SECTION 5

Quarterly Sampling Results

The DMT sediment and surface water study was performed in accordance with the USEPA technical approach for the evaluation of chromium in sediment (USEPA, 2005a), as described in the Work Plan and Section 3 of this report. The quarterly sampling program was conducted within the zone potentially impacted by chromium releases at or from DMT and at reference locations to support the following objectives:

1. Characterize the nature and extent of chromium in pore water, surface water, and sediment in the Patapsco River adjacent to DMT as compared to USEPA's NRWQC (as applicable) and concentrations measured at reference locations.
2. Evaluate the fate and transport of chromium based on the characterization of geochemical conditions that govern the presence of chromium as Cr(III) versus Cr(VI).
3. Provide data to support the human health and ecological risk assessments for DMT, including concentrations of other COPR constituents at DMT relative to those measured at reference locations.

This section presents the results of the four quarterly sampling events, including summaries of the full data set across the seasons and quarterly data summaries that characterize seasonal influences on analytical results. This section is organized as follows:

Section 5.1: Nature and Extent of Chromium at DMT
Section 5.2: Delineation of Geochemical Conditions that Influence Fate and Transport of Chromium
Section 5.3: Distribution and Extent of Other COPR Constituents
Section 5.4: Comparison to Results from Previous Studies Conducted in Baltimore Harbor

A summary of the data validation procedures and reports are provided in Appendix D, and full analytical results are provided in Appendix E. The data validation process demonstrated and documented that analytical data were within the acceptance criteria for the associated methods, and are of sufficient quality to be used for qualitative and quantitative purposes. The only exception to this determination related to SEM mercury results for four sediment samples collected in the first quarterly sampling event[1]. Overall, the validation has demonstrated that the quality of the data is sufficient for achieving project objectives and can be used both in the characterization of chromium and other COPR constituents at DMT as well as the evaluation of risks, and thus is of sufficient quality for risk-management decision making. Specifically, as detailed below, the DMT data are

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[1] The SEM mercury results for these samples were determined to be unreliable (i.e., flagged as rejected [R] results) due to non-recovery of mercury in the matrix spike and matrix spike duplicate. However, the non-recovery of the spiked mercury can be attributed to the nature of the AVS extraction, and not to the sediment sample matrix.

sufficient to support the conclusion that the nature and extent of chromium in the Patapsco River and Colgate Creek are delineated, in accordance with the approach defined in the Work Plan, and as such, meet the requirements as stipulated in the Consent Decree.

5.1 Nature and Extent of Chromium

Results for chromium in all media are presented in Tables 5-1 to 5-4, which show the detection frequency, the range of detected concentrations, the average concentration, and the location-specific results for pore water, surface water, surficial sediment (0 to 6 inches) and subsurface sediment (approximately 6 inches to 3 feet below sediment surface), respectively. The maximum detected concentrations of Cr(VI) and total chromium in each medium during any sampling event is illustrated on Figure 5-1a. Pore water, surface water, and sediment results for chromium are discussed in detail below.

5.1.1 Nature and Extent of Chromium in Pore Water

Pore water results for DMT and the three reference locations for the May 2007 through February 2008 sampling efforts are presented in Tables 5-1a (DMT locations) and 5-1b (reference locations), and illustrated on Figure 5-1b. Pore water was collected from each location during each quarter of sampling, with very limited exceptions when the volume of pore water extracted from the sediment was insufficient to conduct any or all of the chemical analyses. Those sampling locations and the associated sampling event are specifically identified in Table 5-1a.

Hexavalent Chromium in Pore Water

Cr(VI) was not detected in pore water in any of the samples taken from DMT in any of the sampling events. The detection limit of 5 µg/L was well below the USEPA’s saltwater acute and chronic NRWQC for Cr(VI) (1,100 and 50 µg/L, respectively). According to USEPA and published scientific studies, if Cr(VI) were present in sediment and biologically available, it would be detected in pore water (USEPA, 2005a; Berry et al., 2004; Besser et al., 2004). The absence of measurable Cr(VI) in pore water establishes that neither whole sediments nor pore water is contaminated with Cr(VI). The absence of Cr(VI) in pore water also demonstrates that Cr(VI) is not being transported to the Patapsco River via groundwater upwelling. The lack of measurements of Cr(VI) in pore water confirms that the nature and extent of Cr(VI) in pore water and sediment is defined.

Dissolved Total Chromium [Cr(III)] in Pore Water

As discussed in Section 3.2, USEPA NRWQCs are based on chromium as Cr(VI) and Cr(III). The absence of Cr(VI) in pore water as discussed above indicates that the dissolved total chromium that is present is in the form of Cr(III). Unfiltered total chromium concentrations (hereafter referred to as total chromium) are also shown in Table 5-1a.

Cr(III) was detected in 70 of 131 pore water samples from the four quarterly sampling events at concentrations ranging from 2.3 to 16.2 µg/L (mean = 3.7 µg/L), with little variation between individual sampling events. The Cr(III) concentrations detected in pore water from DMT locations were consistent with or less than those at the three reference locations (mean = 6.5 µg/L; Figure 5-1b). Most importantly, however, concentrations of Cr(III) at both DMT and reference locations were well below each of the NRWQC, the freshwater acute and chronic criteria as well as the hardness-adjusted acute and chronic criteria as illustrated on Figure 5-2a.

Concentrations of Cr(III) in pore water were significantly lower at the shallow water Transects A, B, C and J than at the deeper water Transects D–H ($p < 0.05$; Figure 5-2b). Transects A, B, C and J are the areas with the highest total chromium concentrations in sediment (see Section 5.1.3). Cr(III) in pore water was detected in 79 percent of the samples in Transects D–H, but only 20 percent of the samples at Transects A, B, C and J. Dissolved Cr(III) is typically found associated with DOC, and Transects A, B, C and J have mostly sandy sediments that contain lower concentrations of organic carbon.

There was no discernable relationship between Cr(III) in pore water and total chromium concentrations in sediment from DMT or reference locations as evidenced by the fact that Cr(III) in pore water was below the mean detected value at the surficial sediment sampling locations with some of the highest total chromium concentrations. Transects D and E near the 13th and 12th Street outfalls, respectively, show a trend of decreasing Cr(III) concentrations with distance from the shoreline; however, this trend was not apparent at the other transects (Figure 5-1b). There was no apparent clustering of higher Cr(III) concentrations adjacent to the shoreline or in the outfall areas. Finally, there are no significant relationship between concentrations of Cr(III) in pore water and location relative to the dredged channels.

The measurements of dissolved Cr(III) in pore water well below the NRWQC confirm that the nature and extent of Cr(III) in pore water are defined.

5.1.2 Nature and Extent of Chromium in Surface Water

Cr(VI) and total chromium surface water results for the May 2007 through February 2008 sampling events are presented in Tables 5-2a (DMT locations) and 5-2b (reference locations) and illustrated on Figure 5-1c. Note that dissolved total chromium in surface water can be Cr(III), Cr(VI), or a mixture of both. Dissolved total chromium is assumed to be Cr(III) if Cr(VI) is not present.

Surface water samples were collected from up to three discrete depths as described in Section 4.1.1 at DMT and reference locations during each of the four quarterly sampling events.

Hexavalent Chromium in Surface Water

Cr(VI) was not detected in 97 percent of the surface water samples analyzed[1] and in those limited locations where it was detected, concentrations were well below the USEPA's NRWQC. The majority of detected concentrations were at or near the detection limit. Detected concentrations were consistently identified in areas adjacent to stormwater outfalls, and with limited exception followed wet weather events.

In total, Cr(VI) was detected in 9 of 320 DMT surface water samples (excluding two duplicate samples). Cr(VI) was not detected in surface water at the reference locations. Cr(VI) was detected at sampling locations B3, B4, C1, D1, D3, E1 and E2 at concentrations ranging from 6 to 35 µg/L (Figure 5-1c). Cr(VI) was detected in three consecutive sampling

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[1] Sample count excludes field duplicate samples.

events at sampling location E1 but was not detected more than once at the other six sampling locations. Six of the nine Cr(VI) detections in surface water occurred during rainfall events (Table 5-5). The remaining three detections were in samples collected when rain occurred within 3 days of sampling. Typically, the detections occurred in the uppermost sampling interval (approximately 3 feet below the air-water interface). The concentrations of Cr(VI) reported in the surface water at DMT were all below the Cr(VI) saltwater acute and chronic NRWQC of 1,100 and 50 μg/L, respectively (Figure 5-3a).

There is evidence that the Cr(VI) detected in surface water is rapidly reduced to Cr(III) because at locations where Cr(VI) was found at concentrations above 25 μg/L (B-4 and E-1), concentrations of dissolved total chromium were significantly higher than the site average of 2.2 μg/L, ranging from 26 to 44 μg/L. The reduction of Cr(VI) to Cr(III) by natural organic matter in the water column is consistent with findings from JHU studies (described further in Section 5.4).

Given the low detection frequency, no discernable pattern of Cr(VI) concentrations with increasing distance from the shoreline was evident, with Cr(VI) detections at both near and far shore sampling locations (Figure 5-1c). There was no relationship between Cr(VI) concentrations in surface water and concentrations of chromium in sediment or pore water (as total or dissolved total chromium). Finally, there was no discernable relationship between key sediment constituents that may influence chromium speciation (i.e. Fe(II), AVS, organic carbon) and the presence or absence of Cr(VI). This serves as additional evidence that the Cr(VI) detections in surface water do not originate from and are not related to concentrations of chromium in sediment.

The DMT stormwater outfalls are in the same vicinity as Transects B–E where Cr(VI) was detected (Figure 5-1c). The fact that Cr(VI) was detected during or after rainfall events suggests a potential source of Cr(VI) from these outfalls. Figure 5-3b illustrates the relationship between Cr(VI) detections in surface water and corresponding rainfall events. However, Fe(II) and DOC were detected in approximately 70 and 80 percent of surface water samples, respectively, indicating that Cr(VI) in the river is likely rapidly reduced upon interaction with key reductants in the water column and sediment.

These Cr(VI) results are consistent with the CSM showing that during the occasions when wet weather stormwater discharges are occurring, the influence of Cr(VI) on the adjacent water body is minimal even in the area where the least mixing/dilution occurs, at least in part because Cr(VI) is rapidly reduced to Cr(III). The measurements of Cr(VI) in surface water well below the NRWQC confirm that the nature and extent of Cr(VI) are defined.

Dissolved Total Chromium in Surface Water

Dissolved total chromium was detected in 19 percent of samples from the four quarters of sampling, at concentrations ranging from 2.3 to 37.6 μg/L (mean = 2.2 μg/L[1]). These concentrations are well below the acute and chronic NRWQC for Cr(III) (Figure 5-4). In samples where dissolved total chromium was detected in surface water, 94 percent of DMT samples were at or near the detection limit of 2.3 μg/L. Dissolved total chromium was

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[1] The mean is lower than the minimum value because the minimum value reported is the minimum detected value, whereas the mean is based on the entire data set, with a value of one-half the detection limit used for samples where chromium was not detected.

detected in 14 percent of reference samples and concentrations were not significantly different than dissolved total chromium concentrations at DMT (reference mean = 1.4 μg/L; r = <0.05). Moreover, there was very little variation in dissolved total chromium concentrations between sampling events.

Dissolved total chromium concentrations in surface water appear to decrease with distance from the shoreline at Transects C, D and E. There were no notable trends in dissolved total chromium concentrations in surface water in shallow (A, B, C and J) versus deep water transects (D–H; Figure 5-1c). There were also no significant trends in concentrations of dissolved total chromium from within the dredged channels. Finally, while there appears to be a trend of higher dissolved total chromium concentrations in the uppermost water column interval versus the bottom waters, the trend is not statistically significant. The most significant relationship is between concentrations of dissolved total chromium in surface water and the few detected concentrations of Cr(VI) as discussed above.

The measurements of dissolved total chromium in surface water at concentrations well below the NRWQC and consistent with reference locations confirms that the nature and extent of chromium in surface water are defined.

5.1.3 Nature and Extent of Chromium in Sediment

Surficial (0-6 inches) and subsurface sediment samples (to a depth of 3 feet below the sediment water interface) were collected at the locations indicated in Figure 5-1b using methodologies described in Section 4.1.2. Surficial samples were collected in May and August 2007, and subsurface samples were collected in August only. An additional Transect J and one station on Transect B were added for sediment collection and analysis in February 2008 to further characterize the nature and extent of chromium at DMT. The results for the combined sediment data sets are discussed in detail below.

A total of 41 locations were sampled near DMT from three depths: 0–6 inches, and two 6–inch subsurface intervals that were selected based on sediment lithology and stratigraphy. Results are summarized in Table 5-3a and 5-3b. The primary findings associated with the sediment sample results are as follows:

- The highest concentrations of total chromium in surficial sediment were found proximate to Area 1501/1602 where concentrations were higher than the Site-wide average and reference areas. Surficial chromium concentrations were also higher than reference in Transect I.
- Overall, concentrations of total chromium in surficial sediment declined with distance from the shoreline, with total chromium concentrations at sampling locations furthest from the shoreline similar to reference concentrations at Transects A, B and D through H.
- Geochemical parameters in sediment provide compelling evidence of geochemical conditions that favor the presence of chromium as Cr(III) rather than Cr(VI), which is consistent with the CSM for DMT.

Total chromium results for surficial and subsurface sediment samples are discussed in detail below.

Total Chromium in Surficial Sediment

Results for total chromium in surficial sediment are presented in Tables 5-3a (DMT locations) and 5-3b (reference locations) and illustrated on Figure 5-1b. Chromium was detected at every location sampled at DMT and reference areas.

Concentrations of total chromium in surficial sediments near DMT ranged from 33 to 2,360 mg/kg (mean = 394 mg/kg). While chromium concentration in surficial sediments Site-wide were significantly greater than the reference locations (range = 89.2 to 166 mg/kg; mean = 127 mg/kg; $p < 0.05$), chromium concentrations at Transects D–H (mean = 156 mg/kg) were consistent with concentrations seen at the reference locations.

The highest concentrations of total chromium in surficial sediments at DMT were seen closest to the shoreline at Transect J, adjacent to Area 1501/1602. Concentrations of total chromium in surficial sediments at Transect J range from 1,260 to 2,360 mg/kg (mean = 1,820 mg/kg). Concentrations of total chromium from the four transects closest to Area 1501/1602 (shallow Transects A, B, C and J) have total chromium concentrations ranging from 58 to 2,360 mg/kg (mean = 719 mg/kg), which are higher than total chromium concentrations at the deep water Transects D–H (range = 33 to 310 mg/kg; mean = 156 mg/kg; $p < 0.05$). Surface sediments in Colgate Creek (Transect I) have total chromium concentrations between these two groups (mean = 410 mg/kg). There is a trend of decreasing chromium concentrations with increasing distance from the shoreline in Transects A, B and C. Total chromium concentrations at sampling locations furthest from the shoreline were similar to reference concentrations at Transects A, B, and D through H.

Total Chromium in Subsurface Sediment

Subsurface sediment samples, collected at two discrete intervals between 0.5 and 3 feet deep, were collected at DMT in August 2007 and February 2008. Results are presented in Table 5-3c and 5-3d and Figure 5-1b. Total chromium concentrations in subsurface sediment from DMT ranged from 1.2 to 8,140 mg/kg (mean = 372 mg/kg). Concentrations of total chromium in subsurface sediment from the reference locations ranged from 55 to 147 mg/kg (mean = 86 mg/kg).

The average concentration of total chromium in subsurface sediment at combined Transects A, B, C and J, which are all within close proximity to Area 1501/1602, is 674 mg/kg. These concentrations are higher than concentrations measured in subsurface samples from deep Transects D-H (mean = 111 mg/kg; $p < 0.05$), which are similar to the reference areas. Total chromium concentrations in subsurface sediment decrease with increasing distance from the shoreline in Transects A and C in Area 1501/1602. Total chromium concentrations appear to increase with distance from the bulkhead at Transect B and Transect I in Colgate Creek.

Conclusions Regarding Chromium Distribution in Surficial and Subsurface Sediment

Total chromium concentrations in surficial and subsurface sediments were highest near Area 1501/1602 and at Transect I in Colgate Creek. Concentrations in Area 1501/1602 generally decreased with increasing distance from the shoreline and with increasing depth in the sediment column. In Transect I in Colgate Creek, the highest concentrations were found at depth at the location furthest from DMT. Transects D–H have mean total chromium concentrations that are statistically similar to reference areas.

The higher concentrations of total chromium in sediment immediately adjacent to Area 1501/1602 are likely related to historical stormwater runoff from uncovered COPR stockpiles and other filling operations prior to placement of the asphalt cover. Prior to construction of Area 1501/1602, approximately 800,000 cubic yards of COPR were stockpiled in the southeast corner of DMT. During this period, stormwater runoff containing Cr(VI) from the stockpiles entered the Patapsco River at the former shoreline that is now occupied by Area 1501/1602. The runoff was eventually contained by earthen dikes and sumps installed by MPA. Over 200,000 cubic yards of material were then placed in containment cells above the water table during construction of Area 1501/1602. During construction, clean fill material was deposited into the river to allow construction of the containment cells. This filling process likely displaced the sediments affected by previous stormwater runoff outward into the river in a progressive mud wave as the filling advanced. Therefore, it is likely that sediment samples collected near the current shoreline of Area 1501/1602 contain chromium contributions from historical runoff. Total chromium in sediment in the vicinity of Transect C may also be due to historical releases of Cr(VI) via the stormwater outfalls that reduced to Cr(III), which precipitated from the water column and accumulated in sediment.

Groundwater upwelling does not appear to contribute to chromium in sediments because Cr(VI) concentrations in groundwater samples from the perimeter of Area 1501/1602 are below the NRWQC, Cr(VI) was not detected in pore water samples, and chromium concentrations are higher in surficial sediment than in subsurface sediment, which is inconsistent with a discharging groundwater source.

The limited horizontal extent of the elevated chromium concentrations indicates that minimal sediment resuspension and transport has occurred. Results for Cr(VI) and Cr(III) in pore water samples from locations in Colgate Creek indicate that additional investigation of nature and extent of chromium in this area is not required.

Based on these findings, and given that Cr(VI) and total dissolved chromium concentrations in pore water and surface water from all DMT locations are well below the NRWQC, the nature and extent of total chromium in sediment is defined.

5.2 Delineation of Geochemical Conditions that Influence Fate and Transport of Chromium

As discussed in Section 3.2, geochemical parameters can be used to understand and predict chromium behavior in an estuarine environment. These parameters were analyzed during each of the four quarterly sampling events. Characterizing in situ geochemical conditions is critical to understanding the behavior of chromium, and provides insight into the distribution, toxicity, and long-term stability of chromium in sediments. This section describes both spatial variations in geochemical constituents at DMT as well as the influence of season on the concentration of these constituents, and evaluates whether these variations influence the behavior of chromium at DMT.

The most important constituents that reduce Cr(VI) to Cr(III) include sulfides, Fe(II), and natural organic matter (Hansel et al., 2003). While sulfides and Fe(II) are able to donate electrons for Cr(VI) reduction, organic carbon, specifically humic and fulvic acids, contain binding sites that can form complexes with chromium and reduce its bioavailability. According to USEPA (2005a), the presence of detectable AVS alone is an indication that any chromium in sediment would be present primarily as Cr(III).

Results for geochemical parameters in pore water, surface water, and sediment are provided in Tables 5-1 through 5-4. Spatial and temporal variations in geochemical conditions are described below.

5.2.1 Spatial Variations in Geochemical Constituents

To evaluate spatial variations in geochemical conditions, results for geochemical parameters at DMT locations were compared to those at the reference locations. Additionally, results for samples from the shallow, sandy transects (Transects A, B, C, and J) were compared to those from the deeper transects with finer-grained sediments (Transects D-H). While concentrations of AVS and Fe(II) were not significantly different in Site versus reference sediments, concentrations of TOC were significantly higher in the reference sediments (mean = 2.9 percent) than in Site sediments (mean = 1.8 percent; $p < 0.05$). However, concentrations of DOC were similar in surface water and pore water at the Site versus at the reference locations. Overall, concentrations of geochemical constituents in all media, including AVS/sulfides, Fe(II), and organic carbon, were substantially lower in the sandy, shallow transects (Transects A, B, C and J) than in the silty deeper Transects (Transects D–H). Despite the lower concentrations of these reducing agents in Transect A, B, C and J, there is a surplus of reducing capacity in these sediments to insure the stability of Cr(III), as evidenced by the fact that Cr(VI) was not detected in pore water at any location. Figure 5-5a clearly demonstrates that concentrations of reducing agents are found in excess in all DMT sediments.

5.2.2 Seasonal Variations in Geochemical Conditions

Seasonal variations in temperature and freshwater input may impact concentrations of key geochemical constituents. Estuarine sediments, such as those in Baltimore Harbor, tend toward anoxic or hypoxic conditions during summer months due to diminished freshwater inputs, high water temperatures, and increased biological activity; which leads to increased oxygen consumption. This results in an increase in the decay of organic matter and blooms of macroalgae throughout the estuary that consume oxygen in the sediment and water column. This decrease in oxygen concentrations is accompanied by an increase in sulfide and Fe(II) production. Reduction and subsequent immobilization of Cr(VI) results from a coupled biotic-abiotic reaction pathway in which Fe(II) or hydrogen sulfide (H_2S) produced during microbial respiration catalyze the reduction of Cr(VI).

The geochemical measures of AVS and Fe(II) showed very strong evidence that there was adequate AVS and/or Fe(II) throughout the Site and during all seasons to maintain the reducing conditions that would ensure the presence of chromium as Cr(III), as illustrated on Figures 5-5a and 5-5b. Figure 5a shows that even in the limited number of areas where AVS measures were low, there were substantial amounts of excess Fe(II) indicating reducing conditions (and thus, the presence of chromium as Cr(III)). Figures 5-5a and 5-5b show seasonal fluctuations, and despite fluctuations in temperature and freshwater inputs that influence concentrations of DO, concentrations of reducing agents in sediments such as AVS and Fe(II) remain substantial. Specifically, AVS was found in concentrations that exceed concentrations of SEM in 90 percent of samples, regardless of season or DO concentration.

As discussed previously, USEPA acknowledges that geochemical factors determine both the bioavailability of chromium and its oxidation and reduction potential (USEPA, 2005a). As shown in Figure 5-5b, regardless of the variations in DO concentrations with season or depth at DMT, the concentrations of reducing agents are sufficient to ensure that chromium is stable as Cr(III). At the few locations where AVS was not found in excess, Fe(II) was available to act as the key reductant in the sediment (Table 5-4) as well as in surface and pore water. The results demonstrate that chromium remains stable as Cr(III) and is not oxidizable in even moderately oxidizing (aerobic) conditions. These results are also very consistent with findings of JHU researchers and researchers at other estuarine sites, as described in Section 5.4.

Chromium is stable as Cr(III) at DMT because reduction processes out-compete oxidation processes, despite fluctuations in concentrations of various geochemical constituents. Concentrations of reducing agents available to reduce Cr(VI) to Cr(III) far exceed the concentrations of the few oxidizing agents known to oxidize Cr(III) to Cr(VI) even in moderately aerobic sediments (Eary and Rai, 1987; Stanin, 2005). Furthermore, while oxidation of Cr(III) is extremely slow in environmentally relevant geochemical and thermodynamic conditions, reduction of Cr(VI) is very rapid under reducing or even mildly oxidizing conditions, making reduction the favored reaction under environmentally relevant pH/redox conditions (Schroeder and Lee, 1975).

5.3 Distribution and Extent of Other COPR Related Constituents

Although the Work Plan focused on the characterization of chromium in sediment and surface water adjacent to DMT, other COPR constituents (aluminum, calcium, iron, magnesium, manganese, and vanadium) were also analyzed to provide data for the human health and ecological risk assessments. Sample results for pore water, surface water, and sediment are provided in Tables 5-1 through 5-3.

The analytical results for the other COPR constituents in surficial sediments are shown in Figure 5-6. The spatial distributions vary for each parameter, indicating that these constituents do not co-occur. Aluminum and iron concentrations tend to be lower in the sandy sediments near Transects A-C relative to the finer-grained sediments in Transects D-H and the reference locations. Calcium and magnesium concentrations tend to be highest along the shoreline of Area 1501/1602. Manganese concentrations are highest along the D and E transects, and vanadium concentrations are generally uniform throughout DMT and in the reference locations. Concentrations of other COPR constituents in surficial sediment have been delineated relative to reference concentrations.

5.4 Comparison to Results from Previous Studies Conducted in Baltimore Harbor

This section includes a discussion of studies conducted by JHU and other researchers at estuarine sites where chromium is a primary constituent of interest. The results from the DMT study are consistent with the findings of these other research efforts regarding the behavior, predictability and stability of chromium in sediments. Each of the studies presented below used approaches consistent with the USEPA approach for evaluating chromium toxicity in different media which includes the direct measurement of chromium species (Cr(VI) and Cr(III)) and geochemical parameters such as AVS and Fe(II) (Berry et al., 2004; USEPA, 2005a). These studies are discussed briefly below and are discussed in significant detail in a chromium literature review (ENVIRON, 2008).

This section concludes with a discussion of the relationship of DMT findings to historical studies at DMT, as well as the similarities of DMT findings from other chromium-related sites (i.e., the JHU and peer reviewed studies described in this section).

5.4.1 Johns Hopkins University Center for Contaminant Transport, Fate, and Remediation

JHU's CTFR performed a series of comprehensive multi-year experiments to evaluate the relationship between the presence of chromium species and toxicity in Baltimore Harbor sediments, pore water, and the water column. The initial investigations by JHU researchers characterized chromium speciation in Baltimore Harbor sediments and pore water (Graham et al., 2009). The characterization study was followed by a series of experimental studies using Baltimore Harbor sediments to evaluate chromium stability (Graham and Wadhawan, 2007a,b). The characterization and experimental studies are summarized below.

Baltimore Harbor Sediment and Pore Water Characterization (Graham et al., 2009)

The JHU researchers evaluated the geochemistry and speciation of chromium in sediment and pore water from 22 Baltimore Harbor locations using a reverse-phase ion-pair high performance liquid chromatography/inductively coupled plasma-mass spectrometry (HPLC/ICP-MS) method. The sample locations in the study included one location from DMT and two locations in Colgate Creek. The study included consideration of geochemical parameters that indicate reducing conditions and thus contribute to the understanding of chromium speciation (e.g. AVS, Fe(II), Mn(II), TOC). The researchers concluded that their findings were consistent with the USEPA EqP model for chromium which indicates that Cr(VI) is unlikely to be present in sediments with measurable AVS concentrations. Their findings further showed that Harbor sediments have considerable capacity to reduce Cr(VI) to Cr(III) based on spiking studies that were performed as part of method validation.

JHU CTFR Experimental Studies on Chromium Stability

The CTFR studies included multiple experimental studies that focused on two key questions related to chromium stability:

1. What geophysical conditions in sediment promote the reduction of Cr(VI) to Cr(III), and how fast are these reduction processes?
2. Once Cr(VI) is reduced to Cr(III), will the chromium remain as Cr(III) or can it be re-oxidized to Cr(VI)?

JHU Experiment 1: Determination of Conditions Conducive to the Reduction of Cr(VI) to Cr(III) in Aquatic Environments and Sediment (Graham and Wadhawan, 2007a)

Graham and Wadhawan (2007a) conducted a study to better understand the fate and rates of reduction of Cr(VI) entering Baltimore Harbor. The study results showed that Cr(VI) was reduced to Cr(III) in a matter of seconds when spiked into harbor and creek sediments. The amount of Cr(VI) used in several of the experiments was 10 times the Cr(VI) NRWQC for marine ecosystems. Study results also showed that the reduction of Cr(VI) was highly correlated to AVS concentrations. The rate of reduction was in fact proportional to the sediment AVS concentration and, therefore, consistent with USEPA guidance (2005a). The researchers concluded that AVS was a good predictor of Cr(VI) reduction kinetics in Baltimore Harbor sediments and that in sediments containing AVS, Cr(VI) is very quickly reduced to Cr(III).

JHU Experiment 2: Study to Determine the Likelihood that the Reduction of Cr(VI) to Cr(III) will be a Permanent Process—Cr(III) Oxidation (Graham and Wadhawan, 2007b)

An extension of JHU's initial study was to evaluate whether the reduction of Cr(VI) to Cr(III) is a permanent process. The primary objective of this study was to determine the significance of oxidants (e.g., manganese oxides and oxygen) in transforming Cr(III) to Cr(VI) in pore water, sediments and the water column. The researchers found that oxidants introduced into an experimental vessel containing Baltimore Harbor sediments were quickly reduced by organic matter, which is found in abundance in harbor sediments as well as DMT. The researchers found that while it was possible to catalyze the reaction of Cr(III) to Cr(VI), the specific conditions necessary to catalyze the reaction are not consistent with conditions occurring in the natural environment. This study demonstrated that Cr(III) is very stable in sediments unless under extreme laboratory conditions that are not characteristic of conditions likely to be encountered in Baltimore Harbor. Therefore, the authors concluded that the reduction of Cr(VI) to Cr(III) can be considered a permanent process. These results are consistent with the findings at DMT in that regardless of seasonal variations in temperature and concentrations of DO, chromium in sediments does not oxidize to Cr(VI). If oxidation were occurring in sediments, then Cr(VI) would have been detected in the pore water.

These findings by Graham and Wadhawan (2007b) are in agreement with the peer reviewed literature that indicates that once reduced, Cr(III) is geochemically stable and unlikely to transform to Cr(VI), even in the presence of oxidizing agents such as DO and manganese oxides (Magar et al., 2008; Saleh et al., 1989; Eary and Rai, 1987). According to the results of numerous peer reviewed articles, the oxidation of aqueous Cr(III) solely by DO is too slow to be considered a significant factor in the formation of Cr(VI) (Rai et al., 1986, Schroeder and Lee, 1975, Eary and Rai, 1987, Nakayama et al., 1981). The slow oxidation kinetics enable Cr(III) to be involved in other reactions (sorption or precipitation) that are much faster (Stanin, 2005) and maintain chromium in its reduced form as Cr(III). Thus, in the event that the water quality conditions in Baltimore Harbor improve in the future, it would still be highly improbable for the redox capacity of the sediments to be altered to the extent necessary for the spontaneous formation of Cr(VI).

While several studies other than JHU have reported the manganese oxide catalyzed oxidation of Cr(III) in the laboratory, the conditions necessary to drive the reaction are artificial and are inconsistent with the in situ conditions at DMT. Cr(III) must be soluble and/or manganese oxides must be fresh and amorphous in order for Cr(III) to adsorb onto manganese oxides surface sites (a necessary step for Cr(III) oxidation by manganese oxides; Wu et al., 2005; Kim et al., 2002). According to Wu et al. (2005) aged and well-crystallized MnO_2 (i.e., pyrolusite), which is what would typically be found in sediments, is weak and slow to oxidize Cr(III). Also, Cr(III) has very low solubility at environmentally relevant pH due to the formation of insoluble hydroxide and oxide compounds and because Cr(III) forms strong complexes with sediment minerals and organic ligands (Fendorf, 1995). Therefore, manganese oxides and Cr(VI) should not exist under the Eh-pH conditions present at DMT.

Overall, the CTFR studies determined that nontoxic Cr(III) is favored in Baltimore Harbor waters because the concentrations of reducing agents available to reduce Cr(VI) to Cr(III) far exceed the concentrations of the few oxidizing agents known to oxidize Cr(III) to Cr(VI). In addition, the kinetics of Cr(VI) reduction to Cr(III) is very fast, thereby outcompeting reactions involving Cr(III) oxidation.

The JHU studies also determined that oxidizing agents, even in the unlikely event that they might be present in environmentally relevant concentrations at DMT, are reduced by constituents readily available in the sediments, namely, organic matter. Moreover, Cr(III) is highly stable in sediments in Baltimore Harbor and only rigorous laboratory conditions will catalyze the formation of Cr(VI) from Cr(III). These studies showed that Cr(VI) cannot persist in the natural environment and that the reduction of Cr(VI) to Cr(III) is likely a permanent process.

5.4.2 Hackensack River Chromium Investigations

The following section summarizes the results of studies conducted at chromium contaminated sites in the lower Hackensack River, New Jersey. The lower Hackensack River is a tidally influenced stretch of river with many characteristics that are similar to the Patapsco River and the DMT site.

The study areas described below have been used for industrial and commercial purposes for more than 100 years, including sodium dichromium manufacturing. It was common practice in the mid-1900s to use COPR generated during chromate production as fill material.

Geochemical Stability of Chromium in Sediments from the Lower Hackensack River, New Jersey (Magar et al., 2008)

Magar et al. (2008) conducted sediment resuspension and oxidation experiments to investigate the potential for release of Cr(III) or Cr(VI) and other chemicals of concern in sediment to the water column in response to a sediment disturbance event at a chromium contaminated site in the lower Hackensack River, NJ. The intertidal sediment exposure experiment was designed to investigate potential aqueous release of Cr(III) or Cr(VI) from intertidal surface sediments during low tide, the conditions under which sediments experience the greatest level of oxygen exposure.

