TECHNICAL MEMORANDUM CH2MHILL

Final: Additional Investigation Results for Sites 8 and 56 at Naval Support Facility, Indian Head

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1.0 Introduction

This memorandum describes the results of the sediment and fish tissue sampling conducted downstream of Site 8 (Mercury Contamination at Building 766) and Site 56 (Lead Contamination at Industrial Wastewater Outfall 97) at the Naval Support Facility, Indian Head (NSF-IH), Indian Head, Maryland. The objectives and rationale for this investigation were outlined in the *Work Plan for Additional Investigation at Sites 8 and 56, NDWIH, Indian Head, Maryland* (herein referred to as Work Plan) (CH2M HILL, 2005).

2.0 Site Background

A synopsis of historical uses, previous environmental investigation results, and removal actions at Sites 8 and 56 is contained in the document entitled *Final Desktop Evaluation for Site 8 – Mercury Contamination at Building 766, and Site 56 – Lead Contamination at Industrial Wastewater Outfall 87, Naval District Washington Indian Head* (CH2M HILL, 2006). To reduce duplication of information, a brief summary of site information, taken from the desktop evaluation document, is presented below.

Historical operations at Sites 8 and 56 released and deposited mercury and lead, respectively, into a stream and a pond located downstream of these sites (Figure 1). To address the mercury and lead contamination in sediments located downstream of both sites, sediment removal actions were performed at Site 8 in 1994 (Halliburton NUS, 1995) and at Site 56 in 1996 (OHM, 1997).

3.0 Objectives

The Work Plan outlines the rationale for the additional investigation; hence, it will not be presented in this report. The objectives, as outlined in the Work Plan, are as follows:

- Characterize current lead and mercury concentrations in the middle and lower sections of the stream and the pond sediment. Compare these results to historical concentrations to assess whether these concentrations have changed.
- Characterize current lead and mercury concentrations in fish tissue from the pond. Compare these results to historical concentrations to determine if the concentrations have changed and to assess bioavailability of lead and mercury in fish.

4.0 Methodology

The additional sediment and fish sampling at Sites 8 and 56 was conducted by CH2M HILL from September 26 to 28, 2005. Field activities were conducted in accordance with the Work Plan. Any deviation from the Work Plan is noted below.

4.1 Stream Sediment Sampling

Eight sediment samples were collected from locations IS08SD01 through IS08SD08 along the stream that runs adjacent to Site 8 and Site 56 and terminates at the marsh/pond area (Figure 1). The actual locations were selected to target depositional areas within the channel. At the time of sampling, the water depth varied from 2 to 6 inches along the stream channel. The sediment samples were collected within the defined stream channel at a depth of 0 to 6 inches below the water–sediment interface using a sediment core device equipped with a liner tube. The lined core device was inserted directly into the stream sediment by hand, capping the top, and retrieving the core sample. This method of collection ensured that the fine material at the sediment–water interface, where the majority of biological exposure occurs, was collected. Most of the samples consisted of a layer of silt/floc material, approximately 2 inches thick, overlying a medium-grained sand. The thickness of the upper silt/floc layer was observed to generally decrease in an upstream direction.

After collection, the sediment samples were homogenized in a clean, stainless-steel bowl. The homogenized samples were then transferred into clean laboratory-supplied containers, which were then placed on ice for preservation. The samples were then shipped overnight under chain-of-custody to Katahdin Analytical Services (Katahdin) for analysis of lead mercury, and percent moisture. The analysis was conducted using U.S. Environmental Protection Agency (USEPA) Contract Laboratory Program (CLP) Inorganic SOW ILMO4 protocol.

4.2 Pond Sediment Sampling

Four sediment samples were collected from locations IS08PS01 through IS08PS04 of the pond (Figure 1). Before the installation of the weir in 1993, the pond was tidally influenced. Since then, the pond has been hydrologically cut off from tidal action in Mattawoman Creek. During the sampling event, the depth of water in the pond varied from 3 to 5 feet. The samples were collected from 0 to 6 inches below the water–sediment interface using a

sediment core device equipped with a liner tube. The sediment samples consisted almost entirely of silt interspersed with decayed vegetative material. The samples were homogenized in a clean, stainless-steel bowl after collection. The homogenized samples were then transferred into laboratory-supplied containers, which were then placed on ice for preservation. The samples were then shipped overnight under chain-of-custody to Katahdin for analysis of lead, mercury and percent moisture. The analyses were conducted using USEPA CLP Inorganic SOW ILMO4 protocol.

4.3 Fish Tissue Sampling

Fishes were collected from the pond using a dip net, baited minnow traps, and a monofilament gill net. The baited minnow traps were collocated with the pond sediment sample locations (Figure 1). The dip nets were also used in close proximity to the pond sediment sample locations. The monofilament gill net was used at the north and south ends of the pond. Baited trap nets were also used at one location near IS08PS02 and one location near IS08PS04. No fishes were caught using the trap nets. However, turtles (eastern painted turtle) were caught in abundance in the trap nets at both locations.

According to the Work Plan, eight whole-body fish samples were to be collected during the fish tissue sampling event; the samples were to consist of four composite eastern mosquitofish samples, two individual bluegill samples, and two brown bullhead samples. However, no brown bullheads were caught during the sampling event, and only one target-size bluegill was caught (and retained for analysis). Other species of fish were caught, however, and were collected in place of the targeted species that could not be collected. The fish species sampled during the field event are described below.

4.3.1 Eastern Mosquitofish

Four composite eastern mosquitofish samples, ISFSH01 through ISFSH04, were collected by dip netting in very close proximity to the four pond sediment sample locations (IS08PS01 through IS08PS04 on Figure 1). Each mosquitofish sample consisted of about 30 to 40 individual fish ranging in size from approximately 25 to 50 millimeters in length. The mosquitofish samples were placed in a Ziploc bag, which was then placed on ice inside a cooler to preserve the tissue samples. The samples were shipped overnight under chain-of-custody to Katahdin for processing (total sample homogenized, whole-body individuals) and analysis of lead, mercury and percent moisture. Analysis was conducted using USEPA CLP Inorganic SOW ILMO4 protocol.

4.3.2 Bluegill

Only one target-size bluegill, IS08FSH05, was caught in the gill net set at the north end of the pond. The individual bluegill was 152 millimeters in length and was retained for analysis. Although not targeted, four composite samples of juvenile bluegill, IS08FSH09 through IS08FSH12, were collected to provide additional bioaccumulation data. The composite bluegill samples were collected in minnow traps that were collocated with the pond sediment sample locations (IS08PS01 through IS08PS04 on Figure 1). The composite bluegill samples ranged from 14 to 44 individual fish per sample, ranging in size from 25 to 76 millimeters. The individual and composite bluegill samples were placed in separate Ziploc bags and placed on ice inside a cooler preserve the tissue samples. The samples were then shipped under chain-of-custody to Katahadin for processing (total sample

homogenized, whole-body individuals) and analysis of lead, mercury and percent moisture. Analysis was conducted using USEPA CLP Inorganic SOW ILMO4 protocol.

4.3.3 Gizzard Shad

Gizzard shad were not a target species in the Work Plan. However, they were found to be abundant in the pond and were collected for analysis. The adults of the species feed on plants, phytoplankton and algae, often retaining a large quantity of sediment in their stomachs (Scott and Crossman, 1998). Therefore, the species should provide a good surrogate for evaluating a longer-lived species that is highly exposed to sediments in the pond.

Multiple gizzard shad were caught in gill net sets at the north and south ends of the pond. Two individual gizzard shad samples, IS08FSH06 and IS08FSH07, were retained for analysis (302 and 176 millimeters in total length, respectively). The individual gizzard shad samples were placed in separate Ziploc bags and iced to preserve the tissue samples. The samples were then shipped under chain-of-custody to Katahadin for processing (total sample homogenized, whole-body) and analysis of lead, mercury and percent moisture. Analysis was conducted using USEPA CLP Inorganic SOW ILMO4 protocol.

5.0 Analytical Results

Historical and 2005 analytical results for mercury and lead at Sites 8 and 56 are presented below. The following subsections also identify the subset of historical analytical results that are used in a comparison with 2005 analytical data presented later in this memorandum.

5.1 Historical Data

Historical data presented in this memorandum were obtained from the following documents:

- Brown and Root Environmental, July 1995. *Summary Biomonitoring Report for Site 8 – Nitroglycerine Plant Office, Indian Head Division, Naval Surface Warfare Center, Indian Head, Maryland*.
- Brown and Root Environmental, February 1996. *Summary Biomonitoring Report for IR Site 56 – IW87 Lead Contaminated Outfall, Indian Head Division, Naval Surface Warfare Center, Indian Head, Maryland.*
- Halliburton NUS, January 1993. *Site Characterization Report for Site 8 – Nitroglycerin Plant Office at Indian Head Division Naval Surface Warfare Center* (herein referred to as the Site 8 Site Characterization Report).
- Halliburton NUS Corporation, July 1994. *Report on April 1994 Biomonitoring for Site 8– Nitroglycerin Plant Office, Indian Head Division, Naval Surface Warfare Center, Indian Head, Maryland*.
- Tetra Tech NUS, July 1999. *Remedial Investigation Report for Sites 12, 39/41, 42, and 44, Indian Head Division, Naval Surface Warfare Center, Indian Head, Maryland* (herein referred to as the Site 12 RI Report).

The historical data relevant to the discussion in this section are provided in Tables B-1 through A-6 in Attachment A. Figure A-1 in Attachment A depicts relevant historical and 2005 sample locations. The figure also shows the extents of the tidal pond before and after the weir was installed in 1993.

Note that only a portion of historical data collected from the sample locations shown in Figure -1 was used in a comparison with the 2005 data. Subsequent sections of this memorandum outline the rationale for selecting the historical data subset from the broader range of sampling locations shown in Figure A-1. The additional sampling locations are included in this memorandum to provide the reader with a comprehensive understanding of historical conditions in the midsection and lower section of the stream as well as the pond.

5.1.1 Stream Sediment—Mercury

During the 1992 field activities documented in the Site Characterization Report at Site 8 (Halliburton NUS, 1993), 18 and 20 samples were collected from the midsection and lower section of the stream, respectively (Figure A-1). These quantities do not include field duplicate samples that were collected. Tables A-1 and A-2 summarize the analytical results from samples collected from the midsection and lower section of stream, respectively. As shown in these tables, samples consisted of soil and sediment samples collected from the stream channel and the channel overbanks. The samples were collected from various depth intervals. Sample locations investigated in the midsection of the stream consisted of SS-47 through SS-58. In the lower section of stream, sample locations comprised SS-34 through SS-46.

