

4 INVESTIGATION OBSERVATIONS AND RESULTS

This section summarizes the nature and extent of the occurrence of MGP residuals at the Site by media sampled (sediment, soil, and surface water) within the areas of concern identified in the CSM presented in the River OU RI/FS Work Plan Revision 1 (NRT, December 2008). The potential for residual contaminant sources is discussed for each media, including interpretation of physical conditions that may affect the distribution of MGP residuals found at the Site.

4.1 River Morphology and Flow

The multi beam bathymetry and side scan sonar facilitated evaluation of the river morphology and flow regime. The bathymetry survey results from the River OU are provided in Appendix E. Observations from the June 2008 bathymetric survey indicate the following:

- The river is approximately 150 feet wide at the upstream end of the survey, and approximately 300 feet wide at the downstream end of the survey. On average, the river is approximately 300 feet wide between the upstream and downstream end of survey.
- Boat Island, located across from the former MGP facility, splits the river into two channels, each on the order of 180 feet wide.
- Referenced to the Lake Michigan Low Water Datum of elevation 578 (NAVD88), water depth downstream of Boat Island is 2 about feet (top of sediment at about elevation 576), extending to the Pennsylvania Avenue bridge (refer to bathymetry maps in Appendix E). This results in a point bar, apparently due to the channelized flow around both sides of the island and an apparent depositional environment directly downstream of the island.
- Water depth in the channel on the east side of Boat Island, adjacent to the former MGP, is around 3-4 feet (sediment elevation 574-575), which is slightly shallower than the approximately 5-foot water depth in the west channel (elevation 573).
- The Sheboygan Outboard Club operates and maintains the facilities on Boat Island. In conversations with members of the Boat Club during RI field planning, they indicated that until recently boats traveled up the eastern channel to dock in their boat slips located along the east side of the island and along the east side of the river at the northern end of the Site. As of 2008, they generally navigate the west channel around the tip of the island rather than the east channel because of shallower water in the east channel.
- In other nearby areas of the river surveyed during the RI, water depths are typically less than 10 feet.

The June 2008 side scan sonar survey results are provided in Appendix E and indicate the following:

- An area of “rock clutter” was identified along the east river bank in the vicinity of a bulkhead located approximately 850 feet upstream of the Upland OU boat house (Figure 2).
- A cluster of debris was identified from the Pennsylvania Bridge to approximately 200 feet downstream of the bridge.
- Debris was also identified scattered about, mostly near shorelines within the survey limits.

The location of an underground electrical line and sanitary sewer lateral, which cross the river diagonally from the northwest corner of the Upland OU boat house to the northwest corner of the building on Boat Island, were not identifiable during the surveys. The approximate location of these utilities are shown on Figure 2 and Sheet 1 based on comments by members of the Sheboygan Outboard Club, who also mentioned these lines were installed in a horizontally-bored conduit approximately 15 feet beneath the river bed.

Flow velocities were measured in accordance with the FSP (September 2008) during surface water sampling in July 2008 (Table 5). Velocities were recorded at transects T1, T6, T9, and T13. Velocities were the greatest near the center of the river and the center of the channels on each side of the island. Maximum velocity observed was 0.76 feet per second (fps) at location t9e.

4.2 Sediment Distribution

Sediment distribution was evaluated based on RI field observations including sediment and surface water sampling logs. Field observations from sediment cores and bathymetry measurements indicate:

- Mostly coarse-grained sediment was observed upstream of the former MGP facility, from transect T1 upstream to slightly south of the Union Pacific railroad bridge, which was the upper boundary of investigation. This area is the narrowest portion of the river investigated, and represents an area of no soft sediment deposition.
- Deposition of sediment is occurring in the vicinity of the Sheboygan Outboard Club boat docks, both on the east shore of the river and at Boat Island, as well as downstream of the island. Deposition has also apparently occurred in the channel on the east side of Boat Island at a higher rate than the west side.