Results revealed no detectable concentrations of Cr(VI) and thus no measurable potential for Cr(III) oxidation to Cr(VI) despite the fact that the experiments were designed to maximize the oxidation potential in surface and suspended sediment samples due to exposure to oxygen. The results of this study demonstrated that Cr(III) is stable and is expected to remain geochemically stable in the study area sediments under ambient conditions, severe weather conditions, and anthropogenic scouring events.

Chromium Geochemistry and Bioaccumulation in Sediments from the Lower Hackensack River, New Jersey, U.S.A. (Martello et al., 2007)

Martello et al. (2007) measured total chromium and Cr(VI) in sediment and sediment pore water in the lower Hackensack River, NJ to assess the relationship between sediment geochemistry and chromium speciation, which in turn controls the mobility, bioavailability and toxicity of chromium. Between 2003 and 2005, more than 100 surface sediment samples (0 to 6 inches) were tested for total Cr, Cr(VI), AVS, Fe(II), Mn(II), ammonia, and organic carbon. Sediment pore water samples were collected by centrifugation or *in situ* samplers co-located with the collection of sediments. Concentrations of AVS and other geochemical measurements indicated reducing conditions in the majority of sediment samples.

Chromium concentrations in whole tissues of polychaetes and clams exposed in the field or in the laboratory showed no relationship with total chromium or Cr(VI) concentrations in the sediment or pore water and no statistical differences in concentrations of chromium in tissues of animals exposed to sediments from site versus reference locations. The results of this study are consistent with the USEPA (2005a) EqP approach as well as sediment studies conducted elsewhere indicating low chromium bioavailability in sediment under reducing and even moderately oxidizing conditions.

Despite the occurrence of elevated concentrations of total chromium in sediments of the lower Hackensack River, the results of this study indicate that little, if any of the chromium is present as Cr(VI), and, therefore, risks associated with exposure to chromium are particularly low. Further, Cr(VI) was not detected in any of the pore water samples. These results are consistent with multiple geochemical indicators showing reducing conditions in pore water and sediment. The low bioaccumulation of chromium to benthic invertebrates is also consistent with these conclusions.

5.4.3 Similarities between Current DMT Study and Recent Chromium-Related Studies

Each of the studies described above were conducted either in the Baltimore Harbor or in river systems with similar characteristics. The findings from these chromium-related studies reported in the peer reviewed literature have substantial similarities to DMT. Specifically,

- Even at sites like DMT that contain high concentrations of chromium in sediment, the chromium exists overwhelmingly in the trivalent form.
- Regardless of high concentrations of total chromium in sediment, Cr(VI) was consistently not detected in the pore water.
- Like DMT, each of these studies has reported measurable concentrations of geochemical constituents, such as AVS and Fe(II), that have been shown to reduce Cr(VI) to Cr(III).
- Cr(III) was shown to be highly stable in each of the studies where Cr(III) oxidation potential was tested.

TABLE 5-1a

Summary of DMT Pore Water Results

Dundalk Marine Terminal, Baltimore, Maryland

		Reference	DMT May 2007 - February 2008							
Parameter	**Units**	**Maximum Concentration**	**Frequency of Detection (a) [detects/samples]**		**Range of Detected Concentrations (b) [min-max]**			**Average Concentration (c) [mean + SD]**		
Analytical Chemistry										
Chromium, dissolved	ug/L	11.6	70	131	2.3	-	16.2	3.7	±	3.47
Hexavalent Chromium, dissolved	ug/L	0	0	131	0	-	0	2.5	±	---
Aluminum, dissolved	ug/L	0	1	137	86.8	-	86.8	186	±	1,710
Calcium, dissolved	mg/L	186	137	137	19.7	-	233	140	±	36.7
Iron, dissolved	ug/L	8,040	92	137	54.4	-	9,300	902	±	1,970
Magnesium, dissolved	mg/L	547	137	137	167	-	645	394	±	111
Manganese, dissolved	ug/l	24,600	137	137	20.8	-	25,600	3,980	±	4,900
Vanadium, dissolved	ug/L	11.3	104	137	1.5	-	11.9	6.55	±	31.8
Chromium, total	ug/L	14.7	129	131	3	-	2,630	74.8	±	291
Aluminum, total	ug/L	1,380	131	133	3	-	61,900	1,510	±	5,800
Calcium, total	mg/L	196	137	137	20.7	-	233	140	±	35.2
Iron, total	ug/L	15,800	136	137	149	-	169,000	5,780	±	15,200
Magnesium, total	mg/L	551	106	106	170	-	677	371	±	111
Manganese, total	ug/L	26,000	137	137	18.4	-	28,400	4,150	±	4,880
Vanadium, total	ug/L	15.1	136	137	2.1	-	350	12.5	±	31.3
Geochemistry										
Acidity As $CaCO_3$, dissolved	mg/L	2,810	9	9	2010	-	3,230	2,600	±	336
Ammonia-Nitrogen, dissolved	mg/L	20.6	61	61	0.54	-	74.3	17.6	±	17.5
Ferrous Iron, dissolved	mg/L	7.6	126	131	0.0092	-	10.5	0.851	±	1.76
Hardness, total dissolved	mg/L	2,700	19	19	1320	-	2,890	2,260	±	485
Organic Carbon, dissolved	mg/L	25	127	127	4.3	-	49.4	18.9	±	8.91
Oxidation-Reduction Potential	mv	642	93	93	342	-	698	563	±	88.3
pH	SU	8	126	126	7.5	-	9.5	7.97	±	0.298
Sulfide	mg/L	0	9	62	0.061	-	300	21	±	43.7

TABLE 5-1a

Summary of DMT Pore Water Results

Dundalk Marine Terminal, Baltimore, Maryland

		Reference	**DMT Quarter 1 (May 2007)**							
Parameter	**Units**	**Maximum Concentration**	**Frequency of Detection (a) [detects/samples]**		**Range of Detected Concentrations (b) [min-max]**			**Average Concentration (c) [mean + SD]**		
Analytical Chemistry										
Chromium, dissolved	ug/L	8.4	17	35	2.6	-	8.5	2.5	±	1.74
Hexavalent Chromium, dissolved	ug/L	0	0	35	0	-	0	2.5	±	---
Aluminum, dissolved	ug/L	0	1	37	86.8	-	86.8	41.4	±	7.68
Calcium, dissolved	mg/L	152	37	37	76	-	177	115	±	31.3
Iron, dissolved	ug/L	8,040	24	37	56.5	-	3,580	393	±	824
Magnesium, dissolved	mg/L	451	37	37	167	-	595	329	±	130
Manganese, dissolved	ug/l	24,600	37	37	110	-	13,300	3,210	±	2,900
Vanadium, dissolved	ug/L	10.9	30	37	1.5	-	9.7	3.8	±	2.34
Chromium, total	ug/L	8.1	35	35	3	-	162	17.5	±	27
Aluminum, total	ug/L	149	37	37	3	-	162	16.8	±	26.4
Calcium, total	mg/L	155	37	37	80.6	-	185	118	±	31.1
Iron, total	ug/L	15,800	37	37	149	-	9,830	2,940	±	2,580
Magnesium, total	mg/L	462	37	37	170	-	613	323	±	126
Manganese, total	ug/L	26,000	37	37	116	-	14,200	3,750	±	3,390
Vanadium, total	ug/L	12.1	37	37	2.1	-	26.8	7.5	±	4.16
Geochemistry										
Acidity As $CaCO_3$, dissolved	mg/L	NA	NA		NA	-	NA	NA	±	NA
Ammonia-Nitrogen, dissolved	mg/L	19.1	31	31	0.54	-	67.8	13.3	±	13.7
Ferrous Iron, dissolved	mg/L	7.6	35	35	0.0092	-	3.8	0.319	±	0.663
Hardness, total dissolved	mg/L	NA	NA		NA	-	NA	NA	±	NA
Organic Carbon, dissolved	mg/L	18.7	33	33	10.6	-	49.4	25.2	±	9.32
Oxidation-Reduction Potential	mv	NA	NA		NA	-	NA	NA	±	NA
pH	SU	8	32	32	7.7	-	8.4	8.01	±	0.187
Sulfide	mg/L	NA	4	30	63	-	300	43.3	±	55

TABLE 5-1a

Summary of DMT Pore Water Results

Dundalk Marine Terminal, Baltimore, Maryland

		Reference	**DMT Quarter 2 (August 2007)**							
Parameter	**Units**	**Maximum Concentration**	**Frequency of Detection (a) [detects/samples]**		**Range of Detected Concentrations (b) [min-max]**			**Average Concentration (c) [mean + SD]**		
Analytical Chemistry										
Chromium, dissolved	ug/L	11.6	21	33	2.7	-	16.2	5.48	±	4.73
Hexavalent Chromium, dissolved	ug/L	0	0	33	0	-	0	2.5	±	---
Aluminum, dissolved	ug/L	0	0	35	0	-	0	612	±	---
Calcium, dissolved	mg/L	167	35	35	66.7	-	208	149	±	23.2
Iron, dissolved	ug/L	5,820	27	35	58.4	-	9,300	1,430	±	2,920
Magnesium, dissolved	mg/L	470	35	35	307	-	645	416	±	62
Manganese, dissolved	ug/l	18,700	35	35	201	-	25,600	4,730	±	5,250
Vanadium, dissolved	ug/L	11.3	32	35	2.6	-	11.1	16.1	±	62.5
Chromium, total	ug/L	10.8	33	33	4.4	-	331	25.9	±	56.5
Aluminum, total	ug/L	370	35	35	104	-	3,620	487	±	611
Calcium, total	mg/L	154	35	35	61.2	-	197	148	±	22.6
Iron, total	ug/L	12,600	35	35	384	-	19,800	4,400	±	4,940
Magnesium, total	mg/L	487	35	35	294	-	598	419	±	62
Manganese, total	ug/L	20,561	35	35	217	-	28,400	4,780	±	5,490
Vanadium, total	ug/L	15.1	35	35	2.3	-	31.2	8.76	±	4.93
Geochemistry										
Acidity As $CaCO_3$, dissolved	mg/L	NA	NA		NA	-	NA	NA	±	NA
Ammonia-Nitrogen, dissolved	mg/L	20.6	30	30	1.5	-	74.3	22.1	±	20
Ferrous Iron, dissolved	mg/L	4.2	32	33	0.019	-	7.4	0.876	±	1.63
Hardness, total dissolved	mg/L	2,350	9	9	1,820	-	2,890	2,350	±	341
Organic Carbon, dissolved	mg/L	25	32	32	8.4	-	42	19.6	±	7.68
Oxidation-Reduction Potential	mv	557	30	30	342	-	648	504	±	106
pH	SU	8	31	31	7.7	-	8.8	8.01	±	0.213
Sulfide	mg/L	0	5	32	0.061	-	0.76	0.0787	±	0.161

TABLE 5-1a

Summary of DMT Pore Water Results

Dundalk Marine Terminal, Baltimore, Maryland

Parameter	Units	Reference	DMT Quarter 3 (December 2007)							
		Maximum Concentration	Frequency of Detection (a) [detects/samples]		Range of Detected Concentrations (b) [min-max]			Average Concentration (c) [mean + SD]		
Analytical Chemistry										
Chromium, dissolved	ug/L	4.8	20	29	2.3	-	12.2	4.57	±	3.57
Hexavalent Chromium, dissolved	ug/L	0	0	29	0	-	0	2.5	±	---
Aluminum, dissolved	ug/L	0	0	31	0	-	0	40.1	±	---
Calcium, dissolved	mg/L	179	31	31	19.7	-	233	165	±	35.2
Iron, dissolved	ug/L	1,290	22	31	60.9	-	6,570	880	±	1,650
Magnesium, dissolved	mg/L	488	31	31	307	-	645	476	±	67.6
Manganese, dissolved	ug/l	14,000	31	31	20.8	-	20,600	4,520	±	5,470
Vanadium, dissolved	ug/L	5.7	16	31	1.6	-	8	2.71	±	2.39
Chromium, total	ug/L	14.7	28	29	6.5	-	2,630	162	±	493
Aluminum, total	ug/L	483	26	27	95.6	-	61,900	4,420	±	12,200
Calcium, total	mg/L	196	31	31	20.7	-	233	161	±	35.4
Iron, total	ug/L	12,300	30	31	517	-	169,000	11,600	±	30,500
Magnesium, total	mg/L	551	NA		NA	-	NA	NA	±	NA
Manganese, total	ug/L	23,000	31	31	18.4	-	23,600	4,820	±	5,410
Vanadium, total	ug/L	7.8	30	31	2.5	-	350	23.7	±	63.9
Geochemistry										
Acidity As $CaCO_3$, dissolved	mg/L	2,810	9	9	2,010	-	3,230	2,600	±	336
Ammonia-Nitrogen, dissolved	mg/L	NA	NA		NA	-	NA	NA	±	NA
Ferrous Iron, dissolved	mg/L	4.1	28	29	0.012	-	10.5	1.18	±	2.3
Hardness, total dissolved	mg/L	NA	NA		NA	-	NA	NA	±	NA
Organic Carbon, dissolved	mg/L	19.9	29	29	7.3	-	38.5	17.9	±	7.38
Oxidation-Reduction Potential	mv	642	29	29	382	-	642	566	±	55.8
pH	SU	8	29	29	7.5	-	9.5	7.89	±	0.352
Sulfide	mg/L	NA	NA		NA	-	NA	NA	±	NA

TABLE 5-1a

Summary of DMT Pore Water Results

Dundalk Marine Terminal, Baltimore, Maryland

Parameter	Units	Reference	DMT Quarter 4 (February 2008)							
		Maximum Concentration	Frequency of Detection (a) [detects/samples]		Range of Detected Concentrations (b) [min-max]			Average Concentration (c) [mean + SD]		
Analytical Chemistry										
Chromium, dissolved	ug/L	9.6	12	34	2.4	-	10.2	2.47	±	2.17
Hexavalent Chromium, dissolved	ug/L	0	0	34	0	-	0	2.5	±	---
Aluminum, dissolved	ug/L	0	0	34	0	-	0	40.1	±	---
Calcium, dissolved	mg/L	186	34	34	29.6	-	224	133	±	37.5
Iron, dissolved	ug/L	1,870	19	34	54.4	-	8,910	932	±	1,830
Magnesium, dissolved	mg/L	547	34	34	195	-	599	368	±	109
Manganese, dissolved	ug/l	15,700	34	34	42.9	-	23,200	3,570	±	5,710
Vanadium, dissolved	ug/L	9.8	26	34	1.7	-	11.9	3.21	±	2.38
Chromium, total	ug/L	14.3	33	34	5	-	1,880	107	±	331
Aluminum, total	ug/L	1,380	33	34	233	-	13,300	1,880	±	2,390
Calcium, total	mg/L	184	34	34	30.3	-	227	135	±	36.9
Iron, total	ug/L	6,650	34	34	245	-	27,600	4,960	±	4,970
Magnesium, total	mg/L	538	34	34	195	-	677	373	±	113
Manganese, total	ug/L	16,400	34	34	126	-	24,200	3,320	±	5,120
Vanadium, total	ug/L	13.6	34	34	2.6	-	63.9	11.5	±	10.9
Geochemistry										
Acidity As $CaCO_3$, dissolved	mg/L	NA	NA		NA	-	NA	NA	±	NA
Ammonia-Nitrogen, dissolved	mg/L	NA	NA		NA	-	NA	NA	±	NA
Ferrous Iron, dissolved	mg/L	2	31	34	0.0095	-	10.3	1.1	±	2.05
Hardness, total dissolved	mg/L	2,700	10	10	1,320	-	2,890	2,170	±	593
Organic Carbon, dissolved	mg/L	13.2	33	33	4.3	-	26.3	12.4	±	5.95
Oxidation-Reduction Potential	mv	599	34	34	395	-	698	613	±	58.2
pH	SU	7.9	34	34	7.5	-	9.3	7.97	±	0.385
Sulfide	mg/L	NA	NA		NA	-	NA	NA	±	NA

(a) For detection frequency, where duplicate samples were present, they were counted as one sample.

(b) Where duplicate samples were present, the greatest value for each analyte was used to calculate range, average, and standard deviation.

(c) Average concentration and standard deviation calculated by using one-half of the detection limit for non-detects.

max = Maximum

mg/L = Milligram per Liter

min= Minimum

mv = Millivolts

NA = Not Analyzed

ND = Not Detected

SD = Standard Deviation

SU = Standard Units

ug/L = Microgram per Liter

TABLE 5-1b

Summary of Reference Area Pore Water Results

Dundalk Marine Terminal, Baltimore, Maryland

Parameter	Units	DMT May 2007 - February 2008							
		Frequency of Detection (a) [detects/samples]		Range of Detected Concentrations (b) [min-max]			Average Concentration (c) [mean + SD]		
Analytical Chemistry									
Chromium, dissolved	ug/L	10	12	4.1	-	11.6	6.5	±	3.62
Hexavalent Chromium, dissolved	ug/L	0	12	0	-	0	2.5	±	---
Aluminum, dissolved	ug/L	0	3	0	-	0	40.1	±	---
Calcium, dissolved	mg/L	12	12	143	-	186	165	±	13.2
Iron, dissolved	ug/L	12	12	89	-	8,040	2,070	±	2,860
Magnesium, dissolved	mg/L	12	12	413	-	547	471	±	36.9
Manganese, dissolved	ug/L	12	12	7,210	-	24,600	14,100	±	4,710
Vanadium, dissolved	ug/L	12	12	3.8	-	11.3	7.65	±	2.48
Chromium, total	ug/L	12	12	2.9	-	14.7	9.86	±	3.56
Aluminum, total	ug/L	11	12	123	-	1,380	470	±	451
Calcium, total	mg/L	12	12	146	-	196	166	±	17.2
Iron, total	ug/L	12	12	2,100	-	15,800	7,410	±	4,500
Magnesium, total	mg/L	12	12	418	-	551	490	±	38.3
Manganese, total	ug/L	12	12	7,640	-	26,000	16,300	±	5,380
Vanadium, total	ug/L	12	12	7.1	-	15.1	10.1	±	2.53
Geochemistry									
Acidity As $CaCO_3$, dissolved	mg/L	1	1	2,810	-	2,810	2,810	±	---
Ammonia-Nitrogen, dissolved	mg/L	6	6	7.9	-	20.6	16.5	±	4.96
Ferrous Iron, dissolved	mg/L	12	12	0.088	-	7.6	2.23	±	2.65
Hardness, total dissolved	mg/L	4	4	2,150	-	2,700	2,370	±	236
Organic Carbon, dissolved	mg/L	12	12	10.8	-	25	17.6	±	4.85
Oxidation-Reduction Potential	mv	9	9	548	-	642	586	±	35.4
pH	SU	12	12	7.7	-	8	7.88	±	0.0937
Sulfide	mg/L	0	6	0	-	0	13.5	±	---

TABLE 5-1b

Summary of Reference Area Pore Water Results

Dundalk Marine Terminal, Baltimore, Maryland

		Quarter 1 (May 2007)							
Parameter	Units	Frequency of Detection (a) [detects/samples]		Range of Detected Concentrations (b) [min-max]			Average Concentration (c) [mean + SD]		
Analytical Chemistry									
Chromium, dissolved	ug/L	3	3	4.1	-	8.4	5.83	±	2.27
Hexavalent Chromium, dissolved	ug/L	0	3	0	-	0	2.5	±	---
Aluminum, dissolved	ug/L	0	3	0	-	0	40.1	±	---
Calcium, dissolved	mg/L	3	3	143	-	152	148	±	4.51
Iron, dissolved	ug/L	3	3	523	-	8,040	4,890	±	3,900
Magnesium, dissolved	mg/L	3	3	413	-	451	437	±	20.6
Manganese, dissolved	ug/L	3	3	11,000	-	24,600	16,000	±	7,480
Vanadium, dissolved	ug/L	3	3	8.5	-	10.9	9.7	±	1.2
Chromium, total	ug/L	3	3	3	-	8.1	5.73	±	2.63
Aluminum, total	ug/L	2	3	123	-	149	104	±	56.9
Calcium, total	mg/L	3	3	146	-	155	151	±	4.73
Iron, total	ug/L	3	3	4,680	-	15,800	10,800	±	5,630
Magnesium, total	mg/L	3	3	418	-	462	445	±	23.6
Manganese, total	ug/L	3	3	15,000	-	26,000	19,300	±	5,860
Vanadium, total	ug/L	3	3	8.9	-	12.1	10.6	±	1.6
Geochemistry									
Acidity As $CaCO_3$, dissolved	mg/L	NA		NA	-	NA	NA	±	NA
Ammonia-Nitrogen, dissolved	mg/L	3	3	7.9	-	19.1	13.6	±	5.6
Ferrous Iron, dissolved	mg/L	3	3	0.46	-	7.6	4.75	±	3.78
Hardness, total dissolved	mg/L	NA		NA	-	NA	NA	±	NA
Organic Carbon, dissolved	mg/L	3	3	12.1	-	18.7	16	±	3.46
Oxidation-Reduction Potential	mv	NA		NA	-	NA	NA	±	NA
pH	SU	3	3	7.7	-	8	7.87	±	0.153
Sulfide	mg/L	0	3	NA	-	NA	27	±	---

TABLE 5-1b

Summary of Reference Area Pore Water Results

Dundalk Marine Terminal, Baltimore, Maryland

		Quarter 2 (August 2007)							
Parameter	**Units**	**Frequency of Detection (a) [detects/samples]**		**Range of Detected Concentrations (b) [min-max]**			**Average Concentration (c) [mean + SD]**		
Analytical Chemistry									
Chromium, dissolved	ug/L	3	3	9.7	-	11.6	10.9	±	1.04
Hexavalent Chromium, dissolved	ug/L	0	3	0	-	0	2.5	±	---
Aluminum, dissolved	ug/L	0	3	0	-	0	40.1	±	---
Calcium, dissolved	mg/L	3	3	160	-	167	163	±	3.61
Iron, dissolved	ug/L	3	3	91.9	-	5,820	2,020	±	3,290
Magnesium, dissolved	mg/L	3	3	433	-	470	448	±	19.3
Manganese, dissolved	ug/L	3	3	11,900	-	18,700	16,000	±	3,630
Vanadium, dissolved	ug/L	3	3	6.9	-	11.3	8.97	±	2.21
Chromium, total	ug/L	3	3	7.9	-	10.8	8.9	±	1.65
Aluminum, total	ug/L	3	3	195	-	370	260	±	95.8
Calcium, total	mg/L	3	3	151	-	154	152	±	1.53
Iron, total	ug/L	3	3	2,100	-	12,600	5,850	±	5,860
Magnesium, total	mg/L	3	3	465	-	487	477	±	11.1
Manganese, total	ug/L	3	3	12,465	-	20,561	17,100	±	4,170
Vanadium, total	ug/L	3	3	10.6	-	15.1	12.1	±	2.57
Geochemistry									
Acidity As $CaCO_3$, dissolved	mg/L	NA		NA	-	NA	NA	±	NA
Ammonia-Nitrogen, dissolved	mg/L	3	3	17.3	-	20.6	19.5	±	1.91
Ferrous Iron, dissolved	mg/L	3	3	0.088	-	4.2	1.47	±	2.36
Hardness, total dissolved	mg/L	3	3	2,150	-	2,350	2,260	±	101
Organic Carbon, dissolved	mg/L	3	3	23.4	-	25	24.1	±	0.833
Oxidation-Reduction Potential	mv	3	3	548	-	557	553	±	4.51
pH	SU	3	3	7.8	-	8	7.9	±	0.1
Sulfide	mg/L	0	3	0	-	0	0.027	±	---

TABLE 5-1b

Summary of Reference Area Pore Water Results

Dundalk Marine Terminal, Baltimore, Maryland

Parameter	Units	Quarter 3 (December 2007)							
		Frequency of Detection (a) [detects/samples]		Range of Detected Concentrations (b) [min-max]			Average Concentration (c) [mean + SD]		
Analytical Chemistry									
Chromium, dissolved	ug/L	1	3	4.8	-	4.8	2.37	±	2.11
Hexavalent Chromium, dissolved	ug/L	0	3	0	-	0	2.5	±	---
Aluminum, dissolved	ug/L	0	3	0	-	0	40.1	±	---
Calcium, dissolved	mg/L	3	3	161	-	179	172	±	9.64
Iron, dissolved	ug/L	3	3	89	-	1,290	656	±	603
Magnesium, dissolved	mg/L	3	3	481	-	488	484	±	3.61
Manganese, dissolved	ug/L	3	3	7,210	-	14,000	11,600	±	3,840
Vanadium, dissolved	ug/L	3	3	3.8	-	5.7	5	±	1.04
Chromium, total	ug/L	3	3	8.9	-	14.7	12.4	±	3.1
Aluminum, total	ug/L	3	3	229	-	483	350	±	127
Calcium, total	mg/L	3	3	167	-	196	185	±	15.7
Iron, total	ug/L	3	3	4,550	-	12,300	7,200	±	4,420
Magnesium, total	mg/L	3	3	506	-	551	529	±	22.5
Manganese, total	ug/L	3	3	7,640	-	23,000	15,400	±	7,680
Vanadium, total	ug/L	3	3	7.1	-	7.8	7.4	±	0.361
Geochemistry									
Acidity As $CaCO_3$, dissolved	mg/L	1	1	2,810	-	2,810	2,810	±	---
Ammonia-Nitrogen, dissolved	mg/L	NA		NA	-	NA	NA	±	NA
Ferrous Iron, dissolved	mg/L	3	3	0.16	-	4.1	1.89	±	2.01
Hardness, total dissolved	mg/L	NA		NA	-	NA	NA	±	NA
Organic Carbon, dissolved	mg/L	3	3	15.7	-	19.9	18.2	±	2.23
Oxidation-Reduction Potential	mv	3	3	615	-	642	628	±	13.5
pH	SU	3	3	7.8	-	8	7.9	±	0.1
Sulfide	mg/L	NA		NA	-	NA	NA	±	NA

TABLE 5-1b

Summary of Reference Area Pore Water Results

Dundalk Marine Terminal, Baltimore, Maryland

Parameter	Units	Quarter 4 (February 2008)							
		Frequency of Detection (a) [detects/samples]		Range of Detected Concentrations (b) [min-max]			Average Concentration (c) [mean + SD]		
Analytical Chemistry									
Chromium, dissolved	ug/L	3	3	5	-	9.6	6.9	±	2.4
Hexavalent Chromium, dissolved	ug/L	0	3	0	-	0	2.5	±	---
Aluminum, dissolved	ug/L	0	3	0	-	0	40.1	±	---
Calcium, dissolved	mg/L	3	3	166	-	186	177	±	10.1
Iron, dissolved	ug/L	3	3	122	-	1,870	726	±	991
Magnesium, dissolved	mg/L	3	3	484	-	547	515	±	31.5
Manganese, dissolved	ug/L	3	3	8,300	-	15,700	12,900	±	3,990
Vanadium, dissolved	ug/L	3	3	5.4	-	9.8	6.93	±	2.48
Chromium, total	ug/L	3	3	10.2	-	14.3	12.4	±	2.06
Aluminum, total	ug/L	3	3	852	-	1,380	1,160	±	277
Calcium, total	mg/L	3	3	167	-	184	175	±	8.5
Iron, total	ug/L	3	3	4,360	-	6,650	5,830	±	1,280
Magnesium, total	mg/L	3	3	483	-	538	508	±	27.8
Manganese, total	ug/L	3	3	8,320	-	16,400	13,300	±	4,340
Vanadium, total	ug/L	3	3	8	-	13.6	10.4	±	2.87
Geochemistry									
Acidity As $CaCO_3$, dissolved	mg/L	NA		NA	-	NA	NA	±	NA
Ammonia-Nitrogen, dissolved	mg/L	NA		NA	-	NA	NA	±	NA
Ferrous Iron, dissolved	mg/L	3	3	0.21	-	2	0.817	±	1.02
Hardness, total dissolved	mg/L	1	1	2,700	-	2,700	2,700	±	---
Organic Carbon, dissolved	mg/L	3	3	10.8	-	13.2	12.3	±	1.29
Oxidation-Reduction Potential	mv	3	3	558	-	599	578	±	20.5
pH	SU	3	3	7.8	-	7.9	7.87	±	0.0577
Sulfide	mg/L	NA		NA	-	NA	NA	±	NA

(a) For detection frequency, where duplicate samples were present, they were counted as one sample.

(b) Where duplicate samples were present, the greatest value for each analyte was used to calculate range, average, and standard deviation.