During the 1992 Site Characterization Study at Site 8, 16 sediment samples were collected from 8 locations in an area designated as a marsh/stream transition area (SS-23 through SS-30). Results from these samples are presented in Table A-3, and the sampling locations are shown in Figure A-1. This area was subsequently submerged after a weir was installed downstream of the pond in April 1993.

Because the 2005 sediment samples were collected from the uppermost 6-inch depth, comparison to historical data considered only the samples collected from a similar depth. Thus, samples collected from other depth intervals (e.g., 6 to 12 inches) were excluded from the dataset used for comparison. Furthermore, historical samples collected from the channel overbanks were excluded from the dataset used for comparative purposes because the 2005 samples were not collected from these areas. Finally, sediment samples collected from the marsh/stream transition area were not included in the dataset because those locations were submerged and are no longer considered part of the stream. Taking these factors into consideration, the historical dataset used in the comparison with the 2005 data comprised of six samples from the midsection and four samples from the lower section of the stream. This data subset is summarized in Table A-7.

5.1.2 Stream Sediment—Lead

For lead, the historical dataset comprised sediment samples that were collected in May 1994 as part of a biomonitoring program for Site 8. One sediment sample, SO-413, was collected from the midsection of the stream and four samples were taken from the lower section of the stream (SO-407, 408, 409, and 412), exclusive of field duplicate samples (Table A-4).

Locations of these samples are shown in Figure A-1. The historical dataset used in the comparison with 2005 data is summarized in Table A-8.

5.1.3 Pond Sediment—Mercury and Lead

During the 1992 Site Characterization Study at Site 8, 57 sediment samples (excluding field duplicate samples) were collected from 23 sampling locations (SS-05 through SS-22 and SS-110 through SS-114) along 6 transects within the pond. These samples were analyzed for mercury, and their concentrations are presented in Table A-5. Locations of these samples are shown in Figure A-1.

Three additional samples from the pond (S12SD003, S12SD004, and S12SD005) were collected in 1997 during a remedial investigation at Site 12 (Tetra Tech NUS, 1999). These samples were collected along the eastern shoreline of the pond during the RI. Locations of these samples are shown in Figure A-1. Table AB-6 presents the lead and mercury results obtained from these sediment samples. As noted in the table, the samples were analyzed for additional analytical parameters that are summarized in the Site 12 RI Report (Tetra Tech NUS, 1999).

In accordance with the Work Plan, only the 1997 data (Table A-6) were used in the comparison with the 2005 analytical data. The 1997 data were used because they represented the most recent historical sediment data for the pond.

5.1.4 Fish Tissue—Mercury and Lead

From October 1992 until November 1995, whole-body fish samples and other aquatic organisms were collected from the pond and two control sites as part of a quarterly biomonitoring program. Samples collected between October 1992 and October 1994 were analyzed for mercury, and samples collected between April 1994 and November 1995 were analyzed for lead. During the biomonitoring program, the three fish species collected most frequently were brown bullhead (*Ameiurus nebulosus*), eastern mosquitofish (*Gambusia holbrooki*), and bluegill (*Lepomis macrochirus*). All fish of each species were combined and homogenized, with one analysis performed per composite species sample. Analytical results from the tissue analyses are presented in Table 1 (mercury) and Table 2 (lead).

5.2 2005 Data

5.2.1 Sediment

The results of the sediment chemical analyses are presented in Tables 3 and 4 for the stream and pond, respectively. Sample locations are shown on Figure 1. Mercury and lead were detected in each of the samples from both the stream and the pond.

Stream

The results presented in Table 3 show substantially lower mercury and lead concentrations in the mid section of the stream than in the lower section of stream. The highest mercury concentration of 64.4 L mg/kg was detected in the sample from location IS08SD07, which was collected approximately 150 feet upstream of the terminus of the stream, where the stream flows through a wetland area bordering the pond (Figure 1). The highest lead concentration of 249 L mg/kg was detected in the sample from location IS08SD05, which

was collected in the stream channel immediately below the confluence of the stream and the drainage swale leading from Site 56 (Figure 1).

It should be noted that the concentrations of the detected metals are all L-qualified, which indicates that the result is biased low due to a low matrix spike recovery. Therefore, concentrations may be higher than the numeric result reported by the laboratory.

Pond

As shown in Table 4, mercury (55.5 L mg/kg) and lead (327 L mg/kg) concentrations in the pond were highest in the sediment sample collected from location IS08PS01, which is in the north end of the pond (Figure 1). Overall, the mercury concentrations ranged from 1.9 to 55.5 L mg/kg, whereas the lead concentrations ranged from 40.9 L to 327 L mg/kg.

5.2.2 Fish Tissue

Table 5 presents information on the fish samples collected and the analytical results for mercury, lead, and percent solids. Mercury was detected in all of the fish tissue samples at concentrations ranging from 0.023 K mg/kg (IS08FSH07) to 0.101 K mg/kg (IS08FSH02). The "K" qualifier was assigned during data validation to all fish tissue mercury concentrations, indicating that the analytical results may be biased high due to high matrix spike recovery. Except for sample IS08FSH04, which is U-qualified, all the other samples have lead concentrations ranging from 0.19 mg/kg (IS08FSH12) to 0.53 mg/kg (IS08FSH06). The maximum concentrations of lead and mercury detected in each fish species are included in Table 5.

6.0 Data Comparison and Evaluation

Following laboratory analyses, the data were validated by a third-party data validator. For each environmental medium sampled (stream sediment, pond sediment, and fish tissue), the validated data (herein referred to as "2005 data") were compared against previous sampling data (herein referred to as "historical data") to assess comparability of the datasets and to meet the objectives of this investigation.

6.1 Overview of Data Comparison Protocol

Below is a summary of the comparison protocol, which comprised an analytical variability evaluation or statistical comparison, or both, depending on the sample medium. A detailed discussion of these protocols is presented in the Work Plan.

6.1.1 Analytical Variability Evaluation

To determine if the 2005 data are comparable to historical data, an analytical variability evaluation was performed on the basis of the USEPA guidelines for data validation of inorganic environmental samples under the Comprehensive Environmental Response, Compensation, and Liabilities Act (CERCLA) program (USEPA, 2004). Based on this guidance, an acceptable range of ±35 percent was selected for sediment samples. Figure 2 in the Work Plan presents a schematic of three possible outcomes stemming from a comparison of the 2005 dataset to the historical dataset based on the ±35 percent variability of the analytical results described above.

6.1.2 Statistical Comparison

Because a sufficient population of stream sediment samples was collected during this investigation, the 2005 and historical stream sediment data were statistically compared, in addition to the analytical variability evaluation described above. The objective of the statistical comparison was to determine whether a statistically significant increase in mercury or lead has occurred since the historical samples were collected. Because USEPA suggests that the Wilcoxon Rank Sum test be used, rather than the Student's *t* Test, when the number of background or site samples is less than 20 (USEPA, 2002), the nonparametric Wilcoxon Rank Sum test was used for these comparisons.

6.1.3 Data Comparison Summary

The following summarizes the comparison procedures for each environmental medium; these procedures were followed for both mercury and lead concentrations.

- **Stream sediment samples**—Historical and 2005 data were compared using both the analytical variability evaluation on the mean concentrations and the statistical comparison procedures.
- **Pond sediment and fish tissue samples**—Historical and 2005 data were compared using the analytical variability evaluation on the maximum concentrations. Each species of fish was evaluated separately to determine whether any of the species have shown a probable increase in mercury or lead concentrations.

The results of the data comparison presented above were used to recommend the appropriate next steps at Sites 8 and 56. Figures 3 and 4 in the Work Plan illustrate the decision logic steps that were followed in performing this comparison to determine the appropriate site management decision for Site 8, Site 56, and the pond.

6.2 Stream Sediment

Tables 6 and 7 summarize the mercury and lead results, respectively, for the 2005 and historical sediment samples collected from the midsection and lower section of the stream. Both analytical variability and statistical analysis were performed on the stream sediment data.

6.2.1 Analytical Variability

Mercury

As shown in Table 6, the mean 2005 mercury concentration was 20.1 L mg/kg, which is more than 35 percent higher than the mean historical sediment mercury concentration of 0.99 mg/kg. The data used to calculate the historical mean concentration are summarized in Table A-7. This increase is not suggestive of analytical variability. However, it should be noted that the 2005 dataset is small and much of the historical sediment data were reported as non-detects at relatively high detection limits. Additionally, the "L" qualifier indicates that the current data is biased low, which means that the L-qualified concentrations could be higher than the concentrations reported by the laboratory. For the noted reasons, these data must be interpreted with caution.

Lead

As shown in Table 7, the mean 2005 lead concentration was 90.6 L mg/kg, which is more than 35 percent lower than the mean historical lead concentration of 432 L mg/kg. The data used to calculate the historical mean concentration are summarized in Table A-8. The results of this comparison suggest a noticeable decrease in lead concentration in the lower stream sediment, but less so in the midsection of the stream where concentrations do not appear to have changed substantially.

6.2.2 Statistical Comparison

The results of the statistical analysis are presented in Attachment B and summarized in Table 8. The statistical analysis was performed using a 0.05 level of significance. The probability of 5 percent or less is commonly used as the criterion for rejection of the null hypothesis. The Wilcoxon Rank Sum Test was used to compare the current data with the historical data.

Mercury

The probability value of 0.01 (Table 8) is less than the 0.05 significance level, which indicates that the null hypothesis can be rejected. This means that the 2005 concentrations are significantly higher than the historical concentrations. This conclusion appears to be driven by the 2005 samples IS08SD05 through IS08SD08, which were collected from the lower section of stream, downstream of the IW-87 Outfall area. The mercury concentrations in these samples ranged from 9.8 L mg/kg to 64.4 L mg/kg (Figure 1). In contrast, samples IS08SD01 through IS08SD04, which were collected upstream of the outfall, ranged in concentration from 0.82 L mg/kg to 2.9 L mg/kg.

Lead

The probability value of 0.92 (Table 8) is greater than the 0.05 significance level, which indicates that the null hypothesis cannot be rejected. This means that the 2005 concentrations are lower than the historical concentrations in the stream sediments.

6.3 Pond Sediment

Tables 6 and 7 summarize the mercury and lead results, respectively, for the 2005 and historical sediment samples collected from the pond.

