ARCADIS BBL
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General Motors Corporation

Flint River Sediment Investigation

North American Operations Flint Operations Site

Flint, Michigan

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1. Introduction

This Flint River Sediment Investigation Report presents the results of the sediment sampling activities within the Flint River (river) implemented on behalf of the General Motors Corporation (GM) in October/November 2006. These activities were performed by ARCADIS of New York, Inc. (ARCADIS BBL, formerly Blasland, Bouck & Lee, Inc. [BBL]) and Exponent, in accordance with a Scope of Work provided to the United States Environmental Protection Agency (USEPA) on October 6, 2006, which was approved by USEPA on October 12, 2006.

1.1 Background

The GM North American Operations (NAO) Flint Operations Site (the Facility) is currently the focus of a Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI). Among other tasks, the RFI includes an assessment of the underground storm sewers at the Facility, and the possible impacts of potential discharges of hazardous constituents via infiltration to the storm sewers and subsequent migration into the River. This assessment is documented in the *Resource Conservation and Recovery Act Facility Investigation Phase II Report* (Blasland, Bouck & Lee, Inc. [BBL], 2004) (RFI Phase II Report). GM submitted the RFI Phase II Report to the USEPA on March 30, 2004, in fulfillment of one of the tasks under the RCRA Section 3008(h) Administrative Order on Consent (R8H-5-00-2), effective March 1, 2004. The USEPA provided GM with comments on the RFI Phase II Report in a letter dated September 2, 2004. In its September 2 letter, the USEPA expressed concern that sediment in the River was not sufficiently characterized to discern potential impacts from Facility-related outfalls to the River.

In response to USEPA concerns, GM prepared and submitted a Scope of Work to USEPA in March 2005. That Scope of Work proposed a sediment investigation designed to assess the presence and distribution of PCBs and metals in surface sediment in the River upstream of, adjacent to, and downstream of the Facility. In April 2005, the Michigan Department of Environmental Quality (MDEQ), accompanied by USEPA, conducted biased sediment sampling in the River at a total of six locations upstream of, adjacent to, and downstream of the Facility. Samples adjacent to the facility were located in the immediate vicinity of specific storm water outfalls through which storm water from the Facility and other non-GM sources discharge. Samples collected included a combination of surficial grab samples and core samples. Samples were analyzed for inorganics, PCBs, semivolatile organic constituents (SVOCs), and volatile organic constituents (VOCs). Split samples were collected by BBL at a subset of locations on behalf of GM. Split sample results were reported to USEPA in September 2005.

During several subsequent correspondences and meetings with USEPA since the MDEQ's sediment sampling data became available, GM agreed to conduct further sediment investigation in the River. Consistent with USEPA's request, the objectives of this work were twofold: 1) further assess the presence and distribution of SVOCs, PCBs, and metals in the surficial sediment in the River upstream of, adjacent to, and downstream of the Facility; and 2) provide a data set which is sufficient to support the Screening Level Ecological Risk Assessment (SLERA), as well as further assessing the depth profile of contamination at select representative depositional areas.

Although GM agreed to conduct further sampling, GM maintains the opinion that existing data indicate that the concentrations of anthropogenic constituents in sediment are typical of effects that would be expected from widely-dispersed sources common in urbanized watersheds. Furthermore, GM maintains the opinion that the existing data are adequate to demonstrate that discharges from the Facility have not been a source of constituents above and beyond what would be expected in the absence of the Facility. The multiple samples collected by MDEQ, which included core samples at depth, were located in areas considered most likely to exhibit impacts from the Facility outfalls, and showed low levels of certain chemicals generally in line with expectations, especially when other ubiquitous urban sources remain active (Figure 1).

This report presents the additional sampling and analysis GM proposed in the Scope of Work approved by USEPA on October 12, 2006. It also included an expansion of the analyte list to include SVOCs, in addition to PCBs and metals, based on possible discharges from the Facility.

1.2 Study Area

The Study Area is a section of the River extending approximately 5.2 miles from the C.S. Mott Lake Dam on the upstream end, which is approximately 1.5 miles upstream of the Facility, downstream to the Hamilton Dam, located approximately 1 mile downstream of the Facility in downtown Flint (Figure 1). The Study Area encompasses reaches of the river located upstream of, adjacent to, and downstream of the Facility, including all 17 storm sewer outlets associated with the Facility, of which all share other off-site storm water sources unrelated to the Facility (GM/other outfalls; Figures 2 through 4).

The upstream reach is largely outside the influence of ubiquitous urban sources (e.g., storm drains and urban runoff), and is reflective of an un-urbanized, undeveloped watershed, with only five non-GM outfalls, which appear to drain residential areas. The majority of this reach represents natural undeveloped wooded areas. Sediment quality in the upstream reach is intended to be representative of un-urbanized background conditions; specifically, conditions in the river upstream of areas potentially impacted by the Facility or other point and non-point sources associated with developed areas of the watershed.

The adjacent reach passes through the City of Flint, and is expected to reflect historic and potentially on-going urban sources. Specifically, it contains 27 non-GM outfalls, 17 GM/other outfalls, four bridge crossings, and confluences with Kearsley and Gilkey Creeks. The watershed of the adjacent reach immediately proximate to the river is characterized by several manufacturing facilities unrelated to the Facility (e.g., Lockhart Chemical Company, PPG Coatings and Resins, Kassel Steel Corporation, former E.I. DuPont de Nemours and Company, etc.), along with several large metals/auto recycling facilities, in addition to areas of vast residential and small commercial development.