(c) Average concentration and standard deviation calculated by using one-half of the detection limit for non-detects.

max = Maximum
mg/L = Milligram per Liter
min= Minimum
mv = Millivolts
NA = Not Analyzed
ND = Not Detected
SD = Standard Deviation
SU = Standard Units
ug/L = Microgram per Liter

TABLE 5-2a

Summary of DMT Surface Water Results

Dundalk Marine Terminal, Baltimore, Maryland

		Reference	**DMT May 2007 - February 2008**							
Parameter	**Units**	**Maximum Concentration**	**Frequency of Detection (a) [detects/samples]**		**Range of Detected Concentrations (b) [min-max]**			**Average Concentration (c) [mean + SD]**		
Analytical Chemistry										
Chromium, dissolved	ug/L	3.4	60	321	2.3	-	37.6	2.18	±	3.91
Hexavalent Chromium, dissolved	ug/L	0	11	321	6	-	34.9	3.06	±	3.66
Aluminum, dissolved	ug/L	0	8	333	87.7	-	145	41.7	±	10.6
Calcium, dissolved	mg/L	199	333	333	47.3	-	333	133	±	43.5
Iron, dissolved	ug/L	0	15	333	52.9	-	235	31.6	±	22.6
Magnesium, dissolved	mg/L	580	333	333	105	-	618	377	±	133
Manganese, dissolved	ug/L	512	326	333	0.62	-	1,160	69	±	138
Vanadium, dissolved	ug/L	3.9	117	333	1.5	-	4.4	1.28	±	0.796
Chromium, total	ug/L	4.5	103	321	2.3	-	44.4	2.98	±	5.11
Aluminum, total	ug/L	387	181	333	80.6	-	805	114	±	105
Calcium, total	mg/L	214	333	333	48.7	-	265	133	±	42.9
Iron, total	ug/L	466	311	333	54.8	-	1,460	197	±	154
Magnesium, total	mg/L	586	333	333	109	-	396,000	1,570	±	21,700
Manganese, total	ug/L	200	233	269	11.1	-	498	101	±	101
Vanadium, total	ug/L	3.8	134	333	1.5	-	5.5	1.52	±	1.12
Geochemistry										
Acidity As $CaCO_3$, dissolved	mg/L	2,990	9	9	1,540	-	2,890	2,480	±	541
Ferrous Iron, dissolved	mg/L	0.025	93	135	0.0082	-	0.52	0.0215	±	0.0467
Hardness, total dissolved	mg/L	2,990	31	31	3.6	-	3,020	2,350	±	726
Organic Carbon, dissolved	mg/L	2.1	255	321	1	-	5.1	1.46	±	0.727
Organic Carbon, total	mg/L	2.8	319	319	1.3	-	8.9	2.31	±	0.781

TABLE 5-2a

Summary of DMT Surface Water Results

Dundalk Marine Terminal, Baltimore, Maryland

Parameter	Units	Reference	DMT Quarter 1 (May 2007)							
		Maximum Concentration	**Frequency of Detection (a) [detects/samples]**		**Range of Detected Concentrations (b) [min-max]**			**Average Concentration (c) [mean + SD]**		
Analytical Chemistry										
Chromium, dissolved	ug/L	0	3	86	2.5	-	3.3	1.21	±	0.348
Hexavalent Chromium, dissolved	ug/L	0	0	86	0	-	0	2.5	±	---
Aluminum, dissolved	ug/L	0	0	91	0	-	0	40.1	±	---
Calcium, dissolved	mg/L	159	91	91	47.3	-	182	92.6	±	35.8
Iron, dissolved	ug/L	0	2	91	55.7	-	68.5	37.2	±	31.5
Magnesium, dissolved	mg/L	465	91	91	105	-	547	249	±	119
Manganese, dissolved	ug/L	347	91	91	0.62	-	546	83.3	±	115
Vanadium, dissolved	ug/L	0	18	91	1.5	-	3	0.998	±	0.527
Chromium, total	ug/L	0	17	86	2.6	-	21.3	1.89	±	2.44
Aluminum, total	ug/L	113	46	91	81.8	-	460	97.4	±	79.1
Calcium, total	mg/L	151	91	91	48.7	-	218	92.6	±	38
Iron, total	ug/L	217	87	91	58.9	-	989	191	±	134
Magnesium, total	mg/L	452	91	91	109	-	545	247	±	117
Manganese, total	ug/L	200	91	91	19.8	-	498	113	±	108
Vanadium, total	ug/L	2.8	5	91	1.6	-	4	0.832	±	0.404
Geochemistry										
Acidity As $CaCO_3$, dissolved	mg/L	NA	NA		NA	-	NA	NA	±	NA
Ferrous Iron, dissolved	mg/L	0.013	28	36	0.01	-	0.52	0.0396	±	0.0849
Hardness, total dissolved	mg/L	NA	NA		NA	-	NA	NA	±	NA
Organic Carbon, dissolved	mg/L	2.1	65	86	1	-	3.3	1.74	±	0.863
Organic Carbon, total	mg/L	2.8	86	86	1.3	-	3.5	2.03	±	0.497

TABLE 5-2a

Summary of DMT Surface Water Results

Dundalk Marine Terminal, Baltimore, Maryland

		Reference	**DMT Quarter 2 (August 2007)**							
Parameter	**Units**	**Maximum Concentration**	**Frequency of Detection (a) [detects/samples]**		**Range of Detected Concentrations (b) [min-max]**			**Average Concentration (c) [mean + SD]**		
Analytical Chemistry										
Chromium, dissolved	ug/L	0	23	97	2.4	-	30.8	3.04	±	5.49
Hexavalent Chromium, dissolved	ug/L	0	5	97	6	-	34.9	3.73	±	5.82
Aluminum, dissolved	ug/L	0	0	100	0	-	0	40.1	±	---
Calcium, dissolved	mg/L	199	100	100	126	-	211	159	±	16.5
Iron, dissolved	ug/L	0	0	100	0	-	0	26.1	±	---
Magnesium, dissolved	mg/L	580	100	100	399	-	618	475	±	45.4
Manganese, dissolved	ug/L	512	93	100	1	-	1,160	96.1	±	214
Vanadium, dissolved	ug/L	3.9	84	100	1.5	-	4.4	2.1	±	0.813
Chromium, total	ug/L	0	38	97	2.4	-	37.5	4.14	±	6.89
Aluminum, total	ug/L	107	39	100	80.6	-	439	90.6	±	87.8
Calcium, total	mg/L	205	100	100	127	-	265	163	±	20.3
Iron, total	ug/L	164	97	100	54.8	-	856	207	±	159
Magnesium, total	mg/L	586	100	100	407	-	628	492	±	48.5
Manganese, total	ug/L	0	0	36	0	-	0	263	±	---
Vanadium, total	ug/L	3.8	92	100	1.5	-	5.5	2.66	±	1.09
Geochemistry										
Acidity As $CaCO_3$, dissolved	mg/L	NA	NA		NA	-	NA	NA	±	NA
Ferrous Iron, dissolved	mg/L	0.018	23	36	0.0089	-	0.084	0.0164	±	0.0161
Hardness, total dissolved	mg/L	2,990	10	10	3.6	-	2,950	2,410	±	870
Organic Carbon, dissolved	mg/L	1.7	93	95	1	-	5.1	1.7	±	0.709
Organic Carbon, total	mg/L	2.5	95	95	1.7	-	8.9	2.94	±	1.03

TABLE 5-2a

Summary of DMT Surface Water Results

Dundalk Marine Terminal, Baltimore, Maryland

		Reference	DMT Quarter 3 (December 2007)							
Parameter	**Units**	**Maximum Concentration**	**Frequency of Detection (a) [detects/samples]**		**Range of Detected Concentrations (b) [min-max]**			**Average Concentration (c) [mean + SD]**		
Analytical Chemistry										
Chromium, dissolved	ug/L	3.4	22	66	2.3	-	37.6	2.65	±	4.75
Hexavalent Chromium, dissolved	ug/L	0	3	66	7	-	30.4	3.12	±	3.61
Aluminum, dissolved	ug/L	0	0	70	0	-	0	40.1	±	---
Calcium, dissolved	mg/L	184	70	70	105	-	333	168	±	38
Iron, dissolved	ug/L	0	2	70	52.9	-	54.4	26.9	±	4.62
Magnesium, dissolved	mg/L	571	70	70	277	-	608	459	±	86.6
Manganese, dissolved	ug/L	40	70	70	3.1	-	46.7	16.5	±	10.4
Vanadium, dissolved	ug/L	2.8	3	70	1.7	-	2.1	0.799	±	0.237
Chromium, total	ug/L	4.5	29	66	2.3	-	44.4	3.07	±	5.5
Aluminum, total	ug/L	307	28	70	81.1	-	678	87.2	±	92.9
Calcium, total	mg/L	214	70	70	104	-	203	162	±	28.5
Iron, total	ug/L	305	63	70	60.1	-	1,460	165	±	180
Magnesium, total	mg/L	555	70	70	263	-	586	458	±	91.2
Manganese, total	ug/L	59	70	70	11.1	-	146	30.1	±	19
Vanadium, total	ug/L	1.6	9	70	1.7	-	5.2	0.938	±	0.625
Geochemistry										
Acidity As $CaCO_3$, dissolved	mg/L	2,990	9	9	1,540	-	2,890	2,480	±	541
Ferrous Iron, dissolved	mg/L	0.012	19	29	0.0082	-	0.11	0.015	±	0.0198
Hardness, total dissolved	mg/L	2,990	11	11	1,540	-	2,890	2,530	±	494
Organic Carbon, dissolved	mg/L	1.5	44	66	1	-	2	1.08	±	0.464
Organic Carbon, total	mg/L	2.8	66	66	1.8	-	3	2.34	±	0.302

TABLE 5-2a

Summary of DMT Surface Water Results

Dundalk Marine Terminal, Baltimore, Maryland

Parameter	Units	Reference	DMT Quarter 4 (February 2008)							
		Maximum Concentration	Frequency of Detection (a) [detects/samples]		Range of Detected Concentrations (b) [min-max]			Average Concentration (c) [mean + SD]		
Analytical Chemistry										
Chromium, dissolved	ug/L	3.3	12	72	2.3	-	17.3	1.76	±	2.23
Hexavalent Chromium, dissolved	ug/L	0	3	72	6.7	-	10.5	2.75	±	1.24
Aluminum, dissolved	ug/L	0	8	72	87.7	-	145	47.5	±	21.9
Calcium, dissolved	mg/L	172	72	72	61.3	-	181	116	±	30.2
Iron, dissolved	ug/L	0	11	72	54.6	-	235	36.6	±	31.3
Magnesium, dissolved	mg/L	515	72	72	138	-	530	320	±	104
Manganese, dissolved	ug/L	86.7	72	72	17	-	356	64.3	±	63.1
Vanadium, dissolved	ug/L	0	12	72	1.6	-	3.1	0.971	±	0.526
Chromium, total	ug/L	3.5	19	72	2.6	-	22.8	2.64	±	3.93
Aluminum, total	ug/L	387	68	72	83.5	-	805	194	±	126
Calcium, total	mg/L	175	72	72	61	-	178	116	±	30.8
Iron, total	ug/L	466	64	72	55.7	-	834	221	±	139
Magnesium, total	mg/L	510	72	72	141	-	396,000	5,810	±	46,600
Manganese, total	ug/L	118	72	72	30.9	-	361	75.7	±	66.8
Vanadium, total	ug/L	2.3	28	72	1.5	-	4.5	1.36	±	0.919
Geochemistry										
Acidity As $CaCO_3$, dissolved	mg/L	NA	NA		NA	-	NA	NA	±	NA
Ferrous Iron, dissolved	mg/L	0.025	23	34	0.0085	-	0.053	0.0131	±	0.0102
Hardness, total dissolved	mg/L	2,830	10	10	802	-	3,020	2,090	±	781
Organic Carbon, dissolved	mg/L	1.9	53	72	1	-	2.4	1.16	±	0.458
Organic Carbon, total	mg/L	2	72	72	1.4	-	2.3	1.78	±	0.203

(a) For detection frequency, where duplicate samples were present, they were counted as one sample.

(b) Where duplicate samples were present, the greatest value for each analyte was used to calculate range, average, and standard deviation.

(c) Average concentration and standard deviation calculated by using one-half of the detection limit for non-detects.

max = Maximum
mg/L = Milligram per Liter
min= Minimum
NA = Not Analyzed
ND = Not Detected
SD = Standard Deviation
ug/L = Microgram per Liter

TABLE 5-2b

Summary of Reference Area Surface Water Results

Dundalk Marine Terminal, Baltimore, Maryland

Parameter	Units	May 2007 - February 2008							
		Frequency of Detection (a) [detects/samples]		Range of Detected Concentrations (b) [min-max]			Average Concentration (c) [mean + SD]		
Analytical Chemistry									
Chromium, dissolved	ug/L	5	36	2.6	-	3.4	1.41	±	0.667
Hexavalent Chromium, dissolved	ug/L	0	36	0	-	0	2.5	±	---
Aluminum, dissolved	ug/L	0	37	0	-	0	40.1	±	---
Calcium, dissolved	mg/L	37	37	78.3	-	199	140	±	34.6
Iron, dissolved	ug/L	0	37	0	-	0	26.1	±	---
Magnesium, dissolved	mg/L	37	37	193	-	580	407	±	114
Manganese, dissolved	ug/L	35	37	1.2	-	512	85.9	±	126
Vanadium, dissolved	ug/L	9	37	1.8	-	3.9	1.26	±	0.961
Chromium, total	ug/L	10	36	2.6	-	4.5	1.73	±	0.98
Aluminum, total	ug/L	21	37	82.4	-	387	109	±	89.2
Calcium, total	mg/L	37	37	73.9	-	214	144	±	37.2
Iron, total	ug/L	31	37	53.2	-	466	158	±	118
Magnesium, total	mg/L	37	37	192	-	586	409	±	114
Manganese, total	ug/L	20	25	11.3	-	200	121	±	138
Vanadium, total	ug/L	17	37	1.6	-	3.8	1.56	±	1.01
Geochemistry									
Acidity As $CaCO_3$, dissolved	mg/L	1	1	2990	-	2990	2990	±	NA
Ferrous Iron, dissolved	mg/L	6	12	0.0095	-	0.025	0.00938	±	0.00684
Hardness, total dissolved	mg/L	5	5	2830	-	2990	2880	±	83.1
Organic Carbon, dissolved	mv	22	36	1	-	2.1	1.09	±	0.555
Organic Carbon, total	mg/L	36	36	1.4	-	2.8	2.07	±	0.402

TABLE 5-2b

Summary of Reference Area Surface Water Results

Dundalk Marine Terminal, Baltimore, Maryland

Parameter	Units	Quarter 1 (May 2007)							
		Frequency of Detection (a) [detects/samples]		Range of Detected Concentrations (b) [min-max]			Average Concentration (c) [mean + SD]		
Analytical Chemistry									
Chromium, dissolved	ug/L	0	9	0	-	0	1.15	±	---
Hexavalent Chromium, dissolved	ug/L	0	9	0	-	0	2.5	±	---
Aluminum, dissolved	ug/L	0	9	0	-	0	40.1	±	---
Calcium, dissolved	mg/L	9	9	78.3	-	159	108	±	33.6
Iron, dissolved	ug/L	0	9	0	-	0	26.1	±	---
Magnesium, dissolved	mg/L	9	9	193	-	465	294	±	112
Manganese, dissolved	ug/L	9	9	10.1	-	347	140	±	136
Vanadium, dissolved	ug/L	0	9	0	-	0	0.75	1	---
Chromium, total	ug/L	0	9	0	-	0	1.15	±	---
Aluminum, total	ug/L	4	9	82.4	-	113	64.4	±	29.9
Calcium, total	mg/L	9	9	73.9	-	151	104	±	31.1
Iron, total	ug/L	9	9	74.4	-	217	135	±	56.4
Magnesium, total	mg/L	9	9	192	-	452	293	±	105
Manganese, total	ug/L	1	3	200	-	200	400	±	173
Vanadium, total	ug/L	5	9	2	-	2.8	1.67	±	0.902
Geochemistry									
Acidity As $CaCO_3$, dissolved	mg/L	NA		NA	-	NA	NA	±	NA
Ferrous Iron, dissolved	mg/L	2	3	0.011	-	0.013	0.00933	±	0.00473
Hardness, total dissolved	mg/L	NA		NA	-	NA	NA	±	NA
Organic Carbon, dissolved	mv	6	9	1.1	-	2.1	1.34	±	0.726
Organic Carbon, total	mg/L	9	9	1.7	-	2.8	2.19	±	0.33

TABLE 5-2b

Summary of Reference Area Surface Water Results

Dundalk Marine Terminal, Baltimore, Maryland

Parameter	Units	Quarter 2 (August 2007)							
		Frequency of Detection (a) [detects/samples]		Range of Detected Concentrations (b) [min-max]			Average Concentration (c) [mean + SD]		
Analytical Chemistry									
Chromium, dissolved	ug/L	0	9	0	-	0	1.15	±	---
Hexavalent Chromium, dissolved	ug/L	0	9	0	-	0	2.5	±	---
Aluminum, dissolved	ug/L	0	9	0	-	0	40.1	±	---
Calcium, dissolved	mg/L	9	9	97.8	-	199	160	±	29.3
Iron, dissolved	ug/L	0	9	0	-	0	26.1	±	---
Magnesium, dissolved	mg/L	9	9	302	-	580	468	±	79.4
Manganese, dissolved	ug/L	7	9	1.2	-	512	135	±	202
Vanadium, dissolved	ug/L	6	9	2.5	-	3.9	2.33	±	1.24
Chromium, total	ug/L	0	9	0	-	0	1.15	±	---
Aluminum, total	ug/L	2	9	98.1	-	107	54	±	27.6
Calcium, total	mg/L	9	9	124	-	205	163	±	24.3
Iron, total	ug/L	5	9	53.2	-	164	65.3	±	53.2
Magnesium, total	mg/L	9	9	376	-	586	481	±	74.4
Manganese, total	ug/L	0	3	0	-	0	263	±	---
Vanadium, total	ug/L	9	9	1.8	-	3.8	2.8	±	0.803
Geochemistry									
Acidity As $CaCO_3$, dissolved	mg/L	NA		NA	-	NA	NA	±	NA
Ferrous Iron, dissolved	mg/L	1	3	0.018	-	0.018	0.00867	±	0.00808
Hardness, total dissolved	mg/L	3	3	2,830	-	2,990	2,890	±	85
Organic Carbon, dissolved	mv	7	9	1.1	-	1.7	1.21	±	0.451
Organic Carbon, total	mg/L	9	9	1.6	-	2.5	2.06	±	0.324

TABLE 5-2b

Summary of Reference Area Surface Water Results

Dundalk Marine Terminal, Baltimore, Maryland

		Quarter 3 (December 2007)							
Parameter	**Units**	**Frequency of Detection (a) [detects/samples]**		**Range of Detected Concentrations (b) [min-max]**			**Average Concentration (c) [mean + SD]**		
Analytical Chemistry									
Chromium, dissolved	ug/L	3	9	2.6	-	3.4	1.73	±	0.902
Hexavalent Chromium, dissolved	ug/L	0	9	0	-	0	2.5	±	---
Aluminum, dissolved	ug/L	0	10	0	-	0	40.1	±	---
Calcium, dissolved	mg/L	10	10	100	-	184	147	±	33.3
Iron, dissolved	ug/L	0	10	0	-	0	26.1	±	---
Magnesium, dissolved	mg/L	10	10	286	-	571	433	±	112
Manganese, dissolved	ug/L	10	10	4.2	-	40	20.3	±	12.1
Vanadium, dissolved	ug/L	3	10	1.8	-	2.8	1.24	±	0.818
Chromium, total	ug/L	6	9	2.6	-	4.5	2.54	±	1.17
Aluminum, total	ug/L	7	10	95.5	-	307	129	±	85.3
Calcium, total	mg/L	10	10	111	-	214	160	±	38.5
Iron, total	ug/L	9	10	80.4	-	305	154	±	84.5
Magnesium, total	mg/L	10	10	289	-	555	434	±	112
Manganese, total	ug/L	10	10	11.3	-	59	32.8	±	17.3
Vanadium, total	ug/L	1	10	1.6	-	1.6	0.835	±	---
Geochemistry									
Acidity As $CaCO_3$, dissolved	mg/L	1	1	2,990	-	2,990	2,990	±	---
Ferrous Iron, dissolved	mg/L	2	3	0.0095	-	0.012	0.0085	±	0.00409
Hardness, total dissolved	mg/L	1	1	2,990	-	2,990	2,990	±	---
Organic Carbon, dissolved	mv	4	9	1	-	1.5	0.844	±	0.43
Organic Carbon, total	mg/L	9	9	2.1	-	2.8	2.42	±	0.254

TABLE 5-2b

Summary of Reference Area Surface Water Results

Dundalk Marine Terminal, Baltimore, Maryland

Parameter	Units	Quarter 4 (February 2008)							
		Frequency of Detection (a) [detects/samples]		Range of Detected Concentrations (b) [min-max]			Average Concentration (c) [mean + SD]		
Analytical Chemistry									
Chromium, dissolved	ug/L	2	9	3.1	-	3.3	1.61	±	0.905
Hexavalent Chromium, dissolved	ug/L	0	9	0	-	0	2.5	±	---
Aluminum, dissolved	ug/L	0	9	0	-	0	40.1	±	---
Calcium, dissolved	mg/L	9	9	113	-	172	144	±	22.2
Iron, dissolved	ug/L	0	9	0	-	0	26.1	±	---
Magnesium, dissolved	mg/L	9	9	317	-	515	431	±	76.1
Manganese, dissolved	ug/L	9	9	37.8	-	86.7	56.4	±	15.9
Vanadium, dissolved	ug/L	0	9	0	-	0	0.75	±	---
Chromium, total	ug/L	4	9	2.7	-	3.5	2.06	±	1.1
Aluminum, total	ug/L	8	9	85.4	-	387	188	±	114
Calcium, total	mg/L	9	9	123	-	175	149	±	21.8
Iron, total	ug/L	8	9	98.7	-	466	279	±	148
Magnesium, total	mg/L	9	9	312	-	510	425	±	78.3
Manganese, total	ug/L	9	9	59.4	-	118	78.1	±	20.2
Vanadium, total	ug/L	2	9	1.7	-	2.3	1.03	±	0.571
Geochemistry									
Acidity As $CaCO_3$, dissolved	mg/L	NA		NA	-	NA	NA	±	NA
Ferrous Iron, dissolved	mg/L	1	3	0.025	-	0.025	0.011	±	---
Hardness, total dissolved	mg/L	1	1	2,830	-	2,830	2,830	±	---
Organic Carbon, dissolved	mv	5	9	1	-	1.9	0.978	±	0.512
Organic Carbon, total	mg/L	9	9	1.4	-	2	1.62	±	0.217

(a) For detection frequency, where duplicate samples were present, they were counted as one sample.

and standard deviation.

(c) Average concentration and standard deviation calculated by using one-half of the detection limit for non-detects.

max = Maximum
mg/L = Milligram per Liter
min= Minimum
NA = Not Analyzed
ND = Not Detected
SD = Standard Deviation
ug/L = Microgram per Liter

TABLE 5-3a

Summary of DMT Surface Sediment Results

Dundalk Marine Terminal, Baltimore, Maryland

		Reference	**DMT May 2007 - February 2008**							
Parameter	**Units**	**Maximum Concentration**	**Frequency of Detection (a) [detects/samples]**		**Range of Detected Concentrations (b) [min-max]**			**Average Concentration (c) [mean + SD]**		
Analytical Chemistry										
Total Chromium	mg/kg	166	77	77	33.1	-	2,360	394	±	450
Geochemistry										
Aluminum	mg/kg	41,400	81	81	1,140	-	35,600	16,400	±	9,540
Calcium	mg/kg	7,570	81	81	198	-	139,000	10,200	±	18,700
Ferrous Iron	mg/kg	11,000	76	76	14.7	-	14,400	5,020	±	4,040
Iron	mg/kg	72,600	81	81	6,180	-	61,900	32,900	±	13,100
Magnesium	mg/kg	10,000	81	81	269	-	30,200	6,920	±	5,610
Manganese	mg/kg	5.26	81	81	70.9	-	3,550	797	±	664
Manganese, Divalent	mg/kg	3.773	25	73	0.582	-	34.002	3.05	±	5.31
Sulfide	mg/kg	2,490	65	72	33.8	-	3,470	963	±	867
TOC	mg/kg	29,000	72	77	390	-	48,000	17,900	±	10,700
Vanadium	mg/kg	127	81	81	9.4	-	237	68.6	±	34.9
AVS-SEM Chemistry										
Acid Volatile Sulfide	umoles/g	29.8	75	77	0.44	-	51.2	14.8	±	11.5
Cadmium	umoles/g	0.0031	73	77	0.000468	-	0.192	0.016	±	0.0381
Copper	umoles/g	262	75	75	0.00458	-	1.02	0.178	±	0.152
Iron	umoles/g	115	77	77	17.2	-	172	81.9	±	34.5
Lead	umoles/g	0.0913	77	77	0.0163	-	0.631	0.121	±	0.112
Nickel	umoles/g	0.185	77	77	0.0214	-	1	0.293	±	0.216
Mercury	umoles/g	NA	5	33	9.9E-06	-	0.000029	6.5E-06	±	7.1E-06
Zinc	umoles/g	0.992	77	77	0.161	-	5.56	1.4	±	1.05
Physical Parameters										
Moisture	%	74	41	41	20.9	-	77.6	50.2	±	17.4
Total Solids	%	24.6	36	36	22.6	-	79.9	46.7	±	17.6
0.001 mm	% passing	41	77	77	0.5	-	31	6.18	±	6.14
0.002 mm	% passing	43	77	77	0.5	-	41	10.6	±	9.14
0.005 mm	% passing	56	77	77	0.5	-	68	17.3	±	14.2
0.02 mm	% passing	78	77	77	0.5	-	83	28.9	±	20.1
0.05 mm	% passing	84	77	77	1.5	-	92.5	41.5	±	23.6
0.064 mm	% passing	90	77	77	1.5	-	94	47.9	±	25
0.075 mm	% passing	92.7	77	77	1.9	-	95	52.2	±	26.3
0.15 mm	% passing	93.5	77	77	3.4	-	96.7	62.8	±	24.9
0.3 mm	% passing	94.8	77	77	35.2	-	98	78.9	±	14.2
0.6 mm	% passing	97.5	77	77	72.9	-	99.4	93.1	±	5.75
1.18 mm	% passing	99.3	77	77	88.4	-	99.9	98.2	±	1.93
2.36 mm	% passing	99.7	77	77	97.1	-	100	99.6	±	0.395
3.35 mm	% passing	99.9	77	77	97.6	-	100	99.9	±	0.286
4.75 mm	% passing	100	77	77	99.6	-	100	99.9	±	0.0762
19 mm	% passing	100	77	77	100	-	100	100	±	---
37.5 mm	% passing	100	77	77	100	-	100	100	±	---
75 mm	% passing	100	77	77	100	-	100	100	±	---

TABLE 5-3a

Summary of DMT Surface Sediment Results

Dundalk Marine Terminal, Baltimore, Maryland

		Reference	**DMT Quarter 1 (May 2007) - Quarter 2 (August 2007)**							
Parameter	**Units**	**Maximum Concentration**	**Frequency of Detection (a) [detects/samples]**		**Range of Detected Concentrations (b) [min-max]**			**Average Concentration (c) [mean + SD]**		
Analytical Chemistry										
Total Chromium	mg/kg	166	72	72	33.1	-	1,310	320	±	293
Geochemistry										
Aluminum	mg/kg	41,400	76	76	1,140	-	35,600	17,000	±	9,490
Calcium	mg/kg	7,570	76	76	198	-	139,000	9,050	±	17,800
Ferrous Iron	mg/kg	11,000	71	71	14.7	-	14,400	5,220	±	4,090
Iron	mg/kg	72,600	76	76	6,180	-	61,900	33,500	±	13,100
Magnesium	mg/kg	10,000	76	76	269	-	25,900	6,420	±	4,690
Manganese	mg/kg	1770.00	76	76	70.9	-	3,550	788	±	662
Manganese, Divalent	mg/kg	6.704	25	73	0.582	-	34.002	3.05	±	5.31
Sulfide	mg/kg	2,960	65	72	33.8	-	3,470	963	±	867
TOC	mg/kg	29,000	67	72	390	-	48,000	18,300	±	10,800
Vanadium	mg/kg	127	76	76	9.4	-	237	69	±	35.6
AVS-SEM Chemistry										
Acid Volatile Sulfide	umoles/g	29.8	70	72	0.44	-	51.2	15.5	±	11.5
Cadmium	umoles/g	0.00312	68	72	0.000468	-	0.192	0.0167	±	0.0393
Copper	umoles/g	0.262	70	70	0.00458	-	1.02	0.178	±	0.156
Iron	umoles/g	115	72	72	17.2	-	172	80.1	±	33.2
Lead	umoles/g	0.0913	72	72	0.0163	-	0.631	0.123	±	0.115
Nickel	umoles/g	0.185	72	72	0.0214	-	1	0.295	±	0.221
Mercury	umoles/g	0	5	33	9.9E-06	-	0.000029	6.5E-06	±	7.1E-06
Zinc	umoles/g	0.992	72	72	0.161	-	5.56	1.39	±	1.06
Physical Parameters										
Moisture	%	74	36	36	20.9	-	77.6	52.6	±	17.2
Total Solids	%	27.6	36	36	22.6	-	79.9	46.7	±	17.6
0.001 mm	% passing	41	72	72	0.5	-	31	6.56	±	6.18
0.002 mm	% passing	43	72	72	0.5	-	41	11.3	±	9.08
0.005 mm	% passing	56	72	72	0.5	-	68	18.4	±	14
0.02 mm	% passing	78	72	72	0.5	-	83	30.6	±	19.7
0.05 mm	% passing	84	72	72	1.5	-	92.5	43.7	±	22.7
0.064 mm	% passing	90	72	72	1.5	-	94	50.3	±	23.9
0.075 mm	% passing	92.7	72	72	1.9	-	95	54.6	±	25.2
0.15 mm	% passing	93.5	72	72	3.4	-	96.7	64.1	±	24.9
0.3 mm	% passing	94.8	72	72	35.2	-	98	78.9	±	14.4
0.6 mm	% passing	97.5	72	72	72.9	-	99.4	92.9	±	5.88
1.18 mm	% passing	99.3	72	72	88.4	-	99.9	98.2	±	1.98
2.36 mm	% passing	99.7	72	72	97.1	-	100	99.6	±	0.395
3.35 mm	% passing	99.9	72	72	97.6	-	100	99.9	±	0.295
4.75 mm	% passing	100	72	72	99.6	-	100	99.9	±	0.0772
19 mm	% passing	100	72	72	100	-	100	100	±	---
37.5 mm	% passing	100	72	72	100	-	100	100	±	---
75 mm	% passing	100	72	72	100	-	100	100	±	---

TABLE 5-3a

Summary of DMT Surface Sediment Results

Dundalk Marine Terminal, Baltimore, Maryland

		Reference	**DMT Quarter 1 (May 2007)**							
Parameter	**Units**	**Maximum Concentration**	**Frequency of Detection (a) [detects/samples]**		**Range of Detected Concentrations (b) [min-max]**			**Average Concentration (c) [mean + SD]**		
Analytical Chemistry										
Total Chromium	mg/kg	127	36	36	47.1	-	1,160	300	±	271
Geochemistry										
Aluminum	mg/kg	37,500	38	38	1,140	-	35,600	16,100	±	9,320
Calcium	mg/kg	2,660	38	38	317	-	139,000	12,000	±	23,500
Ferrous Iron	mg/kg	10,800	35	35	14.7	-	13,600	4,640	±	4,360
Iron	mg/kg	49,800	38	38	6,240	-	54,800	32,000	±	12,800
Magnesium	mg/kg	8,370	38	38	269	-	21,500	6,100	±	4,370
Manganese	mg/kg	1620.00	38	38	134	-	2,600	780	±	647
Manganese, Divalent	mg/kg	3.773	17	36	0.0582	-	13.992	2.22	±	3.32
Sulfide	mg/kg	2,960	29	36	33.8	-	2,630	630	±	686
TOC	mg/kg	27,000	35	36	390	-	40,000	17,800	±	9,540
Vanadium	mg/kg	80.5	38	38	9.4	-	156	64.3	±	30.4
AVS-SEM Chemistry										
Acid Volatile Sulfide	umoles/g	29.8	34	36	0.44	-	51.2	15.2	±	12.7
Cadmium	umoles/g	0.00312	35	36	0.000468	-	0.192	0.0184	±	0.0444
Copper	umoles/g	0.262	36	36	0.0389	-	1.02	0.215	±	0.18
Iron	umoles/g	115	36	36	17.5	-	172	85.1	±	35.6
Lead	umoles/g	0.0913	36	36	0.0199	-	0.631	0.131	±	0.135
Nickel	umoles/g	0.185	36	36	0.0265	-	0.626	0.265	±	0.191
Mercury	umoles/g	0	5	33	9.9E-06	-	0.000029	6.5E-06	±	7.1E-06
Zinc	umoles/g	0.992	36	36	0.262	-	4.99	1.41	±	1.1
Physical Parameters										
Moisture	%	67.8	NA		NA	-	NA	NA	±	NA
Total Solids	%	27.6	NA		NA	-	NA	NA	±	NA
0.001 mm	% passing	41	36	36	0.5	-	31	6.99	±	7.17
0.002 mm	% passing	43	36	36	0.5	-	41	11.6	±	9.99
0.005 mm	% passing	56	36	36	0.5	-	68	19.1	±	15.5
0.02 mm	% passing	78	36	36	0.5	-	83	31.1	±	21.3
0.05 mm	% passing	84	36	36	1.5	-	92.5	43.3	±	24.1
0.064 mm	% passing	90	36	36	1.5	-	94	48.9	±	24.7
0.075 mm	% passing	92.7	36	36	1.9	-	95	53.1	±	25.8
0.15 mm	% passing	93.5	36	36	3.4	-	96.7	63.2	±	25.2
0.3 mm	% passing	94.8	36	36	41.4	-	98	78.4	±	14.1
0.6 mm	% passing	96.5	36	36	75.4	-	99.3	92.9	±	5.65
1.18 mm	% passing	98.8	36	36	88.4	-	99.9	98.1	±	2.04
2.36 mm	% passing	99.7	36	36	97.1	-	100	99.5	±	0.507
3.35 mm	% passing	99.9	36	36	97.6	-	100	99.8	±	0.403
4.75 mm	% passing	100	36	36	99.6	-	100	99.9	±	0.0833
19 mm	% passing	100	36	36	100	-	100	100	±	---
37.5 mm	% passing	100	36	36	100	-	100	100	±	---
75 mm	% passing	100	36	36	100	-	100	100	±	---

TABLE 5-3a

Summary of DMT Surface Sediment Results

Dundalk Marine Terminal, Baltimore, Maryland

		Reference	**DMT Quarter 2 (August 2007)**							
Parameter	**Units**	**Maximum Concentration**	**Frequency of Detection (a) [detects/samples]**		**Range of Detected Concentrations (b) [min-max]**			**Average Concentration (c) [mean + SD]**		
Analytical Chemistry										
Total Chromium	mg/kg	166	36	36	33.1	-	1,310	340	±	315
Geochemistry										
Aluminum	mg/kg	41,400	38	38	1,200	-	34,600	18,000	±	9,690
Calcium	mg/kg	7,570	38	38	198	-	45,100	6,140	±	8,520
Ferrous Iron	mg/kg	11,000	36	36	129	-	14,400	5,780	±	3,780
Iron	mg/kg	72,600	38	38	6,180	-	61,900	35,100	±	13,500
Magnesium	mg/kg	10,000	38	38	378	-	25,900	6,740	±	5,030
Manganese	mg/kg	1770.00	38	38	70.9	-	3,550	796	±	686
Manganese, Divalent	mg/kg	6.704	7	37	4.005		34.002	3.75	±	6.63
Sulfide	mg/kg	2,490	36	36	45.3	-	3,470	1,300	±	908
TOC	mg/kg	29,000	32	36	3,000	-	48,000	18,900	±	12,000
Vanadium	mg/kg	127	38	38	9.71	-	237	73.7	±	39.9
AVS-SEM Chemistry										
Acid Volatile Sulfide	umoles/g	22	36	36	0.57	-	41.5	15.8	±	10.3
Cadmium	umoles/g	0.0019	33	36	0.000825	-	0.169	0.0151	±	0.034
Copper	umoles/g	0.0914	34	34	0.00458	-	0.463	0.139	±	0.116
Iron	umoles/g	75.9	36	36	17.2	-	162	75.1	±	30.4
Lead	umoles/g	0.0681	36	36	0.0163	-	0.493	0.115	±	0.0906
Nickel	umoles/g	0.166	36	36	0.0214	-	1	0.326	±	0.246
Mercury	umoles/g	NA	NA		NA	-	NA	NA	±	NA
Zinc	umoles/g	0.681	36	36	0.161	-	5.56	1.37	±	1.03
Physical Parameters										
Moisture	%	74	36	36	20.9	-	77.6	52.6	±	17.2
Total Solids	%	24.6	36	36	22.6	-	79.9	46.7	±	17.6
0.001 mm	% passing	13	36	36	0.5	-	19	6.13	±	5.05
0.002 mm	% passing	26	36	36	0.5	-	36	10.9	±	8.18
0.005 mm	% passing	41	36	36	0.5	-	53	17.8	±	12.6
0.02 mm	% passing	49	36	36	1.5	-	73.5	30.1	±	18.2
0.05 mm	% passing	70	36	36	2	-	86	44.2	±	21.5
0.064 mm	% passing	84	36	36	2	-	91	51.7	±	23.3
0.075 mm	% passing	91.3	36	36	2.2	-	93.1	56.2	±	24.8
0.15 mm	% passing	92.4	36	36	3.6	-	95	65.1	±	24.9
0.3 mm	% passing	94.6	36	36	35.2	-	97.4	79.4	±	14.8
0.6 mm	% passing	97.5	36	36	72.9	-	99.4	93	±	6.19
1.18 mm	% passing	99.3	36	36	90.3	-	99.9	98.3	±	1.94
2.36 mm	% passing	99.6	36	36	99.2	-	100	99.7	±	0.208
3.35 mm	% passing	99.9	36	36	99.7	-	100	99.9	±	0.0717
4.75 mm	% passing	99.9	36	36	99.7	-	100	100	±	0.0652
19 mm	% passing	100	36	36	100	-	100	100	±	---
37.5 mm	% passing	100	36	36	100	-	100	100	±	---
75 mm	% passing	100	36	36	100	-	100	100	±	---

