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Final

Site 28 Baseline Ecological Risk Assessment Report

Naval Support Facility, Indian Head
Indian Head, Maryland

Contract Task Order 0111

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Executive Summary

This document presents the Baseline Ecological Risk Assessment (BERA) for the shoreline sediments at Site 28 at the Naval Support Facility, Indian Head (NSF-IH), in Indian Head, Maryland. This BERA report was prepared by CH2M HILL under the U.S. Department of the Navy (Navy), Naval Facilities Engineering Command, Atlantic Division (LANTDIV), Comprehensive Long-Term Environmental Action Navy (CLEAN) II Contract N62470-95-D-6007, Contract Task Order (CTO) 0111. This BERA has been submitted to the Naval Facilities Engineering Command Washington (NAVFAC Washington), NSF-IH, the United States Environmental Protection Agency (USEPA), and the Maryland Department of the Environment (MDE). The activities described herein are part of the overall Installation Restoration (IR) Program being implemented at NSF-IH.

A screening-level ecological risk assessment (SERA) was completed for Site 28 as part of the remedial investigation for the site (CH2M HILL, 2005a). The results of the SERA suggested the potential for unacceptable ecological risk at the site, including potential risks from several metals in the shoreline sediments and in the Mattawoman Creek sediment across from the site. The assessment and measurement endpoints selected for the BERA are described in Table ES- 1.

TABLE ES-1
Assessment and Measurement Endpoints for Site 28
Site 28 BERA Report
NSF-IH, Indian Head, Maryland

Assessment Endpoints	Measurement Endpoints
Evaluate the survival and growth of the benthic invertebrate community and its ability to function as a prey base for finfish**.**	Results of 28-day sediment toxicity tests (survival and growth) with the amphipod *Hyalella azteca*, using site, reference, and control sediment to evaluate the status of the benthic invertebrate community as a prey base for finfish. Comparison of the abundance of benthic invertebrates in site sediment with abundance of benthic invertebrates in reference sediment.
Evaluate the potential for adverse changes in the survival, growth, and reproduction of finfish and piscivorous wildlife that utilize the site.	Comparison of estimated exposure doses to toxicity reference values using site-specific bioaccumulation data obtained from chemical of potential concern (COPC) concentrations in fish tissue from the site to a reference hazard quotient (HQ) of 1.0. Comparison of COPC concentrations in fish tissue from the site with tissue residue effects values from the literature and with background fish tissue concentrations collected from an upstream reference site.
Evaluate the potential for adverse changes in the survival, growth, and reproduction of omnivorous birds that utilize the site.	Comparison of estimated exposure doses to toxicity reference values using the site-specific bioaccumulation data obtained from COPC concentrations in benthic invertebrate tissue (from 28-day bioaccumulation bioassays with *Lumbriculus variegatus*) to a reference HQ of 1.0. Mallard exposure assessment will be based on 67% animal diet during nesting period for females.

In support of the BERA, surface sediment samples were collected from three locations along the immediate shoreline of Site 28, from two locations along the vegetated bar directly across the channel from Site 28, and from two reference locations, from October 25 through October 28, 2005. The sediment samples were analyzed for target analyte list (TAL) metals, total organic carbon (TOC), pH, sulfide, and grain size. To evaluate direct toxicity to benthic invertebrates, laboratory toxicity tests with the amphipod *Hyalella azteca* were conducted on split samples from all the sediment sampling locations, and benthic grab samples were collected to examine the benthic community structure. To evaluate bioaccumulation of chemicals from the sediments into the aquatic food chain, laboratory bioaccumulation bioassays were conducted with the aquatic worm *Lumbriculus variegates*, and fish were collected for fish tissue chemical analysis from the shoreline and reference sample locations.

The results of the sediment toxicity testing and benthic community sampling indicate that an unacceptable risk exists for benthic invertebrates in the vicinity of sample location IS28SD03. The shoreline immediately upstream of this location is also known to pose unacceptable risk based on previous toxicity testing in the location of the ongoing apatite treatment pilot study. The sediments in the vicinity of sample locations IS28SD01 and IS28SD02 pose a low level of risk to benthic invertebrates. Silver in the sediment along the vegetated bar across from Site 28 poses no unacceptable risk to the benthic invertebrate community of the creek.

The results of the fish tissue chemical analysis revealed that although lead and zinc are accumulating in fish at the site, neither metal poses an unacceptable risk to finfish. Additionally, the levels of zinc in the fish are comparable to background levels.

The results of the bioaccumulation bioassays and associated risk estimates for aquatic omnivorous birds indicate that lead and zinc in the shoreline sediments at Site 28 pose a low risk to these receptors. The primary area of concern is in the vicinity of sample location IS28SD03 and the shoreline immediately upstream of this location where the apatite treatment pilot study is being conducted.

The results of the fish tissue analysis and associated risk estimates for piscivorous birds indicate that lead, mercury, and zinc are not accumulating in fish at levels that would pose an unacceptable risk to these receptors.

The results of the fish tissue analysis and associated risk estimates for piscivorous mammals indicate that lead, mercury, and zinc are not accumulating in fish at levels that would pose an unacceptable risk to these receptors.

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Acronyms and Abbreviations

BERA	Baseline Ecological Risk Assessment
B-IBI	Benthic Index of Biotic Integrity
BTAG	Biological Technical Assistance Group
CNO	Chief of Naval Operations
COC	chemical of concern
COPC	chemical of potential concern
CSM	conceptual site model
CTO	Contract Task Order
ER-L	effects range-low
ER-M	effects range-median
GPS	global positioning system
ha	hectare
HQ	hazard quotient
IHIRT	Indian Head Installation Restoration Team
IR	Installation Restoration
kg	kilogram
L	liter
LANTDIV	Naval Facilities Engineering Command, Atlantic Division
LC_{50}	median lethal concentration
LOAEL	lowest-observed-adverse-effect level
MDE	Maryland Department of the Environment
µm	micrometer
µg/L	micrograms per liter
MFO	mixed-function oxidase
mg	milligram
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
NAVFAC Washington	Naval Facilities Engineering Command Washington
NOAEL	no-observed-adverse-effect level
NOEC	no observed effect concentration
NOS	Naval Ordnance Station
NSF-IH	Naval Support Facility, Indian Head
PAH	polycyclic aromatic hydrocarbon
PEC	probable effect concentration
PEL	probable effect level
PRG	preliminary remediation goal

RI	remedial investigation
SERA	screening-level ecological risk assessment
SQG	sediment quality guideline
TAL	target analyte list
TEL	threshold effects level
TIE	toxicity identification evaluation
TOC	total organic carbon
UET	upper effects threshold
USEPA	U.S. Environmental Protection Agency

SECTION 1

Introduction

This Baseline Ecological Risk Assessment (BERA) report was prepared by CH2M HILL under the U.S. Department of the Navy (Navy), Naval Facilities Engineering Command, Atlantic Division (LANTDIV), Comprehensive Long-Term Environmental Action Navy (CLEAN) II Contract N62470-95-D-6007, Contract Task Order (CTO) 0111. This BERA has been submitted to the Naval Facilities Engineering Command Washington (NAVFAC Washington), Naval Support Facility, Indian Head (NSF-IH), the United States Environmental Protection Agency (USEPA), and the Maryland Department of the Environment (MDE). The activities described herein are part of the overall Installation Restoration (IR) Program being implemented at NSF-IH. Figure 1-1 shows the location of Site 28.

This document was prepared in accordance with USEPA guidance (USEPA, 1997; USEPA, 1998) and Chief of Naval Operations (CNO) policy (CNO, 1999).

The document is organized as follows:

- Section 1: Introduction
- Section 2: Problem Formulation
- Section 3: Investigation Activities
- Section 4: Results
- Section 5: Risk Characterization
- Section 6: References

1.1 Site Background

This section provides a summary of the background information for Site 28. Detailed site background information is provided in Sections 1.3 and 1.5 of the *Final Remedial Investigation Report, Site 28* [herein referred to as Remedial Investigation (RI) report] (CH2M HILL, 2005a).

NSF-IH is a facility of the Naval Support Activity South Potomac in the Naval District Washington Region. The facility, located in northwestern Charles County, Maryland, provides services, research, development, testing, and evaluation in energetics (TTNUS, 2004). The facility consists of the Main Area, located on Cornwallis Neck Peninsula, and the Stump Neck Annex, located across Mattawoman Creek from the main facility area. The Main Area is bounded by the Potomac River to the northwest, west, and south; Mattawoman Creek to the south and east; and the town of Indian Head to the northeast.

Site 28, also referred to as the "Original Naval Ordnance Station (NOS) Burning Ground," the "Slavins Dock Area," and the "Wildlife Area," is located on the Main Area of NSF-IH (Figure 1-1). The site encompasses observation Well 14 and the former sites of a zinc recovery furnace and a shoreline burning cage (Figure 1-2). The small burning cage, located to the south of observation Well 14, was used to burn debris (e.g., wooden crates). The exact location of the shoreline burning cage is unknown. It is shown outside of the existing

perimeter fence on at least one historical map; however, burned debris, glass, and slaglike materials were observed inside the fence in an area adjacent to the mouth of Swale 4 (Figure 1-2). The area where the zinc recovery furnace and the small burning cage were located is referred to as Zone A. Zone A comprises the area between the north and south fence lines, the area outside of the fence line to the north, and shoreline to the east. The area referred to as the "Original Burning Ground" in the Initial Assessment Study (NEESA, 1983) and as the "Shoreline Burning Cage" by Dolph (2001) is included in Zone B. This area, outside the NSF-IH fence line but within Navy property, is south of Zone A. Figure 1-2 shows the site, swales, and other features.

1.2 Environmental Setting

The environmental setting information is provided in Section 2 of the RI report and Section 2 of the *Final Work Plan for Baseline Ecological Risk Assessment Site 28* (herein referred to as BERA work plan; CH2M HILL, 2005b). In general, the 1.8-acre, eastward-sloping site includes a mixture of habitats. The northern portion of Zone A is comprised mostly of tall grass, with some areas of exposed soil, gravel, and burned debris. There are four swales in Zone A that discharge to Mattawoman Creek. Swales 2 and 3 connect with Swale 1, which conveys stormwater runoff into Mattawoman Creek. The discharge area for Swale 1 supports a small emergent wetland habitat dominated by obligate wetland vegetation. Flow in these swales is intermittent, responding to seasonal fluctuations, and appears to contain groundwater discharging to the swales as springs. Swale 4, in the southern portion of Zone A, collects water via a culvert that runs from the west and under the dirt road at Site 28. This drainage also receives runoff from the site. The results of the RI suggest that the major source of water in Swale 4 is likely groundwater (CH2M HILL, 2005a). The presence of water and obligate wetlands vegetation during dry periods suggest that Swale 4 flows perennially.

The southern portion of Zone A, and most of Zone B, is mixed hardwood forest. The tree cover in this area is primarily deciduous (e.g., oak, maple, and sweet gum), with a few conifer species. There are several areas (e.g., adjacent to the southern fence line) where a shrubby understory is present. There are also several wetland areas in the forested portion of the site.

The shoreline at the site along Mattawoman Creek is tidal freshwater, varies from a sand/gravel to muddy composition, and supports few herbaceous plant species. The littoral zone adjacent to the site is composed of a predominantly sand and gravel substrate along the central portion of the site, in contrast to the fine silty mud substrate immediately upstream and downstream of the site. The abundance of sand and gravel adjacent to the site may be an indication of historical erosion of soils from the site to Mattawoman Creek. Although the majority of the site is steep, the slope decreases considerably from the fence line to the shoreline of Mattawoman Creek. The immediate shoreline area is relatively stable because of the flat topography and stable substrate (sand and gravel). Restoration of the shoreline at Site 28 is addressed in the Engineering Evaluation/Cost Analysis (EE/CA) for the site (CH2M HILL, 2006). The EE/CA states that after the final grading of the site has been completed, native wetland plants will be planted at the bottom of the slope in the tidal fringe.

Site 28 contains a number of habitats and, therefore, is likely to support a number of species including mammals, songbirds, raptors, reptiles, and amphibians. The portion of Site 28 that is directly adjacent to Mattawoman Creek supports a number of aquatic bird species. A survey of rare, threatened, and endangered species was conducted for the installation by the Maryland Natural Heritage Program in 1991 and 1992 (MDNR, 1992). The survey focused on areas with a high potential for supporting rare, threatened, and endangered species. Of the listed species, the bald eagle (*Haliaeetus leucocephalus*) is the only known federally listed threatened species identified on NSF-IH.

1.3 Results of Steps 1-3A of the Ecological Risk Assessment

A screening-level ecological risk assessment (SERA) was completed as part of the RI for the site (CH2M HILL, 2005a). Section 7 of the RI report presents a detailed discussion of the ecological risk assessment. Section 2.2 of the BERA work plan presents a summary of the data used for the SERA, as well as the risk characterization and conclusions from the RI.

In general, the results of the SERA suggested that potentially unacceptable ecological risks exist at Site 28. Therefore, the initial step of a BERA, Step 3A, was completed and included with the SERA in the RI report. The BERA work plan presents detailed information on Step 4 (Study Design and Data Quality Objective Process) of the ecological risk assessment process. Therefore, that information will not be presented in this report.

1.4 Chemicals, Media, and Area of Focus

This BERA investigation was undertaken to refine the risk estimates from the SERA and Step 3A. The area of focus for this BERA investigation is the sediment along the immediate shoreline of Site 28 and in the off-shore sediment of Mattawoman Creek. Section 2.3 of the BERA work plan presents detailed information on the environmental media and chemicals of potential concern (COPCs) considered in the BERA. To reduce duplication, the information will not be presented in this report.

Table 1-1 shows the potential COPCs and ecological receptors identified for Mattawoman Creek adjacent to Site 28 after the SERA and Step 3A risk process.

TABLE 1-1
Potential COPCs and Ecological Receptors Identified for the BERA
Site 28 BERA Report
NSF-IH, Indian Head, Maryland

COC	Benthic Invertebrates and Aquatic Plants	Water Column Receptors[2]	Semiaquatic Upper-Trophic-Level Receptors
Arsenic	x		
Cadmium	x	x	
Copper	x		
Lead	x		x
Mercury			x

TABLE 1-1
Potential COPCs and Ecological Receptors Identified for the BERA
Site 28 BERA Report
NSF-IH, Indian Head, Maryland

COC	Benthic Invertebrates and Aquatic Plants	Water Column Receptors[2]	Semiaquatic Upper-Trophic-Level Receptors
Silver	x[1]		
Zinc	x	x	x

[1]Mattawoman Creek sediment only (not a COPC for the immediate shoreline sediment).

[2]Potential risk to water column receptors will be evaluated after the soil/sediment removal at Site 28 is completed; therefore, no surface water data were collected as part of the BERA.

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LEGEND

- Approximate Site Boundary
- Buildings
- Road
- Wooded Area
- Dense Wooded Area

N

2000 0 2000 4000 Feet

Figure 1-1
Facility Map
Site 28 BERA Report
NSF-IH, Indian Head, Maryland

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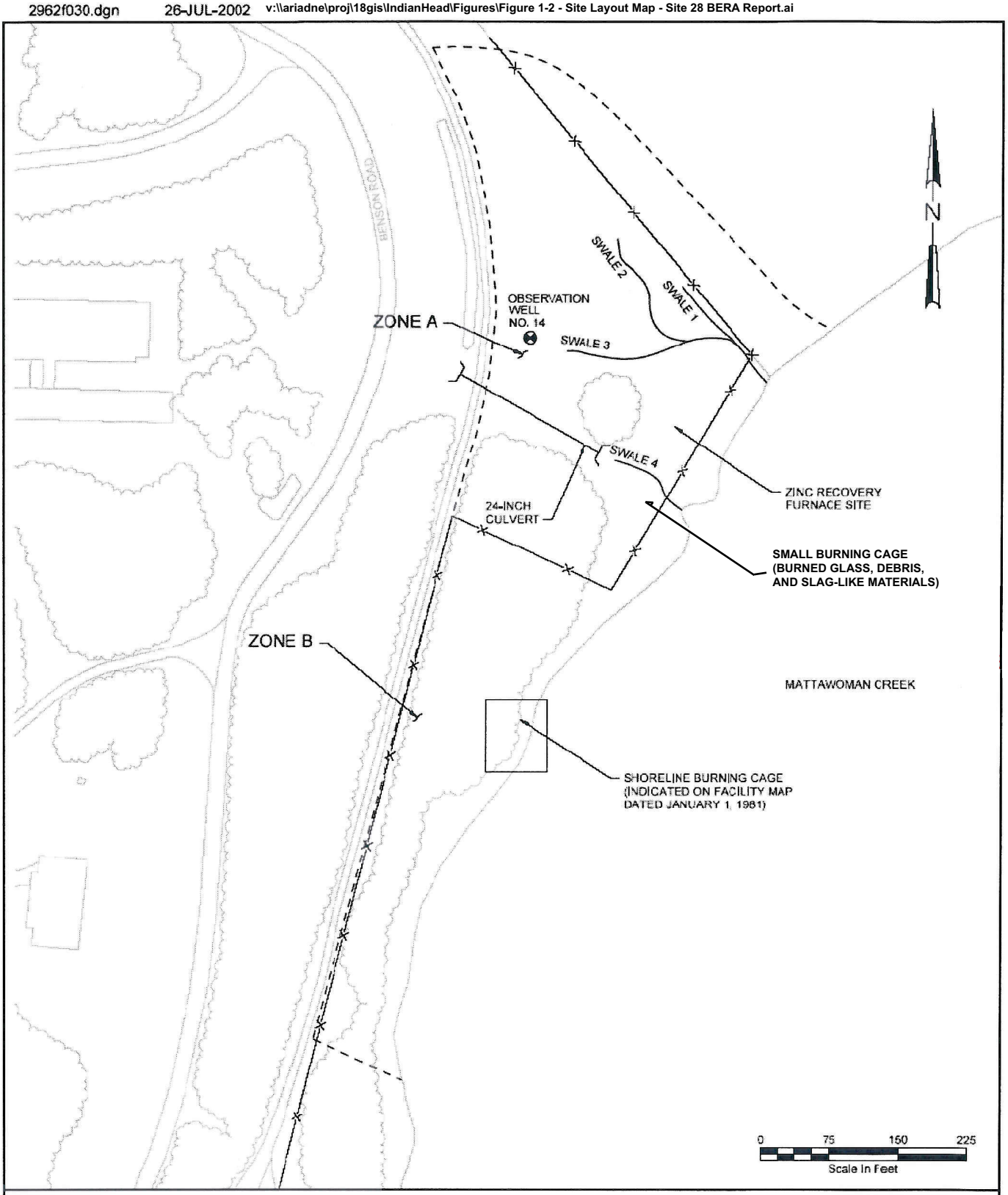

LEGEND

-X——X- FENCE LINE

- - - - - APPROXIMATE SITE BOUNDARY

Figure 1-2
Site Layout Map
Site 28 BERA Report
NSF-IH, Indian Head, Maryland

NOTE: SWALE LOCATIONS ARE APPROXIMATE.

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SECTION 2

Problem Formulation

The information presented in this section is taken from Section 3 of the BERA work plan. The BERA problem formulation is a revision of the previous problem formulation from the SERA and is focused on defining the issues associated with the identified COPCs during the SERA. This revised problem formulation consists of an evaluation of the toxicity of the COPCs and a refined conceptual model. The conceptual model includes a discussion of exposure pathways, assessment endpoints, and risk hypotheses.

2.1 Ecotoxicity Review

Based on the SERA Step 3A results, there is potential unacceptable risk to benthic invertebrate, aquatic plant, and water column receptors, as well as semi-aquatic upper-trophic-level receptors, from exposures to site-related COPCs in near-shore and creek sediments and/or surface water. The risk driving COPCs for benthic invertebrates and/or plants along the Site 28 shoreline are arsenic, cadmium, copper, lead, and zinc. The risk-driving COPCs for surface water are cadmium and zinc. Additionally, lead, mercury, and zinc in shoreline sediment may pose a risk to upper-trophic-level receptors. Silver may pose a risk to benthic invertebrate and aquatic plant communities in Mattawoman Creek. Ecotoxicity profiles for each of the COPCs are provided in the following subsections.

2.1.1 Arsenic

Arsenic occurs as two forms in environmental media: arsenic (III), usually the most toxic, and arsenic (V) (USEPA, 1985). The presence of arsenic in these forms is dependent on environmental conditions such as pH, organic content, amount of suspended solids, and sediment chemistry. Arsenic is readily adsorbed onto sediments containing abundant organic matter. The majority of the toxicity information available for arsenic is based on aqueous exposure studies.

Acute toxicity of arsenic (III) to six invertebrate species ranged from 0.812 milligrams per liter (mg/L) for a water flea (USEPA, 1985) to 97.0 mg/L for a midge (Holcombe et al., 1983). Acute toxicity of arsenic (V) ranged from 0.69 mg/L for the alga *Selenastrum capricornutum* (USEPA, 1985) to 49.6 mg/L for *Daphnia pulex* (Passino and Novak, 1984). Three chronic toxicity values were calculated for arsenic (III) ranging from 0.914 mg/L to 3.026 mg/L for *Daphnia magna* and fathead minnow, *Pimephales promelas*, respectively (USEPA, 1985). The only chronic test that could be used to calculate a chronic value for arsenic (V) used the fathead minnow and resulted in a value of 0.8916 mg/L.

Chronic toxicity to aquatic plants is dependent on the chemical form of arsenic. Plant values for arsenic (III) range from 2.3 mg/L to greater than 59.2 mg/L, while values for arsenic (V) range from 0.048 mg/L to 202.0 mg/L. Endpoints for arsenic (V) tended toward non-lethal effects concentrations, while arsenic (III) endpoints tended toward lethality concentrations (USEPA, 1985). Sodium arsenate ($AsHN_2O_4$) showed no impact on growth curves of

planktonic alga at all concentrations tested (0.05-2.0 mg/L) (Maeda et al., 1983). The toxicity information available for arsenic suggests that benthic invertebrates are more sensitive to arsenic than are aquatic plants.

2.1.2 Cadmium

Several acute toxicity studies regarding the toxicity of cadmium in aquatic invertebrates and fish have been conducted. The LC_{50} values (median lethal concentration) reported for fish and aquatic invertebrates ranged from 0.000233 mg/L for *Daphnia magna* to 25 mg/L for goldfish at a hardness of 100 mg/L (USEPA, 1980).

The eggs of three aquatic species (goldfish, leopard frog, and largemouth bass) were exposed to cadmium-spiked sediments (2.3 percent organic matter) until 4 days post hatch (6-7 days total exposure) (Francis et al., 1984). Sediments with 1,000 mg/kg were not toxic to goldfish or leopard frog. However, 25 and 0 percent mortality was reported for largemouth bass at sediment concentrations of 1,000 and 100 mg/kg, respectively (Francis et al., 1984).

Following laboratory exposure to cadmium for 3 days, the LC_{50} values for American toad (*Bufo americanus*) tadpoles ranged from 2.87 to 7.84 mg/L (Ferrari et al., 1993). An embryo-larvae laboratory study where Eastern narrow-mouthed toads (*Gastrophryne carolinensis*) were exposed to cadmium for 7 days resulted in an LC_{50} value of 40 mg/L (Birge et al., 1979). Studies with the African clawed frog (*Xenopus laevis*) have shown 2-day LC_{50} values ranging from 3.2 to 11.7 mg/L (USEPA, 1985). Chronic exposures (100 days) with *X. laevis* tadpoles have resulted in toxicity values (development) of 0.65 mg/L (USEPA, 1985).

In the chronic laboratory studies, both developmental and other growth effects resulted for various amphibian species. Following 24 days of exposure to concentrations of cadmium ranging from less than 2 to 504.5 micrograms per liter (µg/L), a decrease in limb regeneration was seen for northwestern salamander (*Ambystoma gracile*) larvae as cadmium concentration increased (Nebeker et al., 1994). In a separate study, where *A. gracile* larvae were exposed to six concentrations of cadmium, growth was significantly reduced at concentrations of 227 and 535 µg/L (Nebeker et al., 1995). The resulting no-observed-adverse-effect level (NOAEL) and lowest-observed-adverse-effect level (LOAEL) values for this study were 106 and 227 µg/L, respectively.

Cadmium exposure via solution has been shown to be toxic to various plant species, although the following data are based on terrestrial plant species. Spruce seedlings displayed a 23 percent reduction in root elongation when exposed to 0.11 mg/L cadmium (as $CdSO_4$) for 7 days (Lamersdorf et al., 1991). Exposing wheat (*Triticum aestivum*) to cadmium [as $Cd(NO_3)_2$] in solution resulted in the measurement of toxicity in multiple endpoints (Ouzounidou et al., 1997). Wheat exposure to 29.8 mg/L resulted in a 53, 40, 42, and 17 percent reduction in root length, shoot-leaf length, root mass, and shoot mass, respectively. Although little data were found for aquatic plant species, the USEPA Region III screening value for sediment flora is 5.1 mg/kg (USEPA, 1995), which is higher than the 1.2 mg/kg screening value for sediment fauna, suggesting that benthic invertebrates are more sensitive to cadmium than are aquatic plants.

2.1.3 Copper

The majority of the toxicity information available for copper is based on aqueous exposure studies. Therefore, little information is available on toxicity from sediment-associated copper. Exposure to copper has been shown to affect caddisfly (*Clistoronia magnifica*) life cycles. The no observed effect concentration (NOEC) of copper was 0.0083 mg/L, and exposure to 0.013 mg/L copper resulted in significant reductions in adult emergence. Exposure to 0.017 mg/L and greater resulted in 60 and 40 percent larvae surviving to pupae and swimming pupae, respectively, and no adults emerged following exposure to greater than 0.0035 mg/L copper (Nebeker et al., 1984).

In a review of copper hazards to fish, wildlife, and invertebrates, Eisler (1998) found that many species of freshwater plants and animals die within 96 hours at concentrations from 5.0 to 9.8 μg/L copper. Sensitive species of freshwater mollusks, crustaceans, and fishes die at concentrations from 0.23-0.91 μg/L. The acute toxicity data indicate a considerable range of toxic effect values both within and among invertebrate taxa. Crustaceans appear to be most susceptible, with 3-day LC_{50} values of 0.024 mg/L for *Daphnia pulex* and 0.019 to 0.022 mg/L for *Gammarus pseudolimnaeus*. Mollusks are less susceptible, with 4-day LC_{50}s ranging from 0.037 to 2 mg/L depending on the species tested. Four-day LC_{50}s for oligochaetes, rotifers, and chironomid larvae range from 0.1 to 1.7 mg/L (Mance, 1990).

Copper toxicity to aquatic biota is primarily related to the dissolved cupric ion [Cu(II)]. The toxicity of copper in its complexed or adsorbed form is less than that of the free ionic form. In aquatic invertebrates it causes gill damage at high concentrations, and in fishes it interferes with osmoregulation. The data presented in Eisler (1998) show that aquatic plants are generally less sensitive to copper than are benthic invertebrates.

2.1.4 Lead

Because of the strong absorption of lead to organic matter, the bioavailability of lead is commonly limited. Organic compounds of lead are more bioavailable than inorganic lead. Lead can bioaccumulate in plants and animals. The primary route of lead exposure to plants is through root uptake, though translocation to shoots is limited (Wallace et al., 1977). Biomagnification of lead has not been reported, because lead concentrations tend to decrease markedly with increasing trophic level in both detritus-based and grazing aquatic food chains (Wong et al., 1978, as cited in Eisler, 1988).

Lead can adversely affect invertebrates and fish. Lead can also adversely affect amphibians, including loss of sodium and developmental problems (Horne and Dunson, 1995). Fish exposed to high levels of lead exhibit a wide range of effects including muscular and neurological degeneration and destruction, growth inhibition, mortality, reproductive problems, and paralysis (Eisler, 1988; USEPA, 1976). Lead adversely affects invertebrate reproduction.

Lead poisoning in birds is particularly well documented, but most lead poisoning in wild birds results from ingestion of lead pellets. In contrast, lead poisoning of birds, such as raptors, from biologically incorporated lead is considered unlikely. Toxic effects include mortality, reduced growth and reproduction, alterations of blood chemistry, lesions, and behavioral changes.

A study on the toxicological effects of lead ingestion in birds found that an oral dose of 3 mg/kg/day[1] caused a reduction in muscle condition and altered feeding activity of starlings (Osborne et al., 1983). The same dose caused clinical symptoms of lead poisoning in red-tailed hawks (Reiser and Temple, 1981). This dose was considered a LOAEL. A NOAEL was estimated by multiplying the LOAEL by an uncertainty factor of 0.1.

A 7-month study on the toxicological effects of lead ingestion in American kestrels found that an oral dose of 3.85 mg/kg/day did not cause any adverse reproductive effects (summarized in Sample et al., 1996); this dose was considered a chronic NOAEL. A chronic LOAEL of 38.5 mg/kg/day was estimated by multiplying the chronic NOAEL by an uncertainty factor of 10. A 12-week study with Japanese quail found that oral exposures to lead acetate in the diet did not have any adverse reproductive effects at doses of 1.13 mg/kg/day (chronic NOAEL), although adverse effects were observed at a dose of 11.3 mg/kg/day (chronic LOAEL; Sample et al., 1996).

2.1.5 Mercury

A variety of adverse biological effects have been attributed to mercury. Mercury is a known teratogen, mutagen, and carcinogen. Mercury has been documented as adversely affecting reproduction, growth and development, behavior, blood and serum chemistry, motor coordination, vision, hearing, histology, and metabolism at relatively low concentrations in birds and mammals. Early developmental stages of organisms are the most sensitive to mercury poisoning. The form of mercury most readily assimilated by biota is methylmercury. After it is incorporated in tissues, methylmercury is very slow to depurate (Eisler, 1987).

A 1-year study conducted on Japanese quail indicated that an oral dose of 0.9 mg/kg/day (as mercuric chloride) caused reduced fertility and egg hatchability (summarized in Sample et al., 1996). This dose was considered a chronic LOAEL. No adverse reproductive effects were observed at a dose of 0.45 mg/kg/day. This dose was considered a chronic NOAEL.

A study conducted on juvenile starlings indicated that a dose of 0.12 mg/kg/day caused kidney lesions (Nicholson and Osborn, 1984). This dose was considered a LOAEL. A NOAEL of 0.01 mg/kg/day was estimated by multiplying the LOAEL by an uncertainty factor of 0.1.

2.1.6 Silver

Silver can be toxic to aquatic organisms. Elevated concentrations can cause growth reduction in juvenile mussels (Calabrese et al., 1984) and adverse effects on reproduction in gastropods (Nelson et al., 1983).

Currently, there are no established sediment quality guidelines (SQGs) for silver in freshwater sediments except for the upper effects threshold (UET) of 4.5 mg/kg that is based on the results of *Hyalella azteca* bioassays (Buchman, 1999). The screening value used in the SERA of 1.0 mg/kg is based on an Effects Range-Low (ER-L) value from Long et al. (1995), which is a conservative value based on results from marine sediments.

[1] Units of mg/kg/day are referenced to kg of body weight (i.e., mg contaminant per kg bodyweight per day)

Silver can exist as silver nitrate, chloride, sulfide, or oxide, but primarily exists in the sulfide form (ATSDR, 1990). Subsequently, transport in the environment depends on the particular compound form. Silver adheres strongly to clay particles found in suspended particulates and sediments. In aquatic environments, the most commonly occurring forms of silver are silver (I) (soluble form), bicarbonate and sulfate salts, or complexes with particulates (ATSDR, 1990). Silver is toxic to microbial communities and inhibits bacterial enzymes; therefore, biotransformation is not expected to be significant (ATSDR, 1990). Silver can bioconcentrate in aquatic biota and bioaccumulate in plants and animals, but is not expected to biomagnify, and food chain transfer is not expected to be significant (Luoma and Jenne, 1977).

2.1.7 Zinc

In the environment, the most common form of zinc is in the +2 oxidation state. Zinc is highly reactive in sediment and can be adsorbed to clay minerals or metallic oxides (Sachdev et al., 1992). The active zinc species in the adsorbed state is the singly charged zinc hydroxide species [i.e., Zn(OH)+] (Sanders and El Kherbawy, 1987). This metal forms stable complexes with organic substances such as humic and fulvic acids. Metallic zinc is insoluble, but the solubilities of zinc compounds range from insoluble (oxides, carbonates, phosphates, and silicates) to extremely soluble (sulphates and chlorides) (Environment Canada, 1996).

Plant species have different tolerance levels to available zinc. Grasses can tolerate high levels of available zinc, while vegetables are sensitive (Vitosh et al., 1994). Zinc is a micronutrient for plants and is required to sustain regulation of growth, chlorophyll synthesis, carbohydrate formation, and regulate enzymatic reactions and hormonal functions. At higher concentrations, however, zinc can produce toxic effects in exposed organisms. Low levels of zinc (e.g., 3.3 mg/kg) have been shown to decrease the annual ring growth of trees (Hagemeyer et al., 1993). Relatively low concentrations (e.g., 25 and 50 mg/kg) of zinc in soil have also been linked to decreasing seed yields (Sheppard et al., 1993; Aery and Sakar, 1991). The most common effects of zinc toxicity to plants are inhibition of root elongation and reduced growth.

Studies using a variety of benthic macroinvertebrate species have been used to document the effects of zinc exposure in the aquatic environment. Two water flea species were exposed to zinc for 2 days and have shown somewhat varying sensitivities. The 2-day LC_{50} values for *Ceriodaphnia dubia* and *Daphnia magna* were 0.13 (Belanger and Cheery, 1990) and 1.59 mg/L (Kazlauskiene et al., 1994), respectively. Further studies with amphipod (*Hyalella azteca*) resulted in a 10-day LC_{50} value of 0.073 mg/L (Phipps et al., 1995).

In a 3-day study where common toad (*Bufo arenarum*) tadpoles were exposed to a range of zinc levels (i.e., 4-32 mg/L), 65 percent mortality resulted at the 32 mg/L exposure level (Herkovits and Perez-Coll, 1991). Twenty-four hours of exposure to 39 mg/L zinc resulted in 100 percent mortality for Western toad (*Bufo boreas*) larvae, while all larvae still metamorphosed following exposure to 0.1 mg/L over the same time period (Porter and Hakanson, 1976). Exposure to 15 mg/L of $ZnSO_4$ yielded no toxicity for African clawed frog (*Xenopus laevis*) tadpoles (Woodall et al., 1988), while exposure to 20 mg/L resulted in 4–15 percent mortality.

For fish, slight differences have been shown for bluegill (*Lepomis macrochirus*), pumpkinseed (*Lepomis gibosus*), and fathead minnow (*Pimephales promelas*). Following 4 days of exposure to zinc, the LC_{50} values for *L. gibbosus*, *L. macrochirus,* and *P. promelas* were 20.1 (Rehwoldt et al., 1972), 12.9 (ANS, 1960), and 0.238 mg/L (Norberg and Mount, 1985), respectively.

Chronic exposure to zinc can result in softening of bone, anemia, enteropathy, and kidney damage. The toxicological effects of zinc ingestion to birds and mammals have been documented in various studies. In a study conducted on white leghorn hens, a dose of 130.9 mg/kg/day caused decreased rates of egg hatchability (summarized in Sample et al., 1996). This dose was considered to be a chronic LOAEL for avian species. No adverse effects were noted at a dose of 14.5 mg/kg/day. This dose was considered to be a chronic NOAEL.

A study conducted on rats indicated that a dose of 160 mg/kg/day of zinc (as zinc oxide) caused no effects during gestation (summarized in Sample et al., 1996). This dose was considered a NOAEL for mammals. However, a dose of 320 mg/kg/day caused reduced fetal growth rates and increased rates of fetal resorption. This zinc dose was considered to be a chronic LOAEL.

2.2 Conceptual Site Model

The conceptual site model (CSM) describes the habitat features of the site, the potential transport and exposure routes for the COPCs, and ecological receptors associated with the site (Figure 2-1). The CSM has been revised to reflect the results of the SERA and the decision to address the upland soil and swale sediments through a removal action. The refined CSM serves as the basis for selecting assessment and measurement endpoints and was used as the basis for developing the sampling and analysis plan (BERA work plan) to evaluate those endpoints.

2.2.1 Transport and Exposure Pathways

The primary source of chemicals in soil, sediment, and surface water at Site 28 is believed to be areas where wastes and materials were stored or burned in the past, or where contaminated soil, sediment, or groundwater have been transported and have accumulated. As described above, a soil removal action is planned to remove the primary source of contamination from the site. Although dissolved COPCs in the groundwater represent an ongoing source for COPC migration to Mattawoman Creek, after the source (contaminated soil and swale sediment) is removed, the concentrations of COPCs dissolved in the groundwater should decrease over time.

Ecological receptors include benthic invertebrates, aquatic plants, water column invertebrates, amphibians, reptiles, and fish in Mattawoman Creek. Receptors may be exposed to chemicals via direct contact with sediments and/or surface water, root uptake, ingestion of sediment and/or surface water, and/or trophic transfer through the food web.

The data gathered to date suggest that some contaminant transport has occurred through soil erosion and surface runoff along the swales and into Mattawoman Creek adjacent to the site, as identified by the elevated concentrations of metals in the creek sediments along the immediate shoreline. Much of the soil at Site 28 is void of vegetation, particularly near the location of the former zinc recovery furnace. As a result, considerable erosion has occurred,

resulting in the transport of soil and related COPCs into Mattawoman Creek. The extent of contaminant migration appears to be limited, however, because the furthest downstream sample along the Mattawoman Creek shoreline contained concentrations of COPCs below risk screening levels.

Additional evidence of possible contaminant migration is the concentrations of metals measured in surface water from the onsite swales. The presence of metals in the surface water likely results from surface runoff from the site and suspension of particulates to which these metals are sorbed. In addition, groundwater is likely discharging to the lower portions of the swales near Mattawoman Creek because a low-permeability clay lens at the base of the slope at Site 28 prevents downward movement of the groundwater. Dissolved metals are present in groundwater at the site, which is likely discharging to the surface water in the swales and ultimately into Mattawoman Creek. Metals in the groundwater must first pass through sediments in the swales or in Mattawoman Creek at the base of the slope prior to entering the water column. In coarse-grained sediments with little organic matter, the dissolved metals in groundwater will pass directly to the water column. In fine-grained or organically rich sediments, a portion of the groundwater-borne metals may adsorb to sediment particles.

The primary process by which COPCs migrate from sediments into the water column are through desorption from sediment particles and resuspension through physical disturbance of the sediments, such as from boat props or high flow during storm events. COPCs that are dissolved in groundwater and adsorb onto sediment particles as groundwater discharges up through the sediments may desorb from the sediments over time and may represent a steady source of COPC input to the water column.

Once in Mattawoman Creek, the primary migration pathway for COPCs that are discharged from groundwater would be diffusion through the water column and bioaccumulation in the food web. Dissolved COPCs in the groundwater that are discharged to Mattawoman Creek will be diluted by the larger volume of receiving water in the creek. Diffusion is further increased by the flow of water in the creek moving the diluted COPCs out of the discharge zone. However, the potential for adverse effects exists for organisms in close proximity to the discharge point for long periods of time.

2.2.2 Assessment Endpoints

The assessment endpoints for the BERA are as follows:

Survival and growth of the benthic invertebrate community. Healthy, viable benthic invertebrate communities are necessary for a well-developed and balanced aquatic ecosystem. Benthic invertebrates influence nutrient cycling and availability and sediment condition. By serving as prey species for many upper-trophic predators, they are critical to the sustenance of the communities of upper-trophic-level species. This assessment endpoint is considered to also be protective of the aquatic plant community because benthic invertebrates are generally more sensitive to the COPCs at this site than are aquatic plants.

Survival and growth of finfish. Finfish are susceptible to direct chemical exposure from site sediment and surface water, and through food chain transfer of bioaccumulative chemicals. Finfish provide an important link between lower and upper-trophic levels of the aquatic

food web. This assessment endpoint and the three below are used as surrogates for amphibians and reptiles, because risks to these receptors are not evaluated directly.

Survival, growth, and reproduction of aquatic omnivorous birds. These receptors are mid-level consumers and are thus susceptible to bioaccumulative chemicals, especially those that have the potential to biomagnify through aquatic foodchains. The mallard (*Anas platyrhnchos*) was chosen to represent this assessment endpoint. Mallards utilize shallow wetland habitats, preferring freshwater to saltwater or brackish water bodies. Their diet consists mainly of aquatic plants, but aquatic insects, mollusks (mostly snails and small bivalves), and crustaceans are also important dietary components. Through foraging, mallards may ingest sediment.

In the spring, mallards shift from a largely herbivorous diet to a diet containing a high proportion of invertebrates to obtain protein for their prebasic molt and then for egg production. Laying females consume a higher proportion of animal foods on the breeding grounds (about 67 percent of the diet) than do male or non-laying females (about 40 percent of the diet). This dietary shift continues throughout the summer, as many females lay clutches to replace destroyed nests. Ducklings consume aquatic invertebrates almost exclusively, particularly during the period of rapid growth, and juveniles in late summer may still be consuming approximately 90 percent animal matter (Swanson and Duebbert, 1989; USEPA, 1993).

This assessment endpoint is also considered to be protective of aquatic insectivorous birds such as the tree swallow (*Tachycineta bicolor*). Tree swallows utilize open areas over water during most of the year and feed almost exclusively on emerging and flying insects.

Survival, growth, and reproduction of piscivorous birds. These receptors are top level consumers and are thus susceptible to bioaccumulative chemicals, especially those that have the potential to biomagnify through aquatic foodchains. The great blue heron (*Ardea herodias*) was chosen to represent this endpoint. Great blue heron usually nest in colonies near their foraging habitat. These birds prefer the shallow edges of freshwater and saltwater lakes, rivers, and wetlands, especially those areas that support their major food source of small fish and amphibians.

Survival, growth, and reproduction of piscivorous mammals. These receptors are top level predators and are susceptible to exposure to bioaccumulative chemicals, especially those that have the potential to biomagnify through aquatic foodchains. The mink (*Mustela vison*) was chosen to represent this assessment endpoint. Mink live in both freshwater and saltwater aquatic and wetland habitats and prefer irregular shorelines. Mink are opportunistic and feed nocturnally on whatever prey are available, including small mammals, aquatic plants and invertebrates, fish, and amphibians.

2.2.3 Risk Hypotheses

Risk hypotheses in this assessment are posed as questions about how assessment endpoints could be affected. Risk hypotheses clarify and articulate relationships that are possible through consideration of available data, information from the scientific literature, and the best professional judgment of risk assessors. The risk hypotheses associated with the assessment endpoints are:

1. Are the concentrations of arsenic, cadmium, copper, lead, or zinc in sediment at Site 28 impairing the survival or growth of benthic invertebrates in shoreline sediments to the extent that the prey base to support finfish has been adversely affected?
2. Are lead, mercury, or zinc bioaccumulating in the food web and impairing the survival, growth, or reproduction of finfish or upper-trophic-level receptors?
3. Is the silver in the sediments of Mattawoman Creek along the opposite shore impairing the survival or growth of benthic invertebrates to the extent that the prey base to support finfish has been adversely affected?

2.2.4 Measurement Endpoints

Measurement endpoints are measures of biological effects (e.g., laboratory toxicity test results) that are related to each respective assessment endpoint (USEPA, 1997). Table 2-1 shows the measurement endpoints associated with each assessment endpoint for the sediment at Site 28:

TABLE 2-1
Measurement Endpoints at Site 28
Site 28 BERA Report
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Assessment Endpoints	Measurement Endpoints
Evaluate the survival and growth of the benthic invertebrate community and its ability to function as a prey base for finfish.	Results of 28-day sediment toxicity tests (survival and growth) with the amphipod *Hyalella azteca*, using site, reference, and control sediment to evaluate the status of the benthic invertebrate community as a prey base for finfish. Comparison of the abundance of benthic invertebrates in site sediment with abundance of benthic invertebrates in reference sediment.
Evaluate the potential for adverse changes in the survival, growth, and reproduction of finfish and piscivorous wildlife that utilize the site.	Comparison of estimated exposure doses to toxicity reference values using site-specific bioaccumulation data obtained from COPC concentrations in fish tissue from the site to a reference hazard quotient (HQ) of 1.0. Comparison of COPC concentrations in fish tissue from the site with tissue residue effects values from the literature and with background fish tissue concentrations collected from an upstream reference site.
Evaluate the potential for adverse changes in the survival, growth, and reproduction of omnivorous birds that utilize the site.	Comparison of estimated exposure doses to toxicity reference values using the site-specific bioaccumulation data obtained from COPC concentrations in benthic invertebrate tissue (from 28-day bioaccumulation bioassays with *Lumbriculus variegatus*) to a reference HQ of 1.0. Mallard exposure assessment will be based on 67% animal diet during nesting period for females.

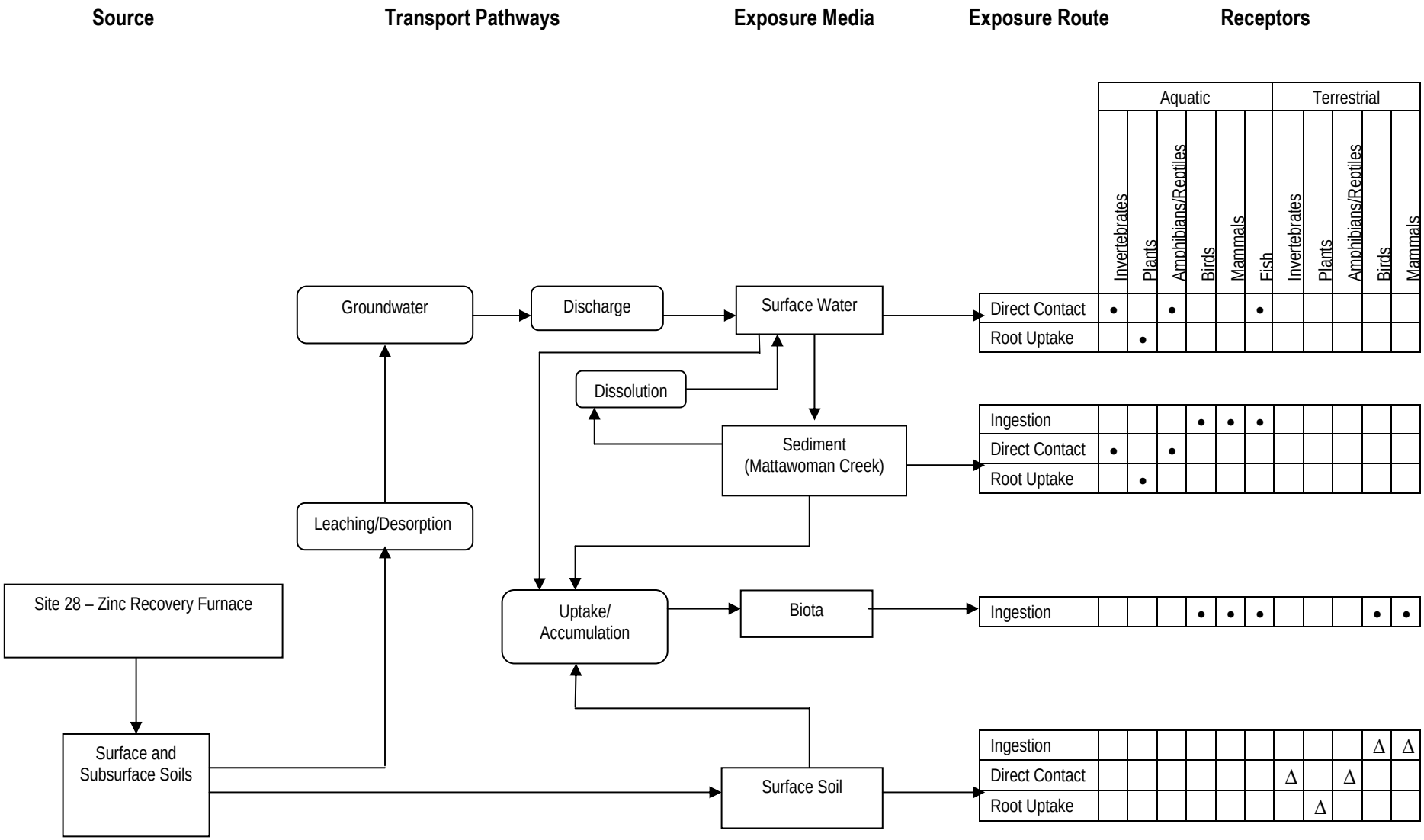

Figure 2-1
Conceptual Site Model
Site 28 BERA Report
NSF-IH, Indian Head, Maryland

Notes:

- • Evaluated in BERA

Δ Soil removal will remove exposure pathway

(Removal will also remove exposure pathway for receptors exposed to swale sediments)

SECTION 3

Investigation Activities

Investigation activities for the BERA were conducted at Site 28 in October 2005 in accordance with the BERA work plan. The sampling strategy was designed to assist further characterization of risk at specific areas identified as driving average contaminant concentrations above screening values. The following sections discuss sampling procedures and laboratory analyses for the various media. Data are presented in Appendices A through D.