- A layer of sand of varying thickness is often present at the sediment surface, underlain by silty sand or finer-grained silt. The silty sand and finer-grained silt is also deposited in layers throughout the core. The layering of coarse and fine-grained sediments suggests depositional events during both high flows (coarse-grained deposition) and low flows (fine-grained deposition), and/or that periodic erosion and re-deposition, is occurring.
- Overall, though there may be localized shallow (1-2 feet) scouring due to boat propeller wash (Section 2.4), sediments within the investigation area are interpreted to be relatively stable and net depositional because:
 - The June 2008 bathymetry did not show evidence of scour in the area of investigation following the early June, high-flow storm event (Section 2.4);
 - Anecdotal comments from the Outboard Club members indicate water depths in the east channel have become shallower over time (Section 4.1); and
 - Relatively soft finer-grained sediments were observed during the RI field investigation layered with coarser-grained sediments.
- Oily sediments were observed near the base of soft sediment deposits in borings T11D and T17C, located downstream of the Pennsylvania Avenue bridge near the center of the historic USACE dredge channel. The upper portions of these borings did not contain oils or high concentrations of PAHs.
- The 1996 and 2008 MGP residual footprints were delineated using different criteria (i.e., sheen and odor in 1996, versus total PAH (13) concentration and staining in 2008). In addition, characterization of tar during sediment logging has been refined since the 1996 investigation. With these differences in mind, the plan-view area of MGP residuals observed in sediments in 1996 are substantially coincident with MGP residuals observed in 2008.
- An area of exception includes the area immediately downstream of the Pennsylvania Avenue Bridge. MGP residuals were identified in the 2008 investigation on Sheet 1, which can be compared to the 1996 investigation on Sheet 3 of Appendix A. Downstream of Pennsylvania Avenue Bridge, localized MGP residuals (oil-coated sediment) were observed in the center of the channel in 2008 (T11D and T17C, as noted above), whereas MGP residuals (sheen without oil coated sediment) were observed along the east shoreline in 1996 but not in the middle of the river.
- In addition, MGP residuals were identified along a limited length of the western shore of the river in 2008, in an area that was not investigated in 1996.

To supplement the qualitative evaluation of sediment stability and Sheboygan River hydrodynamics, the SR&H ROD was reviewed, as discussed in Section 1.3.6.

4.3 Observations of MGP Residuals in Sediments

Sediment borings were logged in accordance with SOP SAS-05-02. As discussed in this SOP, visual observations of sediment borings and MGP residuals were made using the non-aqueous phase liquids (NAPLs) standard descriptors outlined in SOP SAS-05-02, Attachment E included in the Multi-Site FSP (September 2008) and as summarized in the table below.

Descriptive Term	Definition
No Visible Evidence	No visible evidence of oil on soil or sediment sample
Sheen	Any visible sheen in the water on soil or sediment particles or the core
Staining	Visible brown or black staining in soil or sediment; can be visible as mottling or in bands; typically associated with fine-grained soil or sediment
Coating	Visible brown or black oil coating soil or sediment particles; typically associated with coarse-grained soil or sediment such as coarse sand, gravels, and cobbles.
Oil Wetted	Visible brown or black oil wetting the soil or sediment sample; oil appears as a liquid and is not held by soil or sediment grains

The occurrence of MGP residuals was documented on the sediment logs (Appendix F) and summarized in Table 6 and Sheet 1. The areas depicting MGP residuals were interpolated based on the residuals observed in surrounding borings and professional judgment. Where present, MGP residuals were most often observed in the form of staining on soft sediments, and were coincident with elevated concentrations of PAHs (Sheet 4). Staining was also observed in sediment borings with concentrations at or below the ambient concentration (refer to Section 3.4.1) and may not be attributable to MGP residuals. In general, sediment borings with staining and concentrations less than the ambient concentration were noted with petroleum-like odors. Sheen was rarely observed in sediments without the presence of other forms of MGP residuals (i.e., staining, oil wetted). Comparing the concentrations of MGP residuals in sediment locations between 1996 and 2008 is not informative due to the varying sample intervals and small sample set from 1996.

For the following discussion, the limit of MGP residuals is defined by cores that contain the presence of staining, oil coating, or oil wetted sediments accompanied with a total PAH (13) concentration in excess of the field screening level of 14,000 µg/kg (or 14 mg/kg) based on ambient concentrations. This limit is

shown on Sheet 1. Vibrocores T18B, T4D, and T14B contained black sediments in combination with odor; however the black sediments were not present as mottling, the odors were weak and/or petroleum-like, and the total PAH (13) concentrations were below 14,000 µg/kg (or 14 mg/kg). Therefore, they were not included in the determination of extent of MGP residuals.