6.3.1 Mercury

The maximum mercury concentration in pond sediment in the 2005 investigation was 55.5 L mg/kg. This concentration is more than 35 percent higher than the historical maximum mercury concentration of 0.1 mg/kg. It should be noted that the "L" qualifier indicates that the data is biased low. Concentrations could, therefore, be higher than the value reported by the laboratory. It should be noted that the 1997 samples were collected along the eastern edge of the pond (on the opposite end from Sites 8 and 56) as part of the Site 12 RI. These data were used for comparison purposes because they were the most recent data available for the pond. In addition, the 2005 sample IS08PS01 yielding the concentration of 55.5 L mg/kg was collected in an area that was formerly part of the stream before a weir was installed on the downstream end of the pond in 1993. Figure A-1 displays the 1993 and current footprints of the pond.

Although the data were not used in the analytical variability evaluation, sediment samples were collected from the pond and analyzed for mercury during the 1992 Site Characterization Study at Site 8. These data were not included because more recent samples were collected from the pond in 1997. Sample locations and analytical results from this investigation are shown in Figure A-1 and Table A-7, respectively, in Attachment A. Sediment concentrations in mercury showed somewhat comparable results between the 1992 and 2005 datasets. The two highest mercury concentrations measured in 1992 were collected from SS-113 (13.2 mg/kg) and SS-114 (13.8 mg/kg), the locations of which are shown in Attachment A, Figure A-1. The 2005 samples IS08PS03 and IS08PS02 were collected in close proximity to SS-113 and SS-114, respectively. Mercury was detected at a concentration of 1.9 L mg/kg in IS08PS03 and at 2.2 L mg/kg in IS08PS02. This comparison suggests that mercury concentrations in sediment may actually have decreased in the pond between 1992 and 2005.

6.3.2 Lead

The maximum lead concentration found in the 2005 pond sediment samples was 327 L mg/kg, which is more than 35 percent higher than the historical maximum concentration of 52.2 mg/kg, obtained during the Site 12 RI. The four pond sediment samples collected during the 2005 investigation contained lead at concentrations ranging from 40.9 L to 327 L mg/kg. Again, it should be noted that the historical lead concentrations are based on samples collected in 1997 along the eastern edge of the pond.

Although the data were not used in the analytical variability evaluation, sediment samples were collected and analyzed for lead from the lower section of stream and the pond during the May 1994 biomonitoring event. Some of the 1994 sampling locations (SO-407 through SO-411) investigated in the lower section of stream are now inundated by the pond, as shown in Figure A-1. Analytical results from the 1994 investigation are shown in Table A-4 in Attachment A. Lead concentrations measured in the 2005 pond sediment samples were lower than those measured during the 1994 biomonitoring event. Examples of this trend include the 2005 lead concentration at IS08PS01 (327 L mg/kg), which was located near the 1994 sample locations SO-407 (811 mg/kg) and SO-408 (780 mg/kg). Similarly, the 2005 lead concentration at IS08PS02 (40.9 L mg/kg) was less than the 1994 lead concentration at nearby sample SO-405 (704 mg/kg). Also, the 2005 lead concentration at IS08PS03 (68.6 L mg/kg) was less than the 1994 concentration at nearby SO-402 (246 mg/kg).

6.4 Fish Tissue

6.4.1 Mercury

Table 9 presents the maximum mercury concentrations for the 2005 and historical mosquitofish and bluegill species. The gizzard shad was not analyzed for mercury before 2005. The October 1994 mosquitofish species exhibited the highest concentration of 0.27 mg/kg compared to the 2005 maximum concentration of 0.10 mg/kg. Comparison of the two maximum concentrations indicates a 63 percent decrease in the mosquitofish from 1994 to 2005. The July 1993 bluegill exhibited the highest concentration of 0.09 mg/kg compared to the 2005 maximum concentration 0.08 mg/kg. Comparison of the two maximum concentrations indicates an 11 percent decrease in the bluegill from 1993 to 2005. In general, the results suggest that the concentrations of mercury in fish within the pond have declined

over time, even taking into consideration factors such as differences in the sizes of the fish samples and possible seasonal fluctuations.

6.4.2 Lead

Table 10 presents the maximum lead concentrations for the 2005 and historical mosquitofish, bluegill, and gizzard shad species. The October 2005 mosquitofish species exhibited the highest concentration of 0.48 mg/kg. Comparison of the 2005 result to the August 1995 maximum concentration of 0.3 mg/kg indicates a 60 percent increase in the mosquitofish.

The November 1995 bluegill exhibited the highest concentration of 0.4 mg/kg compared to the 2005 maximum concentration 0.37 mg/kg. Comparison of the two maximum concentrations indicates a decrease of about 8 percent in the bluegill from 1995 to 2005, although this decrease may be attributable to the lower number of significant digits that were used to report the 1995 fish tissue concentration.

The August 1995 gizzard shad species exhibited the highest concentration of 1.6 mg/kg compared to the 2005 maximum concentration of 0.53 mg/kg. Comparing the two maximum concentrations indicates a decrease of about 67 percent in the gizzard shad from 1995 to 2005.

6.5 Evaluation Outcomes

The following bullets summarize the outcomes of the evaluation described above.

6.5.1 Stream Sediment

Analytical Variability Comparison (Mean Concentrations)

- Mercury: The 2005 mean concentration (20.1 L mg/kg) is more than 35 percent higher than the historical mean concentration (0.99 mg/kg) measured during the 1992 Site Characterization Study.
- Lead: The 2005 mean concentration (90.6 L mg/kg) is more than 35 percent lower than the historical mean concentration (432 L mg/kg) measured in 1994 as part of previous biomonitoring activities.

Statistical Comparison (Wilcoxon Rank Sum Test)

- Mercury: The 2005 concentrations statistically exceeded historical concentrations.
- Lead: The 2005 concentrations did not statistically exceed historical concentrations.

6.5.2 Pond Sediment

Analytical Variability Comparison (Maximum Concentrations)

- Mercury: The 2005 maximum concentration (55.5 L mg/kg) is more than 35 percent higher than the historical maximum concentration (0.12 mg/kg) measured during the 1997 RI for Site 12.
- Lead: The 2005 maximum concentration (327 L mg/kg) is more than 35 percent higher than the historical maximum concentration (52.2 J mg/kg) measured during the 1997 RI for Site 12.

6.5.3 Fish Tissue

Nine of eleven tissue samples collected in 2005 were bluegill and mosquitofish, species that were also collected during historical biomonitoring activities. These samples were analyzed for mercury and lead. The other two samples were gizzard shad, which were only analyzed for lead and not for mercury during historical biomonitoring activities.

Analytical Variability Comparison (Maximum Concentrations)

- Mercury: For the mosquitofish, the 2005 maximum concentration (0.10 mg/kg) is more than 35 percent lower than the historical maximum concentration (0.27 mg/kg) measured during the October 1994 biomonitoring event. For the bluegill, the 2005 maximum concentration (0.08 mg/kg) is lower than but within 35 percent of the historical maximum concentration of 0.09 mg/kg measured during the July 1993 biomonitoring event.

- Lead: For the mosquitofish, the 2005 maximum concentration (0.48 mg/kg) is more than 35 percent higher than the historical maximum concentration (0.3 mg/kg) measured during the October 1994 biomonitoring event. For the bluegill, the 2005 maximum concentration (0.37 mg/kg) is lower than but within 35 percent of the historical maximum concentration of 0.4 mg/kg. The 2005 maximum concentration in gizzard shad (0.53 mg/kg) is more than 35 percent lower than the historical maximum concentration of 1.6 mg/kg measured during the August 1995 biomonitoring event.

6.6 Recommended Next Steps

The Work Plan presents a two-step decision logic process for determining the next step at Sites 8 and 56 based on the comparison of historical and 2005 data. The decision logic is summarized in Figure 4 of the Work Plan.

The first step in the decision logic involves comparing the historical and 2005 data for fish tissue and pond sediment. Possible outcomes of this comparison fall under one of the following four scenarios:

- Scenario A—Concentrations in fish tissue have increased, but concentrations in pond sediment have decreased from those in the historical dataset.

- Scenario B—Concentrations in both fish tissue and pond sediment in the 2005 dataset have increased from those in the historical dataset.

- Scenario C—Concentrations in fish tissue have decreased, but concentrations in pond sediment have increased from those in the historical dataset.

- Scenario D—Concentrations in both fish tissue and pond sediment have decreased from those in the historical dataset.

Based on the comparison outcomes above, Scenario B represents the outcome of the fish tissue and pond sediment data comparison.

As shown on Figure 4 in the Work Plan, the second step of the decision logic process is to compare the historical and 2005 datasets for stream sediment. The outcome of the analytical variability and statistical comparisons indicate that the 2005 mercury concentrations in stream sediment have increased compared to those in the historical dataset. The opposite is

true for lead concentrations—both the analytical variability and statistical comparisons suggest that lead concentrations in the 2005 dataset have decreased compared to those in the historical dataset.

Based on these comparison outcomes and applying the decision logic outlined in the Figure 4 of the Work Plan, the appropriate next step for Site 8 and 56 was to perform an ecological risk evaluation. This evaluation is presented in the section below.

7.0 Ecological Risk Evaluation

The mercury concentrations in all of the sediment samples collected from the stream and the pond exceeded the USEPA Region III ecological screening value for mercury (0.18 mg/kg) (USEPA, 2005). Therefore, mercury in sediment poses a potential risk to ecological receptors in the stream and the pond. All of the sediment samples collected from the pond and four of the eight sediment samples from the stream have lead concentrations that exceed the USEPA Region III ecological screening value for lead (35.8 mg/kg). The four samples that exceeded the lead screening value were those collected from locations IS08SD05 through IS08SD08, downstream of the IW-87 Outfall (Figure 1). Thus, lead in the lower stream sediments and in the pond poses a potential risk to ecological receptors.

7.1 Risk to the Benthic Invertebrate Community

The USEPA Region III screening values are based on published consensus-based sediment quality guidelines for freshwater ecosystems (MacDonald et al., 2000), which are guidelines for assessing the potential for adverse effects to sediment-dwelling organisms. Therefore, the potential risk identified is relevant for the benthic community in the stream and pond, and potentially for amphibians, but not directly relevant to many fishes and other wildlife. However, the potential risk to fishes and other higher-trophic-level receptors can be evaluated using the fish tissue data collected as part of the 2005 investigation.

