To: Kasim, Margaret/WDC; Morris, Jeffrey CIV (NAVFACWASH); Joe Rail (e-mail); Jorgensen, Shawn A CIV NDW; cdetore@mde.state.md.us; orenshaw.dennis@epamail.epa.gov; David Steckler (David.Steckler@navy.mil)

Cc: Mason, John/PHL; Coghlan, Gunarti/WDC; Corack, Ed/WDC

Subject: RE: Abbreviated Work Plan for Manganese Investigation at Site 21

Team:

Following the email exchange between CH2M HILL and the Navy pertaining to the scope for the Site 21 field effort, an impromptu conference call was held on Friday, January 6, 2006. David's concerns regarding: 1) the level of effort required to collect macro-core samples for lithologic description; and 2) the need for vertical delineation were discussed. David indicated that, given the number of mobilizations required to characterize Sites 17 and 47, vertical as well as lateral delineation is required during this effort. David felt that the collection of lithologic data could be eliminated in the interest of efficiency and that this data could be collected during monitoring well installation for LTM.

Per the Navy's recommendation, the following will be done:

1) Macro-core sampling will be eliminated from the direct-push portion of the effort as lithologic data will be collected during monitoring well installation.
2) At each Tier I sampling location, groundwater samples will be collected at approximately 4, 8, and 12 feet below the water table.The depths roughly correspond to the screened interval of monitoring well IS21MW02. The samples will be collected by advancing the Geoprobe sampler to the shallow depth for the first sample and then move downward for the additional samples. This is to eliminate the potential for cross-contamination. Further, the data generated from this effort should be considered "qualitative" to "semi-quantitative". The results will act as a guide for permanent monitoring well locations and also for lateral delineation.
3. At the Tier II and possibly Tier III locations, the decision to collect groundwater samples at multiple depths will be determined based on the results of the Tier I sampling (i.e., an informal Triad-like decision tree will be applied to the data at every point).

The only deviation to the consensus reached during the November 2, 2005 conference call with the Team is the addition of the vertical delineation of manganese in the shallow aquifer. Please comment and/or concur by Tuesday, January 17, 2006.

FYI - Shawn informed us that this is the Bald Eagle nesting season, which ends June 15, 2006. Therefore, the earliest we can start fieldwork at both sites will be June 19, 2006. Even with the change in schedule, please review the WP so I can get Team concurrence on the sampling approach.

Thanks.

Margaret

From: Kasim, Margaret/WDC
Sent: Thursday, January 05, 2006 4:56 PM
To: 'Morris, Jeffrey CIV (NAVFACWASH)'; Joe Rail (e-mail); 'Jorgensen, Shawn A CIV NDW'; 'cdetore@mde.state.md.us'; orenshaw.dennis@epamail.epa.gov; David Steckler (David.Steckler@navy.mil)
Cc: Saroff, Scott/SYR; Mason, John/PHL; Coghlan, Gunarti/WDC

Subject: Abbreviated Work Plan for Manganese Investigation at Site 21

Team:

This email serves as a work plan for the manganese (Mn) investigation at Site 21. It presents the proposed sampling approach for collecting and analyzing shallow groundwater samples downgradient of monitoring well IS21MW02 for Mn, as agreed to during the IHIRT conference call on November 2, 2005.

Manganese was detected in monitoring well IS21MW02 at concentrations of 23,000 μg/L and 10,900 μg/L during the 2000 and 2002 sampling events, respectively. These concentrations exceed the facility wide background concentration of 824 μg/L.

The primary objective of this additional sampling is to characterize the extent of manganese in shallow groundwater downgradient of IS21MW02. The groundwater samples will be collected using direct-push technology (DPT) from the proposed locations shown on Figure 1. Locations IS21DP01 through IS21DP03 are proposed mainly for downgradient characterization whereas locations IS21DP04 and IS21DP05 are proposed to aid siting of permanent monitoring wells for landfill LTM.

The collected groundwater samples from the DPT borings will be field filtered using a 0.45μ filter as agreed to by the Team and sent to an offsite laboratory for manganese analysis using EPA Method SW-846 6010B on a 24-hour turnaround time. During advancement of each borehole, macro-core samples will be collected for lithologic description by the CH2M HILL's geologist.

Per the Navy's suggestion, the objective of this groundwater sampling will be accomplished through a triad-like sampling approach, as described below.

Tier 1 Sampling: Locations IS21DP01 through IS21DP05 will be sampled and sent to the lab for Mn analysis on a 24-hr TAT. Upon receipt of the lab results, the data will be compared to the background concentration and emailed to the Team. The following rules will be used for making decisions:

- If the results at all locations are less than the background concentration of 824 μg/L, then the downgradient extent of manganese has been delineated. No other samples will be collected.
- If the result of one or more locations is higher than the background concentration of 824 μg/L, then the downgradient extent of manganese has not been completely delineated around those locations.

Tier 2 Sampling: If the results indicate the second bullet above, then samples will be collected from one or more of the proposed locations, without station IDs, shown on the figure. The locations that will be sampled will be those close to the location with the concentration that exceeds background concentration. The samples will be collected, analyzed, and the results evaluated as for the Tier 1 samples. The same decision rules apply. If there are any exceedances, the Team will make a decision if additional locations should be sampled.

The data will not be validated by a third-party data validator, as they will not be used for risk assessment. However, the data will be evaluated by a CH2M HILL's chemist to assess the validity of the results. A technical memorandum will be prepared (with accompanying figures, tables, and appendices) and submitted to the Team. The technical memorandum will be attached as an appendix to the Final FS report.

Note that sampling, sample handling and shipping, decontamination, and IDW handling will be done in accordance with standard operating procedures outlined in Tetra Tech's "Master Plans for Installation Restoration Program Environmental Investigations, Naval District Washington, Indian Head, Indian Head Head" dated June 2004. All other procedures will follow previous practices.

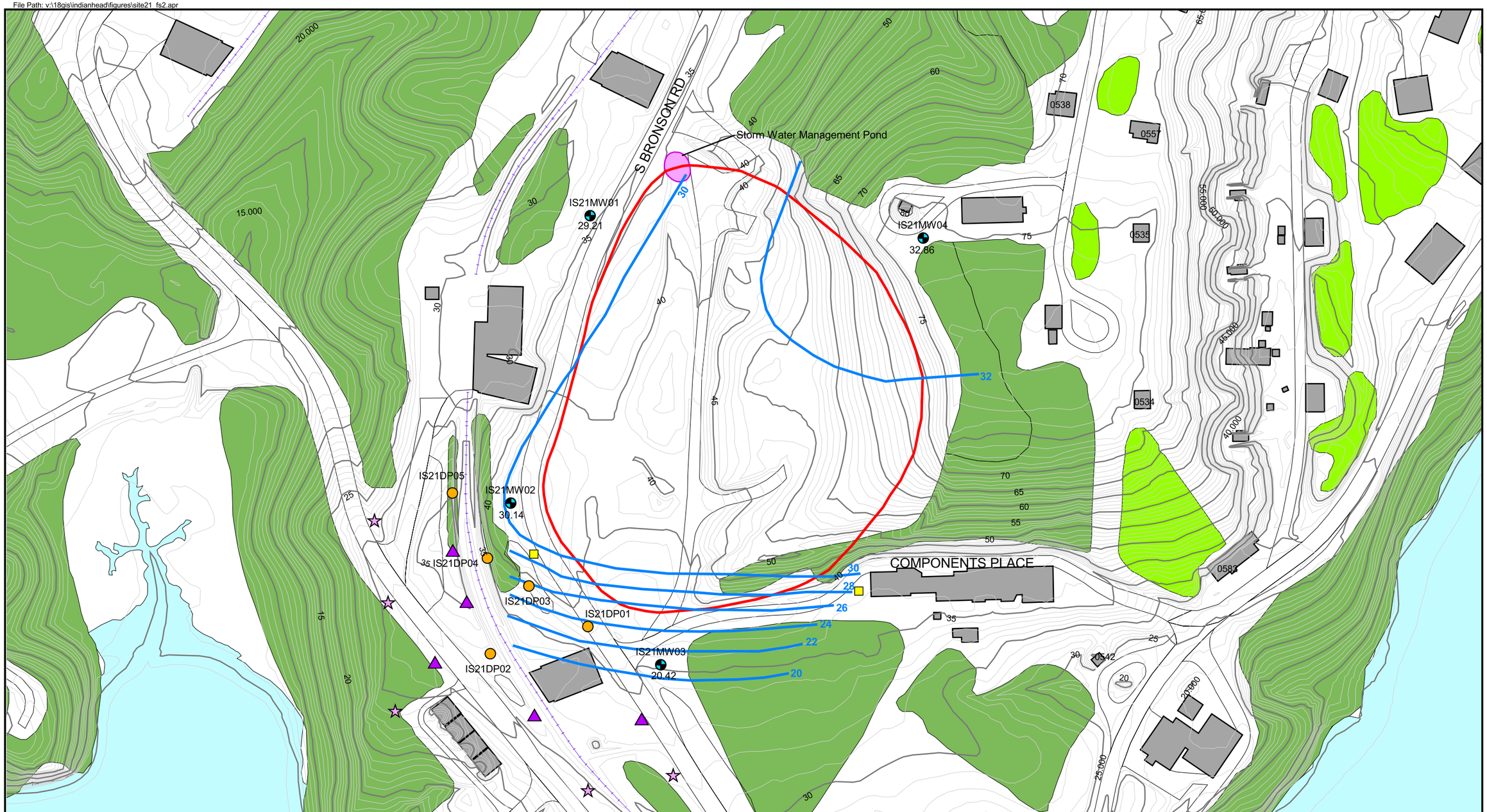
This work will be performed concurrently with the Site 47 fieldwork, which consists of collecting saturated soil and groundwater samples for the bench-scale studies. Therefore, this work is proposed to start on January 30, 2006.

How about we go with the old thumbs up or thumbs down approach? Please let me know by January 10, 2006. Thanks.