3.1 Benthic Invertebrate Community

To assess potential risk to the benthic invertebrate community, sediments samples were collected for chemical analysis, bulk sediment toxicity testing, and benthic community abundance and structure evaluation.

Five sediment samples were collected from locations IS28SD01, IS28SD02, IS28SD03, IS28SD11, and IS28SD13 (Figure 3-1) and two reference samples from locations BGDSD05 and BGDSD06 in Mattawoman Creek (Figure 3-2) from October 25 through October 28, 2005. Sample locations were identified using a global positioning system (GPS). The BERA work plan outlines the rationale for the selection of the sample locations. As depicted on Figure 3-1, the sampled locations do not coincide with the previously sampled locations proposed in the BERA work plan. Slight changes were made in the field to ensure adequate sample collection for the toxicity testing, particularly at location IS28SD03 where the substrate was primarily sand and gravel.

The reference locations BGDSD05 and BGDSD06 are approximately ½ mile upstream of Site 28, in the upgradient Area 6 sampled in the Mattawoman Creek Study (TetraTech NUS, 2002). Care was taken to ensure that the reference sediment closely resembled the physical characteristics of the site sediment (i.e., similar grain size and amount of organic material). The samples collected from locations BGDSD05 and BGDSD06 are referred to as Reference 1 and Reference 2, respectively. The physical characteristics of Reference 1 matched those of the sediment samples (IS28SD11 and IS28SD13) collected along the vegetated bar across the channel from Site 28. The physical characteristics of Reference 2 matched those of the sediment samples (IS28SD01, IS28SD02, and IS28SD03) collected along the shoreline of Site 28.

3.1.1 Sediment Chemistry

All seven sediment grab samples (five site and two reference) were collected from a depth of approximately 0 to 6 inches below the sediment/water interface using an Eckman dredge. The samples were analyzed for target analyte list (TAL) metals, total organic carbon (TOC), pH, sulfide, and grain size (by sieve analysis). To evaluate direct toxicity to benthic invertebrates, laboratory toxicity tests were conducted on split samples from the sediment sampling locations. At each location, sufficient sample volume to conduct the tests was

collected and homogenized, and the pH and oxidation-reduction potential were measured before filling bottles for chemical and toxicological analyses.

The raw sediment chemistry data are provided in Appendix A, and the grain size data are provided in Appendix B. Associations between biological and chemical data were evaluated by examining the relationship between chemical concentrations and biological endpoints (i.e., sediment toxicity and benthic community abundance).

3.1.2 Bulk Sediment Toxicity

Bulk sediment toxicity tests were conducted on the five site and two reference sediment samples using the amphipod *Hyalella azteca* (amphipod). The toxicity tests were conducted for 28 days, with survival and growth as test endpoints. Toxicity testing methods and results are provided in Appendix C. The growth and survival of test organisms in site sediment were statistically compared with the results of these parameters from reference and control sediment. An alpha level of 0.05 was used in the statistical comparisons, which corresponds to a 5 percent chance of incorrectly concluding that the response of the site samples is statistically equivalent to the reference or control samples, when in fact they are statistically different. The results of the site samples were statistically compared with the results of the reference site sample to determine risk relative to reference conditions in Mattawoman Creek. The results of the reference sample were statistically compared with the results of the laboratory control sample to determine background levels of risk from Mattawoman Creek sediment.

3.1.3 Benthic Community Abundance and Structure

Three replicate benthic grab samples were collected adjacent to each of the five site and two reference sediment sample locations for macroinvertebrate community evaluation. The grab samples were collected using an Eckman dredge and sieved with a 500-micrometer (µm) mesh in the field. Each grab sample was preserved in the field using a 5 percent formalin solution and shipped to the laboratory for identification and enumeration.

The results are presented in Appendix D. In evaluating the benthic invertebrate community, emphasis was placed on invertebrate abundance as the measurement endpoint because abundance is more relevant than other measures of community structure when evaluating the ability of the benthic invertebrate community to function as a prey base for finfish and other wildlife.

The following benthic community parameters were calculated for each sample: total abundance, taxa richness (i.e., number of species), and the Benthic Index of Biotic Integrity (B-IBI). The B-IBI is a multiple metric index developed to identify the degree to which the benthic community meets the Chesapeake Bay Program's Benthic Community Restoration Goals (Weisberg et al., 1997). The B-IBI scores range from 1 to 5 under this methodology. Sites with scores greater than or equal to 3 are considered to meet restoration goals, scores from 2.7 to 2.9 are considered marginally degraded, scores from 2.1 to 2.6 are degraded, and scores of 2 or less are severely degraded. This approach has been applied to tidal freshwater systems by including total abundance, percent abundance of pollution-indicative taxa, percent abundance of deposit feeders, and incorporating a tolerance score based on tolerance values assigned in Lenat (1993). The B-IBI score was used as supplemental

information to assess health of the benthic community at each location. However, it should be noted that the benthic samples were collected out of the timeframe specified by this protocol, which is July 15 to September 30. Therefore, the use of the B-IBI to evaluate these data, which were collected in October, may not be entirely representative.

3.2 Upper Trophic Level Receptors and Finfish

A total of three composite fish samples were collected to quantify risks to several receptors. These composite samples include two samples (forage-size epibenthic fishes and larger fishes) from the site and one sample (forage-size epibenthic fishes) from the reference location. All samples were analyzed for TAL metals and percent moisture.

To more accurately quantify the risk to piscivorous birds, forage-size (<6 inch) epibenthic fishes were collected from the littoral zone adjacent to Site 28 using minnow traps placed along the shoreline. *Fundulus spp*. were collected preferentially because these fish have relatively small home ranges and feed on a variety of benthic invertebrates. A composite sample (IS28FSH01) (19 fish) made up of forage-size fish from each minnow trap consisted of *Fundulus spp*. (banded killifish and mummichog). The sample was submitted for whole-body analysis.

To more accurately quantify the risk to piscivorous mammals, larger fish were collected from the littoral zone along the shoreline of the site and combined into a composite sample (IS28FSH03). The fish collected were two largemouth bass, 8 and 11 inches in length. The fishes were de-boned because mink (the surrogate piscivorous mammal used in this assessment) generally do not consume fish whole. The muscle tissue, internal organs, and skin of the fish were combined and submitted for chemical analysis.

One composite sample (IS28FSH02) consisting of 20 forage-size (<6 inch) epibenthic fishes (*Fundulus spp*.) was collected from the reference location.

In addition to collection and evaluation of fish tissue samples for bioaccumulation evaluation, sediment samples were collected from locations IS28SD01, IS28SD02, and IS28SD03 (along the shoreline) and the two reference locations BGDSD05 and BGDSD06 to assess bioaccumulation in aquatic invertebrates. A 28-day bioaccumulation bioassay was conducted to assess potential risks to aquatic omnivorous birds. *Lumbriculus variegatus* (oligochaete) was the test organism used for the bioassay. *L. variegates* is found throughout North America mostly in shallow habitats at the edges of ponds, lakes, or marshes where it feeds on decaying vegetation and microorganisms, thus making it a representative benthic invertebrate component of the mallard diet.

The invertebrate tissue samples were analyzed for TAL metals and percent moisture. The tissue residue data were used to model exposure to upper-trophic-level receptors using the food chain model described in Appendix E. To assess risk to the fish community, fish COPC concentrations were also compared with tissue residue data from fish collected at the reference site (forage-size fish), with fish tissue residue data from the Mattawoman Creek Study (TetraTech NUS, 2002), and with tissue residue data from the literature associated with adverse effects.

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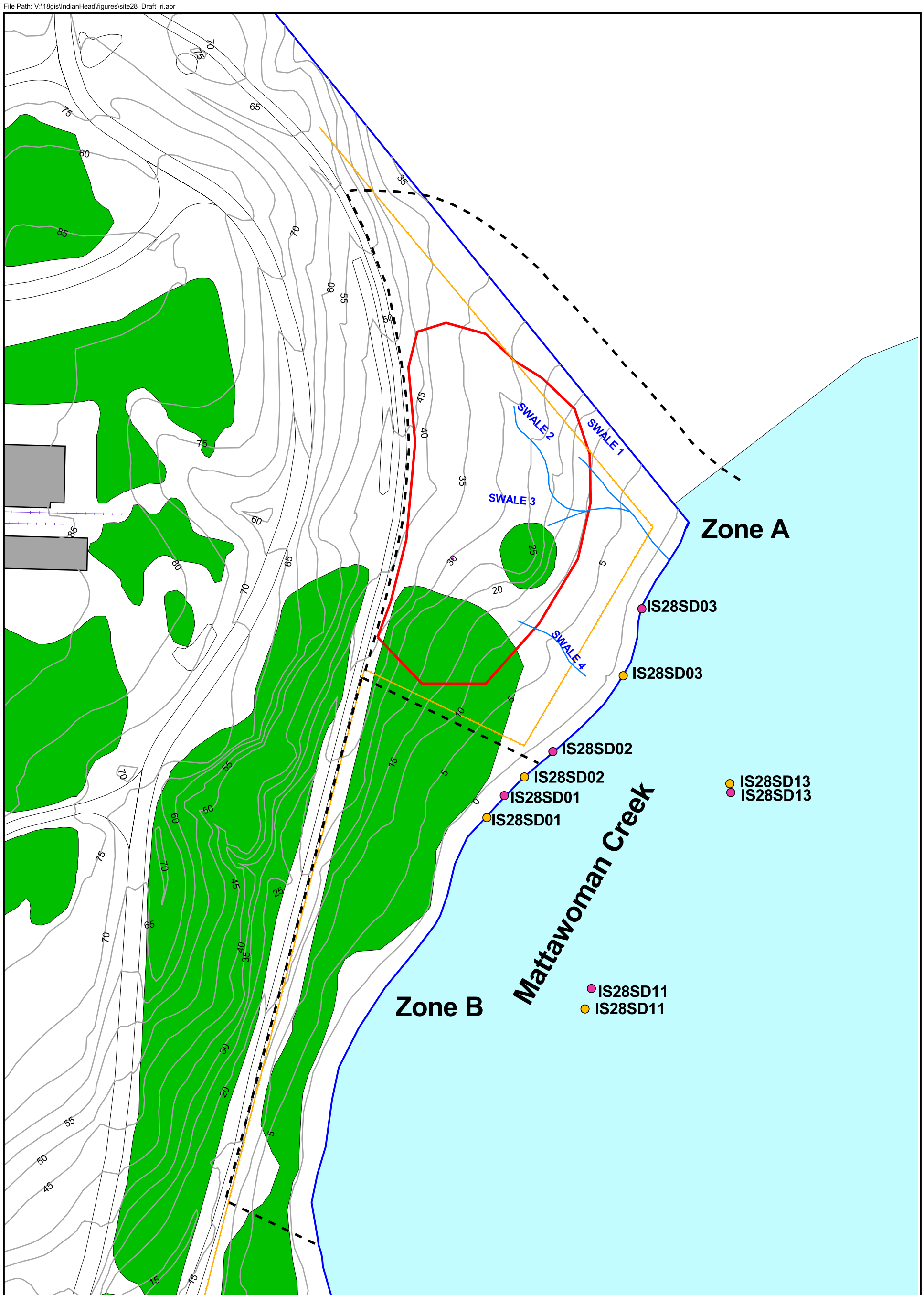

LEGEND

- BERA Sample Location
- RI Sample Location (CH2M Hill, 2005)
- Zone Boundary
- Fence Line
- Approximate Site Boundaries
- Five foot Contours
- Buildings
- Railroads
- Roads

N

50 0 50 100 150 Feet

Figure 3-1
Sediment Sampling Locations
Site 28 BERA Report
NSF-IH, Indian Head, Maryland

CH2MHILL

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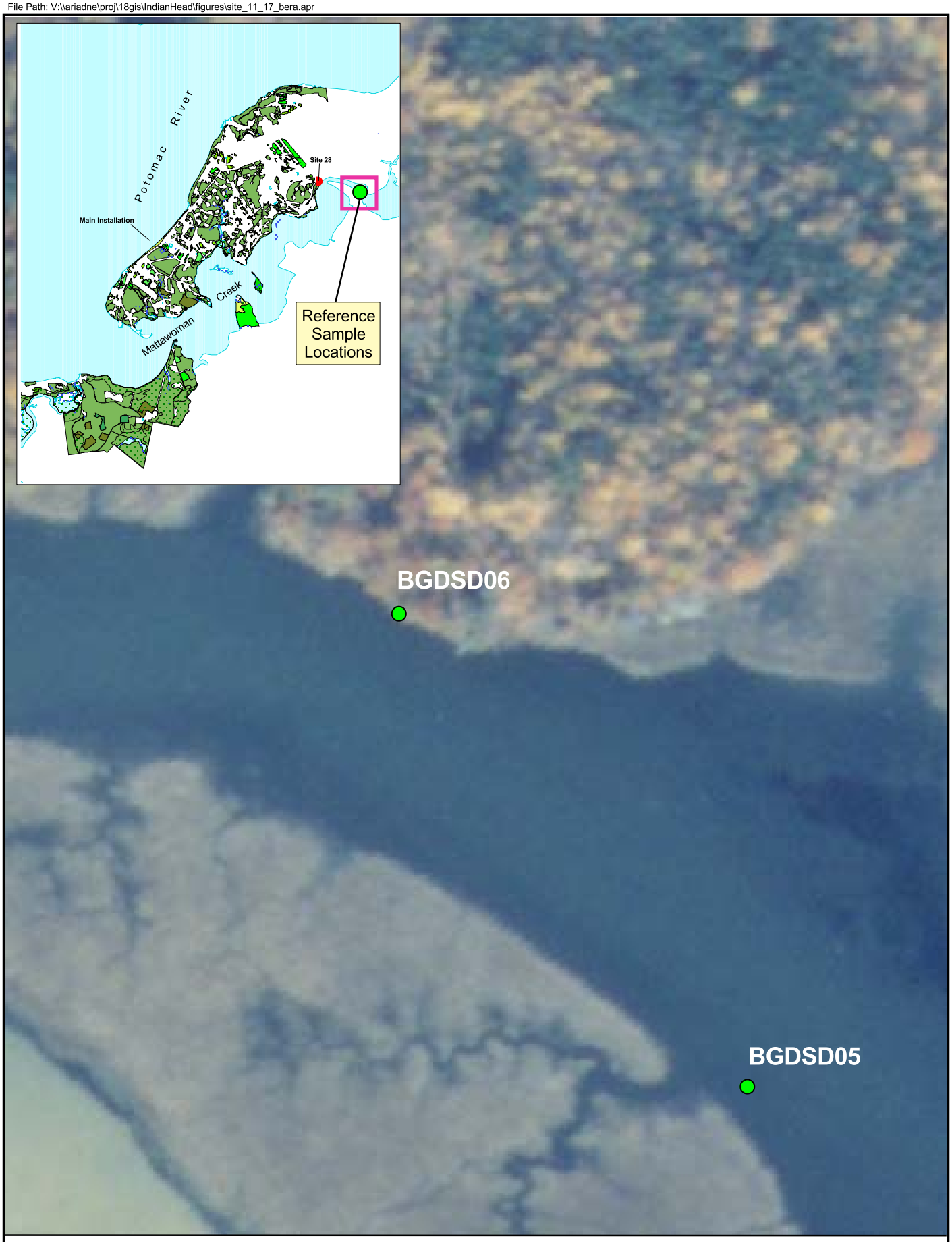

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0 100 200 Feet

Figure 3-2
Reference Sediment Sample Locations
Site 28 BERA Report
NSF-IH, Indian Head, Maryland

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SECTION 4

Results

This section summarizes the various data collected during the BERA investigation activities and presents the evaluation of the chemical, toxicological, and biological data at Site 28. Potential risk to the benthic invertebrate community was evaluated using the sediment quality triad approach. Potential risk to fishes was evaluated by comparing COPC concentrations in fish tissue to reference fish tissue concentrations from the Mattawoman Creek Study (TetraTech NUS, 2002) and critical residue values from the literature. Potential risk to piscivorous wildlife was evaluated by modeling exposure using the concentrations of COPCs in fish tissue samples. Potential risk to omnivorous birds was evaluated by modeling exposure using the concentrations of COPCs in invertebrate tissue samples from the bioaccumulation assays.

4.1 Sediment Chemistry and Physical Characteristics

Analytical results of the five sediment samples and two reference samples are presented in Table A-1 in Appendix A. The concentrations of COPCs in the sediment samples are summarized in Table 4-1.

TABLE 4-1
Summary of Sediment COPC Analytical Results
Site 28 BERA Report
NSF-IH, Indian Head, Maryland

Sample ID Location	PEC[1]	BGDSD05 Ref 1		BGDSD06 Ref 2		IS28SD16 IS28SD01		IS28SD17 IS28SD02		IS28SD18 IS28SD03		IS28SD19 IS28SD11		IS28SD20 IS28SD13	
Metals (mg/kg)															
Arsenic	33.0	**9.3**		**4**	**J**	**2.2**	**J**	**7.7**		**24.8**		**6.6**		**5.6**	**J**
Cadmium	4.98	**0.71**	**J**	**0.55**	**J**	**0.21**	**J**	**0.61**	**J**	**5.3**		**0.81**	**J**	**0.94**	**J**
Copper	149	**25.9**		**13.1**		**5**	**J**	**13.3**		**30.1**		**20.4**		**21.2**	
Lead	128	**60**	**K**	**20.2**	**K**	**12**	**K**	**23.1**	**K**	**265**	**K**	**27.9**	**K**	**27.8**	**K**
Mercury	1.06	**0.62**		0.13	U	0.062	U	**0.12**	**J**	0.067	U	**0.23**	**J**	**0.21**	**J**
Silver	1.0[2]	**0.3**	**J**	0.1	U	0.058	U	0.088	U	0.052	U	**0.38**	**J**	**0.42**	**J**
Zinc	459	**119**	**K**	**89.7**	**K**	**49.5**	**K**	**176**	**K**	**5,280**	**K**	**126**	**K**	**126**	**K**

[1] Probable Effect Concentration (MacDonald et al., 2000).
[2] USEPA Region III screening value (March 2005); PEC not available.
U - Analyte not detected above value indicated.
B - Analyte detected in associated blank.
J - Reported value is estimated.
K - Reported value may be biased high.
L - Reported value may be biased low.
Boldface indicates that the COPC is detected.
Shaded values exceed PEC.

As shown in Table 4-1, several COPC metals were detected in all samples. However, only one sample, IS28SD03, had cadmium, lead, and zinc concentrations that exceed their respective consensus-based probable effect concentrations (PEC) for freshwater sediments, as presented in MacDonald et al. (2000). The consensus-based PECs represent concentrations above which adverse affects are most likely expected to occur. This sample was collected from location IS28SD03 (Figure 3-1). None of the other samples contained COPC concentrations above their respective PECs.

A PEC value was not available for silver, so the recently updated USEPA Region III screening value for silver is presented in Table 4-1 instead. The samples located along the vegetated bar across the channel from Site 28 (IS28SD11 and IS28SD13) did not exceed the silver screening value. Silver was the only COPC identified for these two locations in the SERA. Although the silver concentrations at IS28SD11 and IS28SD13 previously exceeded the screening value, the concentrations measured in this sampling effort do not exceed the screening value.

Grain size distribution curves for the sediment samples are included in Appendix B. Table 4-2 provides a summary of the grain size distribution for all samples. The distribution curve for reference sample BGDSD06 (Reference 2) reflects mostly fine-grained sand (61.7 percent) with some fines (silt and clay) (19 percent). The grain size distribution curves reflect variability between this reference sample and site samples (IS28SD01, IS28SD02, and IS28SD03), and within the site samples. The site samples show the percent of fines to be less than 10 percent, whereas the reference sample has percent fines about 20 percent. With respect to the fractions coarser than the fines, the percentages vary as shown on Table 4-2. The grain size distribution varies among the site samples with ranges for each size fraction as follows: 5.0 to 9.5 percent silt and clay, 29.3 to 45.3 percent fine-grained sand, 13.2 to 30.9 percent medium-grained sand, 3.3 to 11.0 percent coarse-grained sand, 11.1 to 35.1 percent fine gravel, and 0 to 3.1 percent coarse gravel.

The distribution curve for reference sample BGDSD05 (Reference 1) consists mostly of fines (71.8 percent). The grain size distribution curves reflect comparability between this reference sample and site samples (IS28SD11 and IS28SD13) (Table 4-2). Both the reference and site samples show the percentage of fines ranges from 66.2 to 73.2 percent. With respect to the fractions coarser than the fines, the percentages indicate that the samples have some fine-grained sand with minor medium-grained sand and coarse-grained sand. Neither the sample collected along the vegetated bar nor the reference samples contained gravel.

TABLE 4-2
Summary of Grain Size Distribution for Sediment Samples
Site 28 BERA Report
NSF-IH, Indian Head, Maryland

	Distribution (Percent)					
Sample Location	**Silt and Clay**	**Fine Sand**	**Medium Sand**	**Coarse Sand**	**Fine Gravel**	**Coarse Gravel**
Reference 2 (BGDSD06)	19.5	61.7	16.6	2.3	0	0
IS28SD01	9.5	45.3	30.9	3.3	11.1	0
IS28SD02	8.2	29.3	13.2	11.0	35.1	3.1
IS28SD03	5.0	44.6	23.6	7.0	19.8	0
Reference 1 (BDGSD05)	71.8	13.3	12.0	2.9	0	0
IS28SD11	66.2	27.2	5.5	1.1	0	0
IS28SD13	73.2	20.7	5.1	1.0	0	0

4.2 Bulk Sediment Toxicity

Toxicity tests were conducted with the amphipod (*Hyalella azteca*), which were exposed to sediment collected from five locations at Site 28 and two reference locations. The toxicity tests were conducted for 28 days with growth and survival as test endpoints. The toxicity testing report, including raw data, summary tables, and statistical analyses, is provided in Appendix C. Summaries of amphipod survival and growth are presented in Tables 4-3 and 4-4, respectively.

The mean survival of amphipods in the laboratory control sample, Reference 1, and Reference 2 was 90 percent, 87.5 percent, and 90 percent, respectively. In general, the mean survival in the site samples ranged from 71.25 percent to 93.75 percent in all samples, except the sample from location IS28SD03, which was 0.00 percent.

A pilot metals sequestration demonstration project is currently being conducted for shoreline sediments in the area just upstream of sample location IS28SD03, where the sediments have been shown to be acutely toxic to benthic invertebrates (Neptune and Co., 2004). A bulk sediment sample was collected in the vicinity of the terminus of Swale 1 (Figure 3-1) as part of the Toxicity Identification Evaluation (TIE) Study (SAIC, 2001) in which 0 percent survival was observed in a 10-day *Hyalella azteca* test. Similarly, a sediment sample from the untreated plot area of the ongoing metals sequestration demonstration project showed 0 percent survival in a 28-day *H. azteca* test (an update on the demonstration project given at the February 2005 meeting of the IHIRT).

Statistical analysis of the site data (IS28SD01, IS28SD02, and IS28SD03) compared to Reference 2 and to the control showed that there was no statistically significant reduction in survival in the site sample from location IS28SD02 (Table 4-3). The results indicate that there is toxicity at location IS28SD03, where 100 percent mortality was observed in the sample. Though reduced survival was also observed in samples from locations IS28SD01 and

IS28SD02, the difference in response of test organisms was only significant in the IS28SD01 sample. The survival of test organisms in samples from locations IS28SD01 and IS28SD02 was only about 10 percent (IS28SD02) to 20 percent (IS28SD01) less than the survival in the control and reference samples.

Statistical analysis of the vegetated bar samples (IS28SD11 and IS28SD13) compared to Reference 1 and to the control showed that there was no statistically significant reduction in survival in the vegetated bar samples.

TABLE 4-3
Summary of Amphipod Survival
Site 28 BERA Report
NSF-IH, Indian Head, Maryland

		Lab Control		Reference 1 (BGDSD05)		Reference 2 (BGDSD06)	
Sample Location	Mean	p-value	Significant?[1]	p-value	Significant?[1]	p-value	Significant?[1]
Lab Control	90.00%	-	-	-	-	-	-
Reference 2 (BGDSD06)	90.00%	0.4796	No	-	-	-	-
IS28SD01	71.25%	0.0045	**Yes**	-	-	0.0045	**Yes**
IS28SD02	78.75%	0.0714	No	-	-	0.0728	No
IS28SD03	0.00%	0.0001	**Yes**	-	-	0.0001	**Yes**
Reference 1 (BGDSD05)	87.50%	0.3374	No	-	-	-	-
IS28SD11	91.25%	0.6166	No	0.7415	No	-	-
IS28SD13	93.75%	0.8123	No	0.8682	No	-	-

[1]Significant difference (alpha = 0.05)

- Not applicable based on differences in substrate characteristics

The mean growth was 0.414 mg (average weight per amphipod) in the laboratory control sample, 0.404 mg in Reference 1, and 0.522 mg in Reference 2, and ranged from 0.391 mg to 0.660 mg in all sites samples, except the sample from location IS28SD03, which had no surviving organisms. Statistical comparison of growth in site samples to growth in the control sample and of growth in the site samples to the reference samples indicated that there were no significant effects on growth of test organisms at any of the sample locations except for location IS28SD03, where no organisms survived (Table 4-4).

TABLE 4-4
Summary of Amphipod Growth
Site 28 BERA Report
NSF-IH, Indian Head, Maryland

Sample Location	Mean	Lab Control		Reference 1 (BGDSD05)		Reference 2 (BGDSD06)	
		p-value	Significant?[1]	p-value	Significant?[1]	p-value	Significant?[1]
Lab Control	0.414	-	-	-	-	-	-
Reference 2 (BGDSD06)	0.522	0.9849	No	-	-	-	-
IS28SD01	0.660	0.9986	No	-	-	0.9842	No
IS28SD02	0.475	0.8715	No	-	-	0.1193	No
IS28SD03	*	*	*	-	-	*	*
Reference 1 (BGDSD05)	0.402	0.3900	No	-	-	-	-
IS28SD11	0.391	0.3426	No	0.4005	No	-	-
IS28SD13	0.440	0.7022	No	0.8917	No	-	-

[1]Significant difference (alpha = 0.05)
* No surviving organisms
- Not applicable based on differences in substrate characteristics
Unit for mean growth is in milligrams (mg)

4.3 Benthic Community Abundance

The benthic macroinvertebrate data are provided in Appendix D, and the results are summarized in Table 4-5. Although the measurement endpoint in this investigation was abundance of invertebrates, the B-IBI score was also calculated to provide supplemental information. The B-IBI methodology specifies a specific timeframe for sample collection (July 15 to September 30). The samples for this investigation were collected in late October. Therefore, the B-IBI results may not be entirely accurate relative to the benthic community health rankings used with this methodology, but they provide another metric to compare site and reference results.

The B-IBI score for each sediment sample was calculated based on four metrics: total abundance (number of organisms per square meter), abundance of pollution-indicative taxa (percent), abundance of deep deposit-feeders (percent), and tolerance score. The benthic invertebrate community conditions were found to meet restoration goals (B-IBI greater than or equal to 3) at each sample location.

TABLE 4-5
Summary of Abundance and B-IBI Score for each Sample Location
Site 28 BERA Report
NSF-IH, Indian Head, Maryland

Sample Location	Abundance (no. / m^2)	Number of Taxa	B-IBI Score
Reference 2 (BGDSD06)	1,072	13	4.5
IS28SD01	2,681	16	5.0
IS28SD02	841	8	4.5
IS28SD03	2,565	10	4.5
Reference 1 (BGDSD05)	174	5	4.0
IS28SD11	232	7	4.0
IS28SD13	246	4	4.0

As noted in Section 4.1 above, the physical characteristics of Reference 1 (71.8 percent fines) are different from that of Reference 2 [mostly fine-grained sand (61.7 percent) with some fines (19 percent)]. The difference in substrate type in the reference samples and corresponding site samples could explain the differences in the number of taxa found in the sediment types. A sandy gravel type substrate provides more surface area and niche habitats for a variety of invertebrates to thrive in contrast to fine-grained homogeneous sediment that provides limited habitat variety.

Qualitative analysis of the benthic community data for the samples across from Site 28 (IS28SD11 and IS28SD13) showed that the abundance and number of taxa were very similar to those for Reference Site #1, and that the B-IBI score was the same for each location (4.0). Therefore, the benthic invertebrate community at locations IS28SD11 and IS28SD13 shows no obvious signs of degraded conditions relative to the reference site.

Qualitative analysis of the benthic invertebrate data for the shoreline samples at Site 28 (IS28SD01, IS28SD02, and IS28SD03) indicated that abundance values ranged from 841 to 2,681 organisms/m^2, which are comparable to or exceed the abundance of 1,072 organisms/m^2 at the reference site. The number of taxa for the shoreline samples ranged from 8 to 16, which was also comparable to the number of taxa of 13 in the reference sample. The benthic invertebrate community at sample location IS28SD02 had lower abundance and diversity than the reference sample or the other shoreline samples. However, the benthic invertebrate community at sample locations IS28SD01 and IS28SD03 displayed a greater abundance than the reference location, and the benthic invertebrate community conditions were found to meet restoration goals (B-IBI greater than or equal to 3) at each sample location.

4.4 Summary of Sediment Quality

A weight-of-evidence approach was used to characterize ecological risk to the benthic invertebrate community at Site 28. The weight of evidence was based on an analysis of exposures and effects. The line of evidence for exposure was the concentrations of COPCs in site sediments, and the lines of evidence for effects were laboratory toxicity test results and the health of the benthic invertebrate community relative to appropriate reference sites. The lines of evidence are summarized in Table 4-6.

TABLE 4-6
Summary of Lines of Evidence to Assess Sediment Quality
Site 28 BERA Report
NSF-IH, Indian Head, Maryland

Sample Location	Sediment Chemistry Results	Toxicity Test Results	Benthic Invertebrate Abundance / Richness	Summary of Risk to Benthic Community
IS28SD01	No COPCs > PECs	71% Survival (sign. < reference); no effects on growth	Greater than Reference	Low
IS28SD02	No COPCs > PECs	Reduced Survival and Growth, but not significant relative to reference	Less than Reference	Low
IS28SD03	3 COPCs > PECs	100% Mortality	Comparable to Reference	High
IS28SD11	No COPCs > PECs	No Effects on Growth or Survival	Comparable to Reference	Comparable to Reference Conditions
IS28SD13	No COPCs > PECs	No Effects on Growth or Survival	Comparable to Reference	Comparable to Reference Conditions

4.5 Invertebrate Tissue

To refine the risk estimate for omnivorous birds, 28-day bioaccumulation assays with the aquatic worm *Lumbriculus variegatus* were conducted with sediment from the shoreline of Site 28 (sample locations IS28SD01, IS28SD02, and IS28SD03). For comparison, the bioassay was also conducted with sediment from both reference locations. Analytical results of the invertebrate tissue data are presented in Table A-2 in Appendix A. A summary of the COPC analytical results is presented in Table 4-7.

TABLE 4-7
Summary of Invertebrate Tissue COPC Analytical Results
Site 28 BERA Report
NSF-IH, Indian Head, Maryland

COPC	IS28SD01	IS28SD02	IS28SD03	Reference 1	Reference 2
Lead	15.2	15.8	349.5	15.1	24.2
Mercury	ND (0.52)	ND (0.44)	ND (0.61)	ND (0.48)	ND (0.88)
Zinc	422	425	9,773	399	488

Concentrations are in mg/kg, dry weight.
ND—Not detected (detection limit shown)
The concentration shown for each sample is an average of four replicates (Table A-2)

The mallard (*Anas platyrhnchos*) was used as the surrogate species to assess risk to omnivorous birds. Mallards utilize shallow wetland habitats, preferring freshwater to saltwater or brackish water bodies. Their diet consists mainly of aquatic plants, but aquatic insects, mollusks (mostly snails and small bivalves), and crustaceans are also important dietary components. In the spring, mallards shift from a largely herbivorous diet to a diet containing a high proportion of invertebrates to obtain protein for their prebasic molt and then for egg production. Laying females consume a higher proportion of animal foods (about 67 percent of the diet) on the breeding grounds than do males or non-laying females. Therefore, mallard exposure was estimated based on a 67 percent animal diet to assess potential risk during the time of the year when they could be most highly exposed to chemicals in site sediment. The ingestion-based exposure model described in Appendix E was used to estimate mallard exposure, and the results were used to estimate potential risk to mallard. A summary of the calculated NOAEL- and LOAEL-based HQs are presented in Table 4-8.

TABLE 4-8
Calculated Hazard Quotients for Mallard
Site 28 BERA Report
NSF-IH, Indian Head, Maryland

COPC	Shoreline Average*		IS28SD01 and IS28SD02 Average		IS28SD03	
	NOAEL-HQ	LOAEL-HQ	NOAEL-HQ	LOAEL-HQ	NOAEL-HQ	LOAEL-HQ
Lead	4.35	0.43	0.54	0.05	11.96	1.20
Mercury	0.39	0.13	0.36	0.12	0.45	0.15
Zinc	9.96	1.10	1.14	0.13	27.62	3.06

Shaded cells indicate HQ > 1.
*Average of IS28SD01, IS28SD02, and IS28SD03

The results of the risk estimate shown on Table 4-8 for a mallard indicate that omnivorous birds that feed along the shoreline of Site 28 are at potential risk of adverse effects from lead and zinc in benthic organisms. The area of risk for omnivorous birds is limited to the shoreline area between the upstream site boundary and the gravel area between sample

locations IS28SD02 and IS28SD03. The risk estimates for the area where samples IS28SD01 and IS28SD02 were collected suggest that the COPCs are not bioaccumulating in benthic organism, to the extent to pose unacceptable risk to birds that forage there.

4.6 Fish Tissue

Three composite fish samples (IS28FSH01, IS28FSH02, and IS28FSH03) were collected to quantify risks to several receptors. Samples IS28FSH01 and IS28FSH03 were collected from the site, and sample IS28FSH02 was collected from a reference location. All samples were analyzed for TAL metals and percent moisture. Analytical results of the two site fish tissue samples (IS28FSH01 and IS28FSH03) and one reference fish tissue sample are presented in Table A-3 in Appendix A.

To assess risk to the fish community, fish COPC concentrations were compared with tissue residue data from the literature associated with adverse effects (Appendix E), with tissue residue data from fish collected at the reference site, and with fish tissue residue data from the Mattawoman Creek Study (TetraTech NUS, 2002). Fish tissue concentrations are presented in Table 4-9 along with critical tissue residue values for each COPC.

A comparison of fish tissue COPC concentrations with literature-based critical residue values suggests that the COPCs in the shoreline sediments at Site 28 are not bioaccumulating in finfish to the extent that poses an unacceptable risk to the fish community.

TABLE 4-9
Calculated Hazard Quotients for COPCs in Fish Tissue
Site 28 BERA Report
NSF-IH, Indian Head, Maryland

COPC	*Fundulus* Tissue Concentration	Bass Tissue Concentration	Critical Residue Value	*Fundulus* HQ	Bass HQ
Lead	1.0	0.99	20.4	0.01	0.05
Mercury	ND (0.19)	--	5.44	0.02	--
Mercury	--	0.25	21.6	--	0.01
Zinc	137	64.3	160	0.86	0.40

Concentrations are in mg/kg, dry weight.
ND—Not detected (detection limit shown)

Table 4-10 shows the concentrations of COPCs in the site forage fish, the reference area, and the reference area in the Mattawoman Creek Study (TetraTech NUS, 2002). Comparison of these data suggests that the concentrations of mercury and zinc in fish at Site 28 are similar to background levels. Though lead is detected in the site fish and not detected in the reference samples, it is, however, detected at a low concentration of 1 mg/kg.

TABLE 4-10
Comparison of COPC Concentrations in Forage Fish
Site 28 BERA Report
NSF-IH, Indian Head, Maryland

COPC	*Fundulus* Site	*Fundulus* Reference	Spottail Shiner Mattawoman Creek Study	Fundulus Nanjemoy Creek (Mattawoman Creek Study)
Lead	1.0	ND (0.91)	ND (0.96)	ND (0.92)
Mercury	ND (0.19)	ND (0.21)	ND (0.20)	ND (0.20)
Zinc	137	120	140	91

Concentrations are in mg/kg, dry weight.
ND—Not detected (detection limit shown)

One largemouth bass (14.8 inches in length) was caught in the reference area for the Mattawoman Creek Study. Chemical analysis was performed on the bass fillet in support of a human health risk assessment for the creek study. Although the data are not entirely comparable because the BERA bass sample included the skin and internal organs in the sample analyzed, and the fish were smaller in size than the one from the Mattawoman Creek Study, the data are presented in Table 4-11 for comparison.

TABLE 4-11
Comparison of COPC Concentrations in Largemouth Bass
Site 28 BERA Report
NSF-IH, Indian Head, Maryland

COPC	Site 28 (de-boned)	Reference Area (fillet only) (Mattawoman Creek Study)
Lead	0.99	ND (0.96)
Mercury	0.25	0.68
Zinc	64.3	53.6

Concentrations are in mg/kg, dry weight.
ND—Not detected (detection limit shown)

As shown in Table 4-11, the concentration of lead is 0.99 mg/kg, whereas it is a non-detect in the reference sample. It should be noted that the detection limit is 0.96 mg/kg for the reference sample. Mercury concentration in the site sample (0.25 mg/kg) is lower than the reference sample (0.68 mg/kg). Zinc concentrations between both the site and reference samples are comparable. The concentrations of lead may be only slightly higher in the site sample than in the reference samples. These differences may be explained by the differences in the composition of the samples, the size of the fish, or by the effect of small sample numbers (i.e., one reference fish sample). Internal organs such as the liver often contain higher concentrations of chemicals than do muscle tissue, with the exception of mercury, which is sequestered primarily in the muscle tissue of fish. Therefore, it is not surprising that the reference sample was higher in mercury concentration considering that the sample was comprised of 100 percent muscle tissue (fillet), and the site sample consisted of skin and internal organs as well as muscle tissue. In addition, larger older fishes typically contain higher concentrations of mercury than do smaller younger fishes of the same species.

The fish tissue concentrations were used to refine the risk estimate for piscivorous birds and mammals. The great blue heron was used as the surrogate species for piscivorous birds, and mink was used to represent piscivorous mammals. These receptors are top level consumers and are, thus, susceptible to bioaccumulative chemicals, especially those that have the potential to biomagnify through aquatic food chains. For the purpose of this assessment, an assumption of 100 percent fish consumption was assumed for both receptor species to assess potential risk. The tissue concentration data were used to model exposure to upper-trophic-level receptors using the food chain model described in Appendix E.

The results of the risk estimates for piscivorous birds and mammals are summarized in Table 4-12. The LOAEL-based HQs were less than 1 for both receptors, indicating that the COPCs are not bioaccumulating in fish tissue at levels that could potentially pose an unacceptable risk to piscivorous birds or mammals that forage at Site 28.

TABLE 4-12
Calculated Hazard Quotients for Piscivorous Wildlife
Site 28 BERA Report
NSF-IH, Indian Head, Maryland

COPC	Great Blue Heron		Mink	
	NOAEL-HQ	LOAEL-HQ	NOAEL-HQ	LOAEL-HQ
Lead	0.05	<0.01	<0.01	<0.01
Mercury	0.64	0.21	0.03	0.02
Zinc	1.67	0.18	0.11	0.02

Shaded cells indicate HQ > 1.

SECTION 5

Risk Characterization

5.1 Assessment Endpoints

The risk for each of the assessment endpoints is characterized as follows:

Survival and growth of the benthic invertebrate community. The results of the sediment toxicity testing and benthic community sampling indicate that an unacceptable risk exists for benthic invertebrates in the vicinity of sample location IS28SD03. The shoreline immediately upstream of this location is also known to pose unacceptable risk based on previous toxicity testing in the location of the ongoing apatite treatment pilot study. The substrate immediately downstream of sample location IS28SD03 consists of sand and gravel, which did not provide adequate sediment for appropriate toxicity testing. The sediments in the vicinity of sample locations IS28SD01 and IS28SD02 pose a low level of risk to benthic invertebrates.

Survival and growth of finfish. The results of the fish tissue chemical analysis revealed that although lead and zinc are accumulating in fish at the site, neither metal poses an unacceptable risk to finfish. Additionally, the levels of zinc in the fish are comparable to background levels.

Survival, growth, and reproduction of aquatic omnivorous birds. The results of the bioaccumulation bioassays and associated risk estimates for aquatic omnivorous birds indicate that lead and zinc in the shoreline sediments at Site 28 pose unacceptable risks to these receptors. The primary area of concern is in the vicinity of sample location IS28SD03 and the shoreline immediately upstream of this location where the apatite treatment pilot study is being conducted.

Survival, growth, and reproduction of piscivorous birds. The results of the fish tissue analysis and associated risk estimates for piscivorous birds indicate that lead, mercury, and zinc are not accumulating in fish at levels that would pose an unacceptable risk to these receptors.

Survival, growth, and reproduction of piscivorous mammals. The results of the fish tissue analysis and associated risk estimates for piscivorous mammals indicate that lead, mercury, and zinc are not accumulating in fish at levels that would pose an unacceptable risk to these receptors.

5.2 Uncertainty

Uncertainties are present in all risk assessments because of the limitations of the available data and the need to make certain assumptions and extrapolations based upon incomplete information. The uncertainties in this BERA are mainly attributable to the following factors:

- Spatial Variability—Contaminant concentrations can vary spatially in sediments because of the variability in sediment grain size distributions, which can affect the accumulation rates of contaminants in various sediments. Fine-grained sediments typically are located in depositional areas where contaminated sediments can accumulate from sediment transport processes. In addition, these sediments can contain higher TOC content to which many chemicals can bind. In contrast, sediments composed of primarily larger particles (sand and gravel) typically are not found in depositional areas and tend to contain less TOC and lower contaminant concentrations. Based on the conceptual site model for Site 28, contaminants may have been transported to Mattawoman Creek and distributed in such a manner that the contamination may not be limited to the area where elevated concentrations were found during the BERA investigation (i.e., IS28SD03). However, to minimize this uncertainty, the sediment samples collected from Mattawoman Creek prior to the BERA (i.e., as part of the RI) and during the BERA investigation were purposely collected from areas of fine-grained sediments, where possible, to ensure that depositional areas would be characterized to account for this spatial variability in contaminant concentrations.

- Ingestion Screening Values—Data on the toxicity of lead to the mallard, great blue heron, and mink; toxicity of mercury to heron; and toxicity of zinc to mallard and heron were lacking, thereby requiring the extrapolation of data from other wildlife species or from laboratory studies with non-wildlife species. This is a typical limitation and extrapolation for ecological risk assessments because so few wildlife species have been tested directly for most chemicals. However, the uncertainties associated with toxicity extrapolation were minimized through the selection of the most appropriate test species for which suitable toxicity data were available. The factors considered in selecting a test species to represent a receptor species included taxonomic relatedness, trophic level, foraging method, and similarity of diet.

  A second uncertainty relates to the derivation of ingestion screening values for lead and zinc in toxicological studies. These studies used forms of the metals (such as salts) that had high water solubility and high bioavailability to receptors. For the BERA, however, the analytical samples on which site-specific exposure estimates were based used total metal (lead and zinc) concentrations, regardless of form. The highly bioavailable forms are expected to compose only a fraction of the total metal concentration; this would likely result in an overestimation of potential risks for these chemicals.

- Chemical Mixtures—It is a requirement for ecological risk assessments that the chemicals be evaluated on a compound-by-compound basis. Nevertheless, information on the ecotoxicological effects of chemical interactions among lead, mercury, and zinc is generally lacking. This could result in an underestimation of risk (if there are additive or synergistic effects among chemicals) or an overestimation of risks (if there are antagonistic effects among chemicals).

- Food Web Exposure Modeling—There are several uncertainties associated with this factor. Chemical concentrations in aquatic plants (for mallard exposure estimates) were modeled from sediment concentrations that were not directly measured. The use of generic, literature-derived exposure models and bioaccumulation factors introduces some uncertainty into the resulting estimates. The values selected and the

methodologies employed were intended to provide a reasonable estimate of potential food web exposure concentrations.

In addition, area use factors were assumed to equal 1. This is a conservative assumption because a percentage of a given receptor's time could be spent foraging offsite in areas where chemical concentrations are expected to be significantly lower. To demonstrate the conservativeness of this assumption, the area use factor was adjusted on the basis of the area of impacted sediments, which is approximately 0.2 ha (shoreline area 400 ft × 50 ft), and the minimum mallard home range (laying female) reported by EPA (1993), which is 38 ha. The resulting HQs, based on the average shoreline sediment concentrations, would be 0.01 or less for lead, mercury, and zinc.

Another uncertainty surrounds the risk conclusion for piscivorous birds. The risk estimate for the great blue heron resulted in a slight exceedence of the NOAEL-based toxicity value, but not the LOAEL-based toxicity value. The threshold value at which toxic effects are expected lies somewhere between the two values. Therefore, there is some uncertainty in the conclusion that zinc in the site sediment poses a low risk to piscivorous birds. However, the finding of similar zinc concentrations in the fish from the reference site also supports this conclusion.