The upstream limit of MGP residuals is located at T3A. The downstream limit of MGP residuals is located at T17B and T17C (Sheet 1). Between transect T3 and transect T11, MGP residuals were observed along the eastern shoreline (Upland OU) and extended into the river as far as Boat Island. Between T11 and T17, MGP residuals contract toward the center of the channel and form a point near T17B and T17C. A localized area of MGP residuals was also observed along the western shore, between transect T3 and T8 (Sheet 1).

The extent of MGP residuals observed in 2008 is generally consistent with the extent of MGP residuals observed in sediment in 1995 and 1996 (shown on Sheet 1) with the exception of downstream of Boat Island where the occurrence of MGP residuals extends into the center of the Sheboygan River and the western shore. These areas had not been previously investigated to the same extent as the 2008 investigation.

Black staining of the brown sediment was the most commonly observed form of MGP residual. However, it should be noted that stained sediment alone does not infer MGP residuals. Stained sediments may be associated with other sources. For example, sediment deposits naturally contain a high amount of organic material (Section 4.5.8) compared to upland soils, which is often present as black mottling within the sediment core. In the field, staining was differentiated from black organic mottling by olfactory observations. Cores that contained black mottling with the presence of petroleum or MGP-like odors were so noted and included in the MGP residuals unless the total PAH (13) concentration was less than the ambient concentration used for making field decisions.

The thickness of stained material within a soft sediment core ranged from 0.1 to 8.8 feet. Stained material greater than 5 feet thick was typically found in cores located near the Upland OU (refer to cross-sections A, B, and C, Sheets 2 & 3). Oil wetted and oil coated sediment was observed in both fine and coarse-grained materials. Similar to the delineation of MGP residuals, geological features were also inferred between boring locations using surrounding borings and professional judgment. These types of MGP residuals were commonly associated with sheen and staining; and found near the base of the sediment

cores. The thickness of oil wetted or oil coated material within a soft sediment core ranged from 0.1 to 1.1 feet. T8A contained 1.1 feet of oil wetted silt near the base of the core.

Review of Cross Section D on Sheet 3 indicates the sediment surface is lower near the eastern shore and middle of the river (water is deeper) and rises approaching Boat Island (water is shallower). The elevation of the top of staining, below non-stained sediments, follows a similar pattern as the top of sediments – i.e., the top of the stained layer is not uniform in elevation. As shown on Cross Section D, the sediment is inferred to be stained throughout the cross section, across the east channel of the river. Review of Cross Section F from the 1996 investigation (Appendix A, Plate 2) indicates the elevation difference of the sediment surface was less (approximately 1 foot) than the difference observed in 2008 (approximately 6 feet). However, Cross Section H from the 1996 investigation, located further downstream, indicates an elevation difference of approximately 3 feet in the top of sediment. The apparent greater elevation differences in top of sediment and top of staining in 2008 versus 1996 may indicate some scouring has occurred in the area; however, this would be inconsistent with anecdotal comments by the Outboard Club members that the east channel is undergoing deposition and the water is shallower (Section 4.1). Further, the cross sections in 1996 and 2008 were not in identical locations, did not extend across the same widths of the river, nor did the 1996 event have accurate vertical control. Therefore, a direct correlation cannot be made with respect to the elevations of the river bed and staining, as well as whether sediment erosion and re-deposition is occurring.

In general, observations of MGP residuals (staining, oil coating, and oil wetted) that exceed 5-feet of thickness are located in two portions of the river (Sheets 1 through 3): Borings T3A, T4A, T5A, T5B1, T6A, and TB403 located along the shoreline of the upland OU; and borings T11D and T12C (see boring logs in Appendix F) located just downstream of the Pennsylvania Avenue bridge.