TABLE 5-3a

Summary of DMT Surface Sediment Results

Dundalk Marine Terminal, Baltimore, Maryland

Parameter	Units	Reference	DMT Quarter 4 (February 2008)							
		Maximum Concentration	**Frequency of Detection (a) [detects/samples]**		**Range of Detected Concentrations (b) [min-max]**			**Average Concentration (c) [mean + SD]**		
Analytical Chemistry										
Total Chromium	mg/kg	166	5	5	58.2	-	2,360	1,470	±	880
Geochemistry										
Aluminum	mg/kg	41,400	5	5	3,190	-	9,540	6,710	±	2,340
Calcium	mg/kg	7,570	5	5	5,510	-	63,500	28,300	±	23,800
Ferrous Iron	mg/kg	11,000	5	5	410	-	4,910	2,180	±	1,780
Iron	mg/kg	72,600	5	5	11,100	-	28,400	22,800	±	6,830
Magnesium	mg/kg	10,000	5	5	951	-	30,200	14,600	±	11,800
Manganese	mg/kg	5.26	5	5	156	-	2,070	936	±	756
Manganese, Divalent	mg/kg	3.773	NA		NA	-	NA	NA	±	NA
Sulfide	mg/kg	2,490	NA		NA	-	NA	NA	±	NA
TOC	mg/kg	29,000	5	5	838	-	21,500	11,000	±	7,480
Vanadium	mg/kg	127	5	5	23.5	-	88.5	62.7	±	23.9
AVS-SEM Chemistry										
Acid Volatile Sulfide	umoles/g	29.8	5	5	0.63	-	16.8	5.11	±	6.77
Cadmium	umoles/g	0.0031	5	5	0.000926	-	0.00907	0.00485	±	0.00359
Copper	umoles/g	262	5	5	0.1	-	0.296	0.178	±	0.0732
Iron	umoles/g	115	5	5	39.4	-	162	108	±	46.1
Lead	umoles/g	0.0913	5	5	0.0282	-	0.214	0.0884	±	0.0728
Nickel	umoles/g	0.185	5	5	0.0393	-	0.414	0.263	±	0.144
Mercury	umoles/g	NA	NA		NA	-	NA	NA	±	NA
Zinc	umoles/g	0.992	5	5	0.508	-	2.57	1.55	±	0.945
Physical Parameters										
Moisture	%	74	5	5	28.5	-	35.6	32.8	±	2.71
Total Solids	%	24.6	NA		NA	-	NA	NA	±	NA
0.001 mm	% passing	41	5	5	0.5	-	1	0.7	±	0.274
0.002 mm	% passing	43	5	5	0.5	-	2	0.9	±	0.652
0.005 mm	% passing	56	5	5	0.5	-	4	1.5	±	1.54
0.02 mm	% passing	78	5	5	1	-	10	4	±	3.94
0.05 mm	% passing	84	5	5	2	-	23	9.8	±	9.93
0.064 mm	% passing	90	5	5	3.5	-	33	14.1	±	13.9
0.075 mm	% passing	92.7	5	5	4.7	-	38.1	17.4	±	15.4
0.15 mm	% passing	93.5	5	5	19.8	-	62.7	43.6	±	17.5
0.3 mm	% passing	94.8	5	5	58.7	-	91.2	79.5	±	12.2
0.6 mm	% passing	97.5	5	5	90.7	-	98.7	95	±	3.11
1.18 mm	% passing	99.3	5	5	98	-	99.6	98.8	±	0.627
2.36 mm	% passing	99.7	5	5	100	-	100	100	±	---
3.35 mm	% passing	99.9	5	5	99.8	-	100	99.9	±	0.0837
4.75 mm	% passing	100	5	5	99.9	-	100	100	±	0.0447
19 mm	% passing	100	5	5	100	-	100	100	±	---
37.5 mm	% passing	100	5	5	100	-	100	100	±	---
75 mm	% passing	100	5	5	100	-	100	100	±	---

(a) For detection frequency, where duplicate samples were present, they were counted as one sample.

(b) Where duplicate samples were present, the greatest value for each analyte was used to calculate range, average, and standard deviation.

(c) Average concentration and standard deviation calculated by using one-half of the detection limit for non-detects.

AVS = Acid Volatile Sulfide
max = Maximum
mg/kg = Milligram/Kilogram
min = Minimum
mm = Millimeter
NA = Not Analyzed

SD = Standard Deviation
SEM = Simultaneously Extracted Metals
TOC = Total Organic Carbon
umoles/g = Micromoles per Gram
% = Percent

TABLE 5-3b

Summary of Reference Area Surface Sediment Results

Dundalk Marine Terminal, Baltimore, Maryland

		Quarter 1 (May 2007) - Quarter 2 (August 2007)							
Parameter	**Units**	**Frequency of Detection (a) [detects/samples]**		**Range of Detected Concentrations (b) [min-max]**			**Average Concentration (c) [mean + SD]**		
Analytical Chemistry									
Total Chromium	mg/kg	6	6	89.2	-	166	127	±	31.9
Geochemistry									
Aluminum	mg/kg	6	6	35,700	-	41,400	37,300	±	2,100
Calcium	mg/kg	6	6	1,900	-	7,570	3,230	±	2,140
Ferrous Iron	mg/kg	6	6	2,230	-	11,000	8,660	±	3,370
Iron	mg/kg	6	6	47,200	-	72,600	54,800	±	9,490
Magnesium	mg/kg	6	6	7,990	-	10,000	8,820	±	768
Manganese	mg/kg	6	6	1,210	-	1,770	1,570	±	200
Manganese, Divalent	mg/kg	4	6	0.658	-	6.704	2.42	±	2.38
Sulfide	mg/kg	6	6	775	-	2,960	1,860	±	814
TOC	mg/kg	6	6	22,000	-	29,000	25,500	±	2,660
Vanadium	mg/kg	6	6	77.2	-	127	94.1	±	19.5
AVS-SEM Chemistry									
Acid Volatile Sulfide	umoles/g	6	6	9.7	-	29.8	20.2	±	7.18
Cadmium	umoles/g	6	6	0.0015	-	0.00312	0.00229	±	0.0007
Copper	umoles/g	6	6	0.0374	-	0.262	0.121	±	0.0802
Iron	umoles/g	6	6	66.4	-	115	86.3	±	19.4
Lead	umoles/g	6	6	0.0565	-	0.0913	0.0706	±	0.0119
Nickel	umoles/g	6	6	0.0663	-	0.185	0.133	±	0.0485
Mercury	umoles/g	0	3	0	-	0	3.9E-06	±	---
Zinc	umoles/g	6	6	0.585	-	0.992	0.746	±	0.144
Physical Parameters									
Moisture	%	6	6	61.9	-	74	68.5	±	5.36
Total Solids	%	6	6	19.2	-	27.6	22.8	±	2.96
0.001 mm	% passing	6	6	8	-	41	19.2	±	12.3
0.002 mm	% passing	6	6	17	-	43	29	±	10.4
0.005 mm	% passing	6	6	28.5	-	56	42.5	±	10.8
0.02 mm	% passing	6	6	43	-	78	58	±	14.3
0.05 mm	% passing	6	6	65	-	84	75.3	±	8.26
0.064 mm	% passing	6	6	76	-	90	84.3	±	5.67
0.075 mm	% passing	6	6	82.6	-	92.7	88.7	±	3.93
0.15 mm	% passing	6	6	84.2	-	93.5	89.8	±	3.64
0.3 mm	% passing	6	6	87.2	-	94.8	91.8	±	3.1
0.6 mm	% passing	6	6	92.7	-	97.5	95	±	1.98
1.18 mm	% passing	6	6	97.2	-	99.3	98.5	±	0.72
2.36 mm	% passing	6	6	99.4	-	99.7	99.6	±	0.122
3.35 mm	% passing	6	6	99.7	-	99.9	99.9	±	0.0837
4.75 mm	% passing	6	6	99.8	-	100	99.9	±	0.0632
19 mm	% passing	6	6	100	-	100	100	±	---
37.5 mm	% passing	6	6	100	-	100	100	±	---
75 mm	% passing	6	6	100	-	100	100	±	---

TABLE 5-3b

Summary of Reference Area Surface Sediment Results

Dundalk Marine Terminal, Baltimore, Maryland

Parameter	Units	Quarter 1 (May 2007)							
		Frequency of Detection (a) [detects/samples]		Range of Detected Concentrations (b) [min-max]			Average Concentration (c) [mean + SD]		
Analytical Chemistry									
Total Chromium	mg/kg	3	3	89.2	-	127	104	±	20.2
Geochemistry									
Aluminum	mg/kg	3	3	35,700	-	37,500	36,500	±	929
Calcium	mg/kg	3	3	1,900	-	2,660	2,250	±	383
Ferrous Iron	mg/kg	3	3	7,950	-	10,800	9,310	±	1,430
Iron	mg/kg	3	3	47,200	-	49,800	48,300	±	1,360
Magnesium	mg/kg	3	3	7,990	-	8,370	8,210	±	199
Manganese	mg/kg	3	3	1,210	-	1,620	1,430	±	207
Manganese, Divalent	mg/kg	3	3	0.658	-	3.773	1.8	±	1.72
Sulfide	mg/kg	3	3	775	-	2,960	1,950	±	1,100
TOC	mg/kg	3	3	25,000	-	27,000	26,300	±	1,150
Vanadium	mg/kg	3	3	77.2	-	80.5	79.4	±	1.91
AVS-SEM Chemistry									
Acid Volatile Sulfide	umoles/g	3	3	9.7	-	29.8	21.5	±	10.5
Cadmium	umoles/g	3	3	0.00273	-	0.00312	0.0029	±	0.0002
Copper	umoles/g	3	3	0.109	-	0.262	0.177	±	0.078
Iron	umoles/g	3	3	87.8	-	115	102	±	13.6
Lead	umoles/g	3	3	0.069	-	0.0913	0.0784	±	0.0115
Nickel	umoles/g	3	3	0.0663	-	0.185	0.13	±	0.0599
Mercury	umoles/g	0	3	0	-	0	3.9E-06	±	---
Zinc	umoles/g	3	3	0.775	-	0.992	0.853	±	0.121
Physical Parameters									
Moisture	%	3	3	61.9	-	67.8	64.1	±	3.25
Total Solids	%	3	3	19.2	-	27.6	23.1	±	4.23
0.001 mm	% passing	3	3	21	-	41	28.3	±	11
0.002 mm	% passing	3	3	34	-	43	37.7	±	4.73
0.005 mm	% passing	3	3	48	-	56	51.3	±	4.16
0.02 mm	% passing	3	3	61	-	78	70	±	8.54
0.05 mm	% passing	3	3	81	-	84	82.7	±	1.53
0.064 mm	% passing	3	3	88	-	90	88.8	±	1.04
0.075 mm	% passing	3	3	89.8	-	92.7	91	±	1.5
0.15 mm	% passing	3	3	90.6	-	93.5	91.9	±	1.46
0.3 mm	% passing	3	3	91.8	-	94.8	93.4	±	1.5
0.6 mm	% passing	3	3	94	-	96.5	95.5	±	1.34
1.18 mm	% passing	3	3	97.2	-	98.8	98.3	±	0.924
2.36 mm	% passing	3	3	99.6	-	99.7	99.6	±	0.0577
3.35 mm	% passing	3	3	99.9	-	99.9	99.9	±	1.7E-14
4.75 mm	% passing	3	3	99.9	-	100	99.9	±	0.0577
19 mm	% passing	3	3	100	-	100	100	±	---
37.5 mm	% passing	3	3	100	-	100	100	±	---
75 mm	% passing	3	3	100	-	100	100	±	---

TABLE 5-3b

Summary of Reference Area Surface Sediment Results

Dundalk Marine Terminal, Baltimore, Maryland

		Quarter 2 (August 2007)							
Parameter	**Units**	**Frequency of Detection (a) [detects/samples]**		**Range of Detected Concentrations (b) [min-max]**			**Average Concentration (c) [mean + SD]**		
Analytical Chemistry									
Total Chromium	mg/kg	3	3	124	-	166	150	±	22.9
Geochemistry									
Aluminum	mg/kg	3	3	36,100	-	41,400	38,200	±	2,820
Calcium	mg/kg	3	3	2,520	-	7,570	4,210	±	2,910
Ferrous Iron	mg/kg	3	3	2,230	-	11,000	8,010	±	5,010
Iron	mg/kg	3	3	54,900	-	72,600	61,200	±	9,870
Magnesium	mg/kg	3	3	8,850	-	10,000	9,430	±	575
Manganese	mg/kg	3	3	1,650	-	1,770	1,700	±	62.4
Manganese, Divalent	mg/kg	1	3	6.704	-	6.704	3.17	±	---
Sulfide	mg/kg	3	3	1,260	-	2,490	1,760	±	645
TOC	mg/kg	3	3	22,000	-	29,000	24,700	±	3,790
Vanadium	mg/kg	3	3	92.2	-	127	109	±	17.5
AVS-SEM Chemistry									
Acid Volatile Sulfide	umoles/g	3	3	14.7	-	22	19	±	3.82
Cadmium	umoles/g	3	3	0.0015	-	0.0019	0.00168	±	0.0002
Copper	umoles/g	3	3	0.0374	-	0.0914	0.0655	±	0.0271
Iron	umoles/g	3	3	66.4	-	75.9	70.6	±	4.84
Lead	umoles/g	3	3	0.0565	-	0.0681	0.0627	±	0.00584
Nickel	umoles/g	3	3	0.081	-	0.166	0.136	±	0.0477
Mercury	umoles/g	NA		NA	-	NA	NA	±	NA
Zinc	umoles/g	3	3	0.585	-	0.681	0.638	±	0.0489
Physical Parameters									
Moisture	%	3	3	71.4	-	74	73	±	1.38
Total Solids	%	3	3	20.8	-	24.6	22.5	±	1.94
0.001 mm	% passing	3	3	8	-	13	10	±	2.65
0.002 mm	% passing	3	3	17	-	26	20.3	±	4.93
0.005 mm	% passing	3	3	28.5	-	41	33.7	±	6.53
0.02 mm	% passing	3	3	43	-	49	46	±	3
0.05 mm	% passing	3	3	65	-	70	68	±	2.65
0.064 mm	% passing	3	3	76	-	84	79.7	±	4.04
0.075 mm	% passing	3	3	82.6	-	91.3	86.4	±	4.47
0.15 mm	% passing	3	3	84.2	-	92.4	87.7	±	4.22
0.3 mm	% passing	3	3	87.2	-	94.6	90.3	±	3.84
0.6 mm	% passing	3	3	92.7	-	97.5	94.4	±	2.66
1.18 mm	% passing	3	3	98.2	-	99.3	98.7	±	0.569
2.36 mm	% passing	3	3	99.4	-	99.6	99.5	±	0.115
3.35 mm	% passing	3	3	99.7	-	99.9	99.8	±	0.1
4.75 mm	% passing	3	3	99.8	-	99.9	99.9	±	0.0577
19 mm	% passing	3	3	100	-	100	100	±	---
37.5 mm	% passing	3	3	100	-	100	100	±	---
75 mm	% passing	3	3	100	-	100	100	±	---

(a) For detection frequency, where duplicate samples were present, they were counted as one sample.

standard deviation.

(c) Average concentration and standard deviation calculated by using one-half of the detection limit for non-detects.

AVS = Acid Volatile Sulfide	SD = Standard Deviation
max = Maximum	SEM = Simultaneously Extracted Metals
mg/kg = Milligram/Kilogram	TOC = Total Organic Carbon
min = Minimum	umoles/g = Micromoles per Gram
mm = Millimeter	% = Percent
NA = Not Analyzed	

TABLE 5-3c

Summary of DMT Subsurface Sediment Results

Dundalk Marine Terminal, Baltimore, Maryland

		Reference	**DMT May 2007 - February 2008**							
Parameter	**Units**	**Maximum Concentration**	**Frequency of Detection (a) [detects/samples]**		**Range of Detected Concentrations (b) [min-max]**			**Average Concentration (c) [mean + SD]**		
Analytical Chemistry										
Total Chromium	mg/kg	147	82	82	1.15	-	8,140	384		1,020
Geochemistry										
Aluminum	mg/kg	37,900	85	85	227	-	50,500	17,300	±	11,900
Calcium	mg/kg	2,440	85	85	10.3	-	82,400	6,650	±	14,700
Ferrous Iron	mg/kg	4,710	28	28	22	-	24,400	6,170	±	6,750
Iron	mg/kg	48,400	85	85	274	-	129,000	29,900	±	20,200
Magnesium	mg/kg	10,100	85	85	16.2	-	55,000	5,720	±	7,000
Manganese	mg/kg	1,670	85	85	1.69	-	2,760	580	±	659
Manganese, Divalent	mg/kg	0	2	18	4.793	-	10.285	1.64	±	2.35
Sulfide	mg/kg	692	17	18	24.9	-	2,400	887	±	873
TOC	mg/kg	26,000	23	28	490	-	51,000	13,500	±	14,300
Vanadium	mg/kg	98	85	85	1.26	-	367	66.9	±	59
AVS-SEM Chemistry										
Acid Volatile Sulfide	umoles/g	NA	6	10	0.63	-	10	3.54	±	3.61
Cadmium	umoles/g	NA	8	10	0.000142	-	0.0115	0.00354	±	0.00397
Copper	umoles/g	NA	10	10	0.00699	-	0.657	0.205	±	0.198
Iron	umoles/g	NA	10	10	1.11	-	192	67.3	±	56.3
Lead	umoles/g	NA	10	10	0.00183	-	0.559	0.126	±	0.167
Nickel	umoles/g	NA	10	10	0.00362	-	0.686	0.166	±	0.207
Zinc	umoles/g	NA	10	10	0.00915	-	4.24	1.41	±	1.46
Physical Parameters										
Moisture	%	74.4	82	82	14.7	-	76.3	42	±	19
Total Solids	%	46.8	18	18	28.6	-	85.3	55.5	±	17.4
0.001 mm	% passing	39	28	28	0.5	-	30	6.34	±	6.74
0.002 mm	% passing	51.5	28	28	0.5	-	39	10.9	±	9.54
0.005 mm	% passing	64.5	28	28	0.5	-	55	17.1	±	13.9
0.02 mm	% passing	85	28	28	0.5	-	79	28.9	±	21.3
0.05 mm	% passing	94.5	28	28	2	-	94	39.6	±	27.6
0.064 mm	% passing	98.5	28	28	2	-	96	44.3	±	28.9
0.075 mm	% passing	99.2	28	28	2.2	-	96.7	46.6	±	29.5
0.15 mm	% passing	99.3	28	28	2.4	-	98.4	56.4	±	29.3
0.3 mm	% passing	99.4	28	28	33.1	-	98.8	74.6	±	19.3
0.6 mm	% passing	99.5	28	28	74	-	99.5	92.2	±	7.65
1.18 mm	% passing	99.6	28	28	90.9	-	99.8	97.7	±	2.55
2.36 mm	% passing	99.7	28	28	91.8	-	100	99.4	±	1.53
3.35 mm	% passing	99.9	28	28	92	-	100	99.6	±	1.5
4.75 mm	% passing	99.9	28	28	92.1	-	100	99.6	±	1.49
19 mm	% passing	100	28	28	92.2	-	100	99.7	±	1.48
37.5 mm	% passing	100	28	28	92.2	-	100	99.7	±	1.47
75 mm	% passing	100	28	28	100	-	100	100	±	---

TABLE 5-3c
Summary of DMT Subsurface Sediment Results
Dundalk Marine Terminal, Baltimore, Maryland

		Reference	DMT Quarter 2 (August 2007)							
Parameter	Units	Maximum Concentration	Frequency of Detection (a) [detects/samples]		Range of Detected Concentrations (b) [min-max]			Average Concentration (c) [mean + SD]		
Analytical Chemistry										
Total Chromium	mg/kg	147	72	72	1.15	-	2,290	240	±	456
Geochemistry										
Aluminum	mg/kg	37,900	75	75	227	-	50,500	18,700	±	11,900
Calcium	mg/kg	2,440	75	75	10.3	-	82,400	6,400	±	14,700
Ferrous Iron	mg/kg	4,710	18	18	85.8	-	24,400	8,340	±	7,110
Iron	mg/kg	48,400	75	75	274	-	129,000	30,900	±	20,600
Magnesium	mg/kg	10,100	75	75	16.2	-	55,000	5,760	±	7,020
Manganese	mg/kg	1,670	75	75	1.69	-	2,760	625	±	682
Manganese, Divalent	mg/kg	0	2	18	4.793	-	10.285	1.64	±	2.35
Sulfide	mg/kg	692	17	18	24.9	-	2,400	887	±	873
TOC	mg/kg	26,000	17	18	490	-	51,000	18,200	±	15,500
Vanadium	mg/kg	98	75	75	1.26	-	367	67.8	±	60.1
AVS-SEM Chemistry										
Acid Volatile Sulfide	umoles/g	NA	NA		NA	-	NA	NA	±	NA
Cadmium	umoles/g	NA	NA		NA	-	NA	NA	±	NA
Copper	umoles/g	NA	NA		NA	-	NA	NA	±	NA
Iron	umoles/g	NA	NA		NA	-	NA	NA	±	NA
Lead	umoles/g	NA	NA		NA	-	NA	NA	±	NA
Nickel	umoles/g	NA	NA		NA	-	NA	NA	±	NA
Zinc	umoles/g	NA	NA		NA	-	NA	NA	±	NA
Physical Parameters										
Moisture	%	74.4	72	72	15.8	-	76.3	44.5	±	18.6
Total Solids	%	46.8	18	18	28.6	-	85.3	55.5	±	17.4
0.001 mm	% passing	39	18	18	0.5	-	30	7.39	±	7.37
0.002 mm	% passing	51.5	18	18	0.5	-	39	13.1	±	9.62
0.005 mm	% passing	64.5	18	18	0.5	-	55	20.6	±	13.3
0.02 mm	% passing	85	18	18	3	-	79	34.1	±	18.9
0.05 mm	% passing	94.5	18	18	3	-	94	47.2	±	24.3
0.064 mm	% passing	98.5	18	18	2	-	96	52.9	±	24.8
0.075 mm	% passing	99.2	18	18	2.2	-	96.7	55.5	±	25.1
0.15 mm	% passing	99.3	18	18	2.4	-	98.4	63.8	±	24.4
0.3 mm	% passing	99.4	18	18	55.9	-	98.8	77.6	±	14.4
0.6 mm	% passing	99.5	18	18	74	-	99.4	91.1	±	7.68
1.18 mm	% passing	99.6	18	18	90.9	-	99.8	97.1	±	2.84
2.36 mm	% passing	99.7	18	18	91.8	-	99.9	99	±	1.84
3.35 mm	% passing	99.9	18	18	92	-	100	99.4	±	1.86
4.75 mm	% passing	99.9	18	18	92.1	-	100	99.4	±	1.85
19 mm	% passing	100	18	18	92.2	-	100	99.5	±	1.84
37.5 mm	% passing	100	18	18	92.2	-	100	99.6	±	1.84
75 mm	% passing	100	18	18	100	-	100	100	±	---

TABLE 5-3c

Summary of DMT Subsurface Sediment Results

Dundalk Marine Terminal, Baltimore, Maryland

		Reference	**DMT Quarter 4 (February 2008)**							
Parameter	**Units**	**Maximum Concentration**	**Frequency of Detection (a) [detects/samples]**		**Range of Detected Concentrations (b) [min-max]**			**Average Concentration (c) [mean + SD]**		
Analytical Chemistry										
Total Chromium	mg/kg	147	10	10	28.2	-	8,140	1,420	±	2,520
Geochemistry						-				
Aluminum	mg/kg	37,900	10	10	846	-	15,500	7,100	±	5,090
Calcium	mg/kg	2,440	10	10	32.6	-	46,500	8,530	±	15,200
Ferrous Iron	mg/kg	4,710	10	10	22	-	11,900	2,270	±	3,870
Iron	mg/kg	48,400	10	10	1,180	-	53,000	22,400	±	16,400
Magnesium	mg/kg	10,100	10	10	116	-	17,600	5,390	±	7,220
Manganese	mg/kg	1,670	10	10	5.77	-	919	240	±	289
Manganese, Divalent	mg/kg	0	NA		NA	-	NA	NA	±	NA
Sulfide	mg/kg	692	NA		NA	-	NA	NA	±	NA
TOC	mg/kg	26,000	6	10	679	-	18,000	5,220	±	6,520
Vanadium	mg/kg	98	10	10	2.36	-	146	60.3	±	52.2
AVS-SEM Chemistry										
Acid Volatile Sulfide	umoles/g	NA	6	10	0.63	-	10	3.54	±	3.61
Cadmium	umoles/g	NA	8	10	0.000142	-	0.0115	0.00354	±	0.00397
Copper	umoles/g	NA	10	10	0.00699	-	0.657	0.205	±	0.198
Iron	umoles/g	NA	10	10	1.11	-	192	67.3	±	56.3
Lead	umoles/g	NA	10	10	0.00183	-	0.559	0.126	±	0.167
Nickel	umoles/g	NA	10	10	0.00362	-	0.686	0.166	±	0.207
Zinc	umoles/g	NA	10	10	0.00915	-	4.24	1.41	±	1.46
Physical Parameters										
Moisture	%	74.4	10	10	14.7	-	46.8	23.6	±	10.2
Total Solids	%	46.8	NA		NA	-	NA	NA	±	NA
0.001 mm	% passing	39	10	10	0.5	-	16	4.45	±	5.25
0.002 mm	% passing	51.5	10	10	0.5	-	23	6.85	±	8.41
0.005 mm	% passing	64.5	10	10	0.5	-	34	10.8	±	13.2
0.02 mm	% passing	85	10	10	0.5	-	60	19.5	±	23.2
0.05 mm	% passing	94.5	10	10	2	-	79	26	±	29.1
0.064 mm	% passing	98.5	10	10	2	-	86	29	±	30.7
0.075 mm	% passing	99.2	10	10	2.5	-	88.5	30.7	±	31.2
0.15 mm	% passing	99.3	10	10	4.1	-	93.8	43.1	±	33.9
0.3 mm	% passing	99.4	10	10	33.1	-	98.5	69	±	25.9
0.6 mm	% passing	99.5	10	10	80.8	-	99.5	94.3	±	7.53
1.18 mm	% passing	99.6	10	10	95.7	-	99.8	99	±	1.31
2.36 mm	% passing	99.7	10	10	100	-	100	100	±	---
3.35 mm	% passing	99.9	10	10	99.5	-	100	99.9	±	0.151
4.75 mm	% passing	99.9	10	10	99.9	-	100	100	±	0.0516
19 mm	% passing	100	10	10	100	-	100	100	±	---
37.5 mm	% passing	100	10	10	100	-	100	100	±	---
75 mm	% passing	100	10	10	100	-	100	100	±	---

(a) For detection frequency, where duplicate samples were present, they were counted as one sample.

(b) Where duplicate samples were present, the greatest value for each analyte was used to calculate range, average, and standard deviation.

(c) Average concentration and standard deviation calculated by using one-half of the detection limit for non-detects.

AVS = Acid Volatile Sulfide
max = Maximum
mg/kg = Milligram/Kilogram
min = Minimum
mm = Millimeter
NA = Not Analyzed

SD = Standard Deviation
SEM = Simultaneously Extracted Metals
TOC = Total Organic Carbon
umoles/g = Micromoles per Gram
% = Percent

TABLE 5-3d

Summary of Reference Area Subsurface Sediment Results

Dundalk Marine Terminal, Baltimore, Maryland

		Quarter 2 (August 2007)							
Parameter	**Units**	**Frequency of Detection (a) [detects/samples]**		**Range of Detected Concentrations (b) [min-max]**			**Average Concentration (c) [mean + SD]**		
Analytical Chemistry									
Total Chromium	mg/kg	6	6	55.3	-	147	86.3	±	34.3
Geochemistry									
Aluminum	mg/kg	6	6	31,500	-	37,900	35,700	±	2,340
Calcium	mg/kg	6	6	1,860	-	2,440	2,020	±	221
Ferrous Iron	mg/kg	2	2	4,200	-	4,710	4,460	±	361
Iron	mg/kg	6	6	45,200	-	48,400	46,300	±	1,150
Magnesium	mg/kg	6	6	8,120	-	10,100	9,420	±	732
Manganese	mg/kg	6	6	1,290	-	1,670	1,510	±	126
Manganese, Divalent	mg/kg	0	2	0	-	0	1.17	±	---
Sulfide	mg/kg	2	2	656	-	692	674	±	25.5
TOC	mg/kg	2	2	26,000	-	26,000	26,000	±	---
Vanadium	mg/kg	6	6	67.9	-	98	77.3	±	10.7
AVS-SEM Chemistry									
Acid Volatile Sulfide	umoles/g	NA		NA	-	NA	NA	±	NA
Cadmium	umoles/g	NA		NA	-	NA	NA	±	NA
Copper	umoles/g	NA		NA	-	NA	NA	±	NA
Iron	umoles/g	NA		NA	-	NA	NA	±	NA
Lead	umoles/g	NA		NA	-	NA	NA	±	NA
Nickel	umoles/g	NA		NA	-	NA	NA	±	NA
Zinc	umoles/g	NA		NA	-	NA	NA	±	NA
Physical Parameters									
Moisture	%	6	6	52.9	-	74.4	61.3	±	7.63
Total Solids	%	2	2	39.3	-	46.8	43.1	±	5.3
0.001 mm	% passing	2	2	36	-	39	37.5	±	2.12
0.002 mm	% passing	2	2	48	-	51.5	49.8	±	2.47
0.005 mm	% passing	2	2	62	-	64.5	63.3	±	1.77
0.02 mm	% passing	2	2	82.5	-	85	83.8	±	1.77
0.05 mm	% passing	2	2	93.5	-	94.5	94	±	0.707
0.064 mm	% passing	2	2	98	-	98.5	98.3	±	0.354
0.075 mm	% passing	2	2	98.1	-	99.2	98.7	±	0.778
0.15 mm	% passing	2	2	98.4	-	99.3	98.9	±	0.636
0.3 mm	% passing	2	2	98.8	-	99.4	99.1	±	0.424
0.6 mm	% passing	2	2	99.3	-	99.5	99.4	±	0.141
1.18 mm	% passing	2	2	99.6	-	99.6	99.6	±	---
2.36 mm	% passing	2	2	99.6	-	99.7	99.7	±	0.0707
3.35 mm	% passing	2	2	99.9	-	99.9	99.9	±	---
4.75 mm	% passing	2	2	99.9	-	99.9	99.9	±	---
19 mm	% passing	2	2	100	-	100	100	±	---
37.5 mm	% passing	2	2	100	-	100	100	±	---
75 mm	% passing	2	2	100	-	100	100	±	---

(a) For detection frequency, where duplicate samples were present, they were counted as one sample.

standard deviation.

(c) Average concentration and standard deviation calculated by using one-half of the detection limit for non-detects.

