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NSWC INDIAN HEAD
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END-OF SEQUENCE REPORT FOR SAMPLING EVENTS 5, 6, 7, AND 8 FOR SITE 12 NSWC
INDIAN HEAD MD
5/1/2006
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**End-of-Sequence Report
For Sampling Events
5, 6, 7, and 8**

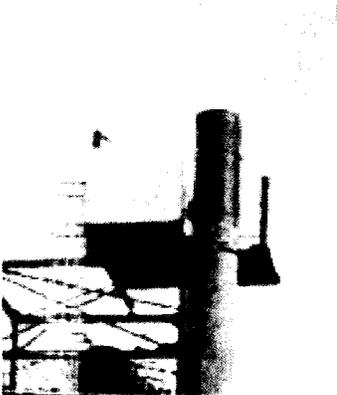
**For
Site 12, Town Gut Landfill
NSF, IH
Indian Head, MD**

**Prepared For:
Department of the Navy
NAVFAC Washington
1314 Harwood Street, SE
Washington Navy Yard
Washington, DC**

**Prepared By:
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**Contract No: N62477-01-D-0076
Delivery Order: 0011**

May 2006



UNITEC

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May 12, 2006

Department of the Navy
NAVFAC Washington
1314 Harwood Street SE
Washington Navy Yard
Washington, DC 20374

Attn: Mr. Joe Rail

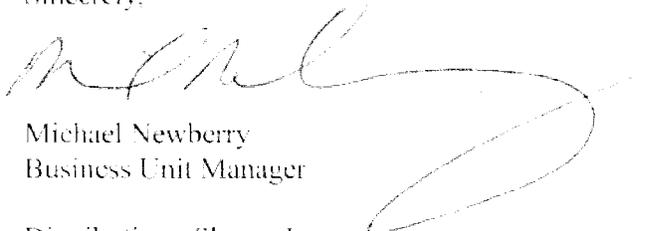
Subject: End-of-Sequence Report for Sampling Events 5, 6, 7, and 8
NSF, III
Indian Head, MD
Contract No: N62477-01-D-0076

Dear Mr. Rail:

Please find attached the End-of-Sequence Report for Long Term Monitoring at Naval Support Facility, Indian Head. This report summarizes the shallow groundwater and surface water sampling events that took place in July and October of 2005 and January and April of 2006.

UNITEC appreciates this opportunity to support the Navy on this project. Should you have any questions, concerning this or any other matter, please contact us at 301-695-0982.

Sincerely,



Michael Newberry
Business Unit Manager

Distribution: Shawn Jorgensen
Joe Rail

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- A Shallow Groundwater and Surface Regulatory Criteria
- B Human Health and Ecological Risk Assessment Calculations

LIST OF ACRONYMS

AWQC	Ambient Water Quality Criteria
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CIS-1,2-DCE	Cis-1,2-Dichloroethene
DO	Dissolved Oxygen
IDW	Investigation-Derived Waste
LTM	Long Term Monitoring
MCL	Maximum Contaminant Level
MDL	Laboratory Method Detection Limit
MW	Monitoring Well
NAVFAC-WASH	Naval Facilities Engineering Command-Washington
NSF, IH	Naval Support Facility, Indian Head
ORP	Oxidation Reduction Potential
QA/QC	Quality Assurance/Quality Control
RBC	Risk-Based Concentration
SW	Surface Water Sampling Location
SMCL	Secondary Maximum Contaminant Level
TCE	Trichloroethene
TCLP	Toxic Characteristic Leaching Potential
USEPA	U.S. Environmental Protection Agency
VC	Vinyl Chloride
VOCs	Volatile Organic Compounds

1.0 Introduction

This End of Sequence Report was generated following the completion of the eighth shallow groundwater and surface water sampling event at Site 12 – Town Gut Landfill, Naval Support Facility, Indian Head (NSF, IH) located in Indian Head, Maryland (Figures 1-3). Long Term Monitoring (LTM) is being conducted under Contract N62477-01D-0076, with copies of the report submitted to Naval Facilities Engineering Command-Washington (NAVFAC-WASH) and NSF, IH. The report presents an overview of the facility and the site and a summary of the methods employed during sample collection, as well as the results of in-situ and analytical testing, trend analyses, and risk assessments.

1.1 Base Description

NSF, IH, consisting of the Main Installation and Stump Neck Annex, is located along the Potomac River in Charles County, Maryland, approximately 25 miles southwest of Washington, DC. The Main Installation and Stump Neck Annex are noncontiguous, separated by Mattawoman Creek. The facility comprises approximately 3,500 acres, of which the Main Installation comprises approximately 70 percent (Figure 1).

Throughout the facility's history, operations have included ordnance research and production. Currently, operations include ordnance research and development, testing and evaluation, and storage. Administration and housing facilities are also located at the base.

1.2 Site Description

Site 12 is centrally located on the Main Installation, comprising approximately 4 acres of undeveloped land (Figure 2). Atkins Road Extension and a portion of the Site 12 Pond, trisect the site, creating northern, central and southern portions.

Between 1968 and 1980, the site was used by NSF, IH to dispose of landscaping waste, fill material and rubble. Unauthorized dumping of paint, varnish and other chemicals may have occurred at the site as well. The site was investigated and remediated under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). The chosen remedy, a 2-foot thick, vegetated soil cover was installed in 2003.

1.3 Report Organization Description

The report is organized as follows: Section 1 presents an introduction to the report; Section 2 presents an overview of field activities conducted as part of LTM; Section 3 presents a summary of the results of water-level gauging and analytical results of shallow groundwater and surface water sampling; Section 4 presents human health and ecological risk assessments; Section 5 presents conclusions and recommendations; and Section 6 presents the references cited throughout the report. The following figures and appendices are presented: Figure 1 – Site 12 Location Map; Figure 2 – Site 12 Topographic Map; Figure 3 – Site 12 Sampling Location Map; Appendix A - Shallow Groundwater and Surface Regulatory Criteria and Appendix B Human Health and Ecological Risk Assessment Calculations.