Margaret

Margaret F. Kasim, Ph.D.
Project Manager/Engineering Geologist
CH2M HILL
13921 Park Center Road, Suite 600
Herndon, VA 20171
Direct Line: 703-471-6405 Ext. 4422
FACSys: 703-796-6112
e-mail: mkasim@ch2m.com

File Path: v:\18gis\indianhead\figures\site21_fs2.apr



LEGEND

- Monitoring Wells
- Approximate Site Boundary
- Proposed Monitoring Wells
- Proposed Tier 1 Sample Locations
- Proposed Tier 2 Sample Locations
- Proposed Tier 3 Sample Locations (Locations tenative and will be finalized based on Tier 1 & 2 sample results)
- Buildings
- Potentiometric Contours (dashed where inferred; feet above msl)
- Road
- Railroads
- Contours (5 ft)
- Contours (1 ft)
- Wooded Area

Note: Potentiometric Surface Elevation Contours were measured on December 9, 2002

N

0 60 120 Feet

1" = 120'

Figure 1
Proposed DPT Groundwater Sampling Locations
Site 21, Bronson Road Landfill
NDWIH, Indian Head, Maryland

CH2MHILL

Attachment B
Correspondences

CH2MHILL TELEPHONE CONVERSATION RECORD

Call To: Dennis Orenshaw/EPA
Curtis DeTore/MDE
Joe Rail/NAVFAC Washington
Shawn Jorgensen/NDWIH
David Steckler/NAVFAC Washington
John Mason/CH2M HILL
Margaret Kasim/CH2M HILL
Gunarti Coghlan/CH2M HILL

Phone No.:

Date: November 2, 2005

Call From:

Time: 10:00 – 10:45 AM

Minutes Taken By: Gunarti Coghlan/CH2M HILL

Subject: Site 21 Path Forward

The conference call was hosted by CH2M HILL to revisit the consensus achieved during the August 11, 2005 Indian Head Installation Restoration Team (IHIRT) conference call regarding the applicability of an engineered impermeable cap at Site 21 and to determine the path forward for the site.

The chronology of the decisions at Site 21 is summarized as follow:

1. August 11, 2005 – Through a conference call, MDE indicated that an engineered cap would be most applicable for Site 21 because it satisfies COMAR 26.04.07.21 – Industrial Sanitary Landfill Closure requirements, which is a state ARAR. Long-term groundwater monitoring and Institutional Controls (ICs) will be an integral part of the engineered cap alternative. EPA and MDE concurred that mitigation of the potential human health risk from manganese exposures in the shallow groundwater at Site 21 through the implementation of an impermeable engineered cap to minimize the leachate infiltration into the groundwater is an acceptable approach. Therefore, the discussion of the remedial alternatives for groundwater will be integrated into the remedial alternatives for soil/landfill, by emphasizing, for example, the ability of an engineered cap to minimize leachate generation to indirectly mitigate the risks associated with the shallow groundwater. It should be noted that the geologic cross sections presented in the Draft Final FS indicated that all solid waste volume lies above groundwater table.

2. August 16, 2005 – CH2M HILL distributed the August 11 conference call minutes to IHIRT.

3. August 19, 2005 - Mr. Shawn Jorgensen suggested that the depiction that solid waste lies above the water table in the cross sections, was incorrect based on the information from the Final RI Report and information from Mr. David Steckler.

4. August – October, 2005 – CH2M HILL worked closely with Mr. Steckler to resolve the misinterpretation of the waste thickness encountered below the water table. A consensus was agreed upon by including an additional cross section based primarily on the electrical resistivity (ER) data.

5. October 12, 2005 – CH2M HILL submitted the revised cross sections to the Navy for approval.
6. October 14, 2005 – CH2M HILL received Navy's approval on the cross sections.
7. October 17, 2005 – CH2M HILL distributed the revised cross sections to IHIRT for review.
8. October 26, 2005 – During the IHIRT meeting in Indian Head, Maryland, the revised cross sections, which indicate the existence of significant waste volume below the water table were presented to the team. The Navy requested MDE to revisit the applicability of an engineered cap at Site 21. Mr. Curtis DeTore indicated that an engineered cap would still likely be applicable for Site 21, irrelevant of the percentage of solid waste volume below the water table. Mr. David Steckler suggested that the revised cross sections were still underestimating the percentage of solid waste lying below the water table and recommended that an additional cross section be developed to depict that more waste are in contact with groundwater. The discussion went over time and a conference was set up to discuss the path forward of the site. CH2M HILL drew another cross section (D-D'), which was based primarily on the ER data and submitted to the team prior to the conference call. Mr. DeTore had an action item to consult with the Solid Waste Management Division (SWM) of MDE on the issue of the amount of waste below the water table waste before the conference call, which was set up for November 2, 2005.

The discussion points during the November 2, 2005 call is summarized below:

1. Mr. DeTore, in consultation with the Solid Waste Management of MDE (SWM), determined that:
    a. An impermeable engineered cap (which is a state ARAR) is applicable at Site 21, despite the fact that significant solid waste is in contact with the groundwater and CH2M HILL's assessment that a impermeable cap would likely result in negligible water table depression. Manganese mobilization in groundwater is likely caused by reducing condition. An impermeable cap would help alleviate the reducing condition and stabilize the manganese sooner. It is extremely difficult for SWM to grant a soil cover variance for this site.
    b. SWM agreed that no active remediation for groundwater is necessary because manganese mobilization is likely caused by a reducing condition and likely localized. SWM, however, requested that a further investigation be conducted before a remedy is chosen. Two additional downgradient groundwater monitoring wells would be installed as part of the additional investigation and these wells will be used for the long-term monitoring for the landfill.
2. CH2M HILL suggested that the elevated manganese concentration in groundwater downgradient of IS21MW02 be further delineated. The team agreed. Mr. Steckler recommended that direct push technology be used and groundwater be filtered using a 0.45 micron filter and analyze for manganese. The team concurred that an additional investigation to determine the extent of manganese be conducted before the FS is finalized.

3. CH2M HILL stated that there were uncertainties associated with the impermeable cap option, as well. It is unknown if the solid waste above or below the water table is the contributor of manganese in the groundwater. If solid waste above the water table is the dominant contributor, an impermeable cap would likely mitigate the issue. However, if the waste in contact with the groundwater is the dominant contributor, an impermeable cap would not resolve the issue. It was suggested that the uncertainties be described in the FS.

4. CH2M HILL requested a further clarification on MDE's position on the applicability of an engineered cap at Site 21 if the results of the further characterization of manganese suggest that the concentrations are lower or the location at which it is observed is isolated. Mr. DeTore suggested that an impermeable cap would be applicable.

5. Mr. Steckler pointed out that significant portions of the solid waste are in contact with groundwater and the impact of an impermeable cap on manganese contamination is uncertain. He further suggested that the ROD for the site include a language that in the event that manganese contamination is exacerbated by an impermeable cap, that no active remediation would be performed. Mr. DeTore indicated that the occurrence would be unlikely but relied on EPA legal counsel. Mr. Orenshaw indicated that inclusion of such language in the ROD is unlikely.

6. Mr. Steckler asked Mr. DeTore if there is any percentage of waste below water that may sway MDE's position on an impermeable cap. Mr. DeTore indicated that there are no such numbers.

7. The additional direct push investigation and the installation of the 2 downgradient groundwater monitoring wells will be accomplished through 2 different field events.

Path Forward for Site 21:

1. Submittal of a work plan to further characterize the extent of manganese in groundwater around and downgradient of monitoring well IS21MW02.

2. An impermeable cap would be the preferred alternative (will be presented in the proposed plan).

Kasim, Margaret/WDC

From: Kasim, Margaret/WDC

Sent: Tuesday, June 20, 2006 11:26 AM

To: Steckler, David J. CIV NAVFACWASH; jeffrey.w.morris@navy.mil; joseph.rail@navy.mil; shawn.a.jorgensen@navy.mil; cdetore@mde.state.md.us; 'Orenshaw.Dennis@epamail.epa.gov'

Cc: Mason, John/PHL; Coghlan, Gunarti/WDC; Saroff, Scott/SYR

Subject: Status Memo - Site 21

Attachments: Status Memo 6_19_06 mk.doc

Hi All - Attached is a memo, which provides an update on the groundwater sampling activities at Site 21 yesterday. Please let me know if you have any questions.

David - Please let me know if you could be available today for a con call with me and John Mason to discuss the possible use of piezometers and/or probably sampling of only one depth interval. Thanks.

Margaret

Day 1 Update on Site 21 Tier 1 Sampling

NSF-IH, Indian Head, MD

TO: Project Team

COPIES: Margaret Kasim

Gunarti Coughlin

FROM: CH2M HILL

DATE: June 20, 2006

CH2M HILL initiated groundwater sampling from the Tier 1 sampling points at Site 21 at Indian Head on June 19, 2006. This memorandum was prepared to provide the project team with a brief update of the sampling status and field observations from the sampling activities. The field activities consist of advancing a borehole using direct-push technology (DPT) and collecting depth-discrete groundwater samples at 4 ft, 8 ft, and 12 ft below the groundwater table using a DPT groundwater sampler. The DPT groundwater sampler consists of a 4-ft length of stainless steel screen that is sheathed in a DP drilling rod, driven to the desired depth, and exposed to collect groundwater when the drill rod sheath is pulled up 4 feet.

The first DPT location (IS21DP05) encountered saturated gravels at 8 ft below ground surface (bgs). The DPT groundwater sampler was advanced to 12 ft bgs and a field-filtered groundwater sample was collected for Manganese (Mn) using a peristaltic pump with 0.25" tubing inserted into the DPT sampler. After sample collection, the DPT groundwater sampler was advanced to a depth of 16 ft below grade. No groundwater was immediately observed in the DPT sampler and was temporarily left to allow groundwater to accumulate while drilling continued at the second DPT location (IS21DP02). After about 2 hours, no groundwater was detected in the DPT sampler at location IS21DP05. The DPT groundwater sampler was then advanced to a depth of 20 ft and allowed to remain in the ground overnight to allow groundwater to accumulate.

The second DP location (DP02) encountered a saturated or near saturated silty sand and gravel at a depth of 8 ft bgs. The DPT groundwater sampler was driven to a depth of 12 ft bgs and the stainless steel screen was exposed. No groundwater or moisture was observed in the DPT sampler. The DPT groundwater sampler was then driven to a depth of 16 ft bgs and the screen was again exposed for about 1 hour to allow groundwater to accumulate; but there was no water. Subsequently, the DPT sampler was advanced to depths of 20 ft and 24 ft bgs, again with no groundwater accumulating in the DPT sampler. To allow for the collection of a groundwater sample from location IS21DP02, a piezometer was installed in the DPT borehole to a depth of 21 ft bgs and the annular space filled with a sand filter pack

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around the piezometer screen and hydrated bentonite near the surface to prevent potential surface infiltration through the borehole annulus. Though installation of a piezometer is a deviation from the approved work plan, it was deemed necessary to ensure groundwater collection.

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Kasim, Margaret/WDC

From: Kasim, Margaret/WDC

Sent: Tuesday, June 20, 2006 1:58 PM

To: Kasim, Margaret/WDC; Steckler, David J. CIV NAVFACWASH; jeffrey.w.morris@navy.mil; joseph.rail@navy.mil; shawn.a.jorgensen@navy.mil; cdetore@mde.state.md.us; Orenshaw.Dennis@epamail.epa.gov

Cc: Mason, John/PHL; Coghlan, Gunarti/WDC; Saroff, Scott/SYR

Subject: RE: Status Memo - Site 21

Hi All:

Following the e-mail I sent with the Site 21 update tech memo this morning, we had a con call with the Navy. As indicated in the tech memo, water was encountered between 8 and 12 feet bgs. Below 12 feet, water was not recovered using the direct-push groundwater sampler. My field guy told me that there was smeared clay on the rods when they were pulled out from depths greater than 12 feet bgs, suggesting a lithologic change that was not anticipated.