AVS = Acid Volatile Sulfide
max = Maximum
mg/kg = Milligram/Kilogram
min = Minimum
mm = Millimeter
NA = Not Analyzed

SD = Standard Deviation
SEM = Simultaneously Extracted Metals
TOC = Total Organic Carbon
umoles/g = Micromoles per Gram
% = Percent

TABLE 5-4

Summary of AVS-SEM Results

Dundalk Marine Terminal, Baltimore, Maryland

Quarter	**Acid Volatile Sulfide (AVS) um/g (b)**	**Cadmium um/g (b)**	**Copper um/g (b)**	**Lead um/g (b)**	**Nickel um/g (b)**	**Mercury um/g (b)**	**Zinc um/g (b)**	**SEM (sum of metals) um/g**	**Excess AVS (AVS-SEM) um/g**	**Iron um/g (b)**	**Excess Fe (Excess AVS-Iron) um/g**
Averages											
Overall	13.5	0.0145	0.181	0.121	0.279	6.49E-06	1.4	2	11.5	80.2	68.7
Sediment < 0.5' Deep	14.8	0.016	0.178	0.121	0.293	6.49E-06	1.4	2.01	12.8	81.9	69.1
Sediment > 0.5' Deep	3.57	0.00354	0.205	0.126	0.166	NA	1.41	1.91	1.66	67.3	65.6
Transect A	2.05	0.00104	0.0864	0.0397	0.224	0.0000154	0.721	1.07	0.98	36.8	35.8
Transect B	3.97	0.00196	0.219	0.0772	0.33	0.0000215	1.09	1.72	2.25	77	74.8
Transect C	10.5	0.00451	0.237	0.145	0.313	3.81E-06	1.8	2.5	8	107	99
Transect D	18.4	0.00213	0.164	0.0953	0.238	3.78E-06	1.16	1.66	16.7	106	89.3
Transect E	16.2	0.00231	0.125	0.0744	0.26	5.38E-06	0.8	1.26	14.9	85.5	70.6
Transect F	17.4	0.00217	0.178	0.0808	0.249	3.85E-06	0.855	1.36	16	102	86
Transect G	19.5	0.00202	0.121	0.0677	0.263	3.88E-06	0.785	1.24	18.3	74.4	56.1
Transect H	29.6	0.0155	0.145	0.105	0.226	3.83E-06	1.07	1.56	28	59.6	31.6
Transect I	20.6	0.119	0.298	0.398	0.445	3.81E-06	3.92	5.18	15.4	57.8	42.4
Transect J	4.97	0.00486	0.23	0.137	0.239	NA	1.76	2.37	2.6	91.8	89.2
Near Bulkhead (1)	15.3	0.0149	0.227	0.139	0.35	7.64E-06	1.53	2.26	13	85	72
Mid Near (2)	13.5	0.0119	0.164	0.103	0.257	9.12E-06	1.27	1.81	11.7	75.7	64
Mid Far (3)	16	0.0169	0.153	0.126	0.275	3.82E-06	1.38	1.95	14.1	75.7	61.6
Away From Bulkhead (4)	9.89	0.0144	0.181	0.117	0.239	4.57E-06	1.42	1.97	7.92	83.9	76

(a) Where duplicate samples were present, the maximum value of each constituent is used.

(b) Analytes that were not detected are presented here as present at 1/2 of the detection limit.

AVS	Acid Volatile Sulfides
NA	Not Analyzed
SEM	Simultaneously Extracted Metals
um/g	Micromoles per Gram

TABLE 5-5

Cr(VI) Detections at DMT and Cumulative Rainfall Totals

Dundalk Marine Terminal, Baltimore, Maryland

Date	Sampling Event	Sampling Location	1 day[a] Rainfall totals	3 day[a] Rainfall totals	7 day[a] Rainfall totals	10 day[a] Rainfall totals	Hexavalent Chromium (ug/L)
8/16/2007	Aug-07	E1	0.15	0.15	0.15	0.39	25.7
8/20/2007	Aug-07	B3	0.81	0.93	1.08	1.08	6
8/20/2007	Aug-07	B4	0.81	0.93	1.08	1.08	34.9
12/5/2007	Dec-07	E1	0.21	0.25	0.79	0.87	30.4
12/6/2007	Dec-07	C1	0	0.21	0.79	0.81	7
12/9/2007	Dec-07	E2	0.12	0.39	0.64	1.18	11
2/23/2008	Feb-08	E1	0.05	0.45	1.65	1.95	8.1
2/25/2008	Feb-08	D3	0	0.05	1.45	1.65	6.7
2/25/2008	Feb-08	D1	0	0.05	1.45	1.65	10.5

(a) Refers to cumulative rainfall totals in inches.

Cr(VI) was not detected in surface water in May 2007 (Q1)

\\Perseus\projects\HoneywellInc\327494DMT\Projects\SW_SD_Sampling_Plan\Q4\Final_Report\Figure 5-1a - Maximum Concentrations.mxd

Maximum Concentration - H-1 (Maximum Water Depth 40.9 feet)

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
Sed (mg/kg)	0 - 0.5	114 K	-	-
Sed (mg/kg)	1 - 1.5	182	-	-
Sed (mg/kg)	2.5 - 3	29.2	-	-
PW (µg/L)	0 - 0.5	19.2	11 J	5 U
SW (µg/L)	Shallow	4.2 J	3.6 J	5 UJ
SW (µg/L)	Mid	2.3 UJ	2.7 J	5 UJ
SW (µg/L)	Deep	2.3 UJ	2.3 U	5 UJ

Maximum Concentration - H-2 (Maximum Water Depth 37.8 feet)

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
Sed (mg/kg)	0 - 0.5	134	-	-
Sed (mg/kg)	1 - 1.5	43.2	-	-
Sed (mg/kg)	2.5 - 3	88.4	-	-
PW (µg/L)	0 - 0.5	12 J	4.3 J	5 U
SW (µg/L)	Shallow	2.3 U	2.3 U	5 UJ
SW (µg/L)	Mid	2.3 U	2.3 U	5 UJ
SW (µg/L)	Deep	2.3 U	2.3 U	5 UJ

Maximum Concentration - H-3 (Maximum Water Depth 38 feet)

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
Sed (mg/kg)	0 - 0.5	71.8	-	-
Sed (mg/kg)	1 - 1.5	71.7	-	-
Sed (mg/kg)	2.5 - 3	101	-	-
PW (µg/L)	0 - 0.5	13.2 J	5.5 J	5 U
SW (µg/L)	Shallow	2.3 U	2.3 U	5 UJ
SW (µg/L)	Mid	2.3 U	2.3 U	5 UJ
SW (µg/L)	Deep	2.3 U	2.3 U	5 UJ

Maximum Concentration - H-4 (Maximum Water Depth 41.5 feet)

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
Sed (mg/kg)	0 - 0.5	207	-	-
Sed (mg/kg)	1 - 1.5	80.7	-	-
Sed (mg/kg)	2.5 - 3	27.9	-	-
PW (µg/L)	0 - 0.5	16.9	12.2 J	5 U
SW (µg/L)	Shallow	2.3 U	2.3 U	5 UJ
SW (µg/L)	Mid	2.3 U	2.3 U	5 UJ
SW (µg/L)	Deep	2.7 J	2.3 U	5 UJ

Maximum Concentration - I-4 (Maximum Water Depth 10.8 feet)

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
Sed (mg/kg)	0 - 0.5	542	-	-
Sed (mg/kg)	0.8 - 1.3	1390	-	-
Sed (mg/kg)	2.1 - 2.6	508	-	-
PW (µg/L)	0 - 0.5	34.7	6.7 J	5 U
SW (µg/L)	Shallow	2.8 J	2.3 U	5 U
SW (µg/L)	Mid	3 J	2.3 U	5 U
SW (µg/L)	Deep	4.1 J	2.3 U	5 U

Maximum Concentration - I-3 (Maximum Water Depth 11.2 feet)

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
Sed (mg/kg)	0 - 0.5	425	-	-
Sed (mg/kg)	1 - 1.5	327	-	-
Sed (mg/kg)	2.5 - 3	332	-	-
PW (µg/L)	0 - 0.5	21.3	4.7 J	5 U
SW (µg/L)	Shallow	3.3 J	2.3 U	5 UJ
SW (µg/L)	Mid	2.3 U	2.3 U	5 U
SW (µg/L)	Deep	3.7 J	2.3 U	5 UJ

Maximum Concentration - I-2 (Maximum Water Depth 10.8 feet)

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
Sed (mg/kg)	0 - 0.5	315	-	-
Sed (mg/kg)	1 - 1.5	308	-	-
Sed (mg/kg)	2.5 - 3	575	-	-
PW (µg/L)	0 - 0.5	49.8	3.1 J	5 U
SW (µg/L)	Shallow	2.3 UJ	2.9 J	5 UJ
SW (µg/L)	Mid	2.3 U	2.3 U	5 U
SW (µg/L)	Deep	2.3 J	2.3 U	5 UJ

Maximum Concentration - I-1 (Maximum Water Depth 5.9 feet)

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
Sed (mg/kg)	0 - 0.5	700	-	-
Sed (mg/kg)	1 - 1.5	16.7	-	-
Sed (mg/kg)	2.5 - 3	22	-	-
PW (µg/L)	0 - 0.5	52.2 L	3.1 J	5 U
SW (µg/L)	Shallow	2.3 U	2.3 U	5 U
SW (µg/L)	Mid	21.3	2.3 J	5 U
SW (µg/L)	Deep	2.3 U	2.3 U	5 U

Maximum Concentration - G-1 (Maximum Water Depth 38 feet)

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
Sed (mg/kg)	0 - 0.5	67.1	-	-
Sed (mg/kg)	1.1 - 1.6	33.1	-	-
Sed (mg/kg)	2.5 - 3	28.8	-	-
PW (µg/L)	0 - 0.5	8.2 J	2.3 U	5 U
SW (µg/L)	Shallow	3 J	2.3 U	5 U
SW (µg/L)	Mid	2.3 U	2.3 U	5 U
SW (µg/L)	Deep	3.3 J	2.3 U	5 U

Maximum Concentration - G-2 (Maximum Water Depth 41.6 feet)

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
Sed (mg/kg)	0 - 0.5	153	-	-
Sed (mg/kg)	0.8 - 1.3	144 K	-	-
Sed (mg/kg)	2.5 - 3	50 K	-	-
PW (µg/L)	0 - 0.5	14.9 J	11.7 J	5 U
SW (µg/L)	Shallow	3.5 J	2.3 U	5 UJ
SW (µg/L)	Mid	2.3 U	2.3 U	5 UJ
SW (µg/L)	Deep	4.6 J	2.6 J	5 UJ

Maximum Concentration - G-3 (Maximum Water Depth 44.9 feet)

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
Sed (mg/kg)	0 - 0.5	164	-	-
Sed (mg/kg)	1 - 1.5	29.8 K	-	-
Sed (mg/kg)	2.5 - 3	29.6 K	-	-
PW (µg/L)	0 - 0.5	15.3	10.1 J	5 UJ
SW (µg/L)	Shallow	2.3 U	2.3 U	5 U
SW (µg/L)	Mid	2.3 U	2.3 U	5 U
SW (µg/L)	Deep	2.3 U	2.3 U	5 U

Maximum Concentration - G-4 (Maximum Water Depth 36.1 feet)

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
Sed (mg/kg)	0 - 0.5	140	-	-
Sed (mg/kg)	1 - 1.5	182	-	-
Sed (mg/kg)	2.5 - 3	197	-	-
PW (µg/L)	0 - 0.5	15.1	13.4 J	5 U
SW (µg/L)	Shallow	3.8 J	2.3 U	5 UJ
SW (µg/L)	Mid	2.3 U	2.3 U	5 UJ
SW (µg/L)	Deep	4 J	2.3 U	5 UJ

Maximum Concentration - D-1 (Maximum Water Depth 42.5 feet)

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
Sed (mg/kg)	0 - 0.5	310	-	-
Sed (mg/kg)	1 - 1.5	372	-	-
Sed (mg/kg)	2.5 - 3	251	-	-
PW (µg/L)	0 - 0.5	13.6 J	11.7 J	5 U
SW (µg/L)	Shallow	16.6 J	17.3 J	10.5
SW (µg/L)	Mid	4.4 J	4.8 J	5 U
SW (µg/L)	Deep	4.2 J	2.7 J	5 U

Maximum Concentration - D-2 (Maximum Water Depth 45.6 feet)

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
Sed (mg/kg)	0 - 0.5	258	-	-
Sed (mg/kg)	1 - 1.5	237	-	-
Sed (mg/kg)	2.5 - 3	66.1	-	-
PW (µg/L)	0 - 0.5	23.7	16.2 J	5 U
SW (µg/L)	Shallow	6 J	2.8 J	5 U
SW (µg/L)	Mid	2.3 U	2.3 U	5 U
SW (µg/L)	Deep	2.3 UJ	2.5 J	5 U

Maximum Concentration - D-3 (Maximum Water Depth 44.5 feet)

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
Sed (mg/kg)	0 - 0.5	306	-	-
Sed (mg/kg)	1 - 1.5	218	-	-
Sed (mg/kg)	2.5 - 3	95.8	-	-
PW (µg/L)	0 - 0.5	16.2	12.4 J	5 U
SW (µg/L)	Shallow	9.7 J	9.4 J	6.3 J
SW (µg/L)	Mid	2.5 J	2.3 U	5 U
SW (µg/L)	Deep	3.7 J	2.3 U	5 U

Maximum Concentration - D-4 (Maximum Water Depth 11.4 feet)

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
Sed (mg/kg)	0 - 0.5	214	-	-
Sed (mg/kg)	0.8 - 1.3	78.1	-	-
Sed (mg/kg)	2.5 - 3	60.2	-	-
PW (µg/L)	0 - 0.5	42.4	3.1 J	5 U
SW (µg/L)	Shallow	3.6 J	2.7 J	5 UJ
SW (µg/L)	Mid	5.9 J	2.3 U	5 UJ
SW (µg/L)	Deep	4.1 J	4.5 J	5 UJ

Maximum Concentration - C-1 (Maximum Water Depth 6.9 feet)

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
Sed (mg/kg)	0 - 0.5	1310	-	-
Sed (mg/kg)	0.8 - 1.3	2090	-	-
Sed (mg/kg)	2.3 - 2.8	1440	-	-
PW (µg/L)	0 - 0.5	222	2.3 U	5 U
SW (µg/L)	Shallow	12.2 J	7.6 J	5 UJ
SW (µg/L)	Mid	8.6 J	6.6 J	7 J
SW (µg/L)	Deep	14.1 J	8.4 J	5 UJ

Maximum Concentration - C-2 (Maximum Water Depth 7.9 feet)

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
Sed (mg/kg)	0 - 0.5	1080	-	-
Sed (mg/kg)	1 - 1.5	91.5	-	-
Sed (mg/kg)	2 - 2.5	3.62	-	-
PW (µg/L)	0 - 0.5	632	2.4 J	5 UJ
SW (µg/L)	Shallow	8.9 J	4.2 J	5 UJ
SW (µg/L)	Mid	2.3 U	2.3 U	5 U
SW (µg/L)	Deep	9.3 J	5.6 J	5 UJ

Maximum Concentration - C-3 (Maximum Water Depth 10.8 feet)

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
Sed (mg/kg)	0 - 0.5	618	-	-
Sed (mg/kg)	1 - 1.5	250	-	-
Sed (mg/kg)	2.4 - 2.9	78.3	-	-
PW (µg/L)	0 - 0.5	53.5	3.4 J	5 U
SW (µg/L)	Shallow	5.7 J	5.6 J	5 UJ
SW (µg/L)	Mid	5.2 J	4.5 J	5 UJ
SW (µg/L)	Deep	7.5 J	5.8 J	5 UJ

Maximum Concentration - C-4 (Maximum Water Depth 11.6 feet)

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
Sed (mg/kg)	0 - 0.5	357	-	-
Sed (mg/kg)	1 - 1.5	57	-	-
Sed (mg/kg)	2.5 - 3	2.32	-	-
PW (µg/L)	0 - 0.5	11.5 J	3.8 J	5 U
SW (µg/L)	Shallow	5 J	5.5 J	5 UJ
SW (µg/L)	Mid	5.1 J	6.2 J	5 UJ
SW (µg/L)	Deep	2.3 UJ	2.6 J	5 UJ

Maximum Concentration - J-4 (Maximum Water Depth 1.6 feet)

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
Sed (mg/kg)	0 - 0.5	2360	-	-
Sed (mg/kg)	0.5 - 1	8140 J	-	-
Sed (mg/kg)	2.5 - 3	114 J	-	-
PW (µg/L)	0 - 0.5	1880	2.3 UL	5 U
SW (µg/L)	Shallow	NA	NA	NA
SW (µg/L)	Mid	16.9	2.3 U	5 U
SW (µg/L)	Deep	NA	NA	NA

Maximum Concentration - A-1 (Maximum Water Depth 6.4 feet)

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
Sed (mg/kg)	0 - 0.5	1200	-	-
Sed (mg/kg)	0.9 - 1.4	1330 K	-	-
Sed (mg/kg)	2.5 - 3	17 K	-	-
PW (µg/L)	0 - 0.5	207 L	2.3 U	5 U
SW (µg/L)	Shallow	2.3 U	2.3 U	5 U
SW (µg/L)	Mid	9.8 J	5.6 J	5 U
SW (µg/L)	Deep	2.8 J	2.3 U	5 UJ

Maximum Concentration - A-2 (Maximum Water Depth 5.8 feet)

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
Sed (mg/kg)	0 - 0.5	363	-	-
Sed (mg/kg)	0.9 - 1.4	315 K	-	-
Sed (mg/kg)	2.5 - 3	78.3 K	-	-
PW (µg/L)	0 - 0.5	2630	4.3 J	5 U
SW (µg/L)	Shallow	2.3 U	2.3 U	5 UJ
SW (µg/L)	Mid	3.4 J	2.4 J	5 U
SW (µg/L)	Deep	2.3 U	2.3 U	5 UJ

Maximum Concentration - A-3 (Maximum Water Depth 6.3 feet)

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
Sed (mg/kg)	0 - 0.5	110	-	-
Sed (mg/kg)	1 - 1.5	2.91 K	-	-
Sed (mg/kg)	2.5 - 3	3.94 K	-	-
PW (µg/L)	0 - 0.5	33.3	3.1 J	5 U
SW (µg/L)	Shallow	NA	NA	NA
SW (µg/L)	Mid	3.5 J	2.3 U	5 UJ
SW (µg/L)	Deep	NA	NA	NA

Maximum Concentration - A-4 (Maximum Water Depth 6.4 feet)

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
Sed (mg/kg)	0 - 0.5	97.4	-	-
Sed (mg/kg)	1 - 1.5	12.8 K	-	-
Sed (mg/kg)	2.5 - 3	34.1 K	-	-
PW (µg/L)	0 - 0.5	509	3.2 J	5 U
SW (µg/L)	Shallow	NA	NA	NA
SW (µg/L)	Mid	3 J	2.3 U	5 UJ
SW (µg/L)	Deep	NA	NA	NA

Maximum Concentration - E-1 (Maximum Water Depth 45.2 feet)

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
Sed (mg/kg)	0 - 0.5	253	-	-
Sed (mg/kg)	1 - 1.5	217	-	-
Sed (mg/kg)	2.5 - 3	68.2	-	-
PW (µg/L)	0 - 0.5	118 L	6.5 J	5 U
SW (µg/L)	Shallow	44.4	37.6	30.4
SW (µg/L)	Mid	5.4 J	5.5 J	5 U
SW (µg/L)	Deep	3 J	2.7 J	5 U

Maximum Concentration - F-1 (Maximum Water Depth 38.6 feet)

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
Sed (mg/kg)	0 - 0.5	117	-	-
Sed (mg/kg)	1 - 1.5	76.7	-	-
Sed (mg/kg)	2.5 - 3	159	-	-
PW (µg/L)	0 - 0.5	8.8 J	7.4 J	5 U
SW (µg/L)	Shallow	2.3 U	2.3 U	5 UJ
SW (µg/L)	Mid	2.3 U	2.3 U	5 UJ
SW (µg/L)	Deep	2.3 U	2.3 U	5 UJ

Maximum Concentration - E-2 (Maximum Water Depth 47.3 feet)

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
Sed (mg/kg)	0 - 0.5	66.9	-	-
Sed (mg/kg)	1 - 1.5	61.4	-	-
Sed (mg/kg)	2.5 - 3	62.1	-	-
PW (µg/L)	0 - 0.5	10.2 J	12.2 J	5 U
SW (µg/L)	Shallow	5.2 J	10.2 J	11 J
SW (µg/L)	Mid	3.7 J	3 J	5 U
SW (µg/L)	Deep	2.3 U	2.3 U	5 U

Maximum Concentration - F-2 (Maximum Water Depth 47.3 feet)

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
Sed (mg/kg)	0 - 0.5	65.8	-	-
Sed (mg/kg)	1 - 1.5	49.3 K	-	-
Sed (mg/kg)	2.5 - 3	36.9 K	-	-
PW (µg/L)	0 - 0.5	10.7 J	6.2 J	5 U
SW (µg/L)	Shallow	2.3 U	2.3 U	5 UJ
SW (µg/L)	Mid	3.8 J	2.3 U	5 UJ
SW (µg/L)	Deep	2.3 U	2.3 U	5 UJ

Maximum Concentration - E-3 (Maximum Water Depth 46.7 feet)

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
Sed (mg/kg)	0 - 0.5	238	-	-
Sed (mg/kg)	1 - 1.5	262	-	-
Sed (mg/kg)	2.5 - 3	259	-	-
PW (µg/L)	0 - 0.5	17.6	13.5 J	5 U
SW (µg/L)	Shallow	3.8 J	3.1 J	5 U
SW (µg/L)	Mid	2.4 J	2.3 U	5 U
SW (µg/L)	Deep	2.3 U	2.3 U	5 U

Maximum Concentration - F-3 (Maximum Water Depth 37.9 feet)

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
Sed (mg/kg)	0 - 0.5	261	-	-
Sed (mg/kg)	1.2 - 1.7	56	-	-
Sed (mg/kg)	2.5 - 3	56.2	-	-
PW (µg/L)	0 - 0.5	14.5 J	10.1 J	5 U
SW (µg/L)	Shallow	2.3 U	2.3 U	5 U
SW (µg/L)	Mid	2.3 U	2.3 U	5 U
SW (µg/L)	Deep	2.3 U	2.3 U	5 UJ

Maximum Concentration - E-4 (Maximum Water Depth 16.5 feet)

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
Sed (mg/kg)	0 - 0.5	114 K	-	-
Sed (mg/kg)	1 - 1.5	52.1	-	-
Sed (mg/kg)	2.5 - 3	125	-	-
PW (µg/L)	0 - 0.5	35.1	2.3 U	5 U
SW (µg/L)	Shallow	3.4 J	3.6 J	5 UJ
SW (µg/L)	Mid	3.7 J	3.2 J	5 UJ
SW (µg/L)	Deep	5.6 J	2.8 J	5 UJ

Maximum Concentration - F-4 (Maximum Water Depth 28.4 feet)

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
Sed (mg/kg)	0 - 0.5	211	-	-
Sed (mg/kg)	1 - 1.5	120	-	-
Sed (mg/kg)	2.5 - 3	55.1	-	-
PW (µg/L)	0 - 0.5	9.4 J	8.2 J	5 U
SW (µg/L)	Shallow	2.3 UJ	2.3 U	5 UJ
SW (µg/L)	Mid	2.3 UJ	2.3 U	5 UJ
SW (µg/L)	Deep	3.8 J	2.3 U	5 UJ

Maximum Concentration - 37A (Maximum Water Depth 38 feet)

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
Sed (mg/kg)	0 - 0.5	124	-	-
Sed (mg/kg)	1 - 1.5	99.4	-	-
Sed (mg/kg)	2.5 - 3	55.3	-	-
PW (µg/L)	0 - 0.5	10.8 J	11.4 J	5 U
SW (µg/L)	Shallow	3.5 J	3.4 J	5 UJ
SW (µg/L)	Mid	2.3 UJ	2.7 J	5 UJ
SW (µg/L)	Deep	2.7 J	2.3 U	5 UJ

Maximum Concentration - 37 (Maximum Water Depth 41.4 feet)

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
Sed (mg/kg)	0 - 0.5	161	-	-
Sed (mg/kg)	1 - 1.5	147	-	-
Sed (mg/kg)	2.5 - 3	84.9	-	-
PW (µg/L)	0 - 0.5	14.7 J	9.7 J	5 U
SW (µg/L)	Shallow	2.9 J	2.3 U	5 UJ
SW (µg/L)	Mid	3.4 J	2.3 U	5 UJ
SW (µg/L)	Deep	3 J	2.3 U	5 UJ

Maximum Concentration - 37B (Maximum Water Depth 38.2 feet)

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
Sed (mg/kg)	0 - 0.5	166	-	-
Sed (mg/kg)	1.2 - 1.7	55.8	-	-
Sed (mg/kg)	2.5 - 3	75.4	-	-
PW (µg/L)	0 - 0.5	13.7 J	11.6 J	5 U
SW (µg/L)	Shallow	3.2 J	2.3 U	5 UJ
SW (µg/L)	Mid	3 J	2.3 U	5 UJ
SW (µg/L)	Deep	4.5 J	2.3 U	5 UJ

Maximum Concentration - J-1 (Maximum Water Depth 1.3 feet)

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
Sed (mg/kg)	0 - 0.5	1830	-	-
Sed (mg/kg)	0.8 - 1.3	1620	-	-
Sed (mg/kg)	2.5 - 3	2730	-	-
PW (µg/L)	0 - 0.5	96.5	2.3 UL	5 U
SW (µg/L)	Shallow	NA	NA	NA
SW (µg/L)	Mid	22.8	2.3 U	5 U
SW (µg/L)	Deep	NA	NA	NA

Maximum Concentration - J-2 (Maximum Water Depth 3.4 feet)

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
Sed (mg/kg)	0 - 0.5	1840	-	-
Sed (mg/kg)	1 - 1.5	605	-	-
Sed (mg/kg)	2.5 - 3	303	-	-
PW (µg/L)	0 - 0.5	112	2.3 UL	5 U
SW (µg/L)	Shallow	NA	NA	NA
SW (µg/L)	Mid	2.7 J	2.3 U	5 U
SW (µg/L)	Deep	NA	NA	NA

Maximum Concentration - J-3 (Maximum Water Depth 4.4 feet)

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
Sed (mg/kg)	0 - 0.5	1260	-	-
Sed (mg/kg)	0.6 - 1.1	28.2	-	-
Sed (mg/kg)	2.5 - 3	567	-	-
PW (µg/L)	0 - 0.5	61.4	2.3 UL	5 U
SW (µg/L)	Shallow	NA	NA	NA
SW (µg/L)	Mid	2.8 J	2.3 U	5 U
SW (µg/L)	Deep	NA	NA	NA

Maximum Concentration - B-4 (Maximum Water Depth 11.4 feet)

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
Sed (mg/kg)	0 - 0.5	424	-	-
Sed (mg/kg)	1 - 1.5	2290	-	-
Sed (mg/kg)	2.5 - 3	690	-	-
PW (µg/L)	0 - 0.5	17.9	2.3 U	5 UJ
SW (µg/L)	Shallow	35.1	29.7	34.9
SW (µg/L)	Mid	31.3	26 J	32.9
SW (µg/L)	Deep	32.9	29	32

Maximum Concentration - B-5 (Maximum Water Depth 7.8 feet)

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
Sed (mg/kg)	0 - 0.5	54.3	-	-
Sed (mg/kg)	0.5 - 1	43.6 J	-	-
Sed (mg/kg)	2.3 - 2.9	37.9 J	-	-
PW (µg/L)	0 - 0.5	46.8	2.3 UL	5 U
SW (µg/L)	Shallow	2.3 U	2.3 U	5 U
SW (µg/L)	Mid	NA	NA	NA
SW (µg/L)	Deep	2.3 U	2.3 U	5 U

Maximum Concentration - B-1 (Maximum Water Depth 7.6 feet)

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
Sed (mg/kg)	0 - 0.5	640	-	-
Sed (mg/kg)	0.8 - 1.3	80.9	-	-
Sed (mg/kg)	2.5 - 3	29.4	-	-
PW (µg/L)	0 - 0.5	50.9	3.5 J	5 UJ
SW (µg/L)	Shallow	5.8 J	3.8 J	5 U
SW (µg/L)	Mid	2.3 U	2.3 U	5 U
SW (µg/L)	Deep	11.1 J	5.2 J	5 U

Maximum Concentration - B-2 (Maximum Water Depth 10.1 feet)

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
Sed (mg/kg)	0 - 0.5	369	-	-
Sed (mg/kg)	0.6 - 1.1	22.7	-	-
Sed (mg/kg)	1.9 - 2.4	1.97	-	-
PW (µg/L)	0 - 0.5	74.1	2.3 U	5 UJ
SW (µg/L)	Shallow	7.4 J	5.7 J	5 UJ
SW (µg/L)	Mid	NA	NA	NA
SW (µg/L)	Deep	10.2 J	7.3 J	5 UJ

Maximum Concentration - B-3 (Maximum Water Depth 11.4 feet)

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
Sed (mg/kg)	0 - 0.5	683	-	-
Sed (mg/kg)	1 - 1.5	94	-	-
Sed (mg/kg)	2.5 - 3	1.15 J	-	-
PW (µg/L)	0 - 0.5	19.1	2.3 J	5 UJ
SW (µg/L)	Shallow	9.4 J	6.1 J	6 J
SW (µg/L)	Mid	2.3 U	2.3 U	5 U
SW (µg/L)	Deep	7.3 J	6 J	5 U

Legend

- ● Sample Location
- ● Sample Location - February 2008 only
- ○ Sample Location - not sampled in December 2007 or February 2008
- Storm Sewer Line
- COPR Extent
- Railroad Centerline
- Areas

Water Depth in Feet (NAVD88)
-4 feet
-50 feet

National Recommended Water Quality Criteria	Cr(III) Freshwater*, µg/L	Cr(III) Saltwater, µg/L	Cr(IV) Freshwater, µg/L	Cr(IV) Saltwater µg/L
Acute Dissolved	1,770	NA	16	1,100
Chronic Dissolved	231	NA	11	50

*The freshwater criteria for Cr(III) are based on hardness of 400 mg/L, which is USEPA's upper limit for calculating site-specific hardness-dependent water quality criteria

N
W E
S

0 300 600 1,200 1,800 2,400
Feet

U = not detected
J = estimated value
UJ = not detected; the associated detection limit is an estimate and may be inaccurate or imprecise
L = analyte present; reported value may be biased low. Actual value may be higher.
UL = Not Detected, quantitation limit is probably higher
K = Analyte present. Reported value may be biased high. Actual value may be lower.
B = Not detected substantially above the level reported in laboratory or field blank

Figure 5-1a
Maximum Total Chromium and Cr(VI) Concentrations in
Pore Water, Surface Water, and Sediment
Dundalk Marine Terminal
Baltimore, Maryland

ENVIRON
CH2MHILL

H-1

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
Sed (mg/kg)	0 - 0.5	114 K	-	-
PW (µg/L)	0 - 0.5	12.5 J	2.8 J	5 U
August 2007				
Sed (mg/kg)	0 - 0.5	89.5	-	-
Sed (mg/kg)	1 - 1.5	182	-	-
Sed (mg/kg)	2.5 - 3	29.2	-	-
PW (µg/L)	0 - 0.5	19.2	4.4 J	5 U
December 2007				
PW (µg/L)	0 - 0.5	17.4	11 J	5 U
February 2008				
PW (µg/L)	0 - 0.5	14.4 J	5.1 J	5 U

H-2

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
Sed (mg/kg)	0 - 0.5	47.1 K	-	-
PW (µg/L)	0 - 0.5	9.1 J	4.3 J	5 U
August 2007				
Sed (mg/kg)	0 - 0.5	134	-	-
Sed (mg/kg)	1 - 1.5	43.2	-	-
Sed (mg/kg)	2.5 - 3	88.4	-	-
PW (µg/L)	0 - 0.5	12 J	3.5 J	5 U

H-3

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
Sed (mg/kg)	0 - 0.5	49.3 K	-	-
PW (µg/L)	0 - 0.5	10.2 J	5.5 J	5 U
August 2007				
Sed (mg/kg)	0 - 0.5	71.8	-	-
Sed (mg/kg)	1 - 1.5	71.7	-	-
Sed (mg/kg)	2.5 - 3	101	-	-
PW (µg/L)	0 - 0.5	13.2 J	3.2 J	5 U

H-4

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
Sed (mg/kg)	0 - 0.5	107 K	-	-
PW (µg/L)	0 - 0.5	6.3 J	3.1 J	5 U
August 2007				
Sed (mg/kg)	0 - 0.5	207	-	-
Sed (mg/kg)	1 - 1.5	80.7	-	-
Sed (mg/kg)	2.5 - 3	27.9	-	-
PW (µg/L)	0 - 0.5	16.2	4.8 J	5 U
December 2007				
PW (µg/L)	0 - 0.5	14.6 J	12.2 J	5 U
February 2008				
PW (µg/L)	0 - 0.5	16.9	6.5 B	5 U