An additional area of uncertainty is associated with the use of a single composite fish sample to represent the dose inputs for upper trophic level receptors. The uncertainty arises because the use of one data point does not allow an interpretation of the natural variability that may be present in the tissue residues of the target fish population. This uncertainty was minimized to some extent by collecting the composite samples from four different locations at both the site and the reference locations, which should account for some of the variability in the populations.

- Changes in Chemical Bioavailability—There is uncertainty associated with the contradictory lines of evidence found at sample location IS28SD03. The toxicity test results for the sample from this location showed 100 percent mortality, but the abundance and richness measures did not suggest any impairment of the benthic invertebrate community. It is possible the disturbance of the sediment during sample collection may have increased the bioavailability and associated toxicity of the metals. Another possibility may be that some of the apatite treatment from the pilot study area may have migrated downstream to this area. This would result in the binding of metals in the upper-most sediments with subsequent reduction in their bioavailability, while the deeper sediments may have remained unaffected by the apatite, thus exhibiting toxicity when tested in the laboratory. An additional possibility may be that the benthic invertebrate community has evolved to become tolerant of the high metal concentrations. Although there is uncertainty from these contradictory measures of risk, the fact that 100 percent mortality was observed in the laboratory indicates that the metals in this area of the site pose unacceptable risks to the benthic invertebrate community.

- Critical Tissue Residue Values—There is uncertainty associated with the use of critical residue values from the literature for fish species other than those evaluated in the assessment. The extrapolation in using a toxicological value from one species to evaluate risk to a different species does introduce uncertainty into the analyses. The critical

residue value used to evaluate lead of 20.4 mg/kg was based on a study with brook trout (*Salvelinus fontinalis*), which is a cold water species not closely related to *Fundulus* or largemouth bass. However, the value used is based on a NOAEL value and was considered more protective than the next lowest value from a similar type of fish, which was a LOAEL-based value of 104.8 mg/kg for fathead minnow (*Pimephales promelas*).

A critical residue value for mercury was available for largemouth bass, but not for *Fundulus*. Therefore, a surrogate value from another species (fathead minnow) was used to evaluate risk to *Fundulus*. However, mercury was not detected in the fish tissue samples, so this uncertainty does not significantly affect the risk conclusion. There is also uncertainty in the comparison of whole-body residue values to deboned bass sample concentrations. The concentrations would tend to be higher for mercury in the deboned samples compared with the whole-body samples, because mercury is sequestered primarily in muscle tissue. However, the HQs for each COPC in the deboned bass tissue samples were below 1.0; thus, this uncertainty is unlikely to affect the conclusions for finfish.

The critical residue value used in the evaluation of zinc (160 mg/kg) was for flagfish. This value represents a whole-body tissue concentration that was found to reduce the growth of this species but did not affect survival. Although zinc toxicological data for *Fundulus* spp. and largemouth bass were not available, this value represented the best data available for freshwater fish species. Other tissue residue values for zinc in the literature include a value of 240 mg/kg (whole-body, 80-day exposure to zinc sulfate) for Atlantic salmon, which produced no effect on growth or survival in this species (Jarvinen and Ankely, 1999). Another tissue residue value of 1,120 mg/kg (whole body, 134-day exposure to zinc sulfate) was found for guppy (*Poecilia reticulata*). No effect was found at this concentration on growth, survival, or reproduction for this species (Jarvinen and Ankely, 1999).

Toxicological data based on whole-body samples from fish species most similar to *Fundulus* or largemouth bass were used where possible to minimize uncertainty. If there is some uncertainty associated with the risk conclusions, it is likely not significant considering the following: (1) concentrations of lead were well below the critical residue value; (2) concentrations of zinc were similar to background fish tissue concentrations; and (3) mercury was not detected in any of the fish tissue samples.

5.3 Conclusions

- Metals in the shoreline sediments in the vicinity of sample location IS28SD03 and the apatite treatment test area pose unacceptable risks to ecological receptors. Three chemicals of concern (COCs) were identified for benthic invertebrates (cadmium, lead, and zinc).
- Metals in the shoreline sediments pose a low risk to omnivorous aquatic birds.
- Metals (arsenic, cadmium, copper, lead, and zinc) in the sediment along the shoreline (other than those areas noted in the first bullet above) of the site pose low risk to the benthic invertebrate community and omnivorous aquatic birds.

- Metals (lead, mercury, and zinc) in the shoreline sediment pose low risk to finfish and piscivorous wildlife.
- Silver in the sediment along the vegetated bar across from Site 28 poses no unacceptable risk to the benthic invertebrate community of the creek. Silver was analyzed in samples from the vegetated bar across the channel (IS28SD11 and IS28SD13) because it was the only COPC identified for these two locations in the SERA. Although the silver concentrations at IS28SD11 and IS28SD13 previously exceeded the screening value, the concentrations measured in this sampling effort do not exceed the screening value.

SECTION 6

References

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Appendix A
Chemistry Results—Sediment and Tissue

Table A-1

Analytical Results for Sediment Samples

Site 28 BERA Report

NSF-IH, Indian Head, Maryland

Station ID	BGDSD05		BGDSD06	IS28SD01	IS28SD02	IS28SD03	IS28SD11	IS28SD13
Sample ID	BGDSD05P	BGDSD051005	BGDSD06	IS28SD16	IS28SD17	IS28SD18	IS28SD19	IS28SD20
Sample Date	10/26/05	10/26/05	10/27/05	10/26/05	10/26/05	10/26/05	10/26/05	10/26/05
Chemical Name								
Total Metals (MG/KG)								
Aluminum	14,200	13,000	6,330	3,210	8,080	1,670	12,800	12,300
Antimony	1.4 UL	1.3 UL	0.83 UL	0.47 UL	0.71 UL	0.61 L	0.96 UL	0.95 UL
Arsenic	9.3	8.3	4 J	2.2 J	7.7	24.8	6.6	5.6 J
Barium	117 J	102 J	69.2 J	29.8 J	69.3 J	27.6 J	119 J	117 J
Beryllium	1 B	0.88 B	0.7 B	0.32 B	0.69 B	0.22 B	1.1 J	1 J
Cadmium	0.71 J	0.33 B	0.55 J	0.21 J	0.61 J	5.3	0.81 J	0.94 J
Calcium	3,220 J	2,880 J	2,080 J	523 J	1,740 J	436 J	3,220	2,470 J
Chromium	24.8 K	22 K	13 K	5.9 K	14.7 K	5.8 K	23.7 K	22.9 K
Cobalt	12.3 J	9.9 J	11.7 J	3.5 J	8.4 J	1.7 J	13.7 J	13.6 J
Copper	25.9	22.3	13.1	5 J	13.3	30.1	20.4	21.2
Cyanide	0.66 J	0.15 U	0.093 U	0.052 U	0.08 U	0.049 U	0.11 U	0.1 U
Iron	21,000	18,400	13,200	5,920	15,700	6,030	25,200	24,800
Lead	60 K	40.1 K	20.2 K	12 K	23.1 K	265 K	27.9 K	27.8 K
Magnesium	2,100 J	1,870 J	1,160 J	527 J	1,440 J	304 J	2,030 J	1,920 J
Manganese	414	466	420	195	540	97	1,050	785
Mercury	0.62	0.44	0.13 U	0.062 U	0.12 J	0.067 U	0.23 J	0.21 J
Nickel	19 J	16.3 J	12.5 J	4.7 J	12 J	4 J	20.1 J	18.6 J
Potassium	1,400 J	1,310 J	852 J	452 J	1,030 J	220 J	1,490 J	1,450 J
Selenium	3.7 U	3.4 U	2.2 U	1.2 U	1.9 U	1.1 U	2.6 U	2.6 U
Silver	0.3 J	0.16 U	0.1 U	0.058 U	0.088 U	0.052 U	0.38 J	0.42 J
Sodium	537 B	579 B	424 B	172 B	367 B	382 B	432 B	389 J
Thallium	3.9 U	3.6 U	2.3 U	1.3 U	2 U	1.2 U	2.7 U	2.7 U
Vanadium	36.9 J	32.8 J	19.4 J	8.2 J	20.5 J	6.7 J	31.9	30.8
Zinc	119 K	95.2 K	89.7 K	49.5 K	176 K	5,280 K	126 K	126 K
Wet Chemistry								
Sulfide (mg/kg)	8 B	8 B	8 B	20 U	8 B	12 B	8 B	8 B
Total organic carbon (TOC) (mg/kg)	60,200 L	63,500 L	35,000 L	6,460 L	15,200 L	4,750 L	44,300 L	35,100 L
pH	6.64	6.57	6.9	7.04	6.78	7.27	7.11	6.96

Notes

NA - Not analyzed

B - Analyte not detected above associated blank

J - Reported value is estimated

K - Reported value may be biased high

U - Analyte not detected

UL - Not detected; reporting limit is biased low

A shaded cell indicates the parameter is detected.

mg/kg - milligrams per kilogram

Table A-2
Analytical Results for Invertebrate Tissue Samples
Site 28 BERA Report
NSF-IH, Indian Head, Maryland

Station ID	BGDSD05				BGDSD06			
Sample ID	IS28REF1-006A	IS28REF1-006B	IS28REF1-006C	IS28REF1-006D	IS28REF2-007A	IS28REF2-007B	IS28REF2-007C	IS28REF2-007D
Sample Date	12/21/05	12/21/05	12/21/05	12/21/05	12/21/05	12/21/05	12/21/05	12/21/05
Chemical Name								
Total Metals (MG/KG)								
Aluminum	2,650	2,540	1,660	3,550	1,330	2,670	6,230	832
Antimony	6.7 U	7.7 U	5.6 U	6.2 U	9.2 U	15.8 U	20.9 U	2.4 U
Arsenic	16.4 J	17.3 J	10.1 J	12.7 J	18.5 J	25.8 U	34.2 U	5.8 J
Barium	188 J	229 J	138 J	173 J	220 J	139 J	487 J	68.9 J
Beryllium	0.41 U	0.47 U	0.34 U	0.37 U	0.56 U	0.96 U	1.3 U	0.15 U
Cadmium	0.82 J	0.7 U	0.51 U	0.56 U	0.84 U	1.4 U	1.9 U	0.22 U
Calcium	2,660 J	2,260 J	1,250 J	1,840 J	1,820 J	5,650 J	9,550 J	1,230 J
Chromium	7.4 J	6.8 J	4.2 J	6.7 J	3 J	7.4 J	18.2 J	2.5 J
Cobalt	5.1 J	3.6 J	2.1 J	3.2 J	2.3 J	10 J	31.6 J	5.1 J
Copper	61.5	72.1	46.5	58.2	68.5 J	47.9 J	147 J	84.4
Iron	7,780	7,050	3,790	7,000	5,310	11,700	25,900	3,600
Lead	19	13.5	9.7	18	11.6	27.6	50.5	7.2
Magnesium	1,400 J	1,490 J	953 J	1,390 J	1,330 J	1,460 J	4,190 J	521 J
Manganese	116	106	54.3	95.1	114	451	1,110	79.3
Mercury	0.52 U	0.54 U	0.39 U	0.47 U	0.64 U	1.2 U	1.5 U	0.18 U
Nickel	9.3 J	7.9 J	5.8 J	7.7 J	8.6 J	12 J	36.5 J	5.2 J
Potassium	8,630 J	11,000 J	7,300 J	9,380	10,500 J	5,790 J	20,600 J	3,170 J
Selenium	7.6 U	8.6 U	6.3 U	6.9 U	10.3 U	17.7 U	23.4 U	2.7 U
Silver	1.8 J	1.4 U	1 U	1.2 J	1.7 U	2.9 U	3.8 U	0.44 U
Sodium	5,370 J	6,520 J	4,170 J	5,910 J	5,760 J	3,890 J	12,400 J	1,900 J
Thallium	7.8 U	8.9 U	6.5 U	7.1 U	10.6 U	18.2 U	24 U	2.8 U
Vanadium	17.8 J	12.3 J	6 J	12.4 J	5.2 J	21.5 J	40.3 J	5.7 J
Zinc	476	482	282	355	457	331	1,010	155

NA - Not analyzed
J - Reported value is estimated
U - Analyte not detected
A shaded cell indicates the constituent is detected.

Table A-2
Analytical Results for Invertebrate Tissue Samples
Site 28 BERA Report
NSF-IH, Indian Head, Maryland

Station ID	IS28SD01				IS28SD02			
Sample ID	IS28SD01-001A	IS28SD01-001B	IS28SD01-001C	IS28SD01-001D	IS28SD02-002A	IS28SD02-002B	IS28SD02-002C	IS28SD02-002D
Sample Date	12/21/05	12/21/05	12/21/05	12/21/05	12/21/05	12/21/05	12/21/05	12/21/05
Chemical Name								
Total Metals (MG/KG)								
Aluminum	1,170	1,730	2,100	1,410	683	1,410	2,620	474
Antimony	6.6 U	8.5 U	7.9 U	6.8 U	5.6 U	6.5 U	6.4 U	6.8 U
Arsenic	21.5	22 J	17.1 J	31	17.9	35.4	32.3	11.1 U
Barium	169 J	152 J	184 J	176 J	105 J	191 J	168 J	45.2 J
Beryllium	0.4 U	0.52 U	0.48 U	0.41 U	0.34 U	0.4 U	0.39 U	0.41 U
Cadmium	0.76 J	0.77 U	0.72 U	0.61 U	0.51 U	1.1 J	0.58 U	0.62 U
Calcium	1,690 J	2,330 J	2,510 J	2,560 J	1,190 J	1,980 J	3,020 J	1,030 J
Chromium	3.3 J	4.8 J	4.9 J	3.8 J	2 J	3.7 J	7.7 J	1.7 U
Cobalt	3.3 J	3 J	2.7 J	3.5 J	1.6 J	3 J	5.5 J	1.2 U
Copper	61.5	52.5 J	67.8	67.1	51.6	59.9	58.7	32 J
Iron	5,130	6,520	6,910	5,160	3,860	6,450	9,840	1,790
Lead	7.2	17.8	12.8	23.1	4.4 J	17.5	37.1	4.3 J
Magnesium	1,230 J	1,400 J	1,600 J	1,340 J	1,010 J	1,230 J	1,640 J	807 J
Manganese	194	270	260	123	75.1	186	225	64.5
Mercury	0.44 U	0.6 U	0.57 U	0.48 U	0.35 U	0.42 U	0.5 U	0.5 U
Nickel	6 J	5.5 J	9.1 J	6.3 J	5.1 J	7.9 J	12.3 J	4.2 J
Potassium	9,890 J	7,840 J	9,620 J	10,500	9,310	9,310 J	8,820 J	6,050 J
Selenium	7.4 U	9.5 U	8.9 U	7.6 U	6.3 U	7.3 U	7.2 U	7.6 U
Silver	1.2 U	1.5 U	1.4 U	1.2 U	1 U	1.2 U	1.2 U	1.2 U
Sodium	5,300 J	4,570 J	5,160 J	6,060 J	4,740 J	4,680 J	4,820 J	3,710 J
Thallium	7.6 U	9.8 U	9.1 U	7.8 U	6.5 U	7.5 U	7.4 U	7.8 U
Vanadium	3.9 J	6.7 J	7 J	4.4 J	2.5 J	7.1 J	14.7 J	1.5 J
Zinc	399	413	465	412	336	615	584	164

NA - Not analyzed
J - Reported value is estimated
U - Analyte not detected
A shaded cell indicates the constituent is detected.

Table A-2
Analytical Results for Invertebrate Tissue Samples
Site 28 BERA Report
NSF-IH, Indian Head, Maryland

Station ID	IS28SD03							
Sample ID	IS28SD03-003A		IS28SD03-003B		IS28SD03-003C		IS28SD03-003D	
Sample Date	12/21/05		12/21/05		12/21/05		12/21/05	
Chemical Name								
Total Metals (MG/KG)								
Aluminum	1,630		1,220		1,420		876	
Antimony	7	U	8.7	U	6.2	U	12.1	U
Arsenic	66.3		49		68.5		41.7	
Barium	268	J	157	J	120	J	170	J
Beryllium	0.43	U	0.53	U	0.37	U	0.73	U
Cadmium	7.9	J	7.1	J	17.5		3.1	J
Calcium	2,820	J	2,120	J	2,450	J	1,780	J
Chromium	3.6	J	3	J	4.1	J	4.3	J
Cobalt	2.3	J	1.6	U	1.6	J	2.2	U
Copper	68.2		59.9	J	74.3		46.1	J
Iron	5,140		4,480		6,650		3,070	
Lead	381		236		609		172	
Magnesium	1,530	J	1,270	J	1,390	J	1,100	J
Manganese	122		101		161		73.7	
Mercury	0.51	U	0.61	U	0.42	U	0.88	U
Nickel	3.4	J	3.7	U	6.3	J	5.1	U
Potassium	9,000	J	9,420	J	7,660	J	7,920	J
Selenium	7.9	U	9.8	U	6.9	U	13.6	U
Silver	1.3	U	1.6	U	1.1	U	2.2	U
Sodium	5,820	J	5,200	J	3,150	J	4,830	J
Thallium	8.1	U	10.1	U	7.1	U	13.9	U
Vanadium	5.8	J	5.1	J	7.1	J	2.4	J
Zinc	8,840		6,680		18,600		4,970	

NA - Not analyzed
J - Reported value is estimated
U - Analyte not detected
A shaded cell indicates the constituent is detected.

Table A-3
Analytical Results for Fish Tissue Samples
Site 28 BERA Report
NSF-IH, Indian Head, Maryland

Station ID **Sample ID** **Sample Date**	ISFSH01 IS28FSH01 10/26/05	ISFSH02 IS28FSH02 10/26/05	ISFSH03 IS28FSH03 10/27/05
Chemical Name			
Total Metals (MG/KG)			
Aluminum	6.2 U	6.7 U	6.5 U
Antimony	1.2 U	1.3 U	1.3 U
Arsenic	1.6 B	1.6 U	1.9 J
Barium	13 J	12.5 J	3.5 J
Beryllium	0.076 U	0.082 U	0.08 U
Cadmium	0.15 U	0.17 U	0.16 U
Calcium	49,000 J	42,000 J	48,000 J
Chromium	1.4 J	1.3 J	1 J
Cobalt	0.38 U	0.41 U	0.4 U
Copper	4.8 J	5.1 J	2.1 B
Iron	83.1 B	54.6 B	33.6 B
Lead	1 J	0.91 U	0.99 J
Magnesium	1,840 J	1,830 J	1,910 J
Manganese	48.6	47.4	7.5 J
Mercury	0.19 U	0.21 U	0.25 J
Nickel	0.69 U	0.74 U	0.72 U
Potassium	12,700	15,700	15,500
Selenium	3.3 U	3.5 U	3.4 U
Silver	0.59 J	0.31 B	0.16 U
Sodium	4,050	4,850	3,500 J
Thallium	3.4 U	3.7 U	3.6 U
Vanadium	0.62 J	0.41 U	0.4 U
Zinc	137 J	120 J	64.3 J

Notes
B - Analyte not detected above associated blank
J - Reported value is estimated
U - Analyte not detected
A shaded cell indicates the parameter is detected.
mg/kg - milligrams per kilogram
Samples IS28FSH01 and IS28FSH03 are the site samples. Sample IS28FSH02 is the reference sample.

Appendix B
Grain Size Data

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ACCURA

AASHTO R18

Geotechnical Laboratory

November 18, 2005

CompuChem
501 Madison Avenue
Cary, North Carolina, 27513

Attention: Mr. Mike Pearce

Subject: Geotechnical Testing
Accura Project Number G05-0054-00
CompuChem COC #12208

Dear Mr. Pearce:

ACCURA is pleased to provide you with this final report for Geotechnical Testing. The testing consisted of 8 Particle Size Analyses without Hydrometer (ASTM D422).

Please find enclosed for your convenience, the individual test results and invoice.

We appreciate this opportunity to work with you. If you have any questions or require additional information, please call (404) 241-8722 ext. 16.

Sincerely,
ACCURA Engineering & Consulting Services, Inc.

Mr. Robert Semenak
Technical Director
Geotechnical Laboratory

Enclosures: as noted

AASHTO & U.S. Army Corps of Engineers Accredited Testing:
ASTM: C40; C117; C127; C128; C136; C566; C702; D546; D421; D422; D558; D559; D560; D698; D854; D1140; D1557; D1883; D2166; D2216; D2217; D2434; D2435; D2487; D2488; D2850; D3080; D3740; D4318; D4767; D5084; E329
AASHTO: T11; T21; T27, T37; T84; T85; T87; T88; T89; T90; T99; T100; T134; T135; T136; T146; T180; T193; T208; T215; T216; T236; T248; T255; T265; T296; T297

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ASTM D422, D1140, C136, C117 / AASHTO T88, T27, T 11, T311
Standard Test Method for Particle-Size Analysis of Soils and Aggregates

PROJECT NUMBER	G05-0054-00	SAMPLE ID	G12239/IS28SD16	TECH	VG
PROJECT NAME	INDIAN HEAD CTO-111	SAMPLE TYPE	JAR	DATE	11/06/05
SAMPLE LOCATION	-	SAMPLE DEPTH	-	CHECK	

AS-RECEIVED MOISTURE CONTENT

Mass of Wet Sample & Tare, g	747.22
Mass of Dry Sample & Tare, g	629.19
Mass of Tare, g	368.38
Moisture Content, %	45.3

HYGROSCOPIC MOISTURE CONTENT

Mass of Wet Sample & Tare, g	
Mass of Dry Sample & Tare, g	
Mass of Tare, g	
Moisture Content, %	NA

Mass of Wet Sample & Tare, g	747.22
Mass of Tare, g	368.38
Mass of Dry Sample, g	260.81

REMARKS

SIEVE ANALYSIS*

PORTION OF SAMPLE RETAINED ON # 4 SIEVE

Mass of Tare, g: 0.00

Sieve Size		Sample & Tare, g	% RETAINED	% PASSING
12"	COBBLES		0.0	100.0
3"	COARSE GRAVEL		0.0	100.0
2.5"			0.0	100.0
2"			0.0	100.0
1.5"			0.0	100.0
1"			0.0	100.0
.75"	FINE GRAVEL	0.00	0.0	100.0
.5"		9.77	3.7	96.3
.375"		11.49	4.4	95.6
#4	COARSE SAND	28.89	11.1	88.9

PORTION OF SAMPLE PASSING # 4 SIEVE

Sieve Size		Cumulative Mass retained, g	% PASSING
#10	MEDIUM SAND	37.47	85.6
#20		54.23	79.2
#40	FINE SAND	118.02	54.7
#60		192.78	26.1
#100		224.50	13.9
#200	FINES	236.15	9.5

* - ASTM Definitions of Classification
** - AASHTO Definitions of Classification

Oven ID #	109/399
Balance ID#	105/398/297
Sieve Shaker ID #	119/1529

PARTICLE-SIZE ANALYSIS*

% COBBLES	0.0	% MEDIUM Sand	30.9
% COARSE Gravel	0.0	% FINE Sand	45.3
% FINE Gravel	11.1	% FINES	9.5
% COARSE Sand	3.3	% TOTAL SAMPLE	100.0

PARTICLE-SIZE ANALYSIS**

% COBBLES	0.0	% COARSE Sand	30.9
% COARSE Gravel (Stone)	0.0	% FINE Sand	45.3
% MEDIUM Gravel (Stone)	4.4	% FINES (Silt-Clay)	9.5
% FINE Gravel (Stone)	10.0	% TOTAL SAMPLE	100.0

DESCRIPTION: NA

USCS (ASTM D2487; D2488): NA AASHTO (M 145): NA

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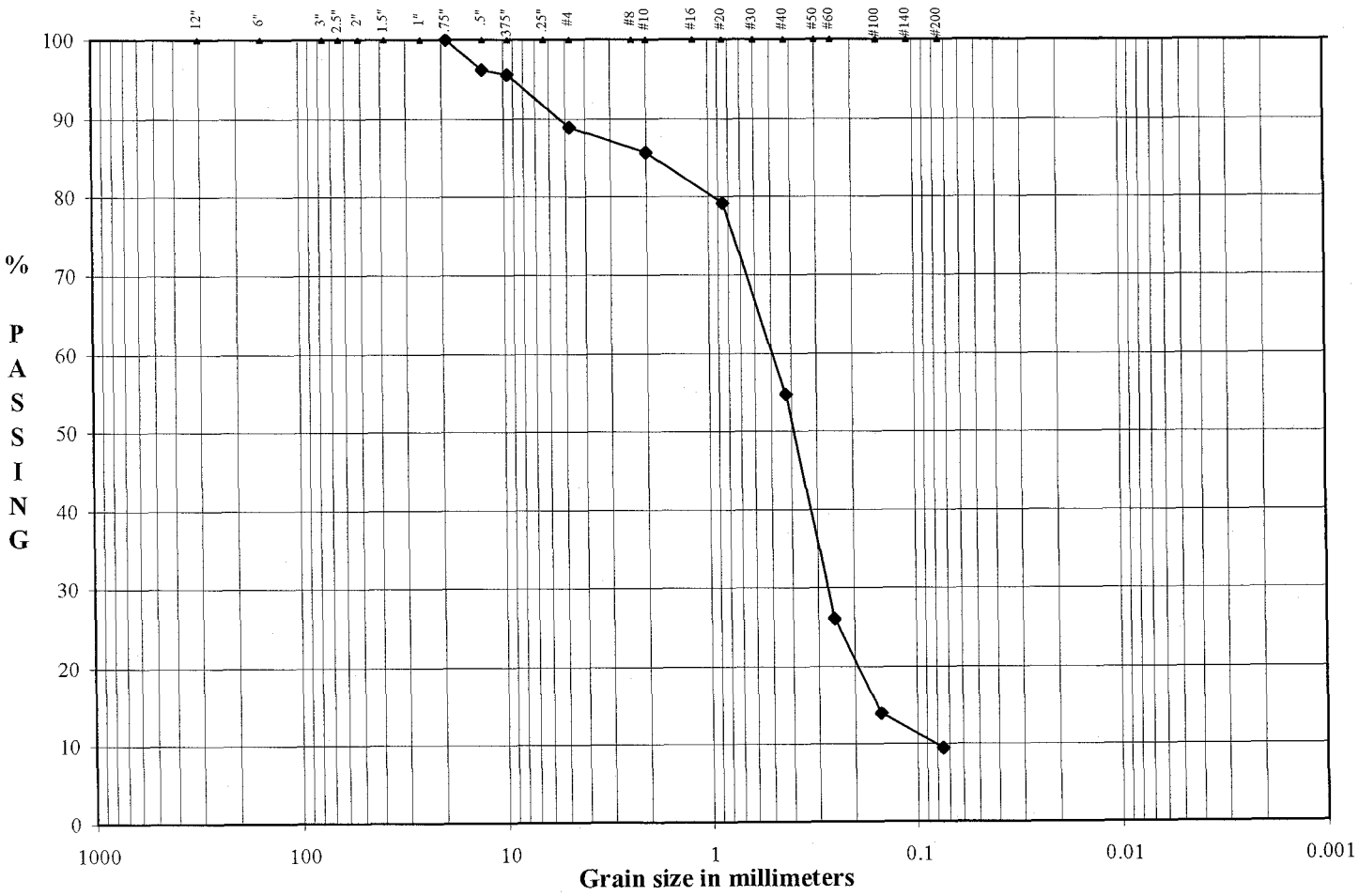
Standard Test Method for Particle-Size Analysis of Soils and Aggregates

PROJECT #	G05-0054-00	SAMPLE ID	G12239/IS28SD16	TECH	VG
PR. NAME	INDIAN HEAD CTO-111	SAMPLE TYPE	JAR	DATE	11/06/05
LOCATION	-	SAMPLE DEPTH	-	CHECK	

Particle-Size Analysis



Boulders	Cobbles	Coarse	Fine	Coarse	Medium	Fine	Silt-Clay
		Gravel		Sand			Fines

D_{10}	NA	mm
D_{30}	NA	mm
D_{60}	NA	mm
Cu	NA	
Cc	NA	

SOIL 3.xls [Particle-Size Graph], REV. 2; 07/21/04

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Standard Test Method for Particle-Size Analysis of Soils and Aggregates

PROJECT NUMBER	G05-0054-00	SAMPLE ID	G12240/IS28SD17	TECH	VG
PROJECT NAME	INDIAN HEAD CTO-111	SAMPLE TYPE	JAR	DATE	11/06/05
SAMPLE LOCATION	-	SAMPLE DEPTH	-	CHECK	PCG

AS-RECEIVED MOISTURE CONTENT

Mass of Wet Sample & Tare, g	637.08
Mass of Dry Sample & Tare, g	546.39
Mass of Tare, g	310.57
Moisture Content, %	38.5

HYGROSCOPIC MOISTURE CONTENT

Mass of Wet Sample & Tare, g	
Mass of Dry Sample & Tare, g	
Mass of Tare, g	
Moisture Content, %	NA

Mass of Wet Sample & Tare, g	637.08
Mass of Tare, g	310.57
Mass of Dry Sample, g	235.82

REMARKS

SIEVE ANALYSIS*

PORTION OF SAMPLE RETAINED ON # 4 SIEVE

Mass of Tare, g: 0.00

Sieve Size		Sample & Tare, g	% RETAINED	% PASSING
12"	COBBLES		0.0	100.0
3"	COARSE GRAVEL		0.0	100.0
2.5"			0.0	100.0
2"			0.0	100.0
1.5"			0.0	100.0
1"		0.00	0.0	100.0
.75"	FINE GRAVEL	7.40	3.1	96.9
.5"		15.26	6.5	93.5
.375"		41.37	17.5	82.5
#4	COARSE SAND	90.21	38.3	61.7

PORTION OF SAMPLE PASSING # 4 SIEVE

Sieve Size		Cumulative Mass retained, g	% PASSING
#10	MEDIUM SAND	116.11	50.8
#20		127.83	45.8
#40	FINE SAND	147.32	37.5
#60		179.58	23.8
#100		206.85	12.3
#200	FINES	216.39	8.2

* - ASTM Definitions of Classification
** - AASHTO Definitions of Classification

Oven ID #	109/399
Balance ID#	105/398/297
Sieve Shaker ID #	119/1529

PARTICLE-SIZE ANALYSIS*

% COBBLES	0.0	% MEDIUM Sand	13.2
% COARSE Gravel	3.1	% FINE Sand	29.3
% FINE Gravel	35.1	% FINES	8.2
% COARSE Sand	11.0	% TOTAL SAMPLE	100.0

PARTICLE-SIZE ANALYSIS**

% COBBLES	0.0	% COARSE Sand	13.2
% COARSE Gravel (Stone)	0.0	% FINE Sand	29.3
% MEDIUM Gravel (Stone)	17.5	% FINES (Silt-Clay)	8.2
% FINE Gravel (Stone)	31.7	% TOTAL SAMPLE	100.0

DESCRIPTION: NA

USCS (ASTM D2487; D2488): NA AASHTO (M 145): NA

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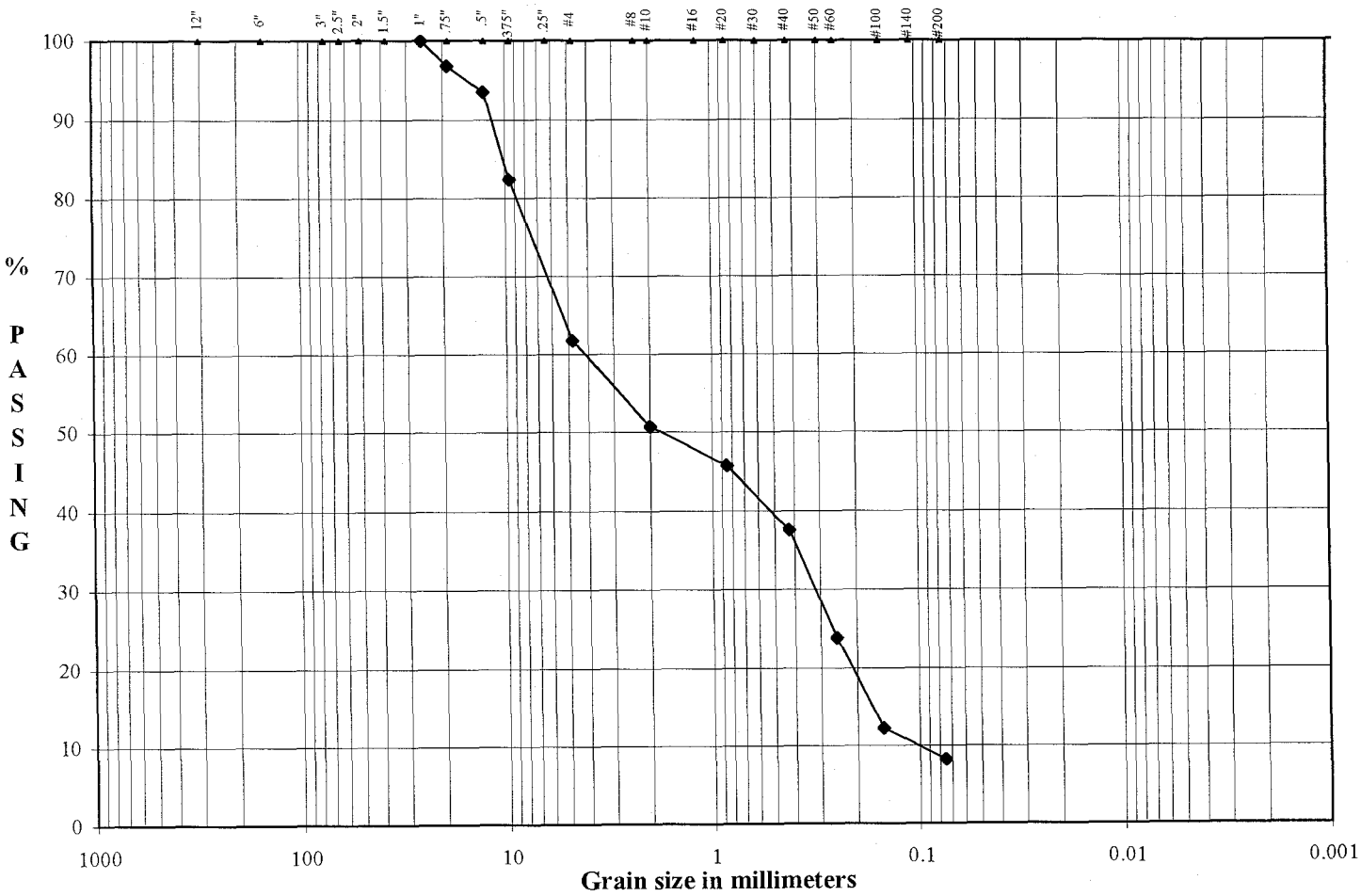
Standard Test Method for Particle-Size Analysis of Soils and Aggregates

PROJECT #	G05-0054-00	SAMPLE ID	G12240/IS28SD17	TECH	VG
PR. NAME	INDIAN HEAD CTO-111	SAMPLE TYPE	JAR	DATE	11/06/05
LOCATION	-	SAMPLE DEPTH	-	CHECK	

Particle-Size Analysis



Boulders	Cobbles	Coarse	Fine	Coarse	Medium	Fine	Silt-Clay
		Gravel		Sand			Fines

D_{10}	NA	mm
D_{30}	NA	mm
D_{60}	NA	mm
Cu	NA	
Cc	NA	

SOIL 3.xls [Particle-Size Graph], REV. 2; 07/21/04

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Standard Test Method for Particle-Size Analysis of Soils and Aggregates

PROJECT NUMBER	G05-0054-00	SAMPLE ID	G12241/IS28SD18	TECH	VG
PROJECT NAME	INDIAN HEAD CTO-111	SAMPLE TYPE	JAR	DATE	11/06/05
SAMPLE LOCATION	-	SAMPLE DEPTH	-	CHECK	

AS-RECEIVED MOISTURE CONTENT

Mass of Wet Sample & Tare, g	777.20
Mass of Dry Sample & Tare, g	658.13
Mass of Tare, g	372.72
Moisture Content, %	41.7

HYGROSCOPIC MOISTURE CONTENT

Mass of Wet Sample & Tare, g	
Mass of Dry Sample & Tare, g	
Mass of Tare, g	
Moisture Content, %	NA

Mass of Wet Sample & Tare, g	777.20
Mass of Tare, g	372.72
Mass of Dry Sample, g	285.41

REMARKS

SIEVE ANALYSIS*

PORTION OF SAMPLE RETAINED ON # 4 SIEVE

Mass of Tare, g: 0.00

Sieve Size		Sample & Tare, g	% RETAINED	% PASSING
12"	COBBLES		0.0	100.0
3"	COARSE GRAVEL		0.0	100.0
2.5"			0.0	100.0
2"			0.0	100.0
1.5"			0.0	100.0
1"			0.0	100.0
.75"	FINE GRAVEL		0.0	100.0
.5"		0.00	0.0	100.0
.375"		23.73	8.3	91.7
#4	COARSE SAND	56.44	19.8	80.2

PORTION OF SAMPLE PASSING # 4 SIEVE

Sieve Size		Cumulative Mass retained, g	% PASSING
#10	MEDIUM SAND	76.32	73.3
#20		93.20	67.3
#40	FINE SAND	143.76	49.6
#60		229.09	19.7
#100		261.52	8.4
#200	FINES	271.18	5.0

* - ASTM Definitions of Classification
** - AASHTO Definitions of Classification

Oven ID #	109/399
Balance ID#	105/398/297
Sieve Shaker ID #	119/1529

PARTICLE-SIZE ANALYSIS*

% COBBLES	0.0	% MEDIUM Sand	23.6
% COARSE Gravel	0.0	% FINE Sand	44.6
% FINE Gravel	19.8	% FINES	5.0
% COARSE Sand	7.0	% TOTAL SAMPLE	100.0

PARTICLE-SIZE ANALYSIS**

% COBBLES	0.0	% COARSE Sand	23.6
% COARSE Gravel (Stone)	0.0	% FINE Sand	44.6
% MEDIUM Gravel (Stone)	8.3	% FINES (Silt-Clay)	5.0
% FINE Gravel (Stone)	18.4	% TOTAL SAMPLE	100.0

DESCRIPTION: NA

USCS (ASTM D2487; D2488): NA AASHTO (M 145): NA

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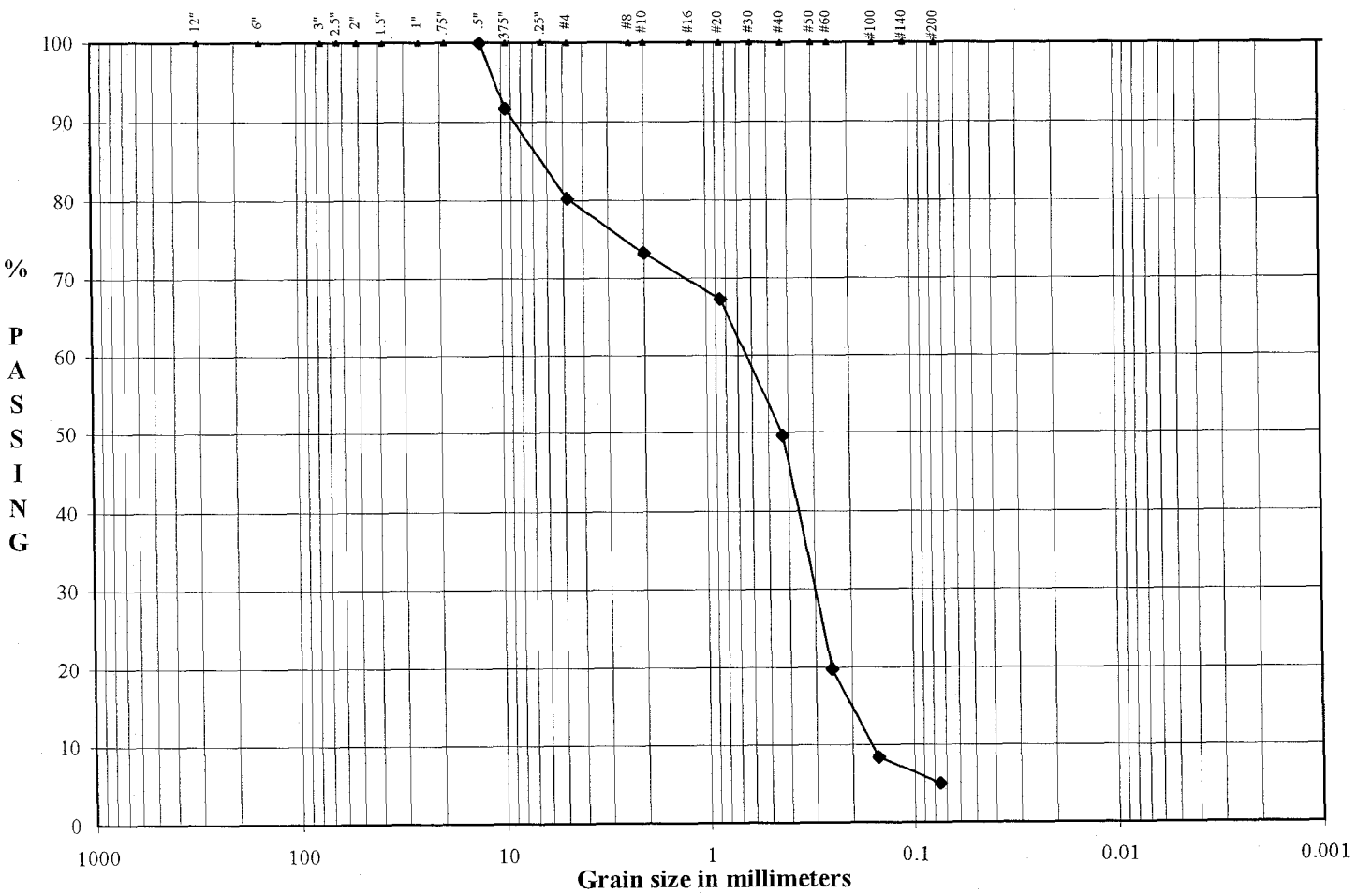
Standard Test Method for Particle-Size Analysis of Soils and Aggregates

PROJECT #	G05-0054-00	SAMPLE ID	G12241/IS28SD18	TECH	VG
PR. NAME	INDIAN HEAD CTO-111	SAMPLE TYPE	JAR	DATE	11/06/05
LOCATION	-	SAMPLE DEPTH	-	CHECK	

Particle-Size Analysis



Boulders	Cobbles	Coarse	Fine	Coarse	Medium	Fine	Silt-Clay
		Gravel		Sand			Fines

D_{10}	NA	mm
D_{30}	NA	mm
D_{60}	NA	mm
Cu	NA	
Cc	NA	

SOIL 3.xls [Particle-Size Graph], REV. 2; 07/21/04

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ASTM D422, D1140, C136, C117 / AASHTO T88, T27, T 11, T311
Standard Test Method for Particle-Size Analysis of Soils and Aggregates

PROJECT NUMBER	G05-0054-00	SAMPLE ID	G12242/IS28SD19	TECH	VG
PROJECT NAME	INDIAN HEAD CTO-111	SAMPLE TYPE	JAR	DATE	11/06/05
SAMPLE LOCATION	-	SAMPLE DEPTH	-	CHECK	

AS-RECEIVED MOISTURE CONTENT

Mass of Wet Sample & Tare, g	672.49
Mass of Dry Sample & Tare, g	467.03
Mass of Tare, g	373.93
Moisture Content, %	220.7

HYGROSCOPIC MOISTURE CONTENT

Mass of Wet Sample & Tare, g	
Mass of Dry Sample & Tare, g	
Mass of Tare, g	
Moisture Content, %	NA

Mass of Wet Sample & Tare, g	672.49
Mass of Tare, g	373.93
Mass of Dry Sample, g	93.10

REMARKS

SIEVE ANALYSIS*

PORTION OF SAMPLE RETAINED ON # 4 SIEVE

Mass of Tare, g: 0.00

Sieve Size		Sample & Tare, g	% RETAINED	% PASSING
12"	COBBLES		0.0	100.0
3"	COARSE GRAVEL		0.0	100.0
2.5"			0.0	100.0
2"			0.0	100.0
1.5"			0.0	100.0
1"			0.0	100.0
.75"	FINE GRAVEL		0.0	100.0
.5"			0.0	100.0
.375"			0.0	100.0
#4	COARSE SAND	0.00	0.0	100.0

PORTION OF SAMPLE PASSING # 4 SIEVE

Sieve Size		Cumulative Mass retained, g	% PASSING
#10	MEDIUM SAND	1.07	98.9
#20		3.32	96.4
#40	FINE SAND	6.21	93.3
#60		8.97	90.4
#100		12.71	86.3
#200	FINES	31.51	66.2

* - ASTM Definitions of Classification
** - AASHTO Definitions of Classification

Oven ID #	109/399
Balance ID#	105/398/297
Sieve Shaker ID #	119/1529

PARTICLE-SIZE ANALYSIS*

% COBBLES	0.0	% MEDIUM Sand	5.5
% COARSE Gravel	0.0	% FINE Sand	27.2
% FINE Gravel	0.0	% FINES	66.2
% COARSE Sand	1.1	% TOTAL SAMPLE	100.0

PARTICLE-SIZE ANALYSIS**

% COBBLES	0.0	% COARSE Sand	5.5
% COARSE Gravel (Stone)	0.0	% FINE Sand	27.2
% MEDIUM Gravel (Stone)	0.0	% FINES (Silt-Clay)	66.2
% FINE Gravel (Stone)	1.1	% TOTAL SAMPLE	100.0