It is possible that the water-bearing unit is not thick in this area. To determine the thickness of the water-bearing unit, we are proposing to make a minute detour from the work plan and collect macro core samples at one location for lithological information. We hope this information will tell us the thickness of the water-bearing unit. We should then be able to use this information to make a decision if we want to continue with collecting water samples from 3 depth intervals (as indicated in the Work Plan) or one depth interval. We would also make a decision on where we want to collect the water sample - from the top, bottom, or middle of the water-bearing unit.

The drillers are at the site and I need to get your buy in immediately. How about the old thumbs up or down by 4:00 p.m. today. Let me know if you have any questions or need clarification. Thanks.

Margaret

From: Kasim, Margaret/WDC
Sent: Tuesday, June 20, 2006 11:26 AM
To: Steckler, David J. CIV NAVFACWASH; jeffrey.w.morris@navy.mil; joseph.rail@navy.mil; shawn.a.jorgensen@navy.mil; cdetore@mde.state.md.us; 'Orenshaw.Dennis@epamail.epa.gov'
Cc: Mason, John/PHL; Coghlan, Gunarti/WDC; Saroff, Scott/SYR
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Margaret

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Sent: Tuesday, June 20, 2006 4:20 PM
To: cdetore@mde.state.md.us; jeffrey.w.morris@navy.mil; joseph.rail@navy.mil; shawn.a.jorgensen@navy.mil; Steckler, David J. CIV NAVFACWASH; Orenshaw.Dennis@epamail.epa.gov
Cc: French, Elisha/WDC; Saroff, Scott/SYR; Mason, John/PHL; Coghlan, Gunarti/WDC
Subject: RE: Status Memo - Site 21

Attachments: 606122CH2M.PDF

606122CH2M.PDF

Here are some updates:

1. David Steckler asked that I check with the lab on the sample volume for analysis, as I had told him that we were unable to collect the full volume from the 2nd depth interval (16-20 feet bgs) at IS2105. Stacy checked w/ the lab - see her e-mail below.

2. Attached is the lab result for Mn for the sample collected yesterday from the 1st depth interval (8-12 feet bgs) at IS21DP05. The result is 3,650 micrograms/liter.

3. Elisha said that they were able to collect only one GW sample from IS21DP03 (12-16 feet bgs) and IS21DP04 (12-16 feet bgs) today. To remind everyone, a GW sample was collected today from a piezometer that was installed at IS21DP02 yesterday and was left overnight.

4. They were setup at IS21DP01 and plan to collect a sample when I spoke to Elisha this afternoon.

5. I spoke to the drilling company today and was told that they have the macro core samplers on site. Once I hear from Curtis, we will go ahead with the macro core sampling at one location. Tomorrow, they will be at Site 47.

That's all for now folks!!!!!

Margaret

From: Davenport, Stacy/WDC
Sent: Tuesday, June 20, 2006 3:49 PM
To: Coghlan, Gunarti/WDC; Kasim, Margaret/WDC
Subject: FW: Mn result

Margaret,

Attached is the result. I just spoke with Virginia Zusman from GPL, and she said that as long as we didn't need any QC run on the sample they only need 100 mL, so they should have enough for the sample. Let me know if you have any other questions!

Stacy

Margaret

-----Original Message-----

From: Kasim, Margaret/WDC
Sent: Tuesday, June 20, 2006 3:54 PM
To: cdetore@mde.state.md.us; jeffrey.w.morris@navy.mil; joseph.rail@navy.mil; shawn.a.jorgensen@navy.mil; 'Steckler, David J. CIV NAVFACWASH'; 'Orenshaw.Dennis@epamail.epa.gov'
Cc: French, Elisha/WDC; Saroff, Scott/SYR; Mason, John/PHL; Coghlan, Gunarti/WDC
Subject: FW: Status Memo - Site 21

Thanks Dennis.

Shawn - Joe and David participated in the con call and are onboard.

Margaret

-----Original Message-----
From: Orenshaw.Dennis@epamail.epa.gov [mailto:Orenshaw.Dennis@epamail.epa.gov]
Sent: Tuesday, June 20, 2006 3:30 PM
To: Kasim, Margaret/WDC
Subject: RE: Status Memo - Site 21

Margaret:
I agree.
Dennis

Margaret.Kasim@CH2M.com

06/20/2006 01:57 PM

To
margaret.kasim@ch2m.com, david.steckler@navy.mil, jeffrey.w.morris@navy.mil, joseph.rail@navy.mil, shawn.a.jorgensen@navy.mil, cdetore@mde.state.md.us, Dennis Orenshaw/R3/USEPA/US@EPA

cc
john.mason@ch2m.com, gunarti.coghlan@ch2m.com, scott.saroff@ch2m.com

Subject
RE: Status Memo - Site 21

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The drillers are at the site and I need to get your buy in immediately.
How about the old thumbs up or down by 4:00 p.m. today. Let me know if you have any questions or need clarification. Thanks.

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Cc: Mason, John/PHL; Coghlan, Gunarti/WDC; Saroff, Scott/SYR
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Margaret

Kasim, Margaret/WDC

From: Kasim, Margaret/WDC
Sent: Thursday, June 22, 2006 11:47 AM
To: Saroff, Scott/SYR; Mason, John/PHL
Cc: Coghlan, Gunarti/WDC
Subject: Site 21 Mn Results and Proposed Path Forward
Attachments: Figure Tier 1 Results 6-22-06.pdf

The results are as follows:

DP01-1216 (sample collected from 12-16 ft bgs)	1,540 ug/L (exceeds background)
GP02-0020 (sample collected from 12-16 ft bgs)	521 ug/L (does not exceed)
DP03-1216 (sample collected from 12-16 ft bgs)	696 ug/L (does not exceed)
GP04-1216 (sample collected from 12-16 ft bgs)	1,480 ug/L (exceeds background)
DP05-0812 (sample collected from 8-12 ft bgs)	3,650 ug/L (exceeds background)
DP05-1620 (sample collected from 16-20 ft bgs)	78 ug/L (does not exceed)

My previous e-mail to the team indicated that GW samples were collected from one depth interval at all locations except IS21DP05; GW samples were collected from 2 depth intervals. The results show Mn exceedance from 8-12 feet and no exceedance from 16-20 feet depth intervals.

Manganese was detected in monitoring well IS21MW02 at concentrations of 23,000 μg/L and 10,900 μg/L during the 2000 and 2002 sampling events, respectively. These concentrations exceed the facility wide background concentration of 824 μg/L.

The electronic work plan stated that "if the results indicate the second bullet above (i.e. exceeds background concentration), then samples will be collected from one or more of the proposed locations, without station IDs, shown on the figure. The locations that will be sampled will be those close to the location with the concentration that exceeds background concentration. The samples will be collected, analyzed, and the results evaluated as for the Tier 1 samples. The same decision rules apply. If there are any exceedances, the Team will make a decision if additional locations should be sampled."

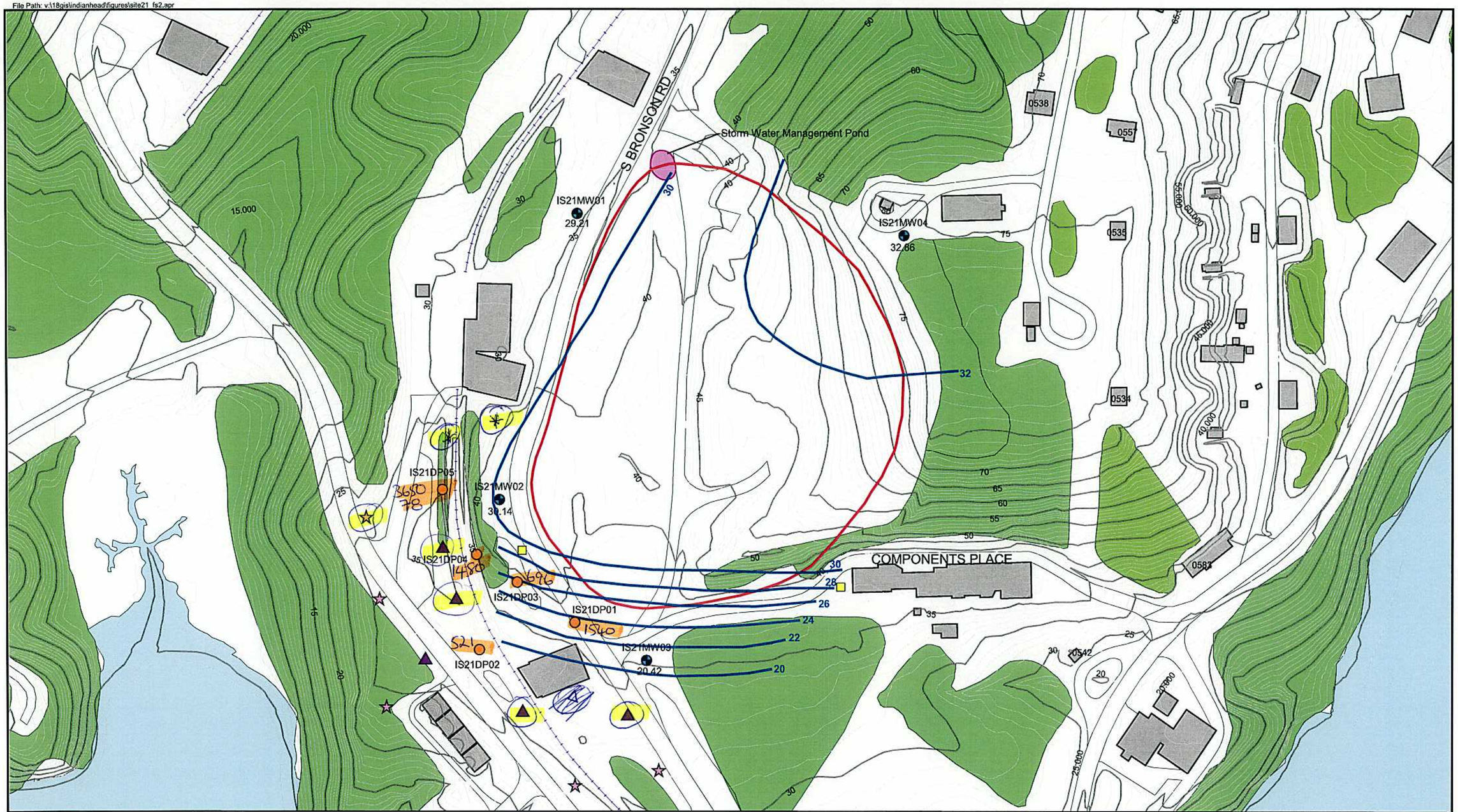
Based on the results presented above, I have circled 7 locations on the attached figure for Tier 2 sampling. I have included Shawn's proposed 2 locations to the north and northwest of location IS21DP05.