Vibrocore sample TB403 contained the thickest observation of staining and oil wetted material (8.8 feet), and parent material boring TB403P contained the lowest observed elevation of MGP residuals (staining at elevation 563). The top of TB403P contained approximately 2 feet of silty soft sediment. Based on sample elevations, the parent material boring sampled some of the impacted soft sediment that was already sampled by the vibrocore from that location. MGP residuals were not observed in the clay parent material just below the soft sediment in TB403P. MGP residuals were not observed in any of the other parent material cores; with the exception of the occasional sheen on the outside of some cores as a result

of contact with oily water within the augers during sampling, as discussed in Section 3.4.3. Sheen as a result of contact water was not recorded in Table 6.

Figure 5 in Appendix B illustrates upland remedial activity along the bank of the river. In this figure, excavation area EZ-403 was extended down to an elevation of approximately 578 feet. The sample collected from the base of the excavation contained elevated concentrations of PAHs. Stained and oil wetted sediments were observed 4 to 15 feet below EZ-403 in sediment cores TB403, T5A, and T6A (located nearest to the former Upland OU excavation) ranging from approximately 574 to 563 feet.

In summary, MGP residuals were visually evident in an area defined upstream by transect T3, downstream by transect T17, and extends from the eastern river shore out to Boat Island, or to near the center of the river channel below Boat Island. Along a limited length of the western river shore, opposite the former MGP site, MGP residuals extended approximately 40 feet from the shore. The most commonly observed MGP residual was staining, which can be found in both silty and sandy soft sediments. Oil wetted and/or oil coated sediments were also observed in both silty and sandy soft sediments and were commonly found near the base of vibrocore samples collected from near the Upland OU shoreline. MGP residuals do not appear to be preferentially associated with any particular grain-size of material or layer within the soft sediment. MGP residuals were not observed in the parent material beneath the soft sediment. MGP residuals were observed in both historic Upland OU samples and River OU RI sediment cores, approximately 15 feet below the former shoreline excavation (EZ-403).

4.4 Surface Water Observations during Sediment Sample Collection

Sheen was observed rising to the surface of the water during vibrocore sampling at T12C, T12B, T12A, T9A, T6A, and TB402. Sheens were observed on the surface water as boat motors were started during the RI. Periodic sheens were also observed along the eastern shore of the river near the former MGP, unrelated to RI sampling activities and boat traffic. This near shore area, where borings were observed with oil-wetted or oil-coated sediment, will be addressed as part of a remedial action and therefore, assessment of the mechanisms resulting in the occurrence of ebullition is not required.

4.5 Sediment Sampling Results

Analytical results are compared to sediment screening benchmarks (SSBs) for the purpose of identifying concentrations that may be of concern with respect to risk for specific receptors or pathways. The SSBs were derived from more than one authoritative study typically cited by federal and/or state regulators, and are listed on Table 7. Additional assessment on the relevance of the sediment concentrations is provided in the BLRA (Appendix D). The following discussion is based on the results of the 2008 sampling event. Only the 2008 sampling event was used in the BLRA.

4.5.1 PAH Results

This discussion of PAHs focuses on the total of 13 parent PAH (Section 3.4.1) results rather than on individual compounds due to the additive affects of PAH mixtures for the benthic community in sediments. As discussed in the Multi-Site RAF (September 2007, Exponent) and confirmed in the BLRA (Appendix D), the benthic community is assumed to be the risk driver based on exposure to PAHs. Refer to Table 8a (16 PAHs) and Table 8b (34 PAHs) for individual compounds by sample location and depth. Field sampling was guided by the field screening level of 14,000 $\mu\text{g}/\text{kg}$ as discussed in Section 3.4.1. Sheet 4 highlights individual sample intervals that were reported at or above the field screening level. At the completion of field sampling, the portions of the river that exceeded the screening level were identified and bounded by two consecutive core locations with concentrations below the ambient screening level.

Borings that contain one or more intervals with total PAH concentrations greater than the field screening level (14,000 $\mu\text{g}/\text{kg}$) are located from transect T2 downstream to transect T14. In the vicinity of Boat Island, there is a pocket of borings that extends from T18B/T18C downstream to T9C/T10D (Sheet 4) where concentrations are below the screening level. This defines the footprint of the sediments in excess of 14 14,000 $\mu\text{g}/\text{kg}$. This footprint is slightly larger than the limits of visually evident MGP residuals, described in Section 4.3, from approximately T3 to T17. The BLRA elaborates upon the risk zones.