DESCRIPTION: NA

USCS (ASTM D2487; D2488): NA AASHTO (M 145): NA

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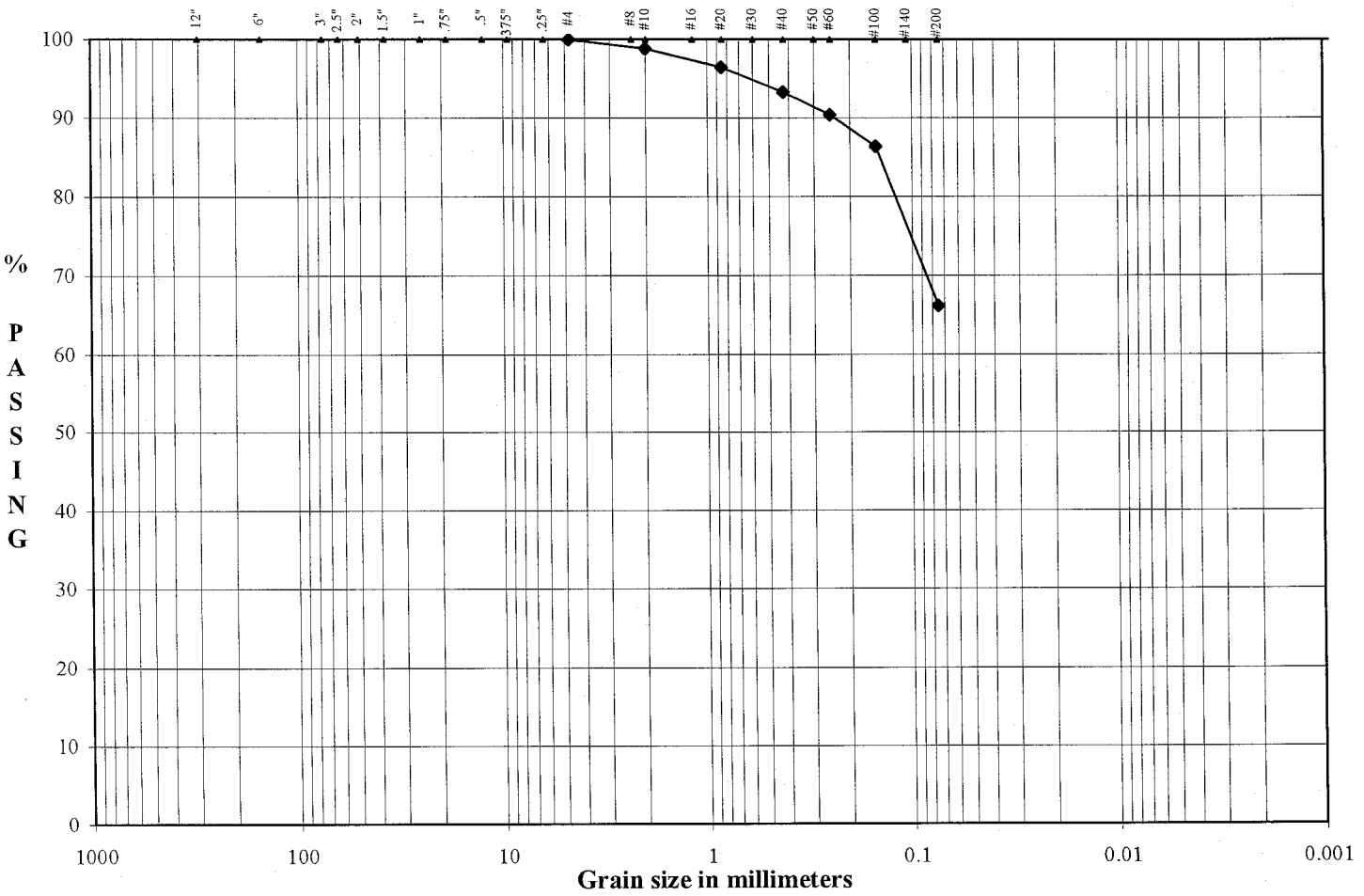
Standard Test Method for Particle-Size Analysis of Soils and Aggregates

PROJECT #	G05-0054-00	SAMPLE ID	G12242/IS28SD19	TECH	VG
PR. NAME	INDIAN HEAD CTO-111	SAMPLE TYPE	JAR	DATE	11/06/05
LOCATION	-	SAMPLE DEPTH	-	CHECK	

Particle-Size Analysis



Boulders	Cobbles	Gravel		Sand			Fines
		Coarse	Fine	Coarse	Medium	Fine	Silt-Clay

D_{10}	NA	mm
D_{30}	NA	mm
D_{60}	NA	mm
Cu	NA	
Cc	NA	

SOIL 3.xls [Particle-Size Graph], REV. 2; 07/21/04

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ASTM D422, D1140, C136, C117 / AASHTO T88, T27, T 11, T311
Standard Test Method for Particle-Size Analysis of Soils and Aggregates

PROJECT NUMBER	G05-0054-00	SAMPLE ID	G12243/IS28SD20	TECH	VG
PROJECT NAME	INDIAN HEAD CTO-111	SAMPLE TYPE	JAR	DATE	11/06/05
SAMPLE LOCATION	-	SAMPLE DEPTH	-	CHECK	

AS-RECEIVED MOISTURE CONTENT

Mass of Wet Sample & Tare, g	643.08
Mass of Dry Sample & Tare, g	457.12
Mass of Tare, g	374.96
Moisture Content, %	226.3

HYGROSCOPIC MOISTURE CONTENT

Mass of Wet Sample & Tare, g	
Mass of Dry Sample & Tare, g	
Mass of Tare, g	
Moisture Content, %	NA

Mass of Wet Sample & Tare, g	643.08
Mass of Tare, g	374.96
Mass of Dry Sample, g	82.16

REMARKS

SIEVE ANALYSIS*

PORTION OF SAMPLE RETAINED ON # 4 SIEVE

Mass of Tare, g: 0.00

Sieve Size		Sample & Tare, g	% RETAINED	% PASSING
12"	COBBLES		0.0	100.0
3"	COARSE GRAVEL		0.0	100.0
2.5"			0.0	100.0
2"			0.0	100.0
1.5"			0.0	100.0
1"			0.0	100.0
.75"	FINE GRAVEL		0.0	100.0
.5"			0.0	100.0
.375"			0.0	100.0
#4	COARSE SAND	0.00	0.0	100.0

PORTION OF SAMPLE PASSING # 4 SIEVE

Sieve Size		Cumulative Mass retained, g	% PASSING
#10	MEDIUM SAND	0.80	99.0
#20		3.04	96.3
#40	FINE SAND	4.98	93.9
#60		6.55	92.0
#100		9.17	88.8
#200	FINES	22.02	73.2

* - ASTM Definitions of Classification
** - AASHTO Definitions of Classification

Oven ID #	109/399
Balance ID#	105/398/297
Sieve Shaker ID #	119/1529

PARTICLE-SIZE ANALYSIS*

% COBBLES	0.0	% MEDIUM Sand	5.1
% COARSE Gravel	0.0	% FINE Sand	20.7
% FINE Gravel	0.0	% FINES	73.2
% COARSE Sand	1.0	% TOTAL SAMPLE	100.0

PARTICLE-SIZE ANALYSIS**

% COBBLES	0.0	% COARSE Sand	5.1
% COARSE Gravel (Stone)	0.0	% FINE Sand	20.7
% MEDIUM Gravel (Stone)	0.0	% FINES (Silt-Clay)	73.2
% FINE Gravel (Stone)	1.0	% TOTAL SAMPLE	100.0

DESCRIPTION: NA

USCS (ASTM D2487; D2488): NA AASHTO (M 145): NA

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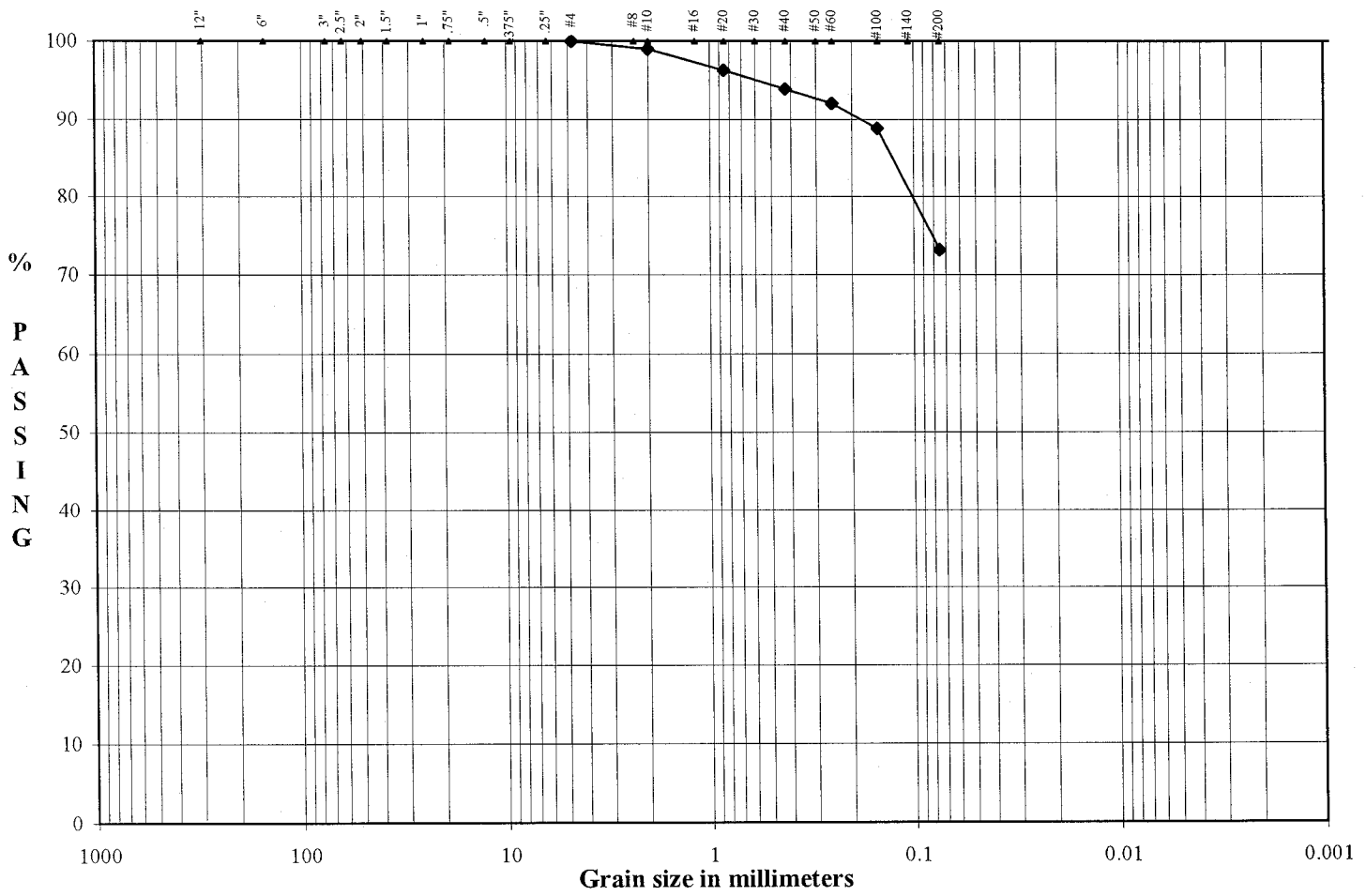
ASTM D422, D1140, C136, C117 / AASHTO T88, T27, T 11, T311
Standard Test Method for Particle-Size Analysis of Soils and Aggregates

PROJECT #	G05-0054-00	SAMPLE ID	G12243/IS28SD20	TECH	VG
PR. NAME	INDIAN HEAD CTO-111	SAMPLE TYPE	JAR	DATE	11/06/05
LOCATION	-	SAMPLE DEPTH	-	CHECK	

Particle-Size Analysis



Boulders	Cobbles	Coarse	Fine	Coarse	Medium	Fine	Silt-Clay
		Gravel		Sand			Fines

D_{10}	NA	mm
D_{30}	NA	mm
D_{60}	NA	mm
Cu	NA	
Cc	NA	

SOIL 3.xls [Particle-Size Graph], REV. 2; 07/21/04

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Standard Test Method for Particle-Size Analysis of Soils and Aggregates

PROJECT NUMBER	G05-0054-00	SAMPLE ID	G12244/BGDSDO51005	TECH	VG
PROJECT NAME	INDIAN HEAD CTO-111	SAMPLE TYPE	JAR	DATE	11/06/05
SAMPLE LOCATION	-	SAMPLE DEPTH	-	CHECK	

AS-RECEIVED MOISTURE CONTENT

Mass of Wet Sample & Tare, g	561.11
Mass of Dry Sample & Tare, g	370.73
Mass of Tare, g	310.38
Moisture Content, %	315.5

HYGROSCOPIC MOISTURE CONTENT

Mass of Wet Sample & Tare, g	
Mass of Dry Sample & Tare, g	
Mass of Tare, g	
Moisture Content, %	NA

Mass of Wet Sample & Tare, g	561.11
Mass of Tare, g	310.38
Mass of Dry Sample, g	60.35

REMARKS

SIEVE ANALYSIS*

PORTION OF SAMPLE RETAINED ON # 4 SIEVE

Mass of Tare, g: 0.00

Sieve Size		Sample & Tare, g	% RETAINED	% PASSING
12"	COBBLES		0.0	100.0
3"	COARSE GRAVEL		0.0	100.0
2.5"			0.0	100.0
2"			0.0	100.0
1.5"			0.0	100.0
1"			0.0	100.0
.75"	FINE GRAVEL		0.0	100.0
.5"			0.0	100.0
.375"			0.0	100.0
#4	COARSE SAND	0.00	0.0	100.0

PORTION OF SAMPLE PASSING # 4 SIEVE

Sieve Size		Cumulative Mass retained, g	% PASSING
#10	MEDIUM SAND	1.77	97.1
#20		4.88	91.9
#40	FINE SAND	9.00	85.1
#60		12.59	79.1
#100		14.98	75.2
#200	FINES	17.02	71.8

* - ASTM Definitions of Classification
** - AASHTO Definitions of Classification

Oven ID #	109/399
Balance ID#	105/398/297
Sieve Shaker ID #	119/1529

PARTICLE-SIZE ANALYSIS*

% COBBLES	0.0	% MEDIUM Sand	12.0
% COARSE Gravel	0.0	% FINE Sand	13.3
% FINE Gravel	0.0	% FINES	71.8
% COARSE Sand	2.9	% TOTAL SAMPLE	100.0

PARTICLE-SIZE ANALYSIS**

% COBBLES	0.0	% COARSE Sand	12.0
% COARSE Gravel (Stone)	0.0	% FINE Sand	13.3
% MEDIUM Gravel (Stone)	0.0	% FINES (Silt-Clay)	71.8
% FINE Gravel (Stone)	2.9	% TOTAL SAMPLE	100.0

DESCRIPTION: NA

USCS (ASTM D2487; D2488): NA AASHTO (M 145): NA

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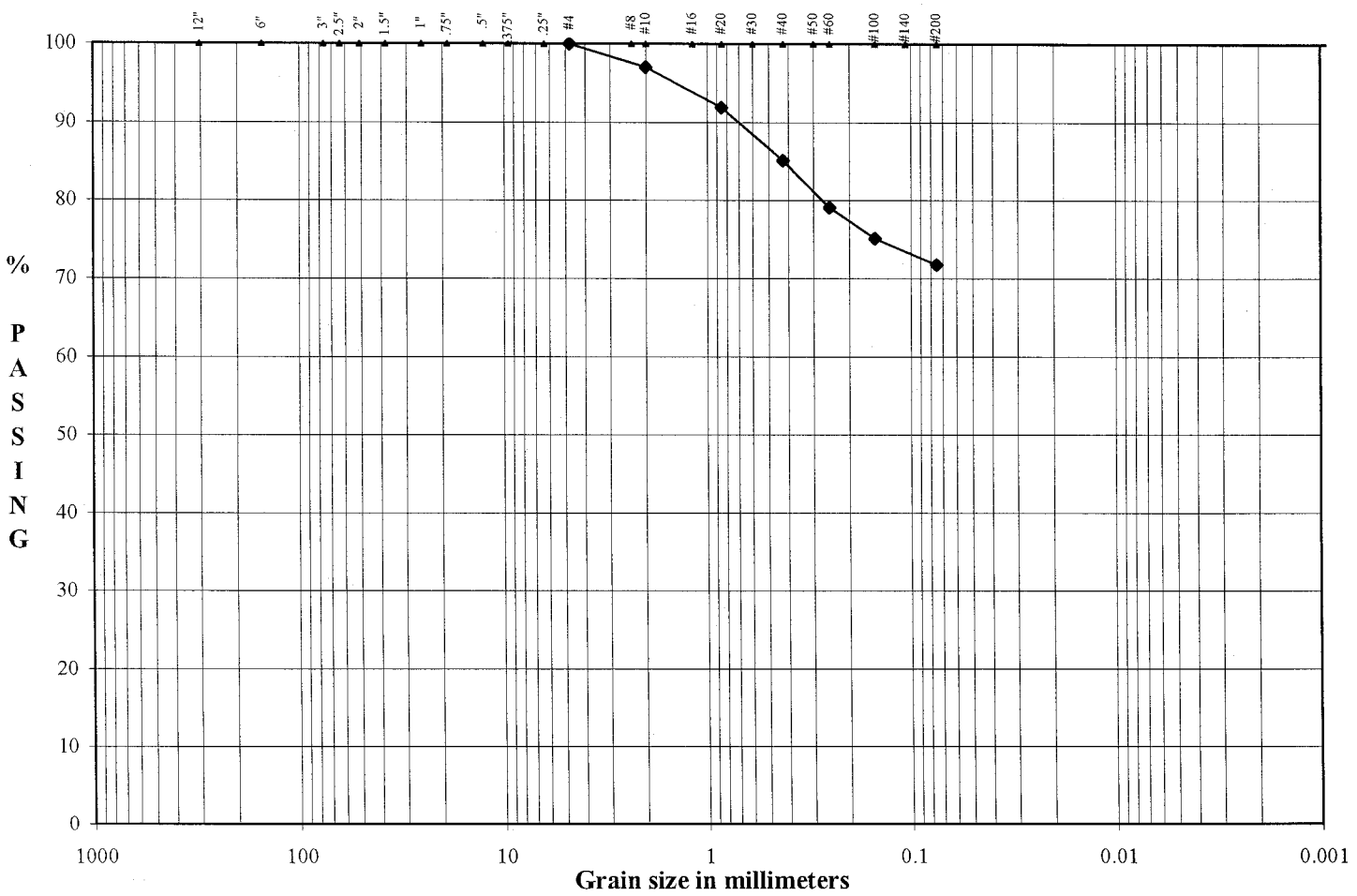
Standard Test Method for Particle-Size Analysis of Soils and Aggregates

PROJECT #	G05-0054-00	SAMPLE ID	G12244/BGDSDO51005	TECH	VG
PR. NAME	INDIAN HEAD CTO-111	SAMPLE TYPE	JAR	DATE	11/06/05
LOCATION	-	SAMPLE DEPTH	-	CHECK	

Particle-Size Analysis



Boulders	Cobbles	Gravel: Coarse	Gravel: Fine	Sand: Coarse	Sand: Medium	Sand: Fine	Fines: Silt-Clay

D_{10}	NA	mm
D_{30}	NA	mm
D_{60}	NA	mm
Cu	NA	
Cc	NA	

SOIL 3.xls [Particle-Size Graph], REV. 2; 07/21/04

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ASTM D422, D1140, C136, C117 / AASHTO T88, T27, T 11, T311
Standard Test Method for Particle-Size Analysis of Soils and Aggregates

PROJECT NUMBER	G05-0054-00	SAMPLE ID	G12245/BGDSD05P	TECH	VG
PROJECT NAME	INDIAN HEAD CTO-111	SAMPLE TYPE	JAR	DATE	11/06/05
SAMPLE LOCATION	-	SAMPLE DEPTH	-	CHECK	

AS-RECEIVED MOISTURE CONTENT

Mass of Wet Sample & Tare, g	639.66
Mass of Dry Sample & Tare, g	439.72
Mass of Tare, g	373.00
Moisture Content, %	299.7

HYGROSCOPIC MOISTURE CONTENT

Mass of Wet Sample & Tare, g	
Mass of Dry Sample & Tare, g	
Mass of Tare, g	
Moisture Content, %	NA

Mass of Wet Sample & Tare, g	639.66
Mass of Tare, g	373.00
Mass of Dry Sample, g	66.72

REMARKS

SIEVE ANALYSIS*

PORTION OF SAMPLE RETAINED ON # 4 SIEVE

Mass of Tare, g: 0.00

Sieve Size		Sample & Tare, g	% RETAINED	% PASSING
12"	COBBLES		0.0	100.0
3"	COARSE GRAVEL		0.0	100.0
2.5"			0.0	100.0
2"			0.0	100.0
1.5"			0.0	100.0
1"			0.0	100.0
.75"	FINE GRAVEL		0.0	100.0
.5"			0.0	100.0
.375"		0.00	0.0	100.0
#4	COARSE SAND	1.48	2.2	97.8

PORTION OF SAMPLE PASSING # 4 SIEVE

Sieve Size		Cumulative Mass retained, g	% PASSING
#10	MEDIUM SAND	6.79	89.8
#20		13.44	79.9
#40	FINE SAND	20.20	69.7
#60		25.09	62.4
#100		28.87	56.7
#200	FINES	32.23	51.7

* - ASTM Definitions of Classification
** - AASHTO Definitions of Classification

Oven ID #	109/399
Balance ID#	105/398/297
Sieve Shaker ID #	119/1529

PARTICLE-SIZE ANALYSIS*

% COBBLES	0.0	% MEDIUM Sand	20.1
% COARSE Gravel	0.0	% FINE Sand	18.0
% FINE Gravel	2.2	% FINES	51.7
% COARSE Sand	8.0	% TOTAL SAMPLE	100.0

PARTICLE-SIZE ANALYSIS**

% COBBLES	0.0	% COARSE Sand	20.1
% COARSE Gravel (Stone)	0.0	% FINE Sand	18.0
% MEDIUM Gravel (Stone)	0.0	% FINES (Silt-Clay)	51.7
% FINE Gravel (Stone)	10.2	% TOTAL SAMPLE	100.0

DESCRIPTION: NA

USCS (ASTM D2487; D2488): NA AASHTO (M 145): NA

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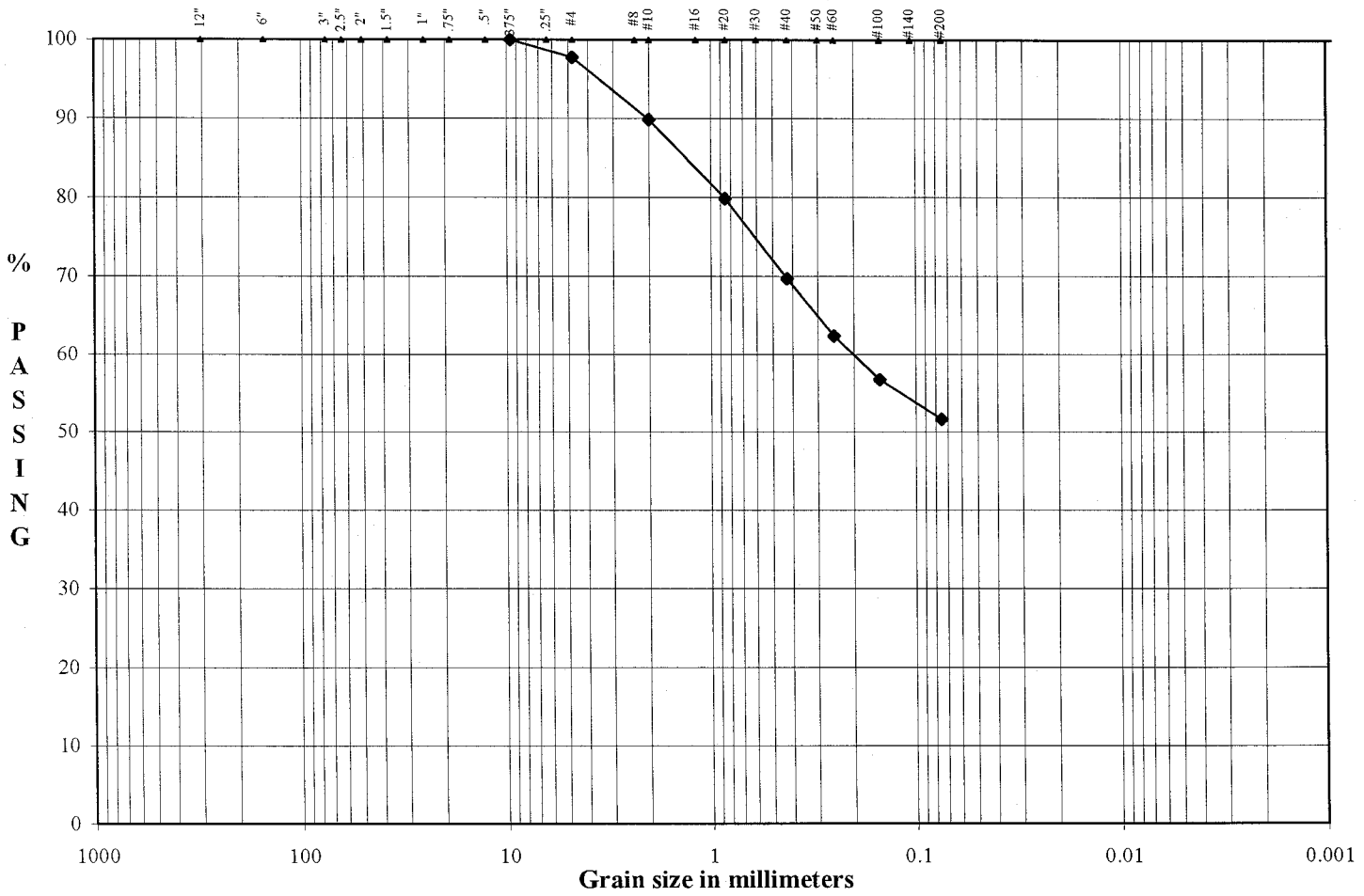
PROJECT #	G05-0054-00	SAMPLE ID	G12245/BGDSD05P	TECH	VG
PR. NAME	INDIAN HEAD CTO-111	SAMPLE TYPE	JAR	DATE	11/06/05
LOCATION	-	SAMPLE DEPTH	-	CHECK	

Particle-Size Analysis



Boulders	Cobbles	Gravel: Coarse	Gravel: Fine	Sand: Coarse	Sand: Medium	Sand: Fine	Fines: Silt-Clay

D_{10}	NA	mm
D_{30}	NA	mm
D_{60}	NA	mm
Cu	NA	
Cc	NA	

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PROJECT NUMBER	G05-0054-00	SAMPLE ID	G12246/BGDSD06	TECH	VG
PROJECT NAME	INDIAN HEAD CTO-111	SAMPLE TYPE	JAR	DATE	11/06/05
SAMPLE LOCATION	-	SAMPLE DEPTH	-	CHECK	

AS-RECEIVED MOISTURE CONTENT

Mass of Wet Sample & Tare, g	601.31
Mass of Dry Sample & Tare, g	411.87
Mass of Tare, g	308.79
Moisture Content, %	183.8

HYGROSCOPIC MOISTURE CONTENT

Mass of Wet Sample & Tare, g	
Mass of Dry Sample & Tare, g	
Mass of Tare, g	
Moisture Content, %	NA

Mass of Wet Sample & Tare, g	601.31
Mass of Tare, g	308.79
Mass of Dry Sample, g	103.08

REMARKS

SIEVE ANALYSIS*

PORTION OF SAMPLE RETAINED ON # 4 SIEVE

Mass of Tare, g: 0.00

Sieve Size		Sample & Tare, g	% RETAINED	% PASSING
12"	COBBLES		0.0	100.0
3"	COARSE GRAVEL		0.0	100.0
2.5"			0.0	100.0
2"			0.0	100.0
1.5"			0.0	100.0
1"			0.0	100.0
.75"	FINE GRAVEL		0.0	100.0
.5"			0.0	100.0
.375"			0.0	100.0
#4	COARSE SAND	0.00	0.0	100.0

PORTION OF SAMPLE PASSING # 4 SIEVE

Sieve Size		Cumulative Mass retained, g	% PASSING
#10	MEDIUM SAND	2.33	97.7
#20		10.27	90.0
#40	FINE SAND	19.46	81.1
#60		30.31	70.6
#100		58.14	43.6
#200	FINES	83.02	19.5

* - ASTM Definitions of Classification
** - AASHTO Definitions of Classification

Oven ID #	109/399
Balance ID#	105/398/297
Sieve Shaker ID #	119/1529

PARTICLE-SIZE ANALYSIS*

% COBBLES	0.0	% MEDIUM Sand	16.6
% COARSE Gravel	0.0	% FINE Sand	61.7
% FINE Gravel	0.0	% FINES	19.5
% COARSE Sand	2.3	% TOTAL SAMPLE	100.0

PARTICLE-SIZE ANALYSIS**

% COBBLES	0.0	% COARSE Sand	16.6
% COARSE Gravel (Stone)	0.0	% FINE Sand	61.7
% MEDIUM Gravel (Stone)	0.0	% FINES (Silt-Clay)	19.5
% FINE Gravel (Stone)	2.3	% TOTAL SAMPLE	100.0

DESCRIPTION: NA

USCS (ASTM D2487; D2488): NA AASHTO (M 145): NA

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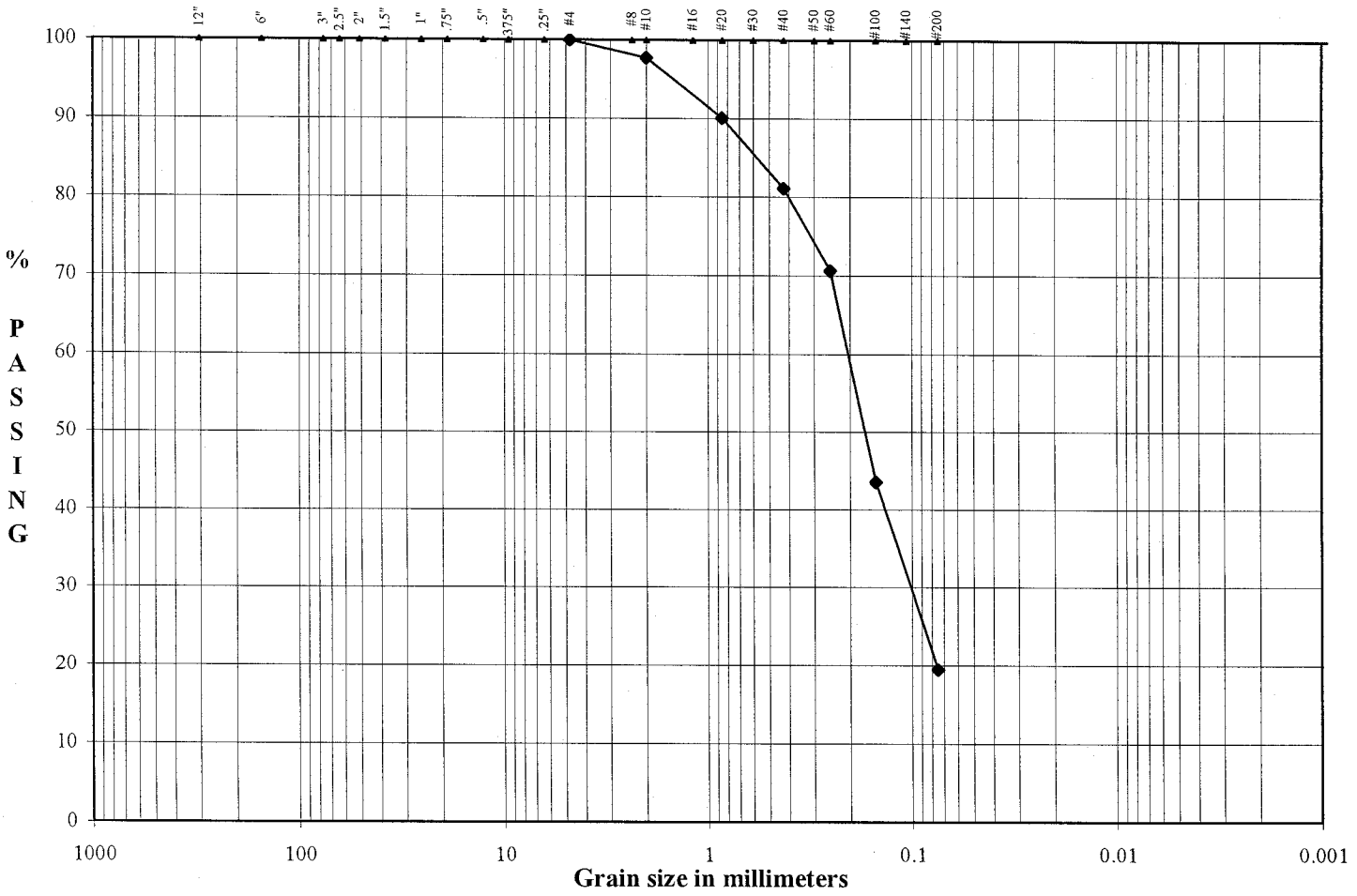
Standard Test Method for Particle-Size Analysis of Soils and Aggregates

PROJECT #	G05-0054-00	SAMPLE ID	G12246/BGDSD06	TECH	VG
PR. NAME	INDIAN HEAD CTO-111	SAMPLE TYPE	JAR	DATE	11/06/05
LOCATION	-	SAMPLE DEPTH	-	CHECK	

Particle-Size Analysis



Boulders	Cobbles	Gravel		Sand			Fines
		Coarse	Fine	Coarse	Medium	Fine	Silt-Clay

D_{10}	NA	mm
D_{30}	NA	mm
D_{60}	NA	mm
Cu	NA	
Cc	NA	

SOIL 3.xls [Particle-Size Graph], REV. 2; 07/21/04

Appendix C
Toxicological Evaluation of Sediment Samples

TOXICOLOGICAL EVALUATION OF SEDIMENT SAMPLES

Site 28 Baseline Ecological Risk Assessment
Indian Head CTO-111
***Hyalella azteca* Survival and Growth Evaluation**

Project Number 152962.AR.FI

Prepared For

CH2M Hill, Inc.
13921 Park Center
Herndon, VA 20171

By

EnviroSystems, Incorporated
1 Lafayette Road
Hampton, New Hampshire 03842

December 2005
Reference Number 13906-05-11

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TOXICOLOGICAL EVALUATION OF SEDIMENT SAMPLES

Site 28 Baseline Ecological Risk Assessment
Indian Head CTO-111
***Hyalella azteca* Survival and Growth Evaluation**

Project Number 152962.AR.FI

1.0 INTRODUCTION

Toxicity tests expose groups of organisms to environmental samples, a laboratory control and/or a field reference site for a specified period to assess potential impacts on a variety of endpoints, such as survival, growth or reproduction. Analysis of variance techniques are used to determine the relative toxicity of the samples as compared to the laboratory control and/or field reference site.

This report presents the results of chronic exposure, survival and growth, toxicity tests conducted on samples collected from the Site 28 Baseline Ecological Risk Assessment project site. The samples were provided by CH2M Hill, Herndon, VA. Testing was based on programs and protocols developed by the ASTM (2004) and US EPA (2000). The toxicity of the samples was assessed by conducting toxicity tests using the freshwater amphipod *Hyalella azteca*. Assays and supporting analyses were performed at EnviroSystems, Incorporated (ESI), Hampton, Massachusetts.

2.0 MATERIALS AND METHODS

2.1 General Methods, Biological Evaluations

Toxicological and analytical protocols used in this program follow procedures outlined in *Test Methods for Measuring the Toxicity of Sediment-Associated Contaminants with Freshwater Invertebrates* (ASTM 2001), *Methods for Measuring the Toxicity and Bioaccumulation of Sediment-associated Contaminants with Freshwater Invertebrates* (US EPA 2000) and *Standard Methods for the Examination of Water and Wastewater*, 20th Edition (APHA 1998). These protocols provide standard approaches for physical and chemical analysis and for the evaluation of toxicological effects of sediments on aquatic invertebrates.

2.2 Test Species

H. azteca were obtained from Aquatic Research Organisms (ARO), Hampton, Massachusetts. Organisms were second instar, approximately 10 - 12 days old, at the start of the assay. Organisms were received at ESI the day prior to starting the assays. Organisms were held in a mix of moderately hard and natural surface water prior to the start of the assay.

2.3 Test Samples and Laboratory Control Sediment

2.3.1 Test Samples

Sediment samples from the Site 28 Baseline Ecological Risk Assessment project site were received by ESI on October 28, 2005. On receipt, samples were inspected, to determine integrity, given unique sample numbers and logged into the laboratory sample management database. Once logged into the sample management database samples were placed in a secure refrigerated, 2 - 4 °C, storage area until required. A listing of sample description, collection and receipt information is summarized in Table 1.

2.3.2 Control Sediments and Overlying Waters

The amphipod assay laboratory control substrate was an artificial sediment consisting primarily of varying size silica sand, with approximately 3-5%, by weight, of natural detritus. The detritus was collected above the water line at a natural water body but in a damp area. The top 0.5 to 1.0 cm of the sediment was collected and autoclaved prior to use in the assay. Additionally, the sediment was supplemented with a laboratory organic mixture prepared by ESI. The material was prepared by soaking trout chow with yeast until it fermented. The digested material was then autoclaved, bottled and stored until required. The organic detritus was mixed into the silica sand. Overlying water was a mix of moderately hard synthetic and natural surface water. The surface water was collected from Bow Lake, Strafford, New Hampshire. Use of synthetic/natural surface water mix is recommended by the protocol (EPA 2000, ASTM 2004) over an artificial reconstituted water.

2.4 *Hyalella azteca* Survival and Growth Assays

The 28 day amphipod survival and growth tests were conducted according to ASTM Method E 1706-95 (ASTM 2001) and EPA method 100.4 (EPA 2000). Endpoints of the assay were survival and growth, measured as dry weight. The assays were started on November 17 and terminated on December 15, 2005.

The site sediment and laboratory control sediment treatments consisted of 8 replicates with 10 organisms/replicate. Test vessels were 400 mL glass beakers containing approximately 150 mL of sediment and 200 mL of overlying water. The overlying water volume to sediment surface area ratio was approximately 7:1. Test vessels were drilled at a consistent height above their bases and the hole covered with Nytex® screen. The screened hole facilitated water exchange without compromising organisms. Vessels were maintained in a water bath during the assay. Depth of the water in the bath was set to be approximately 1 cm below the drain hole in the test vessel to eliminate flow of water from the bath into the test vessel. The water bath was maintained in a limited-access temperature controlled room. Temperatures in the room and water bath were independently maintained at 23 ±1°C. The photoperiod in the test chamber was set at 16:8 hour light:dark. Light was provided by cool white flourescent bulbs.

One day prior to test initiation (Day -1), control and test sediments were sieved using a 2 mm sieve to remove rocks, twigs, and other debris. Sediments were placed in the test vessels. Overlying water was immediately added, and the vessels were left undisturbed overnight to settle. Floating detritus was removed the next morning. On Day 0, organisms were added below the water surface of each test vessel.

Overlying water in each replicate was renewed daily after collection of water quality data. The volume of water added to each test chamber was approximately 500 mL or two volumes. Water exchanges were facilitated by use of a distribution system designed to provide equal, regulated, flow to each chamber. The system was activated manually by the addition of water during the assay.

Prior to the daily overlying water renewal, temperature, specific conductance, pH, dissolved oxygen and ammonia were measured in one replicate of each treatment. A temperature data logger was placed in a surrogate test chamber to collect data on a hourly basis during the 10 day exposure period. Alkalinity and hardness of the overlying water were measured at the start and end of the assay. Daily overlying water quality records are available in Appendix A. Each replicate was fed 1.0 mL of a yeast/trout chow/alfalfa suspension after the daily renewal.

After 28 days exposure, all replicates of each test treatment were terminated to collect data for the survival and growth endpoints. Each test chamber was gently swirled to loosen the sediments and the test material was dumped into an 8" stainless steel sieve with a 0.5 mm mesh screen. The sediments were washed through the sieve using synthetic, moderately hard reconstituted water and material left on the screen was sorted to recover the organisms. This process was continued until the entire sample was evaluated. Organisms recovered were set aside to determine growth. Surviving amphipods were counted and placed on tared weighing pans. Pans were dried overnight at 70°C to obtain dry weight to the nearest 0.01 mg. The mean dry weight of surviving organisms was determined to assess growth.

2.5 Statistical Analysis

Endpoints were analyzed using CETIS® (Comprehensive Environmental Toxicity Information System) software to determine significant differences between the test sediments and the laboratory control sediment. Data sets were evaluated using EPA Decision Tree protocol to select the most appropriate statistical model for analysis of the data. Statistical difference was evaluated at α=0.05. Statistical comparisons were made against the laboratory control treatment and project reference sites.

2.6 Quality Control

As part of the laboratory quality control program, reference toxicant evaluations are conducted by ESI on a regular basis for each test species. These results provide relative health and response data while allowing for comparison with historic data sets. Results were within two standard deviations of ESI's historic mean for the species. Results are summarized in Table 2.

2.7 Protocol Deviations

Review of data collected during this series of assays documented a single deviation from the prescribed protocol. The method protocol specified that temperature should be monitored daily in one chamber from each treatment and should be monitored continuously in the water bath holding the test chambers. To obtain continuous temperature data a data logger was placed in the water bath and set to collect data on an hourly basis. At the end of the assay it was not possible to recover data from the logger due to a malfunction in the logger's ability to transfer stored data from the unit to a host computer. As daily temperature values were collected from at least one replicate for each treatment data is available to document temperatures during the assay and variation between test chambers. Additionally, historic data collected from the laboratory facility used to

conduct the assay has documented that temperatures in the water bath in the temperature controlled room have not varied by more than ±3C from the set value of 23°C. This deviation was determined to not have a significant negative impact on the overall outcome of the assay.

3.0 TOXICOLOGICAL TESTING RESULTS AND DISCUSSION

Amphipod survival and growth data for the 10 day exposure assays are summarized in Tables 3 and 4. Water quality data collected during the assays are summarized in Table 5. Support data, including copies of laboratory bench sheets, individual endpoint summaries and statistical analysis data printouts are provided in Appendix A.

3.1 *Hyalella azteca* Survival and Growth Assays

Mean survival and growth in the laboratory control treatment at the end of the 28-day exposure period was 90.0% and 0.414 mg/amphipod, respectively. At the start of the assay the amphipods had a mean dry weight of 0.039 mg/individual. These values exceeded minimum endpoint requirements for the assay of 80% survival and demonstration of growth. Temperatures during the exposure period ranged from 21 to 25°C with a mean value of 22.8°C. These values are within the acceptable range of 23±1°C, mean, and 20 to 26°C maximum range specified by the protocol.

Tables 3 and 4 provide a summary of survival and growth data plus associated statistical analysis results. Mean survival in the project site sediments ranged from 0.0 - 93.75%. Mean growth, dry weight, of the surviving amphipods ranged from 0.391 - 0.660 mg/amphipod. Statistical analysis of the survival data documented that amphipods maintained in the project site sediments, as compared to both project reference sites, showed significant reduction in survival at two sites, IS28SD01 and IS28SD03. Review of growth data showed significant reductions in growth for amphipods exposed to sediments from sites IS28SD11 and IS28SD13 when compared to project reference site IS28REF2.

4.0 REFERENCES

APHA. 1998. *Standard Methods for the Examination of Water and Wastewater*, 20th Edition. Washington D.C.

ASTM. 2001. Annual Book of ASTM Standards. Volume 11.05. *Test Methods for Measuring the Toxicity of sediment-Associated Contaminants with Freshwater Invertebrates*. E 1706-00. ASTM, Philadelphia.

U.S. EPA. 2000. *Methods for Measuring the Toxicity and Bioaccumulation of Sediment-associated Contaminants with Freshwater Invertebrates.* Second Edition. EPA/600-R-99/064.

Table 1. Sample Collection and Receipt Summary. Site 28 Baseline Ecological Risk Assessment. Indian Head CTO-111. CH2M Hill December 2005.

Sample ID	ESI Lab Code	Matrix	Sample Collected Date	Sample Collected Time	Sample Received Date	Sample Received Time
IS28SD01	13906-001	Sediment	10/26/05	1030	10/28/05	1030
IS28SD02	13906-002	Sediment	10/27/05	900	10/28/05	1030
IS28SD03	13906-003	Sediment	10/26/05	845	10/28/05	1030
IS28SD11	13906-004	Sediment	10/25/05	1450	10/28/05	1030
IS28SD13	13906-005	Sediment	10/27/05	1000	10/28/05	1030
IS28REF1	13906-006	Sediment	10/26/05	1540	10/28/05	1030
IS28REF2	13906-007	Sediment	10/27/05	1130	10/28/05	1030

TABLE 2. Reference Toxicant Evaluation. Site 28 Baseline Ecological Risk Assessment. Indian Head CTO-111. CH2M Hill December 2005.

Date	Endpoint	Value	N	Historic Mean/ Central Tendency	Acceptable Range	Reference Toxicant
H. azteca						
11/03/05	Survival LC-50	0.0045	44	0.013	0.000 - 0.072	Cadmium(mg/L)

Note: Reference toxicant testing was conducted at ESI.

Table 3. *Hyalella azteca* Day 28 Survival Summary. Site 28 Baseline Ecological Risk Assessment. Indian Head CTO-111. CH2M Hill December 2005.

			Survival Summary			
Sample ID	Lab Code	# Reps	Mean	Minimum	Maximum	CV
LAB CONTROL	13906-000	8	90.00%	80.0%	100.0%	8.40%
IS28REF1	13906-006	8	87.50%	70.0%	100.0%	13.31%
IS28REF2	13906-007	8	90.00%	80.0%	100.0%	8.40%
IS28SD01	13906-001	8	71.25%	60.0%	100.0%	20.46%
IS28SD02	13906-002	8	78.75%	50.0%	100.0%	21.93%
IS28SD03	13906-003	8	0.00%	0.0%	0.0%	0.00%
IS28SD11	13906-004	8	91.25%	80.0%	100.0%	9.15%
IS28SD13	13906-005	8	93.75%	80.0%	100.0%	9.77%

Percent Survival			Statistically Significant Difference as Compared to					
Sample ID	Lab Code	Mean	Lab Control		IS28REF1		IS28REF2	
			p Value		p Value		p Value	
LAB CONTROL	13906-000	90.00%	-	-	-	-	-	-
IS28REF1	13906-006	87.50%	0.3374	No	-	-	-	-
IS28REF2	13906-007	90.00%	0.4796	No	0.6552	No	-	-
IS28SD01	13906-001	71.25%	0.0045	Yes	0.0187	Yes	0.0045	Yes
IS28SD02	13906-002	78.75%	0.0714	No	0.1488	No	0.0728	No
IS28SD03	13906-003	0.00%	0.0001	Yes	0.0000	Yes	0.0001	Yes
IS28SD11	13906-004	91.25%	0.6166	No	0.7415	No	0.6285	No
IS28SD13	13906-005	93.75%	0.8123	No	0.8682	No	0.8213	No

Table 4. *Hyalella azteca* Day 28 Growth Summary. Site 28 Baseline Ecological Risk Assessment. Indian Head CTO-111. CH2M Hill December 2005.

			Growth - Measured As Dry Weight (mg) / Amphipod			
Sample ID	Sample	# Reps	Mean	Minimum	Maximum	CV
LAB CONTROL	13906-000	8	0.414	0.286	0.587	27.37%
IS28REF1	13906-006	8	0.402	0.360	0.503	11.61%
IS28REF2	13906-007	8	0.522	0.427	0.602	10.54%
IS28SD01	13906-001	8	0.660	0.439	0.943	23.40%
IS28SD02	13906-002	8	0.475	0.384	0.612	19.29%
IS28SD03	13906-003	8	No Surviving Organisms			
IS28SD11	13906-004	8	0.391	0.211	0.514	29.27%
IS28SD13	13906-005	8	0.440	0.341	0.522	15.47%

Mean Dry Weight (mg) / Amphipod			Statistically Significant Difference as Compared to					
Sample ID	Lab Code	Mean	Lab Control		IS28REF1		IS28REF2	
			p Value		p Value		p Value	
LAB CONTROL	13906-000	0.414	-	-	-	-	-	-
IS28REF1	13906-006	0.402	0.3900	No	-	-	-	-
IS28REF2	13906-007	0.522	0.9849	No	0.9998	No	-	-
IS28SD01	13906-001	0.660	0.9986	No	0.9990	No	0.9842	No
IS28SD02	13906-002	0.475	0.8715	No	0.9682	No	0.1193	No
IS28SD03	13906-003	-	-	-	-	-	-	-
IS28SD11	13906-004	0.391	0.3426	No	0.4005	No	0.0056	Yes
IS28SD13	13906-005	0.440	0.7022	No	0.8917	No	0.0095	Yes

Table 5. *Hyalella azteca* Survival and Growth Evaluation Supporting Water Chemistries. Site 28 Baseline Ecological Risk Assessment. Indian Head CTO-111. CH2M Hill December 2005.