The benthic macroinvertebrate community was monitored in the pond for 3 years from 1993 to 1995 as part of the Site 8 biomonitoring program. However, benthic macroinvertebrate samples were not collected in the stream during the biomonitoring study. The biomonitoring summary report (Brown and Root Environmental, 1995) concluded that the benthic macroinvertebrate community in the pond was depauperate, with low densities and taxa richness. These data, however, were generally consistent with the benthic invertebrate community found at the control site (Stump Neck Beaver Pond) and typical of the simple structure and low diversity of tidal freshwater marshes and ponds of the east coast. The benthic invertebrate community in the pond was dominated by oligochaetes and chironomids throughout the biomonitoring period, which was consistent with the Stump Neck Beaver Pond where these taxa were dominant. The biomonitoring report attributed the low densities and diversity of macroinvertebrates in the pond in 1993 to unusually heavy rains in the spring of 1993 and the draining of the pond to install the weir in April 1993. The report stated that it was unknown if the low densities found in 1994 and 1995 could have been related to slow recolonization of the benthic community following the disturbance in 1993 (significant flooding and the subsequent drainage of the pond to install the weir) or a long-term change in the benthic community structure caused by changes in the composition of the bottom substrate. In summary, the lead and mercury concentrations

in the pond sediments exceeded ecological screening values and were determined to pose potential risk to the benthic community. The risk may not be significant because of the similarity in the benthic community structure between the site and the Stump Neck Beaver Pond; however, there is uncertainty given the age of the data and the timing of their collection relative to the installation of the weir.

7.2 Risk to the Fish Community

To characterize ecological risk to fishes in the pond, the maximum mercury and lead concentrations in fish tissue samples were compared to critical residue values from the literature (Table 11). The maximum mercury and lead concentrations in fish tissue were observed in the same mosquitofish sample, IS08FSH02. Table 12 presents the hazard quotient (HQ) calculated for each metal using the maximum concentration and critical residue value.

Because the maximum concentrations of mercury and lead are less than their respective critical residue values, the calculated HQ is less than 1 for each metal. Therefore, fish should not be at risk from these chemicals. This finding supports the conclusions of the biomonitoring studies, which indicated that (1) mercury and lead in the pond sediments may be in a form that is not readily bioavailable; (2) biota were not accumulating lead to a significant degree; and (3) mercury levels in biota were low, indicating that mercury had stabilized.

There is, however, an uncertainty associated with the use of critical residue values, which were obtained from the literature for a different species, fathead minnow (*Pimephales promelas*). The extrapolation of toxicity data from fathead minnow to mosquitofish would result in an uncertainty. However, no tissue residue toxicity data were found for mosquitofish, bluegill, or gizzard shad.

The 2005 mercury and lead concentrations in mosquitofish sample IS08FSH02 and bluegill sample IS08FSH05 were compared to two fish species (pumpkinseed and spottail shiner) collected from a reference area, Area 6, as part of the Mattawoman Creek Study (Tetra Tech NUS, 2002) (Table 13). Although different fish species are represented, the 2005 data suggest that fishes in the pond are acquiring body burdens of mercury and lead at concentrations above background conditions in the creek. However, as discussed above, the tissue residue data suggest that mercury and lead are not bioaccumulating in fishes at concentrations that warrant further investigation.

7.3 Risk to Piscivorous Wildlife

The maximum whole-body fish tissue concentrations were used to estimate the risk to piscivorous wildlife that might forage at the site using an ingestion-based exposure model described in Attachment C. Three receptors were chosen as surrogate species to represent piscivorous wildlife that might feed on fish at the site; these include the mink, great blue heron, and osprey. The average mercury and lead concentrations in the gizzard shad samples were used to estimate risk to mink and osprey based upon the likely size of fish preyed on by these piscivorous wildlife species. The average mercury and lead concentrations in the smaller-sized fish species (mosquitofish and bluegill) were used to estimate risk to great blue heron based on this species' likely prey size. Calculated no

adverse effect level (NOAEL) and lowest observed adverse effect level (LOAEL)-based HQs for the receptors are presented in Table 14. Only one NOAEL-based HQ for great blue heron exceeded 1. None of the LOAEL-based HQs exceeded 1. These results suggest that mercury and lead are not bioaccumulating in fish tissue at levels likely to pose an unacceptable risk to piscivorous wildlife.

8.0 Summary of Results

The results of the additional investigation at Sites 8 and 56 are summarized below.

- The 2005 mercury concentrations in the stream sediments appear to show a statistically significant increase relative to historical concentrations. The area with elevated mercury concentrations relative to historical levels is limited to the lower section of stream; however, the results for the midsection are ambiguous because much of the historical mercury concentrations were reported as non-detected at relatively high detection limits, which adds some uncertainty to this conclusion.
- The 2005 lead concentrations in the sediment samples from the stream, particularly those in the stream's lower section, show a decrease in concentration compared to the historical samples. In the pond, lead concentrations measured in 2005 were lower than those measured in 1994.
- Mercury concentrations in 2005 were higher in the pond sediment as compared to samples collected during the 1997 RI at Site 12. However, the historical samples were collected from the eastern edge of the pond, on the opposite side of the stream. The 2005 mercury concentrations are relatively consistent with mercury concentrations observed in pond sediment during the 1992 Site Characterization Study at Site 8.
- 2005 mercury concentrations in fish tissue did not exceed historical maximum concentrations, suggesting that the bioavailability of mercury in the pond system has not changed over time.
- Only one fish tissue sample, mosquitofish IS08FSH02, exhibited a 2005 lead concentration exceeding the historical level by more than the 35-percent analytical variability threshold. The maximum lead concentrations in the bluegill and gizzard shad were lower in 2005 than they were during historical biomonitoring events.
- Fish tissue mercury and lead concentrations are below critical residue values, suggesting that fish are not at risk from lead and mercury in the pond sediments.
- Mercury and lead are not bioaccumulating in fish tissue at levels likely to pose an unacceptable risk to piscivorous wildlife.
- Mercury and lead concentrations in the stream sediments and the upper portion of the pond (the area that was stream habitat prior to installation of the weir) may pose a risk to the benthic invertebrate community and/or amphibians.

9.0 Recommendations

Based on the findings of this additional investigation and ecological risk evaluation for Sites 8 and 56, the following recommendations are proposed:

- The elevated concentrations of mercury found in the lower section of stream and upper portion of the pond warrant further site-specific investigation to identify whether the concentrations represent a significant risk to the benthic community and/or amphibians. At the recommendation of the National Oceanic and Atmospheric Administration, NSF-IH is considering the removal of the weir at the downstream end of the pond. The recommendation for further investigation will be reconsidered and discussed among the IHIRT if NSF-IH decides to remove the weir.
- Site 56 should be closed pursuant to CERCLA and Maryland Department of the Environment regulations because this site is no longer contributing to lead concentrations in the stream and pond. Lead in the stream will be addressed through the ecological risk assessment for Site 8.
- The concentrations of lead and mercury in the pond, with the exception of the upper portion of the pond, do not warrant further evaluation based on the 2005 data and historical biomonitoring, which have shown that these metals are not bioaccumulating in organisms at significant levels to warrant concern.

10.0 References

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TABLE 1
Historical Mercury Concentrations in Fish Tissue
Additional Investigation Results for Sites 8 and 56
NSF-IH, Indian Head, Maryland

Species	Oct 92	Jan 93	Apr 93	Jul 93	Oct 93	Apr 94	Oct 94
Brown bullhead*	0.04 (3)			0.05 (2)	0.05 (1)		***0.06 (2)***
Mosquitofish*	0.06 (16)	0.15 (4)			0.12 (36)		***0.27 (75)***
Bluegill*	0.02 (11)	0.02 (6)	0.06 (1)	***0.09 (2)***		0.07 (3)	0.07 (4)
Gizzard shad	—	—	—	—	—	—	—
Goldfish	—	—	—	—	—	—	—
Common carp	—	—	—	—	—	—	—
Creek chubsucker	—	0.03 (1)	—	—	—	—	—
Largemouth bass	—	—	—	—	—	—	—
Largemouth bass	—	—	—	—	—	—	—
White crappie	—	—	—	—	—	—	0.06 (2)
Black crappie	—	—	—	—	—	—	—
Pumpkinseed	—	—	—	—	—	0.09 (3)	—
Carp	—	—	—	—	—	0.03 (2)	—
Shiner	—	—	—	—	0.05 (4)	—	—
Mummichog	—	—	0.03 (8)	—	—	—	—
Warmouth	—	—	—	0.23 (1)	—	—	—
Crayfish	—	—	—	0.07 (2)	0.09 (4)	—	—

All units are in milligrams per kilogram.
Parentheses indicate the number of fish comprising the sample that was analyzed.
* Fish species targeted for sampling during the 2005 investigation. The maximum concentration for each species is shown in bold and italics.

Data are from *Summary Biomonitoring Report for Site 8—Nitroglycerin Plant Office* (Brown and Root Environmental, 1995).

TABLE 2
Historical Lead Concentrations in Fish Tissue, Sites 8 and 56
Additional Investigation Results for Sites 8 and 56
NSF-IH, Indian Head, Maryland

Species	Apr 94	Oct 94	Aug 95	Nov 95
Brown bullhead[a]		0.5 (2)		***1.2 (4)***
Mosquitofish[a]		0.2 (75)	***0.3 (100+)***	
Bluegill[a]	<0.2[b] (3)	0.2 U (4)	0.2 (12)	***0.4 (12)***
Gizzard shad			1.6 (1)	0.7 (6)
Goldfish			0.3 (2)	0.4 (3)
Common carp	<0.2[b] (2)		0.4 (2)	<0.2[b] (1)
Creek chubsucker			0.4 (3)	0.4 (2)
Largemouth bass			0.7 (1)	0.2 U (2)
Largemouth bass			0.2 U (3)	
White crappie		0.2 U (2)	0.2 U (8)	<0.2[b] (2)
Black crappie			<0.2 (3)	<0.2[b] (6)
Pumpkinseed	0.2 U (3)			
Carp				
Shiner				
Mummichog				
Warmouth				
Crayfish				

All units are in milligrams per kilogram.
Parentheses indicate the number of fish composing the sample.
U—Nondetect, level shown is the detection limit.

[a]Fish species targeted for sampling during the 2005 investigation. The maximum concentration for each species is shown in bold and italics.
[b]Detected, but below measurable quantity.

Data are from: *Summary Biomonitoring Report for Lead at Site 8—Nitroglycerin Plant Office* (Brown and Root Environmental, 1995).

Summary Biomonitoring Report for IR Site 56—IW87, Lead Contaminated Outfall, Indian Head Division (Brown and Root Environmental, 1996).