The downstream reach contains 18 non-GM outfalls, and is characterized by increased development over the adjacent and upstream reaches, as it passed through areas near downtown Flint. This area is developed as expected for a city with a population over 100,000. There are variously sized commercial and residential businesses located throughout the area, with the University of Michigan encompassing a large area of the immediate watershed.

Further, Interstate 475, which traverses through the watershed of the adjacent and downstream reaches, contributes significant runoff flow to these reaches of the Study Area, along with the vast lengths of City streets.

Downstream of the Study Area, below Hamilton Dam, the river is channelized and lined with concrete for a distance of 2 miles, and little sediment is expected to be present along the lined reaches of the river.

1.2.1 Study Area Watershed

The Study Area is approximately in the center of the entire river watershed, which encompasses approximately 1,360 square miles in southeastern Michigan, before draining into the Saginaw River and eventually into Saginaw Bay. The Study Area drainage area is approximately 750 square miles. Within the 5.2-mile Study Area, there are contributions from three hydrologic units: upstream river subbasin, the Kearsley Creek subbasin, and a subbasin between Kearsley Creek and Swartz Creek, slightly downstream of the Study Area. Of these three subbasins, the upstream river subbasin and the Kearsley Creek subbasin are both impounded just prior to entering the Study Area; these impoundments may serve as sediment traps that retard the downstream movement of sediment from these tributaries.

The third subbasin within the Study Area drains urban Flint and contains Gilkey Creek in its entirety. On a relative basis, Gilkey Creek accounts for approximately 2 percent of the drainage area (15.6 square miles), Kearsley Creek accounts for approximately 15 percent (115 square miles), and the mainstream of the river upstream accounts for approximately 82 percent (617 square miles). The urban Flint area outside of these watersheds adds approximately 4 square miles, or less than 1 percent to the contributing drainage area; however, this would likely account for much more than 1% of the watershed flow due to the increased areas of impervious cover.

Several tributaries and numerous storm sewer outfalls drain into the river in the Study Area other than the GM/other outfalls. Typical of a developed urban area, much of the runoff from the city is drained via underground pipe to the nearest receiving water. For the river, this includes a relatively extensive area of runoff from industrial, commercial, residential, and other properties (such as roads and railroads) that have a potential to contribute both dissolved and particulate-associated contaminants to the river. The storm sewer outfall locations (i.e., draining more than several blocks) and tributaries are shown on Figures 2 through 4.

1.2.2 Hydrology

USGS flow data from a gage located several miles downstream of the Facility indicate that the average monthly flows in the river range from 236 cubic feet per second (cfs) in August to 1,479 cfs in March (period of record is 1932 to 2003).

Within the Study Area, the river elevation drops approximately 20 feet, from approximately 720 feet at C. S. Mott Dam to approximately 700 feet at Hamilton Dam, and is typically 100 to 300 feet wide. This is consistent with what the Michigan Department of Natural Resources (MDNR) refers to as the Upper Flint basin in the river Assessment Report (Leonardi and Gruhn, 2001), with a low gradient and alternating high- and low-energy areas, except for the increased encroachment of urban and industrial development on and near the shores of the river as it flows through the City of Flint. There are numerous bridge crossings, developed riverbanks (roads and railroads), numerous storm sewer outfalls, and a potable water treatment plant within the 5.2-mile reach of the Study Area. These structures affect river hydraulics, sediment characteristics, and ecological habitat. Where the shore is undeveloped, there is park land, with native trees and other vegetation, with only a few areas of hardened shoreline. Generally the relatively small proportion of natural environment along the river limits the ecological habitat quality in the adjacent and downstream reaches. In addition, urban encroachment results in the incidental introduction of debris and litter, and use of the river as a clandestine disposal site.

1.2.3 Flow Control Structures

There are two dams in the river within the study area reach. The Utah Dam is located in the Study Area approximately 0.5 mile downstream of Kearsley Creek near GM's outfall 002 (Figure 3). It is a steel and concrete sluice gate structure approximately 200 feet wide. The dam is currently secured in the open position and has not been operated in several years; thus it does not impound water. The Hamilton Dam is located at the downstream end of the Study Area, approximately 2 miles downstream of the Utah Dam. It is a concrete structure spanning 200 feet, and has a storage capacity of approximately 100 acre-feet. It is constructed using several parallel Taintor Gates that swing open upward from the bottom of the riverbed, and is used to regulate the levels of the river downstream of the C. S. Mott Dam at Mott Lake. River levels are monitored by the City of Flint at the City's water treatment facility near the crossing of Dort Highway. The following action levels dictate the City's opening and closing of the Hamilton Dam, unless the river level downstream is lower than upstream (in such a case the dam is to be opened to allow flow pass through):

- At 710 feet above mean sea level, dam opened
- At 708 feet above mean sea level, dam closed until level of river marks 710 feet above mean sea level

Action levels for the operation of the Hamilton Dam are governed by the City's NPDES permit for the City's wastewater treatment facility, as well as an agreement with the Holloway Home Association, which controls the river levels to manage ice concerns and weed growth.