Field ID	Lab Code	Exposure (Days)	Alkalinity (mg/L)	Hardness (mg/L)	Ammonia (mg/L)	Conductivity (µmho/cm)	pH (SU)
LAB CONTROL	13906-000	Day 0	24	40	0.45	201	7.01
		Day 28	34	56	<0.1	217	6.84
IS28REF1	13906-006	Day 0	30	53	0.24	239	7.22
		Day 28	47	88	<0.1	295	7.40
IS28REF2	13906-007	Day 0	41	61	0.70	268	7.26
		Day 28	47	81	<0.1	276	7.43
IS28SD01	13906-001	Day 0	47	58	0.51	232	7.34
		Day 28	47	69	<0.1	259	7.04
IS28SD02	13906-002	Day 0	33	50	0.26	222	7.35
		Day 28	48	81	<0.1	280	7.14
IS28SD03	13906-003	Day 0	56	57	0.89	266	7.30
		Day 28	53	120	<0.1	250	7.13
IS28SD11	13906-004	Day 0	56	58	0.58	227	7.33
		Day 28	52	75	<0.1	272	7.36
IS28SD13	13906-005	Day 0	38	55	0.73	236	7.29
		Day 28	50	80	<0.1	2795	7.48

Note:
* Additional water quality data are detailed in data appendix.

APPENDIX A
RAW DATA
STATISTICAL SUPPORT

Contents	Number of Pages
H. Azteca Sediment Evaluation	
Daily Water Quality Measurements and Feeding Record	4
Day 28 Organism Recovery Bench Sheets	6
Day 28 Dry Weight Data Bench Sheets	1
Day 28 Survival and Growth Statistical Analysis	39
Initial Dry Weight Data	1
Organism History	1
Analytical Chemistry Support Data Summary Report - Water Chemistry	3
Sample Receipt and Chain of Custody Records	2
Total Appendix Pages	57

H. azteca SEDIMENT ASSAY
Daily Water Quality Measurements & Feeding Record

STUDY # 13906	Client: CH2M Hill	Overlying Water: MHR/Pond	START DATE: 11/17/05

DAY	Lab				-001				Water Quality Station #	S/C Meter #	ΔH_2O fed	DATE	INIT
	D.O. (mg/L)	Cond. (µMHOS/cm)	pH (SU)	Temp. (°C)	D.O. (mg/L)	Cond. (µMHOS/cm)	pH (SU)	TEMP (°C)					
0	7.6	201	7.01	21	7.6	232	7.34	21	1	330i	✓	11/17/05	BB
1	7.7	204	6.91	21	7.7	296	7.12	21	1	330i	✓	11/18/05	BB
2	7.1	206	6.80	21	7.0	328	7.12	21	1	330i	✓	11/19/05	BB
3	7.5	227	6.62	23	6.7	382	7.32	23	1	330i	✓	11/20/05	BB
4	7.4	227	6.60	24	6.8	320	7.14	24	1	330i	✓	11/21/05	BB
5	7.9	228	6.75	24	7.3	308	7.25	24	1	330i	✓	11/22/05	BB
6	8.5	216	6.70	23	7.9	274	7.23	23	1	330i	✓	11-23-05	CP
7	6.0	218	6.92	24	5.1	272	7.09	23	1	330i	✓	11/24	CVB
8	7.3	230	6.80	21	7.0	281	7.16	21	1	330i	✓	11/25	YL
9	9.2	226	6.78 ~~6.45~~	21	9.6	288	7.23 ~~6.66~~	23	1	330i	✓	11-26	CP
10	7.5	226	6.68	22	7.3	315	7.52	24	2	330i	✓	11/27	YL
11	7.9	187	6.65	22	7.3	295	7.31	23	1	330i	✓	11-28	AF
12	7.7	192	6.91	23	7.6	280	7.17	23	2	330i	✓	11/29	YL
13	8.0	192	6.70	25	7.6	260	7.33	25	2	330i	✓	11/30	YL
14	7.6	204	6.64	23	7.6	265	6.92	23	2	330i	✓	12/1/05	BB
15	7.1	190	6.71	23	7.2	246	7.19	23	2	330i	✓	12/2/05	BB
16	7.2	207	6.57	23	6.0	280	6.99	23	1	330i	✓	12/3/05	BB
17	7.9	200	7.01	23	7.2	256	7.21	23	2	330i	✓	12-4	CP
18	7.5	220	6.62	23	7.1	291	6.94	23	2	330i	✓	12-5	YL
19	8.8	208	6.78	21	8.2	272	7.12	21	2	330i	✓	12-6	YL
20	8.9	195	6.94	22	9.0	262	7.33	22	2	330i	✓	12-7	YL
21	8.6	204	6.79	21	8.4	264	7.48	21	2	330i	✓	12/8	YL
22	7.4	229	7.00	23	6.9	287	7.35	23	1	330i	✓	12/9	YL
23	~~6.2~~	187	6.91	24	6.3	249	7.31	24	2	330i	✓	12/10/05	BB
24	6.3	154	7.07	25	6.3	215	7.27	25	1	330i	✓	12/11/05	PS
25	8.2	184	7.18	24	7.9	238	7.27	25	1	330i	✓	12/12	YL
26	7.7	203	7.22	25	7.8	250	7.37	25	1	330i	✓	12/13	YL
27	8.5	205	7.27	22	8.4	240	7.33	22	1	330i	✓	12/14	YL
28	7.6	217	6.84	23	7.6	259	7.04	23	2	330i	✓	12/15/05	BB

Pull Alkalinity, Hardness, Ammonia Day 0, 7, 14, 21, 28
23° C
Feed 1 mL of YCT/Replicate Daily
Two Volume Additions Daily

H. azteca SEDIMENT ASSAY
Daily Water Quality Measurements & Feeding Record

STUDY # 13906	Client: CH2M Hill	Overlying Water: MHR/Pond	START DATE: 11/17/05

DAY	-002				-003				Water Quality Station #	S/C Meter #	ΔH_2O fed	DATE	INIT
	D.O. (mg/L)	Cond. (µMHOS/cm)	pH (SU)	Temp. (°C)	D.O. (mg/L)	Cond. (µMHOS/cm)	pH (SU)	TEMP (°C)					
0	8.3	222	7.35	21	6.3	266	7.30	21	1	330i	✓	11/17/05	BB
1	7.7	281	7.20	21	6.9	393	7.26	21	1	330i	✓	11/18/05	BB
2	6.8	301	7.16	21	6.7	430	7.32	21	1	330i	✓	11/19/05	BB
3	7.2	346	7.37	23	7.1	525	7.48	23	1	330i	✓	11/20/05	BB
4	6.9	306	7.25	24	5.2	487	7.41	24	1	330i	✓	11/21/05	BB
5	7.5	293	7.26	24	6.3	401	7.45	24	1	330i	✓	11/22/05	BB
6	8.2	265	7.32	23	7.8	343	7.45	23	1	330i	✓	11/23	YK
7	5.4	259	7.17	23	4.5	320	7.29	23	1	330i	✓	11/24	CMS
8	6.9	257	7.39	21	6.9	316	7.58	21	1	330i	✓	11/24	YK
9	9.8	247	7.32	23	7.8	300	7.40	23	1	330i	✓	11-26	CP
10	7.5	258	7.45	24	6.5	331	7.48	24	2	330i	✓	11/27	YK
11	7.5	233	7.30	23	6.3	302	7.36	23	1	330i	✓	11-28	AF
12	7.6	236	7.30	23	6.7	294	7.38	23	1	330i	✓	11/29	YK
13	7.6	233	7.30	26	6.5	279	7.38	25	2	330i	✓	11/30	YK
14	7.2	245	7.25	24	7.3	268	7.32	24	2	330i	✓	12/1/05	BB
15	6.8	234	7.47	23	6.7	247	7.31	23	2	330i	✓	12/2/05	BB
16	6.1	268	7.35	23	6.1	266	7.20	23	1	330i	✓	12/3/05	BB
17	8.1	252	7.45	23	7.3	236	7.42	23	2	330i	✓	12-4	CP
18	7.4	293	7.50	23	7.0	248	7.34	23	2	330i	✓	12-5	YK
19	8.3	273	7.49	22	8.4	245	7.36	22	2	330i	✓	12-6	YK
20	8.9	268	7.44	22	8.6	235	7.54	22	2	330i	✓	12-7	YK
21	8.5	270	7.64	21	8.7	232	7.60	21	2	330i	✓	12-8	YK
22	7.0	308	7.75	24	6.8	255	7.55	24	1	330i	✓	12/9	YK
23	6.3	284	7.62	24	6.4	232	7.31	24	2	330i	✓	12/10/05	BB
24	6.6	238	7.70	25	5.9	178	7.45	25	1	330i	✓	12/11/05	PS
25	8.3	270	7.90	25	8.0	206	7.75	25	1	330i	✓	12/12	YK
26	8.1	281	7.65	25	7.7	227	7.52	25	1	330i	✓	12/13	YK
27	8.4	263	7.46	22	8.3	228	7.40	22	1	330i	✓	12/14	YK
28	7.4	280	7.14	23	7.4	250	7.13	23	2	330i	✓	12/15/05	BB

Pull Alkalinity, Hardness, Ammonia Day 0, 7, 14, 21, 28
23° C
Feed 1 mL of YCT/Replicate Daily
Two Volume Additions Daily

H. azteca SEDIMENT ASSAY
Daily Water Quality Measurements & Feeding Record

STUDY # 13906	Client: CH2M Hill	Overlying Water: MHR/Pond	START DATE: 11/17/05

DAY	-004				-005				Water Quality Station #	S/C Meter #	ΔH₂O fed	DATE	INIT
	D.O. (mg/L)	Cond. (µMHOS/cm)	pH (SU)	Temp. (°C)	D.O. (mg/L)	Cond. (µMHOS/cm)	pH (SU)	TEMP (°C)					
0	8.1	227	7.33	21	8.1	236	7.29	21	1	330i	✓	11/17/05	BB
1	7.3	293	7.31	21	7.6	296	7.27	21	1	330i	✓	11/18/05	BB
2	6.7	315	7.35	21	7.1	325	7.29	21	1	330i	✓	11/19/05	BB
3	7.1	358	7.44	23	7.2	371	7.34	23	1	330i	✓	11/20/05	BB
4	6.7	312	7.40	24	6.9	331	7.32	24	1	330i	✓	11/21/05	BB
5	7.3	243	7.42	24	7.6	307	7.32	24	1	330i	✓	11/22/05	BB
6	8.0	258	7.41	23	8.0	269	7.34	24	1	330i	✓	11/23	YL
7	4.9	257	7.29	23	5.4	257	7.22	23	1	330i	✓	11/24	CB
8	6.9	251	7.56	21	7.0	249	7.42	21	1	330i	✓	11/25	YL
9	8.0	240	7.32	23	8.2	246	7.29	24	1	330i	✓	11-26	CP
10	7.5	248	7.42	24	7.6	248	7.33	24	2	330i	✓	11/27	YL
11	7.3	228	7.17	24	7.5	224	7.13	24	1	330i	✓	11-28	AF
12	7.5	228	7.34	23	7.6	229	7.30	23	2	330i	✓	11/29	YL
13	7.5	223	7.33	26	7.7	220	7.22	26	2	330i	✓	11/30	YL
14	7.3	224	7.28	24	7.4	224	7.16	24	2	330i	✓	12/1/05	BB
15	6.7	213	7.33	23	7.1	216	7.25	23	2	330i	✓	12/2/05	BB
16	6.4	234	7.22	23	6.7	227	7.18	23	1	330i	✓	12/3/05	BB
17	8.2	224	7.44	23	8.1	220	7.49	23	2	330i	✓	12-4	CP
18	7.7	261	7.34	23	7.5	251	7.28	23	2	330i	✓	12-5	YL
19	8.4	237	7.29	22	8.3	233	7.28	22	2	330i	✓	12-6	YL
20	8.8	241	7.55	22	8.8	227	7.54	22	2	330i	✓	12-7	YL
21	8.7	239	7.62	21	8.8	244	7.56	21	2	330i	✓	12-8	YL
22	7.3	267	7.52	24	7.6	264	7.55	24	1	330i	✓	12/9	YL
23	6.0	248	7.54	24	6.3	247	7.55	24	2	330i	✓	12/10/05	BB
24	6.6	210	7.56	25	6.7	206	7.58	25	1	330i	✓	12/11/05	PS
25	7.9	239	7.80	25	7.8	236	7.82	25	1	330i	✓	12/12	YL
26	7.8	261	7.70	25	7.9	263	7.81	25	1	330i	✓	12/13	YL
27	8.6	255	7.57	22	8.4	260	7.65	22	1	330i	✓	12/14	YL
28	7.3	222	7.36	23	7.5	279	7.48	23	2	330i	✓	12/15/05	BB

Pull Alkalinity, Hardness, Ammonia Day 0, 7, 14, 21, 28
23° C
Feed 1 mL of YCT/Replicate Daily
Two Volume Additions Daily

H. azteca SEDIMENT ASSAY
Daily Water Quality Measurements & Feeding Record

STUDY # 13906	Client: CH2M Hill	Overlying Water: MHR/Pond	START DATE: 11/17/05

DAY	-006				-007				Water Quality Station #	S/C Meter #	ΔH2O fed	DATE	INIT
	D.O. (mg/L)	Cond. (µMHOS/cm)	pH (SU)	Temp. (°C)	D.O. (mg/L)	Cond. (µMHOS/cm)	pH (SU)	TEMP (°C)					
0	8.2	239	7.22	21	7.7	268	7.26	21	1	330i	✓	11/17/05	BB
1	7.8	293	7.22	21	7.7	332	7.33	21	1	330i	✓	11/18/05	BB
2	7.1	319	7.26	21	7.1	354	7.37	21	1	330i	✓	11/19/05	BB
3	7.3	368	7.27	23	7.3	408	7.34	23	1	330i	✓	11/20/05	BB
4	7.1	326	7.30	24	6.9	323	7.30	24	1	330i	✓	11/21/05	BB
5	7.7	311	7.29	24	7.7	281	7.36	24	1	330i	✓	11/22/05	BB
6	8.3	283	7.29	23	8.0	256	7.20	23	1	330i	✓	11/23/05	YK
7	5.2	278	~~EMS~~	23	5.1	252	~~EMS~~	23	1	330i	—	11/24	[illegible]
8	6.9	260	7.33	21	6.8	273	7.47	21	1	330i	✓	11/25	YK
9	8.6	256	7.28	24	8.8	239	7.23	24	1	330i	✓	11-26	CP
10	7.4	268	7.29	24	7.3	264	7.46	24	2	330i	✓	11/27	YK
11	7.5	260	7.12	24	7.5	274	7.45	24	1	330i	✓	11-28	AF
12	7.7	250	7.20	23	7.5	813	7.22	23	2	330i	✓	11/29	YK
13	7.6	243	7.21	26	7.7	254	7.37	26	2	330i	✓	11/30	YK
14	7.6	245	7.19	24	7.6	260	7.43	24	2	330i	✓	12/1/05	BB
15	7.1	237	7.23	23	6.6	272	7.39	23	2	330i	✓	12/2/05	BB
16	6.7	256	7.15	23	6.6	285	7.38	23	1	330i	✓	12/3/05	BB
17	7.8	240	7.74	23	7.4	265	7.74	23	2	330i	✓	12-4	CP
18	7.1	276	7.31	23	6.9	293	7.54	23	2	330i	✓	12-5	YK
19	8.4	262	7.33	22	7.9	247	7.48	22	2	330i	✓	12-6	YK
20	8.7	270	7.66	22	8.6	267	7.42	22	2	330i	✓	12-7	YK
21	8.5	290	7.62	21	8.4	262	7.65	21	2	330i	✓	12-8	YK
22	7.4	313	7.65	24	7.0	270	7.64	24	1	330i	✓	12-9	YK
23	6.4	332	7.61	24	6.2	251	7.63	24	2	330i	✓	12/10/05	BB
24	6.8	317	7.80	25	6.3	225	7.67	25	1	330i	✓	12/11/05	BB
25	8.0	341	7.89	25	8.0	245	7.87	25	1	330i	✓	12/12	YK
26	8.0	310	7.90	25	8.0	259	7.81	25	1	330i	✓	12/13	YK
27	8.4	291	7.60	22	8.5	265	7.64	22	1	330i	✓	12/14	YK
28	7.5	295	7.40	23	7.6	276	7.43	23	2	330i	✓	12/15/05	BB

Pull Alkalinity, Hardness, Ammonia Day 0, 7, 14, 21, 28
23° C
Feed 1 mL of YCT/Replicate Daily
Two Volume Additions Daily

STUDY: 13906
CLIENT: CH2M Hill
PROJECT: Indian Head CTO
TASK: Hyalella azteca 28 Day Exposure Assay
DATA: Survival Summary
START DATE: 11/17/05
DATE ENDED: 12/15/05

LAB CONTROL	0A	9
	0B	9
	0C	10
	0D	8
	0E	8
	0F	9
	0G	9
	0H	12
IS28SD01	1A	7
	1B	6
	1C	10
	1D	6
	1E	6
	1F	8
	1G	8
	1H	6
IS28SD02	2A	10
	2B	7
	2C	8
	2D	7
	2E	7
	2F	10
	2G	9
	2H	5
IS28SD03	3A	0
	3B	0
	3C	0
	3D	0
	3E	0
	3F	0
	3G	0
	3H	0
IS28SD11	4A	9
	4B	9
	4C	8
	4D	10
	4E	9
	4F	10
	4G	10
	4H	8
IS28SD13	5A	10
	5B	10
	5C	10
	5D	8
	5E	10
	5F	10
	5G	9
	5H	8

IS28REF1	6A	10
	6B	7
	6C	8
	6D	10
	6E	8
	6F	8
	6G	10
	6H	9
IS28REF2	7A	9
	7B	10
	7C	8
	7D	9
	7E	9
	7F	10
	7G	9
	7H	8

ESI STUDY# 13906 CH2M Hill
***H. azteca* SEDIMENT ASSAY**

DAY 28:

SAMPLE ID	TIME	#LIVE	COMMENTS
lab A	1240	9	
lab B	1250	9	
lab C	1255	10	
lab D	1300	8	
lab E	1302	8	
lab F	1310	9	
lab G	1312	9	
lab H	1315	12	
-001A	1320	7	
-001B	1325	6	
-001C	1329	10	
-001D	1330	6	
-001E	1332	6	
-001F	1333	8	
-001G	1335	8	
-001H	1338	6	

ANALYST: [illegible]
DATE: 12/15/05

ESI STUDY# 13906 CH2M Hill
***H. azteca* SEDIMENT ASSAY**

DAY 28:

SAMPLE ID	TIME	#LIVE	COMMENTS
002-A	1:22	~~IIII~~ ~~IIII~~ - 10	
002-B	1:28	~~IIII~~ III - 7	
002-C	1:33	~~IIII~~ III - 8	
002-D	1:36	~~III~~ II - 7	
002-E	1:40	~~IIII~~ II - 7	
002-F	1:44	~~IIII~~ ~~IIII~~ - 10	
002-G	1:48	~~IIII~~ IIII - 9	
002-H	1:56	~~IIII~~ - 5	
003-A	2:02	Ø	
003-B	2:02	Ø	
003-C	2:15	Ø	
003-D	2:22	Ø	
003-E	2:26	Ø	
003-F	2:31	Ø	
003-G	2:36	Ø	
003-H	2:40	Ø	

ANALYST: G.L.
DATE: 12/15

ESI STUDY# 13906 CH2M Hill
***H. azteca* SEDIMENT ASSAY**

DAY 28:

SAMPLE ID	TIME	#LIVE	COMMENTS
-004A	1340	9	
-004B	1346	9	
-004C	1348	8	
-004D	1350	10	
-004E	1351	9	
-004F	1353	10	
-004G	1354	10	
-004H	1355	8	
-005A	1358	10	
-005B	1359	10	
-005C	1400	10	
-005D	1402	8	
-005E	1405	10	
-005F	1407	10	
-005G	1410	9	
-005H	1412	8	

ANALYST: YK
DATE: 012115/05

ESI STUDY# 13906 CH2M Hill
***H. azteca* SEDIMENT ASSAY**

DAY 28:

SAMPLE ID	TIME	#LIVE	COMMENTS
-006A	1415	10	
-006B	1418	7	
-006C	1421	8	
-006D	1425	10	
-006E	1428	8	
-006F	1432	8	
-006G	1435	10	
-006H	1440	9	
-007A	1446	9	
-007B	1450	10	
-007C	1453	8	
-007D	1455	9	
-007E	1457	9	
-007F	1459	10	
-007G	1500	9	
-007H	1503	8	

ANALYST: [illegible]
DATE: 12/15/05

Hyalella azteca Assay
GROWTH DATA

STUDY NUMBER: 13906 **CLIENT:** CH2M Hill

ESI SAMPLE ID	REP	FOIL TARE WEIGHT (g) mg	*H. azteca* + FOIL (g) mg
Lab	A	207.50	212.29
	B	207.47	212.75
	C	207.50	210.84
	D	207.38	210.96
	E	210.35	212.86
	F	210.55	213.12
	G	200.30	203.27
	H	204.17	210.00
-001	A	209.85	215.16
	B	207.69	211.14
	C	209.96	215.42
	D	210.24	214.70
215.85 →	E	210.19	~~211.850~~
211.11 →	F	207.60	~~215.72~~
	G	210.16	215.22
	H	197.72	201.59
-002	A	210.75	214.60
	B	207.33	210.94
	C	206.06	209.23
	D	206.36	210.54
ES yk	E	209.3 ~~211.69~~	212.59
ES yk	F	211.94 ~~210.94~~	215.88
ES yk	G	209.08 ~~209.48~~	213.14
	H	207.86	210.92
-003	A	211.69	—
	B	210.94	—
	C	209.48	—
	D	209.86	—
	E	206.87	—
	F	206.67	—
	G	213.45	—
	H	209.55	—
RECORDED BY:		yk	CY
DATE:		12/15/05	12/16/05

ESI SAMPLE ID	REP	FOIL TARE WEIGHT (g) mg	*H. azteca* + FOIL (g)
-004	A	204.35	208.45
	B	213.52	216.99
	C	206.87	210.98
	D	212.58	215.63
	E	208.27	216.77
	F	207.76	212.47
	G	207.80	212.87
	H	208.17	209.86
-005	A	209.53	213.73
	B	210.37	214.58
	C	209.40	214.47
	D	205.85	208.58
	E	207.61	212.83
	F	207.36	212.05
	G	209.64	212.81
	H	209.79	213.68
-006	A	209.12	212.84
	B	210.56	213.08
	C	210.91	214.22
	D	210.06	213.77
	E	208.75	212.77
	F	207.52	210.85
	G	209.75	213.44
	H	205.76	209.47
-007	A	206.74	212.16
	B	208.24	213.54
	C	208.42	212.79
	D	209.82	213.66
	E	206.67	211.67
	F	205.64	210.62
	G	206.61	211.53
	H	208.82	212.58
RECORDED BY:		yk	
DATE:		12/15/05	

NOTES:

CETIS Test Summary

Report Date: 15 Dec-05 11:02 PM
Link: 05-2884-6524

Hyalella 28-d Survival and Growth Sediment Test — **EnviroSystems, Inc.**

Test No:	04-3537-1169	**Test Type:**	Leptocheirus (28-d)	**Duration:**	28d 0h
Start Date:	17 Nov-05 12:00 PM	**Protocol:**	EPA/600/R-99/064 (2000)	**Species:**	Hyalella azteca
Ending Date:	15 Dec-05 12:00 PM	**Dil Water:**	50/50 Mix of Surface Water and MHR	**Source:**	Aquatic Research Organisms, NH
Setup Date:	17 Nov-05 12:00 PM	**Brine:**	Not Applicable		

Sample No:	08-6868-8888	**Material:**	Control Sediment - Fresh	**Client:**	CH2M Hill
Sample Date:	16 Nov-05 12:00 PM	**Code:**	13906-000	**Project:**	Ecologcal Risk Assessment
Receive Date:	16 Nov-05 12:00 PM	**Source:**	ESI Control		
Sample Age:	24h	**Station:**			
Sample No:	12-6242-6075	**Material:**	Freshwater Sedment	**Client:**	CH2M Hill
Sample Date:	26 Oct-05 10:30 AM	**Code:**	13906-001	**Project:**	Ecologcal Risk Assessment
Receive Date:	28 Oct-05 10:30 AM	**Source:**	Indian Head CT0 0101		
Sample Age:	22d 1h	**Station:**	IS28SD01; 13906-001		
Sample No:	07-6519-9575	**Material:**	Freshwater Sedment	**Client:**	CH2M Hill
Sample Date:	27 Oct-05 09:00 AM	**Code:**	13906-002	**Project:**	Ecologcal Risk Assessment
Receive Date:	28 Oct-05 10:30 AM	**Source:**	Indian Head CT0 0101		
Sample Age:	21d 3h	**Station:**	IS28SD02; 13906-002		
Sample No:	09-5811-1335	**Material:**	Freshwater Sedment	**Client:**	CH2M Hill
Sample Date:	26 Oct-05 08:45 AM	**Code:**	13906-003	**Project:**	Ecologcal Risk Assessment
Receive Date:	28 Oct-05 10:30 AM	**Source:**	Indian Head CT0 0101		
Sample Age:	22d 3h	**Station:**	IS28SD03; 13906-003		
Sample No:	12-7285-3356	**Material:**	Freshwater Sedment	**Client:**	CH2M Hill
Sample Date:	25 Oct-05 02:50 PM	**Code:**	13906-004	**Project:**	Ecologcal Risk Assessment
Receive Date:	28 Oct-05 10:30 AM	**Source:**	Indian Head CT0 0101		
Sample Age:	22d 21h	**Station:**	IS28SD11; 13906-004		
Sample No:	06-4936-0798	**Material:**	Freshwater Sedment	**Client:**	CH2M Hill
Sample Date:	27 Oct-05 10:00 AM	**Code:**	13906-005	**Project:**	Ecologcal Risk Assessment
Receive Date:	28 Oct-05 10:30 AM	**Source:**	Indian Head CT0 0101		
Sample Age:	21d 2h	**Station:**	IS28SD13; 13906-005		
Sample No:	01-0947-2935	**Material:**	Freshwater Sedment	**Client:**	CH2M Hill
Sample Date:	26 Oct-05 03:40 PM	**Code:**	13906-006	**Project:**	Ecologcal Risk Assessment
Receive Date:	28 Oct-05 10:30 AM	**Source:**	Indian Head CT0 0101		
Sample Age:	21d 20h	**Station:**	IS28REF1; 13906-006		
Sample No:	14-4052-2119	**Material:**	Freshwater Sedment	**Client:**	CH2M Hill
Sample Date:	27 Oct-05 11:30 AM	**Code:**	13906-007	**Project:**	Ecologcal Risk Assessment
Receive Date:	28 Oct-05 10:30 AM	**Source:**	Indian Head CT0 0101		
Sample Age:	21d 0h	**Station:**	IS28REF2; 13906-007		

Proportion Survived Summary

Sample Code	Reps	Mean	Minimum	Maximum	SE	SD	CV
13906-000	8	0.90000	0.80000	1.00000	0.02673	0.07559	8.40%
13906-006	8	0.87500	0.70000	1.00000	0.04119	0.11650	13.31%
13906-007	8	0.90000	0.80000	1.00000	0.02673	0.07559	8.40%
13906-001	8	0.71250	0.60000	1.00000	0.05154	0.14577	20.46%
13906-002	8	0.78750	0.50000	1.00000	0.06105	0.17269	21.93%
13906-003	8	0.00000	0.00000	0.00000	0.00000	0.00000	0.00%
13906-004	8	0.91250	0.80000	1.00000	0.02950	0.08345	9.15%
13906-005	8	0.93750	0.80000	1.00000	0.03239	0.09161	9.77%

CETIS Test Summary

Report Date: 15 Dec-05 11:02 PM
Link: 05-2884-6524

Proportion Survived Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8
13906-000	0.90000	0.90000	1.00000	0.80000	0.80000	0.90000	0.90000	1.00000
13906-006	1.00000	0.70000	0.80000	1.00000	0.80000	0.80000	1.00000	0.90000
13906-007	0.90000	1.00000	0.80000	0.90000	0.90000	1.00000	0.90000	0.80000
13906-001	0.70000	0.60000	1.00000	0.60000	0.60000	0.80000	0.80000	0.60000
13906-002	1.00000	0.70000	0.80000	0.70000	0.70000	1.00000	0.90000	0.50000
13906-003	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
13906-004	0.90000	0.90000	0.80000	1.00000	0.90000	1.00000	1.00000	0.80000
13906-005	1.00000	1.00000	1.00000	0.80000	1.00000	1.00000	0.90000	0.80000

CETIS Data Worksheet

Report Date: 16 Dec-05 3:33 PM
Link: 05-2884-6524

Hyalella 28-d Survival and Growth Sediment Test — EnviroSystems, Inc.

Start Date:	17 Nov-05 12:00 PM	**Species:**	Hyalella azteca	**Sample Code:**	13906-000
Ending Date:	15 Dec-05 12:00 PM	**Protocol:**	EPA/600/R-99/064 (2000)	**Sample Source:**	ESI Control
Sample Date:	16 Nov-05 12:00 PM	**Material:**	Control Sediment - Fresh	**Sample Station:**	

Sample Code	Rep	Pos	# Exposed	# Survived	Total Weight-mg	Tare Weight-mg	Pan Count	Neonate Weight-mg	# Offspring
13906-000		13	10	9	212.29	207.5	9		
13906-000		30	10	9	212.75	207.47	9		
13906-000		60	10	10	210.84	207.5	10		
13906-000		25	10	8	210.96	207.38	8		
13906-000		43	10	8	212.86	210.35	8		
13906-000		32	10	9	213.12	210.55	9		
13906-000		55	10	9	203.27	200.3	9		
13906-000		49	12	12	210	204.17	12		
13906-006		23	10	10	212.84	209.12	10		
13906-006		36	10	7	213.08	210.56	7		
13906-006		46	10	8	214.22	210.91	8		
13906-006		16	10	10	213.77	210.06	10		
13906-006		17	10	8	212.77	208.75	8		
13906-006		51	10	8	210.85	207.52	8		
13906-006		27	10	10	213.44	209.75	10		
13906-006		37	10	9	209.47	205.76	9		
13906-007		12	10	9	212.16	206.74	9		
13906-007		44	10	10	213.54	208.24	10		
13906-007		2	10	8	212.79	208.42	8		
13906-007		3	10	9	213.66	209.82	9		
13906-007		38	10	9	211.67	206.67	9		
13906-007		62	10	10	210.62	205.64	10		
13906-007		63	10	9	211.53	206.61	9		
13906-007		52	10	8	212.58	208.82	8		
13906-001		24	10	7	215.16	209.85	7		
13906-001		18	10	6	211.14	207.69	6		
13906-001		1	10	10	215.42	209.96	10		
13906-001		5	10	6	214.7	210.24	6		
13906-001		15	10	6	215.85	210.19	6		
13906-001		10	10	8	211.11	207.6	8		
13906-001		35	10	8	215.22	210.16	8		
13906-001		48	10	6	201.59	197.72	6		
13906-002		8	10	10	214.6	210.75	10		
13906-002		61	10	7	210.94	207.33	7		
13906-002		54	10	8	209.23	206.06	8		
13906-002		20	10	7	210.54	206.36	7		
13906-002		11	10	7	212.59	209.31	7		
13906-002		58	10	10	215.88	211.44	10		
13906-002		9	10	9	213.14	209.68	9		
13906-002		19	10	5	210.92	207.86	5		
13906-003		29	10	0			0		
13906-003		28	10	0			0		
13906-003		7	10	0			0		
13906-003		21	10	0			0		
13906-003		22	10	0			0		
13906-003		6	10	0			0		
13906-003		41	10	0			0		
13906-003		39	10	0			0		
13906-004		57	10	9	208.45	204.35	9		
13906-004		53	10	9	216.99	213.52	9		
13906-004		26	10	8	210.98	206.87	8		
13906-004		31	10	10	215.63	212.58	10		
13906-004		59	10	9	210.77	208.27	9		

CETIS Data Worksheet

Report Date: 16 Dec-05 3:33 PM
Link: 05-2884-6524

Sample Code	Rep	Pos	# Exposed	# Survived	Total Weight-mg	Tare Weight-mg	Pan Count	Neonate Weight-mg	# Offspring
13906-004		56	10	10	212.47	207.76	10		
13906-004		4	10	10	212.87	207.8	10		
13906-004		47	10	8	209.86	208.17	8		
13906-005		45	10	10	213.73	209.53	10		
13906-005		40	10	10	214.58	210.37	10		
13906-005		14	10	10	214.47	209.4	10		
13906-005		64	10	8	208.58	205.85	8		
13906-005		34	10	10	212.83	207.61	10		
13906-005		42	10	10	212.05	207.36	10		
13906-005		33	10	9	212.81	209.64	9		
13906-005		50	10	8	213.68	209.79	8		

CETIS Analysis Detail

Hyalella 28-d Survival and Growth Sediment Test — **EnviroSystems, Inc.**

Test No:	04-3537-1169	**Test Type:**	Leptocheirus (28-d)	**Duration:**	28d 0h
Start Date:	17 Nov-05 12:00 PM	**Protocol:**	EPA/600/R-99/064 (2000)	**Species:**	Hyalella azteca
Ending Date:	15 Dec-05 12:00 PM	**Dil Water:**	50/50 Mix of Surface Water and MHR	**Source:**	Aquatic Research Organisms, NH
Setup Date:	17 Nov-05 12:00 PM	**Brine:**	Not Applicable		

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Proportion Survived	Comparison	05-2884-6524	05-2884-6524	15 Dec-05 11:00 PM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Angular (Corrected)				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	2.06537	8.88539	0.35943	Equal Variances
Distribution	Shapiro-Wilk W	0.89475	0.84420	0.06628	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	0.0039298	0.0039298	1	0.18	0.67478	Non-Significant Effect
Error	0.2995839	0.0213989	14			
Total	0.30351375	0.0253287	15			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13906-000		13906-006	0.42854	1.76131	0.3374	0.12883	Non-Significant Effect

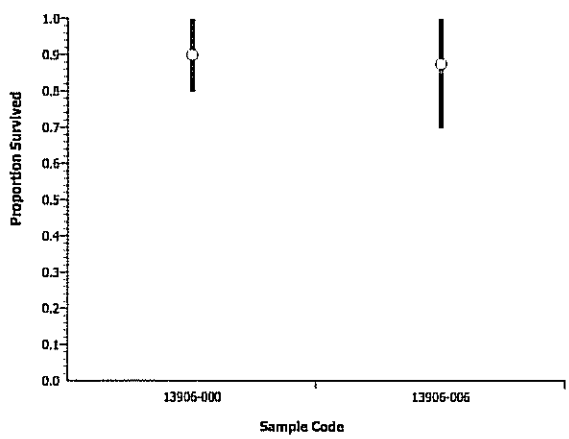
Data Summary

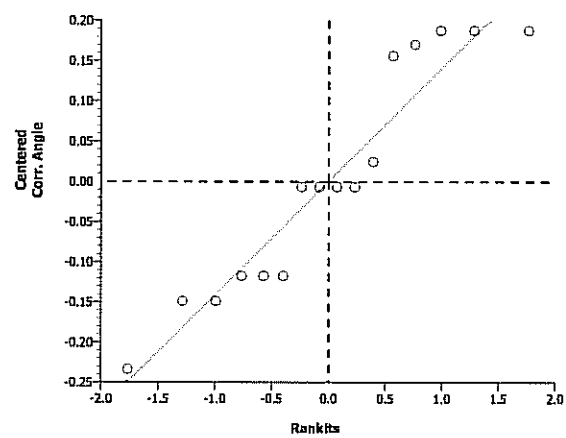
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13906-000	8	0.90000	0.80000	1.00000	0.07559	1.25606	1.10715	1.42595	0.11816
13906-006	8	0.87500	0.70000	1.00000	0.11650	1.22471	0.99116	1.41202	0.16981

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13906-000	0.90000	0.90000	1.00000	0.80000	0.80000	0.90000	0.90000	1.00000		
13906-006	1.00000	0.70000	0.80000	1.00000	0.80000	0.80000	1.00000	0.90000		

Graphics





CETIS Analysis Detail

Hyalella 28-d Survival and Growth Sediment Test — EnviroSystems, Inc.

Test No:	04-3537-1169	**Test Type:**	Leptocheirus (28-d)	**Duration:**	28d 0h
Start Date:	17 Nov-05 12:00 PM	**Protocol:**	EPA/600/R-99/064 (2000)	**Species:**	Hyalella azteca
Ending Date:	15 Dec-05 12:00 PM	**Dil Water:**	50/50 Mix of Surface Water and MHR	**Source:**	Aquatic Research Organisms, NH
Setup Date:	17 Nov-05 12:00 PM	**Brine:**	Not Applicable		

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Proportion Survived	Comparison	05-2884-6524	05-2884-6524	15 Dec-05 11:00 PM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Mann-Whitney U	C > T	Angular (Corrected)				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	1.04901	8.88539	0.95130	Equal Variances
Distribution	Shapiro-Wilk W	0.83087	0.84420	0.00606	Non-normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	1.214E-05	1.214E-05	1	0.00	0.97662	Non-Significant Effect
Error	0.190898	0.0136356	14			
Total	0.19091013	0.0136477	15			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	Ties	Decision(0.05)
13906-000		13906-007	33		0.4796	3	Non-Significant Effect

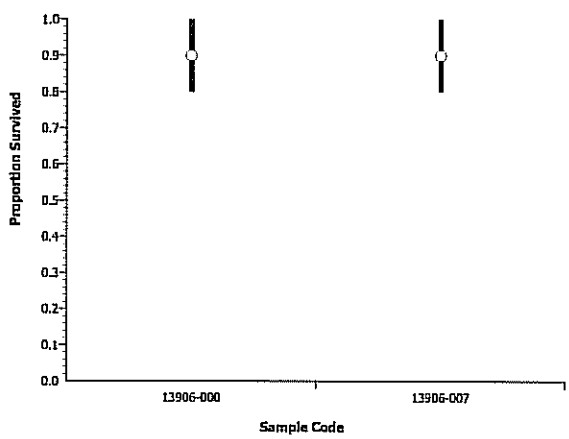
Data Summary

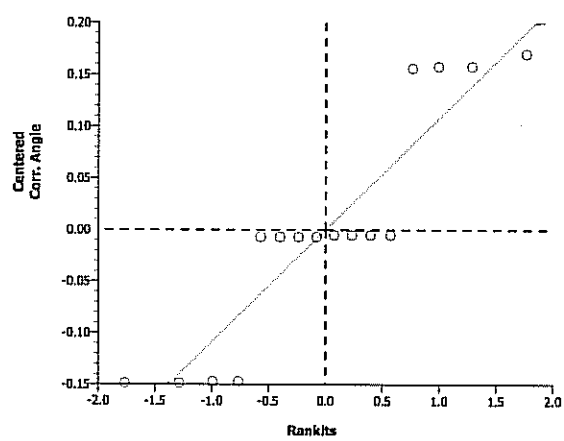
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13906-000	8	0.90000	0.80000	1.00000	0.07559	1.25606	1.10715	1.42595	0.11816
13906-007	8	0.90000	0.80000	1.00000	0.07559	1.25431	1.10715	1.41202	0.11537

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13906-000	0.90000	0.90000	1.00000	0.80000	0.80000	0.90000	0.90000	1.00000		
13906-007	0.90000	1.00000	0.80000	0.90000	0.90000	1.00000	0.90000	0.80000		

Graphics





CETIS Analysis Detail

Hyalella 28-d Survival and Growth Sediment Test — EnviroSystems, Inc.

Test No:	04-3537-1169	**Test Type:**	Leptocheirus (28-d)	**Duration:**	28d 0h
Start Date:	17 Nov-05 12:00 PM	**Protocol:**	EPA/600/R-99/064 (2000)	**Species:**	Hyalella azteca
Ending Date:	15 Dec-05 12:00 PM	**Dil Water:**	50/50 Mix of Surface Water and MHR	**Source:**	Aquatic Research Organisms, NH
Setup Date:	17 Nov-05 12:00 PM	**Brine:**	Not Applicable		

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Proportion Survived	Comparison	05-2884-6524	05-2884-6524	15 Dec-05 11:00 PM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Angular (Corrected)				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	2.47043	8.88539	0.25577	Equal Variances
Distribution	Shapiro-Wilk W	0.86083	0.84420	0.01866	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	0.2224704	0.2224704	1	9.18	0.00899	Significant Effect
Error	0.3391711	0.0242265	14			
Total	0.56164157	0.2466969	15			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13906-000		13906-001	3.03034	1.76131	0.0045	0.13707	Significant Effect

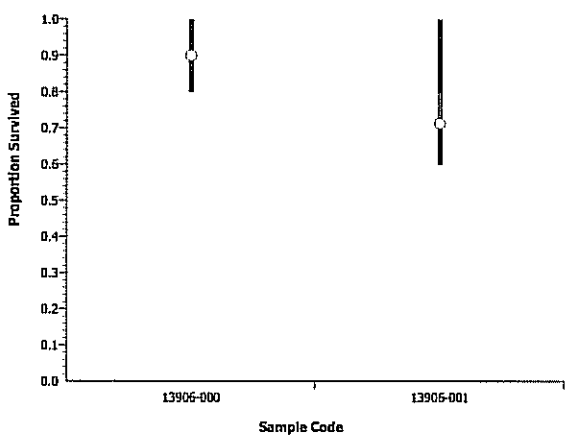
Data Summary

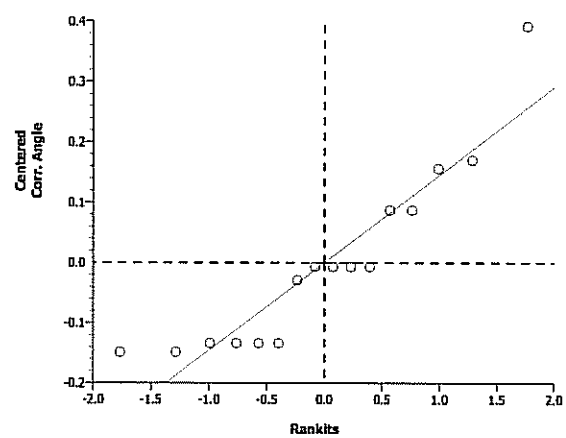
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13906-000	8	0.90000	0.80000	1.00000	0.07559	1.25606	1.10715	1.42595	0.11816
13906-001	8	0.71250	0.60000	1.00000	0.14577	1.02022	0.88608	1.41202	0.18572

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13906-000	0.90000	0.90000	1.00000	0.80000	0.80000	0.90000	0.90000	1.00000		
13906-001	0.70000	0.60000	1.00000	0.60000	0.60000	0.80000	0.80000	0.60000		

Graphics





CETIS Analysis Detail

Hyalella 28-d Survival and Growth Sediment Test — **EnviroSystems, Inc.**

Test No:	04-3537-1169	**Test Type:**	Leptocheirus (28-d)	**Duration:**	28d 0h
Start Date:	17 Nov-05 12:00 PM	**Protocol:**	EPA/600/R-99/064 (2000)	**Species:**	Hyalella azteca
Ending Date:	15 Dec-05 12:00 PM	**Dil Water:**	50/50 Mix of Surface Water and MHR	**Source:**	Aquatic Research Organisms, NH
Setup Date:	17 Nov-05 12:00 PM	**Brine:**	Not Applicable		

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Proportion Survived	Comparison	05-2884-6524	05-2884-6524	15 Dec-05 11:00 PM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Angular (Corrected)				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	3.57172	8.88539	0.11486	Equal Variances
Distribution	Shapiro-Wilk W	0.93782	0.84420	0.31520	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	0.0769168	0.0769168	1	2.41	0.14286	Non-Significant Effect
Error	0.4468022	0.0319145	14			
Total	0.52371899	0.1088312	15			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13906-000		13906-002	1.55245	1.76131	0.0714	0.15733	Non-Significant Effect

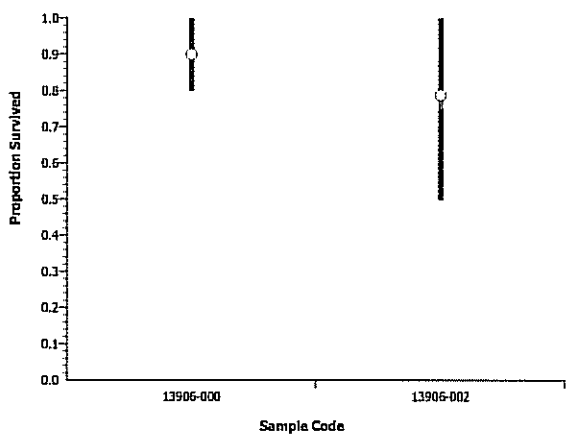
Data Summary

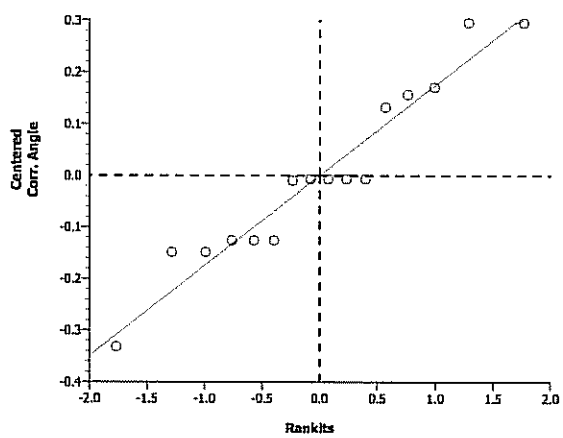
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13906-000	8	0.90000	0.80000	1.00000	0.07559	1.25606	1.10715	1.42595	0.11816
13906-002	8	0.78750	0.50000	1.00000	0.17269	1.11739	0.78540	1.41202	0.22331

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13906-000	0.90000	0.90000	1.00000	0.80000	0.80000	0.90000	0.90000	1.00000		
13906-002	1.00000	0.70000	0.80000	0.70000	0.70000	1.00000	0.90000	0.50000		

Graphics





CETIS Analysis Detail

Hyalella 28-d Survival and Growth Sediment Test — **EnviroSystems, Inc.**

Test No:	04-3537-1169	**Test Type:**	Leptocheirus (28-d)	**Duration:**	28d 0h
Start Date:	17 Nov-05 12:00 PM	**Protocol:**	EPA/600/R-99/064 (2000)	**Species:**	Hyalella azteca
Ending Date:	15 Dec-05 12:00 PM	**Dil Water:**	50/50 Mix of Surface Water and MHR	**Source:**	Aquatic Research Organisms, NH
Setup Date:	17 Nov-05 12:00 PM	**Brine:**	Not Applicable		

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Proportion Survived	Comparison	05-2884-6524	05-2884-6524	15 Dec-05 11:00 PM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Mann-Whitney U	C > T	Angular (Corrected)				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Modified Levene	6.87508	8.86159	0.02010	Equal Variances
Distribution	Shapiro-Wilk W	0.72580	0.84420	0.00011	Non-normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	4.816058	4.816058	1	689.90	0.00000	Significant Effect
Error	0.0977318	0.0069808	14			
Total	4.91378998	4.8230390	15			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	Ties	Decision(0.05)
13906-000		13906-003	64		0.0001	3	Significant Effect

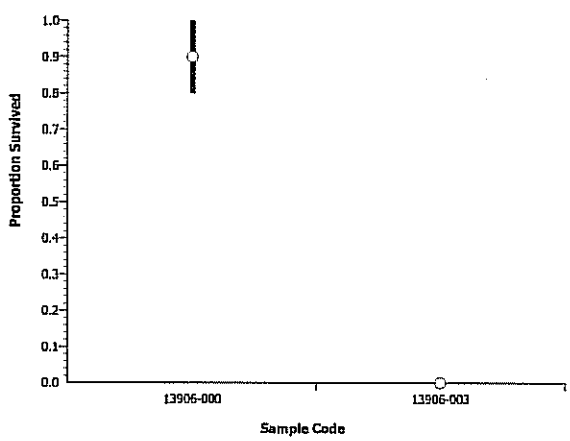
Data Summary

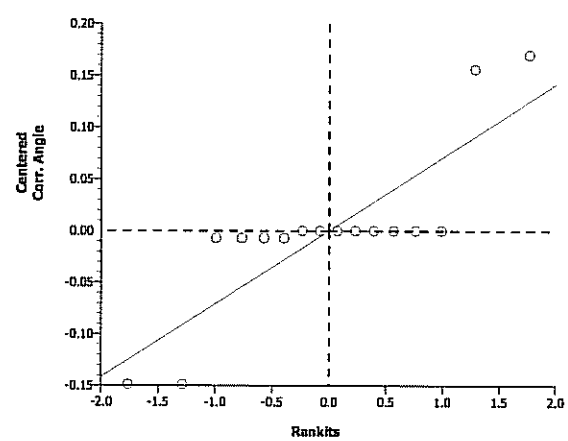
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13906-000	8	0.90000	0.80000	1.00000	0.07559	1.25606	1.10715	1.42595	0.11816
13906-003	8	0.00000	0.00000	0.00000	0.00000	0.15878	0.15878	0.15878	0.00001

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13906-000	0.90000	0.90000	1.00000	0.80000	0.80000	0.90000	0.90000	1.00000		
13906-003	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000		

Graphics





CETIS Analysis Detail

Hyalella 28-d Survival and Growth Sediment Test — **EnviroSystems, Inc.**

Test No:	04-3537-1169	**Test Type:**	Leptocheirus (28-d)	**Duration:**	28d 0h
Start Date:	17 Nov-05 12:00 PM	**Protocol:**	EPA/600/R-99/064 (2000)	**Species:**	Hyalella azteca
Ending Date:	15 Dec-05 12:00 PM	**Dil Water:**	50/50 Mix of Surface Water and MHR	**Source:**	Aquatic Research Organisms, NH
Setup Date:	17 Nov-05 12:00 PM	**Brine:**	Not Applicable		

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Proportion Survived	Comparison	05-2884-6524	05-2884-6524	15 Dec-05 11:00 PM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Angular (Corrected)				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	1.17350	8.88539	0.83824	Equal Variances
Distribution	Shapiro-Wilk W	0.87554	0.84420	0.03237	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	0.0013882	0.0013882	1	0.09	0.76674	Non-Significant Effect
Error	0.2124202	0.0151729	14			
Total	0.21380843	0.0165611	15			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13906-000		13906-004	-0.3025	1.76131	0.6166	0.10848	Non-Significant Effect

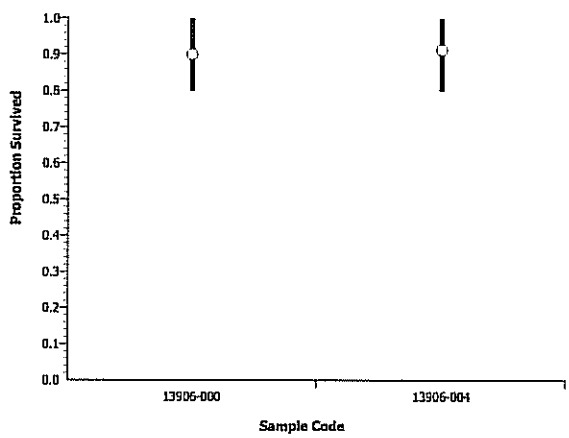
Data Summary

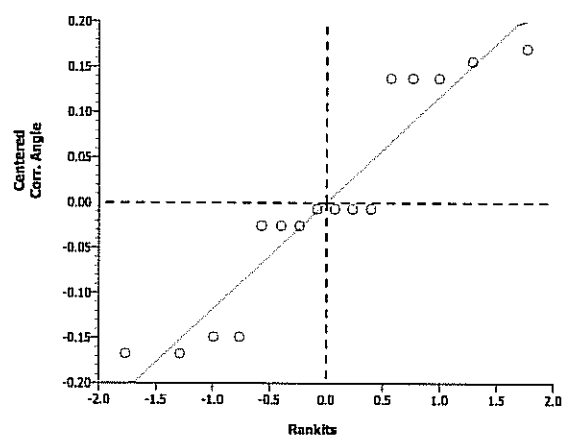
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13906-000	8	0.90000	0.80000	1.00000	0.07559	1.25606	1.10715	1.42595	0.11816
13906-004	8	0.91250	0.80000	1.00000	0.08345	1.27469	1.10715	1.41202	0.12800

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13906-000	0.90000	0.90000	1.00000	0.80000	0.80000	0.90000	0.90000	1.00000		
13906-004	0.90000	0.90000	0.80000	1.00000	0.90000	1.00000	1.00000	0.80000		

Graphics





CETIS Analysis Detail

Hyalella 28-d Survival and Growth Sediment Test — EnviroSystems, Inc.