For discussion purposes, the borings have also been split into the following groups based on maximum total PAHs (13) at a single depth interval (Sheet 4): 0 – 9,999 $\mu\text{g}/\text{kg}$; 10,000 - 99,999 $\mu\text{g}/\text{kg}$; 100,000 – 99,999 $\mu\text{g}/\text{kg}$; and >1,000,000 $\mu\text{g}/\text{kg}$.

Within the 14,000 µg/kg (or 14 mg/kg) PAH footprint, sample locations that contain one or more intervals with total PAH concentrations greater than 100,000 µg/kg are substantially coincident with observations of MGP residuals (Sheet 4). Borings with total PAH concentrations that exceed 100,000 µg/kg are found along the eastern shore of the river from transect T13 downstream to transect T17 and extend westward from the river shoreline out to Boat Island or to the center of the river channel south of the Pennsylvania Avenue Bridge. Total PAH concentrations in the upstream segments of the river upstream of transect T3, in the channel west of Boat Island, and downstream of transect T13 are below 100,000 µg/kg. The only exception is T2A which contained a concentration of 331,080 µg/kg at depth interval 1.9 to 3.2 feet. Evaluation of the area of total PAH concentrations greater than 100,000 µg/kg indicates the following:

- The maximum concentration depth interval varies within a core (top, middle, or bottom). The maximum total PAH concentration (22,310,000 µg/kg) occurred at the base of T6A (6.3 – 7.4 feet).
- Several borings within this area have concentrations greater than 100,000 µg/kg at the bottom depth interval.
- Only 3 of 9 parent material borings (TB402P, TB403P, and T12CP) contain concentrations greater than 100,000 µg/kg. These concentrations occur in the upper depth intervals within each core and are believed to be caused by samples which overlap into the overlying sediment sampled with the vibrocores, or by exposure to oily water within sampling augers as described in Section 3.4.3.
- The vertical extent of PAHs exceeding 100,000 µg/kg was defined for each parent material core. A minimum of two consecutive depth intervals were collected with total PAH concentrations below 10,000 µg/kg. These concentrations are consistent with the ambient PAH concentrations.

4.5.2 PVOC Results

The distribution of PVOCs is similar to PAHs (Sheet 4). The discussion of PVOCs will focus on total BTEX, and have been split into two groups based on maximum concentration at a single depth interval: (0 - 999 µg/kg) and (>1,000 µg/kg). Refer to Table 9 for individual compounds by sample location and depth.

Total BTEX concentrations greater than 1,000 µg/kg occur in borings that contain total PAH concentrations in excess of 100,000 µg/kg. The only exception is boring T7B where maximum BTEX is

3,128 $\mu\text{g}/\text{kg}$, while maximum total PAH is 17,288 $\mu\text{g}/\text{kg}$. BTEX concentrations were commonly present below the method detection limit. The highest BTEX concentrations (greater than 1,000,000 $\mu\text{g}/\text{kg}$) were present in borings TB403, T6A, and T8A. These borings also contain total PAH concentrations greater than 1,000,000 $\mu\text{g}/\text{kg}$ at the same depth intervals.

Individual compounds that exceed SSBs (Table 9) substantially occur in borings that fall within the area of MGP residual observations (Sheet 4). The exceptions are T11E, T13B, T13C, T14A, T14C, and T15B. In these borings benzene, ethyl-benzene, and total xylene concentrations are below their method detection limits; however, toluene concentrations range from below detection limit to 910 $\mu\text{g}/\text{kg}$. The SSB for toluene is 383 $\mu\text{g}/\text{kg}$.

4.5.3 PCB Results

A sub-set of the sediment samples were selected for PCB analysis as discussed in Section 3.4.4. The discussion of PCBs will focus on total PCBs (illustrated on Sheet 5), individual compounds are included in Table 10. The table below summarizes total PCB data for soft sediments. PCBs were also analyzed in the parent material at T8CP, the concentrations in those samples were all below the detection limits.

Depth Interval	Uncorrected Depth Interval (feet)	Total Concentration Values (µg/kg)		Number of Samples
		Maximum	Minimum	
1	0 – 0.5	57,700	189	19
2	0.5 – 1.5	74,400	17	22
3	1.5 – 2.5	44,900	17	18
4	2.5 – 3.5	50,900	16	13
5	3.5 – 4.5	102,000	16	13
6	4.5 – 5.5	108,000	18	8
7	5.5 – 6.5	98,200	36	5
8	6.5 – 7.5	270,000	18	5
9	7.5 – 8.5	275	17	2

Notes: Uncorrected core compaction depths were used for ease of evaluating concentration ranges.