In 1963, the United States Army Corps of Engineers in partnership with the City of Flint initiated a flood control project on the river and one of its tributaries. The River Flood

Control Project extends approximately 2 miles from the Hamilton Dam downstream to Third Avenue (Sunset Drive), and approximately 1.5 miles on Swartz-Thread Creek, from the confluence with the river. The riverbed and banks were concrete lined in an effort to control flooding through the downtown area and just downstream. The project, while succeeding in controlling the flooding, also resulted in loss of natural river bed and stream bank habitat for aquatic species (Leonardi and Gruhn, 2001). Per Section 43 of the Operations and Maintenance Manual, Saginaw River Flood Control Project, Sections A, B, C-1, C-2, and D, Flint River Segment at Flint, Michigan (U.S. Army Corps. of Engineers, Detroit, Michigan, 1982), the City of Flint is required to remove sediment accumulation at least annually from the reach of the river that extends from Hamilton Dam upstream approximately 420 feet.

1.3 Purpose and Objectives

As described in the Scope of Work, the objectives of this work were twofold: 1) further assess the presence and distribution of SVOCs, PCBs, and metals in the surficial sediment in the river upstream of, adjacent to, and downstream of the Facility; and 2) provide a data set which is sufficient to support the SLERA to evaluate the ecological significance of discharges from the Facility on sediment quality, as well as further assessing the depth profile of contamination at select representative depositional areas.

Based on those objectives, the following specific questions were presented in the Scope of Work:

- What is the general distribution of SVOCs, PCBs, and inorganics in surficial sediment in the river adjacent to the Facility?
- How do SVOC, PCB, and inorganic concentrations in river sediments adjacent to the facility compare to appropriate site-specific and urban background conditions?
- Are there elevated SVOC, PCB, and inorganic concentrations in sediment at depths that are isolated from benthic invertebrates, but at locations where surface sediment could get scoured, thus exposing these elevated concentrations?
- Do river sediments potentially pose unacceptable ecological risks?

1.4 Report Organization

Section 1 of this report presents the project background, a study area description, and the project purpose and objectives. Section 2 provides a summary of the sediment sampling activities. Section 3 presents results of the data assessment including the sediment characteristics, general trends in analytical chemistry, a statistical analysis, and an evaluation of background concentrations. Section 4 presents a summary of the SLERA, which is provided as Appendix C to this report. The conclusions of the 2006 sediment investigation are presented in Section 5, while Section 6 presents the references cited.

2. Sediment Sampling Activities

As described in the Scope of Work, sediment samples were collected from each of three reaches of the River designated for purposes of this investigation:

- Upstream of the Facility (from C.S. Mott Lake Dam to 1.9 miles downstream of this dam)
- Adjacent to the Facility (2.6 miles)
- Downstream of the Facility to Hamilton Dam (0.7 miles).

The survey and sediment sampling activities were conducted in accordance with the Scope of Work as described below.

2.1 Survey Activities

On October 30 and 31, 2006 BMJ Surveyors, Inc. surveyed the nine regularly-spaced transects established in the Scope of Work along the river throughout the 5.2-mile study area perpendicular to flow direction. Three transects were evenly spaced along each of three reaches described above. As described in the Scope of Work, three additional “biased” transects were established to coincide with locations of Storm Sewer Outfalls 003, 005, and 013, through which the Facility as well as other non-GM outfalls discharge. The location of these twelve transects are illustrated on Figures 2 through 4 as Transects FRT1 through FRT12.

In addition to surveying the transect endpoints, BMJ surveyed the location of the additional non-GM outfalls within the Study Area that were not previously identified.

2.2 Sampling Activities

On October 31, 2006 sampling was initiated working from the furthest downstream transect (FRT 9) in an upstream direction. Work was completed on November 1, 2006 at Transect FRT 1. The river width was measured at each transect, and the river width was divided into three equally spaced segments at each transect to establish three sampling stations (Stations A, B, and C). All field sampling and laboratory analysis activities were performed in accordance with the Quality Assurance Project Plan, Field

Sampling Plan, and Health and Safety Plan prepared and used for the Facility RFI (amended as necessary). All samples were submitted to Merit Laboratories of East Lansing, MI for analysis of SVOCs, PCBs, total organic carbon (TOC), metals, and particle size. Data validation was performed by Conestoga-Rovers and Associates. The resulting validation report is included in Appendix B

Surface Sediment Samples

Surface sediment samples were collected at all locations using an Ekman grab sampler at each of the sample locations. The sediment thickness was determined by manually probing the river bed with a 3/8-inch diameter steel rod, and water depth was also recorded at each of the sample locations. The top 2 inches of sediment (surficial sediment) recovered was described, photographed, and classified as fine- or coarse-grained sediment. Table 1 provides the surficial sediment descriptions. Appendix A presents the field notes and photographs.

Within each reach, five of the nine surficial sediment samples from the three evenly-spaced transects established in each reach were randomly selected to be submitted for laboratory analysis. Samples from the following locations were submitted for analysis:

- FRT 1C , FRT 2B, FRT 2C, FRT 3A, and FRT 3B from Transects FRT1 through FRT3 (Figure 2)

- FRT 4A, FRT 4C, FRT 5A, FRT 5B, and FRT 6B from Transects FRT4 through FRT6 (Figure 3)

- FRT 7A, FRT 7C, FRT 8B, FRT 9A, and FRT 9B from Transects FRT7 through FRT9 (Figure 4)

In addition, two surficial samples from each of the three biased transects were randomly-selected from the nine sample locations established along the three spatially-biased transects at the locations of Storm Sewer Outfalls 003, 005, and 013, respectively. The following samples (locations are shown on Figure 3) were submitted for analysis:

- FRT 10A and FRT 10B from Transect FRT10

- FRT 11B and FRT 11C from Transect FRT11

- FRT 12B and FRT 12C from Transect FRT12

A total of 21 surficial sediment samples were submitted for laboratory analysis.