One thing to note is that some of these locations shifted from what is shown on the figure based on accessibility. Let me know what you think about the proposed Tier 2 locations and the results before I send out an e-mail to the team. Please get back to me within the next 2 hrs.

The PN for all Site 21 field effort is 185522.FI.FS
Thanks.

Margaret
Margaret F. Kasim, Ph.D.
Project Manager/Engineering Geologist
CH2M HILL
13921 Park Center Road, Suite 600
Herndon, VA 20171
Direct Line: 703-471-6405 Ext. 4422
FACSys: 703-796-6112
e-mail: mkasim@ch2m.com

File Path: v:\18gis\indianhead\figures\site21_fs2.apr



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- Potentiometric Contours (dashed where inferred; feet above msl)
- Road
- Railroads
- Contours (5 ft)
- Contours (1 ft)
- Wooded Area

Proposed Tier 2 Sample Location

Tier 1 Sample location showing Mn result in µg/L

N

0 60 120 Feet

1" = 120'

Note: Potentiometric Surface Elevation Contours were measured on December 9, 2002

Figure 1
Proposed DPT Groundwater Sampling Locations
Site 21, Bronson Road Landfill
NDWIH, Indian Head, Maryland

CH2MHILL

Kasim, Margaret/WDC

From: Kasim, Margaret/WDC
Sent: Wednesday, June 28, 2006 11:37 AM
To: Jorgensen, Shawn A CIV NDW
Cc: French, Elisha/WDC; Coghlan, Gunarti/WDC; Mason, John/PHL; Saroff, Scott/SYR; cdetore@mde.state.md.us; Orenshaw.Dennis@epamail.epa.gov; Steckler, David J. CIV NAVFACWASH; Morris, Jeffrey CIV (NAVFACWASH); Rail, Joseph CIV (NAVFACWASH)
Subject: RE: Site 21 Mn Results and Proposed Path Forward

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Please Let me know if you have any questions or recommendations. Thanks.

Margaret

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Sent: Tuesday, June 27, 2006 4:41 PM
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Shawn

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Sent: Monday, June 26, 2006 9:08
To: cdetore@mde.state.md.us; Orenshaw.Dennis@epamail.epa.gov; Steckler, David J. CIV NAVFACWASH; Morris, Jeffrey CIV (NAVFACWASH); Rail, Joseph CIV (NAVFACWASH); Jorgensen, Shawn A CIV NDW
Cc: elisha.french@ch2m.com; gunarti.coghlan@ch2m.com; john.mason@ch2m.com; scott.saroff@ch2m.com
Subject: RE: Site 21 Mn Results and Proposed Path Forward

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Sent: Friday, June 23, 2006 9:19 AM
To: Kasim, Margaret/WDC; Orenshaw.Dennis@epamail.epa.gov; david.steckler@navy.mil; jeffrey.w.morris@navy.mil; joseph.rail@navy.mil; shawn.a.jorgensen@navy.mil
Cc: French, Elisha/WDC; Coghlan, Gunarti/WDC; Mason, John/PHL; Saroff, Scott/SYR
Subject: Re: Site 21 Mn Results and Proposed Path Forward

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In light of this, I recommend sampling at all of the locations that you have indicated and down gradient of the GP02-0020 sample location.

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Thanks.

Margaret
Margaret F. Kasim, Ph.D.
Project Manager/Engineering Geologist
CH2M HILL
13921 Park Center Road, Suite 600
Herndon, VA 20171
Direct Line: 703-471-6405 Ext. 4422
FACSys: 703-796-6112
e-mail: mkasim@ch2m.com <mailto:mkasim@ch2m.com>

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If the reader of this message is not the intended recipient, you are hereby notified that any dissemination, distribution, or copying of this communication, or any of its contents, is strictly prohibited.
If you have received this communication in error, please re-send this communication to the sender and delete the original message and any copy of it from your computer system. Thank you.

<<<<GWIASIG 0.07>>>>

Kasim, Margaret/WDC

From: Kasim, Margaret/WDC
Sent: Monday, July 17, 2006 9:57 AM
To: Jorgensen Shawn A (NMCI); Morris, Jeffrey W CIV (NAVFACWASH); 'Rail, Joseph CIV (NAVFACWASH)'; Steckler, David J. CIV NAVFACWASH; cdetore@mde.state.md.us; orenshaw.dennis@epamail.epa.gov
Cc: Saroff, Scott/SYR; Mason, John/PHL; Coghlan, Gunarti/WDC
Subject: FW: Site 21 Mn Results and Proposed Path Forward

Attachments: Site 21 Mn Results 7-6-06.pdf; Mn Results.xls

Site 21 Mn Results 7-6-06.pdf Mn Results.xls

Curtis and Dennis - I have shared the information below with the Navy. Attached are a figure and table with the manganese results.

Locations DP16 and DP17 were not sampled because water was not encountered though attempts were made at several locations and various depth intervals at each location. It should be noted that this was not an uncommon occurrence. Significant effort was made by the field team to collect GW samples, which was the reason for installing piezometers at two locations to ensure the collection of GW samples.

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Let me know if you have any comments. We plan to be in the field the week of July 31.

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FACSys: 703-796-6112
e-mail: mkasim@ch2m.com <mailto:mkasim@ch2m.com>

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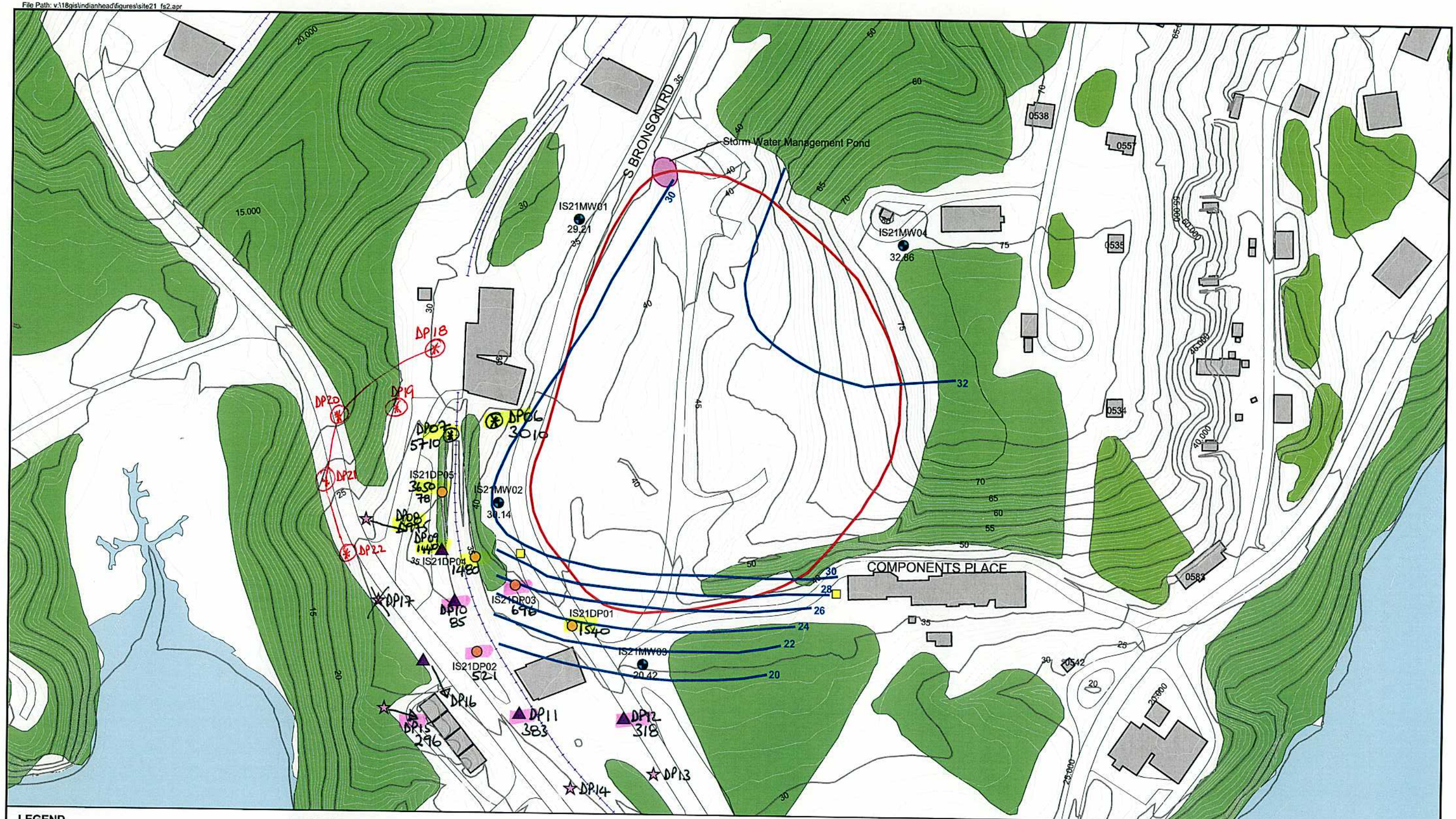
<<<<GWIASIG 0.07>>>>

Site 21 Manganese Investigation
NSF-IH, Indian Head, Maryland

Station ID	Sample ID	Depth Interval Sampled (feet bgs)	Mn Concentration (ug/L)	Exceed BG? (824 ug/L)	Date Collected	Comments
IS21DP01	IS21-DP01-1216	12-16 feet	1,540	yes	6/20/2006	
IS21DP02	IS21-GP02-0020	1-21	521	no	6/20/2006	Piezometer - used 20-foot screen
IS21DP03	IS21-DP03-1216	12-16	696	no	6/20/2006	
IS21DP04	IS21-GP04-1216	12-16	1,480	yes	6/20/2006	
IS21DP05	IS21-DP05-0812	8-12	3,650	yes	6/20/2006	
	IS21-DP05-1620	16-20	78	no	6/20/2006	
IS21DP06	IS21-GP06-1216	12-16	3,010	yes	6/28/2006	
IS21DP07	IS21-GP07-0610	6-10	5,710	yes	6/28/2006	
IS21DP08	IS21-GP08-0812	8-12	975	yes	6/28/2006	
IS21DP09	IS21-GP09-0408	4-8	1,440	yes	6/29/2006	
IS21DP10	IS21-GP10-0812	8-12	85	no	6/28/2006	
IS21DP11	IS21-GP11-0616	6-16	383	no	6/30/2006	Piezometer - used 10-foot screen
IS21DP12	IS21-GP12-1418	14-18	318	no	6/29/2006	
IS21DP13		16-20			6/29/2006	Sampled, but did not analyze. Not necessary.
IS21DP14		12-16			6/29/2006	Sampled, but did not analyze. Not necessary.
IS21DP15	IS21-GP15-1418	14-18	296	no	6/29/2006	
IS21DP16						No water; did not sample
IS21DP17						No water; did not sample

File Path: v:\18gis\indianhead\figures\site21 fs2.apr



LEGEND

- Monitoring Wells
- Approximate Site Boundary
- Proposed Monitoring Wells
- Proposed Tier 1 Sample Locations
- Proposed Tier 2 Sample Locations
- Proposed Tier 3 Sample Locations (Locations tenative and will be finalized based on Tier 1 & 2 sample results)
- Buildings
- Potentiometric Contours (dashed where inferred; feet above msl)
- Road
- Railroads
- Contours (5 ft)
- Contours (1 ft)
- Wooded Area

Exceeds Mn background conc.