2.0 Field Activities

LTM was performed in July and October 2005 and January and April 2006. Field activities included water level gauging and shallow groundwater and surface water sampling.

2.1 Water Level Gauging

Synoptic water level measurements were collected from site monitoring wells in the following manner:

First, all well caps were removed, allowing water levels to equilibrate. Following equilibration, depth-to-water and total depths were recorded. The two up gradient wells, monitoring well #7 (MW-7) and MW-12, were gauged first followed by the down gradient wells in any order, thereby limiting the potential for cross-contamination.

2.2 Groundwater Sampling

Shallow groundwater samples were collected using low-flow methodology as described below. Based on knowledge of well construction (provided by NAVFAC-WASH), clean, single-use polyethylene tubing was lowered into the well to a point near the midsection of the screen. The tubing was connected to a peristaltic pump and an inline Horiba U22 with a flow-through cell, for the measurement of in-situ parameters (pH, temperature, conductivity, oxidation-reduction potential [ORP], dissolved oxygen [DO], and turbidity). Shallow groundwater was purged at a rate low enough to maintain constant head in the well (typically 0.5 liters per minute or less). In-situ parameters were recorded during purging at one to two minute intervals. Purging continued until three successive rounds of measurements indicated that parameters had stabilized (defined as pH +/- 0.1; temperature +/- 0.1°C; conductivity +/- 3%; ORP +/- 10 millivolts; DO +/- 10%; and turbidity reduced to the extent practicable and +/- 10%). Once parameters stabilized, the Horiba was disconnected, in order to collect samples directly from the pump. Volatile organic compounds (VOCs) were collected first, followed by total metals. After the total metals sample was collected, a 0.45-micron groundwater filter was attached to the tubing. A minimum of 100 milliliters was allowed to pass through the filter prior to collection of the dissolved metals sample. Appropriate quality assurance/quality control (QA/QC) samples were collected. Upon collection, samples were immediately placed on ice for later shipment to the analytical laboratory. It should be noted that MW-7 and MW-12 could not be purged up to the full three well volumes during the sampling events because they did not recharge sufficiently.

2.3 Surface Water Sampling

Surface water samples were collected as described below. At the desired surface water sampling location (SW), clean, single-use polyethylene tubing was lowered into the water to a point in the water column at least one-foot below the surface and one-foot above the bottom. The tubing was connected to a peristaltic pump and an inline Horiba U22 with a flow-through cell, for the measurement of in-situ parameters. Water was purged slowly so as not to stir up sediment (typically 0.5 liters per minute or less). In-situ parameters were recorded during purging at one to two minute intervals. Purging continued until three successive rounds of measurements indicated that parameters had stabilized. Once parameters stabilized, the Horiba was disconnected, in order to collect samples directly from the pump.

VOCs were collected first, followed by total metals. After the total metals sample was collected, a 0.45-micron groundwater filter was attached to the tubing. A minimum of 100 milliliters was allowed to pass through the filter prior to collection of the dissolved metals sample. Appropriate QA/QC samples

were collected. Upon collection, samples were immediately placed on ice for later shipment to the analytical laboratory.

2.4 Sample Shipping and Laboratory Analysis

At the completion of each day, samples were repacked in the cooler. Ice was added to the sample coolers and the samples were driven to the analytical laboratory under chain-of-custody procedures (Appendix B). Samples were analyzed for the VOCs trichloroethene (TCE), cis-1, 2-dichloroethene (CIS-1, 2-DCE), and vinyl chloride (VC), using United States Environmental Protection Agency (USEPA) method SW-846 8260B and the total and filtered metals arsenic, iron, lead, and manganese, using USEPA method SW-846 6010B.

2.5 Data Validation

Data validation was performed in accordance with the Master Work Plan (TtNUS, 2003). Meridian Science and Technology, Inc. performed the QA assessments of the data. No major problems were found for any of the sampling events.

2.6 Decontamination

Of the down-hole equipment employed during LTM, only the water level probe required decontamination. This was performed by spraying the probe with potable water mixed with Alconox®, followed by spraying with deionized water and wiping with clean paper towels. All other equipment was used once and then thrown away. This primarily includes the polyethylene tubing inserted into the wells and pond.

2.7 Investigation-Derived Waste

Investigation-derived waste (IDW) consisted primarily of purge water and decontamination rinsate. IDW from this site was previously tested for Toxic Characteristic Leaching Potential (TCLP) for toxicity, corrosivity, reactivity, and ignitability. Samples were found to be nontoxic and IDW was disposed of accordingly.

3.0 Results and Trend Analysis

This section presents the results of LTM.

3.1 Water Level Gauging

Figure 3 presents a shallow groundwater map showing ranges of depth to water measurements observed during the sampling events. Groundwater flows from upgradient areas across Atkins Road, beneath the landfill, towards the pond. Generally, the period with the highest shallow groundwater table was January, followed by April, October, and then July.

3.2 Analytical Testing

3.2.1 Shallow Groundwater Samples

3.2.1.1 VOCs

VOCs were not detected at or above the Method Detection Limit (MDL) in any of the groundwater samples. No identifiable trends were present.

3.2.1.2 Total (unfiltered) Metals

Arsenic

In the upgradient wells (MW-7 and MW-12) arsenic concentrations ranged from below the MDL (at both wells during several sampling events) to 29.7 micrograms per liter ($\mu\text{g/l}$) at MW-7 during the 5th sampling event. Samples collected from MW-7 during the 5th and 6th sampling events were above the USEPA Maximum Contaminant Level (MCL) of 10 $\mu\text{g/l}$ (USEPA, 2004).

In the downgradient wells (MW-8, MW-9, MW-10, MW-11, and MW-13) arsenic concentrations ranged from below the MDL to 81.8 $\mu\text{g/l}$ at MW-8 during the 6th sampling event. Samples collected from MW-8 during the 7th sampling event, MW-9 during the 8th sampling event, and MW-10 during all four sampling events in this sequence were above the USEPA MCL of 10 $\mu\text{g/l}$ (USEPA, 2004). No readily identifiable trends were present.