The summary table indicates that the minimum concentration of PCBs is 16 µg/kg, and the maximum concentration is 270,000 µg/kg. The maximum concentration occurred between 6.5 and 7.5 feet below the top of sediment at T14B (Sheet 5). PCBs do not appear to be coincident with the presence of MGP residuals (oil-wetted or oil-coated sediment) or elevated PAHs. Rather, the data suggest that the greatest concentration of PCB containing material is downstream of the Pennsylvania Avenue Bridge, where MGP residuals (oil-wetted or oil-coated sediment) was not observed and total PAH concentrations were generally less than 10 mg/kg. The greatest PCB concentrations were observed coincident with the upper limit of the USACE dredge channel (Sheet 5).

4.5.4 Metals Results

The range of metals concentrations detected in sediment samples is summarized below and the results are provided on Sheet 6 and Table 11. Note that only select metals, including metals identified in the SR&H ROD (cadmium, chromium, copper, lead, mercury, nickel, and zinc) are summarized on Sheet 6.

Parameter	Concentration Values (mg/kg)		SSBs
	Maximum	Minimum	
Aluminum	21,900	2,010	NS
Antimony	19.3	<MDL	2
Arsenic	6.7	1.2	9.79
Barium	341	9.8	NS
Cadmium	18.6	0.033	0.99
Chromium	1,260	5.4	43.4
Copper	344	3.7	31.6
Iron	23,000	4,170	20,000
Lead	1,400	1.9	35.8
Manganese	584	91	460
Mercury	2.0	0.003	0.18
Nickel	163	3.6	22.7
Selenium	1.1	<MDL	NS
Silver	0.96	<MDL	1.6
Vanadium	40	6.6	NS
Zinc	365	8.0	121

Notes:

1. “<MDL” indicates concentrations were below the method detection limit.
2. “NS” indicates there is no SSB for this parameter.

Lead and chromium have the highest concentrations above the SSBs. The maximum concentration of chromium (1,260 mg/kg) was observed at T2A (4.5 to 5.9 feet). The maximum concentration of lead (1,400 mg/kg) was observed at T4A (0.6 to 1.7 feet). Analytical data indicates that metals are present at or above the SSBs in all parts of the river (Sheet 6). For example, lead and mercury exceed the SSBs at BKG6 located at the upstream end of the site; and, cadmium, chromium, copper, lead, mercury, nickel, and zinc all exceed the SSBs at T16B at the downstream extent of 2008 investigations. The general distribution of metals does not appear to be correlated to the presence of MGP residuals or elevated PAH concentrations. Evaluation of historic development in the area, indicated that a tannery and toy factory

were present just upstream of the former MGP site (see Section 1.3.2). The presence of high concentrations in T2A and T4A is consistent with a source located upstream of the former MGP.

4.5.5 Cyanide Results

Cyanide was detected in 3 of 25 sediment samples submitted for analysis (Table 10). The maximum concentration detected was 4.3 mg/kg. Cyanide was characterized to assess potential confounding effects in toxicity testing results and is not considered a COPC.

4.5.6 Ammonia Results

Ammonia was characterized to assess potential confounding effects in toxicity testing results and is not considered a COPC. The minimum concentration of ammonia detected was 44 mg/kg. The maximum concentration of ammonia detected was 404 mg/kg (Table 10).

4.5.7 Sulfide Results

Sulfide was characterized to assess potential confounding effects in toxicity testing results and is not considered a COPC. The minimum concentration of sulfide reported was below the detection limit of 18.9 mg/kg. The maximum concentration of sulfide detected was 888 mg/kg (Table 10).

4.5.8 TOC Results

TOC results (Table 10) indicate that organic carbon is commonly present in the substrate materials in concentrations around 5%. A maximum concentration of 11.7% was found in silty sediments at the base of boring TB403 from 7.9 to 8.8 feet. A minimum concentration of 0.71 % was found in sandy sediments in boring T4B from 5.4 to 6.6 feet. TOC conversion is $\text{mg/kg} / 10,000 = \% \text{ TOC}$.