Sediment Core Samples

Four sediment cores were collected from the 36 locations occupied for sediment probing and sampling. Three cores were collected from locations on the regularly spaced transects, one from each of the three reaches. These three cores were collected at the location in each reach exhibiting the thickest sediments based on probing. The fourth core was collected from the location with the thickest sediment indicated by probing on the biased transects at Outfalls 003, 005, and 013. Sediment cores were collected from the following locations:

- FRT 2C which represented the thickest sediment bed at Transects FRT1 through FRT3 (Figure 2)

- FRT 4A which represented the thickest sediment bed at Transects FRT4 through FRT6 (Figure 3)

- FRT 7C which represented the thickest sediment bed at Transects FRT7 through FRT9 (Figure 4)

- FRT 12C which represented the thickest sediment bed at the biased Transects FRT10 through FRT12 (Figure 3)

Sediment cores were manually driven to refusal and collected using Lexan tubing. Subsurface sediment (>2 inches deep) was collected from each core at the 2- to 12-inch depth interval and successive 1-foot depth intervals below the first 12 inches (to the refusal depth). These subsurface sediment samples were described in the field log, homogenized, and photographed. Table 2 provides the subsurface sediment descriptions. Appendix A presents the field notes and photographs.

3. Data Assessment and Results

This section provides the general sediment characteristics and analytical results. After validation of the laboratory results, the analytical data were assessed by river mile (RM) to determine the general spatial trends in sediment concentrations for constituents with two or more detections in surface sediment samples in any reach. Statistical comparisons of concentrations in surface sediments in the unbiased transects and the adjacent biased and unbiased transects were performed for these chemicals. The data were also assessed to evaluate if there were subsurface constituent concentrations at locations where sediment could get scoured, potentially exposing these higher concentrations. Finally, a comparison of sediment data against background concentrations was performed.

3.1 Sediment Characteristics

Surficial sediments in the Study Area were generally comprised of fine to coarse sand with trace silts, clays, gravels, and organics (leaves and shells) (Table 1). Some sampling locations contained primarily zebra mussels (FRT 1A, FRT 2A, FRT 3C, and FRT 7B), while others contained mostly gravel (FRT 5C, FRT 6A, FRT 9C, and FRT 12C). One location, FRT 11A resulted in no recovery of sediments. Three of the four cores (FRT 2C, FRT 4A, and FRT 12C) contained subsurface sediments comprised of primarily fine to coarse sand, while FRT 7C was comprised of mostly silts. These sediment descriptions were generally consistent with the particle size results (Tables 3 through 6). Thirty of the 35 samples (86%) contained particle size results with greater than 50% (by weight) fine to coarse sands. The five remaining samples (FRT 9A [0 to 2 inches], FRT 12C [0 to 2 inches], FRT 7C [2 to 12 inches], FRT 7C [12 to 24 inches], and FRT 7C [24 to 36 inches]) contained greater than 50% (by weight) clay.

The sediment probing survey indicated that sediment thickness in the Study Area ranged from 0 to 8.9 feet, with an average of 2.3 feet and median of 2 feet (Table 1). The five locations with the deepest sediments were found along the sides of the River channel where flow velocities tend to be lowest (the A and C stations, generally west and east bank areas, respectively) characteristic of a typical meandering stream. The greatest sediment thicknesses recorded were 8.9, 7.5, 6.6, 5 and 4.4 feet at locations FRT 7C, 2C, 9A, 12C, and 8C, respectively. Probing at all remaining sampling stations indicated less than 4 feet of sediment.

3.2 Analytical Results Summary

Fully 99% (242 of 245 individual Aroclor analyses) of the PCB results showed non-detectable PCB concentrations at a detection limit of 0.33 ppm (Tables 3 through 6). The maximum detected PCB concentration was 0.5 ppm (blind duplicate of the sample was estimated at 0.2 ppm), or approximately 1.5 times higher than the detection limit. The other two detected concentrations were estimated at 0.02 and 0.1 ppm, respectively. Aroclor 1254 or Aroclor 1260 were detected in these samples. Given the very low PCB concentrations, no further assessment of the PCB results was conducted.

For SVOCs, 90% (2,043 of 2,275 analyses) of results showed non-detectable concentrations. A total of 47 (72%) of the 65 SVOCs were detected only once or not at all within the dataset.

For inorganic constituents, six of the 18 inorganic analytes were infrequently detected. The remaining twelve constituents tended to all be detected in most or all of the samples. Arsenic, barium, cobalt, lead, manganese, and zinc were detected in all surface samples.

Due to the low detection frequencies for some of the chemicals, only SVOC and inorganic constituents with two or more detections in surface sediment concentrations in any reach were further used in assessing general trends and statistical comparisons. Table 7 presents a list of the SVOCs and inorganics that were detected in at least two samples in any reach.

3.2.1 General Spatial Trends in Unbiased Surface Sediment Concentrations

General trends in unbiased surface sediment concentrations (i.e. those results obtained from the three evenly-spaced transects in each reach) with two or more detections within each reach were assessed by plotting the concentrations contaminants by RM (Figures 5 through 30). Numbering of RMs began at the upstream end of the Study Area (i.e. C.S. Mott Lake Dam was set at RM 0.0) and continued to the Hamilton Dam. Non-detected values for constituent concentrations are plotted at one-half their detection limit, and are denoted using a diamond symbol. Estimated values are denoted with a square symbol, and detections are presented as triangles. These figures also illustrate the cumulative number of outfalls from upstream to downstream.