Test No:	04-3537-1169	**Test Type:**	Leptocheirus (28-d)	**Duration:**	28d 0h
Start Date:	17 Nov-05 12:00 PM	**Protocol:**	EPA/600/R-99/064 (2000)	**Species:**	Hyalella azteca
Ending Date:	15 Dec-05 12:00 PM	**Dil Water:**	50/50 Mix of Surface Water and MHR	**Source:**	Aquatic Research Organisms, NH
Setup Date:	17 Nov-05 12:00 PM	**Brine:**	Not Applicable		

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Proportion Survived	Comparison	05-2884-6524	05-2884-6524	15 Dec-05 11:01 PM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Angular (Corrected)				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	1.41012	8.88539	0.66160	Equal Variances
Distribution	Shapiro-Wilk W	0.90095	0.84420	0.08346	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	0.0141000	0.0141000	1	0.84	0.37545	Non-Significant Effect
Error	0.2355453	0.0168247	14			
Total	0.2496453	0.0309247	15			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13906-000		13906-005	-0.9155	1.76131	0.8123	0.11423	Non-Significant Effect

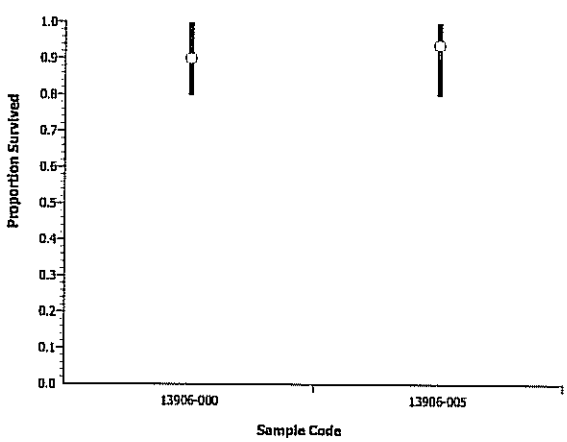
Data Summary

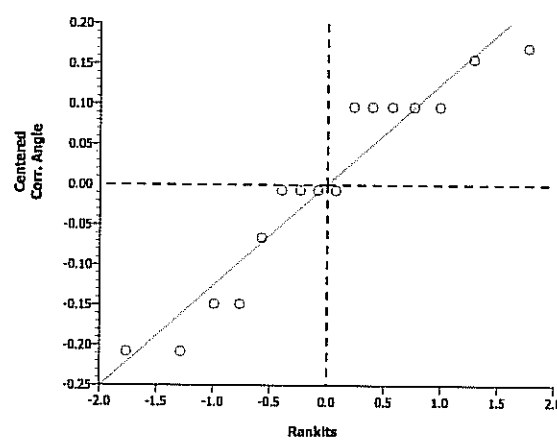
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13906-000	8	0.90000	0.80000	1.00000	0.07559	1.25606	1.10715	1.42595	0.11816
13906-005	8	0.93750	0.80000	1.00000	0.09161	1.31543	1.10715	1.41202	0.14031

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13906-000	0.90000	0.90000	1.00000	0.80000	0.80000	0.90000	0.90000	1.00000		
13906-005	1.00000	1.00000	1.00000	0.80000	1.00000	1.00000	0.90000	0.80000		

Graphics





CETIS Analysis Detail

Hyalella 28-d Survival and Growth Sediment Test — EnviroSystems, Inc.

Test No:	04-3537-1169	**Test Type:**	Leptocheirus (28-d)	**Duration:**	28d 0h
Start Date:	17 Nov-05 12:00 PM	**Protocol:**	EPA/600/R-99/064 (2000)	**Species:**	Hyalella azteca
Ending Date:	15 Dec-05 12:00 PM	**Dil Water:**	50/50 Mix of Surface Water and MHR	**Source:**	Aquatic Research Organisms, NH
Setup Date:	17 Nov-05 12:00 PM	**Brine:**	Not Applicable		

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Proportion Survived	Comparison	05-2884-6524	05-2884-6524	15 Dec-05 11:01 PM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Angular (Corrected)				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	2.16658	8.88539	0.32928	Equal Variances
Distribution	Shapiro-Wilk W	0.89766	0.84420	0.07386	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	0.0035051	0.0035051	1	0.17	0.68956	Non-Significant Effect
Error	0.2950183	0.0210727	14			
Total	0.29852343	0.0245778	15			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13906-006		13906-007	-0.4078	1.76131	0.6552	0.12784	Non-Significant Effect

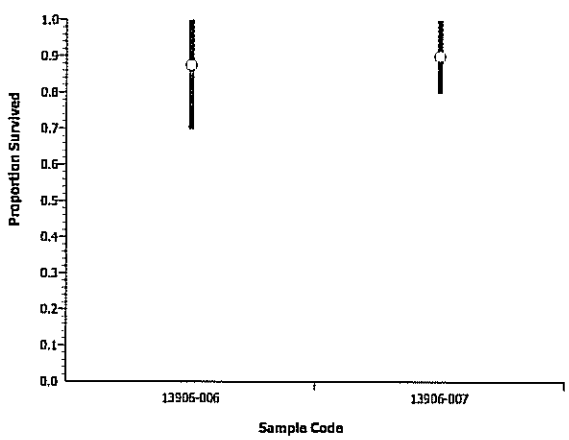
Data Summary

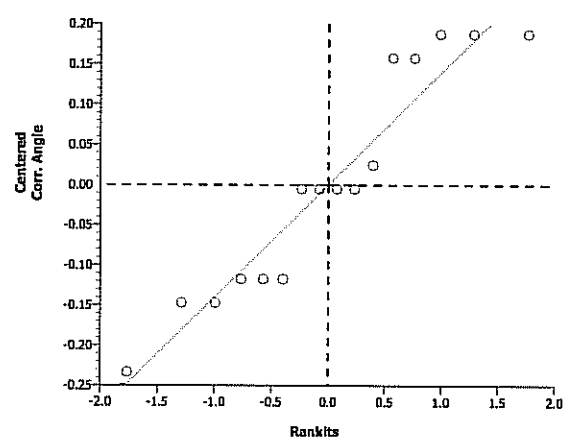
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13906-006	8	0.87500	0.70000	1.00000	0.11650	1.22471	0.99116	1.41202	0.16981
13906-007	8	0.90000	0.80000	1.00000	0.07559	1.25431	1.10715	1.41202	0.11537

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13906-006	1.00000	0.70000	0.80000	1.00000	0.80000	0.80000	1.00000	0.90000		
13906-007	0.90000	1.00000	0.80000	0.90000	0.90000	1.00000	0.90000	0.80000		

Graphics





CETIS Analysis Detail

Hyalella 28-d Survival and Growth Sediment Test — EnviroSystems, Inc.

Test No:	04-3537-1169	**Test Type:**	Leptocheirus (28-d)	**Duration:**	28d 0h
Start Date:	17 Nov-05 12:00 PM	**Protocol:**	EPA/600/R-99/064 (2000)	**Species:**	Hyalella azteca
Ending Date:	15 Dec-05 12:00 PM	**Dil Water:**	50/50 Mix of Surface Water and MHR	**Source:**	Aquatic Research Organisms, NH
Setup Date:	17 Nov-05 12:00 PM	**Brine:**	Not Applicable		

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Proportion Survived	Comparison	05-2884-6524	05-2884-6524	15 Dec-05 11:01 PM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Angular (Corrected)				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	1.19612	8.88539	0.81928	Equal Variances
Distribution	Shapiro-Wilk W	0.88964	0.84420	0.05481	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	0.1672643	0.1672643	1	5.28	0.03747	Significant Effect
Error	0.4432915	0.0316637	14			
Total	0.61055574	0.198928	15			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13906-006		13906-001	2.29838	1.76131	0.0187	0.15671	Significant Effect

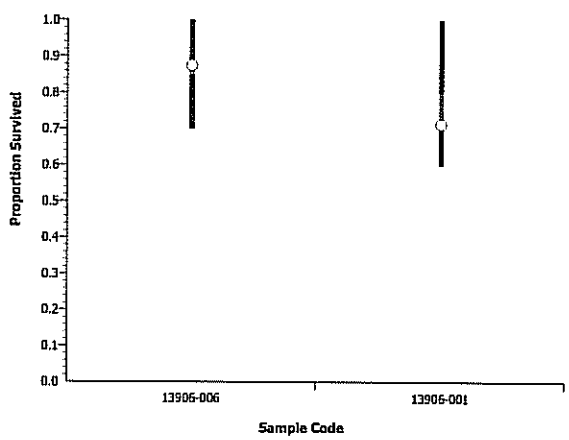
Data Summary

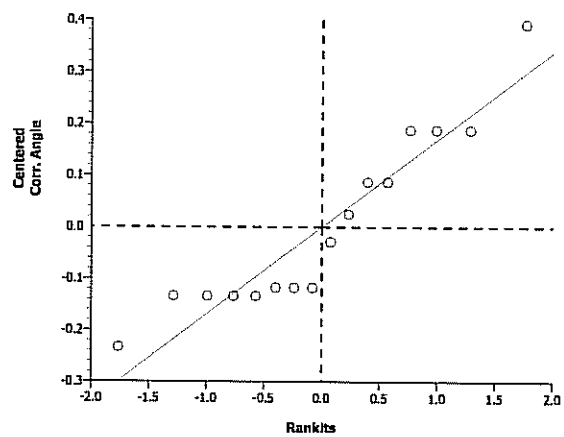
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13906-006	8	0.87500	0.70000	1.00000	0.11650	1.22471	0.99116	1.41202	0.16981
13906-001	8	0.71250	0.60000	1.00000	0.14577	1.02022	0.88608	1.41202	0.18572

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13906-006	1.00000	0.70000	0.80000	1.00000	0.80000	0.80000	1.00000	0.90000		
13906-001	0.70000	0.60000	1.00000	0.60000	0.60000	0.80000	0.80000	0.60000		

Graphics





CETIS Analysis Detail

Hyalella 28-d Survival and Growth Sediment Test — EnviroSystems, Inc.

Test No:	04-3537-1169	**Test Type:**	Leptocheirus (28-d)	**Duration:**	28d 0h
Start Date:	17 Nov-05 12:00 PM	**Protocol:**	EPA/600/R-99/064 (2000)	**Species:**	Hyalella azteca
Ending Date:	15 Dec-05 12:00 PM	**Dil Water:**	50/50 Mix of Surface Water and MHR	**Source:**	Aquatic Research Organisms, NH
Setup Date:	17 Nov-05 12:00 PM	**Brine:**	Not Applicable		

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Proportion Survived	Comparison	05-2884-6524	05-2884-6524	15 Dec-05 11:01 PM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Angular (Corrected)				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	1.72934	8.88539	0.48698	Equal Variances
Distribution	Shapiro-Wilk W	0.91852	0.84420	0.15913	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	0.0460749	0.0460749	1	1.17	0.29751	Non-Significant Effect
Error	0.5509226	0.0393516	14			
Total	0.59699743	0.0854265	15			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13906-006		13906-002	1.08206	1.76131	0.1488	0.1747	Non-Significant Effect

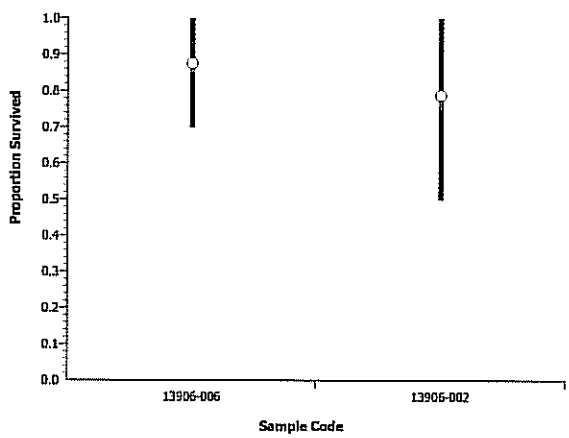
Data Summary

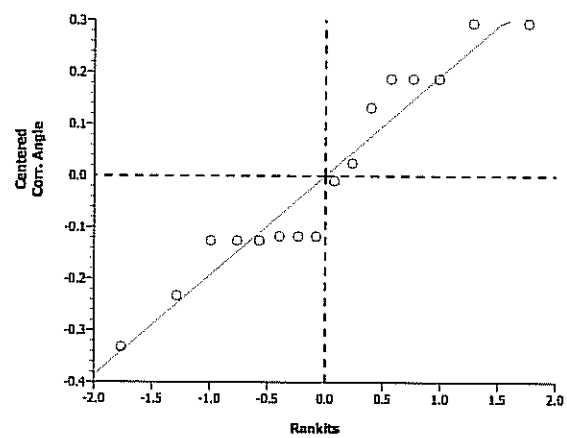
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13906-006	8	0.87500	0.70000	1.00000	0.11650	1.22471	0.99116	1.41202	0.16981
13906-002	8	0.78750	0.50000	1.00000	0.17269	1.11739	0.78540	1.41202	0.22331

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13906-006	1.00000	0.70000	0.80000	1.00000	0.80000	0.80000	1.00000	0.90000		
13906-002	1.00000	0.70000	0.80000	0.70000	0.70000	1.00000	0.90000	0.50000		

Graphics





CETIS Analysis Detail

Hyalella 28-d Survival and Growth Sediment Test — EnviroSystems, Inc.

Test No:	04-3537-1169	**Test Type:**	Leptocheirus (28-d)	**Duration:**	28d 0h
Start Date:	17 Nov-05 12:00 PM	**Protocol:**	EPA/600/R-99/064 (2000)	**Species:**	Hyalella azteca
Ending Date:	15 Dec-05 12:00 PM	**Dil Water:**	50/50 Mix of Surface Water and MHR	**Source:**	Aquatic Research Organisms, NH
Setup Date:	17 Nov-05 12:00 PM	**Brine:**	Not Applicable		

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Proportion Survived	Comparison	05-2884-6524	05-2884-6524	15 Dec-05 11:01 PM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Unequal Variance t	C > T	Angular (Corrected)				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Modified Levene	25.38089	8.86159	0.00018	Unequal Variances
Distribution	Shapiro-Wilk W	0.86336	0.84420	0.02052	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	4.544843	4.544843	1	315.22	0.00000	Significant Effect
Error	0.2018521	0.0144180	14			
Total	4.74669532	4.5592612	15			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13906-006		13906-003	17.7544	1.89458	0.0000	0.11375	Significant Effect

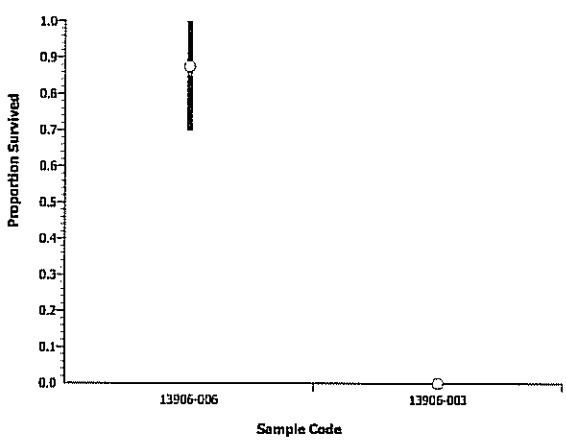
Data Summary

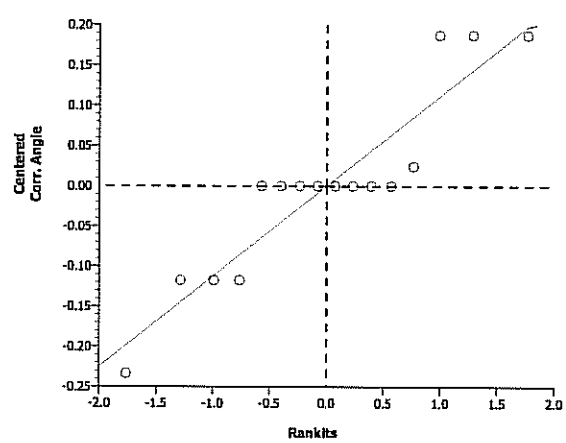
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13906-006	8	0.87500	0.70000	1.00000	0.11650	1.22471	0.99116	1.41202	0.16981
13906-003	8	0.00000	0.00000	0.00000	0.00000	0.15878	0.15878	0.15878	0.00001

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13906-006	1.00000	0.70000	0.80000	1.00000	0.80000	0.80000	1.00000	0.90000		
13906-003	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000		

Graphics





CETIS Analysis Detail

Hyalella 28-d Survival and Growth Sediment Test — **EnviroSystems, Inc.**

Test No:	04-3537-1169	**Test Type:**	Leptocheirus (28-d)	**Duration:**	28d 0h
Start Date:	17 Nov-05 12:00 PM	**Protocol:**	EPA/600/R-99/064 (2000)	**Species:**	Hyalella azteca
Ending Date:	15 Dec-05 12:00 PM	**Dil Water:**	50/50 Mix of Surface Water and MHR	**Source:**	Aquatic Research Organisms, NH
Setup Date:	17 Nov-05 12:00 PM	**Brine:**	Not Applicable		

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Proportion Survived	Comparison	05-2884-6524	05-2884-6524	15 Dec-05 11:01 PM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Angular (Corrected)				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	1.76000	8.88539	0.47328	Equal Variances
Distribution	Shapiro-Wilk W	0.90042	0.84420	0.08182	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	0.0099893	0.0099893	1	0.44	0.51705	Non-Significant Effect
Error	0.3165406	0.0226100	14			
Total	0.32652988	0.0325994	15			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13906-006		13906-004	-0.6647	1.76131	0.7415	0.13242	Non-Significant Effect

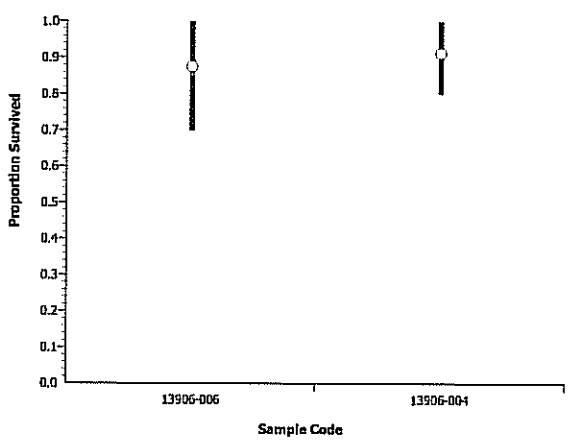
Data Summary

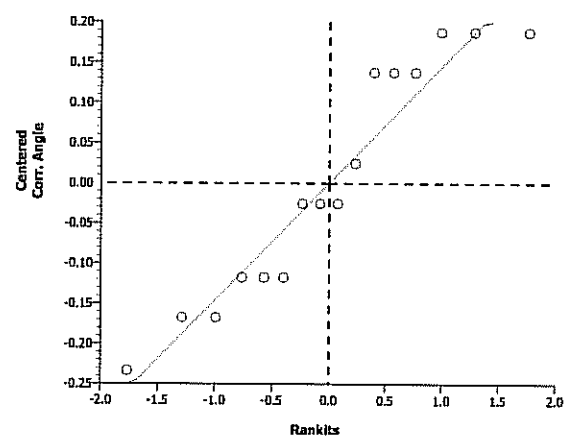
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13906-006	8	0.87500	0.70000	1.00000	0.11650	1.22471	0.99116	1.41202	0.16981
13906-004	8	0.91250	0.80000	1.00000	0.08345	1.27469	1.10715	1.41202	0.12800

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13906-006	1.00000	0.70000	0.80000	1.00000	0.80000	0.80000	1.00000	0.90000		
13906-004	0.90000	0.90000	0.80000	1.00000	0.90000	1.00000	1.00000	0.80000		

Graphics





CETIS Analysis Detail

Hyalella 28-d Survival and Growth Sediment Test — **EnviroSystems, Inc.**

Test No:	04-3537-1169	**Test Type:**	Leptocheirus (28-d)	**Duration:**	28d 0h
Start Date:	17 Nov-05 12:00 PM	**Protocol:**	EPA/600/R-99/064 (2000)	**Species:**	Hyalella azteca
Ending Date:	15 Dec-05 12:00 PM	**Dil Water:**	50/50 Mix of Surface Water and MHR	**Source:**	Aquatic Research Organisms, NH
Setup Date:	17 Nov-05 12:00 PM	**Brine:**	Not Applicable		

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Proportion Survived	Comparison	05-2884-6524	05-2884-6524	15 Dec-05 11:01 PM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Angular (Corrected)				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	1.46468	8.88539	0.62712	Equal Variances
Distribution	Shapiro-Wilk W	0.88339	0.84420	0.04340	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	0.0329175	0.0329175	1	1.36	0.26356	Non-Significant Effect
Error	0.3396656	0.0242618	14			
Total	0.37258304	0.0571793	15			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13906-006		13906-005	-1.1648	1.76131	0.8682	0.13717	Non-Significant Effect

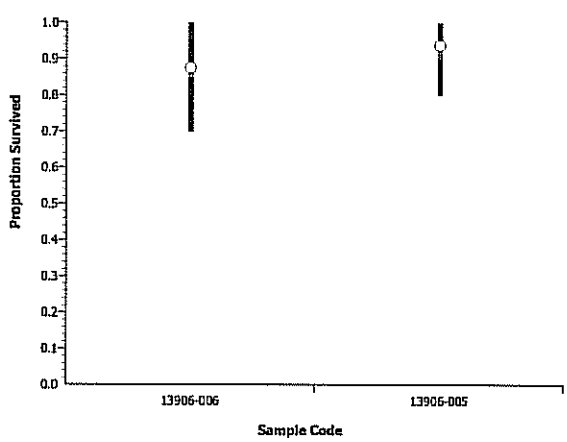
Data Summary

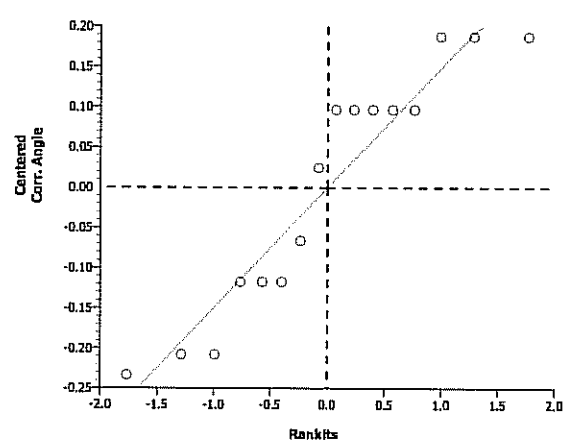
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13906-006	8	0.87500	0.70000	1.00000	0.11650	1.22471	0.99116	1.41202	0.16981
13906-005	8	0.93750	0.80000	1.00000	0.09161	1.31543	1.10715	1.41202	0.14031

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13906-006	1.00000	0.70000	0.80000	1.00000	0.80000	0.80000	1.00000	0.90000		
13906-005	1.00000	1.00000	1.00000	0.80000	1.00000	1.00000	0.90000	0.80000		

Graphics





CETIS Analysis Detail

Hyalella 28-d Survival and Growth Sediment Test — EnviroSystems, Inc.

Test No:	04-3537-1169	**Test Type:**	Leptocheirus (28-d)	**Duration:**	28d 0h
Start Date:	17 Nov-05 12:00 PM	**Protocol:**	EPA/600/R-99/064 (2000)	**Species:**	Hyalella azteca
Ending Date:	15 Dec-05 12:00 PM	**Dil Water:**	50/50 Mix of Surface Water and MHR	**Source:**	Aquatic Research Organisms, NH
Setup Date:	17 Nov-05 12:00 PM	**Brine:**	Not Applicable		

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Proportion Survived	Comparison	05-2884-6524	05-2884-6524	15 Dec-05 11:01 PM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Angular (Corrected)				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	2.59149	8.88539	0.23224	Equal Variances
Distribution	Shapiro-Wilk W	0.85730	0.84420	0.01635	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	0.2191958	0.2191958	1	9.17	0.00903	Significant Effect
Error	0.3346055	0.0239004	14			
Total	0.5538013	0.2430962	15			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13906-007		13906-001	3.02840	1.76131	0.0045	0.13615	Significant Effect

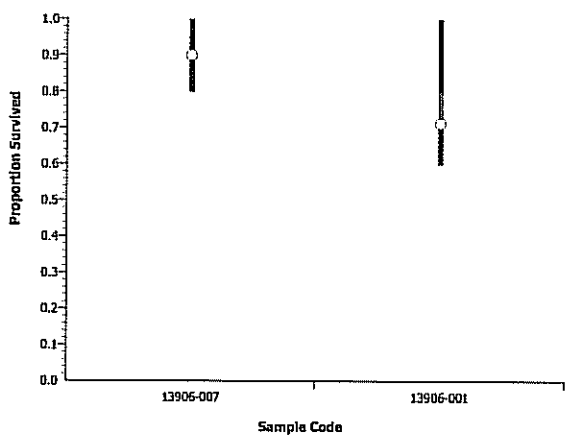
Data Summary

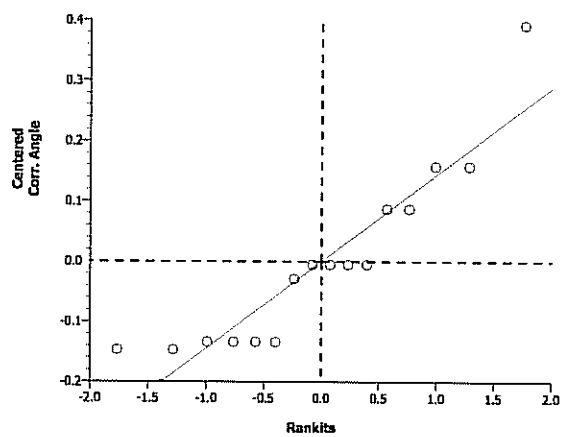
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13906-007	8	0.90000	0.80000	1.00000	0.07559	1.25431	1.10715	1.41202	0.11537
13906-001	8	0.71250	0.60000	1.00000	0.14577	1.02022	0.88608	1.41202	0.18572

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13906-007	0.90000	1.00000	0.80000	0.90000	0.90000	1.00000	0.90000	0.80000		
13906-001	0.70000	0.60000	1.00000	0.60000	0.60000	0.80000	0.80000	0.60000		

Graphics





CETIS Analysis Detail

Hyalella 28-d Survival and Growth Sediment Test — **EnviroSystems, Inc.**

Test No:	04-3537-1169	**Test Type:**	Leptocheirus (28-d)	**Duration:**	28d 0h
Start Date:	17 Nov-05 12:00 PM	**Protocol:**	EPA/600/R-99/064 (2000)	**Species:**	Hyalella azteca
Ending Date:	15 Dec-05 12:00 PM	**Dil Water:**	50/50 Mix of Surface Water and MHR	**Source:**	Aquatic Research Organisms, NH
Setup Date:	17 Nov-05 12:00 PM	**Brine:**	Not Applicable		

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Proportion Survived	Comparison	05-2884-6524	05-2884-6524	15 Dec-05 11:01 PM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Angular (Corrected)				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	3.74675	8.88539	0.10259	Equal Variances
Distribution	Shapiro-Wilk W	0.93737	0.84420	0.31038	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	0.0749963	0.0749963	1	2.37	0.14565	Non-Significant Effect
Error	0.4422366	0.0315883	14			
Total	0.51723290	0.1065846	15			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13906-007		13906-002	1.54084	1.76131	0.0728	0.15652	Non-Significant Effect

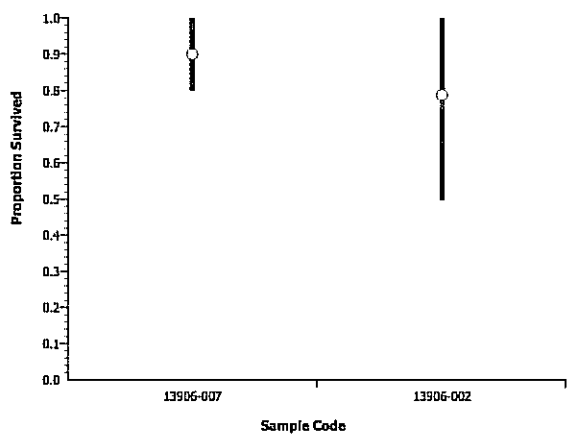
Data Summary

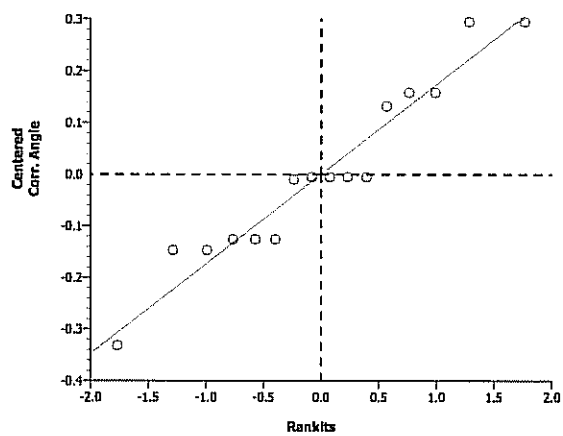
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13906-007	8	0.90000	0.80000	1.00000	0.07559	1.25431	1.10715	1.41202	0.11537
13906-002	8	0.78750	0.50000	1.00000	0.17269	1.11739	0.78540	1.41202	0.22331

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13906-007	0.90000	1.00000	0.80000	0.90000	0.90000	1.00000	0.90000	0.80000		
13906-002	1.00000	0.70000	0.80000	0.70000	0.70000	1.00000	0.90000	0.50000		

Graphics





CETIS Analysis Detail

Hyalella 28-d Survival and Growth Sediment Test — EnviroSystems, Inc.

Test No:	04-3537-1169	**Test Type:**	Leptocheirus (28-d)	**Duration:**	28d 0h
Start Date:	17 Nov-05 12:00 PM	**Protocol:**	EPA/600/R-99/064 (2000)	**Species:**	Hyalella azteca
Ending Date:	15 Dec-05 12:00 PM	**Dil Water:**	50/50 Mix of Surface Water and MHR	**Source:**	Aquatic Research Organisms, NH
Setup Date:	17 Nov-05 12:00 PM	**Brine:**	Not Applicable		

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Proportion Survived	Comparison	05-2884-6524	05-2884-6524	15 Dec-05 11:01 PM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Mann-Whitney U	C > T	Angular (Corrected)				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Modified Levene	6.93374	8.86159	0.01966	Equal Variances
Distribution	Shapiro-Wilk W	0.71493	0.84420	0.00007	Non-normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	4.800778	4.800778	1	721.41	0.00000	Significant Effect
Error	0.0931662	0.0066547	14			
Total	4.89394408	4.8074326	15			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	Ties	Decision(0.05)
13906-007		13906-003	64		0.0001	4	Significant Effect

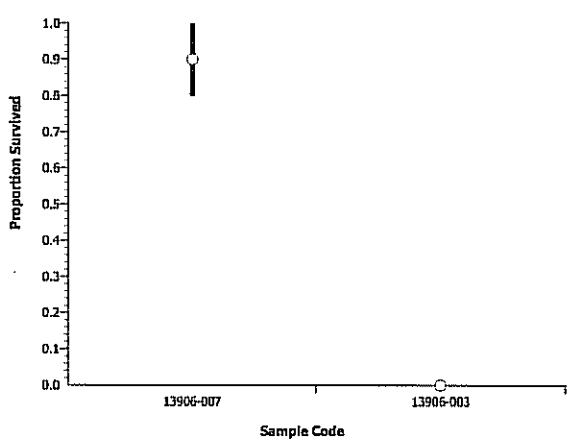
Data Summary

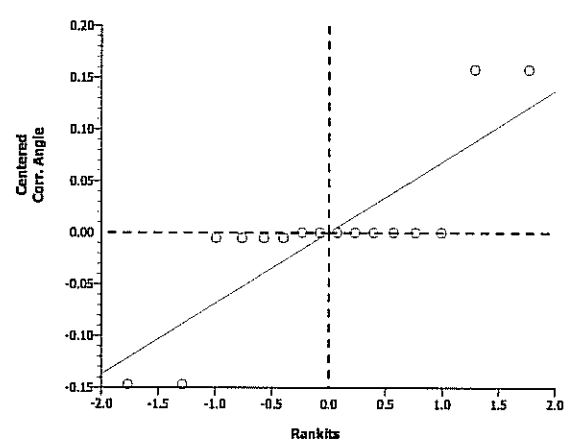
		Original Data				Transformed Data			
Sample Code	**Count**	**Mean**	**Minimum**	**Maximum**	**SD**	**Mean**	**Minimum**	**Maximum**	**SD**
13906-007	8	0.90000	0.80000	1.00000	0.07559	1.25431	1.10715	1.41202	0.11537
13906-003	8	0.00000	0.00000	0.00000	0.00000	0.15878	0.15878	0.15878	0.00001

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13906-007	0.90000	1.00000	0.80000	0.90000	0.90000	1.00000	0.90000	0.80000		
13906-003	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000		

Graphics





CETIS Analysis Detail

Hyalella 28-d Survival and Growth Sediment Test — **EnviroSystems, Inc.**

Test No:	04-3537-1169	**Test Type:**	Leptocheirus (28-d)	**Duration:**	28d 0h
Start Date:	17 Nov-05 12:00 PM	**Protocol:**	EPA/600/R-99/064 (2000)	**Species:**	Hyalella azteca
Ending Date:	15 Dec-05 12:00 PM	**Dil Water:**	50/50 Mix of Surface Water and MHR	**Source:**	Aquatic Research Organisms, NH
Setup Date:	17 Nov-05 12:00 PM	**Brine:**	Not Applicable		

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Proportion Survived	Comparison	05-2884-6524	05-2884-6524	15 Dec-05 11:01 PM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Angular (Corrected)				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	1.23101	8.88539	0.79094	Equal Variances
Distribution	Shapiro-Wilk W	0.86968	0.84420	0.02599	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	0.00166	0.00166	1	0.11	0.74305	Non-Significant Effect
Error	0.2078546	0.0148468	14			
Total	0.20951456	0.0165067	15			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13906-007		13906-004	-0.3344	1.76131	0.6285	0.10731	Non-Significant Effect

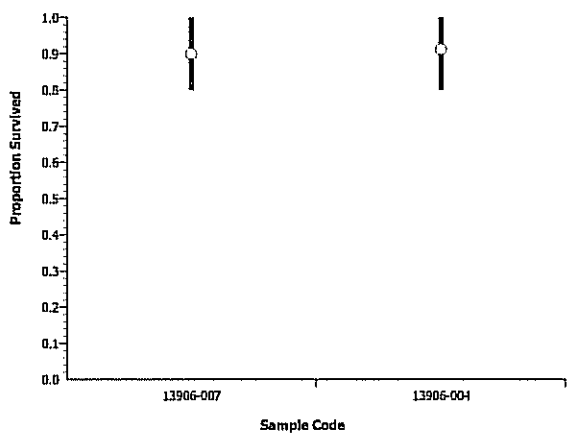
Data Summary

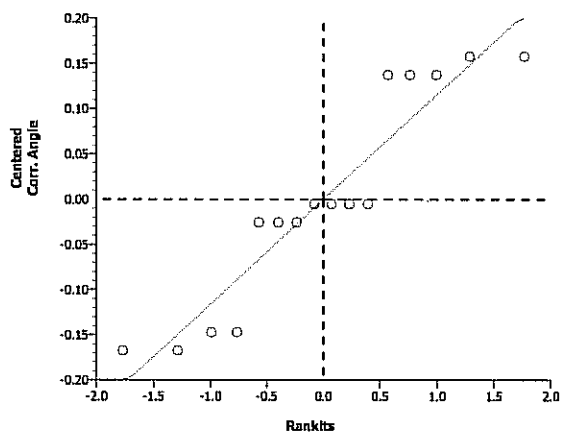
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13906-007	8	0.90000	0.80000	1.00000	0.07559	1.25431	1.10715	1.41202	0.11537
13906-004	8	0.91250	0.80000	1.00000	0.08345	1.27469	1.10715	1.41202	0.12800

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13906-007	0.90000	1.00000	0.80000	0.90000	0.90000	1.00000	0.90000	0.80000		
13906-004	0.90000	0.90000	0.80000	1.00000	0.90000	1.00000	1.00000	0.80000		

Graphics





CETIS Analysis Detail

Hyalella 28-d Survival and Growth Sediment Test — EnviroSystems, Inc.