TABLE 3
2005 Analytical Results for Stream Sediment Samples
Additional Investigation Results for Sites 8 and 56
NSF-IH, Indian Head, Maryland

Sample ID	Location	Lead (mg/kg)	Mercury (mg/kg)	Percent Solids
IS08SD01-0905	Midsection	9.0 L	2.6 L	64
IS08SD02-0905[1]	Midsection	10.5 L	0.82 L	62
IS08SD02P-0905 (duplicate)	Midsection	11.5 L	1.9 L	61
IS08SD03-0905	Midsection	7.1 L	2.9 L	66
IS08SD04-0905	Midsection	3.3 L	0.87 L	74
IS08SD05-0905	Lower Section	249 L	49.1 L	43
IS08SD06-0905	Lower Section	173 L	29.2 L	45
IS08SD07-0905	Lower Section	208 L	64.4 L	60
IS08SD08-0905	Lower Section	63.8 L	9.8 L	63
	Mean Concentration	90.6 L	20.1 L	
	Maximum Concentration	249 L	64.4 L	

[1] Analytical results from this sample were not used in the calculation of the mean concentration because these values are lower than the corresponding duplicate samples.

Concentrations are in dry weight.

Midsection of stream extends from downstream edge of 1994 removal action to Outfall IW-87.

Lower section of stream extends from Outfall IW-87 to the pond.

L – Positive result is biased low due to low matrix spike recovery.

IS08SD01-0905 indicates that the sample was collected from location IS08SD01 in September (09) 2005 (05). IS08 refers to Indian Head, Site 8; SD01 refers to a sediment sample from location 1.

TABLE 4
Analytical Results for Pond Sediment Samples
Additional Investigation Results for Sites 8 and 56
NSF-IH, Indian Head, Maryland

Sample ID	Location	Lead (mg/kg)	Mercury (mg/kg)	Percent Solids
IS08PS01-0905	Northern Portion of Pond	327 L	55.5 L	27
IS08PS02-0905	North-Central Portion of Pond	40.9 L	2.2 L	43
IS08PS03-0905	South Central Portion of Pond	68.6 L	1.9 L	34
IS08PS04-0905	Southern Portion of Pond	96.5 L	1.9 L	29
	Mean Concentration	133	15.4	
	Maximum Concentration	327 L	55.5 L	

Concentrations are in dry weight.

L – Positive result is biased low due to low matrix spike recovery.

IS08PS01-0905 indicates that the sample was collected from location IS08PS01 in September (09) 2005 (05). IS08 refers to Indian Head, Site 8; PS01 refers to a pond sediment sample from location 1.

TABLE 5
Analytical Results for Fish Tissue Samples
Additional Investigation Results for Sites 8 and 56
NSF-IH, Indian Head, Maryland

Sample ID	Species	Sample Type (No. of fish)	Size Range (mm)	Lead (mg/kg)	Mercury (mg/kg)	Percent Solids
IS08FSH01	Mosquitofish	Composite (30)	25 - 50	0.35	0.073 K	22
IS08FSH02	Mosquitofish	Composite (30)	25 - 50	0.48	0.101 K	23
IS08FSH03	Mosquitofish	Composite (30)	25 - 50	0.20 J	0.042 K	20
IS08FSH04	Mosquitofish	Composite (40)	25 - 50	0.15 U	0.048 K	22
IS08FSH05	Bluegill	Individual (1)	152	0.37	0.078 K	23
IS08FSH06	Gizzard shad	Individual (1)	302	0.53	0.050 K	31
IS08FSH07	Gizzard shad	Individual (1)	176	0.52	0.023 K	26
IS08FSH09	Bluegill	Composite (44)	38 - 76	0.23	0.062 K	23
IS08FSH10	Bluegill	Composite (16)	25 - 50	0.28 J	0.030 K	23
IS08FSH11	Bluegill	Composite (14)	35 - 65	0.29	0.033 K	22
IS08FSH12	Bluegill	Composite (22)	35 - 52	0.19	0.034 K	24
		Maximum Mosquitofish		0.48	0.101 K	
		Maximum Bluegill		0.37	0.078 K	
		Maximum Gizzard Shad		0.53	0.050 K	

Original results were reported by the lab as dry weight values and were converted to wet weight using the percent solids value.

K - Positive result is estimated and biased high due to high matrix spike recovery

J – Estimated value

U – Analyte was not detected above the reported method detection limit.

TABLE 6
Comparison of Historical and 2005 Mercury Concentrations in Stream and Pond Sediment Samples
Additional Investigation Results for Sites 8 and 56
NSF-IH, Indian Head, Maryland

Area Name	# Samples	Mean	Maximum	Range	Date Sampled	Name of Investigation
Stream	10[1]	0.99[2]	2.9 K	0.13 U – 2.9 K	May 1994	1992 Site Characterization Study
	8	20.1 L	64.4 L	0.9 L – 64.4 L	Oct. 2005	2005 Investigation
Pond	3	0.12	0.1	0.09 – 0.16	Oct. 1997	1999 Site 12 RI
	4	15.4	55.5 L	1.9 L – 55.5 L	Oct. 2005	2005 Investigation

All units are in milligrams per kilogram
[1] Soil samples collected from stream channel overbanks are not included in this number of samples

[2] One-half detection limit used for non-detected samples in calculating mean

K - Positive result is estimated and biased high due to high matrix spike recovery

L – Positive result is biased low due to low matrix spike recovery
U - Non-detected at reported detection limit

Historical stream sediment samples from the 0 to 6-inch depth interval are used for comparative purposes.

TABLE 7
Comparison of Historical and Current Lead Concentrations in Stream and Pond Sediment Samples
Additional Investigation Results for Sites 8 and 56
NSFIH, Indian Head, Maryland

Area Name	# Samples	Mean	Maximum	Range	Date Sampled	Name of Investigation
Stream	5	432	811	6.73 - 811	May 1994	April1994 Biomonitoring[2]
	8	90.6 L	249 L	3.3 L – 249 L	Oct. 2005	2005 Investigation
Pond	3	40	52.2 J	28.1 J – 52.2 J	Oct. 1997	1999 Site 12 RI Report
	4	133	327(L)	40.9 L – 327 L	Oct. 2005	2005 Investigation

[1] Only one sample was collected in 1994.

[2] The results from sediment samples collected in May 1994 were included in a report summarizing the April 1994 biomonitoring event (Haliburton NUS, 1994).

All units are in milligrams per kilogram.

J – Estimated value

L – Positive result is biased low due to low matrix spike recovery

Non-detected values were included in the mean as one half the non-detected (U-flagged) analytical results.

Historical stream sediment samples from the 0 to 6-inch depth interval are used for comparative purposes.

TABLE 8
Statistical Comparison of Historical and Current Lead and Mercury Concentrations in Stream Sediment
Additional Investigation Results for Sites 8 and 56
NSFIH, Indian Head, Maryland

Parameter	P-value	Are Historical Concentrations Exceeded (using 0.05 significance level)?	Current Mean / Median	Historical Mean / Median	Number of 2005 Samples	Number of Historical Samples
Mercury	0.0036	Yes	20.1 / 6.35	0.992 / 0.65	8	10
Lead	0.9249	No	90.6 / 37.7	432.7 / 491.0	8	5

TABLE 9
Comparison of Historical and 2005 Maximum Mercury Concentrations in Fish Tissue Samples
Additional Investigation Results for Sites 8 and 56
NSF-IH, Indian Head, Maryland

Species	Oct 92	Jan 93	Apr 93	Jul 93	Oct 93	Apr 94	Oct 94	Oct 05
Mosquitofish	0.06 (16)	0.15 (4)			0.12 (36)		***0.27*** (75)	0.10 (30)
Bluegill	0.02 (11)	0.02 (6)	0.06 (1)	***0.09*** (2)		0.07 (3)	0.07 (4)	0.08 (1)
Gizzard shad	—	—	—	—	—	—	—	0.05 (1)

All units are in milligrams per kilogram, wet weight.
Parentheses indicate the number of fish composing the composite sample that was analyzed .
The maximum concentration for each species is shown in bold font.

Historical data source: *Summary Biomonitoring Report for Site 8—Nitroglycerin Plant Office* (Brown and Root Environmental, 1995).

TABLE 10
Comparison of Historical and 2005 Maximum Lead Concentrations in Fish Tissue Samples
Additional Investigation Results for Sites 8 and 56
NSF-IH, Indian Head, Maryland

Species	Apr 94	Oct 94	Aug 95	Nov 95	Oct 05
Mosquitofish		0.2 (75)	0.3 (100+)		***0.48*** (30)
Bluegill	<0.2 (3)	0.2 U (4)	0.2 (12)	***0.4*** (12)	0.37 (1)
Gizzard shad			***1.6*** (1)	0.7 (6)	0.53 (1)

All units are in milligrams per kilogram, wet weight.
Parentheses indicate the number of fish composing the composite sample that was analyzed.
U—Nondetect, level shown is the detection limit.

The maximum concentration for each species is shown in bold font.
Historical data source: *Summary Biomonitoring Report for Lead at Site 8—Nitroglycerin Plant Office* (Brown and Root Environmental, 1996).

TABLE 11
Mercury and Lead Critical Residue Values
Additional Investigation Results for Sites 8 and 56
NSF-IH, Indian Head, Maryland

	Lead	Mercury
Tissue Benchmark (mg/kg, wet weight)	26.2	1.36
Benchmark Type	LOAEL	LOAEL
Fish Species	*Pimephales promelas*	*Pimephales promelas*
Effect	Behavior	Reduced Growth
Tissue	**Whole body**	**Whole body**
Exposure Route	Water	Water
Life-Stage	Juvenile	Adult
Reference	Environmental Residues Effects Database (ERED) http://el.erdc.usace.army.mil/ered/	Spry and Wiener, 1991
Comments	Significant reduction in feeding rate and ability to capture and eat prey (exposure duration not reported). NOAEL not reported for fathead minnow, but 2.55 mg/kg reported for brook trout (*Salvelinus fontinalis*) – no effect on growth	41-week exposure; aqueous mercuric chloride NOAEL not reported in Spry and Wiener, but NOEAL values ranging from 0.32 to 2.64 mg/kg (no effect on growth) reported in ERED for fathead minnow

TABLE 12
Calculated Hazard Quotients for Mercury and Lead
Additional Investigation Results for Sites 8 and 56
NSF-IH, Indian Head, Maryland

Chemical	IS08FSH02 - Mosquitofish (mg/kg, wet wt.)	Critical Residue Value (mg/kg, wet wt.)	Hazard Quotient
Mercury	0.10	1.36	0.07
Lead	0.48	26.2	0.01

The maximum lead and mercury concentrations in fish tissue were both observed in Mosquitofish sample, IS08FSH02

TABLE 13
Comparison of Maximum Mercury and Lead Concentrations in Fish Tissue to Mattawoman Creek Reference Fish Tissue
Additional Investigation Results for Sites 8 and 56
NSF-IH, Indian Head, Maryland