Iron

Iron was detected in samples collected from both upgradient wells during all four sampling events in this sequence*. Concentrations ranged from 2,500 $\mu\text{g/l}$ at MW-7 during the 8th sampling event to 186,000 $\mu\text{g/l}$ at MW-7 during the 5th sampling event. Samples collected from both wells throughout the sampling events were consistently above the USEPA Region III groundwater Risk-Based Concentration (RBC) of 11,000 $\mu\text{g/l}$ (USEPA Region III, October 25, 2005).

Iron was detected in samples collected from all the downgradient wells during all four sampling events in this sequence. Concentrations ranged from 3,450 $\mu\text{g/l}$ at MW-10 during the 5th sampling event to 146,000 $\mu\text{g/l}$ at MW-8 during the 6th sampling event. Samples collected from all wells consistently exceeded the USEPA Region III RBC of 11,000 $\mu\text{g/l}$ (USEPA Region III, October 25, 2005) throughout the sampling events. No readily identifiable trends were present.

Lead

Lead was detected in samples collected from both upgradient wells during all four sampling events in this sequence* (exception: MW-7 was not sampled during the 7th sampling event). Concentrations ranged from 2.7 $\mu\text{g/l}$ at MW-7 during the 8th sampling event to 145 $\mu\text{g/l}$ at MW-7 during the 5th sampling event. With the exception of the samples collected from MW-7 during the 8th sampling event and MW-12 during the 7th sampling event, all the samples collected from the upgradient wells during this sampling period were above the USEPA Action Level of 15 $\mu\text{g/l}$ (USEPA, 2004).

In the downgradient wells lead concentrations ranged from below the MDL to 56.7 $\mu\text{g/l}$ at MW-10 during the 6th sampling event. Samples collected from MW-8 during the 6th sampling event and MW-

* MW-7 was not sampled during the 7th sampling event due to the fact that that well did not recharge sufficiently during the two-day sampling event

10 during the 6th and 7th sampling events exceeded the USEPA Action Level of 15 µg/l (USEPA, 2004). No readily identifiable trends were present.

Manganese

Manganese was detected in samples collected from both upgradient wells during all four sampling events in this sequence. Concentrations ranged from 24.4 µg/l at MW-12 during the 7th sampling event to 596 µg/l at MW-7 during the 5th sampling event. With the exception of the sample collected from MW-12 during the 7th sampling event, all samples collected during this sampling sequence exceeded the USEPA Secondary Maximum Contaminant Level (SMCL) of 50 µg/l (USEPA, 2004).

Manganese was detected in samples collected from all the downgradient wells during all four sampling events in this sequence. Concentrations ranged from 228 µg/l at MW-10 during the 5th sampling events to 10,500 µg/l at MW-9 during the 6th sampling event. All samples exceeded the USEPA SMCL of 50 µg/l (USEPA, 2004). No readily identifiable trends were present.

3.2.1.3 Dissolved (filtered) Metals

Arsenic

In the upgradient wells dissolved arsenic was only detected at MW-7 during the 5th sampling event. The dissolved arsenic concentration in this sample was 3.5 µg/l, which was below the USEPA MCL of 10 µg/l (USEPA, 2004)

In the downgradient wells concentrations ranged from below the MDL to 35.5 µg/l at MW-10 during the 6th sampling event. Samples collected from MW-10 during the 6th, 7th, and 8th sampling events exceeded the USEPA MCL of 10 µg/l (USEPA, 2004). No readily identifiable trends were present.

Iron

Dissolved iron was detected in samples collected from both upgradient wells during all four sampling events in this sequence*. Concentrations ranged from 136 µg/l at MW-12 during the 7th sampling event to 10,800 µg/l at MW-12 during the 5th sampling event, all of which were below the USEPA Region III groundwater RBC of 11,000 µg/l (USEPA Region III, October 25, 2005).

Dissolved iron was detected in samples collected from all the downgradient wells during all four sampling events in this sequence. Concentrations ranged from 10,300 µg/l at MW-11 during the 5th sampling event to 117,000 µg/l at MW-11 during the 6th sampling event. With the exception of samples collected from MW-11 during the 5th sampling event and MW-13 during the 7th sampling event, all samples collected exceeded the USEPA Region III RBC of 11,000 µg/l (USEPA Region III, October 25, 2005). No readily identifiable trends were present.

Lead

In the upgradient wells dissolved lead was detected in samples collected from MW-7 during the 5th sampling event and MW-12 during the 5th and 8th sampling events. Concentrations in these samples ranged from 2.2 µg/l at MW-12 during the 8th sampling event to 9.5 µg/l at MW-12 during the 5th sampling event, all of which were below the USEPA Action Level of 15 µg/l (USEPA, 2004).

* MW-7 was not sampled during the 7th sampling event due to the fact that that well did not recharge sufficiently during the two-day sampling event

In the downgradient wells dissolved lead concentrations ranged from below the MDL to 5.3 µg/l at MW-9 during the 6th sampling event, all of which were below the USEPA Action Level of 15 µg/l (USEPA, 2004). No readily identifiable trends were present.

Manganese

Dissolved manganese was detected in samples collected from both upgradient wells during all four sampling events in this sequence*. Concentrations ranged from 20.8 µg/l at MW-12 during the 7th sampling event to 98.9 µg/l at MW-7 during the 5th sampling event. With the exception of the samples collected from MW-7 during the 5th and 8th sampling events, all samples collected during this sampling sequence were below the USEPA Secondary Maximum Contaminant Level (SMCL) of 50 µg/l (USEPA, 2004).

Dissolved manganese was detected in samples collected from all the downgradient wells during all four sampling events in this sequence. Concentrations ranged from 803 µg/l at MW-10 during the 7th sampling events to 11,100 µg/l at MW-9 during the 6th sampling event. All samples exceeded the USEPA SMCL of 50 µg/l (USEPA, 2004). No readily identifiable trends were present.