I-4

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
Sed (mg/kg)	0 - 0.5	374 K	-	-
PW (µg/L)	0 - 0.5	27	2.7 J	5 U
August 2007				
Sed (mg/kg)	0 - 0.5	542	-	-
Sed (mg/kg)	0.8 - 1.3	1390	-	-
Sed (mg/kg)	2.1 - 2.6	508	-	-
PW (µg/L)	0 - 0.5	25	5.8 J	5 U
December 2007				
PW (µg/L)	0 - 0.5	24.3 L	6.7 J	5 U
February 2008				
PW (µg/L)	0 - 0.5	34.7	2.3 U	5 U

I-3

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
Sed (mg/kg)	0 - 0.5	357 K	-	-
PW (µg/L)	0 - 0.5	21.3	2.3 U	5 U
August 2007				
Sed (mg/kg)	0 - 0.5	425	-	-
Sed (mg/kg)	1 - 1.5	327	-	-
Sed (mg/kg)	2.5 - 3	332	-	-
PW (µg/L)	0 - 0.5	13.5 J	2.7 J	5 U
December 2007				
PW (µg/L)	0 - 0.5	15.6	4.7 J	5 U
February 2008				
PW (µg/L)	0 - 0.5	16.3	2.3 U	5 U

I-2

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
Sed (mg/kg)	0 - 0.5	254 K	-	-
PW (µg/L)	0 - 0.5	11.2 J	2.6 J	5 U
August 2007				
Sed (mg/kg)	0 - 0.5	315	-	-
Sed (mg/kg)	1 - 1.5	308	-	-
Sed (mg/kg)	2.5 - 3	575	-	-
PW (µg/L)	0 - 0.5	14.1 J	2.3 U	5 U
December 2007				
PW (µg/L)	0 - 0.5	12.2 J	3.1 J	5 U
February 2008				
PW (µg/L)	0 - 0.5	49.8	2.3 U	5 U

I-1

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
Sed (mg/kg)	0 - 0.5	316 K	-	-
PW (µg/L)	0 - 0.5	23.9	2.3 U	5 U
August 2007				
Sed (mg/kg)	0 - 0.5	700	-	-
Sed (mg/kg)	1 - 1.5	16.7	-	-
Sed (mg/kg)	2.5 - 3	22	-	-
PW (µg/L)	0 - 0.5	10.2 J	2.3 U	5 U
December 2007				
PW (µg/L)	0 - 0.5	52.2 L	3.1 J	5 U
February 2008				
PW (µg/L)	0 - 0.5	12.5 J	2.3 U	5 U

G-1

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
Sed (mg/kg)	0 - 0.5	67 J	-	-
PW (µg/L)	0 - 0.5	5 J	2.3 U	5 U
August 2007				
Sed (mg/kg)	0 - 0.5	67.1	-	-
Sed (mg/kg)	1.1 - 1.6	33.1	-	-
Sed (mg/kg)	2.5 - 3	28.8	-	-
PW (µg/L)	0 - 0.5	8.2 J	2.3 U	5 U

G-2

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
Sed (mg/kg)	0 - 0.5	123 J	-	-
PW (µg/L)	0 - 0.5	6.3 J	2.3 U	5 U
August 2007				
Sed (mg/kg)	0 - 0.5	153	-	-
Sed (mg/kg)	0.8 - 1.3	144 K	-	-
Sed (mg/kg)	2.5 - 3	50 K	-	-
PW (µg/L)	0 - 0.5	14.9 J	11.7 J	5 U
December 2007				
PW (µg/L)	0 - 0.5	14.5 J	10.2 J	5 U
February 2008				
PW (µg/L)	0 - 0.5	7.6 B	5 B	5 U

G-3

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
Sed (mg/kg)	0 - 0.5	148 K	-	-
PW (µg/L)	0 - 0.5	6.2 J	2.6 J	5 U
August 2007				
Sed (mg/kg)	0 - 0.5	164	-	-
Sed (mg/kg)	1 - 1.5	29.8 K	-	-
Sed (mg/kg)	2.5 - 3	29.6 K	-	-
PW (µg/L)	0 - 0.5	15.3	10.1 J	5 UJ

G-4

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
Sed (mg/kg)	0 - 0.5	121 K	-	-
PW (µg/L)	0 - 0.5	7.9 J	4.2 J	5 U
August 2007				
Sed (mg/kg)	0 - 0.5	140	-	-
Sed (mg/kg)	1 - 1.5	182	-	-
Sed (mg/kg)	2.5 - 3	197	-	-
PW (µg/L)	0 - 0.5	15.1	13.4 J	5 U
December 2007				
PW (µg/L)	0 - 0.5	9.8 J	8.1 J	5 U
February 2008				
PW (µg/L)	0 - 0.5	8 B	3.2 B	5 U

D-1

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
Sed (mg/kg)	0 - 0.5	304	-	-
PW (µg/L)	0 - 0.5	6.1 J	3.3 J	5 U
August 2007				
Sed (mg/kg)	0 - 0.5	310	-	-
Sed (mg/kg)	1 - 1.5	372	-	-
Sed (mg/kg)	2.5 - 3	251	-	-
PW (µg/L)	0 - 0.5	13 J	11 J	5 U
December 2007				
PW (µg/L)	0 - 0.5	13.6 J	11.7 J	5 U
February 2008				
PW (µg/L)	0 - 0.5	8.2 J	2.3 U	5 U

D-2

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
Sed (mg/kg)	0 - 0.5	239 J	-	-
PW (µg/L)	0 - 0.5	11.1 J	3.3 J	5 U
August 2007				
Sed (mg/kg)	0 - 0.5	258	-	-
Sed (mg/kg)	1 - 1.5	237	-	-
Sed (mg/kg)	2.5 - 3	66.1	-	-
PW (µg/L)	0 - 0.5	13.4 J	16.2 J	5 U
December 2007				
PW (µg/L)	0 - 0.5	23.7	9 J	5 U
February 2008				
PW (µg/L)	0 - 0.5	10.7 J	4.4 J	5 U

D-3

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
Sed (mg/kg)	0 - 0.5	306	-	-
PW (µg/L)	0 - 0.5	11.4 J	8.5 J	5 U
August 2007				
Sed (mg/kg)	0 - 0.5	253	-	-
Sed (mg/kg)	1 - 1.5	218	-	-
Sed (mg/kg)	2.5 - 3	95.8	-	-
PW (µg/L)	0 - 0.5	16.2	12.4 J	5 U
December 2007				
PW (µg/L)	0 - 0.5	13.5 J	6.6 J	5 U
February 2008				
PW (µg/L)	0 - 0.5	12.9 J	3.7 J	5 U

D-4

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
Sed (mg/kg)	0 - 0.5	198	-	-
PW (µg/L)	0 - 0.5	42.4	2.3 U	5 U
August 2007				
Sed (mg/kg)	0 - 0.5	214	-	-
Sed (mg/kg)	0.8 - 1.3	78.1	-	-
Sed (mg/kg)	2.5 - 3	60.2	-	-
PW (µg/L)	0 - 0.5	9.6 J	3.1 J	5 U
December 2007				
PW (µg/L)	0 - 0.5	24.2	2.3 UL	5 U
February 2008				
PW (µg/L)	0 - 0.5	21.2	2.3 U	5 U

C-1

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
Sed (mg/kg)	0 - 0.5	1160	-	-
PW (µg/L)	0 - 0.5	21.6	2.3 U	5 U
August 2007				
Sed (mg/kg)	0 - 0.5	1310	-	-
Sed (mg/kg)	0.8 - 1.3	2090	-	-
Sed (mg/kg)	2.3 - 2.8	1440	-	-
PW (µg/L)	0 - 0.5	38.6	2.3 U	5 U
December 2007				
PW (µg/L)	0 - 0.5	222	2.3 U	5 U
February 2008				
PW (µg/L)	0 - 0.5	149	2.3 U	5 U

C-2

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
Sed (mg/kg)	0 - 0.5	1080	-	-
PW (µg/L)	0 - 0.5	26.7	2.3 U	5 U
August 2007				
Sed (mg/kg)	0 - 0.5	1070	-	-
Sed (mg/kg)	1 - 1.5	91.5	-	-
Sed (mg/kg)	2 - 2.5	3.62	-	-
PW (µg/L)	0 - 0.5	331	2.3 U	5 U
December 2007				
PW (µg/L)	0 - 0.5	520	2.3 U	5 UJ
February 2008				
PW (µg/L)	0 - 0.5	632	2.4 J	5 U

C-3

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
Sed (mg/kg)	0 - 0.5	582	-	-
PW (µg/L)	0 - 0.5	17.2	2.3 U	5 U
August 2007				
Sed (mg/kg)	0 - 0.5	618	-	-
Sed (mg/kg)	1 - 1.5	250	-	-
Sed (mg/kg)	2.4 - 2.9	78.3	-	-
PW (µg/L)	0 - 0.5	22	2.3 U	5 U
December 2007				
Sed (mg/kg)	-		-	-
PW (µg/L)	0 - 0.5	53.5	3.4 J	5 U
February 2008				
PW (µg/L)	0 - 0.5	37.5	2.3 U	5 U

C-4

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
Sed (mg/kg)	0 - 0.5	357	-	-
PW (µg/L)	0 - 0.5	5.3 J	2.3 U	5 U
August 2007				
Sed (mg/kg)	0 - 0.5	315	-	-
Sed (mg/kg)	1 - 1.5	57	-	-
Sed (mg/kg)	2.5 - 3	2.32	-	-
PW (µg/L)	0 - 0.5	9.5 J	2.3 U	5 U
December 2007				
PW (µg/L)	0 - 0.5	11.5 J	3.8 J	5 U
February 2008				
PW (µg/L)	0 - 0.5	6.7 J	2.3 U	5 U

J-4

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
February 2008				
Sed (mg/kg)	0 - 0.5	2360	-	-
Sed (mg/kg)	0.5 - 1	8140 J	-	-
Sed (mg/kg)	2.5 - 3	114 J	-	-
PW (µg/L)	0 - 0.5	1880	2.3 UL	5 U

A-1

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
Sed (mg/kg)	0 - 0.5	698	-	-
PW (µg/L)	0 - 0.5	162	2.3 U	5 U
August 2007				
Sed (mg/kg)	0 - 0.5	1200	-	-
Sed (mg/kg)	0.9 - 1.4	1330 K	-	-
Sed (mg/kg)	2.5 - 3	17 K	-	-
PW (µg/L)	0 - 0.5	77.6	2.3 U	5 U
December 2007				
PW (µg/L)	0 - 0.5	207 L	2.3 UL	5 U
February 2008				
PW (µg/L)	0 - 0.5	68	2.3 U	5 U

A-2

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
Sed (mg/kg)	0 - 0.5	363	-	-
PW (µg/L)	0 - 0.5	19	2.3 U	5 U
August 2007				
Sed (mg/kg)	0 - 0.5	347	-	-
Sed (mg/kg)	0.9 - 1.4	315 K	-	-
Sed (mg/kg)	2.5 - 3	78.3 K	-	-
PW (µg/L)	NS	-	-	-
December 2007				
PW (µg/L)	0 - 0.5	2630	4.3 J	5 U
February 2008				
PW (µg/L)	0 - 0.5	5 J	2.3 U	5 U

A-3

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
Sed (mg/kg)	0 - 0.5	96.6	-	-
PW (µg/L)	0 - 0.5	33.3	2.3 U	5 U
August 2007				
Sed (mg/kg)	0 - 0.5	110	-	-
Sed (mg/kg)	1 - 1.5	2.91 K	-	-
Sed (mg/kg)	2.5 - 3	3.94 K	-	-
PW (µg/L)	NS	-	-	-
December 2007				
PW (µg/L)	0 - 0.5	2.3 UJ	3.1 J	5 U
February 2008				
PW (µg/L)	0 - 0.5	32 L	2.9 J	5 U

A-4

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
Sed (mg/kg)	0 - 0.5	89.6	-	-
PW (µg/L)	NES	-	-	-
August 2007				
Sed (mg/kg)	0 - 0.5	97.4	-	-
Sed (mg/kg)	1 - 1.5	12.8 K	-	-
Sed (mg/kg)	2.5 - 3	34.1 K	-	-
PW (µg/L)	NS	-	-	-
December 2007				
PW (µg/L)	0 - 0.5	509	3.2 J	5 U
February 2008				
PW (µg/L)	0 - 0.5	56.7 L	2.3 U	5 U

E-1

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
Sed (mg/kg)	0 - 0.5	223 K	-	-
PW (µg/L)	0 - 0.5	3.4 J	4.8 J	5 U
August 2007				
Sed (mg/kg)	0 - 0.5	253	-	-
Sed (mg/kg)	1 - 1.5	217	-	-
Sed (mg/kg)	2.5 - 3	68.2	-	-
PW (µg/L)	0 - 0.5	7.5 J	6.5 J	5 U
December 2007				
PW (µg/L)	0 - 0.5	118 L	4 J	5 U
February 2008				
PW (µg/L)	0 - 0.5	91.1	2.3 U	5 U

E-2

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
Sed (mg/kg)	0 - 0.5	66.9	-	-
PW (µg/L)	0 - 0.5	5.9 J	2.3 U	5 U
August 2007				
Sed (mg/kg)	0 - 0.5	64.9	-	-
Sed (mg/kg)	1 - 1.5	61.4	-	-
Sed (mg/kg)	2.5 - 3	62.1	-	-
PW (µg/L)	0 - 0.5	10.2 J	12.2 J	5 U
December 2007				
PW (µg/L)	0 - 0.5	10.1 J	8.1 J	5 U
February 2008				
PW (µg/L)	0 - 0.5	8.5 B	5.7 B	5 U

E-3

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
Sed (mg/kg)	0 - 0.5	238	-	-
PW (µg/L)	0 - 0.5	5.8 J	3.2 J	5 U
August 2007				
Sed (mg/kg)	0 - 0.5	197	-	-
Sed (mg/kg)	1 - 1.5	262	-	-
Sed (mg/kg)	2.5 - 3	259	-	-
PW (µg/L)	0 - 0.5	17.6	13.5 J	5 U

E-4

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
Sed (mg/kg)	0 - 0.5	61.2	-	-
PW (µg/L)	0 - 0.5	35.1	2.3 U	5 U
August 2007				
Sed (mg/kg)	0 - 0.5	114 K	-	-
Sed (mg/kg)	1 - 1.5	52.1	-	-
Sed (mg/kg)	2.5 - 3	125	-	-
PW (µg/L)	0 - 0.5	4.4 J	2.3 U	5 U
December 2007				
PW (µg/L)	0 - 0.5	6.5 J	2.3 UL	5 U
February 2008				
PW (µg/L)	0 - 0.5	2.3 U	2.3 U	5 U

F-1

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
Sed (mg/kg)	0 - 0.5	97.9	-	-
PW (µg/L)	0 - 0.5	3 J	3 J	5 U
August 2007				
Sed (mg/kg)	0 - 0.5	117	-	-
Sed (mg/kg)	1 - 1.5	76.7	-	-
Sed (mg/kg)	2.5 - 3	159	-	-
PW (µg/L)	0 - 0.5	8.8 J	7.4 J	5 U

F-2

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
Sed (mg/kg)	0 - 0.5	65.8	-	-
PW (µg/L)	0 - 0.5	3.8 J	2.3 U	5 U
August 2007				
Sed (mg/kg)	0 - 0.5	33.1	-	-
Sed (mg/kg)	1 - 1.5	49.3 K	-	-
Sed (mg/kg)	2.5 - 3	36.9 K	-	-
PW (µg/L)	0 - 0.5	5.6 J	3.2 J	5 U
December 2007				
PW (µg/L)	0 - 0.5	7.4 J	3.5 J	5 U
February 2008				
PW (µg/L)	0 - 0.5	10.7 J	6.2 J	5 U

F-3

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
Sed (mg/kg)	0 - 0.5	152	-	-
PW (µg/L)	0 - 0.5	11.5 J	4.7 J	5 U
August 2007				
Sed (mg/kg)	0 - 0.5	211	-	-
Sed (mg/kg)	1.2 - 1.7	56	-	-
Sed (mg/kg)	2.5 - 3	56.2	-	-
PW (µg/L)	0 - 0.5	14.5 J	10.1 J	5 U

F-4

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
Sed (mg/kg)	0 - 0.5	211	-	-
PW (µg/L)	0 - 0.5	4.6 J	3.2 J	5 U
August 2007				
Sed (mg/kg)	0 - 0.5	190	-	-
Sed (mg/kg)	1 - 1.5	120	-	-
Sed (mg/kg)	2.5 - 3	55.1	-	-
PW (µg/L)	0 - 0.5	8 J	8.2 J	5 U
December 2007				
PW (µg/L)	0 - 0.5	9.3 J	2.3 U	5 U
February 2008				
PW (µg/L)	0 - 0.5	9.4 J	5.7 J	5 U

37A

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
Sed (mg/kg)	0 - 0.5	95.6	-	-
PW (µg/L)	0 - 0.5	2.9 J	4.1 J	5 U
August 2007				
Sed (mg/kg)	0 - 0.5	124	-	-
Sed (mg/kg)	1 - 1.5	99.4	-	-
Sed (mg/kg)	2.5 - 3	55.3	-	-
PW (µg/L)	0 - 0.5	10.8 J	11.4 J	5 U
December 2007				
PW (µg/L)	0 - 0.5	8.9 J	4.8 J	5 U
February 2008				
PW (µg/L)	0 - 0.5	10.2 J	6.1 J	5 U

37

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
Sed (mg/kg)	0 - 0.5	127	-	-
PW (µg/L)	0 - 0.5	6.2 J	5 J	5 U
August 2007				
Sed (mg/kg)	0 - 0.5	161	-	-
Sed (mg/kg)	1 - 1.5	147	-	-
Sed (mg/kg)	2.5 - 3	84.9	-	-
PW (µg/L)	0 - 0.5	7.9 J	9.7 J	5 U
December 2007				
PW (µg/L)	0 - 0.5	14.7 J	2.3 U	5 U
February 2008				
PW (µg/L)	0 - 0.5	14.3 J	9.6 B	5 U

37B

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
Sed (mg/kg)	0 - 0.5	89.2	-	-
PW (µg/L)	0 - 0.5	8.1 J	8.4 J	5 U
August 2007				
Sed (mg/kg)	0 - 0.5	166	-	-
Sed (mg/kg)	1.2 - 1.7	55.8	-	-
Sed (mg/kg)	2.5 - 3	75.4	-	-
PW (µg/L)	0 - 0.5	8 J	11.6 J	5 U
December 2007				
PW (µg/L)	0 - 0.5	13.7 J	2.3 U	5 U
February 2008				
PW (µg/L)	0 - 0.5	12.6 J	5 J	5 U

J-1

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
February 2008				
Sed (mg/kg)	0 - 0.5	1830	-	-
Sed (mg/kg)	0.8 - 1.3	1620	-	-
Sed (mg/kg)	2.5 - 3	2730	-	-
PW (µg/L)	0 - 0.5	96.5	2.3 UL	5 U

J-2

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
February 2008				
Sed (mg/kg)	0 - 0.5	1840	-	-
Sed (mg/kg)	1 - 1.5	605	-	-
Sed (mg/kg)	2.5 - 3	303	-	-
PW (µg/L)	0 - 0.5	112	2.3 UL	5 U

J-3

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
February 2008				
Sed (mg/kg)	0 - 0.5	1260	-	-
Sed (mg/kg)	0.6 - 1.1	28.2	-	-
Sed (mg/kg)	2.5 - 3	567	-	-
PW (µg/L)	0 - 0.5	61.4	2.3 UL	5 U

B-4

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
Sed (mg/kg)	0 - 0.5	424	-	-
PW (µg/L)	0 - 0.5	6.2 J	2.3 U	5 U
August 2007				
Sed (mg/kg)	0 - 0.5	404 K	-	-
Sed (mg/kg)	1 - 1.5	2290	-	-
Sed (mg/kg)	2.5 - 3	690	-	-
PW (µg/L)	0 - 0.5	10.9 J	2.3 U	5 U
December 2007				
PW (µg/L)	0 - 0.5	10 J	2.3 U	5 UJ
February 2008				
PW (µg/L)	0 - 0.5	17.9	2.3 U	5 U

B-5

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
February 2008				
Sed (mg/kg)	0 - 0.5	54.3	-	-
Sed (mg/kg)	0.5 - 1	43.6 J	-	-
Sed (mg/kg)	2.3 - 2.9	37.9 J	-	-
PW (µg/L)	0 - 0.5	46.8	2.3 UL	5 U

B-1

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
Sed (mg/kg)	0 - 0.5	640	-	-
PW (µg/L)	0 - 0.5	9.1 J	2.3 U	5 U
August 2007				
Sed (mg/kg)	0 - 0.5	595	-	-
Sed (mg/kg)	0.8 - 1.3	80.9	-	-
Sed (mg/kg)	2.5 - 3	29.4	-	-
PW (µg/L)	0 - 0.5	44.7	3.5 J	5 U
December 2007				
PW (µg/L)	0 - 0.5	50.9	2.3 U	5 UJ
February 2008				
PW (µg/L)	0 - 0.5	42.9	2.3 U	5 U

B-2

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
Sed (mg/kg)	0 - 0.5	369	-	-
PW (µg/L)	0 - 0.5	13.2 J	2.3 U	5 U
August 2007				
Sed (mg/kg)	0 - 0.5	236	-	-
Sed (mg/kg)	0.6 - 1.1	22.7	-	-
Sed (mg/kg)	1.9 - 2.4	1.97	-	-
PW (µg/L)	0 - 0.5	8.7 J	2.3 U	5 U
December 2007				
PW (µg/L)	0 - 0.5	74.1	2.3 U	5 UJ
February 2008				
PW (µg/L)	0 - 0.5	52	2.3 U	5 U

B-3

Matrix	Depth Interval (ft)	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
Sed (mg/kg)	0 - 0.5	683	-	-
PW (µg/L)	0 - 0.5	5.6 J	2.3 U	5 U
August 2007				
Sed (mg/kg)	0 - 0.5	637 K	-	-
Sed (mg/kg)	1 - 1.5	94	-	-
Sed (mg/kg)	2.5 - 3	1.15 J	-	-
PW (µg/L)	0 - 0.5	4.5 J	2.3 U	5 U
December 2007				
PW (µg/L)	0 - 0.5	19.1	2.3 J	5 UJ
February 2008				
PW (µg/L)	0 - 0.5	11.6 J	2.3 U	5 U

Legend

- ● Sample Location
- ● Sample Location - February 2008 only
- ○ Sample Location - not sampled in December 2007 or February 2008
- Storm Sewer Line
- COPR Extent
- Railroad Centerline
- ▭ Areas

Water Depth in Feet (NAVD88)

- -4 feet
- -50 feet

National Recommended Water Quality Criteria	Cr(III) Freshwater*, µg/L	Cr(III) Saltwater, µg/L	Cr(IV) Freshwater, µg/L	Cr(IV) Saltwater µg/L
Acute Dissolved	1,770	NA	16	1,100
Chronic Dissolved	231	NA	11	50

*The freshwater criteria for Cr(III) are based on hardness of 400 mg/L, which is USEPA's upper limit for calculating site-specific hardness-dependent water quality criteria

N
W E
S

0 300 600 1,200 1,800 2,400
Feet

U = not detected
J = estimated value
UJ = not detected; the associated detection limit is an estimate and may be inaccurate or imprecise
L = analyte present; reported value may be biased low. Actual value may be higher.
UL = Not Detected, quantitation limit is probably higher
K = Analyte present. Reported value may be biased high. Actual value may be lower.
B = Not detected substantially above the level reported in laboratory or field blank

Figure 5-1b
Total Chromium and Cr(VI) Results for Pore Water and Sediment
Dundalk Marine Terminal
Baltimore, Maryland

ENVIRON
CH2MHILL

H-1

Matrix	Depth	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
SW - S (µg/L)	3 ft	2.3 U	2.3 U	5 U
SW - M (µg/L)	15 ft	2.3 U	2.3 U	5 U
SW - D (µg/L)	28 ft	2.3 U	2.3 U	5 U
August 2007				
SW - S (µg/L)	3 ft	2.3 U	2.3 U	5 UJ
SW - M (µg/L)	22 ft	2.3 U	2.3 U	5 UJ
SW - D (µg/L)	35 ft	2.3 U	2.3 U	5 UJ
December 2007				
SW - S (µg/L)	1.5 ft	2.5 J	3.6 J	5 UJ
SW - M (µg/L)	16.5 ft	2.3 UJ	2.7 J	5 UJ
SW - D (µg/L)	32.5 ft	2.3 U	2.3 U	5 UJ
February 2008				
SW - S (µg/L)	2.5 ft	4.2 J	2.3 J	5 U
SW - M (µg/L)	18 ft	2.3 U	2.3 U	5 U
SW - D (µg/L)	34.5 ft	2.3 U	2.3 U	5 U

H-2

Matrix	Depth	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
SW - S (µg/L)	3 ft	2.3 U	2.3 U	5 U
SW - M (µg/L)	16 ft	2.3 U	2.3 U	5 U
SW - D (µg/L)	30 ft	2.3 U	2.3 U	5 U
August 2007				
SW - S (µg/L)	3 ft	2.3 U	2.3 U	5 UJ
SW - M (µg/L)	25 ft	2.3 U	2.3 U	5 UJ
SW - D (µg/L)	35 ft	2.3 U	2.3 U	5 UJ

H-3

Matrix	Depth	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
SW - S (µg/L)	3 ft	2.3 U	2.3 U	5 U
SW - M (µg/L)	16 ft	2.3 U	2.3 U	5 U
SW - D (µg/L)	30 ft	2.3 U	2.3 U	5 U
August 2007				
SW - S (µg/L)	3 ft	2.3 U	2.3 U	5 UJ
SW - M (µg/L)	22 ft	2.3 U	2.3 U	5 UJ
SW - D (µg/L)	36 ft	2.3 U	2.3 U	5 UJ

H-4

Matrix	Depth	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
SW - S (µg/L)	3 ft	2.3 U	2.3 U	5 U
SW - M (µg/L)	18 ft	2.3 U	2.3 U	5 U
SW - D (µg/L)	34 ft	2.6 J	2.3 U	5 U
August 2007				
SW - S (µg/L)	3 ft	2.3 U	2.3 U	5 U
SW - M (µg/L)	20 ft	2.3 U	2.3 U	5 U
SW - D (µg/L)	38 ft	2.3 U	2.3 U	5 UJ
December 2007				
SW - S (µg/L)	2 ft	2.3 U	2.3 U	5 UJ
SW - M (µg/L)	19 ft	2.3 U	2.3 U	5 UJ
SW - D (µg/L)	38 ft	2.7 J	2.3 U	5 UJ
February 2008				
SW - S (µg/L)	2.5 ft	2.3 U	2.3 U	5 U
SW - M (µg/L)	19 ft	2.3 U	2.3 U	5 U
SW - D (µg/L)	40 ft	2.3 U	2.3 U	5 U

I-4

Matrix	Depth	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
SW - S (µg/L)	3 ft	2.3 U	2.3 U	5 U
SW - D (µg/L)	6 ft	2.3 U	2.3 U	5 U
August 2007				
SW - S (µg/L)	3 ft	2.3 U	2.3 U	5 U
SW - M (µg/L)	5.5 ft	3 J	2.3 U	5 U
SW - D (µg/L)	9 ft	4.1 J	2.3 U	5 U
December 2007				
SW - S (µg/L)	1.5 ft	2.8 J	2.3 U	5 U
SW - D (µg/L)	6.5 ft	4 J	2.3 U	5 U
February 2008				
SW - S (µg/L)	2.5 ft	2.3 U	2.3 U	5 U
SW - D (µg/L)	7.5 ft	2.3 U	2.3 U	5 U

I-3

Matrix	Depth	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
SW - S (µg/L)	3 ft	2.3 U	2.3 U	5 U
SW - M (µg/L)	5.3 ft	2.3 U	2.3 U	5 U
SW - D (µg/L)	8.5 ft	3.7 J	2.3 U	5 U
August 2007				
SW - S (µg/L)	3 ft	3.3 J	2.3 U	5 U
SW - M (µg/L)	5.5 ft	2.3 U	2.3 U	5 U
SW - D (µg/L)	9 ft	2.3 U	2.3 U	5 U
December 2007				
SW - S (µg/L)	2 ft	2.3 U	2.3 U	5 UJ
SW - D (µg/L)	6.5 ft	2.3 U	2.3 U	5 UJ
February 2008				
SW - S (µg/L)	2.5 ft	2.3 U	2.3 U	5 U
SW - D (µg/L)	7.5 ft	2.3 U	2.3 U	5 U

I-2

Matrix	Depth	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
SW - S (µg/L)	3 ft	2.3 U	2.3 U	5 U
SW - D (µg/L)	7 ft	2.3 U	2.3 U	5 U
August 2007				
SW - S (µg/L)	3 ft	2.3 U	2.3 U	5 U
SW - M (µg/L)	5.5 ft	2.3 U	2.3 U	5 U
SW - D (µg/L)	9 ft	2.3 U	2.3 U	5 U
December 2007				
SW - S (µg/L)	2 ft	2.3 UJ	2.9 J	5 UJ
SW - D (µg/L)	6 ft	2.3 J	2.3 U	5 UJ
February 2008				
SW - S (µg/L)	2.5 ft	2.3 U	2.3 U	5 U
SW - D (µg/L)	7 ft	2.3 U	2.3 U	5 U

I-1

Matrix	Depth	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
SW - M (µg/L)	2.1 ft	21.3	2.3 U	5 U
August 2007				
SW - S (µg/L)	2 ft	2.3 U	2.3 U	5 U
SW - D (µg/L)	4 ft	2.3 U	2.3 U	5 U
December 2007				
SW - M (µg/L)	1.5 ft	3 J	2.3 J	5 U
February 2008				
SW - M (µg/L)	2.1 ft	2.8 J	2.3 U	5 U

G-1

Matrix	Depth	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
SW - S (µg/L)	3 ft	2.3 U	2.3 U	5 U
SW - M (µg/L)	17 ft	2.3 U	2.3 U	5 U
SW - D (µg/L)	32 ft	2.3 U	2.3 U	5 U
August 2007				
SW - S (µg/L)	3 ft	3 J	2.3 U	5 U
SW - M (µg/L)	20 ft	2.3 U	2.3 U	5 U
SW - D (µg/L)	35 ft	3.3 J	2.3 U	5 U

G-2

Matrix	Depth	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
SW - S (µg/L)	3 ft	2.3 U	2.3 U	5 U
SW - M (µg/L)	19.5 ft	2.3 U	2.3 U	5 U
SW - D (µg/L)	37 ft	2.3 U	2.3 U	5 U
August 2007				
SW - S (µg/L)	3 ft	2.3 U	2.3 U	5 UJ
SW - M (µg/L)	20 ft	2.3 U	2.3 U	5 UJ
SW - D (µg/L)	37 ft	2.3 U	2.3 U	5 UJ
December 2007				
SW - S (µg/L)	2 ft	3.5 J	2.3 U	5 UJ
SW - M (µg/L)	18 ft	2.3 U	2.3 U	5 UJ
SW - D (µg/L)	38 ft	4.6 J	2.3 U	5 UJ
February 2008				
SW - S (µg/L)	2.5 ft	2.3 U	2.3 UL	5 U
SW - M (µg/L)	20 ft	2.3 U	2.3 UL	5 U
SW - D (µg/L)	39 ft	2.3 UJ	2.6 J	5 U

G-3

Matrix	Depth	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
SW - S (µg/L)	3 ft	2.3 U	2.3 U	5 U
SW - M (µg/L)	22 ft	2.3 U	2.3 U	5 U
SW - D (µg/L)	41.5 ft	2.3 U	2.3 U	5 U
August 2007				
SW - S (µg/L)	3 ft	2.3 U	2.3 U	5 U
SW - M (µg/L)	25 ft	2.3 U	2.3 U	5 U
SW - D (µg/L)	40 ft	2.3 U	2.3 U	5 U

G-4

Matrix	Depth	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
SW - S (µg/L)	3 ft	2.3 U	2.3 U	5 U
SW - M (µg/L)	14.5 ft	2.3 U	2.3 U	5 U
SW - D (µg/L)	27 ft	2.3 U	2.3 U	5 U
August 2007				
SW - S (µg/L)	3 ft	2.3 U	2.3 U	5 U
SW - M (µg/L)	13 ft	2.3 U	2.3 U	5 U
SW - D (µg/L)	24 ft	4 J	2.3 U	5 U
December 2007				
SW - S (µg/L)	2 ft	3.8 J	2.3 U	5 UJ
SW - M (µg/L)	17 ft	2.3 U	2.3 U	5 UJ
SW - D (µg/L)	34 ft	2.3 U	2.3 U	5 UJ
February 2008				
SW - S (µg/L)	2.5 ft	2.3 U	2.3 UL	5 U
SW - M (µg/L)	17 ft	2.3 U	2.3 UL	5 U
SW - D (µg/L)	35 ft	2.3 U	2.3 UL	5 U