	2005 Investigation Results		Reference Samples	
COC	**IS08FSH02 Mosquitofish**	**IS08FSH05 Bluegill**	**Mattawoman Creek Pumpkinseed**	**Mattawoman Creek Spottail Shiner**
Mercury	0.101	0.078	ND (0.05)	ND (0.05)
Lead	0.48	0.37	ND (0.24)	ND (0.24)

ND - not detected (detection limit in parentheses)
All values in milligrams per kilogram, wet weight

TABLE 14
Summary of Hazard Quotients for Piscivorous Wildlife
Additional Investigation Results for Sites 8 and 56
NSF-IH, Indian Head, Maryland

	Mink		Great Blue Heron		Osprey	
	NOAEL	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**
Mercury	0.03	0.02	**1.69**	0.56	0.01	<0.01
Lead	<0.01	<0.01	0.06	0.01	0.03	<0.01

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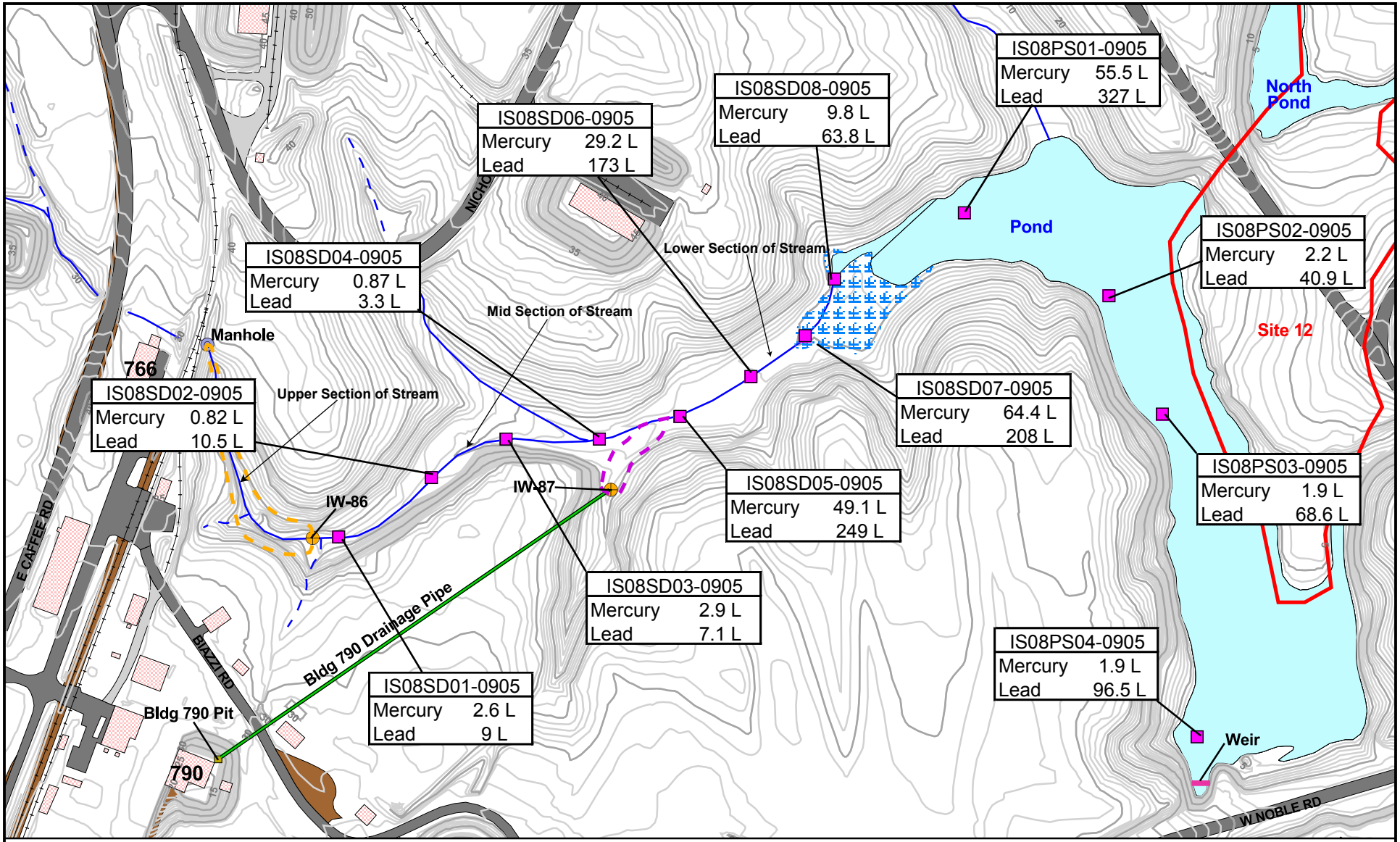

All results in mg/kg (milligrams per kilogram)
ND - Non Detect
K(m) - Positive result is estimated and biased high due to high matrix spike recovery
J - Analyte was positively identified but the quantitation is an estimate

Figure 1
Analytical Results for 2005 Stream and Pond Sediment Samples
Additional Investigation Results for Sites 8 and 56
NSF-IH, Indian Head, Maryland

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Appendix A
Historical and Recent Data

TABLE A-1
Sediment/Soil Analytical Results - Midsection of Stream - August 1992
Additional Investigation Results for Sites 8 and 56
NSF-IH, Indian Head, Maryland

Sample Number	Location Description	Mercury (mg/kg)	
		0 to 6 inches	6 to 12 inches
SS-47	Stream Sediment	1.3 U	1.3 U
SS-48	Overbank	1.4 U	---
SS-49	Stream Sediment	1.3 U	1.4 U
SS-50	Overbank	15.5 U	---
SS-50-D	Overbank	14.8 U	---
SS-51	Stream Sediment	0.13 U	0.43 K(m)
SS-52	Overbank	1.3 U	---
SS-53	Stream Sediment	1.3 U	1.4 U
SS-54	Overbank	3.7 U	---
SS-55	Stream Sediment	1.4 U	0.48 K(m)
SS-56	Overbank	1.5 U	---
SS-57	Stream Sediment	1.2 U	0.26 K(m)
SS-57-D	Stream Sediment	1.3 U	---
SS-58	Overbank	1.3 U	---

Notes:
--- No sample collected
SS-50-D and SS-57-D are field duplicate samples of SS-50 and SS-57, respectively.
U Analyte was not detected above the reported method detection limits
K(m) Positive results is estimated and biased high due to high matrix spike recovery
Source: Site Characterization Report for Site 8 - Nitroglycerin Plant Office (Halliburton NUS, 1993).

TABLE A-2
Sediment/Soil Analytical Results - Lower Section of Stream - August 1992
Additional Investigation Results for Sites 8 and 56
NSF-IH, Indian Head Maryland

Sample Number	Location Description	Mercury (mg/kg)	
		0 to 6 inches	6 to 12 inches
SS-34	North Overbank	1.1 J(m)	5.5 J(m)
SS-35	Mid - Overbank	29.6 UJ(m)	15.5 UJ(m)
SS-36	South Overbank	1.3 UJ(m)	3.3 UJ(m)
SS-37	Stream Sediments	1.5 K(m)	4.6 J(m)
SS-37-D	Stream Sediments	2.9 K(m)	---
SS-38	Overbank	1.3 U	---
SS-39	Former Stream Channel	7.4 K(m)	---
SS-40	Former Stream Channel	2.3 U	---
SS-41	Stream Sediments	1.2 K(m)	6.1 L(m)
SS-41-D	Stream Sediments	---	6.7 K(m)
SS-42	Overbank	2.0 U	---
SS-43	Stream Sediments	1.3 U	1.7 U
SS-44	Overbank	1.7 U	---
SS-45	Stream Sediments	1.4 K(m)	2.6 K(m)
SS-45-D	Stream Sediments	1.8 K(m)	---
SS-46	Overbank	2.8 K(m)	---

Notes:
--- No sample collected
SS-37-D, SS-41-D, and SS-45-D are field duplicate samples of SS-37, SS-41, and SS-45, respectively.
K(m) Positive results is estimated and biased high due to high matrix spike recovery
J(m) Value is estimated due to matrix spike noncompliances. Bias cannot be determined.
UJ(m) Nondetect is estimated due to matrix spike noncompliance. Bias cannot be determined.
Source: Site Characterization Report for Site 8 - Nitroglycerin Plant Office (Halliburton NUS, 1993).

TABLE A-3
Sediment/Soil Analytical Results - Marsh/Stream Transition Area - August 1992
Additional Investigation Results for Sites 8 and 56
NSF-IH, Indian Head Maryland

Sample Number	Location Description	Mercury (mg/kg)		
		0 to 6 inches	6 to 12 inches	12 to 18 inches
SS-23	Transect 7 - North	0.42 UJ(m)	0.26 UJ(m)	---
SS-24	Transect 7 - Middle	1.4 J(m)	1.9 J(m)	0.80 J(m)
SS-25	Transect 7 - South	3.9 UJ(m)	2.1 UJ(m)	---
SS-26	Transect 8 - North	4.8 UJ(m)	4.3 UJ(m)	---
SS-27	Transect 8 - Middle	45.7 UJ(m)	---	---
SS-28	Transect 8 - South	53.2 UJ(m)	61.3 UJ(m)	---
SS-29	Transect 9 - North	0.32 UJ(m)	18.4 UJ(m)	---
SS-29-D	Transect 9 - North	0.42 UJ(m)	---	---
SS-30	Transect 9 - South	18.9 UJ(m)	14.4 UJ(m)	---

Notes:
--- No sample collected
SS-29-D is a field duplicate sample of SS-29
U Analyte was not detected above the reported method detection limits
UJ(m) Nondetect is estimated due to matrix spike noncompliance. Bias cannot be determined.
J(m) Value is estimated due to matrix spike noncompliances. Bias cannot be determined.
Source: Site Characterization Report for Site 8 - Nitroglycerin Plant Office (Halliburton NUS, 1993).