3.2.2 Surface Water Samples

3.2.2.1 VOCs

With the exception of the samples collected from SW-7 and SW-8 during the 6th sampling event, VOCs were not detected at or above the MDL in any of the surface water samples collected during this sequence. TCE was detected at 1.8 µg/l and 1.3 µg/l at SW-7 and SW-8 respectively during the 6th sampling event, both of which were below the USEPA Ambient Water Quality Criteria (AWQC) of 2.7 µg/l (40 CFR 131.36, July 1, 2005). No readily identifiable trends were present.

3.2.2.2 Total (unfiltered) Metals

Arsenic

Concentrations of arsenic ranged from below the MDL to 28.9 µg/l at SW-10 during the 5th sampling event. The USEPA AWQC of 0.018 µg/l (40 CFR 131.36, July 1, 2005) was consistently exceeded at all surface water sampling locations throughout the sampling events in this sequence. No readily identifiable trends were present.

Iron

Iron was detected at all surface water sampling locations during all four sampling events in this sequence. Concentrations ranged from 1,290 µg/l at SW-10 during the 7th sampling event to 91,100 µg/l at SW-10 during the 5th sampling event, all of which exceeded the USEPA AWQC of 300 µg/l (40 CFR 131.36, July 1, 2005). No readily identifiable trends were present.

Lead

With the exception of the sample collected from SW-7 during the 7th sampling event, lead was detected in all surface water samples collected during this sequence. Concentrations in the remaining samples ranged from 2.1 µg/l at SW-10 during the 7th sampling event to 42.7 µg/l at SW-10 during the 5th sampling event. With the exception of the sample collected from SW-10 during the 7th sampling event, all surface water samples collected during this sequence were below the USEPA Action Level of 15 µg/l (USEPA, 2004). No readily identifiable trends were present.

Manganese

Manganese was detected in all surface water samples collected during this sequence. Concentrations ranged from 30.5 µg/l at SW-9 during the 6th sampling event to 1,300 µg/l at SW-10 during the 5th sampling event. With the exception of the samples collected from SW-9 during the 5th and 6th sampling events, all surface water samples collected during this sequence were above the USEPA AWQC of 50 µg/l (40 CFR 131.36, July 1, 2005). No readily identifiable trends were present.

3.2.2.3 Dissolved (filtered) Metals

Arsenic

With the exception of the samples collected from SW-9 during the 5th and 8th sampling events, dissolved arsenic was not detected in any of the surface water samples collected during this sequence. The concentrations at SW-9 were 12.0 µg/l and 5.5 µg/l during the 5th and 8th sampling events respectively, both of which exceeded the USEPA AWQC of 00.018 µg/l (40 CFR 131.36, July 1, 2005). No readily identifiable trends were present.

Iron

Dissolved iron was detected in all surface water samples collected during this sequence. Concentrations ranged from 148 µg/l at SW-8 during the 7th sampling event to 1,560 µg/l at SW-7 during the 6th sampling event. Nine (9) of the fifteen (15) surface water samples collected during this sequence exceeded the USEPA AWQC of 300 µg/l (40 CFR 131.36, July 1, 2005). No readily identifiable trends were present.

Lead

With the exception of the samples collected during the 8th sampling event, dissolved lead was not detected above the MDL in any of surface water samples collected during this sequence. Concentrations of samples collected during the 8th sampling event ranged from 0.8 µg/l at SW-8 to 3.6 µg/l at SW-9, all of which were below the USEPA Action Level of 15 µg/l (USEPA, 2004). No readily identifiable trends were present.

Manganese

Dissolved manganese was detected in all surface water samples collected during this sequence. Concentrations ranged from 3.4 µg/l at SW-7 during the 5th sampling event to 1,020 µg/l at SW-10 during the 5th sampling event. Nine (9) of the fifteen (15) surface water samples collected during this sequence exceeded the USEPA AWQC of 50 µg/l (40 CFR 131.36, July 1, 2005) throughout this sequence. No readily identifiable trends were present.

4.0 Human Health and Ecological Risk Assessment

A human health risk assessment was performed for the site using methodology found in the Risk Assessment Guidance for Superfund Volume III, USEPA, 2001. Hazard Quotients and Cancer Risks for human health were calculated for dermal contact with shallow groundwater and ingestion of shallow groundwater. The individual Hazard Quotients for each COC and exposure method were totaled to produce a value called the Hazard Index for the site. In addition, the individual Cancer Risks for each COC and exposure method were summed to produce a total Cancer Risk for the site. The ecological risk assessment was based on USEPA Region III Freshwater Screening Benchmarks for an Ecological

Risk Assessment. The following COCs were included in this risk assessment: arsenic, iron, lead, manganese, TCE, CIS-1-2-DCE, and VC.

It should be noted that the following was taken into account when the Human Health Risk Assessment and Ecological Risk Assessment for the site were performed:

- Human Health Risk Assessment calculations were conducted according to an industrial use scenario.
- Human Health Risk Assessment calculations were considered for shallow groundwater ingestion and dermal contact with shallow groundwater. Hazard Quotient and Cancer Risk calculations are included in Appendix B.
- The values used for the COC concentrations in shallow groundwater and surface water were the Upper Confidence Limit 95% (UCL95) values calculated based on a lognormal distribution. A sample UCL95 calculation is included in Appendix B.

HUMAN HEALTH RISK ASSESSMENT

Table 1. UCL95 Concentrations for Constituents of Concern in Shallow Groundwater Site 12, NDW-IH Indian Head, Maryland	
COC	UCL95 Concentration in Shallow Groundwater in $\mu\text{g/l}$
Arsenic	27.53
Iron	186000.0 (maximum value used)
Lead	81.62
Manganese	10500.0 (maximum value used)
CIS-1-2-DCE	2.5
TCE	2.5
VC	5.0

A Hazard Quotient and Cancer Risk were calculated for each COC for the following exposure methods: dermal contact with shallow groundwater and ingestion of shallow groundwater using the UCL95 values. A summary of the UCL95 concentrations of the COCs in shallow groundwater is presented in Table 1. Hazard Quotients and Cancer Risks for each COC for the different exposure methods are presented in Tables 2 and 3. Table 4 provides a summary of the Hazard Index and total Cancer Risk for the site.