SVOCs and inorganics concentrations were consistently higher at Stations FRT 4C, 7C, 9A, and 9B than the remainder of the river. In addition to these four stations, Station FRT 2C exhibited high concentrations (similar in value to Stations FRT 4C, 7C, 9A, and 9B) for 10 of the 12 inorganic concentrations. Many urban sources have the potential to affect each of these stations, including 50 non-GM outfalls and 17 GM/other outfalls that include contributions from non-GM sources. Station FRT 2C is located in the upstream reach, which is minimally influenced by the urban environment of the City of Flint). Station FRT 4C is situated at the upstream end of the adjacent reach. Eight non-GM outfalls, as well as Kearsley Creek, enter the River in the half-mile stretch of the Study Area upstream of this station.

Stations FRT 7C, 9A, and 9B were all located in the downstream reach. Station FRT 7C is located on the western shoreline (opposite of the Facility) approximately one-half mile downstream of the Facility opposite of Gilkey Creek. Stations FRT 9A and 9B are located on the last transect within the Study Area, and are immediately downstream of five non-GM outfalls.

Specific spatial trends are summarized below.

SVOCs

- Aanthracene, carbazole, and fluorene were either not-detected or detected at concentrations below the detection limit (Figures 5, 12, and15).

- Benzo(a)anthracene and phenanthrene exhibit similarly low concentrations throughout the Study Area, with the vast majority of the results below or at the detection limit. Reported and estimated concentrations slightly above the detection limit occur at Stations FRT 9A and 9B (Figures 6 and 17). These stations are immediately downstream of five non-GM outfalls – three on the east shoreline and two on the west shoreline (Figure 4).

- Bis(2-ethylhexyl)phthalate concentrations are detected in only three samples – two estimated values of 0.04 mg/kg and 0.1 mg/kg (Stations FRT 2B and 2C, respectively) in the upstream reach and the highest concentration of 1.77 mg/kg at Station FRT 4A (RM 2.85) (Figure 11). There are six non-GM outfalls and no GM outfalls within approximately one-half-mile upstream of Station FRT 4A.

- Benzo[a]pyrene, benzo[b]fluoranthene, benzo[g,h,i]perylene, benzo[k]fluoranthene, chrysene, fluoranthene, indeno[1,2,3-cd]pyrene, and pyrene reflect a similar pattern, with concentrations ranging from 0.1 to 2.83 mg/kg at Transects FRT 4, 7, and 9, and at or near the detection limit at the upstream and adjacent transects (Figures 7, 8, 9, 10, 13, 14, 16, and 18; Table 3). Concentrations above the detection limit were consistently observed at Stations FRT 4C, 7C, 9A, and 9B, with the highest concentrations (1.24 to 2.83 mg/kg) detected at Station FRT 9A in each case. Fluoranthene and pyrene were detected (0.48 mg/kg and 0.25 mg/kg, respectively) at Station FRT 5B.

As previously described, Transect FRT 4 is located at the top of the adjacent reach (RM 2.85) downstream of only one GM outfall (Outfall 001). Station FRT 4C is located along the eastern shoreline (Figure 3). Station FRT 7C is located adjacent to a non-GM outfall (Figure 4). Stations FRT 9A and 9B are located on the furthest downstream transect within the Study Area, and are immediately downstream of five non-GM outfalls (Figure 4). Station FRT 5B is located in the middle of the adjacent reach (RM 3.7), downstream of several GM and non-GM outfalls (Figure 3).

Inorganics

- Cobalt concentrations are fairly consistently (e.g., ranging over less than a factor of 10) throughout the Study Area. The maximum concentration occurs at Station FRT 2C (9.93 mg/kg; Figure 23). Station FRT 2C is located in the upstream reach, which is minimally influenced by the urban environment of the City of Flint.

- Concentrations of arsenic, cadmium, nickel, selenium, and vanadium were also fairly consistent (e.g., ranging over less than a factor of 15), with the maximum concentrations for each metal occurring at Transect 9 (Figures 19, 21, 27, 28, and 29). Transect 9 is immediately downstream of five non-GM outfalls – three on the east shoreline and two on the west shoreline (Figure 4).

- Lead appeared to be relatively enriched in sediment at Transects FRT 5 and 9, where the maximum concentration was observed at Station FRT 5A (214 mg/kg) (Figure 25). At Transects 9A and 9B, concentrations of lead were 117 and 72.8 mg/kg, respectively. Transect 5 is located in the middle of the adjacent reach, downstream of several GM and non-GM outfalls (Figure 3), while Transect 9 is immediately downstream of five non-GM outfalls (Figure 4).

- Barium concentrations were all reported as estimated values and maximum concentrations in each reach were similar and the maximum estimated value of 127 mg/kg occurs at Station FRT 9A in the downstream reach (Figure 20).

- Chromium, copper, and zinc all reflect a pattern of generally increasing concentrations in the downstream direction with the maximum concentrations occurring at Transect 8 for chromium (Figure 22) and Transect 9 for copper and zinc (Figures 24 and 30). The greatest difference between maximum values was noted for zinc, which exhibits markedly higher concentrations at Transect FRT 9 located immediately downstream of five non-GM outfalls.

- Manganese concentrations are highly variable, with no clear trends (Figure 26). The maximum concentrations detected in the upstream reach are higher than the concentrations in the adjacent reach.