Test No:	04-3537-1169	**Test Type:**	Leptocheirus (28-d)	**Duration:**	28d 0h
Start Date:	17 Nov-05 12:00 PM	**Protocol:**	EPA/600/R-99/064 (2000)	**Species:**	Hyalella azteca
Ending Date:	15 Dec-05 12:00 PM	**Dil Water:**	50/50 Mix of Surface Water and MHR	**Source:**	Aquatic Research Organisms, NH
Setup Date:	17 Nov-05 12:00 PM	**Brine:**	Not Applicable		

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Proportion Survived	Comparison	05-2884-6524	05-2884-6524	15 Dec-05 11:01 PM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Angular (Corrected)				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	1.47922	8.88539	0.61828	Equal Variances
Distribution	Shapiro-Wilk W	0.89244	0.84420	0.06082	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	0.0149396	0.0149396	1	0.91	0.35745	Non-Significant Effect
Error	0.2309796	0.0164985	14			
Total	0.24591923	0.0314382	15			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13906-007		13906-005	-0.9516	1.76131	0.8213	0.11312	Non-Significant Effect

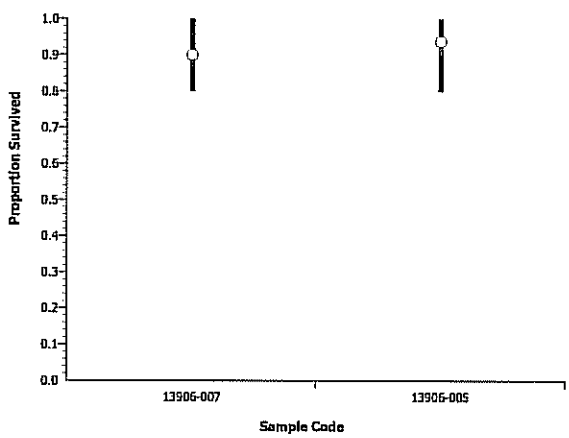
Data Summary

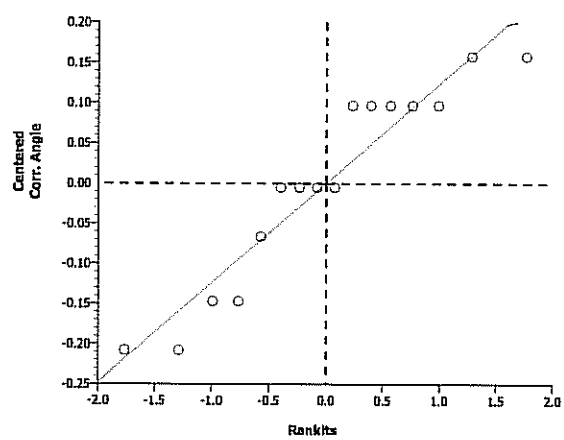
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13906-007	8	0.90000	0.80000	1.00000	0.07559	1.25431	1.10715	1.41202	0.11537
13906-005	8	0.93750	0.80000	1.00000	0.09161	1.31543	1.10715	1.41202	0.14031

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13906-007	0.90000	1.00000	0.80000	0.90000	0.90000	1.00000	0.90000	0.80000		
13906-005	1.00000	1.00000	1.00000	0.80000	1.00000	1.00000	0.90000	0.80000		

Graphics





CETIS Test Summary

Report Date: 16 Dec-05 4:12 PM
Link: 05-2884-6524

Hyalella 28-d Survival and Growth Sediment Test — **EnviroSystems, Inc.**

Test No:	04-3537-1169	**Test Type:**	Leptocheirus (28-d)	**Duration:**	28d 0h
Start Date:	17 Nov-05 12:00 PM	**Protocol:**	EPA/600/R-99/064 (2000)	**Species:**	Hyalella azteca
Ending Date:	15 Dec-05 12:00 PM	**Dil Water:**	50/50 Mix of Surface Water and MHR	**Source:**	Aquatic Research Organisms, NH
Setup Date:	17 Nov-05 12:00 PM	**Brine:**	Not Applicable		

Sample No:	08-6868-8888	**Material:**	Control Sediment - Fresh	**Client:**	CH2M Hill
Sample Date:	16 Nov-05 12:00 PM	**Code:**	13906-000	**Project:**	Ecologcal Risk Assessment
Receive Date:	16 Nov-05 12:00 PM	**Source:**	ESI Control		
Sample Age:	24h	**Station:**			
Sample No:	12-6242-6075	**Material:**	Freshwater Sedment	**Client:**	CH2M Hill
Sample Date:	26 Oct-05 10:30 AM	**Code:**	13906-001	**Project:**	Ecologcal Risk Assessment
Receive Date:	28 Oct-05 10:30 AM	**Source:**	Indian Head CT0 111; Site 28		
Sample Age:	22d 1h	**Station:**	IS28SD01; 13906-001		
Sample No:	07-6519-9575	**Material:**	Freshwater Sedment	**Client:**	CH2M Hill
Sample Date:	27 Oct-05 09:00 AM	**Code:**	13906-002	**Project:**	Ecologcal Risk Assessment
Receive Date:	28 Oct-05 10:30 AM	**Source:**	Indian Head CT0 111; Site 28		
Sample Age:	21d 3h	**Station:**	IS28SD02; 13906-002		
Sample No:	09-5811-1335	**Material:**	Freshwater Sedment	**Client:**	CH2M Hill
Sample Date:	26 Oct-05 08:45 AM	**Code:**	13906-003	**Project:**	Ecologcal Risk Assessment
Receive Date:	28 Oct-05 10:30 AM	**Source:**	Indian Head CT0 111; Site 28		
Sample Age:	22d 3h	**Station:**	IS28SD03; 13906-003		
Sample No:	12-7285-3356	**Material:**	Freshwater Sedment	**Client:**	CH2M Hill
Sample Date:	25 Oct-05 02:50 PM	**Code:**	13906-004	**Project:**	Ecologcal Risk Assessment
Receive Date:	28 Oct-05 10:30 AM	**Source:**	Indian Head CT0 111; Site 28		
Sample Age:	22d 21h	**Station:**	IS28SD11; 13906-004		
Sample No:	06-4936-0798	**Material:**	Freshwater Sedment	**Client:**	CH2M Hill
Sample Date:	27 Oct-05 10:00 AM	**Code:**	13906-005	**Project:**	Ecologcal Risk Assessment
Receive Date:	28 Oct-05 10:30 AM	**Source:**	Indian Head CT0 111; Site 28		
Sample Age:	21d 2h	**Station:**	IS28SD13; 13906-005		
Sample No:	01-0947-2935	**Material:**	Freshwater Sedment	**Client:**	CH2M Hill
Sample Date:	26 Oct-05 03:40 PM	**Code:**	13906-006	**Project:**	Ecologcal Risk Assessment
Receive Date:	28 Oct-05 10:30 AM	**Source:**	Indian Head CT0 111; Site 28		
Sample Age:	21d 20h	**Station:**	IS28REF1; 13906-006		
Sample No:	14-4052-2119	**Material:**	Freshwater Sedment	**Client:**	CH2M Hill
Sample Date:	27 Oct-05 11:30 AM	**Code:**	13906-007	**Project:**	Ecologcal Risk Assessment
Receive Date:	28 Oct-05 10:30 AM	**Source:**	Indian Head CT0 111; Site 28		
Sample Age:	21d 0h	**Station:**	IS28REF2; 13906-007		

CETIS Test Summary

Report Date: 16 Dec-05 4:12 PM
Link: 05-2884-6524

Mean Dry Weight-mg Summary

Sample Code	Reps	Mean	Minimum	Maximum	SE	SD	CV
13906-000	8	0.41444	0.28555	0.58667	0.04011	0.11344	27.37%
13906-006	8	0.40209	0.36000	0.50250	0.01651	0.04669	11.61%
13906-007	8	0.52192	0.42667	0.60222	0.01945	0.05502	10.54%
13906-001	8	0.66031	0.43875	0.94333	0.05462	0.15450	23.40%
13906-002	8	0.47539	0.38445	0.61200	0.03242	0.09169	19.29%
13906-003	8						
13906-004	8	0.39086	0.21125	0.51375	0.04045	0.11442	29.27%
13906-005	8	0.43984	0.34125	0.52200	0.02406	0.06804	15.47%

Proportion Survived Summary

Sample Code	Reps	Mean	Minimum	Maximum	SE	SD	CV
13906-000	8	0.90000	0.80000	1.00000	0.02673	0.07559	8.40%
13906-006	8	0.87500	0.70000	1.00000	0.04119	0.11650	13.31%
13906-007	8	0.90000	0.80000	1.00000	0.02673	0.07559	8.40%
13906-001	8	0.71250	0.60000	1.00000	0.05154	0.14577	20.46%
13906-002	8	0.78750	0.50000	1.00000	0.06105	0.17269	21.93%
13906-003	8	0.00000	0.00000	0.00000	0.00000	0.00000	0.00%
13906-004	8	0.91250	0.80000	1.00000	0.02950	0.08345	9.15%
13906-005	8	0.93750	0.80000	1.00000	0.03239	0.09161	9.77%

Mean Dry Weight-mg Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8
13906-000	0.53222	0.58667	0.33400	0.44750	0.31375	0.28555	0.33000	0.48583
13906-006	0.37200	0.36000	0.41375	0.37100	0.50250	0.41625	0.36900	0.41222
13906-007	0.60222	0.53000	0.54625	0.42667	0.55556	0.49800	0.54667	0.47000
13906-001	0.75857	0.57500	0.54600	0.74333	0.94333	0.43875	0.63250	0.64500
13906-002	0.38500	0.51571	0.39625	0.59714	0.46857	0.44400	0.38445	0.61200
13906-003	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
13906-004	0.45555	0.38556	0.51375	0.30500	0.27778	0.47100	0.50700	0.21125
13906-005	0.42000	0.42100	0.50700	0.34125	0.52200	0.46900	0.35222	0.48625

Proportion Survived Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8
13906-000	0.90000	0.90000	1.00000	0.80000	0.80000	0.90000	0.90000	1.00000
13906-006	1.00000	0.70000	0.80000	1.00000	0.80000	0.80000	1.00000	0.90000
13906-007	0.90000	1.00000	0.80000	0.90000	0.90000	1.00000	0.90000	0.80000
13906-001	0.70000	0.60000	1.00000	0.60000	0.60000	0.80000	0.80000	0.60000
13906-002	1.00000	0.70000	0.80000	0.70000	0.70000	1.00000	0.90000	0.50000
13906-003	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
13906-004	0.90000	0.90000	0.80000	1.00000	0.90000	1.00000	1.00000	0.80000
13906-005	1.00000	1.00000	1.00000	0.80000	1.00000	1.00000	0.90000	0.80000

CETIS Analysis Detail

Hyalella 28-d Survival and Growth Sediment Test — EnviroSystems, Inc.

Test No:	04-3537-1169	**Test Type:**	Leptocheirus (28-d)	**Duration:**	28d 0h
Start Date:	17 Nov-05 12:00 PM	**Protocol:**	EPA/600/R-99/064 (2000)	**Species:**	Hyalella azteca
Ending Date:	15 Dec-05 12:00 PM	**Dil Water:**	50/50 Mix of Surface Water and MHR	**Source:**	Aquatic Research Organisms, NH
Setup Date:	17 Nov-05 12:00 PM	**Brine:**	Not Applicable		

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Mean Dry Weight-mg	Comparison	05-2884-6524	05-2884-6524	16 Dec-05 3:25 PM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	5.90278	8.88539	0.03202	Equal Variances
Distribution	Shapiro-Wilk W	0.96672	0.84420	0.74845	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	0.0006101	0.0006101	1	0.08	0.78000	Non-Significant Effect
Error	0.1053351	0.0075239	14			
Total	0.10594515	0.0081340	15			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13906-000		13906-006	0.28476	1.76131	0.3900	0.07639	Non-Significant Effect

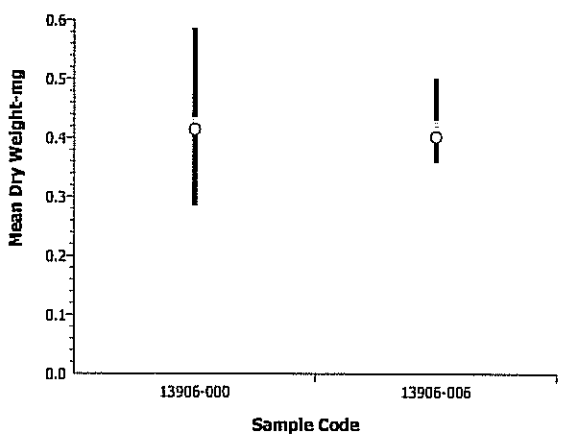
Data Summary

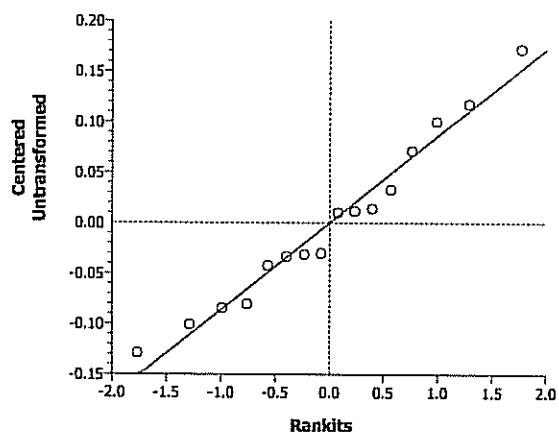
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13906-000	8	0.41444	0.28555	0.58667	0.11344				
13906-006	8	0.40209	0.36000	0.50250	0.04669				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13906-000	0.53222	0.58667	0.33400	0.44750	0.31375	0.28555	0.33000	0.48583		
13906-006	0.37200	0.36000	0.41375	0.37100	0.50250	0.41625	0.36900	0.41222		

Graphics





CETIS Analysis Detail

Hyalella 28-d Survival and Growth Sediment Test — EnviroSystems, Inc.

Test No:	04-3537-1169	**Test Type:**	Leptocheirus (28-d)	**Duration:**	28d 0h
Start Date:	17 Nov-05 12:00 PM	**Protocol:**	EPA/600/R-99/064 (2000)	**Species:**	Hyalella azteca
Ending Date:	15 Dec-05 12:00 PM	**Dil Water:**	50/50 Mix of Surface Water and MHR	**Source:**	Aquatic Research Organisms, NH
Setup Date:	17 Nov-05 12:00 PM	**Brine:**	Not Applicable		

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Mean Dry Weight-mg	Comparison	05-2884-6524	05-2884-6524	16 Dec-05 3:25 PM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	4.25073	8.88539	0.07544	Equal Variances
Distribution	Shapiro-Wilk W	0.96011	0.84420	0.63345	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	0.0462069	0.0462069	1	5.81	0.03021	Significant Effect
Error	0.1112658	0.0079476	14			
Total	0.15747274	0.0541545	15			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13906-000		13906-007	-2.4112	1.76131	0.9849	0.07851	Non-Significant Effect

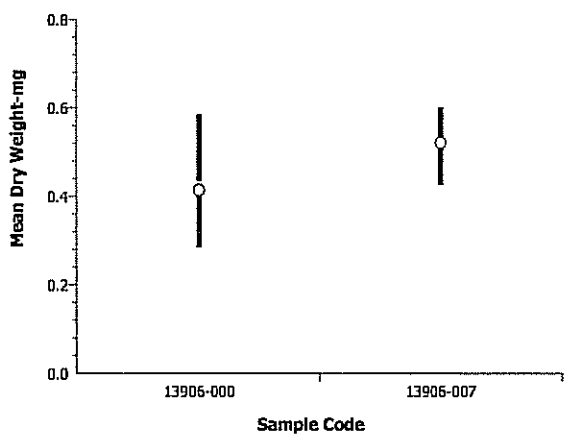
Data Summary

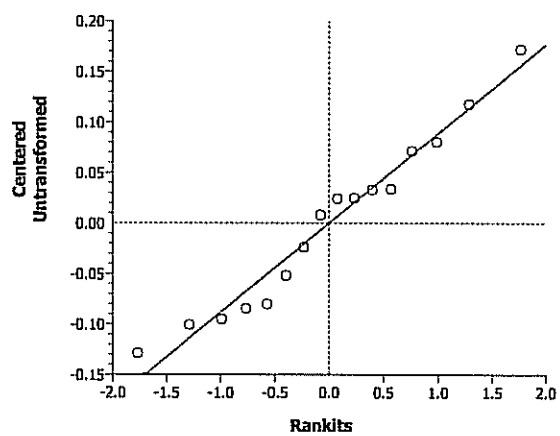
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13906-000	8	0.41444	0.28555	0.58667	0.11344				
13906-007	8	0.52192	0.42667	0.60222	0.05502				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13906-000	0.53222	0.58667	0.33400	0.44750	0.31375	0.28555	0.33000	0.48583		
13906-007	0.60222	0.53000	0.54625	0.42667	0.55556	0.49800	0.54667	0.47000		

Graphics





CETIS Analysis Detail

Hyalella 28-d Survival and Growth Sediment Test — EnviroSystems, Inc.

Test No:	04-3537-1169	**Test Type:**	Leptocheirus (28-d)	**Duration:**	28d 0h
Start Date:	17 Nov-05 12:00 PM	**Protocol:**	EPA/600/R-99/064 (2000)	**Species:**	Hyalella azteca
Ending Date:	15 Dec-05 12:00 PM	**Dil Water:**	50/50 Mix of Surface Water and MHR	**Source:**	Aquatic Research Organisms, NH
Setup Date:	17 Nov-05 12:00 PM	**Brine:**	Not Applicable		

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Mean Dry Weight-mg	Comparison	05-2884-6524	05-2884-6524	16 Dec-05 3:25 PM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	1.85503	8.88539	0.43368	Equal Variances
Distribution	Shapiro-Wilk W	0.96540	0.84420	0.72548	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	0.2418078	0.2418078	1	13.16	0.00274	Significant Effect
Error	0.2571675	0.0183691	14			
Total	0.49897531	0.2601769	15			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13906-000		13906-001	-3.6282	1.76131	0.9986	0.11936	Non-Significant Effect

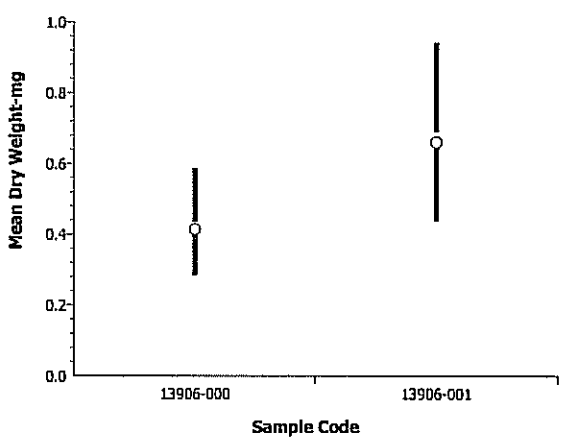
Data Summary

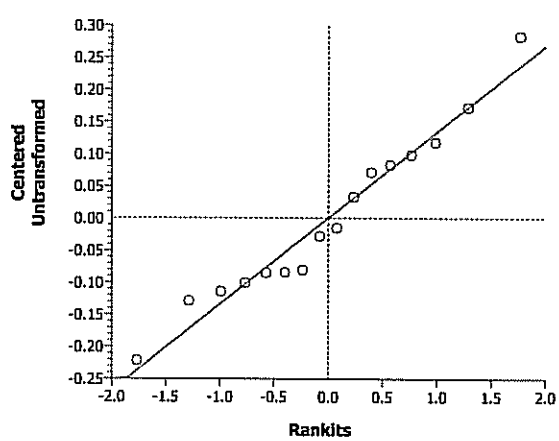
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13906-000	8	0.41444	0.28555	0.58667	0.11344				
13906-001	8	0.66031	0.43875	0.94333	0.15450				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13906-000	0.53222	0.58667	0.33400	0.44750	0.31375	0.28555	0.33000	0.48583		
13906-001	0.75857	0.57500	0.54600	0.74333	0.94333	0.43875	0.63250	0.64500		

Graphics





CETIS Analysis Detail

Hyalella 28-d Survival and Growth Sediment Test — EnviroSystems, Inc.

Test No:	04-3537-1169	**Test Type:**	Leptocheirus (28-d)	**Duration:**	28d 0h
Start Date:	17 Nov-05 12:00 PM	**Protocol:**	EPA/600/R-99/064 (2000)	**Species:**	Hyalella azteca
Ending Date:	15 Dec-05 12:00 PM	**Dil Water:**	50/50 Mix of Surface Water and MHR	**Source:**	Aquatic Research Organisms, NH
Setup Date:	17 Nov-05 12:00 PM	**Brine:**	Not Applicable		

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Mean Dry Weight-mg	Comparison	05-2884-6524	05-2884-6524	16 Dec-05 3:25 PM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	1.53065	8.88539	0.58817	Equal Variances
Distribution	Shapiro-Wilk W	0.90009	0.84420	0.08083	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	0.0148594	0.0148594	1	1.40	0.25693	Non-Significant Effect
Error	0.1489232	0.0106374	14			
Total	0.1637826	0.0254968	15			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13906-000		13906-002	-1.1819	1.76131	0.8715	0.09083	Non-Significant Effect

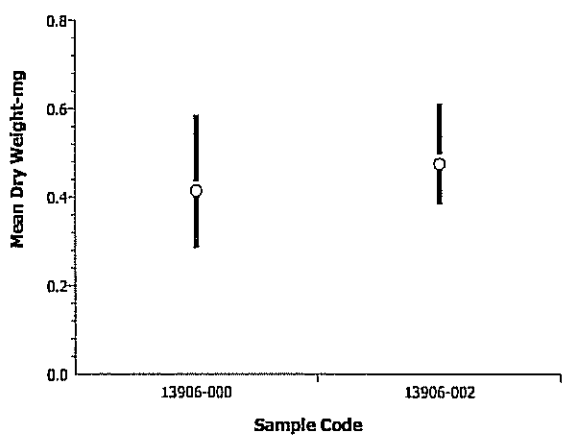
Data Summary

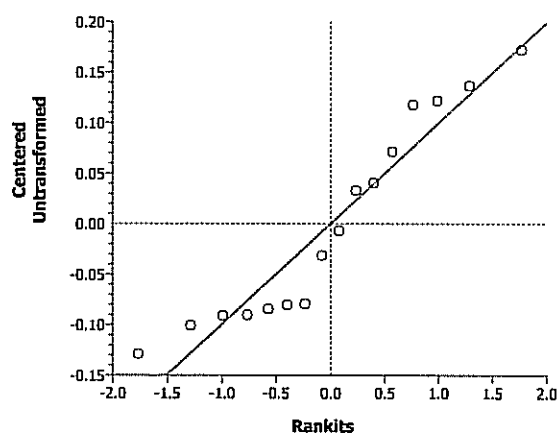
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13906-000	8	0.41444	0.28555	0.58667	0.11344				
13906-002	8	0.47539	0.38445	0.61200	0.09169				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13906-000	0.53222	0.58667	0.33400	0.44750	0.31375	0.28555	0.33000	0.48583		
13906-002	0.38500	0.51571	0.39625	0.59714	0.46857	0.44400	0.38445	0.61200		

Graphics





CETIS Analysis Detail

Hyalella 28-d Survival and Growth Sediment Test — EnviroSystems, Inc.

Test No:	04-3537-1169	**Test Type:**	Leptocheirus (28-d)	**Duration:**	28d 0h
Start Date:	17 Nov-05 12:00 PM	**Protocol:**	EPA/600/R-99/064 (2000)	**Species:**	Hyalella azteca
Ending Date:	15 Dec-05 12:00 PM	**Dil Water:**	50/50 Mix of Surface Water and MHR	**Source:**	Aquatic Research Organisms, NH
Setup Date:	17 Nov-05 12:00 PM	**Brine:**	Not Applicable		

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Mean Dry Weight-mg	Comparison	05-2884-6524	05-2884-6524	16 Dec-05 3:26 PM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	1.01743	8.88539	0.98240	Equal Variances
Distribution	Shapiro-Wilk W	0.92508	0.84420	0.20157	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	0.002224	0.002224	1	0.17	0.68520	Non-Significant Effect
Error	0.1817207	0.0129801	14			
Total	0.1839447	0.0152040	15			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13906-000		13906-004	0.41393	1.76131	0.3426	0.10033	Non-Significant Effect

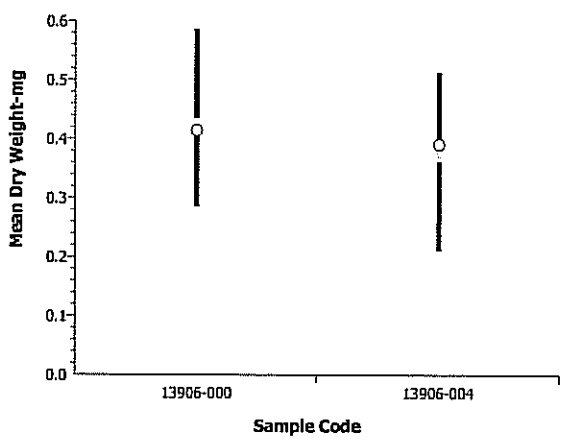
Data Summary

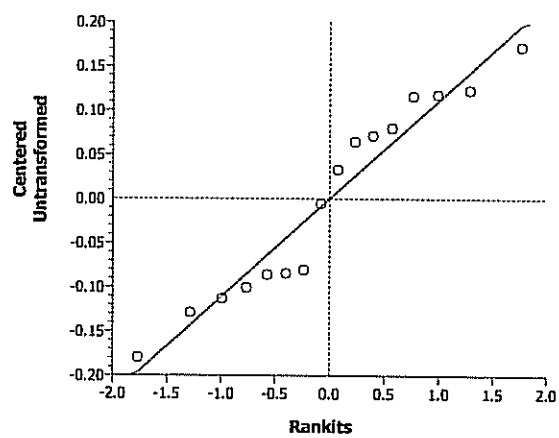
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13906-000	8	0.41444	0.28555	0.58667	0.11344				
13906-004	8	0.39086	0.21125	0.51375	0.11442				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13906-000	0.53222	0.58667	0.33400	0.44750	0.31375	0.28555	0.33000	0.48583		
13906-004	0.45555	0.38556	0.51375	0.30500	0.27778	0.47100	0.50700	0.21125		

Graphics





CETIS Analysis Detail

Hyalella 28-d Survival and Growth Sediment Test — EnviroSystems, Inc.

Test No:	04-3537-1169	**Test Type:**	Leptocheirus (28-d)	**Duration:**	28d 0h
Start Date:	17 Nov-05 12:00 PM	**Protocol:**	EPA/600/R-99/064 (2000)	**Species:**	Hyalella azteca
Ending Date:	15 Dec-05 12:00 PM	**Dil Water:**	50/50 Mix of Surface Water and MHR	**Source:**	Aquatic Research Organisms, NH
Setup Date:	17 Nov-05 12:00 PM	**Brine:**	Not Applicable		

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Mean Dry Weight-mg	Comparison	05-2884-6524	05-2884-6524	16 Dec-05 3:26 PM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	2.77919	8.88539	0.20087	Equal Variances
Distribution	Shapiro-Wilk W	0.93980	0.84420	0.33713	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	0.0025806	0.0025806	1	0.29	0.59560	Non-Significant Effect
Error	0.1224859	0.008749	14			
Total	0.12506644	0.0113296	15			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13906-000		13906-005	-0.5431	1.76131	0.7022	0.08237	Non-Significant Effect

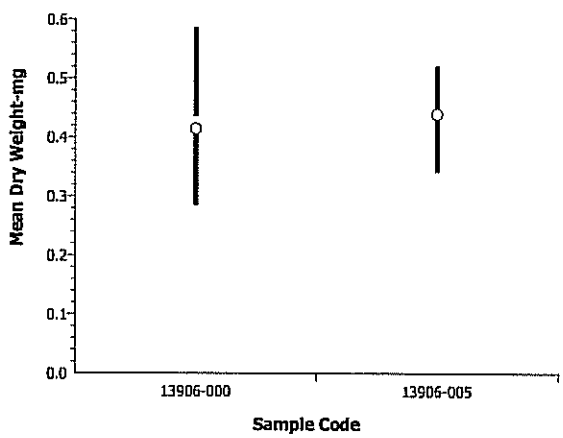
Data Summary

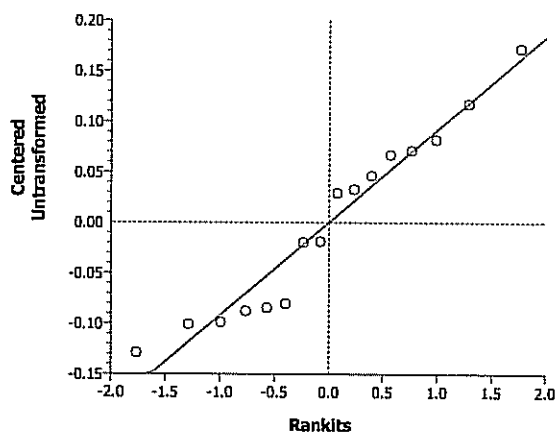
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13906-000	8	0.41444	0.28555	0.58667	0.11344				
13906-005	8	0.43984	0.34125	0.52200	0.06804				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13906-000	0.53222	0.58667	0.33400	0.44750	0.31375	0.28555	0.33000	0.48583		
13906-005	0.42000	0.42100	0.50700	0.34125	0.52200	0.46900	0.35222	0.48625		

Graphics





CETIS Analysis Detail

Hyalella 28-d Survival and Growth Sediment Test — **EnviroSystems, Inc.**

Test No:	04-3537-1169	**Test Type:**	Leptocheirus (28-d)	**Duration:**	28d 0h
Start Date:	17 Nov-05 12:00 PM	**Protocol:**	EPA/600/R-99/064 (2000)	**Species:**	Hyalella azteca
Ending Date:	15 Dec-05 12:00 PM	**Dil Water:**	50/50 Mix of Surface Water and MHR	**Source:**	Aquatic Research Organisms, NH
Setup Date:	17 Nov-05 12:00 PM	**Brine:**	Not Applicable		

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Mean Dry Weight-mg	Comparison	05-2884-6524	05-2884-6524	16 Dec-05 3:26 PM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	1.38865	8.88539	0.67576	Equal Variances
Distribution	Shapiro-Wilk W	0.96296	0.84420	0.68283	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	0.057436	0.057436	1	22.06	0.00034	Significant Effect
Error	0.0364504	0.0026036	14			
Total	0.09388636	0.0600396	15			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13906-006		13906-007	-4.6968	1.76131	0.9998	0.04494	Non-Significant Effect

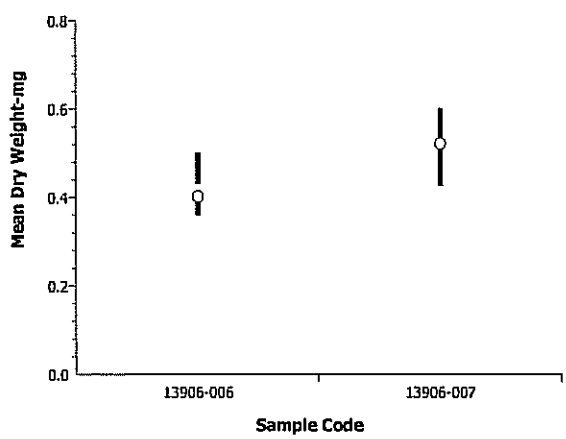
Data Summary

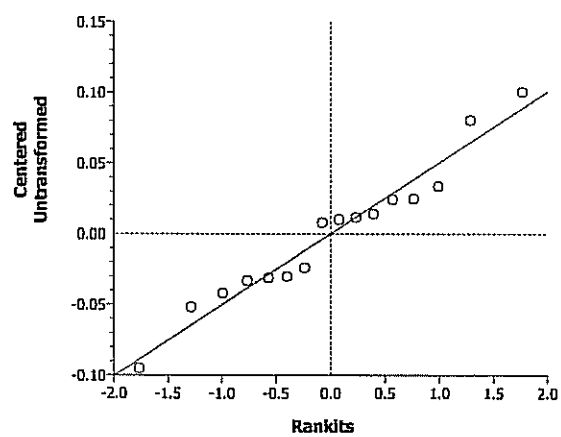
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13906-006	8	0.40209	0.36000	0.50250	0.04669				
13906-007	8	0.52192	0.42667	0.60222	0.05502				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13906-006	0.37200	0.36000	0.41375	0.37100	0.50250	0.41625	0.36900	0.41222		
13906-007	0.60222	0.53000	0.54625	0.42667	0.55556	0.49800	0.54667	0.47000		

Graphics





CETIS Analysis Detail

Hyalella 28-d Survival and Growth Sediment Test — EnviroSystems, Inc.

Test No:	04-3537-1169	**Test Type:**	Leptocheirus (28-d)	**Duration:**	28d 0h
Start Date:	17 Nov-05 12:00 PM	**Protocol:**	EPA/600/R-99/064 (2000)	**Species:**	Hyalella azteca
Ending Date:	15 Dec-05 12:00 PM	**Dil Water:**	50/50 Mix of Surface Water and MHR	**Source:**	Aquatic Research Organisms, NH
Setup Date:	17 Nov-05 12:00 PM	**Brine:**	Not Applicable		

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Mean Dry Weight-mg	Comparison	05-2884-6524	05-2884-6524	16 Dec-05 3:26 PM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Unequal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	10.94983	8.88539	0.00534	Unequal Variances
Distribution	Shapiro-Wilk W	0.92212	0.84420	0.18129	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	0.26671	0.26671	1	20.48	0.00048	Significant Effect
Error	0.1823521	0.0130252	14			
Total	0.44906200	0.2797351	15			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13906-006		13906-001	-4.5251	1.85955	0.9990	0.10611	Non-Significant Effect

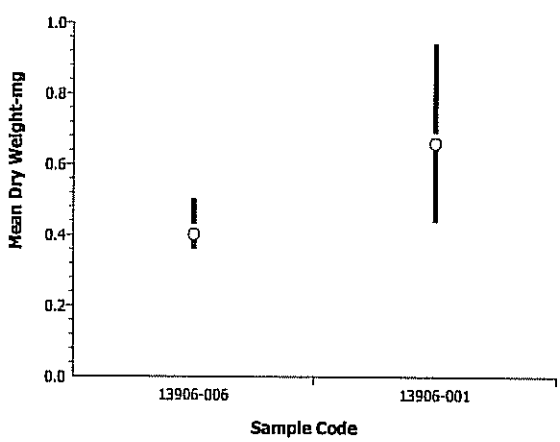
Data Summary

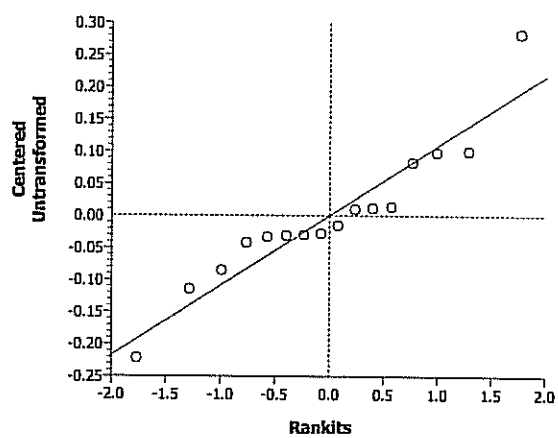
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13906-006	8	0.40209	0.36000	0.50250	0.04669				
13906-001	8	0.66031	0.43875	0.94333	0.15450				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13906-006	0.37200	0.36000	0.41375	0.37100	0.50250	0.41625	0.36900	0.41222		
13906-001	0.75857	0.57500	0.54600	0.74333	0.94333	0.43875	0.63250	0.64500		

Graphics





CETIS Analysis Detail

Hyalella 28-d Survival and Growth Sediment Test — **EnviroSystems, Inc.**

Test No:	04-3537-1169	**Test Type:**	Leptocheirus (28-d)	**Duration:**	28d 0h
Start Date:	17 Nov-05 12:00 PM	**Protocol:**	EPA/600/R-99/064 (2000)	**Species:**	Hyalella azteca
Ending Date:	15 Dec-05 12:00 PM	**Dil Water:**	50/50 Mix of Surface Water and MHR	**Source:**	Aquatic Research Organisms, NH
Setup Date:	17 Nov-05 12:00 PM	**Brine:**	Not Applicable		

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Mean Dry Weight-mg	Comparison	05-2884-6524	05-2884-6524	16 Dec-05 3:26 PM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	3.85640	8.88539	0.09574	Equal Variances
Distribution	Shapiro-Wilk W	0.91327	0.84420	0.13142	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	0.0214914	0.0214914	1	4.06	0.06353	Non-Significant Effect
Error	0.0741077	0.0052934	14			
Total	0.09559909	0.0267848	15			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13906-006		13906-002	-2.015	1.76131	0.9682	0.06407	Non-Significant Effect

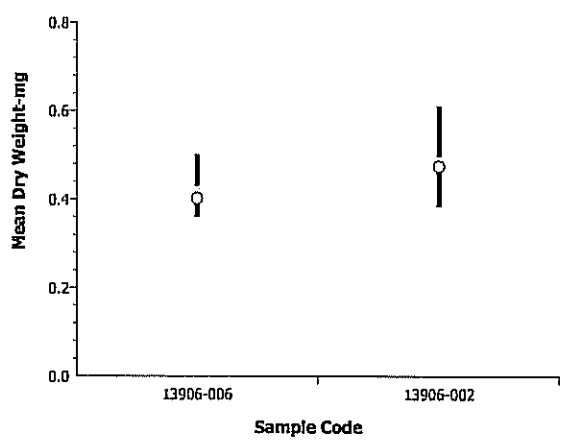
Data Summary

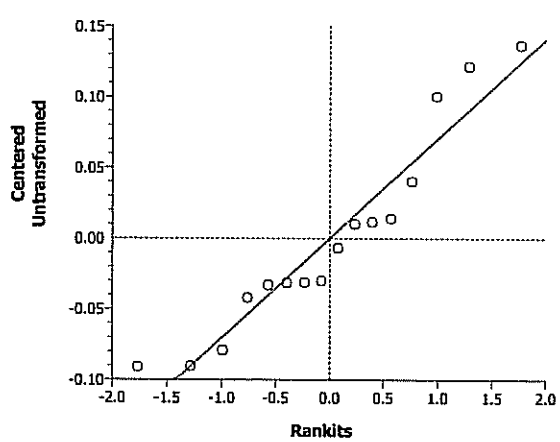
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13906-006	8	0.40209	0.36000	0.50250	0.04669				
13906-002	8	0.47539	0.38445	0.61200	0.09169				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13906-006	0.37200	0.36000	0.41375	0.37100	0.50250	0.41625	0.36900	0.41222		
13906-002	0.38500	0.51571	0.39625	0.59714	0.46857	0.44400	0.38445	0.61200		

Graphics





CETIS Analysis Detail

Hyalella 28-d Survival and Growth Sediment Test — EnviroSystems, Inc.

Test No:	04-3537-1169	**Test Type:**	Leptocheirus (28-d)	**Duration:**	28d 0h
Start Date:	17 Nov-05 12:00 PM	**Protocol:**	EPA/600/R-99/064 (2000)	**Species:**	Hyalella azteca
Ending Date:	15 Dec-05 12:00 PM	**Dil Water:**	50/50 Mix of Surface Water and MHR	**Source:**	Aquatic Research Organisms, NH
Setup Date:	17 Nov-05 12:00 PM	**Brine:**	Not Applicable		

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Mean Dry Weight-mg	Comparison	05-2884-6524	05-2884-6524	16 Dec-05 3:26 PM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	6.00568	8.88539	0.03055	Equal Variances
Distribution	Shapiro-Wilk W	0.96081	0.84420	0.64542	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	0.0005044	0.0005044	1	0.07	0.80091	Non-Significant Effect
Error	0.1069053	0.0076361	14			
Total	0.10740966	0.0081405	15			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13906-006		13906-004	0.25701	1.76131	0.4005	0.07696	Non-Significant Effect

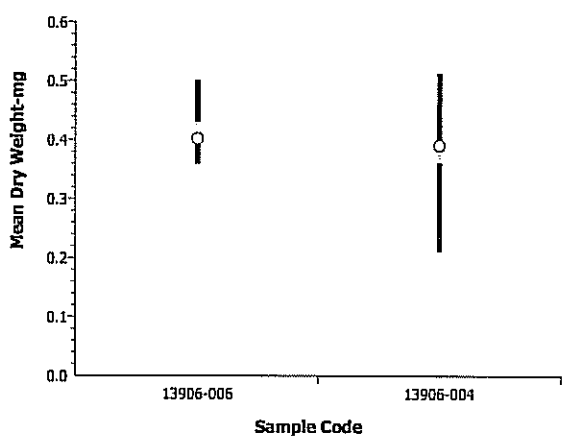
Data Summary

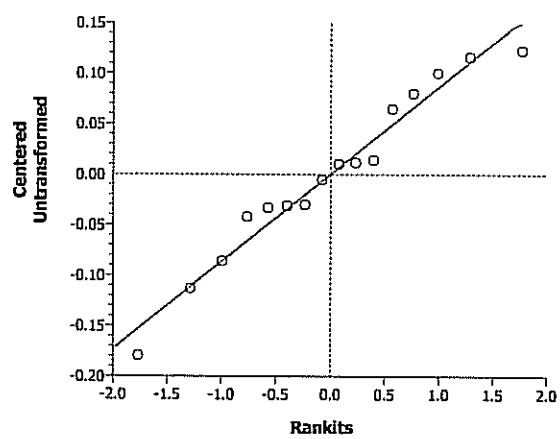
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13906-006	8	0.40209	0.36000	0.50250	0.04669				
13906-004	8	0.39086	0.21125	0.51375	0.11442				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13906-006	0.37200	0.36000	0.41375	0.37100	0.50250	0.41625	0.36900	0.41222		
13906-004	0.45555	0.38556	0.51375	0.30500	0.27778	0.47100	0.50700	0.21125		

Graphics





CETIS Analysis Detail

Hyalella 28-d Survival and Growth Sediment Test — EnviroSystems, Inc.

Test No:	04-3537-1169	**Test Type:**	Leptocheirus (28-d)	**Duration:**	28d 0h
Start Date:	17 Nov-05 12:00 PM	**Protocol:**	EPA/600/R-99/064 (2000)	**Species:**	Hyalella azteca
Ending Date:	15 Dec-05 12:00 PM	**Dil Water:**	50/50 Mix of Surface Water and MHR	**Source:**	Aquatic Research Organisms, NH
Setup Date:	17 Nov-05 12:00 PM	**Brine:**	Not Applicable		

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Mean Dry Weight-mg	Comparison	05-2884-6524	05-2884-6524	16 Dec-05 3:26 PM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	2.12392	8.88539	0.34159	Equal Variances
Distribution	Shapiro-Wilk W	0.96995	0.84420	0.80336	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	0.0057002	0.0057002	1	1.67	0.21666	Non-Significant Effect
Error	0.0476704	0.0034050	14			
Total	0.05337059	0.0091052	15			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13906-006		13906-005	-1.2938	1.76131	0.8917	0.05139	Non-Significant Effect

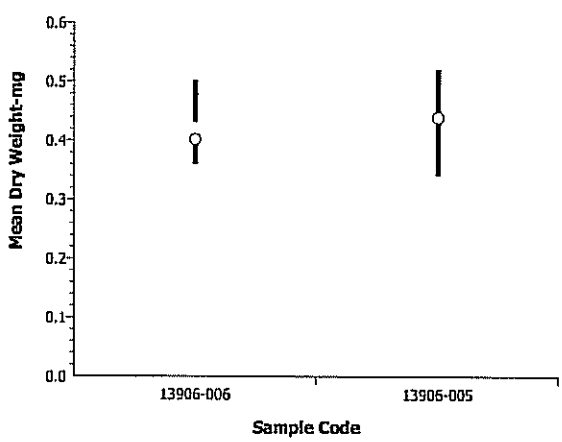
Data Summary

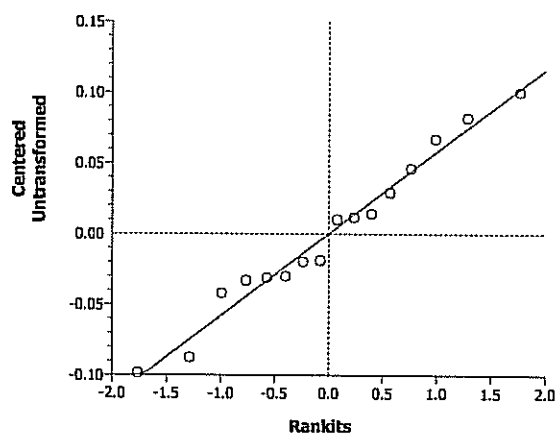
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13906-006	8	0.40209	0.36000	0.50250	0.04669				
13906-005	8	0.43984	0.34125	0.52200	0.06804				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13906-006	0.37200	0.36000	0.41375	0.37100	0.50250	0.41625	0.36900	0.41222		
13906-005	0.42000	0.42100	0.50700	0.34125	0.52200	0.46900	0.35222	0.48625		

Graphics





CETIS Analysis Detail

Hyalella 28-d Survival and Growth Sediment Test — EnviroSystems, Inc.

Test No:	04-3537-1169	**Test Type:**	Leptocheirus (28-d)	**Duration:**	28d 0h
Start Date:	17 Nov-05 12:00 PM	**Protocol:**	EPA/600/R-99/064 (2000)	**Species:**	Hyalella azteca
Ending Date:	15 Dec-05 12:00 PM	**Dil Water:**	50/50 Mix of Surface Water and MHR	**Source:**	Aquatic Research Organisms, NH
Setup Date:	17 Nov-05 12:00 PM	**Brine:**	Not Applicable		

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Mean Dry Weight-mg	Comparison	05-2884-6524	05-2884-6524	16 Dec-05 3:26 PM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	7.88522	8.88539	0.01418	Equal Variances
Distribution	Shapiro-Wilk W	0.95073	0.84420	0.48132	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	0.0766081	0.0766081	1	5.70	0.03167	Significant Effect
Error	0.1882828	0.0134488	14			
Total	0.26489086	0.0900568	15			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13906-007		13906-001	-2.3867	1.76131	0.9842	0.10213	Non-Significant Effect

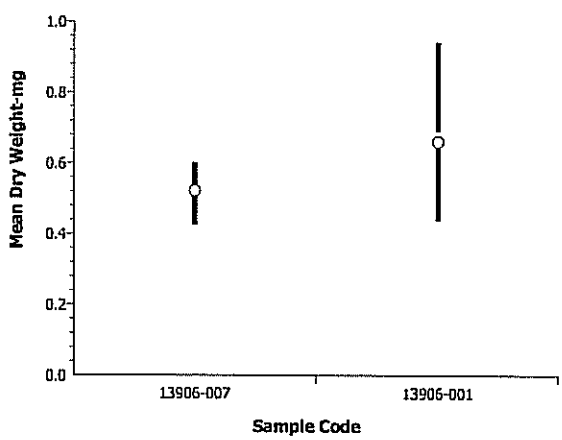
Data Summary

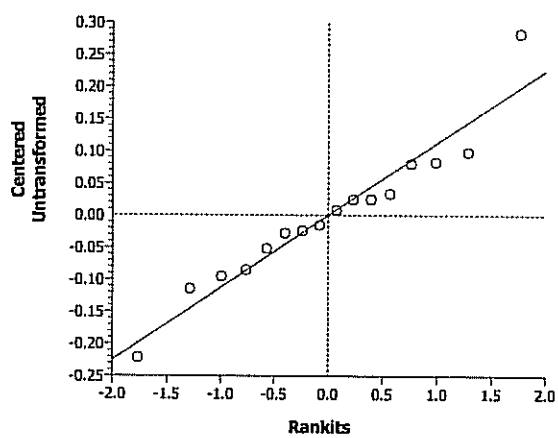
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13906-007	8	0.52192	0.42667	0.60222	0.05502				
13906-001	8	0.66031	0.43875	0.94333	0.15450				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13906-007	0.60222	0.53000	0.54625	0.42667	0.55556	0.49800	0.54667	0.47000		
13906-001	0.75857	0.57500	0.54600	0.74333	0.94333	0.43875	0.63250	0.64500		

Graphics





CETIS Analysis Detail

Hyalella 28-d Survival and Growth Sediment Test — EnviroSystems, Inc.