Table 2.		
Summary of Dermal Contact with Shallow Groundwater Risk		
Site 12, NDW-IH Indian Head, Maryland		
COC	Hazard Quotient	Cancer Risk
Arsenic	0.07	2.7×10^{-6}
Iron	0.49	NCSF
Lead	NRFD	NCSF
Manganese	0.42	NCSF
CIS-1-2-DCE	2.0×10^{-4}	NCSF
TCE	6.6×10^{-3}	4.0×10^{-8}
VC	1.3×10^{-3}	2.0×10^{-7}
Total	0.98	2.9×10^{-6}
NCSF-Cancer Risk can not be calculated because no Cancer Slope Factor is available		
NRFD-Hazard Quotient can not be calculated because no Reference Dose is available		

Table 3.		
Summary of Ingestion of Shallow Groundwater Risk		
Site 12, NDW-IH Indian Head, Maryland		
COC	Hazard Quotient	Cancer Risk
Arsenic	7.48	2.8×10^{-4}
Iron	50.55	NCSF
Lead	NRFD	NCSF
Manganese	42.80	NCSF
CIS-1-2-DCE	0.02	NCSF
TCE	0.67	6.9×10^{-6}
VC	0.13	2.5×10^{-5}
Total	101.65	3.1×10^{-4}
NCSF-Cancer Risk can not be calculated because no Cancer Slope Factor is available		
NRFD-Hazard Quotient can not be calculated because no Reference Dose is available		

Table 4.		
Summary of Hazard Quotients and Cancer Risks for all Exposure Methods		
Site 12, NDW-IH Indian Head, Maryland		
COC	Hazard Quotient	Cancer Risk
Dermal Contact with Shallow Groundwater	0.98	2.9×10^{-6}
Ingestion of Shallow Groundwater	101.65	3.1×10^{-4}
Total	102.63 (Hazard Index)	3.1×10^{-4}

According to the Risk Assessment Guidance for Superfund Volume III, USEPA, 2001, Hazard Indexes above unity or one and total Cancer Risks above 1.0×10^{-4} are considered an unacceptable risk to human health. Both the Hazard Index (102.63) and the total Cancer Risk (3.1×10^{-4}) for the site are above these thresholds. The major contributing factors to these values are the Cancer Risk from ingestion of arsenic in shallow groundwater at the site, and Hazard Quotients from ingestion of arsenic, iron, manganese, and TCE in shallow groundwater at the site.

ECOLOGICAL RISK ASSESSMENT

An ecological risk assessment for the site was performed based on the USEPA Region III Freshwater Screening Benchmarks for an Ecological Risk Assessment depicted in Table 6. Based on the UCL95 concentrations for the COCs in surface water (Table 5), arsenic, iron, lead and manganese were above the thresholds listed in Table 6. TCE and VC were below the thresholds, while no Freshwater Screening Benchmark was available for CIS-1-2-DCE. Based on this data, arsenic, iron, lead and manganese in surface water pose an ecological risk to the site.

COC	UCL95 Concentration in Surface Water in µg/l
Arsenic	18.26
Iron	11093.88
Lead	11.28
Manganese	528.54
CIS-1-2-DCE	2.5
TCE	2.5
VC	5.0

COC	Freshwater Screening Benchmark in µg/l
Arsenic	5.0
Iron	300
Lead	2.5
Manganese	120
CIS-1-2-DCE	None Available
TCE	21
VC	930

5.0 Conclusions and Recommendations

Eight quarters of LTM were conducted at Site 12, NSF, Indian Head. The field effort consisted of water level gauging and shallow groundwater and surface water sampling. As discussed above, some comparison criteria (included in Appendix A) were exceeded in shallow groundwater and surface water samples collected at the site. The results of the human health risk assessment indicate that both the Hazard Index (102.63) and the total Cancer Risk (3.1×10^{-4}) for the site are above the acceptable thresholds (unity or one and 1.0×10^{-4} respectively). The major contributing factors to these values are the Cancer Risk from ingestion of arsenic in shallow groundwater at the site, and Hazard Quotients from ingestion of arsenic, iron, manganese, and TCE in shallow groundwater at the site. Based on the results of the ecological risk assessment of the site arsenic, iron, lead and manganese in surface water pose an ecological risk to the site. Few conclusions can be drawn at this point due to the absence of temporal or spatial trends.

It is recommended that quarterly monitoring of the site continue to identify contaminant levels for further trend analysis. It is also recommended that the two up-gradient wells, MW-7 and MW-12 be redeveloped to allow for sufficient purging and recharging.

6.0 References Cited

USEPA. 2004. Drinking Water Standards and Health Advisories.

USEPA Region III. 2005. Freshwater Screening Benchmarks for Ecological Risk.

USEPA Region III. 2005. USEPA Region III RBC Table.

USEPA. 2005. Ambient Water Quality Criteria. 40 CFR Part 131.36. July 1, 2005.

Tetra Tech NUS, Inc. 2002. "Post-Closure Long-Term Monitoring Plan Site 12-Town Gut Landfill."