In addition, as shown in Figures 5 through 30, SVOC and inorganic concentrations generally increase within the downstream reach. This increasing concentration trend from Transect 7 to Transect 9 suggests strong influence from the non-GM outfalls that discharge in this downstream reach.

The statistically-significant differences between reaches were assessed below in accordance with the approved Scope of Work.

3.2.2 Statistical Assessment of Surface Sediment

In accordance with the Scope of Work, concentrations of constituents in surface sediment were compared between the river reaches. For each of the 14 SVOCs and 12 inorganics identified in Table 8, means were compared using t-tests and analysis of variance (ANOVA). However, due to small sample sizes and frequent non-detections for many of the constituents, assumptions of normality (normal distribution, equal variances) were not consistently achieved, potentially limiting the usability of the t-tests. In recognition of the data limitations, medians were compared using the Kruskal-Wallis test as a potentially more reliable measure of central tendency for data that are not normally distributed. All statistics were performed to a 95% confidence ($p<0.05$) using Statgraphics 5.1. One-half of the detection limit was used in computing the mean and median values for non-detected concentrations. Statistical comparisons were performed on surficial samples from the unbiased transects (FRT 1 through FRT 9) in each reach, as well as between the unbiased and biased surface sediment samples from the adjacent reach.

No statistical difference was observed in the mean concentrations of the 26 constituents between the upstream and adjacent geographical groupings (Table 8). Six constituents, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, indeno(1,2,3-cd)pyrene, and zinc, had statistically higher mean concentrations in the downstream reach compared to both the upstream and adjacent reaches (Table 8); however, these results are highly influenced by results at two locations: FRT 9A and 9B (Table 3). Transect FRT 9 was immediately downstream of five non GM outfalls – two on the west side and three on the east side of the River (Figure 4). Mean concentrations of benzo(g,h,i)perylene, fluoranthene, fluorene, pyrene, and chromium were statistically higher in the downstream reach (containing 18 non-GM outfalls) compared to the upstream reach; however, statistical differences in the mean concentrations were not found between the adjacent and downstream reaches. These differences in the mean concentrations are highly influenced by results at Transect 9, which is immediately downstream of five non GM outfalls.

The results of the Kruskal-Wallis tests indicated statistically different median concentrations between reaches for six constituents. Median concentrations of benzo(b)fluoranthene and benzo(k)fluoranthene were statistically higher in the downstream reach than both the upstream and adjacent reaches. However, no statistical difference was found for median concentrations between the upstream and adjacent reaches for these chemicals. Median concentrations of four metals, chromium, copper, lead, and zinc were statistically higher in both the adjacent and downstream reaches compared to the upstream reach. Because the metals data contain fewer non-detections and tend to be more normally distributed than the SVOC data, conclusions based on differences of both medians and means can be made with more confidence than for SVOC data in general.

Unbiased sample locations were randomly selected among sediment transect locations, while biased sample locations were purposely placed in areas where impacts, if any, from sewer outfalls draining the GM facility (as well as other, non-GM areas) would potentially be expected. The results of biased and unbiased sediment samples associated with the adjacent reach were compared to assess whether biased locations identified areas that have accumulated higher concentrations than would be randomly distributed in the river from all sources. The results of this comparison are summarized in Table 9. This comparison indicates that, while the constituent concentrations in the biased samples are generally higher than the unbiased samples, there are no significant differences ($p<0.05$) of either the means or medians of these two groups, with only one exception: Indeno(1,2,3-cd)pyrene, which exhibited a significantly higher median concentration in the biased samples; although, this constituent was not detected at significant concentrations in soil and/or groundwater at the Facility as part of the RFI.

Overall, there were a total of 13 constituents showing statistically higher mean and/or median concentrations between the three reaches. These constituents are highlighted in Tables 8 and 9, and include the following:

- Benzo(a)pyrene
- Benzo(b)fluoranthene
- Benzo(g,h,i)perylene
- Benzo(k)fluoranthene
- Chrysene
- Fluoranthene
- Fluorene
- Indeno(1,2,3-cd)pyrene
- Pyrene
- Chromium (Total)
- Copper
- Lead
- Zinc

These differences in mean and/or median concentrations were often a result of one or two samples from locations bounded by lower concentrations with somewhat elevated concentrations exerting a strong influence on the distribution.

3.2.3 Assessment of Trends Sediment Core Concentrations

Sediment cores were collected to assess the vertical distribution of SVOCs, PCBs, and inorganics. A review of the analytical results for the sediment core samples indicates that for almost all constituents, the maximum concentrations occur in the 0- to 12-inch layer, and in most cases, in the surface (0-2 inch layer). This is particularly true for sediments in the reach adjacent to the facility, as indicated by cores FRT 4C and FRT 12C (near Outfall 013). Contaminant concentrations in core FRT 2C in the upstream reach were uniformly low throughout the core. In core FRT 7A from the downstream reach, many of the constituent concentrations were highest in the 2-12 inch layer, typically only modestly higher than in the surface layer. The greatest difference between the surface (0-2 inch) and the shallow subsurface (2-12 inch) concentrations in core FRT 7A were for zinc (factor of 6.9), lead (factor of 7.2), nickel (factor of 10.5) and chromium (factor of 20).