D-1

Matrix	Depth	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
SW - S (µg/L)	3 ft	3.1 J	2.3 U	5 U
SW - M (µg/L)	18 ft	2.3 U	2.3 U	5 U
SW - D (µg/L)	34 ft	2.3 U	2.3 U	5 U
August 2007				
SW - S (µg/L)	0.3 ft	2.3 U	2.3 U	5 U
SW - M (µg/L)	20 ft	2.3 U	2.3 U	5 U
SW - D (µg/L)	40 ft	2.3 U	2.3 U	5 U
December 2007				
SW - S (µg/L)	1.5 ft	7.9 J	6.5 J	5 U
SW - M (µg/L)	19 ft	4.4 J	4.8 J	5 U
SW - D (µg/L)	37.5 ft	4.2 J	2.5 J	5 U
February 2008				
SW - S (µg/L)	2.5 ft	16.6 J	17.3 J	10.5
SW - M (µg/L)	20 ft	2.3 UL	2.3 UL	5 U
SW - D (µg/L)	40.5 ft	2.3 UJ	2.7 J	5 U

D-2

Matrix	Depth	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
SW - S (µg/L)	3 ft	2.3 U	2.3 U	5 U
SW - M (µg/L)	22 ft	2.3 U	2.3 U	5 U
SW - D (µg/L)	42 ft	2.3 U	2.3 U	5 U
August 2007				
SW - S (µg/L)	3 ft	6 J	2.3 U	5 U
SW - M (µg/L)	22 ft	2.3 U	2.3 U	5 U
SW - D (µg/L)	42 ft	2.3 U	2.3 U	5 U
December 2007				
SW - S (µg/L)	2 ft	2.3 U	2.3 U	5 U
SW - M (µg/L)	22 ft	2.3 U	2.3 U	5 U
SW - D (µg/L)	42 ft	2.3 UJ	2.5 J	5 U
February 2008				
SW - S (µg/L)	2.5 ft	3.8 J	2.8 J	5 U
SW - M (µg/L)	21 ft	2.3 UL	2.3 UL	5 U
SW - D (µg/L)	43.5 ft	2.3 UL	2.3 UL	5 U

D-3

Matrix	Depth	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
SW - S (µg/L)	3 ft	6.2 J	2.3 U	5 U
SW - M (µg/L)	23 ft	2.3 U	2.3 U	5 U
SW - D (µg/L)	40 ft	2.3 U	2.3 U	5 U
August 2007				
SW - S (µg/L)	3 ft	3.9 J	3.2 J	5 U
SW - M (µg/L)	25 ft	2.5 J	2.3 U	5 U
SW - D (µg/L)	39 ft	2.3 U	2.3 U	5 U
December 2007				
SW - S (µg/L)	2 ft	2.9 J	2.3 U	5 U
SW - M (µg/L)	22 ft	2.3 U	2.3 U	5 U
SW - D (µg/L)	40 ft	3.7 J	2.3 U	5 U
February 2008				
SW - S (µg/L)	2.5 ft	9.7 J	9.4 J	6.3 J
SW - M (µg/L)	21 ft	2.3 UL	2.3 UL	5 U
SW - D (µg/L)	42.5 ft	2.3 UL	2.3 UL	5 U

D-4

Matrix	Depth	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
SW - S (µg/L)	3 ft	2.3 U	2.3 U	5 UJ
SW - M (µg/L)	5 ft	2.3 U	2.3 U	5 UJ
SW - D (µg/L)	8 ft	2.3 U	2.3 U	5 UJ
August 2007				
SW - S (µg/L)	3 ft	3.6 J	2.3 U	5 UJ
SW - M (µg/L)	5 ft	5.9 J	2.3 U	5 UJ
SW - D (µg/L)	8.5 ft	4.1 J	2.3 U	5 UJ
December 2007				
SW - S (µg/L)	2 ft	2.3 UJ	2.7 J	5 U
SW - D (µg/L)	9 ft	2.3 UJ	4.5 J	5 U
February 2008				
SW - S (µg/L)	1.5 ft	2.3 UL	2.3 UL	5 U
SW - M (µg/L)	5 ft	2.6 J	2.3 UL	5 U
SW - D (µg/L)	10 ft	3.2 J	2.3 UL	5 U

C-1

Matrix	Depth	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
SW - M (µg/L)	2 ft	3.2 J	2.3 U	5 UJ
August 2007				
SW - S (µg/L)	2 ft	12.2 J	7.6 J	5 UJ
SW - D (µg/L)	4 ft	14.1 J	8.4 J	5 UJ
December 2007				
SW - M (µg/L)	2 ft	8.6 J	6.6 J	7 J
February 2008				
SW - M (µg/L)	2.2 ft	2.3 UL	2.3 UL	5 U

C-2

Matrix	Depth	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
SW - S (µg/L)	2 ft	2.3 U	2.3 U	5 UJ
SW - D (µg/L)	4 ft	2.3 U	2.3 U	5 UJ
August 2007				
SW - S (µg/L)	2 ft	8.9 J	4.2 J	5 U
SW - D (µg/L)	5 ft	9.3 J	5.6 J	5 UJ
December 2007				
SW - S (µg/L)	2 ft	2.3 U	2.3 U	5 U
SW - D (µg/L)	6 ft	2.3 U	2.3 U	5 U
February 2008				
SW - M (µg/L)	3 ft	2.3 UL	2.3 UL	5 U

C-3

Matrix	Depth	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
SW - S (µg/L)	3 ft	2.3 U	2.3 U	5 UJ
SW - D (µg/L)	6 ft	2.3 U	2.3 U	5 UJ
August 2007				
SW - S (µg/L)	2 ft	5.7 J	5.6 J	5 UJ
SW - M (µg/L)	5 ft	5.2 J	4.5 J	5 UJ
SW - D (µg/L)	8 ft	7.5 J	5.8 J	5 UJ
December 2007				
SW - S (µg/L)	2 ft	2.3 UJ	2.9 J	5 U
SW - D (µg/L)	8 ft	2.3 U	2.3 U	5 U
February 2008				
SW - S (µg/L)	2 ft	2.3 UL	2.3 UL	5 U
SW - D (µg/L)	8.5 ft	2.3 UL	2.3 UL	5 U

C-4

Matrix	Depth	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
SW - S (µg/L)	3 ft	2.3 U	2.3 U	5 UJ
SW - D (µg/L)	7.5 ft	2.3 U	2.3 U	5 UJ
August 2007				
SW - S (µg/L)	2 ft	5 J	5.5 J	5 UJ
SW - M (µg/L)	5.5 ft	5.1 J	6.2 J	5 UJ
SW - D (µg/L)	9 ft	2.3 UJ	2.6 J	5 UJ
December 2007				
SW - S (µg/L)	2 ft	2.3 U	2.3 U	5 U
SW - D (µg/L)	8 ft	2.3 U	2.3 J	5 U
February 2008				
SW - S (µg/L)	3 ft	2.3 UL	2.3 UL	5 U
SW - D (µg/L)	9 ft	2.3 UL	2.3 UL	5 U

J-4

Matrix	Depth	Total Cr	Dissolved Cr	Cr(VI)
February 2008				
SW - M (µg/L)	1 ft	16.9	2.3 U	5 U

A-1

Matrix	Depth	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
SW - M (µg/L)	2 ft	6.8 J	2.3 U	5 U
August 2007				
SW - S (µg/L)	2 ft	2.3 U	2.3 U	5 U
SW - D (µg/L)	4 ft	2.8 J	2.3 U	5 UJ
December 2007				
SW - M (µg/L)	1.5 ft	9.8 J	5.6 J	5 U
February 2008				
SW - S (µg/L)	1.5 ft	2.3 U	2.3 UL	5 U
SW - D (µg/L)	4 ft	2.3 U	2.3 UL	5 U

A-2

Matrix	Depth	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
SW - M (µg/L)	2 ft	3.4 J	2.3 U	5 U
August 2007				
SW - S (µg/L)	1.5 ft	2.3 U	2.3 U	5 UJ
SW - D (µg/L)	3.5 ft	2.3 U	2.3 U	5 UJ
December 2007				
SW - M (µg/L)	2 ft	2.3 U	2.3 U	5 U
February 2008				
SW - M (µg/L)	2.4 ft	2.3 UJ	2.4 J	5 U

A-3

Matrix	Depth	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
SW - M (µg/L)	2 ft	3.5 J	2.3 U	5 U
August 2007				
SW - M (µg/L)	2.5 ft	2.3 U	2.3 U	5 UJ
December 2007				
SW - M (µg/L)	2 ft	2.3 U	2.3 U	5 U
February 2008				
SW - M (µg/L)	2.3 ft	2.3 U	2.3 U	5 U

A-4

Matrix	Depth	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
SW - M (µg/L)	2 ft	3 J	2.3 U	5 U
August 2007				
SW - M (µg/L)	2.2 ft	2.3 U	2.3 U	5 UJ
December 2007				
SW - M (µg/L)	2 ft	2.3 U	2.3 U	5 U
February 2008				
SW - M (µg/L)	2.5 ft	2.3 U	2.3 U	5 U

E-1

Matrix	Depth	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
SW - S (µg/L)	3 ft	2.3 U	2.3 U	5 U
SW - M (µg/L)	21.5 ft	2.3 U	2.3 U	5 U
SW - D (µg/L)	41 ft	2.3 U	2.3 U	5 U
August 2007				
SW - S (µg/L)	3 ft	37.5	21.3	25.7
SW - M (µg/L)	22 ft	2.3 U	2.3 U	5 U
SW - D (µg/L)	42 ft	2.3 U	2.3 U	5 U
December 2007				
SW - S (µg/L)	1.5 ft	44.4	37.6	30.4
SW - M (µg/L)	17 ft	5.4 J	5.5 J	5 U
SW - D (µg/L)	37 ft	3 J	2.7 J	5 U
February 2008				
SW - S (µg/L)	2.5 ft	11.8 J	6.1 J	8.1 J
SW - M (µg/L)	19 ft	3.1 J	2.4 J	5 U
SW - D (µg/L)	43.5 ft	2.3 U	2.3 U	5 U

E-2

Matrix	Depth	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
SW - S (µg/L)	3 ft	2.3 U	2.3 U	5 U
SW - M (µg/L)	22 ft	2.3 U	2.3 U	5 U
SW - D (µg/L)	42.5 ft	2.3 U	2.3 U	5 U
August 2007				
SW - S (µg/L)	3 ft	4.4 J	2.3 U	5 U
SW - M (µg/L)	22 ft	2.3 U	2.3 U	5 U
SW - D (µg/L)	42 ft	2.3 U	2.3 U	5 U
December 2007				
SW - S (µg/L)	2 ft	5.2 J	10.2 J	11 J
SW - M (µg/L)	22 ft	3.7 J	3 J	5 U
SW - D (µg/L)	42 ft	2.3 U	2.3 U	5 U
February 2008				
SW - S (µg/L)	2.5 ft	2.3 U	2.3 UL	5 U
SW - M (µg/L)	19 ft	2.3 UJ	2.7 B	5 U
SW - D (µg/L)	41 ft	2.3 U	2.3 UL	5 U

E-3

Matrix	Depth	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
SW - S (µg/L)	3 ft	2.3 U	2.3 U	5 U
SW - M (µg/L)	25 ft	2.3 U	2.3 U	5 U
SW - D (µg/L)	39 ft	2.3 U	2.3 U	5 U
August 2007				
SW - S (µg/L)	3 ft	3.8 J	3.1 J	5 U
SW - M (µg/L)	28 ft	2.4 J	2.3 U	5 U
SW - D (µg/L)	40 ft	2.3 U	2.3 U	5 U

E-4

Matrix	Depth	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
SW - S (µg/L)	3 ft	2.3 UJ	3.3 J	5 UJ
SW - M (µg/L)	6 ft	2.6 J	3.2 J	5 UJ
SW - D (µg/L)	11 ft	3.9 J	2.3 J	5 UJ
August 2007				
SW - S (µg/L)	3 ft	3.3 J	2.4 J	5 U
SW - M (µg/L)	7 ft	3.7 J	2.3 U	5 U
SW - D (µg/L)	12 ft	5.6 J	2.3 U	5 U
December 2007				
SW - S (µg/L)	2 ft	3.4 J	3.6 J	5 U
SW - M (µg/L)	9 ft	2.5 J	2.3 U	5 U
SW - D (µg/L)	13 ft	3.1 J	2.3 U	5 U
February 2008				
SW - S (µg/L)	2 ft	2.3 UL	2.3 UL	5 U
SW - M (µg/L)	9 ft	2.3 UL	2.3 UL	5 U
SW - D (µg/L)	15.5 ft	5.6 J	2.8 J	5 U

F-1

Matrix	Depth	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
SW - S (µg/L)	3 ft	2.3 U	2.3 U	5 U
SW - M (µg/L)	18 ft	2.3 U	2.3 U	5 U
SW - D (µg/L)	34 ft	2.3 U	2.3 U	5 U
August 2007				
SW - S (µg/L)	3 ft	2.3 U	2.3 U	5 UJ
SW - M (µg/L)	25 ft	2.3 U	2.3 U	5 UJ
SW - D (µg/L)	35 ft	2.3 U	2.3 U	5 UJ

F-2

Matrix	Depth	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
SW - S (µg/L)	3 ft	2.3 U	2.3 U	5 U
SW - M (µg/L)	15 ft	2.3 U	2.3 U	5 U
SW - D (µg/L)	42 ft	2.3 U	2.3 U	5 U
August 2007				
SW - S (µg/L)	3 ft	2.3 U	2.3 U	5 U
SW - M (µg/L)	25 ft	2.3 U	2.3 U	5 UJ
SW - D (µg/L)	43 ft	2.3 U	2.3 U	5 UJ
December 2007				
SW - S (µg/L)	2 ft	2.3 U	2.3 U	5 UJ
SW - M (µg/L)	20 ft	2.3 U	2.3 U	5 UJ
SW - D (µg/L)	40 ft	2.3 U	2.3 U	5 UJ
February 2008				
SW - S (µg/L)	2.5 ft	2.3 U	2.3 U	5 UJ
SW - M (µg/L)	22 ft	3.8 J	2.3 U	5 UJ
SW - D (µg/L)	43 ft	2.3 U	2.3 U	5 UJ

F-3

Matrix	Depth	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
SW - S (µg/L)	3 ft	2.3 U	2.3 U	5 U
SW - M (µg/L)	16 ft	2.3 U	2.3 U	5 U
SW - D (µg/L)	30 ft	2.3 U	2.3 U	5 U
August 2007				
SW - S (µg/L)	3 ft	2.3 U	2.3 U	5 U
SW - M (µg/L)	20 ft	2.3 U	2.3 U	5 U
SW - D (µg/L)	35 ft	2.3 U	2.3 U	5 UJ

F-4

Matrix	Depth	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
SW - S (µg/L)	3 ft	2.3 UJ	2.3 U	5 UJ
SW - M (µg/L)	15 ft	2.3 UJ	2.3 U	5 UJ
SW - D (µg/L)	24.5 ft	3.8 J	2.3 U	5 UJ
August 2007				
SW - S (µg/L)	3 ft	2.3 U	2.3 U	5 U
SW - M (µg/L)	10 ft	2.3 U	2.3 U	5 U
SW - D (µg/L)	24 ft	2.3 U	2.3 U	5 U
December 2007				
SW - S (µg/L)	2 ft	2.3 U	2.3 U	5 UJ
SW - M (µg/L)	15 ft	2.3 U	2.3 U	5 UJ
SW - D (µg/L)	25 ft	2.3 U	2.3 U	5 UJ
February 2008				
SW - S (µg/L)	2.5 ft	2.3 U	2.3 U	5 UJ
SW - M (µg/L)	15 ft	2.3 U	2.3 U	5 UJ
SW - D (µg/L)	26 ft	2.3 U	2.3 U	5 UJ

37A

Matrix	Depth	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
SW - S (µg/L)	3 ft	2.3 U	2.3 U	5 U
SW - M (µg/L)	20 ft	2.3 U	2.3 U	5 U
SW - D (µg/L)	35 ft	2.3 U	2.3 U	5 U
August 2007				
SW - S (µg/L)	3 ft	2.3 U	2.3 U	5 UJ
SW - M (µg/L)	19 ft	2.3 U	2.3 U	5 UJ
SW - D (µg/L)	35 ft	2.3 U	2.3 U	5 UJ
December 2007				
SW - S (µg/L)	2 ft	2.3 UJ	3.4 J	5 U
SW - M (µg/L)	18 ft	2.3 UJ	2.7 J	5 U
SW - D (µg/L)	36 ft	2.3 U	2.3 U	5 U
February 2008				
SW - S (µg/L)	2.5 ft	3.5 J	3.3 J	5 UJ
SW - M (µg/L)	18 ft	2.3 U	2.3 U	5 UJ
SW - D (µg/L)	36 ft	2.7 J	2.3 U	5 UJ

37

Matrix	Depth	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
SW - S (µg/L)	3 ft	2.3 U	2.3 U	5 U
SW - M (µg/L)	22 ft	2.3 U	2.3 U	5 U
SW - D (µg/L)	37 ft	2.3 U	2.3 U	5 U
August 2007				
SW - S (µg/L)	3 ft	2.3 U	2.3 U	5 UJ
SW - M (µg/L)	14 ft	2.3 U	2.3 U	5 UJ
SW - D (µg/L)	37 ft	2.3 U	2.3 U	5 UJ
December 2007				
SW - S (µg/L)	2 ft	2.9 J	2.3 U	5 UJ
SW - M (µg/L)	17 ft	3.4 J	2.3 U	5 UJ
SW - D (µg/L)	37 ft	3 J	2.3 U	5 UJ
February 2008				
SW - S (µg/L)	2.5 ft	2.3 U	2.3 U	5 U
SW - M (µg/L)	19 ft	2.3 U	2.3 U	5 U
SW - D (µg/L)	38 ft	2.3 U	2.3 U	5 U

37B

Matrix	Depth	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
SW - S (µg/L)	3 ft	2.3 U	2.3 U	5 U
SW - M (µg/L)	20 ft	2.3 U	2.3 U	5 U
SW - D (µg/L)	34 ft	2.3 U	2.3 U	5 U
August 2007				
SW - S (µg/L)	3 ft	2.3 U	2.3 U	5 UJ
SW - M (µg/L)	19 ft	2.3 U	2.3 U	5 UJ
SW - D (µg/L)	35 ft	2.3 U	2.3 U	5 UJ
December 2007				
SW - S (µg/L)	2 ft	2.3 U	2.3 U	5 U
SW - M (µg/L)	17 ft	3 J	2.3 U	5 U
SW - D (µg/L)	35 ft	4.5 J	2.3 U	5 UJ
February 2008				
SW - S (µg/L)	2.5 ft	3.2 J	2.3 U	5 UJ
SW - M (µg/L)	19 ft	2.3 U	2.3 U	5 UJ
SW - D (µg/L)	37 ft	3.4 J	2.3 U	5 U

J-1

Matrix	Depth	Total Cr	Dissolved Cr	Cr(VI)
February 2008				
SW - M (µg/L)	0.8 ft	22.8	2.3 U	5 U

J-2

Matrix	Depth	Total Cr	Dissolved Cr	Cr(VI)
February 2008				
SW - M (µg/L)	2 ft	2.7 J	2.3 U	5 U

J-3

Matrix	Depth	Total Cr	Dissolved Cr	Cr(VI)
February 2008				
SW - M (µg/L)	2.2 ft	2.8 J	2.3 U	5 U

B-1

Matrix	Depth	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
SW - M (µg/L)	2.5 ft	2.3 U	2.3 U	5 U
August 2007				
SW - S (µg/L)	2 ft	5.8 J	3.8 J	5 U
SW - D (µg/L)	5 ft	11.1 J	5.2 J	5 U
December 2007				
SW - S (µg/L)	2 ft	2.3 U	2.3 U	5 U
SW - D (µg/L)	7 ft	2.3 U	2.3 U	5 U
February 2008				
SW - S (µg/L)	3 ft	2.3 U	2.3 U	5 U
SW - D (µg/L)	7 ft	4 J	4.2 J	5 U

B-2

Matrix	Depth	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
SW - S (µg/L)	3 ft	2.6 J	2.3 U	5 UJ
SW - D (µg/L)	7 ft	2.6 J	2.3 U	5 UJ
August 2007				
SW - S (µg/L)	3 ft	7.4 J	5.7 J	5 U
SW - D (µg/L)	6 ft	10.2 J	7.3 J	5 U
December 2007				
SW - S (µg/L)	2 ft	2.3 U	2.3 U	5 U
SW - D (µg/L)	9 ft	3.3 J	3.3 J	5 U
February 2008				
SW - S (µg/L)	3 ft	2.3 UL	2.3 UL	5 U
SW - D (µg/L)	9 ft	5.5 J	2.3 UL	5 U

B-3

Matrix	Depth	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
SW - S (µg/L)	3 ft	6.2 J	2.3 U	5 U
SW - D (µg/L)	7 ft	4 J	2.3 U	5 U
August 2007				
SW - S (µg/L)	3 ft	9.4 J	6.1 J	6 J
SW - D (µg/L)	7 ft	7.3 J	6 J	5 U
December 2007				
SW - S (µg/L)	1.5 ft	2.3 U	2.3 U	5 U
SW - M (µg/L)	5.5 ft	2.3 U	2.3 U	5 U
SW - D (µg/L)	10 ft	3.2 J	2.3 U	5 U
February 2008				
SW - S (µg/L)	3 ft	2.3 UL	2.3 UL	5 U
SW - D (µg/L)	9.5 ft	2.3 UL	2.3 UL	5 U

B-4

Matrix	Depth	Total Cr	Dissolved Cr	Cr(VI)
May 2007				
SW - S (µg/L)	3 ft	2.3 U	2.3 U	5 U
SW - D (µg/L)	6 ft	2.3 U	2.3 U	5 U
August 2007				
SW - S (µg/L)	3 ft	35.1	29.7	34.9
SW - M (µg/L)	5.5 ft	31.3	26 J	32.9
SW - D (µg/L)	8.5 ft	32.9	29	32
December 2007				
SW - S (µg/L)	1.5 ft	2.3 U	2.3 U	5 U
SW - M (µg/L)	5.5 ft	4.2 J	2.3 U	5 U
SW - D (µg/L)	10.4 ft	5 J	3.1 J	5 U
February 2008				
SW - S (µg/L)	1.5 ft	2.3 UL	2.3 UL	5 U
SW - M (µg/L)	5.5 ft	3.7 J	2.3 UL	5 U
SW - D (µg/L)	10 ft	2.7 J	2.3 UL	5 U

B-5

Matrix	Depth	Total Cr	Dissolved Cr	Cr(VI)
February 2008				
SW - S (µg/L)	2.5 ft	2.3 U	2.3 U	5 U
SW - D (µg/L)	7 ft	2.3 U	2.3 U	5 U

Legend

- ● Sample Location
- ● Sample Location - February 2008 only
- ○ Sample Location - not sampled in December 2007 or February 2008
- Storm Sewer Line
- COPR Extent
- Railroad Centerline
- ☐ Areas

Water Depth in Feet (NAVD88)

- -4 feet
- -50 feet

National Recommended Water Quality Criteria	Cr(III) Freshwater*, µg/L	Cr(III) Saltwater, µg/L	Cr(IV) Freshwater, µg/L	Cr(IV) Saltwater µg/L
Acute Dissolved	1,770	NA	16	1,100
Chronic Dissolved	231	NA	11	50

*The freshwater criteria for Cr(III) are based on hardness of 400 mg/L, which is USEPA's upper limit for calculating site-specific hardness-dependent water quality criteria

N
W E
S

0 300 600 1,200 1,800 2,400
Feet

SW - S = surface depth sample
SW – M = mid-depth sample
SW – D = deep depth sample
U = not detected
J = estimated value
UJ = not detected; the associated detection limit is an estimate and may be inaccurate or imprecise
L = Analyte present. Reported value may be biased low. Actual value is expected higher.

Figure 5-1c
Total Chromium and Cr(VI) Results for Surface Water
Dundalk Marine Terminal
Baltimore, Maryland

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Figure 5-2a. Maximum Cr(III) Concentrations in Pore Water by Transect against Water Quality Criteria - May 2007 through February 2008

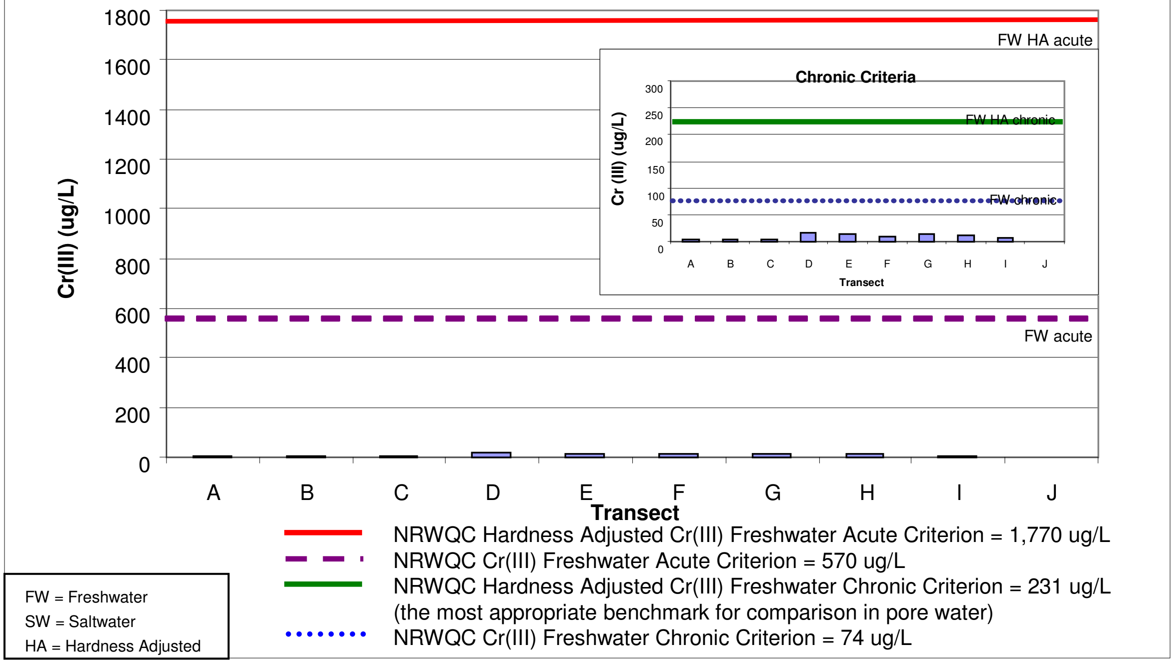

Figure 5-2b. Mean Concentrations of Cr(III) in Pore Water by Distance from the Shoreline - May 2007 through February 2008

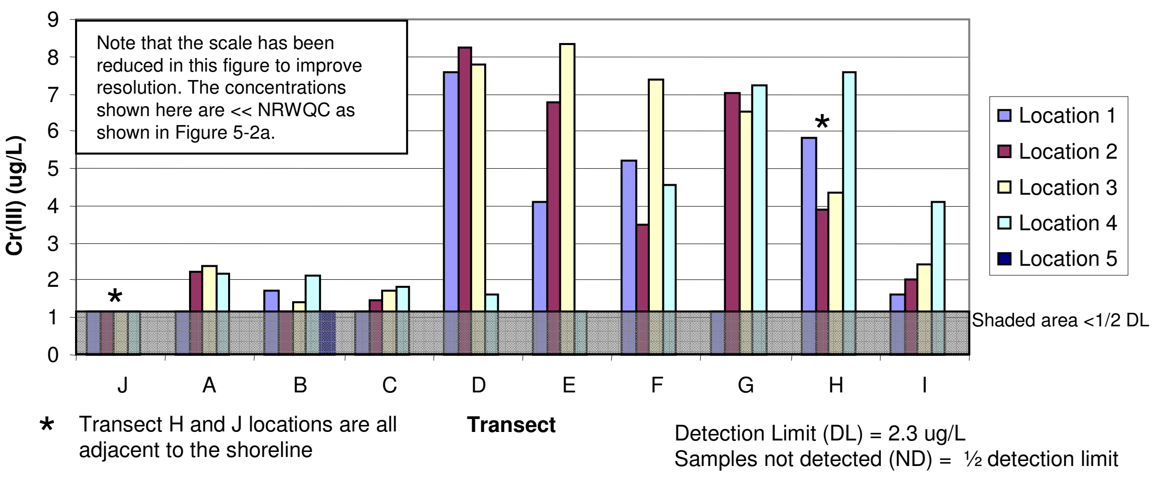

Figure 5-2a. This figure shows that even the maximum concentration of dissolved Cr(III) in pore water at DMT is not only below the current chronic NRWQC but is far below the hardness adjusted value recommended by USEPA for sites that are estuarine or marine and even further below the acute criterion. **Figure 5-2b.** This figure demonstrates the higher concentrations of dissolved Cr(III) in pore water at the deeper water Transects D – H than in the shallow Transects A, B, C and J. Only Transect D and E show a declining trend in dissolved Cr(III) concentrations with distance from the shoreline.

[1] Cr(III) as dissolved total chromium

FIGURE 5-2a-b
Dissolved Chromium in Pore Water
Dundalk Marine Terminal, Baltimore, Maryland

Figure 5-3a. Maximum Cr(VI) Concentrations in Surface Water by Transect against Water Quality Criteria - May 2007 through February 2008

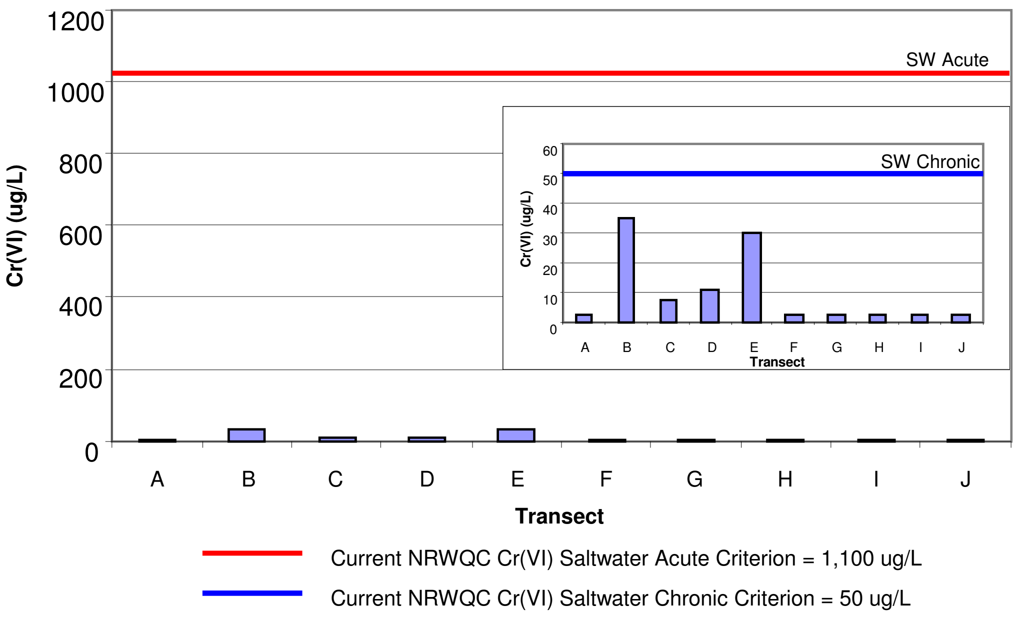

Figure 5-3b: Cr(VI) Detections in Surface Water and Corresponding 3-Day Rainfall Totals

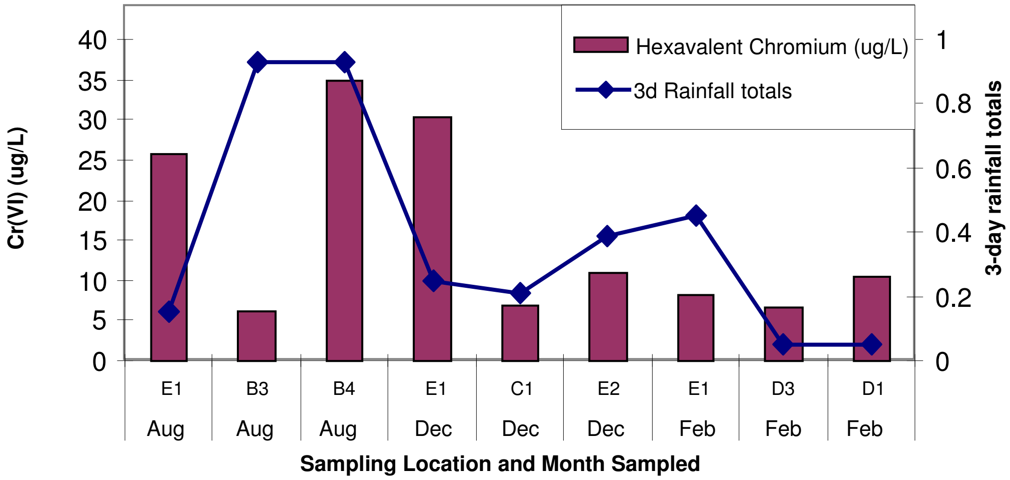

Figure 5-3a. This figure shows that even the maximum concentrations of Cr(VI) at DMT are below both the acute and chronic NRWQC. Cr(VI) was detected at Transects B, C, D and E only. **Figure 5-3b**. This figure demonstrates the relationship between Cr(VI) detections in surface water and corresponding 3-day rainfall totals.