FIGURES

FIGURE 1: Site 12 Location Map

FIGURE 2: Site 12 Topographic Map

FIGURE 3: Site 12 Sampling Location Map





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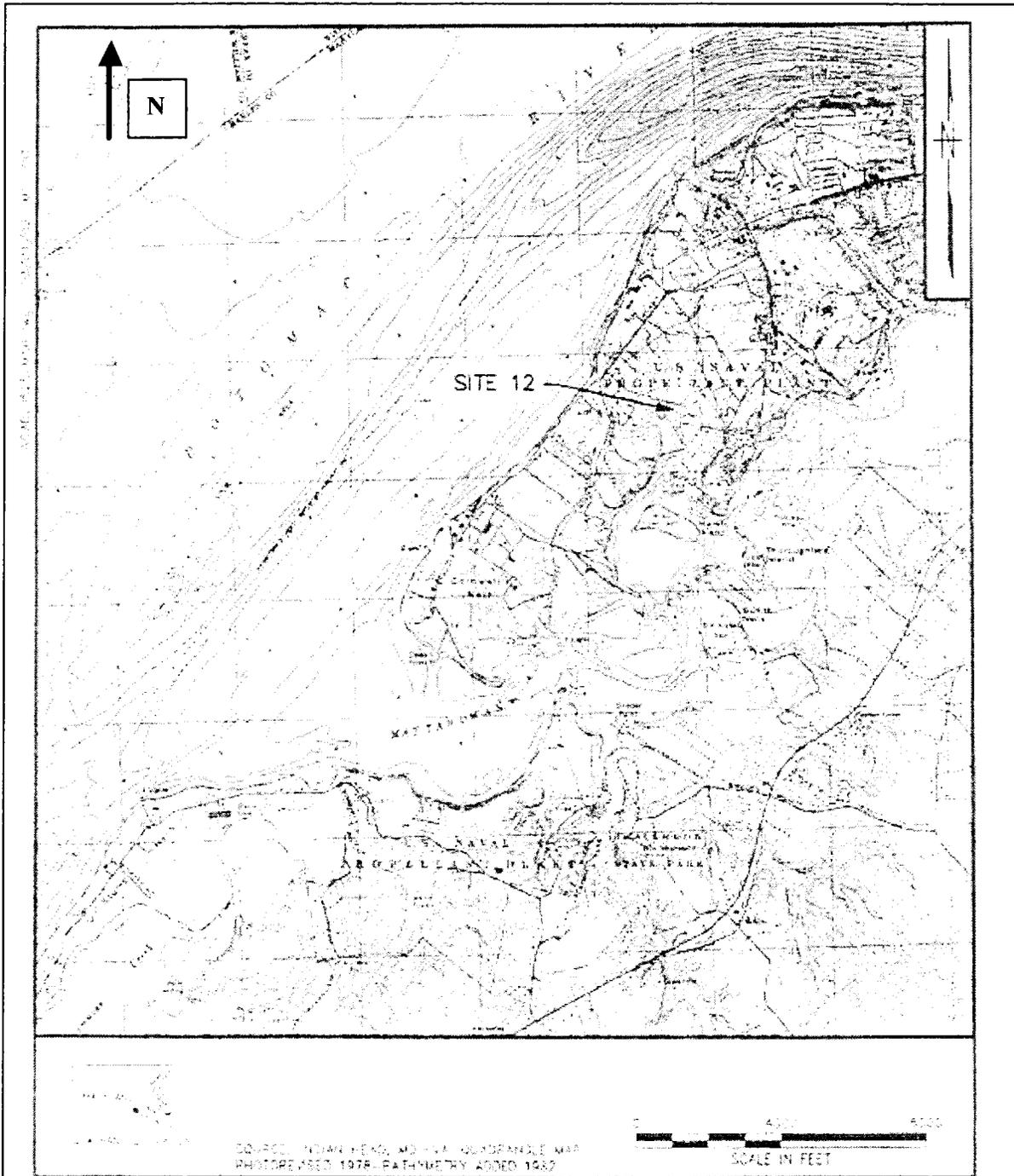
NSF, IH
Indian Head, MD

Site 12 Location Map
Indian Head, Maryland

UNITEC Contract No. N62477-01-D-0076
Figure 1.



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**NSF, IH
Indian Head, MD**

**Site 12 Location and Topographic Map
Indian Head, Maryland
7.5 Minute USGS Quadrangle**

**UNITEC Contract No. N62477-01-D-0076
Figure 2**

APPENDIX A

Shallow Groundwater and Surface Regulatory Criteria



Groundwater and Surface Water Criteria		
Constituent	Groundwater	Surface Water
TCE	5 MCL	2.7 AWQC
Cis-1,2-DCE	70 MCL	70 MCL
VC	2 MCL	2 AWQC
Arsenic	10 MCL	0.018 AWQC
Iron	22,000 RBC	300 AWQC
Lead	15 (Action Level)	15 (Action Level)
Manganese	50 SMCL	50 AWQC

NOTES

All values are in ug/l

MCL – Maximum Contaminant Level

USEPA Drinking Water Standards and Health Advisories - 2004

SMCL – Secondary Maximum Contaminant Level

USEPA Drinking Water Standards and Health Advisory - 2004

AWQC – Ambient Water Quality Criteria, 40 CFR 131.36

40CFR131.36 – July 1, 2005

RBC- EPA Region 3 Risk-Based Concentration

USEPA Region III RBC Table – September 25, 2001

Action Level

USEPA Drinking Water Standards and Health Advisory-2004

APPENDIX B

Human Health and Ecological Risk Assessment Calculations

IRON IN SURFACE WATER

		Results	Natural Log
		Iron 4670	8.45
		Iron 4310	8.37
		Iron 3740	8.23
		Iron 91100	11.42
		Iron 5400	8.59
		Iron 3180	8.06
		Iron 1930	7.57
		Iron 3440	8.14
		Iron 1400	7.24
		Iron 2190	7.69
		Iron 2240	7.71
		Iron 1290	7.16
		Iron 3910	8.27
		Iron 2260	7.72
		Iron 2900	7.97
		Iron 3590	8.19
n	16		
Mean	8.17		
s	0.959037		
H	2.744		
UCL	11093.88		

UCL95= EXP ((AVG. of Natural Logs + (0.5 x St. Dev of Natural Logs Squared) + ((St. Dev. Of Natural Logs x H constant)/Square Root of n-1))))

EQUATIONS USED TO ESTIMATE CHRONIC DAILY INTAKES		
	Carcinogenic	Non-Carcinogenic
Groundwater		
Ingestion	$(CW \cdot IRW_a \cdot EF_o \cdot ED_o) / (AT_c \cdot BW_a)$	$(CW \cdot IRW_a \cdot EF_o \cdot ED_o) / (BW_a \cdot AT_n)$
Dermal Contact	$(CW \cdot SAW_a \cdot PC \cdot ET \cdot EF_o \cdot ED_o \cdot CF) / (AT_c \cdot BW_a)$	$(CW \cdot SAW_a \cdot PC \cdot ET \cdot EF_o \cdot ED_o \cdot CF) / (BW_a \cdot AT_n)$