Does not exceed Mn background conc.

Unit: µg/L

N

0 60 120 Feet

1" = 120'

Note: Potentiometric Surface Elevation Contours were measured on December 9, 2002

Figure 1
Proposed DPT Groundwater Sampling Locations
Site 21, Bronson Road Landfill
NDWIH, Indian Head, Maryland

CH2MHILL

Kasim, Margaret/WDC

From: Kasim, Margaret/WDC
Sent: Friday, August 11, 2006 9:49 AM
To: Morris, Jeffrey W CIV (NAVFACWASH); 'Rail, Joseph CIV (NAVFACWASH)'; Steckler, David J. CIV NAVFACWASH; 'Jorgensen, Shawn A CIV NDW'
Cc: Mason, John/PHL; Saroff, Scott/NJO; Coghlan, Gunarti/WDC
Subject: FW: Site 21 Mn Results and Proposed Path Forward

Attachments: Mn Results.xls; Figure 1 - DPT Groundwater Sampling Locations.pdf

Mn Results.xls Figure 1 - DPT Groundwater Sam...

The Tier 4 sampling was completed on 8/2/06. The attached table has been updated to reflect all DPT analytical results for dissolved Mn. The attached figure shows the DPT locations with their corresponding Mn concentration. I have also included the dissolved Mn results for the monitoring wells; groundwater samples were collected from the wells in support of the geochemical analysis, which Dick Glanzman will be performing for our meeting at MDE.

Below is an excerpt taken from the electronic WP, which states the objective of the investigation:

"This email serves as a work plan for the manganese (Mn) investigation at Site 21. It presents the proposed sampling approach for collecting and analyzing shallow groundwater samples downgradient of monitoring well IS21MW02 for Mn, as agreed to during the IHIRT conference call on November 2, 2005.

Manganese was detected in monitoring well IS21MW02 at concentrations of 23,000 mg/L and 10,900 mg/L during the 2000 and 2002 sampling events, respectively. These concentrations exceed the facility wide background concentration of 824 mg/L.

The primary objective of this additional sampling is to characterize the extent of manganese in shallow groundwater downgradient of IS21MW02. The groundwater samples will be collected using direct-push technology (DPT) from the proposed locations shown on Figure 1. Locations IS21DP01 through IS21DP03 are proposed mainly for downgradient characterization whereas locations IS21DP04 and IS21DP05 are proposed to aid siting of permanent monitoring wells for landfill LTM."

Below is a summary of key findings:

1. The DPT results show that there may be a Mn plume migrating to the west as shown on the figure. However, the DPT results may not be representative of the dissolved Mn concentration migrating in the groundwater and, as these results are not repeatable, the results may be anomalously high. To collect a more representative groundwater sample to assess the migration of dissolved Mn, a groundwater monitoring well should be installed and incorporated into a groundwater sampling program, as part of the LTM. This method would allow for the on-going monitoring of the Mn and would further assess the dissolved Mn concentration in groundwater.

2. Mn levels in MW02 are observed to have decreased from 23,000 mg/L in 2000 to 10,900 mg/L in 2002 to 713 in 2006.

The objective of this DPT investigation was to characterize the extent of Mn in the shallow GW. Except for the area to the west of MW02, we have characterized the extent of Mn in the other geographic directions. The results indicate that it is not isolated at or around MW02. Therefore, I would recommend we present the results in a tech memo for review by the team. Ultimately, the tech memo will be attached as appendix to the final Site 21 FS.

Let me know if we need to have a con call to discuss the results and the proposed path forward before I submit this information to the regulators.

Thanks.

Margaret

-----Original Message-----
From: Kasim, Margaret/WDC
Sent: Thursday, July 06, 2006 11:00 AM
To: 'Jorgensen, Shawn A CIV NDW'; Morris, Jeffrey CIV (NAVFACWASH); Rail, Joseph CIV (NAVFACWASH); Steckler, David J. CIV NAVFACWASH
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-----Original Message-----
From: Kasim, Margaret/WDC
Sent: Wednesday, June 28, 2006 11:37 AM
To: 'Jorgensen, Shawn A CIV NDW'
Cc: French, Elisha/WDC; Coghlan, Gunarti/WDC; Mason, John/PHL; Saroff, Scott/SYR; cdetore@mde.state.md.us; Orenshaw.Dennis@epamail.epa.gov; Steckler, David J. CIV NAVFACWASH; Morris, Jeffrey CIV (NAVFACWASH); Rail, Joseph CIV (NAVFACWASH)
Subject: RE: Site 21 Mn Results and Proposed Path Forward

Elisha completed the macro-core sampling for lithology at Shawn's location to the northeast of IS21DP05. The length of the sampler is 4 feet. Below is the description:

0-4 feet bgs: silt at top grading into very clayey soil; slightly gravelly.
4-8 feet bgs: poorly graded sand with silt and gravel. At the base of 8 feet, less than 6

inches of well graded sand was observed.
8-12 feet bgs: poorly graded sand with silt and gravel. More silt matrix. At 11.3 feet bgs, lithology transitions into a poorly graded gravel with silt and sand.
12-16 feet bgs: poorly graded gravel with silt and sand.
16-20 feet bgs: clay (moderately plastic; silty; mottled; pinkish grey)

Saturated soil was from 11.3 to 16 feet bgs. A groundwater sample was collected from the center of the interval per Curtis' recommendation.

It appears that the water-bearing unit is about 5 feet thick. Based on this information, we will be collecting a GW sample from the middle of one interval at each of the 8 Tier 2 location.

Please Let me know if you have any questions or recommendations. Thanks.

Margaret

-----Original Message-----
From: Jorgensen, Shawn A CIV NDW [mailto:shawn.a.jorgensen@navy.mil]
Sent: Tuesday, June 27, 2006 4:41 PM
To: Kasim, Margaret/WDC
Cc: French, Elisha/WDC; Coghlan, Gunarti/WDC; Mason, John/PHL; Saroff, Scott/SYR; cdetore@mde.state.md.us; Orenshaw.Dennis@epamail.epa.gov; Steckler, David J. CIV NAVFACWASH; Morris, Jeffrey CIV (NAVFACWASH); Rail, Joseph CIV (NAVFACWASH)
Subject: RE: Site 21 Mn Results and Proposed Path Forward

Wow! No surprises here - Murphy's Law rules at Indian Head. Why couldn't we have just had a nice small contiguous plume, instead of DP01 off by itself! What's up with that?

Now that Manganese and I have become one (the Mn mind meld has occurred), I have only one comment/concern. What if groundwater flow on the western edge of the site is from the direction of IS21MW02 towards IS21DP05? Most likely the westernmost proposed location (star) will catch this. However, I want to ensure that we are all aware of this potential and that we are all making an informed decision that we may miss something to the northwest or need to obtain additional samples in that direction later.

I'm comfortable with the proposed sample locations, including the additional one that Curtis suggested, but I think that we may need additional samples (Tier 3?) in the future, once the results are back.

Also, for everyone's information, I have included the building use history for Buildings 1384 and 480 that is contained in the database that was prepared by Jim Dolph and the Reservists for use with the Mattawoman Creek Study. Although nothing screams of Mn use, the term "X-ray" being related to Building 480 makes me wonder what was done in that building (taking x-rays or developing x-rays).

V/R,
Shawn

-----Original Message-----
From: Margaret.Kasim@ch2m.com [mailto:Margaret.Kasim@ch2m.com]
Sent: Monday, June 26, 2006 9:08
To: cdetore@mde.state.md.us; Orenshaw.Dennis@epamail.epa.gov; Steckler, David J. CIV NAVFACWASH; Morris, Jeffrey CIV (NAVFACWASH); Rail, Joseph CIV (NAVFACWASH); Jorgensen, Shawn A CIV NDW
Cc: elisha.french@ch2m.com; gunarti.coghlan@ch2m.com; john.mason@ch2m.com; scott.saroff@ch2m.com
Subject: RE: Site 21 Mn Results and Proposed Path Forward

Curtis - Below is the response I got to your question about use of a 20-foot screen at location IS21DP02:

"A 20' piezometer was installed for several reasons. First, there was no single 4' interval that was capable of producing a sufficient volume of water by the DP-GW method for sampling at that location. Second, only 10' sections of screen were available for the investigation, and we had very little well riser on hand. As we had a rod in the ground at another location, and we were anticipating that we may get poor productivity and wanted to ensure that some sample would be recovered, we screened from the 8' interval where water had been successfully sampled at DP-05 all the way through the formation."

Per your recommendation, the purple triangle to the west of IS21DP02 will be sampled in addition to the proposed locations.

Team - let me know if anyone else has additional comments or recommendations before we go out again on Wednesday. Our initial plan was to be at Site 21 today and tomorrow to collect the Tier 2 samples.
Because work at Site 47 is planned to resume on Wednesday, we have to complete all work at Site 47 by Tuesday. Therefore, we will be at Site
21 on Wednesday.

Margaret

-----Original Message-----
From: Curtis DeTore [mailto:cdetore@mde.state.md.us]
Sent: Friday, June 23, 2006 9:19 AM
To: Kasim, Margaret/WDC; Orenshaw.Dennis@epamail.epa.gov; david.steckler@navy.mil; jeffrey.w.morris@navy.mil; joseph.rail@navy.mil; shawn.a.jorgensen@navy.mil
Cc: French, Elisha/WDC; Coghlan, Gunarti/WDC; Mason, John/PHL; Saroff, Scott/SYR
Subject: Re: Site 21 Mn Results and Proposed Path Forward

Could you please explain why a 20 ft. screen was used at GP02-0020 instead of the industry standard 10 ft. screen. Since the Mn exceedances are from 8-16 feet deep (as opposed to the 8-12 that you state below) and no exceedances existed from 16-20 feet deep, the use of a 20 ft. screen could cause the sample to be diluted as it includes the entire section of the aquifer that shows no contamination.