Samples collected upstream of the visually impacted sediments (table below) contained TOC concentrations that are similar to the rest of the site (approximately 5%). Some of these samples, such as BKG3, were composed of coarse grained sands.

Sample	Total Organic Carbon (%)
BKG3 0 - 0.5'	4.4%
BKG6 0 - 0.6'	3.1%
BKG6 0.6 - 2'	4.7%
BKG7 0 - 0.6'	6.2%
BKG7 0.6 - 1.8'	2.9%
BKG7 1.8 - 2.5'	5.8%
BKG8 0 - 0.8'	6.4%
BKG8 0.8 - 2'	5.1%
T1A 0 - 0.5'	6.1%
T1A 0.5 - 1.8'	6.4%
T1B 0 - 0.5'	4.4%
T1B 0.5 - 1'	6.1%
T1C 0 - 0.5'	4.3%
T1C 0.5 - 1'	3.1%
T2A 0 - 0.6'	6.4%
T2A 0.6 - 1.9'	5.9%
T2A 1.9 - 3.2'	1.6%
T2A 3.2 - 4.5'	2.8%
T2A 4.5 - 5.9'	3.0%
T2B 0 - 0.7'	5.9%
T2B 0.7 - 2.2'	6.4%
T2B 2.2 - 3'	5.2%
T2C 0 - 0.5'	4.7%
T2C 0.5 - 1.5'	3.9%
T2C 1.5 - 2.5'	4.0%
T2C 2.5 - 3.5'	4.5%
T2C 3.5 - 4.5'	4.1%
T2C 4.5 - 5.5'	6.5%
Max	6.5%
Min	1.6%
Average	4.8%

The TOC results indicate the presence of a consistent concentration of carbon in both impacted and non-impacted sediments, which can sequester organic compounds, reducing bioavailability to benthic organisms and limiting migration in the system.

4.5.9 Black Carbon Results

Black Carbon results (Table 10) suggest that black carbon is commonly present in the substrate materials in concentrations around 3%. A maximum concentration of 6.2% was found in the sandy surface sediments of boring T13B from 0 to 0.5 feet. A minimum concentration of 0.71 % was found in sandy sediments in boring T4B from 5.4 to 6.6 feet. The black carbon conversion is the same for TOC mg/kg / 10,000 = % black carbon.

These results support the TOC results suggesting that there is a consistent concentration of carbon in both impacted and non-impacted sediments, which can sequester organic compounds, reducing bioavailability to benthic organisms and limiting migration in the system.

4.5.10 Geotechnical Results

The geotechnical testing results are provided in Appendix H and summarized below.

Sample	Material	Organic Content	Moisture Content	Specific Gravity
T1A (6-18")	Dark brown gravelly medium to coarse sand, trace silt (SP)	2.9%	10.7%	2.5
T2B (6-18")	Dark brown organic fine to medium sand, little gravel, some silt and clay (SM)	8.6 %	62.3 %	2.6
T3A (30-42")	Dark brown slightly organic, silty fine to medium sand (SM)	5.8 %	46.7 %	2.4
T4C (78-90")	Gray silt, some sand and clay, trace gravel (ML)	2.1%	21.7%	2.7
T7B (30-42")	Brown fine to coarse sand, some silt, little gravel and clay (SM)	2.8%	25.7%	2.6
T8C (16-18")	Dark brown fine to medium sand, little silt and clay, trace gravel (SP-SM)	2.5%	23.4%	2.6
T8C (30-42")	Dark brown fine to coarse sand, some silt and clay, trace gravel (SM)	3.5%	41.6%	2.5
T8C (78-90")	Brown fine to medium sand, some silt and clay, trace gravel (SM)	3.4%	19.9%	2.7
T8D1 (6-18")	Brown slightly organic clayey fine to coarse sand, little gravel (SC/SM)	7.7%	58.9%	2.6
T8E (18-26")	Brown slightly organic clayey fine to coarse sand, some gravel (SC)	4.8%	18.5%	2.7