TABLE A-4
Sediment Analytical Results - Pond, Midsection, and Lower Section of Stream - May 1994
Additional Investigation Results for Sites 8 and 56
NSF-IH, Indian Head, Maryland

Sample Number	Location Description	Lead Results (mg/kg)	Area
SO-400-00/01	Transect No. 2, 15 feet from west bank	236	Pond
SO-401-00/01	Transect No. 2, 100 feet from east bank	163	Pond
SO-402-00/01	Transect No. 4, 25 feet from west bank (403 Dup)	246	Pond
SO-403-00/01	Transect No. 4, 25 feet from west bank (402 Dup)	220	Pond
SO-404-00/01	Transect No. 4, 20 feet from east bank	199	Pond
SO-405-00/01	Transect No. 6, 80 feet from west bank	704	Pond
SO-406-00/01	Transect No. 6, 30 feet from east bank	196	Pond
SO-407-00/01	Transect no. 8, center of stream in swamp	811	Lower Section of Stream
SO-408-00/01	50 Feet north of Transect 8	780	Lower Section of Stream
SO-409-00/01	50 Feet downgradient of SS-35	491	Lower Section of Stream
SO-410-00/01	Center of Stream (Duplicate of 411)	40.6	Lower Section of Stream
SO-411-00/01	Center of stream (Duplicate of 410)	73	Lower Section of Stream
SO-412-00/01	Immediately downstream of discharge (IW-87)	79.2	Lower Section of Stream
SO-413-00/01	Upgradient of discharge (IW-87)	6.73	Midsection of Stream

Notes
Source: April 1994 Biomonitoring Report for Site 8 - Nitroglycerin Plant Office (Halliburton NUS, 1994)

TABLE A-5
Sediment/Soil Analytical Results - Pond - August 1992
Additional Investigation Results for Sites 8 and 56
NSF-IH, Indian Head Maryland

Sample Number	Location Description	Mercury (mg/kg)			
		0 to 6 inches	6 to 12 inches	12 to 18 inches	18 to 24 inches
SS-05	Transect 1 - East	2.5 J(d)	0.80 J(d)	---	---
SS-06	Transect 1 - Middle	2.3 J(d)	0.48 J(d)	---	---
SS-07	Transect 1 - West	0.95 J(d)	0.27 J(d)	---	---
SS-110	Between Transects 1 and 2 - West	0.81	0.29	---	---
SS-08	Transect 2 - East	0.29 J(d)	0.18 UJ(d)	0.23 UJ (d)	---
SS-09	Transect 2 - Middle	2.5 J(d)	0.49 J(d)	---	---
SS-09-D	Transect 2 - Middle	2.8 J(d)	---	---	---
SS-10	Transect 2 - West	5.1 J(d)	3.9 J(d)	6.0 J(d)	---
SS-10A	Transect 2 - West	---	0.92	0.26 U	---
SS-111	Between Transects 2 and 3 - West	6.1	0.27 U	---	---
SS-11	Transect 3 - East	7.9 J(d)	6.0 J(d)	---	---
SS-11A	Transect 3 - East	---	0.38	0.21 U	0.16 U
SS-12	Transect 3 - Middle	4.2 J(d)	0.43 J(d)	0.17 UJ(d)	---
SS-13	Transect 3 - West	7.0 J(d)	1.0 J(d)(1)	---	---
SS-13-D	Transect 3 - West	---	0.26 J(d)(1)	---	---
SS-112	Between Transects 3 and 4 West	7.4	0.19 U	0.24 U	---
SS-14	Transect 4 - East	5.4	0.5	---	---
SS-15	Transect 4 - Middle	8.3	0.19 U	---	---
SS-15-D	Transect 4 - Middle	8.2	6.1	---	---
SS-16	Transect 4 - West	9.2	---	---	---
SS-113	Between Transects 4 and 5 - West	13.2	13.4	---	---
SS-17	Transect 5 - East	6.6	1.1	0.17 U	---
SS-18	Transect 5 - Middle	0.44(2)	---	0.69(3)	---
SS-18-D	Transect 5 - Middle	0.48(2)	---	---	---
SS-19	Transect 5 - West	8.1(4)	0.33 U(5)	---	---
SS-114	Between Transects 5 and 6 - West	11.4	0.18 U	---	---
SS-114-D	Between Transects 5 and 6 - West	13.8	---	---	---
SS-20	Transect 6 -East	0.47 U	1.4 U	---	---
SS-21	Transect 6 - Middle	0.56 U	4.6(6)	0.27 U(7)	---
SS-22	Transect 6 - West	2.8 U	1.4	0.28	---

Notes
(1) Sample taken from a depth of 6 to 16 inches
(2) Sample taken from a depth of 0 to 10 inches
(3) Sample taken from a depth of 10 to 18 inches
(4) Sample taken from a depth of 0 to 4 inches
(5) Sample taken from a depth of 4 to 12 inches
(6) Sample taken from a depth of 8 to 14 inches
(7) Sample taken from a depth of 14 to 20 inches
--- No sample collected
"D" in the sample number designates this sample as a field duplicate.
U Analyte was not detected above the reported method detection limits
J(d) Value is estimated due to laboratory duplicate imprecision. Bias cannot be determined.
UJ(d) Nondetect is estimated due to laboratory duplicate imprecision. Bias cannot be determined.
Source: Site Characterization Report for Site 8 - Nitroglycerin Plant Office (Halliburton NUS, 1993)

TABLE A-6
Mercury and Lead Analytical Results - Pond - October 1997
Additional Investigation Results for Sites 8 and 56
NSF-IH, Indian Head Maryland

Sample Number:	**S12SD003**	**S12SD004**	**S12SD005**
Location:	**S12SD/SW03**	**S12SD/SW04**	**S12SD/SW04**
LEAD	28.1 J	52.2 J	
MERCURY	0.09	0.1	0.16

Notes
Results are presented in units of mg/kg.
Sediment samples were also analyzed for additional metals, volatile organic compounds, semivolatile organic compounds, pesticides, polychlorinated biphenyls, explosives, total organic carbon, and pH. These analytical results are presented in the Site 12 Remedial Investigation Report.

Source: 1999 Remedial Investigation Report for Site 12 (Tetra Tech NUS, 1999)

TABLE A-7

Historical Mercury Concentrations in Stream Used in Comparison with 2005 Concentrations
Additional Investigation Results for Sites 8 and 56
NSF-IH, Indian Head Maryland

Sample ID	Result (mg/kg)	1/2 Det Limit	Area
SS-47	1.3 U	0.65	Midsection of Stream
SS-49	1.3 U	0.65	Midsection of Stream
SS-51	0.13 U	0.07	Midsection of Stream
SS-53	1.3 U	0.65	Midsection of Stream
SS-55	1.4 U	0.70	Midsection of Stream
SS-57[1]			Midsection of Stream
SS-57D (dup)	1.3 U	0.65	Midsection of Stream
SS-37[1]			Lower Section of Stream
SS-37D (dup)	2.9 K		Lower Section of Stream
SS-41	1.2 K		Lower Section of Stream
SS-43	1.3 U	0.65	Lower Section of Stream
SS-45[1]			Lower Section of Stream
SS-45D (dup)	1.8 K		Lower Section of Stream
	Mean	**0.99**	
	Median	**0.65**	

Notes
Concentrations are shown as dry weight values.

[1] Analytical results from these samples were not used in the calculation of mean and median because their values are lower than their corresponding duplicate samples. Mercury concentrations in SS-57, SS-37, and SS-45 were 1.2, 1.5, and 1.4 mg/kg, respectively.

U Analyte was not detected above the reported method detection limit

K Positive result is estimated and biased high due to high matrix spike recovery

Source: Site Characterization Report for Site 8 - Nitroglycerin Plant Office
(Hallburton NUS, 1993)

TABLE A-8

Historical Lead Concentrations in Stream Used in Comparison with 2005 Concentrations

Additional Investigation Results for Sites 8 and 56

NSF-IH, Indian Head Maryland

Sample ID	Result (mg/kg)	Area
SO-407	811	Lower Section of Stream
SO-408	780	Lower Section of Stream
SO-409	491	Lower Section of Stream
SO-410[1]		Lower Section of Stream
SO-411(dup of 410)	73.0	Lower Section of Stream
SO-413	6.73	Mid Section of Stream
Mean	**432**	
Median	**491**	

Notes

Concentrations are shown as dry weight values.

[1] Analytical results for this sample was not used in the calculation of mean and median because this value is lower than its corresponding duplicate sample.

Source: April 1994 Biomonitoring Report for Site 8 - Nitroglycerin Plant Office (Hallburton NUS, 1993)

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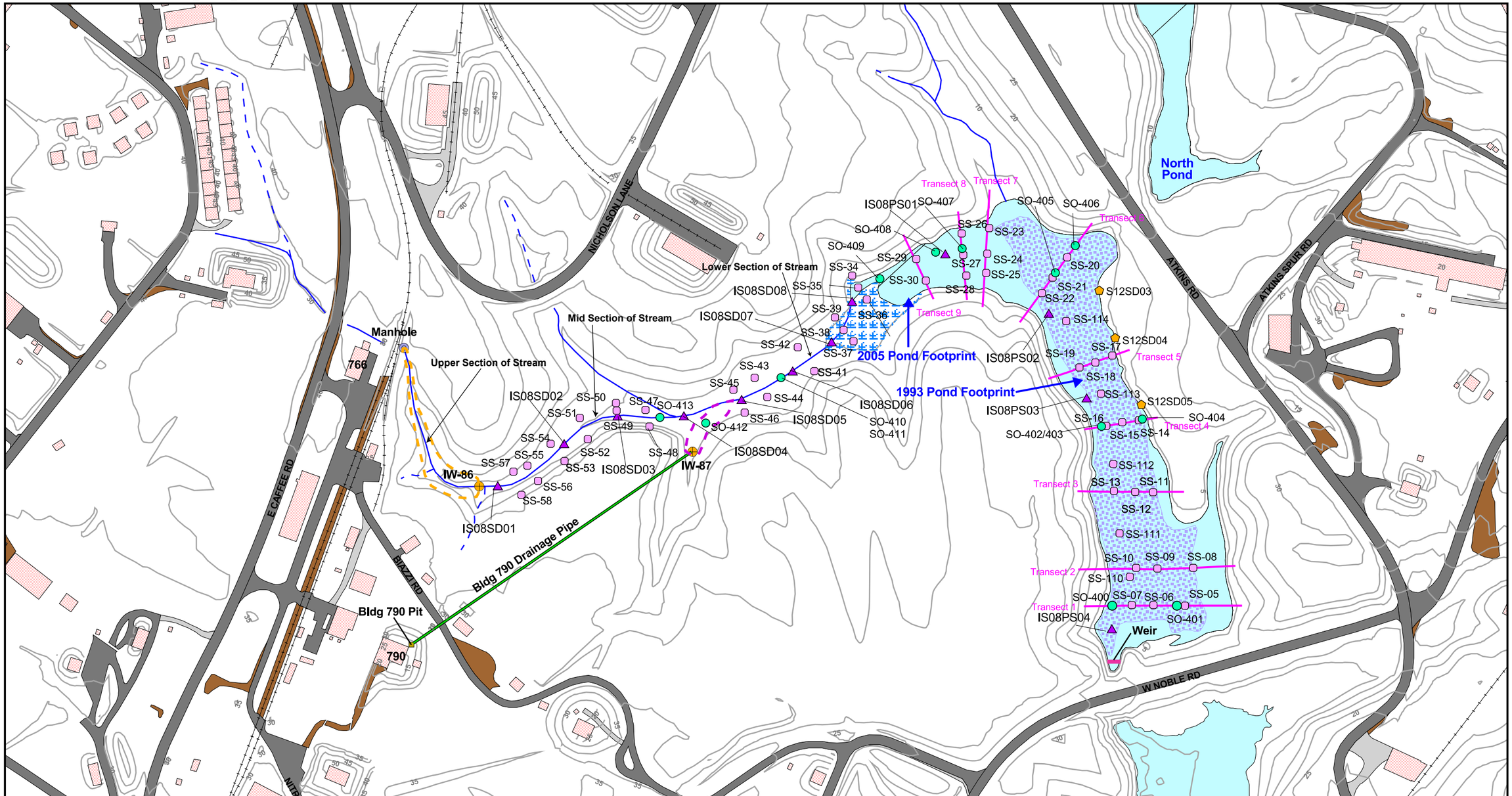