In light of this, I recommend sampling at all of the locations that you have indicated and down gradient of the GP02-0020 sample location.

>>> <Margaret.Kasim@CH2M.com> 06/22/06 5:15 PM >>>
Attached are the lab results, and figure showing the sample results and proposed Tier 2 locations. Below are the results of the Tier 1
samples:

DP01-1216 (sample collected from 12-16 ft bgs) 1,540 ug/L (exceeds
background)
GP02-0020 (sample collected from a piezometer from about 1 ft to 21 feet bgs [20-foot screen]) 521 ug/L (does not exceed)
DP03-1216 (sample collected from 12-16 ft bgs) 696 ug/L (does
not
exceed)
GP04-1216 (sample collected from 12-16 ft bgs) 1,480 ug/L (exceeds
background)
DP05-0812 (sample collected from 8-12 ft bgs) 3,650 ug/L (exceeds
background)
DP05-1620 (sample collected from 16-20 ft bgs) 78 ug/L (does
not
exceed)

My previous e-mail indicated that GW samples were collected from one depth interval at all locations except IS21DP05; GW samples were collected from 2 depth intervals. The results show Mn exceedance from
8-12 feet and no exceedance from 16-20 feet depth intervals.

Manganese was detected in monitoring well IS21MW02 at concentrations of 23,000 mg/L and 10,900 mg/L during the 2000 and 2002 sampling events, respectively. These concentrations exceed the facility wide background concentration of 824 mg/L.

The electronic work plan stated that "if the results indicate the second bullet above

(i.e. exceeds background concentration), then samples will be collected from one or more of the proposed locations, without station IDs, shown on the figure. The locations that will be sampled will be those close to the location with the concentration that exceeds background concentration. The samples will be collected, analyzed, and the results evaluated as for the Tier 1 samples. The same decision rules apply. If there are any exceedances, the Team will make a decision if additional locations should be sampled."

Based on the results presented above, I have circled 7 locations on the attached figure for Tier 2 sampling. These include the 2 locations to the north and northwest of location IS21DP05 proposed by Shawn.

One thing to note is that some of these locations shifted from what is shown on the figure based on accessibility. Let me know what you think about the results and proposed Tier 2 locations.

Thanks.

Margaret
Margaret F. Kasim, Ph.D.
Project Manager/Engineering Geologist
CH2M HILL
13921 Park Center Road, Suite 600
Herndon, VA 20171
Direct Line: 703-471-6405 Ext. 4422
FACSys: 703-796-6112
e-mail: mkasim@ch2m.com <mailto:mkasim@ch2m.com>

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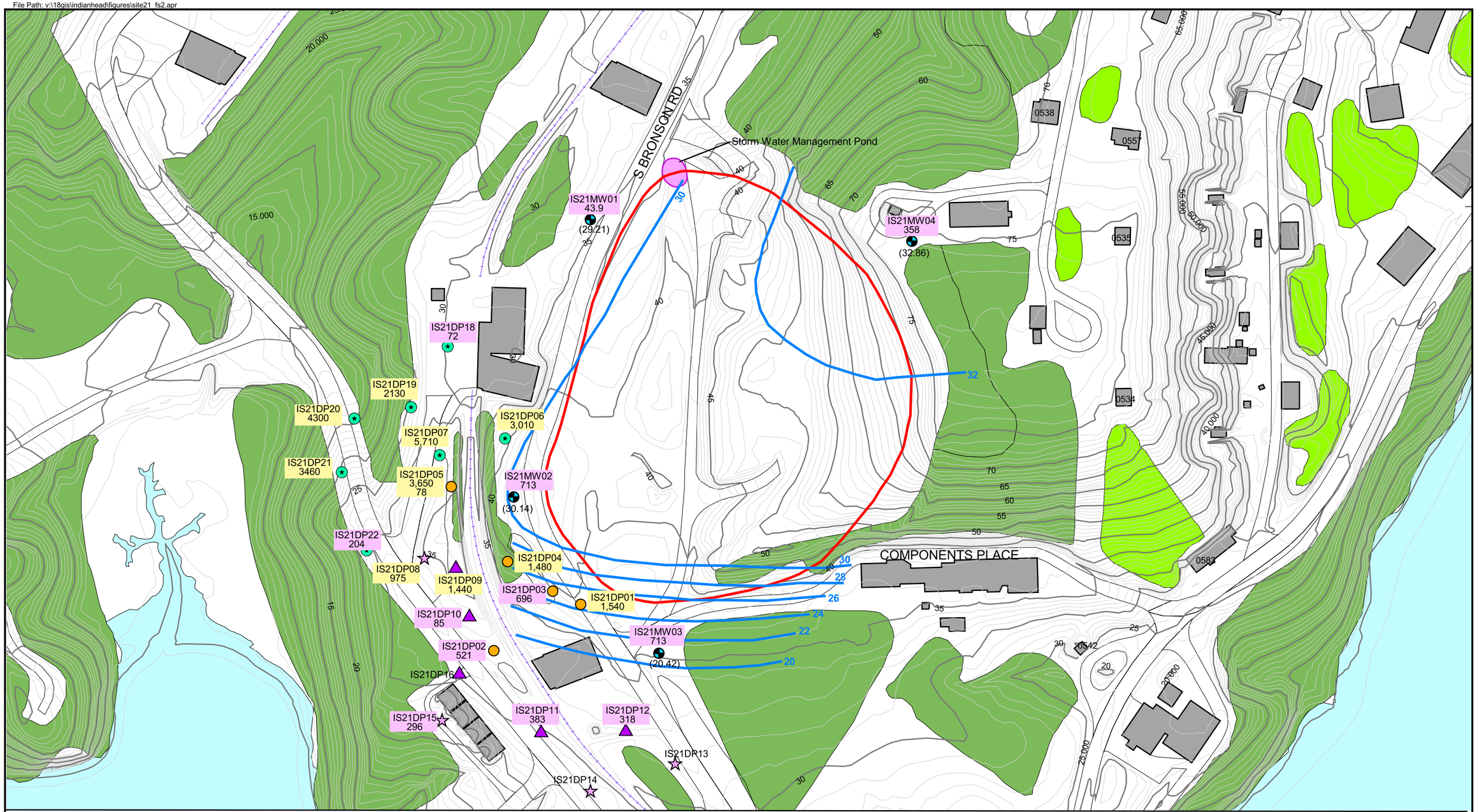
<<<<GWIASIG 0.07>>>>

Site 21 Manganese Investigation
NSF-IH, Indian Head, Maryland

Station ID	Sample ID	Depth Interval Sampled (feet bgs)	Mn Concentration (ug/L)	Exceed BG? (824 ug/L)	Date Collected	Comments
IS21DP01	IS21-DP01-1216	12-16 feet	1,540	yes	6/20/2006	
IS21DP02	IS21-GP02-0020	1-21	521	no	6/20/2006	Piezometer - used 20-foot screen
IS21DP03	IS21-DP03-1216	12-16	696	no	6/20/2006	
IS21DP04	IS21-GP04-1216	12-16	1,480	yes	6/20/2006	
IS21DP05	IS21-DP05-0812	8-12	3,650	yes	6/20/2006	
	IS21-DP05-1620	16-20	78	no	6/20/2006	
IS21DP06	IS21-GP06-1216	12-16	3,010	yes	6/28/2006	
IS21DP07	IS21-GP07-0610	6-10	5,710	yes	6/28/2006	
IS21DP08	IS21-GP08-0812	8-12	975	yes	6/28/2006	
IS21DP09	IS21-GP09-0408	4-8	1,440	yes	6/29/2006	
IS21DP10	IS21-GP10-0812	8-12	85	no	6/28/2006	
IS21DP11	IS21-GP11-0616	6-16	383	no	6/30/2006	Piezometer - used 10-foot screen
IS21DP12	IS21-GP12-1418	14-18	318	no	6/29/2006	
IS21DP13		16-20			6/29/2006	Sampled, but did not analyze. Not necessary.
IS21DP14		12-16			6/29/2006	Sampled, but did not analyze. Not necessary.
IS21DP15	IS21-GP15-1418	14-18	296	no	6/29/2006	
IS21DP16						No water; did not sample
IS21DP17						No water; did not sample
IS21DP18	IS21-GP18-1216	12-16	72	no	7/31/2006	Primary and duplictae samples were collected. The higher concentration is shown.
IS21DP19	IS21-GP19-1216	12-16	2,130	yes	7/31/2006	
IS21DP20	IS21-GP20-0610	6-10	4,300	yes	8/1/2006	
IS21DP21	IS21-GP21-0812	8-12	3,460	yes	8/1/2006	
IS21DP22	IS21-GP22-2024	20-24	204	no	8/2/2006	

File Path: v:\18gis\indianhead\figures\site21_fs2.apr



LEGEND

- 713 (30.14) Monitoring Well — Groundwater elevation is in parenthesis. Dissolved concentration is from the June 2006 sampling event.
- Approximate Site Boundary
- Tier 1 Sample Locations
- Tier 2 Sample Locations
- Tier 3 Sample Locations
- Tier 4 Sample Locations
- Buildings
- Potentiometric Contours (dashed where inferred; feet above msl)
- Road
- Railroads
- Contours (5 ft)
- Contours (1 ft)
- Wooded Area
- Exceeds Mn background concentration
- Does not exceed Mn background concentration

Unit: µg/L

Mn background concentration is 824 µg/L

N

0 60 120 Feet

1" = 120'

Figure 1
DPT Groundwater Sampling Locations
Site 21, Bronson Road Landfill
NDWIH, Indian Head, Maryland

Note: Potentiometric Surface Elevation Contours were measured on December 9, 2002

CH2MHILL

Attachment C
Laboratory Reports

Analytical Report For 606122

for

CH2M Hill Inc

Project Manager : Stacy Davenport

Project Name : Indian Head Site 21 CTO-043

June 20, 2006

GPL

Laboratories

GPL Laboratories, LLLP Certifies that the test results meet all requirements of the NELAC Standards unless otherwise noted.