VALUES USED TO ESTIMATE CHRONIC DAILY INTAKE			
Variable	Term	Unit	Value
AT _c	Average Time Carcinogens	Days	25550
AT _n	Average Time non carcinogen	Days	2290
BW _a	Body weight adult	Kg	70
CF	Conversion factor	-	0.000001
CW	Chemical concentration in water	mg/L	user specified
ED _o	Exposure duration for carcinogen, residential	Years	25
EF _o	Exposure frequency residential	Days	250
ET	Exposure Time	Hours/day	24
IRW _a	Ingestion rate water	L/day	2
PC	Permeability constant	cm/hr	1
SAW _a	Surface area for water contact adult	cm ²	820

Industrial Scenario

Intake for HQ= (CW*IRWa*Efo*Edo)/(Bwa*Atn)
 Intake for Cancer Risk= (CW*IRWa*Efo*Eco)/(Bwa*Atc)
 Risk= Intake*CSF
 HQ= Intake/REFD

GROUNDWATER INGESTION						
IRWa	Efo	Bwa	Atn	IRWb	Atc	
2	250	70	0	2	25550	

GROUNDWATER INGESTION						
DOC	Conc (mg/L)	NON-CARCINOGENIC RISK			CARCINOGENIC RISK	
		RED	HQ	RISK	CSF	RISK
Arsenic	1.86E+02	3.00E-04	7.48E+00	2.80E-04	1.50E+00	2.80E-04
Iron	2.75E-02	3.00E-01	5.06E+01	NONE	NONE	NONE
Lead	8.16E-02	NONE	NONE	NONE	NONE	NONE
Manganese	1.05E+01	2.00E-02	4.28E+01	NONE	NONE	NONE
CIS-1,2-DCE	2.50E-03	1.00E-02	2.00E-02	NONE	NONE	NONE
TCE	2.50E-03	3.00E-04	6.70E-01	4.00E-01	6.90E-06	6.90E-06
VC	5.00E-03	3.00E-03	1.30E-01	7.20E-01	2.50E-05	2.50E-05
TOTAL			1.02E+02			3.12E-04

Hazard Quotient for Ingestion of Shallow Groundwater

$$\frac{(0.02753 \text{ mg/L} \times 2 \text{ L/day} \times 250 \text{ days} \times 25 \text{ years})}{(2190 \text{ Days} \times 70 \text{ kg})}$$

$$344.125 / 153,300 =$$

$$0.002244 / (3 \times 10^{-4}) = \text{Reference Dose} =$$

7.48

Iron

$$\frac{(186 \text{ mg/L} \times 2 \text{ L/day} \times 250 \text{ days} \times 25 \text{ years})}{(2190 \text{ Days} \times 70 \text{ kg})} =$$

$$\frac{2,325,000}{153,300} =$$

$$\frac{15,166.34}{(3 \times 10^{-1})} = \text{RFDo} =$$

50.55

Lead

$$\frac{(.08162 \times 2 \text{ L/day} \times 250 \text{ days} \times 25 \text{ years})}{(2190 \text{ Days} \times 70 \text{ kg})} =$$

$$1,020.25 / 153,300 =$$

$$0.006655 / (No \text{ RFDo}) =$$

NA

Manganese

$$\frac{(10.5 \text{ mg/L} \times 2 \text{ L/day} \times 250 \text{ days} \times 25 \text{ years})}{(2190 \text{ Days} \times 70 \text{ kg})} =$$

$$131,250 / 153,300 =$$

$$0.85616 / (2 \times 10^{-2}) (\text{RFDo}) =$$

42.80

Hazard Quotient for Ingestion of Shallow Groundwater (cont.)

$$\frac{\text{cis-1-2-DCE}}{(.0025 \text{ mg/L} \times 2 \text{ L/day} \times 250 \text{ days} \times 25 \text{ years}) / (2190 \text{ Days} \times 70 \text{ kg}) =$$

$$31.25 / 153,300 =$$

$$0.0002038 / .01 =$$

$$\boxed{0.0203}$$

TCE

$$(.0025 \text{ mg/L} \times 2 \text{ L/day} \times 250 \text{ days} \times 25 \text{ years}) / (2190 \text{ Days} \times 70 \text{ kg}) =$$

$$31.25 / 153,300 =$$

$$0.0002038 / (3 \times 10^{-4}) =$$

$$0.6793$$

VL

$$(.005 \text{ mg/L} \times 2 \text{ L/day} \times 250 \text{ days} \times 25 \text{ years}) / (2190 \text{ Days} \times 70 \text{ kg}) =$$

$$62.5 / 153,300 =$$

$$0.0004076 / (3 \times 10^{-3}) =$$

$$0.1356$$

Risks for Ingestion of Swallow Groundwater

$$\begin{aligned}
 & (.02753 \text{ mg/L} \times 2 \text{ L/day} \times 250 \text{ days} \times 25 \text{ years}) / (25530 \times 70) \\
 & 344.125 / 1,788,500 = \\
 & 0.0001924 \times 1.5 = \text{CSF} \\
 & 2.88 \times 10^{-4}
 \end{aligned}$$

Iron
No Cancer Slope Factor

Lead
No Cancer Slope Factor

Manganese
No Cancer Slope Factor

CIS-1-2-DCE
No Cancer Slope Factor

TCE

$$\begin{aligned}
 & (.0025 \text{ mg/L} \times 2 \text{ L/day} \times 250 \text{ days} \times 25 \text{ years}) / (25530 \times 70) \\
 & 31.25 / 1,788,500 = \\
 & 1.74 \times 10^{-5} \times .4 = \\
 & \boxed{6.9 \times 10^{-6}}
 \end{aligned}$$

Cancer Risk for Ingestion of Shallow Ground
(Cont.)