FIGURE 5-3a-b
Cr(VI) in Surface Water
Dundalk Marine Terminal, Baltimore, Maryland

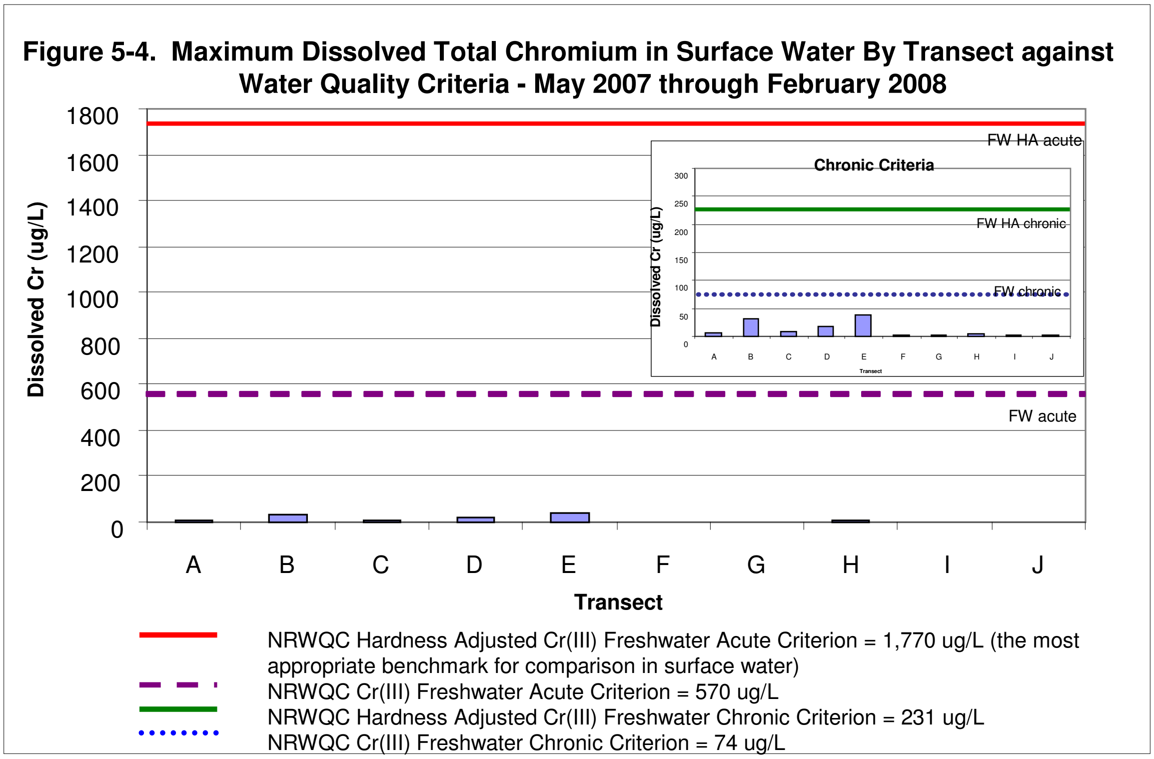

Figure 5-4. This figure shows that even the maximum concentration of dissolved chromium in surface water at DMT is not only below the current NRWQC but is far below the hardness adjusted value recommended by USEPA for sites that are estuarine or marine and even further below the Freshwater Acute Criterion of 570 ug/L. Organisms that inhabit the water column would only be acutely exposed to dissolved chromium in surface water.

FIGURE 5-4
Dissolved Chromium in Surface Water
Dundalk Marine Terminal, Baltimore, Maryland

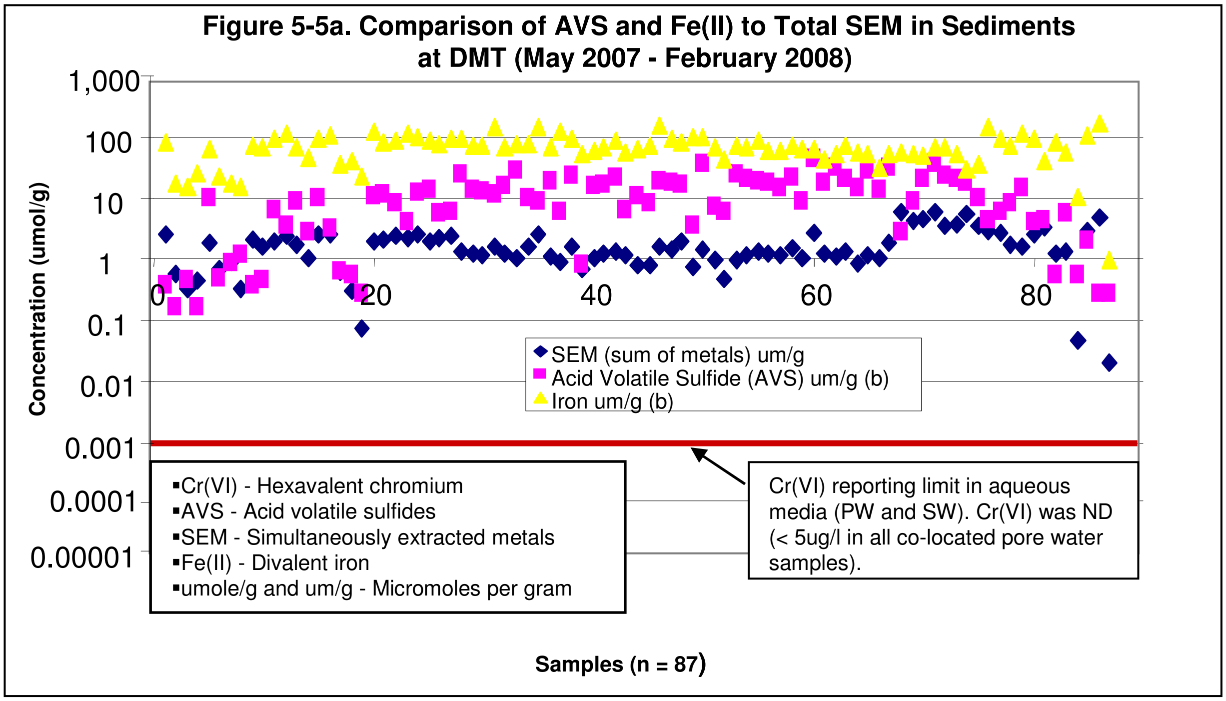

Figure 5-5a. Comparison of AVS and Fe(II) to Total SEM in Sediments at DMT (May 2007 - February 2008)

- Cr(VI) - Hexavalent chromium
- AVS - Acid volatile sulfides
- SEM - Simultaneously extracted metals
- Fe(II) - Divalent iron
- umole/g and um/g - Micromoles per gram

Cr(VI) reporting limit in aqueous media (PW and SW). Cr(VI) was ND (< 5ug/l in all co-located pore water samples).

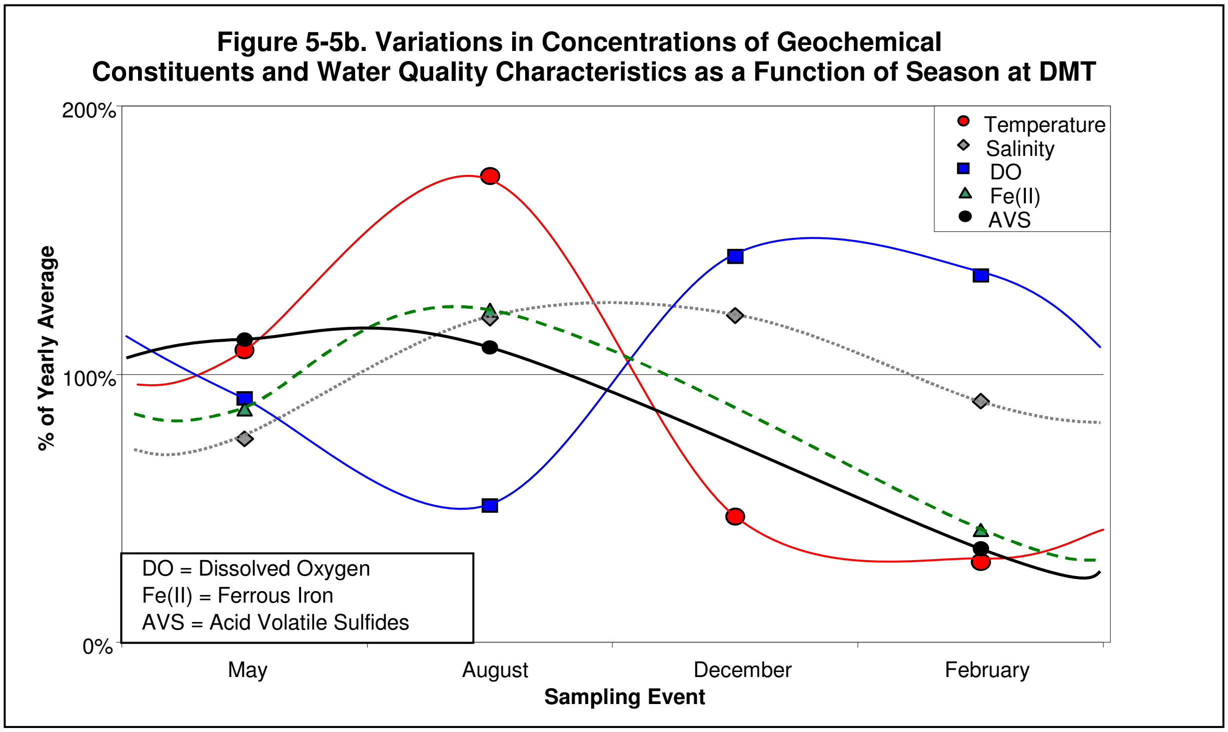

Figure 5-5b. Variations in Concentrations of Geochemical Constituents and Water Quality Characteristics as a Function of Season at DMT

DO = Dissolved Oxygen
Fe(II) = Ferrous Iron
AVS = Acid Volatile Sulfides

Figure 5-5a. This figure shows that in the few areas where SEM metals exceed AVS or AVS only slightly exceeds SEM, there is abundant Fe(II) so that divalent metals are not biologically available for uptake by biota and there is sufficient reducing power in the sediments to insure the existence of Cr(III) vs. Cr(VI). **Figure 5-5b.** This figure shows how changes in the water temperatures that occurs with season influences salinity and dissolved oxygen concentrations which in turn influences concentrations of the key reductants AVS and Fe(II). Note that AVS and Fe(II) are highest in the warmest months due to increases in microbial activity that deplete oxygen in the water column. Despite seasonal fluctuations there is ample reducing power in DMT sediments to insure the stability of Cr(III).

FIGURE 5-5a-b
Geochemical Constituents in Sediment
Dundalk Marine Terminal, Baltimore, Maryland

\\Aphrodite\projects\HoneywellInc\327494DMT\Projects\SW_SD_Sampling_Plan\Figure 5-6 - Results for Other COPR Constituents in SD.mxd

I-4

Matrix	Depth Interval (ft)	Al	Ca	Fe	Mg	Mn	V
May 2007							
Sed (mg/kg)	0 - 0.5	12400	35900	32700	5980	368	156
August 2007							
Sed (mg/kg)	0 - 0.5	21100	10400	42500	7830	447	145
Sed (mg/kg)	0.8 - 1.3	19900	7020	50300	6190	323	229
Sed (mg/kg)	2.1 - 2.6	12600	2880	28700	3240	131	287

I-3

Matrix	Depth Interval (ft)	Al	Ca	Fe	Mg	Mn	V
May 2007							
Sed (mg/kg)	0 - 0.5	17900	7560	34400	7530	425	122
August 2007							
Sed (mg/kg)	0 - 0.5	20400	6280	34200	6830	411	237
Sed (mg/kg)	1 - 1.5	19900	5160	32700	6470	393	153
Sed (mg/kg)	2.5 - 3	15700	5760	27300	5460	284	134

I-2

Matrix	Depth Interval (ft)	Al	Ca	Fe	Mg	Mn	V
May 2007							
Sed (mg/kg)	0 - 0.5	12300	6360	23500	5830	274	85.5
August 2007							
Sed (mg/kg)	0 - 0.5	12200	9030	24800	7600	260	91.5
Sed (mg/kg)	1 - 1.5	15600	8710	29600	7490	332	95.7
Sed (mg/kg)	2.5 - 3	19700	5320	39600	5890	345	170

I-1

Matrix	Depth Interval (ft)	Al	Ca	Fe	Mg	Mn	V
May 2007							
Sed (mg/kg)	0 - 0.5	9320	7110	19200	5690	218	59.1
August 2007							
Sed (mg/kg)	0 - 0.5	7350	9370	18100	8320	207	70.8
Sed (mg/kg)	1 - 1.5	6250	371	7550	1330	168	17.2
Sed (mg/kg)	2.5 - 3	9190	588	12700	2130	296	22.1

H-1

Matrix	Depth Interval (ft)	Al	Ca	Fe	Mg	Mn	V
May 2007							
Sed (mg/kg)	0 - 0.5	14200	139000	23100	6220	544	55.3
August 2007							
Sed (mg/kg)	0 - 0.5	19600	3000	28900	5040	545	55
Sed (mg/kg)	1 - 1.5	18800	6110	30500	6450	653	87.6
Sed (mg/kg)	2.5 - 3	5420	2050	3460	803	61.4	20

H-2

Matrix	Depth Interval (ft)	Al	Ca	Fe	Mg	Mn	V
May 2007							
Sed (mg/kg)	0 - 0.5	7290	14900	12100	2080	171	29.3
August 2007							
Sed (mg/kg)	0 - 0.5	24000	4690	32100	6440	521	77
Sed (mg/kg)	1 - 1.5	5710	49900	8490	2180	119	24.2
Sed (mg/kg)	2.5 - 3	5660	1500	14500	1780	215	99

H-3

Matrix	Depth Interval (ft)	Al	Ca	Fe	Mg	Mn	V
May 2007							
Sed (mg/kg)	0 - 0.5	8550	4820	11900	2700	240	28.7
August 2007							
Sed (mg/kg)	0 - 0.5	9860	2780	14800	2840	242	45.4
Sed (mg/kg)	1 - 1.5	11300	4560	17200	3710	318	44.2
Sed (mg/kg)	2.5 - 3	14300	3460	20800	3670	370	57.6

H-4

Matrix	Depth Interval (ft)	Al	Ca	Fe	Mg	Mn	V
May 2007							
Sed (mg/kg)	0 - 0.5	21300	2570	31900	5570	573	60.8
August 2007							
Sed (mg/kg)	0 - 0.5	23200	17400	37500	9340	795	99.6
Sed (mg/kg)	1 - 1.5	18000	1210	22500	3020	295	48.4
Sed (mg/kg)	2.5 - 3	12300	514	5910	1260	63	25.5

C-1

Matrix	Depth Interval (ft)	Al	Ca	Fe	Mg	Mn	V
May 2007							
Sed (mg/kg)	0 - 0.5	10300	49100	25100	21500	1100	61.8
August 2007							
Sed (mg/kg)	0 - 0.5	11200	45100	29800	22500	1120	67.9
Sed (mg/kg)	0.8 - 1.3	19000	23300	47800	15300	546	112
Sed (mg/kg)	2.3 - 2.8	8560	29500	46200	15500	249	86.5

J-1

Matrix	Depth Interval (ft)	Al	Ca	Fe	Mg	Mn	V
February 2008							
Sed (mg/kg)	0 - 0.5	7740	63500	24300	22000	1290	67.2
Sed (mg/kg)	0.8 - 1.3	9860	46500	53000	12200	233	95
Sed (mg/kg)	2.5 - 3	15500	21800	36800	17000	567	134

C-2

Matrix	Depth Interval (ft)	Al	Ca	Fe	Mg	Mn	V
May 2007							
Sed (mg/kg)	0 - 0.5	9230	23000	24300	11700	717	62.4
August 2007							
Sed (mg/kg)	0 - 0.5	8200	24000	22900	12500	652	62.6
Sed (mg/kg)	1 - 1.5	955	137	2390	270	19.7	6.77
Sed (mg/kg)	2 - 2.5	440	90.6	1390	171	9.02	1.65

J-2

Matrix	Depth Interval (ft)	Al	Ca	Fe	Mg	Mn	V
February 2008							
Sed (mg/kg)	0 - 0.5	7010	41600	26700	13400	670	88.5
Sed (mg/kg)	1 - 1.5	10100	1270	21500	2240	207	52.5
Sed (mg/kg)	2.5 - 3	2560	420	6450	752	65.5	13.5

C-3

Matrix	Depth Interval (ft)	Al	Ca	Fe	Mg	Mn	V
May 2007							
Sed (mg/kg)	0 - 0.5	11400	4640	27500	4440	420	57.9
August 2007							
Sed (mg/kg)	0 - 0.5	12800	2900	29500	4830	465	58.4
Sed (mg/kg)	1 - 1.5	24300	1740	30300	5200	533	48.1
Sed (mg/kg)	2.4 - 2.9	18700	1200	23400	3710	305	38.2

J-3

Matrix	Depth Interval (ft)	Al	Ca	Fe	Mg	Mn	V
February 2008							
Sed (mg/kg)	0 - 0.5	6090	17800	23700	6430	492	64.1
Sed (mg/kg)	0.6 - 1.1	1200	190	10400	138	23.7	20.8
Sed (mg/kg)	2.5 - 3	10400	1430	29400	2150	214	89.2

C-4

Matrix	Depth Interval (ft)	Al	Ca	Fe	Mg	Mn	V
May 2007							
Sed (mg/kg)	0 - 0.5	13700	3210	31400	3730	477	61.3
August 2007							
Sed (mg/kg)	0 - 0.5	14200	2810	31200	4290	600	57.6
Sed (mg/kg)	1 - 1.5	37600	1930	48800	10500	2010	74.6
Sed (mg/kg)	2.5 - 3	1120	56.4	865	201	7.94	2.05

J-4

Matrix	Depth Interval (ft)	Al	Ca	Fe	Mg	Mn	V
February 2008							
Sed (mg/kg)	0 - 0.5	9540	13300	28400	30200	2070	70
Sed (mg/kg)	0.5 - 1	12000	12500	37200	17600	919	146
Sed (mg/kg)	2.5 - 3	846	32.6	1180	116	5.77	2.36

A-1

Matrix	Depth Interval (ft)	Al	Ca	Fe	Mg	Mn	V
May 2007							
Sed (mg/kg)	0 - 0.5	4390	12900	30800	4830	406	42.7
August 2007							
Sed (mg/kg)	0 - 0.5	7410	5500	36800	5550	438	69.7
Sed (mg/kg)	0.9 - 1.4	6450	1280	35700	1930	145	75
Sed (mg/kg)	2.5 - 3	227	10.3 J	1570	24.1	1.89	1.42

A-2

Matrix	Depth Interval (ft)	Al	Ca	Fe	Mg	Mn	V
May 2007							
Sed (mg/kg)	0 - 0.5	1470	317	7410	372	134	15
August 2007							
Sed (mg/kg)	0 - 0.5	1420	275	6950	422	70.9	14.8
Sed (mg/kg)	0.9 - 1.4	11400	374	33600	1470	83.1	32
Sed (mg/kg)	2.5 - 3	272	10.5 J	316	16.2	1.69	2.02

A-3

Matrix	Depth Interval (ft)	Al	Ca	Fe	Mg	Mn	V
May 2007							
Sed (mg/kg)	0 - 0.5	1140	341	6240	269	177	9.4
August 2007							
Sed (mg/kg)	0 - 0.5	1200	198	6180	378	120	9.71
Sed (mg/kg)	1 - 1.5	1200	89.3	20400	233	15.1	2.98
Sed (mg/kg)	2.5 - 3	1530	51.2	5110	200	2.96	3.28

A-4

Matrix	Depth Interval (ft)	Al	Ca	Fe	Mg	Mn	V
May 2007							
Sed (mg/kg)	0 - 0.5	1770	416	37600	305	185	13.4
August 2007							
Sed (mg/kg)	0 - 0.5	1520	294	25600	423	116	12.3
Sed (mg/kg)	1 - 1.5	3250	88.1	8240	344	8.08	12.5
Sed (mg/kg)	2.5 - 3	12700	150	6030	953	25.3	32.3

B-1

Matrix	Depth Interval (ft)	Al	Ca	Fe	Mg	Mn	V
May 2007							
Sed (mg/kg)	0 - 0.5	6930	3280	25900	3880	618	50.3
August 2007							
Sed (mg/kg)	0 - 0.5	5650	5310	25200	3830	275	48.6
Sed (mg/kg)	0.8 - 1.3	12200	3380	19100	2610	221	33.8
Sed (mg/kg)	2.5 - 3	18500	341	15500	2920	76.4	40.8

B-2

Matrix	Depth Interval (ft)	Al	Ca	Fe	Mg	Mn	V
May 2007							
Sed (mg/kg)	0 - 0.5	7310	13100	24300	2540	383	38
August 2007							
Sed (mg/kg)	0 - 0.5	6260	1990	20600	1940	254	29.5
Sed (mg/kg)	0.6 - 1.1	18100	299	12700	2620	61.3	31.4
Sed (mg/kg)	1.9 - 2.4	889	59.2	1600	177	3.86	2.3

B-3

Matrix	Depth Interval (ft)	Al	Ca	Fe	Mg	Mn	V
May 2007							
Sed (mg/kg)	0 - 0.5	19700	3110	39300	5030	559	86.2
August 2007							
Sed (mg/kg)	0 - 0.5	28400	2240	48400	6710	807	90.2
Sed (mg/kg)	1 - 1.5	9440	1470	14100	2420	203	22.5
Sed (mg/kg)	2.5 - 3	227	41.5	274	98.3	3.01	1.26

B-4

Matrix	Depth Interval (ft)	Al	Ca	Fe	Mg	Mn	V
May 2007							
Sed (mg/kg)	0 - 0.5	17200	2210	36500	4050	462	90
August 2007							
Sed (mg/kg)	0 - 0.5	16800	2510	34600	4070	463	88.2
Sed (mg/kg)	1 - 1.5	27400	2570	129000	4900	357	367
Sed (mg/kg)	2.5 - 3	31900	1650	50400	7110	516	78.1

B-5

Matrix	Depth Interval (ft)	Al	Ca	Fe	Mg	Mn	V
February 2008							
Sed (mg/kg)	0 - 0.5	3110	5510	10800	863	156	22.9
Sed (mg/kg)	0.5 - 1	3840	920	12900	794 J	78	24.7 J
Sed (mg/kg)	2.3 - 2.9	4690	229	14700	939	84.8	24.9

D-1

Matrix	Depth Interval (ft)	Al	Ca	Fe	Mg	Mn	V
May 2007							
Sed (mg/kg)	0 - 0.5	27600	18500	44100	17800	2010	89
August 2007							
Sed (mg/kg)	0 - 0.5	27500	9750	46100	10700	1800	85.6
Sed (mg/kg)	1 - 1.5	23700	21200	36400	55000	2760	85.6
Sed (mg/kg)	2.5 - 3	23400	79700	36800	10200	1540	71.3

D-2

Matrix	Depth Interval (ft)	Al	Ca	Fe	Mg	Mn	V
May 2007							
Sed (mg/kg)	0 - 0.5	24900	4030	42200	7390	1900	76.4
August 2007							
Sed (mg/kg)	0 - 0.5	28000	4910	49300	7940	3550	91.6
Sed (mg/kg)	1 - 1.5	28400	4030	45000	6950	1420	86.9
Sed (mg/kg)	2.5 - 3	28500	2850	50600	5950	770	65.8

D-3

Matrix	Depth Interval (ft)	Al	Ca	Fe	Mg	Mn	V
May 2007							
Sed (mg/kg)	0 - 0.5	29400	3680	48600	7890	1940	91
August 2007							
Sed (mg/kg)	0 - 0.5	30500	3730	52900	8010	2260	93.5
Sed (mg/kg)	1 - 1.5	28400	3510	44600	7180	1360	85
Sed (mg/kg)	2.5 - 3	31100	2870	52400	6760	1200	60.6

D-4

Matrix	Depth Interval (ft)	Al	Ca	Fe	Mg	Mn	V
May 2007							
Sed (mg/kg)	0 - 0.5	12000	7690	28700	3110	428	48
August 2007							
Sed (mg/kg)	0 - 0.5	19600	1470	36300	4310	415	59.5
Sed (mg/kg)	0.8 - 1.3	42600	2060	47500	7790	675	82.5
Sed (mg/kg)	2.5 - 3	39200	2010	51000	10600	2280	79.3

E-1

Matrix	Depth Interval (ft)	Al	Ca	Fe	Mg	Mn	V
May 2007							
Sed (mg/kg)	0 - 0.5	20600	25600	37100	11300	2600	67.2
August 2007							
Sed (mg/kg)	0 - 0.5	28500	22800	48400	25900	1620	86.6
Sed (mg/kg)	1 - 1.5	27500	9650	42600	12100	1780	80.8
Sed (mg/kg)	2.5 - 3	27700	2500	48800	7180	911	59.9

E-2

Matrix	Depth Interval (ft)	Al	Ca	Fe	Mg	Mn	V
May 2007							
Sed (mg/kg)	0 - 0.5	30200	2010	53400	7660	1250	57.9
August 2007							
Sed (mg/kg)	0 - 0.5	30200	1550	56700	7550	1050	61.3
Sed (mg/kg)	1 - 1.5	31600	2880	55900	6800	879	60.3
Sed (mg/kg)	2.5 - 3	30800	2940	56500	6350	839	61.2

E-3

Matrix	Depth Interval (ft)	Al	Ca	Fe	Mg	Mn	V
May 2007							
Sed (mg/kg)	0 - 0.5	29100	3770	47300	7500	1020	97.3
August 2007							
Sed (mg/kg)	0 - 0.5	26800	3100	45900	7210	1220	83.1
Sed (mg/kg)	1 - 1.5	25400	3260	45300	6680	2050	90.2
Sed (mg/kg)	2.5 - 3	28200	3550	46400	7290	1850	106

E-4

Matrix	Depth Interval (ft)	Al	Ca	Fe	Mg	Mn	V
May 2007							
Sed (mg/kg)	0 - 0.5	6890	1770	14800	1840	253	26
August 2007							
Sed (mg/kg)	0 - 0.5	12300	3290	23400	3850	374	40.9
Sed (mg/kg)	1 - 1.5	27800	2200	31900	4920	532	55.3
Sed (mg/kg)	2.5 - 3	30100	1750	37500	5290	325	65.7

G-1

Matrix	Depth Interval (ft)	Al	Ca	Fe	Mg	Mn	V
May 2007							
Sed (mg/kg)	0 - 0.5	7240	1910	16700	2250	236	26
August 2007							
Sed (mg/kg)	0 - 0.5	8680	3260	24000	2700	255	34.9
Sed (mg/kg)	1.1 - 1.6	14300	7650	28500	3190	131	41.7
Sed (mg/kg)	2.5 - 3	12300	2070	28600	2760	183	34.9

G-2

Matrix	Depth Interval (ft)	Al	Ca	Fe	Mg	Mn	V
May 2007							
Sed (mg/kg)	0 - 0.5	19000	2540	32700	5410	614	61.4
August 2007							
Sed (mg/kg)	0 - 0.5	23000	2270	40700	6300	770	79.4
Sed (mg/kg)	0.8 - 1.3	19400	2260	32900	4640	466	61.8
Sed (mg/kg)	2.5 - 3	13300	1310	24800	3550	148	48.1

G-3

Matrix	Depth Interval (ft)	Al	Ca	Fe	Mg	Mn	V
May 2007							
Sed (mg/kg)	0 - 0.5	22500	13700	38000	5740	698	75.4
August 2007							
Sed (mg/kg)	0 - 0.5	24800	3010	43700	6620	899	86.5
Sed (mg/kg)	1 - 1.5	12700	1210	20300	2750	133	39.3
Sed (mg/kg)	2.5 - 3	13400	2290	32100	3240	200	40.2

G-4

Matrix	Depth Interval (ft)	Al	Ca	Fe	Mg	Mn	V
May 2007							
Sed (mg/kg)	0 - 0.5	21500	3890	39300	5720	1100	66.5
August 2007							
Sed (mg/kg)	0 - 0.5	21100	2390	36700	5470	1340	70.8
Sed (mg/kg)	1 - 1.5	27600	2740	45100	6650	1200	91.2
Sed (mg/kg)	2.5 - 3	25700	2490	42200	6120	1570	94.3

F-1

Matrix	Depth Interval (ft)	Al	Ca	Fe	Mg	Mn	V
May 2007							
Sed (mg/kg)	0 - 0.5	19200	10300	39500	4640	591	64.1
August 2007							
Sed (mg/kg)	0 - 0.5	19200	4220	38100	5130	725	66.2
Sed (mg/kg)	1 - 1.5	13100	82400	20400	3740	524	40.6
Sed (mg/kg)	2.5 - 3	25300	10800	40900	6090	1210	94.9

F-2

Matrix	Depth Interval (ft)	Al	Ca	Fe	Mg	Mn	V
May 2007							
Sed (mg/kg)	0 - 0.5	30400	1190	54800	6170	803	68.5
August 2007							
Sed (mg/kg)	0 - 0.5	12600	515	30000	2080	471	33.9
Sed (mg/kg)	1 - 1.5	17600	794	28300	1920	41.5	61.1
Sed (mg/kg)	2.5 - 3	15100	782	18300	1590	36.1	41.8

F-3

Matrix	Depth Interval (ft)	Al	Ca	Fe	Mg	Mn	V
May 2007							
Sed (mg/kg)	0 - 0.5	35600	2410	52000	8890	1350	94.9
August 2007							
Sed (mg/kg)	0 - 0.5	31700	2510	55900	8340	1240	107
Sed (mg/kg)	1.2 - 1.7	36500	2020	46800	10700	1960	70.3
Sed (mg/kg)	2.5 - 3	36800	1980	45700	10700	1640	67.7

F-4

Matrix	Depth Interval (ft)	Al	Ca	Fe	Mg	Mn	V
May 2007							
Sed (mg/kg)	0 - 0.5	32300	3090	54200	8180	1790	105
August 2007							
Sed (mg/kg)	0 - 0.5	34600	3950	55100	8570	1420	105
Sed (mg/kg)	1 - 1.5	38500	1890	47100	8260	1260	85.7
Sed (mg/kg)	2.5 - 3	33700	1830	44600	9230	1390	65.5

37A

Matrix	Depth Interval (ft)	Al	Ca	Fe	Mg	Mn	V
May 2007							
Sed (mg/kg)	0 - 0.5	36200	2660	47800	7990	1210	80.5
August 2007							
Sed (mg/kg)	0 - 0.5	37100	2520	54900	9430	1650	92.2
Sed (mg/kg)	1 - 1.5	36200	1930	46700	9100	1290	76.8
Sed (mg/kg)	2.5 - 3	36100	1870	45200	10100	1490	67.9

37

Matrix	Depth Interval (ft)	Al	Ca	Fe	Mg	Mn	V
May 2007							
Sed (mg/kg)	0 - 0.5	37500	2200	49800	8280	1470	80.5
August 2007							
Sed (mg/kg)	0 - 0.5	41400	7570	72600	10000	1770	127
Sed (mg/kg)	1 - 1.5	31500	2440	48400	8120	1550	98
Sed (mg/kg)	2.5 - 3	34700	1940	46300	9750	1470	74.8

37B

Matrix	Depth Interval (ft)	Al	Ca	Fe	Mg	Mn	V
May 2007							
Sed (mg/kg)	0 - 0.5	35700	1900	47200	8370	1620	77.2
August 2007							
Sed (mg/kg)	0 - 0.5	36100	2530	56200	8850	1680	107
Sed (mg/kg)	1.2 - 1.7	37900	2090	45500	9980	1670	71
Sed (mg/kg)	2.5 - 3	37600	1860	45800	9460	1560	75.2

Legend

- ● Sample Location
- Curb
- Railroad Centerline
- Storm Sewer Line
- Areas
- COPR Extent Boundary

Depth in Meters (NOAA, 2006)

- -0.3 - 0
- 0 - 1.8
- 1.8 - 3.6
- 3.6 - 5.4
- 5.4 - 9.1
- 9.1 - 18.2

Notes:
Al - Aluminum
Ca - Calcium
Fe - Iron
Mg - Magnesium
Mn - Manganese
V - Vanadium
J - Estimated value

0 300 600 1,200 1,800 2,400
Feet

Figure 5-6
Results for Other COPR Constituents in Surface Sediment
Dundalk Marine Terminal
Baltimore, Maryland

ENVIRON CH2MHILL