3.3 Evaluation of Background Concentrations

The background values that were used in this analysis were the typical urban background soil concentrations for polycyclic aromatic hydrocarbons (PAHs) that were compiled by ATSDR (1995), and the mean concentrations of metals in Michigan surface soils for residential, commercial, and industrial land uses in an urban watershed (Murray et al. 2004). Appropriate urban background concentrations for sediment would be preferable to soil data, but such data are not readily available. The soil data compiled by ATSDR (1995) and Murray et al. (2004) are deemed to be a suitable surrogate for sediment data in this analysis, because sediment in river Study Area is expected to be of local terrigenous origin.

The sediment data for the 13 constituents identified in Section 3.2.2 were compared to background values for urban areas to interpret the significance of the concentrations that were measured in the river sediments (refer to Tables 10, 11, 12, and 13). Comparison of these data to urban background values indicates that the concentrations of these constituents are generally within the ranges that would be expected in an urban waterway such as the Flint River, which is impacted by numerous potential sources discharging to the Study Area. Of the constituents that do exceed background values, situations where the sediment concentrations exceed by more than a factor of 3 are limited to a few individual samples.

Concentrations of benzo(a)pyrene, chrysene, lead, and zinc exceeded the urban background values for surface sediment in the adjacent and downstream reaches (Tables 10 and 11). Exceedances of the background values were small, generally within a factor of 2 or 3, and the highest exceedances were associated with samples from stations FRT 5A for lead, FRT 9A and B for the PAHs and zinc for the unbiased dataset, and stations FRT 12C for the samples that were biased to the GM-outfalls. Stations FRT 9A and B are the farthest downstream stations, and are located immediately downstream of five non-GM outfalls. Mean concentrations of metals did not exceed the urban background values, and the mean concentration of benzo[a]pyrene only exceeded by a small margin.

In subsurface sediment, concentrations of benzo(a)pyrene, chrysene, chromium, copper, lead, and zinc at several depth intervals exceeded the urban background levels, but only at downstream locations (Tables 12 and 13). The greatest exceedances of the background values were for station FRT 7C. This station is located adjacent to a non-GM-related outfall and near the mouth of Gilkey Creek, and is thus likely to be predominantly influenced by non-GM sources. Mean concentrations of the inorganics (across all depth intervals) did not exceed the urban watershed background levels. The mean concentrations of benzo(a)pyrene and chrysene across all depth intervals for both unbiased and biased subsurface sediments exceeded the range of urban background levels for these constituents.

3.4 Data Analysis Conclusions

As discussed in Section 3.2, only SVOCs and metals warranted statistical and spatial trend analysis. PCBs were only detected in two samples at very low concentrations; and therefore, were not subject to statistical and/or spatial trend analysis.

As for SVOCs, 90% (2,043 of 2,275 analyses) of results for SVOCs showed non-detectable concentrations, and detectable and/or elevated concentrations of SVOCs were only consistently observed at Stations 4C, 7C, 9A, and 9B, with Stations 9A and B strongly influencing the statistical analyses. However, many urban sources contribute to each of these stations, including the tributaries of Kearsley Creek and Gilky Creek, as well as 50 non-GM outfalls, in addition to the 17 GM outfalls. Specifically, Transect 9 is located immediately downstream of five non-GM outfalls. Additionally, due small sample sizes and frequent non-detections for many of the SVOCs, the statistical evaluations of SVOC concentrations indicated that the comparison of median values using the Kruskal-Wallis test produced potentially more reliable results, in lieu of the use of mean values, t-tests, and ANOVA.

As for metals, Figures 5 through 30 show consistent trends of higher concentrations of select metals occurring downstream, which have been confirmed with statistical analysis. Additionally, conclusions for select metals based on the differences of both the medians and means can be made with more confidence than for the SVOC data in general due to the metals data represented by more non-detections and thus more likely to closely represent a normal distribution.

Based on these conclusions and the more detailed information discussed in Section 3.2.2 and 3.2.3, only the following chemicals warrant further evaluation:

- Benzo(b)fluoranthene
- Benzo(k)fluoranthene
- Indeno(1,2,3-cd)pyrene
- Chromium (Total)
- Copper
- Lead
- Zinc

This is despite the fact that approximately 50 non-GM outfalls were identified along the Study Reach, which include many potential sources of metals unrelated to the Facility. These seven constituents were detected based on the median statistic to have significant differences in:

1. Unbiased sediment concentrations between either the adjacent or downstream reaches as compared to the upstream reach (see Table 8); and/or

2. Biased sediment concentrations between the adjacent reach as compared to the upstream reach (see Table 9).

As such, these seven constituents are included for further evaluation in the SLERA.

Conclusions regarding other constituents detected based on mean values are not as robust in terms of conclusions regarding differences from upstream sediments due to sensitivity of the mean to single high or low point values that could occur with localized proximately to any one of the numerous outfalls (including approximately 50 non-GM outfalls) in the Study Area. The effect of using the mean value is further compounded in this case due to the large number of non-detect concentrations and the overall relatively low levels of analyzed constituents in the sediments.

The identification of these constituents as warranting further evaluation is supported by the conclusions noted concerning the comparisons of sediment constituent concentrations to urban background values presented in Section 3.3, since only a subset of these seven constituents were identified to exceed urban background values.

4. Screening-Level Ecological Risk Assessment

The process for the river SLERA included the following elements: chemical constituents in sediment were screened against conservative screening values (Region 5 ESLs) to identify the constituents of potential concern (CoPCs) subject to further evaluation, and concentrations of CoPCs were compared to alternate screening values (no-effect concentrations, NECs) that are based on toxicity to benthic invertebrates. Exceedance of an NEC is not necessarily indicative of an adverse effect because the NEC is a concentration below which no adverse effects would be expected. Sediment concentrations were also compared to background levels as part of the uncertainty analysis, to provide additional lines of evidence from which to draw conclusions regarding ecological risk.