Sample	Material	Organic Content	Moisture Content	Specific Gravity
T10AP (48-72")	Brown slightly organic lean clay, little sand (CL/OL)	4.3%	25.6%	2.6
T10CP (62-86")	Gray slightly organic lean clay, some sand (CL/OL)	4.8%	55.2%	2.5
T12B (42-45")	Brown organic fine to medium sand, some silt and clay, trace gravel (SM)	13.6 %	60.1 %	2.5
T12D (16-18")	Brown sandy organic, some clay, trace gravel (ML)	7.6%	61.1%	2.6
T16A (0-9")	Dark brown gravelly fine to coarse sand (SP)	21.0%	15.1%	2.6
TB402 (18-30")	Dark brown organic silt, some sand (ML)	8.3%	75.2%	2.5
TB402 (66-78")	Dark brown fine to medium sand, some silt, trace gravel (SM)	2.2%	18.5%	2.6

The organic content is higher in some of the samples compared to the TOC and black carbon results discussed above; however, some samples were collected from locations where elevated PAHs, as well as other MGP residuals, were observed. The moisture contents are typical for a range of coarse and fine-grained sediments.

4.6 Soil Results

Soil analytical results are compared to soil screening benchmarks (SSBs) listed in Table 12 to identify concentrations that may be of concern with respect to specific receptors or pathways. Source references for the SSBs for each parameter are also listed on Table 12. Soil borings were only conducted on Boat Island as shown on Sheet 1. Corresponding analytical results are summarized for each COPC in Tables 13 through 16.

4.6.1 Boat Island Surface Soil Sampling

Surface soils (0-2 feet bgs) at borings SS1 through SS4 consisted of sand with varying amounts of silt. There was no visual or olfactory indication of MGP residuals in any of the borings completed on the island. Analytical data indicates:

- PAH concentrations were below the SSBs with the exception of benzo(a)pyrene which exceeded the SSB at locations SS1, SS2, and SS3; and, dibenzo(a,h)anthracene which exceeded the SSB at SS1. The maximum concentration of benzo(a)pyrene was 411 µg/kg at SS1.
- PVOc concentrations were all below the SSBs.
- PCBs were detected in SS1, SS2, and SS3 at concentrations below 2,000 µg/kg.
- Metal concentrations were below the SSBs with the exception of arsenic which exceeded the SSB in all four borings. The maximum concentration was 5,900 µg/kg.
- Cyanide concentrations were below the SSBs in all borings.
- Phenol concentrations were all below the detection limits in all borings.

4.7 Surface Water Results

Five surface water composite samples were collected from the Site as discussed in Section 3.6 and shown on Sheet 1. Results are summarized in Tables 17 through 19 and the following results are noted:

- Surface water sheens were not observed at the time of surface water sampling, although surface water samples were collected in areas where sediment is oil-wetted or oil-coated (i.e., where ebullition is likely to occur).
- PAHs were below method detection limits in all samples except for Naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene. The maximum concentration of these compounds was 0.079 µg/L at the upstream composite sample (t1a,b,c).
- PVOcs, and cyanide were below the method detection limits in all samples except for toluene. The maximum concentration of toluene was 0.46 µg/L at the downstream composite sample (t13a,b,c).
- Metals concentrations are similar for all five composite samples.
- PCBs concentrations were below the method detection limits in all samples.

There does not appear to be any correlation between surface water concentration and observed MGP residuals in sediment.

4.8 Sample Validation and QA/QC

Trip blanks, duplicate samples and MS/MSD samples were collected and analyzed to satisfy Quality Assurance/Quality Control (QA/QC) requirements in accordance with Section 2 of the Multi Site QAPP.

MEC^x, in Aurora, Colorado validated laboratory procedures and sample results for analytical laboratories as discussed in Section 4 of the Multi Site QAPP.

The validation summaries are included in Appendix I. All of the data was acceptable for use in decision making with qualifiers, as appropriate. Analytical data tables discussed above include the data validator qualifications.

The data validation reports calculated the relative percent differences and percent recoveries to assess precision and accuracy of the data sets. RI activities were performed in accordance with the standard operating procedures included in the Multi-Site FSP and QAPP to minimize errors and ensure representativeness. Data for sediment, surface water and soil were 100% complete. Data comparability is not required because each media and sample was analyzed by the same methods.