LEGEND

- 2005 Sediment Sample Location
- 1997 Sediment Sample Location (Site 12 Remedial Investigation)
- 1994 Sediment Sample Location (Biomonitoring for Site 8)
- 1992 Sediment Sample Location (Site Characterization Study at Site 8)
- Approximate Extent of 1994 Removal Action at Site 8
- Approximate Extent 1996 Removal Action at Site 56
- Elevation Contours (5 ft Interval)
- Perennial Swale
- Intermittent Swale
- Extent of Historic Tidal Pond
- Marsh
- Buildings
- Asphalt Road
- Dirt Road
- Gravel Road

N

0 200 400 Feet

Figure A-1
Historical and 2005 Sediment Sample Locations
Additional Investigation Results for Sites 8 and 56
NSF-IH, Indian Head, Maryland

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Appendix B
Statistical Comparison of Historical and 2005 Stream Sediment Data

Statistical Comparison of Historical and 2005 Stream Sediment Data

Introduction

Background comparisons were performed for stream sediment at Sites 8 and 56 at Naval Support Facility, Indian Head (NSF-IH), Indian Head, Maryland. Summaries of the 2005 and historical data are provided in Tables B-1, B-2, and B-3. Table B-1 presents the 2005 lead and mercury concentrations, and Tables B-2 and B-3 present the historical concentrations used for statistical comparison for mercury and lead, respectively. The results of the Wilcoxon Rank Sum (WRS) statistical comparison between current and historical concentrations are shown in Table B-4.

In this evaluation, non-detected values were provided a proxy of ½ the detection limit. When duplicates were available, detected values were chosen over non-detected values, and higher detections were chosen over lower detections.

Wilcoxon Rank Sum Comparisons

The WRS test is a nonparametric test used for determining whether a difference exists between two populations. The WRS test was used instead of a parametric test such as the Student's *t*-test because the assumption of normality of the data set was not justified in this case. The WRS test can be used to test whether measurements from one population (such as the site population) tend to be shifted higher than those from another population (such as the background population). Acknowledged as a nonparametric test, it is suggested by U.S. Environmental Protection Agency (USEPA) background guidance for cases when the sample size is less than 20 (USEPA, 2002). As a nonparametric test based on ranks of the data, it is less influenced by spurious results in either data set than parametric tests, such as a t-test performed on the concentrations, which makes a distributional assumption about the data.

This test calculates the probability that the observed differences between the two populations are due merely to random variability in the data, as opposed to being due to an actual elevated shift in one. If this probability is less than a chosen significance level, in this case 0.05, then the decision is made that a significant difference does exist between the two populations. A significance level of 0. 05 implies that one has 95 percent confidence ([1 – 0. 05] x 100 percent) that the two groups will be determined to be statistically equivalent when they actually are.

References

USEPA. *Guidance for Data Quality Assessment. Practical Methods for Data Analysis*. Office of Research and Development, Washington, D.C. 2000.

USEPA. *Guidance for Comparing Background and Chemical Concentrations in Soil for CERCLA Sites*, Office of Emergency and Remedial Response, 2002.

TABLE B-1
2005 Analytical Results for Stream Sediment Samples
Additional Investigation Results for Sites 8 and 56
NSF-IH, Indian Head, Maryland

Sample ID	Location	Lead (mg/kg)	Mercury (mg/kg)	Percent Solids
IS08SD01-0905	Midsection	9.0 L	2.6 L	64
IS08SD02-0905[1]	Midsection	10.5 L	0.82 L	62
IS08SD02P-0905 (duplicate)	Midsection	11.5 L	1.9 L	61
IS08SD03-0905	Midsection	7.1 L	2.9 L	66
IS08SD04-0905	Midsection	3.3 L	0.87 L	74
IS08SD05-0905	Lower Section	249 L	49.1 L	43
IS08SD06-0905	Lower Section	173 L	29.2 L	45
IS08SD07-0905	Lower Section	208 L	64.4 L	60
IS08SD08-0905	Lower Section	63.8 L	9.8 L	63
	Mean Concentration	90.6 L	20.1 L	
	Maximum Concentration	249 L	64.4 L	

[1] Analytical results from this sample were not used in the calculation of the mean concentration because these values are lower than the corresponding duplicate samples.

Concentrations are in dry weight.

Midsection of stream extends from downstream edge of 1994 removal action to Outfall IW-87.

Lower section of stream extends from Outfall IW-87 to the pond.

L – Positive result is biased low due to low matrix spike recovery.

IS08SD01-0905 indicates that the sample was collected from location IS08SD01 in September (09) 2005 (05). IS08 refers to Indian Head, Site 8; SD01 refers to a sediment sample from location 1.

TABLE B-2
Historical Mercury Concentrations in Stream Used in Comparison with 2005 Concentrations
Additional Investigation Results for Sites 8 and 56
NSF-IH, Indian Head Maryland

Sample ID	Result (mg/kg)	1/2 Det Limit	Area
SS-47	1.3 U	0.65	Midsection of Stream
SS-49	1.3 U	0.65	Midsection of Stream
SS-51	0.13 U	0.07	Midsection of Stream
SS-53	1.3 U	0.65	Midsection of Stream
SS-55	1.4 U	0.70	Midsection of Stream
SS-57[1]			Midsection of Stream
SS-57D (dup)	1.3 U	0.65	Midsection of Stream
SS-37[1]			Lower Section of Stream
SS-37D (dup)	2.9 K		Lower Section of Stream
SS-41	1.2 K		Lower Section of Stream
SS-43	1.3 U	0.65	Lower Section of Stream
SS-45[1]			Lower Section of Stream
SS-45D (dup)	1.8 K		Lower Section of Stream
	Mean	**0.99**	
	Median	**0.65**	

Notes

Concentrations are shown as dry weight values.

[1] Analytical results from these samples were not used in the calculation of mean and median because their values are lower than their corresponding duplicate samples. Mercury concentrations in SS-57, SS-37, and SS-45 were 1.2, 1.5, and 1.4 mg/kg, respectively.

U Analyte was not detected above the reported method detection limit

K Positive result is estimated and biased high due to high matrix spike recovery

Source: Site Characterization Report for Site 8 - Nitroglycerin Plant Office (Halliburton NUS, 1993)

TABLE B-3
Historical Lead Concentrations in Stream Used in Comparison with 2005 Concentrations
Additional Investigation Results for Sites 8 and 56
NSF-IH, Indian Head Maryland

Sample ID	Result (mg/kg)	Area
SO-407	811	Lower Section of Stream
SO-408	780	Lower Section of Stream
SO-409	491	Lower Section of Stream
SO-410[1]		Lower Section of Stream
SO-411(dup of 410)	73.0	Lower Section of Stream
SO-413	6.73	Mid Section of Stream
Mean	**432**	
Median	**491**	

Notes

Concentrations are shown as dry weight values.

[1] Analytical results for this sample was not used in the calculation of mean and median because this value is lower than its corresponding duplicate sample.

Source: April 1994 Biomonitoring Report for Site 8 - Nitroglycerin Plant Office (Halliburton NUS, 1994)

TABLE B-4
Central Tendency Comparisons of Site (Indian Head Sites 8 and 56) and Historical Data
Additional Investigation Results for Sites 8 and 56
NSF-IH, Indian Head, Maryland

Parameter	Assumed Distribution for Comparison	Probability that the Observed Differences Would Occur Purely by Chance	Are Historical Concentrations Exceeded (using 0.05 significance level)?	Site Mean	Historical Mean	Site Median	Historical Median	Number of Site Samples	Number of Background Samples
Lead	Nonparametric	0.9249	no	90.6	432.7	37.7	491.0	8	5
Mercury	Nonparametric	0.0036	Yes	20.1	0.992	6.35	0.65	8	10

Appendix C
Food Web Exposure Model and Ingestion Screening Values

Food Web Exposure Model for Piscivorous Wildlife

Mink, great blue heron, and osprey exposures (via the food web) to lead and mercury were determined using measured fish tissue concentrations and food web models. Incidental ingestion of sediment was not included when calculating the total level of exposure because these receptors feed directly on fish and are unlikely to have a significant exposure to sediment via incidental ingestion.

Fish tissue concentrations were reported in wet weight and were converted to dry weight for the food web exposure model using the reported percent moisture values.

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 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 C-1.

TABLE C-1
Exposure Parameters for the Piscivorous Wildlife
Additional Investigation Results for Sites 8 and 56
NSF-IH, Indian Head Maryland

Receptor	Body Weight (kg)		Food Ingestion Rate (kg/day - dry)		Dietary Composition (percent)	
	Value	Reference	Value	Reference	Fishes	Reference
Mink	0.777	Silva and Downing, 1995	0.0266	USEPA, 1993	100%	Assumed 100% for this evaluation; USEPA 1993 reported 94% fish
Great blue heron	2.23	Quinney, 1982	0.3931	Allometric equation	100%	USEPA, 1993
Osprey	1.49	Dunning, 1993	0.0780	USEPA, 1993	100%	USEPA, 1993

Ingestion Screening Values

Ingestion screening values for dietary exposures of lead and mercury 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. 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 Lowest Observed Adverse Effect Levels (LOAEL) was estimated from a NOAEL using an uncertainty factor of 5. Ingestion screening values for birds and mammals are shown in Table C-2.

TABLE C-2
Ingestion Screening Values for the Piscivorous Wildlife
Additional Investigation Results for Sites 8 and 56
NSF-IH, Indian Head Maryland

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 Value used for great blue heron
	red-tailed hawk	1.10	12 weeks	oral in diet	survival/ neurological	0.49	1.20	USEPA 1995 Value used for osprey

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