Reviewed by, Project Manager	Approved by, Laboratory Director

7210A Corporate CT Frederick, MD 21703 Phone (301) 694-5310 Fax: (301) 620-0731
www.gplab.com

GPL LABORATORIES, LLLP

Summary of Analytical Results

Client ID: IS21-GP05-0812
GPL ID: 606122-001-001-1/1
Matrix: WATER
Date Collected: 06/19/2006
Date Received: 06/19/2006

Prep Method: CLP_DIGESTION
Prep Date: 06/19/2006
Prep Time: 21:00
Prep Batch: 82191

Analytical Method: CLP_ILM04.1
Date Analyzed: 06/20/2006
Time Analyzed: 13:35
Analysis Batch: 89094

Parameter	Result	Rep Limit	Units	Qualifier	D.F.
Manganese	3650	15	ug/L		1

GPL LABORATORIES, LLP
ANALYTICAL RESULTS

Project Name : Indian Head Site 21 CTO-043

Date Printed June 20, 2006

GPL ID	Client ID
606122-001-001-1/1	IS21-GP05-0812

Analytical Report For 606134

for

CH2M Hill Inc

Project Manager : Stacy Davenport

Project Name : Indian Head Site 21 CTO-043

June 21, 2006

GPL

Laboratories

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Reviewed by, Project Manager	Approved by, Laboratory Director

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Summary of Analytical Results

Client ID: IS21-EB02-062006
GPL ID: 606134-001-001-1/1
Matrix: WATER
Date Collected: 06/20/2006
Date Received: 06/20/2006

Prep Method: CLP_DIGESTION
Prep Date: 06/21/2006
Prep Time: 00:00
Prep Batch: 82238

Analytical Method: CLP_ILM04.1
Date Analyzed: 06/21/2006
Time Analyzed: 16:43
Analysis Batch: 89150

Parameter	Result	Rep Limit	Units	Qualifier	D.F.
Manganese	BQL	15	ug/L	U	1

GPL LABORATORIES, LLLP

Summary of Analytical Results

Client ID: IS21-GP02-0020
GPL ID: 606134-002-002-1/1
Matrix: WATER
Date Collected: 06/20/2006
Date Received: 06/20/2006

Prep Method: CLP_DIGESTION
Prep Date: 06/21/2006
Prep Time: 00:00
Prep Batch: 82238

Analytical Method: CLP_ILM04.1
Date Analyzed: 06/21/2006
Time Analyzed: 16:51
Analysis Batch: 89150

Parameter	Result	Rep Limit	Units	Qualifier	D.F.
Manganese	521	15	ug/L		1

GPL LABORATORIES, LLLP

Summary of Analytical Results

Client ID: IS21-DP01-1216
GPL ID: 606134-003-003-1/1
Matrix: WATER
Date Collected: 06/20/2006
Date Received: 06/20/2006

Prep Method: CLP_DIGESTION
Prep Date: 06/21/2006
Prep Time: 00:00
Prep Batch: 82238

Analytical Method: CLP_ILM04.1
Date Analyzed: 06/21/2006
Time Analyzed: 16:59
Analysis Batch: 89150

Parameter	Result	Rep Limit	Units	Qualifier	D.F.
Manganese	1540	15	ug/L		1

GPL LABORATORIES, LLLP

Summary of Analytical Results

Client ID: IS21-DP05-1620
GPL ID: 606134-004-004-1/1
Matrix: WATER
Date Collected: 06/20/2006
Date Received: 06/20/2006

Prep Method: CLP_DIGESTION
Prep Date: 06/21/2006
Prep Time: 00:00
Prep Batch: 82238

Analytical Method: CLP_ILM04.1
Date Analyzed: 06/21/2006
Time Analyzed: 17:07
Analysis Batch: 89150

Parameter	Result	Rep Limit	Units	Qualifier	D.F.
Manganese	77.6	15	ug/L		1

GPL LABORATORIES, LLLP

Summary of Analytical Results

Client ID: IS21-GP04-1216
GPL ID: 606134-005-005-1/1
Matrix: WATER
Date Collected: 06/20/2006
Date Received: 06/20/2006

Prep Method: CLP_DIGESTION
Prep Date: 06/21/2006
Prep Time: 00:00
Prep Batch: 82238

Analytical Method: CLP_ILM04.1
Date Analyzed: 06/21/2006
Time Analyzed: 17:15
Analysis Batch: 89150

Parameter	Result	Rep Limit	Units	Qualifier	D.F.
Manganese	1480	15	ug/L		1

GPL LABORATORIES, LLLP

Summary of Analytical Results

Client ID: IS21-DP03-1216
GPL ID: 606134-006-006-1/1
Matrix: WATER
Date Collected: 06/20/2006
Date Received: 06/20/2006

Prep Method: CLP_DIGESTION
Prep Date: 06/21/2006
Prep Time: 00:00
Prep Batch: 82238

Analytical Method: CLP_ILM04.1
Date Analyzed: 06/21/2006
Time Analyzed: 17:23
Analysis Batch: 89150

Parameter	Result	Rep Limit	Units	Qualifier	D.F.
Manganese	696	15	ug/L		1

GPL LABORATORIES, LLP
ANALYTICAL RESULTS

Project Name : Indian Head Site 21 CTO-043

Date Printed June 21, 2006

GPL ID	Client ID
606134-003-003-1/1	IS21-DP01-1216
606134-006-006-1/1	IS21-DP03-1216
606134-004-004-1/1	IS21-DP05-1620
606134-001-001-1/1	IS21-EB02-062006
606134-002-002-1/1	IS21-GP02-0020
606134-005-005-1/1	IS21-GP04-1216

Analytical Report For 606193

for

CH2M Hill Inc

Project Manager : Stacy Davenport

Project Name : Indian Head Site 21 CTO-043

June 30, 2006

GPL

Laboratories

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Reviewed by, Project Manager	Approved by, Laboratory Director

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GPL LABORATORIES, LLLP

Summary of Analytical Results

Client ID: IS21-GP06-1216
GPL ID: 606193-001-001-1/1
Matrix: WATER
Date Collected: 06/28/2006
Date Received: 06/28/2006

Prep Method: CLP_DIGESTION
Prep Date: 06/29/2006
Prep Time: 00:00
Prep Batch: 82378

Analytical Method: CLP_ILM04.1
Date Analyzed: 06/29/2006
Time Analyzed: 16:34
Analysis Batch: 89367

Parameter	Result	Rep Limit	Units	Qualifier	D.F.
Manganese	3010	15	ug/L		1

GPL LABORATORIES, LLLP

Summary of Analytical Results

Client ID: IS21-GP07-0610
GPL ID: 606193-002-002-1/1
Matrix: WATER
Date Collected: 06/28/2006
Date Received: 06/28/2006

Prep Method: CLP_DIGESTION
Prep Date: 06/29/2006
Prep Time: 00:00
Prep Batch: 82378

Analytical Method: CLP_ILM04.1
Date Analyzed: 06/29/2006
Time Analyzed: 17:16
Analysis Batch: 89367

Parameter	Result	Rep Limit	Units	Qualifier	D.F.
Manganese	5710	15	ug/L		1

GPL LABORATORIES, LLLP

Summary of Analytical Results

Client ID: IS21-GP08-1440
GPL ID: 606193-003-003-1/1
Matrix: WATER
Date Collected: 06/28/2006
Date Received: 06/28/2006

Prep Method: CLP_DIGESTION
Prep Date: 06/29/2006
Prep Time: 00:00
Prep Batch: 82378

Analytical Method: CLP_ILM04.1
Date Analyzed: 06/29/2006
Time Analyzed: 17:24
Analysis Batch: 89367

Parameter	Result	Rep Limit	Units	Qualifier	D.F.
Manganese	975	15	ug/L		1

GPL LABORATORIES, LLLP

Summary of Analytical Results

Client ID: IS21-GP10-0812
GPL ID: 606193-004-004-1/1
Matrix: WATER
Date Collected: 06/28/2006
Date Received: 06/28/2006

Prep Method: CLP_DIGESTION
Prep Date: 06/29/2006
Prep Time: 00:00
Prep Batch: 82378

Analytical Method: CLP_ILM04.1
Date Analyzed: 06/29/2006
Time Analyzed: 17:32
Analysis Batch: 89367

Parameter	Result	Rep Limit	Units	Qualifier	D.F.
Manganese	85.2	15	ug/L		1

GPL LABORATORIES, LLLP

Summary of Analytical Results

Client ID: IS21-GP10P-0812
GPL ID: 606193-005-005-1/1
Matrix: WATER
Date Collected: 06/28/2006
Date Received: 06/28/2006

Prep Method: CLP_DIGESTION
Prep Date: 06/29/2006
Prep Time: 00:00
Prep Batch: 82378

Analytical Method: CLP_ILM04.1
Date Analyzed: 06/29/2006
Time Analyzed: 17:57
Analysis Batch: 89367

Parameter	Result	Rep Limit	Units	Qualifier	D.F.
Manganese	48.2	15	ug/L		1

GPL LABORATORIES, LLP
ANALYTICAL RESULTS

Project Name : Indian Head Site 21 CTO-043

Date Printed June 30, 2006

GPL ID	Client ID
606193-001-001-1/1	IS21-GP06-1216
606193-002-002-1/1	IS21-GP07-0610
606193-003-003-1/1	IS21-GP08-1440
606193-004-004-1/1	IS21-GP10-0812
606193-005-005-1/1	IS21-GP10P-0812

Analytical Report For 606198

for

CH2M Hill Inc

Project Manager : Stacy Davenport

Project Name : Indian Head Site 21 CTO-043

July 3, 2006

GPL

Laboratories

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Reviewed by, Project Manager	Approved by, Laboratory Director

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www.gplab.com

GPL LABORATORIES, LLLP

Summary of Analytical Results

Client ID: IS21-GP12-1418
GPL ID: 606198-001-001-1/1
Matrix: WATER
Date Collected: 06/29/2006
Date Received: 06/29/2006

Prep Method: CLP_DIGESTION
Prep Date: 06/30/2006
Prep Time: 00:00
Prep Batch: 82409

Analytical Method: CLP_ILM04.1
Date Analyzed: 06/30/2006
Time Analyzed: 18:20
Analysis Batch: 89418

Parameter	Result	Rep Limit	Units	Qualifier	D.F.
Manganese	956	15	ug/L		1

GPL LABORATORIES, LLLP

Summary of Analytical Results

Client ID: IS21-GP12-1418 FIL
GPL ID: 606198-002-002-1/1
Matrix: WATER
Date Collected: 06/29/2006
Date Received: 06/29/2006

Prep Method: CLP_DIGESTION
Prep Date: 06/30/2006
Prep Time: 00:00
Prep Batch: 82409

Analytical Method: CLP_ILM04.1
Date Analyzed: 06/30/2006
Time Analyzed: 18:29
Analysis Batch: 89418

Parameter	Result	Rep Limit	Units	Qualifier	D.F.
Manganese	318	15	ug/L		1

GPL LABORATORIES, LLLP

Summary of Analytical Results

Client ID: IS21-GP09-0408
GPL ID: 606198-003-003-1/1
Matrix: WATER
Date Collected: 06/29/2006
Date Received: 06/29/2006

Prep Method: CLP_DIGESTION
Prep Date: 06/30/2006
Prep Time: 00:00
Prep Batch: 82409

Analytical Method: CLP_ILM04.1
Date Analyzed: 06/30/2006
Time Analyzed: 18:37
Analysis Batch: 89418