Test No:	04-3537-1169	**Test Type:**	Leptocheirus (28-d)	**Duration:**	28d 0h
Start Date:	17 Nov-05 12:00 PM	**Protocol:**	EPA/600/R-99/064 (2000)	**Species:**	Hyalella azteca
Ending Date:	15 Dec-05 12:00 PM	**Dil Water:**	50/50 Mix of Surface Water and MHR	**Source:**	Aquatic Research Organisms, NH
Setup Date:	17 Nov-05 12:00 PM	**Brine:**	Not Applicable		

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Mean Dry Weight-mg	Comparison	05-2884-6524	05-2884-6524	16 Dec-05 3:26 PM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	2.77708	8.88539	0.20119	Equal Variances
Distribution	Shapiro-Wilk W	0.94196	0.84420	0.36248	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	0.0086599	0.0086599	1	1.51	0.23869	Non-Significant Effect
Error	0.0800385	0.0057170	14			
Total	0.08869837	0.0143769	15			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13906-007		13906-002	1.23076	1.76131	0.1193	0.06659	Non-Significant Effect

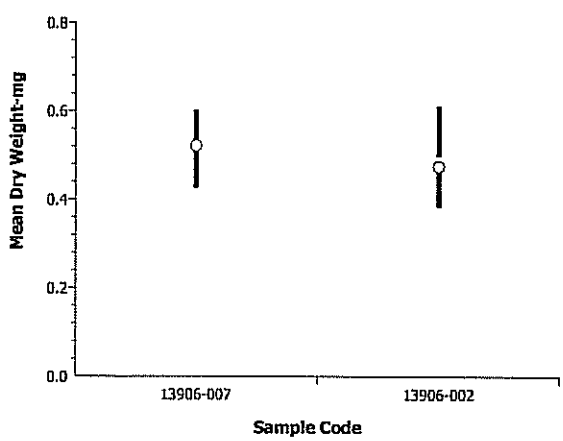
Data Summary

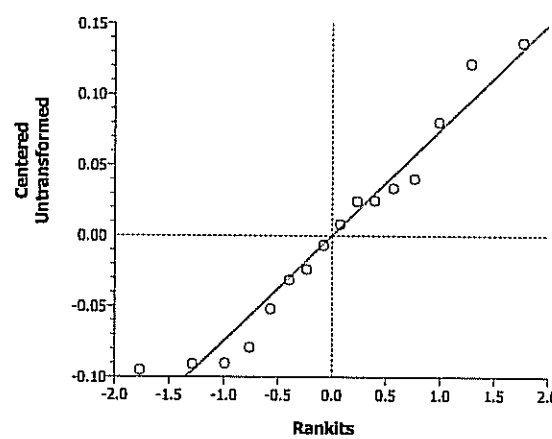
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13906-007	8	0.52192	0.42667	0.60222	0.05502				
13906-002	8	0.47539	0.38445	0.61200	0.09169				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13906-007	0.60222	0.53000	0.54625	0.42667	0.55556	0.49800	0.54667	0.47000		
13906-002	0.38500	0.51571	0.39625	0.59714	0.46857	0.44400	0.38445	0.61200		

Graphics





CETIS Analysis Detail

Hyalella 28-d Survival and Growth Sediment Test — **EnviroSystems, Inc.**

Test No:	04-3537-1169	**Test Type:**	Leptocheirus (28-d)	**Duration:**	28d 0h
Start Date:	17 Nov-05 12:00 PM	**Protocol:**	EPA/600/R-99/064 (2000)	**Species:**	Hyalella azteca
Ending Date:	15 Dec-05 12:00 PM	**Dil Water:**	50/50 Mix of Surface Water and MHR	**Source:**	Aquatic Research Organisms, NH
Setup Date:	17 Nov-05 12:00 PM	**Brine:**	Not Applicable		

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Mean Dry Weight-mg	Comparison	05-2884-6524	05-2884-6524	16 Dec-05 3:27 PM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	4.32482	8.88539	0.07226	Equal Variances
Distribution	Shapiro-Wilk W	0.96256	0.84420	0.67585	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	0.0687054	0.0687054	1	8.52	0.01120	Significant Effect
Error	0.112836	0.0080597	14			
Total	0.18154143	0.0767651	15			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13906-007		13906-004	2.91968	1.76131	0.0056	0.07906	Significant Effect

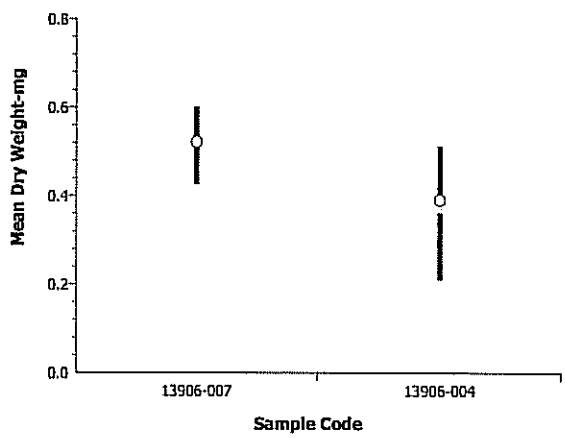
Data Summary

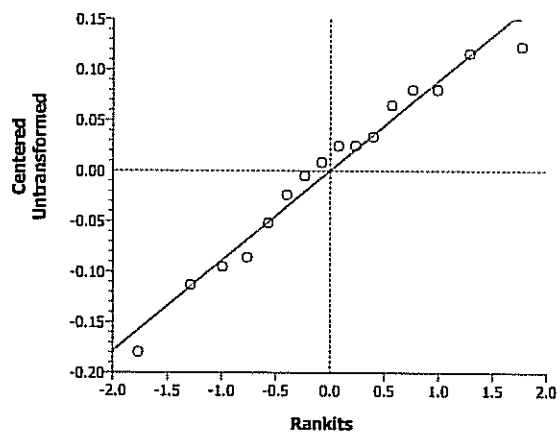
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13906-007	8	0.52192	0.42667	0.60222	0.05502				
13906-004	8	0.39086	0.21125	0.51375	0.11442				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13906-007	0.60222	0.53000	0.54625	0.42667	0.55556	0.49800	0.54667	0.47000		
13906-004	0.45555	0.38556	0.51375	0.30500	0.27778	0.47100	0.50700	0.21125		

Graphics





CETIS Analysis Detail

Hyalella 28-d Survival and Growth Sediment Test — EnviroSystems, Inc.

Test No:	04-3537-1169	**Test Type:**	Leptocheirus (28-d)	**Duration:**	28d 0h
Start Date:	17 Nov-05 12:00 PM	**Protocol:**	EPA/600/R-99/064 (2000)	**Species:**	Hyalella azteca
Ending Date:	15 Dec-05 12:00 PM	**Dil Water:**	50/50 Mix of Surface Water and MHR	**Source:**	Aquatic Research Organisms, NH
Setup Date:	17 Nov-05 12:00 PM	**Brine:**	Not Applicable		

Endpoint	Analysis Type	Sample Link	Control Link	Date Analyzed	Version
Mean Dry Weight-mg	Comparison	05-2884-6524	05-2884-6524	16 Dec-05 3:27 PM	CETISv1.026

Method	Alt H	Data Transform	Z	NOEL	LOEL	Toxic Units	ChV	MSDp
Equal Variance t	C > T	Untransformed				N/A		

ANOVA Assumptions

Attribute	Test	Statistic	Critical	P Level	Decision(0.01)
Variances	Variance Ratio	1.52948	8.88539	0.58883	Equal Variances
Distribution	Shapiro-Wilk W	0.93099	0.84420	0.24862	Normal Distribution

ANOVA Table

Source	Sum of Squares	Mean Square	DF	F Statistic	P Level	Decision(0.05)
Between	0.0269481	0.0269481	1	7.04	0.01892	Significant Effect
Error	0.0536012	0.0038287	14			
Total	0.08054923	0.0307767	15			

Group Comparisons

Sample	vs	Sample	Statistic	Critical	P Level	MSD	Decision(0.05)
13906-007		13906-005	2.65302	1.76131	0.0095	0.05449	Significant Effect

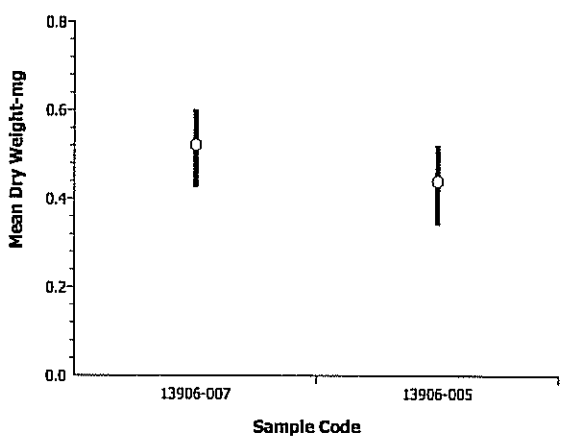
Data Summary

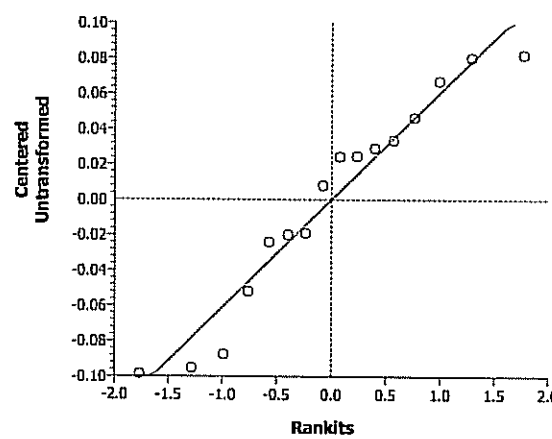
		Original Data				Transformed Data			
Sample Code	Count	Mean	Minimum	Maximum	SD	Mean	Minimum	Maximum	SD
13906-007	8	0.52192	0.42667	0.60222	0.05502				
13906-005	8	0.43984	0.34125	0.52200	0.06804				

Data Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
13906-007	0.60222	0.53000	0.54625	0.42667	0.55556	0.49800	0.54667	0.47000		
13906-005	0.42000	0.42100	0.50700	0.34125	0.52200	0.46900	0.35222	0.48625		

Graphics





STUDY NUMBER: 13906 ***Hyalella azteca* Assay** CLIENT: CH2M Hill

ESI SAMPLE ID	REP	TARE WEIGHT (G)	*H. azteca* + FOIL (G)	NET WEIGHT (MG)	# *H. azteca*	MEAN DRY WEIGHT PER *H. azteca* (MG)
START ORGANISMS	A	0.20718	0.20741	0.23	10	0.023
	B	0.20941	0.20975	0.34	10	0.034
	C	0.20942	0.21036	0.44	10	0.044
	D	0.20887	0.20944	0.57	10	0.057
RECORDED BY:		BB	BB	MR	BB	MR
DATE:		11/12/05	11/18/05	12/20/05	11/17/05	12/20/05

NOTES:

T = 0.0395

Aquatic Research Organisms

received 11-17-05 1400

DATA SHEET

I. Organism History

Species: Hyalella azteca

Source: Lab reared X Hatchery reared ____ Field collected ____

Hatch date 11/10/05 Receipt date ____

Lot number 11 10 05 HA Strain ARO

Brood Origination US FWS MO

II. Water Quality

Temperature 23 °C Salinity — ppt DO 7.8

pH 7.6 Hardness ≈120 ppm

III. Culture Conditions

System: FW Static renewal

Diet: Flake Food X Phytoplankton ____ Trout Chow X

Brine Shrimp ____ Rotifers ____ Other ____

Prophylactic Treatments: ____

Comments: ____

IV. Shipping Information

Client: ESI # of Organisms: 700

Carrier: Pick-up Date Shipped: 11/~~24~~17/05

Biologist: ____

1 - 800 - 927 - 1650

PO Box 1271 • One Lafayette Road • Hampton, NH 03842 • (603) 926-1650

STUDY: 13906
CLIENT: CH2M Hill
PROJECT: CTO 111, Indian Head Site 28
TASK: Hyalella azteca 28-day Assay
DATA: Water Quality Data - Alkalinity
START DATE: 11/17/05
DATE ENDED: 12/15/05

ID	LAB ID	RESULT	QUAL	QLIMIT	UNITS	SAMPLED
-Lab Ha Start	13906-008	24		10	mg/L	11/17/05
-Lab Ha Day 7	13906-032	29		10	mg/L	11/23/05
-Lab Ha Day 15	13906-092	21		10	mg/L	12/02/05
-Lab Ha Day 21	13906-134	27		10	mg/L	12/08/05
-Lab Ha Day 28	13906-176	34		10	mg/L	12/15/05
-001 Ha Start	13906-009	47		10	mg/L	11/17/05
-001 Ha Day 7	13906-033	96		10	mg/L	11/23/05
-001 Ha Day 15	13906-093	69		10	mg/L	12/02/05
-001 Ha Day 21	13906-135	24		10	mg/L	12/08/05
-001 Ha Day 28	13906-177	47		10	mg/L	12/15/05
-002 Ha Start	13906-010	33		10	mg/L	11/17/05
-002 Ha Day 7	13906-034	72		10	mg/L	11/23/05
-002 Ha Day 15	13906-094	58		10	mg/L	12/02/05
-002 Ha Day 21	13906-136	65		10	mg/L	12/08/05
-002 Ha Day 28	13906-178	48		10	mg/L	12/15/05
-003 Ha Start	13906-011	56		10	mg/L	11/17/05
-003 Ha Day 7	13906-035	150		10	mg/L	11/23/05
-003 Ha Day 15	13906-095	72		10	mg/L	12/02/05
-003 Ha Day 21	13906-137	37		10	mg/L	12/08/05
-003 Ha Day 28	13906-179	53		10	mg/L	12/15/05
-004 Ha Start	13906-012	56		10	mg/L	11/17/05
-004 Ha Day 7	13906-036	51		10	mg/L	11/23/05
-004 Ha Day 15	13906-096	49		10	mg/L	12/02/05
-004 Ha Day 21	13906-138	42		10	mg/L	12/08/05
-004 Ha Day 28	13906-180	52		10	mg/L	12/15/05
-005 Ha Start	13906-013	38		10	mg/L	11/17/05
-005 Ha Day 7	13906-037	47		10	mg/L	11/23/05
-005 Ha Day 15	13906-097	17		10	mg/L	12/02/05
-005 Ha Day 21	13906-139	53		10	mg/L	12/08/05
-005 Ha Day 28	13906-181	50		10	mg/L	12/15/05
-006 Ha Start	13906-014	30		10	mg/L	11/17/05
-006 Ha Day 7	13906-038	50		10	mg/L	11/23/05
-006 Ha Day 15	13906-098	44		10	mg/L	12/02/05
-006 Ha Day 21	13906-140	55		10	mg/L	12/08/05
-006 Ha Day 28	13906-182	47		10	mg/L	12/15/05
-007 Ha Start	13906-015	41		10	mg/L	11/17/05
-007 Ha Day 7	13906-039	57		10	mg/L	11/23/05
-007 Ha Day 15	13906-099	77		10	mg/L	12/02/05
-007 Ha Day 21	13906-141	56		10	mg/L	12/08/05
-007 Ha Day 28	13906-183	47		10	mg/L	12/15/05

STUDY: 13906
CLIENT: CH2M Hill
PROJECT: CTO 111, Indian Head Site 28
TASK: Hyalella azteca 28-day Assay
DATA: Water Quality Data - Ammonia
START DATE: 11/17/05
DATE ENDED: 12/15/05

ID	LAB ID	RESULT	QUAL	QLIMIT	UNITS	SAMPLED
-Lab Ha Start	13906-024	0.45		0.1	mg/L as N	11/17/05
-Lab Ha Day 7	13906-048	ND		0.1	mg/L as N	11/23/05
-Lab Ha Day 15	13906-108	0.2		0.1	mg/L as N	12/02/05
-Lab Ha Day 21	13906-150	0.16		0.1	mg/L as N	12/08/05
-Lab Ha Day 28	13906-192	ND		0.1	mg/L as N	12/15/05
-001 Ha Start	13906-025	0.51		0.1	mg/L as N	11/17/05
-001 Ha Day 7	13906-049	2.1		0.1	mg/L as N	11/23/05
-001 Ha Day 15	13906-109	ND		0.1	mg/L as N	12/02/05
-001 Ha Day 21	13906-151	ND		0.1	mg/L as N	12/08/05
-001 Ha Day 28	13906-193	ND		0.1	mg/L as N	12/15/05
-002 Ha Start	13906-026	0.26		0.1	mg/L as N	11/17/05
-002 Ha Day 7	13906-050	ND		0.1	mg/L as N	11/23/05
-002 Ha Day 15	13906-110	ND		0.1	mg/L as N	12/02/05
-002 Ha Day 21	13906-152	ND		0.1	mg/L as N	12/08/05
-002 Ha Day 28	13906-194	ND		0.1	mg/L as N	12/15/05
-003 Ha Start	13906-027	0.89		0.1	mg/L as N	11/17/05
-003 Ha Day 7	13906-051	4.2		0.1	mg/L as N	11/23/05
-003 Ha Day 15	13906-111	ND		0.1	mg/L as N	12/02/05
-003 Ha Day 21	13906-153	ND		0.1	mg/L as N	12/08/05
-003 Ha Day 28	13906-195	ND		0.1	mg/L as N	12/15/05
-004 Ha Start	13906-028	0.58		0.1	mg/L as N	11/17/05
-004 Ha Day 7	13906-052	ND		0.1	mg/L as N	11/23/05
-004 Ha Day 15	13906-112	ND		0.1	mg/L as N	12/02/05
-004 Ha Day 21	13906-154	ND		0.1	mg/L as N	12/08/05
-004 Ha Day 28	13906-196	ND		0.1	mg/L as N	12/15/05
-005 Ha Start	13906-029	0.73		0.1	mg/L as N	11/17/05
-005 Ha Day 7	13906-053	ND		0.1	mg/L as N	11/23/05
-005 Ha Day 15	13906-113	ND		0.1	mg/L as N	12/02/05
-005 Ha Day 21	13906-155	ND		0.1	mg/L as N	12/08/05
-005 Ha Day 28	13906-197	ND		0.1	mg/L as N	12/15/05
-006 Ha Start	13906-030	0.24		0.1	mg/L as N	11/17/05
-006 Ha Day 7	13906-054	0.41		0.1	mg/L as N	11/23/05
-006 Ha Day 15	13906-114	ND		0.1	mg/L as N	12/02/05
-006 Ha Day 21	13906-156	ND		0.1	mg/L as N	12/08/05
-006 Ha Day 28	13906-198	ND		0.1	mg/L as N	12/15/05
-007 Ha Start	13906-031	0.7		0.1	mg/L as N	11/17/05
-007 Ha Day 7	13906-055	ND		0.1	mg/L as N	11/23/05
-007 Ha Day 15	13906-115	ND		0.1	mg/L as N	12/02/05
-007 Ha Day 21	13906-157	ND		0.1	mg/L as N	12/08/05
-007 Ha Day 28	13906-199	ND		0.1	mg/L as N	12/15/05

STUDY: 13906
CLIENT: CH2M Hill
PROJECT: CTO 111, Indian Head Site 28
TASK: Hyalella azteca 28-day Assay
DATA: Water Quality Data - Hardness
START DATE: 11/17/05
DATE ENDED: 12/15/05

ID	LAB ID	RESULT	QUAL	QLIMIT	UNITS	SAMPLED
-001 Ha Start	13906-017	58		0.3	mg/L	11/17/05
-001 Ha Day 7	13906-041	80		0.3	mg/L	11/23/05
-001 Ha Day 15	13906-101	76		0.3	mg/L	12/02/05
-002 Ha Start	13906-018	50		0.3	mg/L	11/17/05
-002 Ha Day 7	13906-042	73		0.3	mg/L	11/23/05
-002 Ha Day 15	13906-102	69		0.3	mg/L	12/02/05
-003 Ha Start	13906-019	57		0.3	mg/L	11/17/05
-003 Ha Day 7	13906-043	93		0.3	mg/L	11/23/05
-003 Ha Day 15	13906-103	62		0.3	mg/L	12/02/05
-004 Ha Start	13906-020	58		0.3	mg/L	11/17/05
-004 Ha Day 7	13906-044	71		0.3	mg/L	11/23/05
-004 Ha Day 15	13906-104	54		0.3	mg/L	12/02/05
-005 Ha Start	13906-021	55		0.3	mg/L	11/17/05
-005 Ha Day 7	13906-045	66		0.3	mg/L	11/23/05
-005 Ha Day 15	13906-105	51		0.3	mg/L	12/02/05
-006 Ha Start	13906-022	53		0.3	mg/L	11/17/05
-006 Ha Day 7	13906-046	64		0.3	mg/L	11/23/05
-006 Ha Day 15	13906-106	66		0.3	mg/L	12/02/05
-007 Ha Start	13906-023	61		0.3	mg/L	11/17/05
-007 Ha Day 7	13906-047	64		0.3	mg/L	11/23/05
-007 Ha Day 15	13906-107	81		0.3	mg/L	12/02/05
-Lab Ha Start	13906-016	40		0.3	mg/L	11/17/05
-Lab Ha Day 7	13906-040	47		0.3	mg/L	11/23/05
-Lab Ha Day 15	13906-100	38		0.3	mg/L	12/02/05
-Lab Ha Day 21	13906-142	44		0.3	mg/L	12/08/05
-001 Ha Day 21	13906-143	85		0.3	mg/L	12/08/05
-002 Ha Day 21	13906-144	68		0.3	mg/L	12/08/05
-003 Ha Day 21	13906-145	66		0.3	mg/L	12/08/05
-004 Ha Day 21	13906-146	71		0.3	mg/L	12/08/05
-005 Ha Day 21	13906-147	62		0.3	mg/L	12/08/05
-006 Ha Day 21	13906-148	75		0.3	mg/L	12/08/05
-007 Ha Day 21	13906-149	72		0.3	mg/L	12/08/05
-Lab Ha Day 28	13906-184	56		0.3	mg/L	12/15/05
-001 Ha Day 28	13906-185	88		0.3	mg/L	12/15/05
-002 Ha Day 28	13906-186	81		0.3	mg/L	12/15/05
-003 Ha Day 28	13906-187	69		0.3	mg/L	12/15/05
-004 Ha Day 28	13906-188	81		0.3	mg/L	12/15/05
-005 Ha Day 28	13906-189	120		0.3	mg/L	12/15/05
-006 Ha Day 28	13906-190	75		0.3	mg/L	12/15/05
-007 Ha Day 28	13906-191	80		0.3	mg/L	12/15/05

LABORATORY SAMPLE RECEIVING LOG

ESI Project Number: 13906 Date/Time Received: 10/28/05 1030

Client Name and Address: CH2M Hill

Method of Shipment/ Pick Up: From: Client

Via: Fed Ex

Description of Shipping / Packing Containers(s) 5 coolers
(Number, Type, Size)

Sample ID	ESI #	# Containers/Vol/Wt	Other	Sampled
IS285D01	-001	3x1g		10/26/05
IS285D02	-002	3x1g		10/27/05
IS285D03	-003	3x1g		10/26/05
IS285D11	-004	1x1g		10/25/05
IS285D13	-005	1x1g		10/27/05
IS28Ref1	-006	3x1g		10/26/05
IS28Ref2	-007	3x1g		10/27/05

Sample Storage Location and Required Storage Conditions Refrigerator "F" Locked, 4°C & Dark

Signature: [signature] Date: 10/28/05

Notes: All samples Rec'd on ice 4°C

Date and Description of Final Sample Removal / Disposal:

ESI
EnviroSystems, Inc.
1 Lafayette Road
Hampton, N.H. 03842
Voice: 603-926-3345
FAX: 603-926-3521

ESI Job No: 13906

CHAIN OF CUSTODY DOCUMENTATION

Client: CH2M HILL	Contact:	Project Name: ~~152962.AR.FI~~ Indian Head CTO-111	Page 1 of 1
Report to: Antone Bartholomew	Address: 13921 Park Center Rd	Project Number: 152962.AR.FI	
Invoice to:	Address: Herndon, VA 20171	Project Manager: Chris Metcalf	
Voice: 703-471-6405 x 4239	Fax:	email:	P.O. No: Quote No:

Protocol: RCRA SDWA NPDES USCOE Other

Lab Number (assigned by lab)	Your Field ID: (must agree with container)	Date Sampled	Time Sampled	Sampled By	Grab or com-posit (G/C)	Container Size (ml.)	Container Type (P/G/T)	Field Preser-vation	Matrix S=Solid W=Water	Filter N=Not needed F=Done in field L=Lab to do	Analyses Requested\ Special Instructions: H. azteca biossay (growth and survival) L. vag. bioaccum. (bioaccumulation 28D)
-001	IS 28 SD01	10/26/05	1030	JB/CH	C	1 gal	P	NO	S		3 containers (1 - 28-D H. azteca, 2 - 28-D L. vag)
-002	IS 28 SD02	10/27/05	900	↓	↓	↓	↓	↓	↓		↓ ↓
-003	IS 28 SD03	10/26/05	845	↓	↓	↓	↓	↓	↓		↓ ↓
-004	IS 28 SD11	10/25/05	1450	↓	↓	↓	↓	↓	↓		1 container (28-Day, H. azteca)
-005	IS 28 SD13	10/27/05	1000	↓	↓	↓	↓	↓	↓		1 container (28 Day, H. azteca)
-006	IS 28 ~~SD~~ REF 1	10/26/05	1540	↓	↓	↓	↓	↓	↓		3 containers (28-D H. azteca, 28-D L. vag)
-007	IS 28 REF 2	10/27/05	1130	↓	↓	↓	↓	↓	↓		↓ ↓

Relinquished By: John R Byers	Date: 10/27/05 Time: 1530	Received By: [signature]	Date: 10/28/05 Time: 1030
Relinquished By:	Date: Time:	Received at Lab By:	Date: Time:

Comments: 28-D, H. azteca (ASTM, 2003 / E1688-00 / EPA, 2000 EPA/R-99/064)
28-D, L. vag. bioaccumulation (ASTM, 2003 / E1688-00 / " ")

Sample Delivery Group No: Page of

No: № 1374

Appendix D
Benthic Community Structure Analysis

NORMANDEAU ASSOCIATES
- Letter of Transmittal -

Date: 12/20/2005

To: Mr. Antoine Bartholomew
CH2M HILL-Herndon
13921 Center Park Rd., Suite 600
Herndon, Virgina 20171

Via: ____ Overnight (610-705-5733)
_x_ U.S. Mail

From: George M. Christian

Subject: Macroinvertebrate Sample Analysis: Indian Head Site

_x_ Enclosed ___ Under Separate Cover Please find the following:

No. Copies	Description
1	7 data tables (1 per sample station)
1	Set of 21 Laboratory Bench Sheets
1	Set of of 21 Laboratory Processing Forms
1	Chain-of-Custody

REMARKS:

Dear Mr. Bartholomew:

Enclosed is a hard-copy of the data tables I e-mailed you today reporting our results for 21 samples collected from Indian Head (US Navy Clean II), MD on 25-27 October 2005 (Task Order CTO-111). Three replicate grab samples were submitted from each of seven sample locations, collected with a Petite Ponar. You may reference this project as follows:

Navy Clean Contract Number:	N62470-95-D-6007	Buyer:	Lori Abadi
CH2M HILL Project Number:	152962.SA.SM	Proj. Mgr.	C. Metcalf
Purchase Order Number:	9113309		
Task Order Number:	CTO-111		

Case Narrative

This anslysis was conducted according to: " *Methods for Calculating the Chesapeake Bay Benthic Index of Biotic Integrity* " (Llanso' and Dauer 2002). No problems were encountered during sample analyses that required corrective actions.

If you have any questions regarding these results, please give me a call.

Sincerely,

George M. Christian
(Project Biologist)

To: abarthol@CH2M.com
From: George Christian <gchristian@normandeau.com>
Subject: Indian Head Site Macroinvertebrate Sample Analyses
Cc: hannah Proctor <hproctor@normandeau.com>
Bcc:
Attached: J:\Spring City Projects\Projects\20163.000 Ch2M Hill - Indian Head, MD (U.S. Navy Clean). xls\Data Tables- 2005.xls;

Antoine,

We have finished our analyses of twenty-one Petite Ponar samples from your Navy Clean project in Indian Head, MD (Purchase Order CTO-111). The data and site scoring requested according to: "Methods for Calculating The Chesapeake Bay Benthic Index of Biotic Integrity" (Llanso' and Dauer 2002) is in the attached file. One table (sheet) has been prepared for each of seven sample locations. The results for all stations indicated that the respective benthic communities "met restoration goals".

No problems were encountered and no corrective actions pertaining to this analysis were necessary.

A hard copy of the tables with sample tracking and QA/QC documentation will be placed in the mail today.

If you have any questions please give me a call. Thank you for letting us be of service.

Sincerely,

George M. Christian
(Project Biologist)

Benthic Macroinvertebrates collected from the Indian Head, Maryland (U.S. Navy Clean II) site.

Station:	**BC 01**
Sample Date:	26 October 2005
Habitat Classification:	Tidal Freshwater
Gear:	Petite Ponar (0.023 square meters)

Taxon	Common Name	Tol.	Replicate A	B	C	Total	Density	Pct.
Tricladida								
Planariidae								
Dugesia tigrina	flatworm	7.5	2			2	29	1.1%
Oligochaeta								
Tubificidae								
Aulodrilus pigueti	tubeworm	4.7	1			1	14	0.5%
Branchiura sowerybi	tubeworm	8.4	1			1	14	0.5%
Limnodrilus sp. [1]	tubeworm	9.8	2	4	3	9	130	4.9%
Basommatophora								
Physidae								
Physella sp.	pouch snail	9.1	3		1	4	58	2.2%
Mesogastropoda								
Hydrobiidae								
Amnicola nr. *limosa*	dusky snail	4.8	2			2	29	1.1%
Veneroida								
Corbiculidae								
Corbicula fluminea	Asiatic clam	6.3	1	6	4	11	159	5.9%
Amphipoda								
Gammaridae								
Gammarus sp.	sideswimmer	8.8	59	9	12	80	1159	43.2%
Talitridae								
Hyalella azteca	sideswimmer	7.9			7	7	101	3.8%
Ephemeroptera								
Caenidae								
Caenis sp.	mayfly	7.6	1			1	14	0.5%
Odonata								
Coenagrionidae								
Ischnura sp.	damselfly	9.6			1	1	14	0.5%
Diptera								
Chironomidae								
Coelotanypus scapularis	midge	6.2	5			5	72	2.7%
Cricotopus bicinctus	midge	8.5	3	1		4	58	2.2%
Dicrotendipes neomodestus	midge	8.1	2			2	29	1.1%
Polypedilum halterale gr.	midge	7.3			1	1	14	0.5%
Stictochironomus nr. *devinctus*	midge	6.7		45	9	54	783	29.2%
Total Taxa			12	5	8	**16**		100.0%
Total Specimens			82	65	38	185		

Metric	Value	Score
Abundance (no./sq.meter)	**2681**	**5**
Abundance of Pollution-indicative Taxa (%) [1]	**4.9%**	**5**
Abundance of Deep Deposit Feeders (%)	**5.9%**	**5**
Tolerance Score (Water Quality Class)	**7.88 "poor"**	**5**
	IBI Score (Ave.)	**5.0**
	Community Condition	**Meets Restoration Goals**

Notes:

1 Immature worms placed in the taxon *Limnodrilus sp.* were considered to be tubificids without capilliform chaetae.

2 The taxa *A. pigueti*, *B. sowerbyi*, *I. templetoni*, *Q. multisetosus*, *C. fluminea*, *Coelotanypus spp.*, Dicrotendipes spp., and *Polypedilum spp*. are listed as pollution indicative in oligohaline habitats.

Benthic Macroinvertebrates collected from the Indian Head, Maryland (U.S. Navy Clean II) site.

Station:	**BC 02**
Sample Date:	27 October 2005
Habitat Classification:	Tidal Freshwater
Gear:	Petite Ponar (0.023 square meters)

Taxon	Common Name	Tol.	Replicate A	Replicate B	Replicate C	Total	Density	Pct.
Oligochaeta								
Tubificidae								
Branchiura sowerybi	tubeworm	8.4		2	4	6	87	10.3%
Limnodrilus hoffmeisteri	tubeworm	9.8			3	3	43	5.2%
Limnodrilus sp. (1)	tubeworm	9.8	1	1		2	29	3.4%
Quistadrilus multisetosus	tubeworm	10.0		1	2	3	43	5.2%
Veneroida								
Corbiculidae								
Corbicula fluminea	Asiatic clam	6.3		3		3	43	5.2%
Diptera								
Chironomidae								
Coelotanypus scapularis	midge	6.2	10	10	18	38	551	65.5%
Polypedilum tritum	midge	6.7	1			1	14	1.7%
Stictochironomus nr. *devinctus*	midge	6.7	2			2	29	3.4%
Total Taxa			4	5	4	**8**		100.0%
Total Specimens			14	17	27	58		

Metric	Value	Score
Abundance (no./sq.meter)	**841**	**3**
Abundance of Pollution-indicative Taxa (%) (1)	**8.6%**	**5**
Abundance of Deep Deposit Feeders (%)	**24.1%**	**5**
Tolerance Score (Water Quality Class)	**6.97 "fairly poor"**	**5**
	IBI Score (Ave.)	**4.5**
	Community Condition	**Meets Restoration Goals**

Notes:

1 Immature worms placed in the taxon *Limnodrilus sp.* were considered to be tubificids without capilliform chaetae.

2 The taxa *B. sowerybyi*, *Q. multisetosus*, *C. fluminea*, *Coelotanypus spp.*, and *Polypedilum spp*. are listed as pollution indicative in oligohaline habitats.

Benthic Macroinvertebrates collected from the Indian Head, Maryland (U.S. Navy Clean II) site.

Station:	**BC 03**
Sample Date:	26 October 2005
Habitat Classification:	Tidal Freshwater
Gear:	Petite Ponar (0.023 square meters)

Taxon	Common Name	Tol.	Replicate A	Replicate B	Replicate C	Total	Density	Pct.
Basommatophora								
Physidae								
Physella sp.	pouch snail	9.1	2	1	2	5	72	2.8%
Mesogastropoda								
Hydrobiidae								
Amnicola nr. *limosa*	dusky snail	4.8	3			3	43	1.7%
Veneroida								
Corbiculidae								
Corbicula fluminea	Asiatic clam	6.3		1		1	14	0.6%
Sphaeriidae								
Pisidium sp.	pill clam	6.5			1	1	14	0.6%
Amphipoda								
Gammaridae								
Gammarus sp.	sideswimmer	8.8	25	7	6	38	551	21.5%
Talitridae								
Hyalella azteca	sideswimmer	7.9	59	16	48	123	1783	69.5%
Coleoptera								
Hydrophilidae								
Berosus sp.	scavenger beetle	8.5			1	1	14	0.6%
Diptera								
Chironomidae								
Orthocladius sp.	midge	6.0	2			2	29	1.1%
Stictochironomus nr. *devinctus*	midge	6.7	2			2	29	1.1%
Tanytarsus sp.	midge	6.7	1			1	14	0.6%
Total Taxa			7	4	5	**10**		100.0%
Total Specimens			94	25	58	177		

Metric	Value	Score
Abundance (no./sq.meter)	**2565**	**5**
Abundance of Pollution-indicative Taxa (%) [1]	**0.0%**	**5**
Abundance of Deep Deposit Feeders (%)	**0.0%**	**5**
Tolerance Score (Water Quality Class)	**8.02 "poor"**	**3**
	IBI Score (Ave.)	**4.5**
	Community Condition	**Meets Restoration Goals**

Notes:

1 The taxon *C. fluminea* is listed as pollution indicative in oligohaline habitats.

Benthic Macroinvertebrates collected from the Indian Head, Maryland (U.S. Navy Clean II) site.

Station:	**BC 05**
Sample Date:	26 October 2005
Habitat Classification:	Tidal Freshwater
Gear:	Petite Ponar (0.023 square meters)

Taxon	Common Name	Tol.	Replicate A	B	C	Total	Density	Pct.
Oligochaeta								
Lumbricidae								
Lumbriculus variegatus	earthworm	7.0	1		n	1	14	8.3%
Tubificidae					o			
Limnodrilus sp. [1]	tubeworm	9.8	1	1		2	29	16.7%
Mesogastropoda					s			
Hydrobiidae					p			
Amnicola nr. *limosa*	dusky snail	4.8	5		e	5	72	41.7%
Veneroida					c			
Corbiculidae					i			
Corbicula fluminea	Asiatic clam	6.3	2	1	m	3	43	25.0%
Diptera					e			
Chironomidae					n			
Clinotanypus sp.	midge	8.0		1	s	1	14	8.3%
Total Taxa			4	3	0	**5**		100.0%
Total Specimens			9	3	0	12		

Metric	Value	Score
Abundance (no./sq.meter)	**174**	**1**
Abundance of Pollution-indicative Taxa (%) [1]	**16.7%**	**5**
Abundance of Deep Deposit Feeders (%)	**25.0%**	**5**
Tolerance Score (Water Quality Class)	**6.46 "fair"**	**5**
	IBI Score (Ave.)	**4.0**
	Community Condition	**Meets Restoration Goals**

Notes:

1 Immature worms placed in the taxon *Limnodrilus sp.* were considered to be tubificids without capilliform chaetae.

2 The taxon *C. fluminea* is listed as pollution indicative in oligohaline habitats.

Benthic Macroinvertebrates collected from the Indian Head, Maryland (U.S. Navy Clean II) site.

Station:	**BC 06**
Sample Date:	27 October 2005
Habitat Classification:	Tidal Freshwater
Gear:	Petite Ponar (0.023 square meters)

Taxon	Common Name	Tol.	Replicate A	Replicate B	Replicate C	Total	Density	Pct.
Hoplonemertini								
Tetrastemmatidae								
Hydrolimax grisea	flatworm	5.2		7	3	10	145	13.5%
Oligochaeta								
Lumbriculidae								
Lumbriculus variegatus	earthworm	7.3	2			2	29	2.7%
Tubificidae								
Ilydrilus templetoni	tubeworm	9.4	2		2	4	58	5.4%
Limnodrilus sp. [1]	tubeworm	9.8	7	5	2	14	203	18.9%
Limnodrilus hoffmeisteri	tubeworm	9.8	3	3		6	87	8.1%
Quistadrilus multisetosus	tubeworm	10.0	2	2	2	6	87	8.1%
Mesogastropoda								
Hydrobiidae								
Amnicola nr. *limosa*	dusky snail	4.8		6		6	87	8.1%
Veneroida								
Corbiculidae								
Corbicula fluminea	Asiatic clam	6.3	1			1	14	1.4%
Amphipoda								
Gammaridae								
Gammarus nr. *fasciatus*	sideswimmer	8.8	1	1		2	29	2.7%
Odonata								
Libellulidae								
Perithemis tenera	dragonfly	9.8		1		1	14	1.4%
Diptera								
Chironomidae								
Clinotanypus sp.	midge	8.0		1	2	3	43	4.1%
Coelotanypus scapularis	midge	6.2	1		1	2	29	2.7%
Procladius sp.	midge	9.3	9	4	4	17	246	23.0%
Total Taxa			9	9	7	**13**		100.0%
Total Specimens			28	30	16	74		

Metric	Value	Score
Abundance (no./sq.meter)	**1072**	**5**
Abundance of Pollution-indicative Taxa (%) [1]	**27.0%**	**5**
Abundance of Deep Deposit Feeders (%)	**43.2%**	**5**
Tolerance Score (Water Quality Class)	**8.34 "poor"**	**3**
	IBI Score (Ave.)	**4.5**
	Community Condition	**Meets Restoration Goals**

Notes:

1 Immature worms placed in the taxon *Limnodrilus sp.* were considered to be tubificids without capilliform chaetae.

2 The taxa *I. templetoni*, *Q. multisetosus*, *C. fluminea*, *Coelotanypus spp.*, and *Procladius spp.* are listed as pollution indicative in oligohaline habitats.

Benthic Macroinvertebrates collected from the Indian Head, Maryland (U.S. Navy Clean II) site.

Station:	**BC 11**
Sample Date:	25 October 2005
Habitat Classification:	Tidal Freshwater
Gear:	Petite Ponar (0.023 square meters)

Taxon	Common Name	Tol.	Replicate A	Replicate B	Replicate C	Total	Density	Pct.
Oligochaeta								
Tubificidae								
Limnodrilus sp. (1)	tubeworm	9.8	1			1	14	6.3%
Veneroida								
Corbiculidae								
Corbicula fluminea	Asiatic clam	6.3	1	1		2	29	12.5%
Diptera								
Chironomidae								
Chironomus sp.	midge	9.8	1			1	14	6.3%
Clinotanypus sp.	midge	8.0			3	3	43	18.8%
Coelotanypus scapularis	midge	6.2		1		1	14	6.3%
Procladius sp.	midge	9.3	7			7	101	43.8%
					1	1	14	6.3%
Total Taxa			4	2	2	7		100.0%
Total Specimens			10	2	4	16		

Metric	Value	Score
Abundance (no./sq.meter)	**232**	**1**
Abundance of Pollution-indicative Taxa (%) (1)	**6.3%**	**5**
Abundance of Deep Deposit Feeders (%)	**6.3%**	**5**
Tolerance Score (Water Quality Class)	**7.97 "poor"**	**5**
	IBI Score (Ave.)	**4.0**
	Community Condition	**Meets Restoration Goals**

Notes:

1 Immature worms placed in the taxon *Limnodrilus sp.* were considered to be tubificids without capilliform chaetae.

2 The taxa *C. fluminea*, *Chironomus spp.*, *Coelotanypus spp.*, and *Procladius spp.* are listed as pollution indicative in oligohaline habitats.

Benthic Macroinvertebrates collected from the Indian Head, Maryland (U.S. Navy Clean II) site.

Station:	**BC 13**
Sample Date:	27 October 2005
Habitat Classification:	Tidal Freshwater
Gear:	Petite Ponar (0.023 square meters)

Taxon	Common Name	Tol.	Replicate A	Replicate B	Replicate C	Total	Density	Pct.
Mesogastropoda								
Hydrobiidae								
Amnicola nr. *limosa*	dusky snail	4.8	5	2		7	101	41.2%
Diptera								
Chironomidae								
Chironomus sp.	midge	9.8	1	2		3	43	17.6%
Coelotanypus scapularis	midge	6.2	2			2	29	11.8%
Procladius sp.	midge	9.3	2	2	1	5	72	29.4%
Total Taxa			4	3	1	**4**		100.0%
Total Specimens			10	6	1	17		

Metric	Value	Score
Abundance (no./sq.meter)	**246**	**1**
Abundance of Pollution-indicative Taxa (%) [1]	**0.0%**	**5**
Abundance of Deep Deposit Feeders (%)	**0.0%**	**5**
Tolerance Score (Water Quality Class)	**7.17 "farily poor"**	**5**
	IBI Score (Ave.)	**4.0**
	Community Condition	**Meets Restoration Goals**

Notes:

1 The taxa *Chironomus spp*., *Coelotanypus spp.* , and *Procladius spp.* are listed as pollution indicative in oligohaline habitats.

Appendix E
Food Web Exposure Model, Ingestion Screening Values, and Critical Tissue Residue Values

Food Web Exposure Model for Wildlife

Mink, great blue heron, and mallard exposures (via the food web) to lead, mercury, and zinc were determined using measured fish and invertebrate tissue concentrations and food web models. Incidental ingestion of sediment was not included when calculating the total level of exposure for mink and great blue heron, because these receptors feed directly on fish and are unlikely to have a significant exposure to sediment via incidental ingestion. Incidental ingestion of sediment was included for mallard exposure calculations.

Dietary intakes for each receptor species were calculated using the following formula (modified from USEPA [1993]):

$$DI_x = \frac{[\sum_i (FIR)(FC_{xi})(PDF_i)]}{BW}$$

where:

DI_x	=	Dietary intake for chemical x (mg chemical/kg body weight/day)
FIR	=	Food ingestion rate (kg/day, dry weight)
FC_{xi}	=	Concentration of chemical x in food item i (mg/kg, dry weight)
PDF_i	=	Proportion of diet composed of food item i (dry weight basis)
BW	=	Body weight (kg, wet weight)

The exposure assumptions used in the food web model were:

- All of the dietary items consumed by the receptor were assumed to be obtained from the site (i.e., an Area Use Factor of 1 was assumed).
- Chemicals in fish and invertebrate tissue were assumed to be 100 percent bioavailable.
- Average ingestion rates were used.
- Average body weights were used.

The exposure parameters used in the food web model are shown in Table E-1.

Tissue concentrations in aquatic plants were estimated by multiplying the mean measured surface sediment concentration for each chemical by chemical-specific soil-to-plant bioconcentration factors (BCFs) (geometric mean) obtained from Bechtel and Jacobs (1998). The BCF values used were based on root uptake and on the ratio between dry-weight sediment and dry-weight plant tissue.

Table E-1 Exposure Parameters for the Wildlife						
Receptor	Body Weight (kg)		Food Ingestion Rate (kg/day - dry)		Dietary Composition (percent)	
	Value	Reference	Value	Reference	Diet Items	Reference
Mink	0.777	Silva and Downing, 1995	0.0266	USEPA, 1993	100% Fish	Assumed 100% for this evaluation; USEPA 1993 reported 94% fish
Great blue heron	2.23	Quinney, 1982	0.3931	Allometric equation	100% Fish	USEPA, 1993
Mallard	1.177	Bellrose, 1980	0.0647	Allometric equation	67% invertebrates, 30% plants, 3% sediment	(nesting female) Swanson and Duebbert, 1989; USEPA, 1993; and Beyer et al., 1994.

Ingestion Screening Values

Ingestion screening values for dietary exposures of lead, mercury, and zinc were derived for each receptor. Toxicological information from the literature for wildlife species most closely related to the receptor species was used, where available, but was also supplemented by laboratory studies of non-wildlife species (e.g., rats) where necessary. The ingestion screening values are expressed as milligrams of the chemical per kilogram body weight of the receptor per day (mg/kg-BW/day).

Sublethal endpoints were emphasized as assessment endpoints where available since they are the most relevant, ecologically, to maintaining viable populations and because they are generally the most studied chronic toxicological endpoints for ecological receptors. Sublethal endpoints are assumed to influence the probability of survival and/or the success of reproduction. If several chronic toxicity studies are available from the literature, the most appropriate study was selected for each receptor species based on study design, study methodology, study duration, study endpoint, and test species. No Observed Adverse Effect Levels (NOAELs) and Lowest Observed Adverse Effect Levels (LOAELs) based on survival, growth, or reproduction were utilized, where available, as the screening values. For lead and birds, a chronic LOAEL was estimated from a NOAEL using an uncertainty factor of 5. Ingestion screening values for birds and mammals are shown in Table E-2.

Table E-2 Ingestion Screening Values for Wildlife								
Chemical	Test Organism	Body Weight (kg)	Duration	Exposure Route	Effect/Endpoint	NOAEL (mg/kg/d)	LOAEL (mg/kg/d)	Reference
Lead	rat	0.35	3 generations	oral in diet	reproduction	8.0	80.0	Sample et al. 1996
	American kestrel	0.13	7 months	oral in diet	reproduction	3.85	19.3	Sample et al. 1996
Mercury	mink	1.0	93 days	oral in diet	Survival / weight loss	0.15	0.25	Sample et al. 1996
	mallard	1.0	3 generations	oral in diet	reproduction	0.026	0.078	USEPA, 1997
Zinc	mink	1.0	25 weeks	oral	reproduction	104	20.8	ATSDR, 1994
	chicken	1.935	44 weeks	oral in diet	reproduction	131	14.5	Sample et al., 1996

Risk Calculation

In risk calculation, the exposure dose is compared with the corresponding reference toxicity values to derive a risk estimate. Chemicals of concern (COCs) were selected using the hazard quotient (HQ) method. HQs were calculated by dividing the exposure dose by the corresponding reference toxicity value.

Critical Residue Values for Fish Tissue

Critical residue values for fish tissue were obtained from the literature and are presented in Table E-3. These values represent chemical residues associated with adverse effect thresholds for finfish, based on whole-body residue values.

Table E-3
Fish Critical Residue Values

Chemical	Tissue Benchmark (mg/kg, dry)[1]	Benchmark Type	Species Scientific Name	Species Common Name	Effect	Tissue	Exposure Route	Life-Stage	Reference	Comments
Values used for *Fundulus*										
Lead	20.4	NOAEL	*Salvelinus fontinalis*	Brook trout	Growth - no effect	Whole body	Adult fish + water	Embryo - juvenile	Jarvinen and Ankley, 1999	84 day exposure
Mercury	5.44	LOAEL	*Pimephales promelas*	Fathead minnow	Reduced Growth	Whole body	Water	Adult	Spry and Wiener, 1991	41-week exposure; aqueous mercuric chloride
Zinc	160	LOAEL	*Jordanella floridae*	Flagfish	Survival - no effect; Growth - reduced	Whole body	Water	Larvae - Adult	Jarvinen and Ankley, 1999	100 day exposure; NOAEL values of 136 and 176 mg/kg also reported same study.
Values used for Largemouth Bass										
Lead	20.4	NOAEL	*Salvelinus fontinalis*	Brook trout	Growth - no effect	Whole body	Adult fish + water	Embryo - juvenile	Jarvinen and Ankley, 1999	84 day exposure
Mercury	21.6	NOAEL	*Micropterus salmoides*	Largemouth bass	Physiological - no effect	Whole body	Combined	Adult	Environmental Residues Effects Database (ACOE)	Condition factor, GSI, serum cortisol, interenal nucelar diameter, testosterone showed no differences between fish with 0.3 or 5.4 mg/kg (wet) body burdens.
Zinc	160	LOAEL	*Jordanella floridae*	Flagfish	Survival - no effect; Growth - reduced	Whole body	Water	Larvae - Adult	Jarvinen and Ankley, 1999	100 day exposure; NOAEL values of 136 and 176 mg/kg also reported same study.

[1] Converted from wet weight to dry weight (assuming tissue percent moisture of 75%)

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