VL

$$(0.005 \text{ mg/L} \times 2 \text{ L/day} \times 250 \text{ days} \times 25 \text{ years}) / 70$$

$$62.5 / 1,788,500$$

$$3.49 \times 10^{-5} \times 72$$

$$2.5 \times 10^{-5}$$

██████████
Industrial Scenario

Intake for HQ= (CW*SAWa*PC*ET*Efo*Edo*CF)/(BWA*Atn)
 Intake for Cancer Risk= (CW*SAWa*PC*ET*Efo*Edo*CF)/(BWA*Atc)
 Risk= Intake*CSF
 HQ= Intake/RFD

GROUNDWATER- DERMAL CONTACT								
SAWa	PC	ET	Efo	Edo	CF	Bwa	Atn	Atc
0	1	24	250	0	0.000001	70	0	25550

GROUNDWATER- DERMAL CONTACT						
COC	Conc.	NON CARCINOGEN RISK		CARCINOGEN RISK		
		RFD	HQ	CSF	Risk	
Arsenic	1.86E+02	3.00E-04	7.00E-02	1.50E+00	2.70E-06	
Iron	2.75E-02	3.00E-01	4.90E-01	NONE	NONE	
Lead	8.16E-02	NONE	NONE	NONE	NONE	
Manganese	1.05E+01	2.00E-02	4.20E-01	NONE	NONE	
Cis-1,2-DCE	2.50E-03	1.00E-02	2.00E-04	NONE	NONE	
TCE	2.50E-03	3.00E-04	6.60E-03	4.00E-01	4.00E-08	
VC	5.00E-03	3.00E-03	1.30E-03	7.20E-01	2.00E-07	
Total			9.80E-01		2.90E-05	

Hazard Quotient for Dermal Contact w/ Shallow
Groundwater

Arsenic

$$\frac{(.02753 \text{ mg/L} \times 820 \text{ cm}^2 \times 1 \times 24 \text{ hrs.} \times 250 \text{ days} \times 25 \text{ yrs.} \times 10^{-6})}{(2190 \text{ d} / 70 \text{ kg})}$$

$$(.02753 \times 123) / (153,300) =$$

$$2.2 \times 10^{-5} / 3 \times 10^{-4} (\text{RfD}_0) =$$

$$\boxed{0.0733}$$

Iron

$$\frac{(186 \text{ mg/L} \times 820 \text{ cm}^2 \times 1 \times 24 \text{ hrs.} \times 250 \text{ days} \times 25 \text{ yrs.} \times 10^{-6})}{(2190 \text{ d} / 70 \text{ kg})}$$

$$(186 \times 123) / 153,300 =$$

$$0.1492 / .3 (\text{RfD}_0) =$$

$$\boxed{0.4974}$$

Lead No Reference Oral Dose

Manganese

$$\frac{(10.5 \text{ mg/L} \times 820 \text{ cm}^2 \times 1 \times 24 \text{ hrs.} \times 250 \text{ days} \times 25 \text{ yrs.} \times 10^{-6})}{(2190 \text{ d} / 70 \text{ kg})}$$

$$(10.5 \times 123) / 153,300 =$$

$$0.00054246 / .02 \text{ RfD}_0 =$$

$$\boxed{0.4212}$$

CIS-1-2-DCE

$$(.0025 \times 820 \text{ cm}^2 \times 1 \times 24 \text{ hrs.} \times 250 \text{ days} \times 25 \text{ yrs.} \times 1 \times 10^{-6}) / \left(\frac{2190}{\text{day}} \times 70 \text{ kg} \right)$$

$$.0025 \times 23 / 153,300 =$$

$$.3075 / 153,300 =$$

$$2 \times 10^{-6} / .01 =$$

$$\boxed{.0002}$$

TCE

$$(.0025 \times 820 \text{ cm}^2 \times 1 \times 24 \text{ hrs.} \times 250 \text{ days} \times 25 \text{ yrs.} \times 1 \times 10^{-6}) / \left(\frac{2190}{\text{day}} \times 70 \text{ kg} \right)$$

$$.0025 \times 23 / 153,300 =$$

$$.3075 / 153,300 =$$

$$2 \times 10^{-6} / 3 \times 10^{-4} =$$

$$\boxed{0.0006}$$

VL

$$(.005 \times 820 \text{ cm}^2 \times 1 \times 24 \text{ hrs.} \times 250 \text{ days} \times 25 \text{ yrs.} \times 1 \times 10^{-6}) / \left(\frac{2190}{\text{day}} \times 70 \text{ kg} \right)$$

$$.005 \times 23 / 153,300 =$$

$$4 \times 10^{-6} / .003 =$$

$$\boxed{0.0013}$$

Cancer Risk of Dermal Contact w/ Shallow Groundwater

Arsenic

$$(.02753 \times 820 \text{ cm}^2 \times 1 \times 24 \text{ hrs} \times 250 \text{ days} \times 25 \text{ yrs} \times 1 \times 10^{-6}) / \frac{70 \times 25550}{\text{days}}$$

$$.02753 \times 123 / 1,788,500$$

$$1.8 \times 10^{-6} \times 1.5 \checkmark \text{ Cancer Slope} =$$

$$\boxed{2.7 \times 10^{-6}}$$

Iron
No Cancer Slope Factor

Lead
No Cancer Slope Factor

Manganese
No Cancer Slope Factor

CIS-1-2-DCE
No Cancer Slope Factor

TCE
(.0025 \times 820 cm² \times 1 \times 24 hrs. \times 250 days \times 25 yrs. \times 1 \times 10⁻⁶) / $\frac{70 \times 25550}{\text{days}}$

$$.3075 / 1,788,500$$

$$1 \times 10^{-7} \times 4 =$$

$$\boxed{4 \times 10^{-8}}$$

Cancer Risk from Dermal Contact w/ Shallow
Groundwater (Cont.):

$$\frac{VL}{(0.005 \times 820 \text{ cm}^2 \times 1 \times 24 \text{ hrs.} \times 250 \text{ days} \times 25 \text{ yrs.} \times 10^{-6}) / (2190 \times 70)}$$

$$.005 \times 123 / 1,758,500 =$$

$$3 \times 10^{-7} \times 72 =$$

$$\boxed{2 \times 10^{-7}}$$