Parameter	Result	Rep Limit	Units	Qualifier	D.F.
Manganese	2340	15	ug/L		1

GPL LABORATORIES, LLLP

Summary of Analytical Results

Client ID: IS21-GP09-0408 FIL
GPL ID: 606198-004-004-1/1
Matrix: WATER
Date Collected: 06/29/2006
Date Received: 06/29/2006

Prep Method: CLP_DIGESTION
Prep Date: 06/30/2006
Prep Time: 00:00
Prep Batch: 82409

Analytical Method: CLP_ILM04.1
Date Analyzed: 06/30/2006
Time Analyzed: 19:02
Analysis Batch: 89418

Parameter	Result	Rep Limit	Units	Qualifier	D.F.
Manganese	1440	15	ug/L		1

GPL LABORATORIES, LLP
ANALYTICAL RESULTS

Project Name : Indian Head Site 21 CTO-043

Date Printed July 3, 2006

GPL ID	Client ID
606198-003-003-1/1	IS21-GP09-0408
606198-004-004-1/1	IS21-GP09-0408 FIL
606198-001-001-1/1	IS21-GP12-1418
606198-002-002-1/1	IS21-GP12-1418 FIL

Analytical Report For 607017

for

CH2M Hill Inc

Project Manager : Stacy Davenport

Project Name : Indian Head Site 21 CTO-043

July 5, 2006

GPL

Laboratories

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Reviewed by, Project Manager	Approved by, Laboratory Director

7210A Corporate CT Frederick, MD 21703 Phone (301) 694-5310 Fax: (301) 620-0731
www.gplab.com

GPL LABORATORIES, LLLP

Summary of Analytical Results

Client ID: IS21-GP11-0616
GPL ID: 607017-001-001-1/1
Matrix: WATER
Date Collected: 06/30/2006
Date Received: 07/03/2006

Prep Method: CLP_DIGESTION
Prep Date: 07/05/2006
Prep Time: 00:00
Prep Batch: 82432

Analytical Method: CLP_ILM04.1
Date Analyzed: 07/05/2006
Time Analyzed: 15:39
Analysis Batch: 89479

Parameter	Result	Rep Limit	Units	Qualifier	D.F.
Manganese	383	15	ug/L		1

GPL LABORATORIES, LLP
ANALYTICAL RESULTS

Project Name : Indian Head Site 21 CTO-043

Date Printed July 5, 2006

GPL ID	Client ID
607017-001-001-1/1	IS21-GP11-0616

Analytical Report For 606199

for

CH2M Hill Inc

Project Manager : Stacy Davenport

Project Name : Indian Head Site 21 CTO-043

July 5, 2006

GPL

Laboratories

GPL Laboratories, LLLP Certifies that the test results meet all requirements of the NELAC Standards unless otherwise noted.

Reviewed by, Project Manager	Approved by, Laboratory Director

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GPL LABORATORIES, LLLP

Summary of Analytical Results

Client ID: IS21-GP15-1418
GPL ID: 606199-003-003-1/1
Matrix: WATER
Date Collected: 06/29/2006
Date Received: 06/29/2006

Prep Method: CLP_DIGESTION
Prep Date: 07/05/2006
Prep Time: 00:00
Prep Batch: 82432

Analytical Method: CLP_ILM04.1
Date Analyzed: 07/05/2006
Time Analyzed: 15:47
Analysis Batch: 89478

Parameter	Result	Rep Limit	Units	Qualifier	D.F.
Manganese	296	15	ug/L		1

GPL LABORATORIES, LLP
ANALYTICAL RESULTS

Project Name : Indian Head Site 21 CTO-043

Date Printed July 5, 2006

GPL ID	Client ID
606199-003-003-1/1	IS21-GP15-1418

Analytical Report For 608010

for

CH2M Hill Inc

Project Manager : Stacy Davenport

Project Name : Indian Head Site 21 CTO-043

August 3, 2006

GPL

Laboratories

GPL Laboratories, LLLP Certifies that the test results meet all requirements of the NELAC Standards unless otherwise noted.

Reviewed by, Project Manager	Approved by, Laboratory Director

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GPL LABORATORIES, LLLP

Summary of Analytical Results

Client ID: IS21-GP18-1216
GPL ID: 608010-001-001-1/1
Matrix: WATER
Date Collected: 07/31/2006
Date Received: 08/01/2006

Prep Method: CLP_DIGESTION
Prep Date: 08/02/2006
Prep Time: 00:00
Prep Batch: 82943

Analytical Method: CLP_ILM04.1
Date Analyzed: 08/02/2006
Time Analyzed: 17:34
Analysis Batch: 90410

Parameter	Result	Rep Limit	Units	Qualifier	D.F.
Manganese	60.4	15	ug/L		1

GPL LABORATORIES, LLLP

Summary of Analytical Results

Client ID: IS21-GP18P-1216
GPL ID: 608010-002-002-1/1
Matrix: WATER
Date Collected: 07/31/2006
Date Received: 08/01/2006

Prep Method: CLP_DIGESTION
Prep Date: 08/02/2006
Prep Time: 00:00
Prep Batch: 82943

Analytical Method: CLP_ILM04.1
Date Analyzed: 08/02/2006
Time Analyzed: 17:42
Analysis Batch: 90410

Parameter	Result	Rep Limit	Units	Qualifier	D.F.
Manganese	72.1	15	ug/L		1

GPL LABORATORIES, LLLP

Summary of Analytical Results

Client ID: IS21-EB01-073106
GPL ID: 608010-003-003-1/1
Matrix: WATER
Date Collected: 07/31/2006
Date Received: 08/01/2006

Prep Method: CLP_DIGESTION
Prep Date: 08/02/2006
Prep Time: 00:00
Prep Batch: 82943

Analytical Method: CLP_ILM04.1
Date Analyzed: 08/02/2006
Time Analyzed: 17:50
Analysis Batch: 90410

Parameter	Result	Rep Limit	Units	Qualifier	D.F.
Manganese	0.28	15	ug/L	J	1

GPL LABORATORIES, LLLP

Summary of Analytical Results

Client ID: IS21-FB01-073106
GPL ID: 608010-004-004-1/1
Matrix: WATER
Date Collected: 07/31/2006
Date Received: 08/01/2006

Prep Method: CLP_DIGESTION
Prep Date: 08/02/2006
Prep Time: 00:00
Prep Batch: 82943

Analytical Method: CLP_ILM04.1
Date Analyzed: 08/02/2006
Time Analyzed: 17:59
Analysis Batch: 90410

Parameter	Result	Rep Limit	Units	Qualifier	D.F.
Manganese	BQL	15	ug/L	U	1

GPL LABORATORIES, LLLP

Summary of Analytical Results

Client ID: IS21-GP19-1216
GPL ID: 608010-005-005-1/1
Matrix: WATER
Date Collected: 07/31/2006
Date Received: 08/01/2006

Prep Method: CLP_DIGESTION
Prep Date: 08/02/2006
Prep Time: 00:00
Prep Batch: 82943

Analytical Method: CLP_ILM04.1
Date Analyzed: 08/02/2006
Time Analyzed: 18:07
Analysis Batch: 90410

Parameter	Result	Rep Limit	Units	Qualifier	D.F.
Manganese	2130	15	ug/L		1

GPL LABORATORIES, LLLP

Summary of Analytical Results

Client ID: IS21-GP21-0812
GPL ID: 608010-006-008-1/3
Matrix: WATER
Date Collected: 08/01/2006
Date Received: 08/01/2006

Prep Method: CLP_DIGESTION
Prep Date: 08/02/2006
Prep Time: 00:00
Prep Batch: 82943

Analytical Method: CLP_ILM04.1
Date Analyzed: 08/02/2006
Time Analyzed: 18:15
Analysis Batch: 90410

Parameter	Result	Rep Limit	Units	Qualifier	D.F.
Manganese	3460	15	ug/L		1

GPL LABORATORIES, LLLP

Summary of Analytical Results

Client ID: IS21-GP20-0610
GPL ID: 608010-007-006-1/1
Matrix: WATER
Date Collected: 08/01/2006
Date Received: 08/01/2006

Prep Method: CLP_DIGESTION
Prep Date: 08/02/2006
Prep Time: 00:00
Prep Batch: 82943

Analytical Method: CLP_ILM04.1
Date Analyzed: 08/02/2006
Time Analyzed: 18:24
Analysis Batch: 90410

Parameter	Result	Rep Limit	Units	Qualifier	D.F.
Manganese	4300	15	ug/L		1

GPL LABORATORIES, LLLP

Summary of Analytical Results

Client ID: IS21-EB01-080106
GPL ID: 608010-008-007-1/1
Matrix: WATER
Date Collected: 08/01/2006
Date Received: 08/01/2006

Prep Method: CLP_DIGESTION
Prep Date: 08/02/2006
Prep Time: 00:00
Prep Batch: 82943

Analytical Method: CLP_ILM04.1
Date Analyzed: 08/02/2006
Time Analyzed: 18:32
Analysis Batch: 90410

Parameter	Result	Rep Limit	Units	Qualifier	D.F.
Manganese	2.2	15	ug/L	J	1

GPL LABORATORIES, LLP
ANALYTICAL RESULTS

Project Name : Indian Head Site 21 CTO-043

Date Printed August 3, 2006

GPL ID	Client ID
608010-003-003-1/1	IS21-EB01-073106
608010-008-007-1/1	IS21-EB01-080106
608010-004-004-1/1	IS21-FB01-073106
608010-001-001-1/1	IS21-GP18-1216
608010-002-002-1/1	IS21-GP18P-1216
608010-005-005-1/1	IS21-GP19-1216
608010-007-006-1/1	IS21-GP20-0610
608010-006-008-1/3	IS21-GP21-0812

Analytical Report For 608030

for

CH2M Hill Inc

Project Manager : Stacy Davenport

Project Name : Indian Head Site 21 CTO-043

August 4, 2006

GPL

Laboratories

GPL Laboratories, LLLP Certifies that the test results meet all requirements of the NELAC Standards unless otherwise noted.

Reviewed by, Project Manager	Approved by, Laboratory Director

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GPL LABORATORIES, LLLP

Summary of Analytical Results

Client ID: FS21-GP22-2024
GPL ID: 608030-001-001-1/1
Matrix: WATER
Date Collected: 08/02/2006
Date Received: 08/03/2006

Prep Method: CLP_DIGESTION
Prep Date: 08/04/2006
Prep Time: 00:00
Prep Batch: 82983

Analytical Method: CLP_ILM04.1
Date Analyzed: 08/04/2006
Time Analyzed: 12:36
Analysis Batch: 90491

Parameter	Result	Rep Limit	Units	Qualifier	D.F.
Manganese	204	15	ug/L		1

GPL LABORATORIES, LLP
ANALYTICAL RESULTS

Project Name : Indian Head Site 21 CTO-043

Date Printed August 4, 2006

GPL ID	Client ID
608030-001-001-1/1	FS21-GP22-2024