Nine PAHs (benzo[a]pyrene, benzo[g,h,i]perylene, benzo[k]fluoranthene, chrysene, fluoranthene, fluorene, indeno[1,2,3-cd]pyrene, and pyrene) and four metals (chromium, copper, lead, and zinc) were included in the ESL screening in order to identify CoPCs. Comparison of CoPC concentrations to NECs indicates a low probability for adverse effects to benthos. In addition, the spatial distribution of samples with concentrations that exceed NECs indicates that exposure to the CoPCs at levels potentially capable of causing adverse effects would occur over small areas. The background screening showed that levels that were detected in the River Study Area sediment are generally within the range of concentrations that would be considered typical for an urban waterway. Furthermore, elevated levels of CoPCs are not associated exclusively with the locations of Facility-related outfalls, and in many cases, appear to have a greater association with non-GM-related outfalls and tributaries.

Numerous chemical sources have been documented within the Study Area, most of which are non-GM-related. In addition to the 17 Facility-influenced outfalls, there are 50 non-GM-related outfalls, as well as influences from tributaries, as discussed in the Section 1.2 (also refer to Figures 5 through 30). Storm sewers that drain portions of the Facility also drain industrial, commercial, and residential areas outside the boundaries of the Study Area. Tributary drainages and runoff from industrial, commercial, and residential properties, as well as roads and railroads in the Flint metropolitan area, also contribute to the sediment and contaminant load of the River. Thus it is impossible to distinguish specific sources of contaminants to the River.

The weight of evidence as presented in the SLERA is adequate to conclude that ecological risks are low to negligible, and therefore, it is concluded that there is no need for further investigation or remediation within the river on the basis of ecological risk.

5. Conclusions

The Flint River Sediment Investigation was conducted as part of the RFI for the Facility, as an extension of the assessment of the possible impacts of potential discharges of hazardous constituents from the Facility via infiltration to storm sewers and subsequent migration to the river. In April 2005 the MDEQ, with USEPA observing, implemented a sediment sampling program targeted at assessing sediment quality in the river immediately adjacent to outfalls that receive storm water contributions from the Facility. Overall the results of the MDEQ investigation indicated relatively low concentrations of most constituents, in-line with levels typically observed in river sediments in industrialized urban settings. A review of these data, which GM provided to USEPA via letter dated December 1, 2005 suggested minimal facility-related contributions to observed constituent concentrations. Subsequently, USEPA expressed a desire for additional information and requested that GM implement a more extensive sampling program and conduct a screening-level ecological risk assessment. The Flint River Sediment Investigation was conducted to satisfy USEPA's request as described in the scope of work submitted to USEPA on October 6, 2006.

Due to the presence of numerous storm water outfalls discharging to the river adjacent to the Facility and downstream of the facility, the results of the investigation, presented in Section 3 of this report, are inconclusive concerning potential contributions of the facility to the observed distribution of constituents analyzed. Statistical differences in median concentrations of three PAHs (benzo[b]fluoranthene, benzo[k]fluoranthene, and indeno[1,2,3-cd]pyrene) and four metals (chromium, copper, lead, and zinc) exist between samples collected in adjacent and downstream sections of the river as compared to the upstream section of the river and exhibit a general increasing trend in the downstream direction through the urban Flint area. However, contaminant contributions of the Facility and the numerous other sources are commingled and indistinguishable and effects of all sources are cumulative. Spatial patterns in sediment concentrations are likely governed by local variations near sources as well as variable sedimentation patterns in the river.

Extensive source control activities have been implemented at the Facility and are on-going. Other industrial, commercial, and urban source activity in the area will likely continue as a source of "background" sediment quality impairment.

This report also presents a comparison of observed sediment concentrations to relevant background values. These comparisons involved 13 constituents exhibiting statistically-significant differences between median or mean concentrations among the Study Area reaches, and show that the concentrations of these constituents are generally within the ranges that would be expected in an urban waterway such as the river, which is impacted by numerous potential sources discharging to the Study Area. Of the constituents that do exceed background values, situations where the sediment concentrations exceed by more than a factor of 3 are limited to a few individual samples.

The SLERA conservatively identified a subset of the eight SVOCs and four metals as CoPCs for further evaluation based on comparison to ESLs and compared these to NECs to provide additional basis to interpret the significance of ESL exceedences. This comparison reveals that for surface sediments, the most relevant strata for evaluation of ecological risk, lead was the only metal with a detected concentration in excess of the NEC value, which only occurred at one location in the reach adjacent to the facility. In the downstream reach, two PAH compounds exceeded the NEC value, at one location and a single PAH compound exceed the NEC value at one other location. Both of these locations are downstream of multiple non-GM outfalls that are present downstream of the Facility. The SLERA also evaluated potential risks by comparison of subsurface values to NEC concentration under the unlikely hypothesis that a hydrodynamic scour event would cleanly remove the surface sediment layer – which is very unlikely considering that during high flow events there is typically a large amount of clean watershed-derived sediment in transport which tends to reduce, not increase exposure due to deposition and mixing. This comparison also indicates negligible to low potential risks that in any case are likely to be spatially-limited based on the very limited number of sample locations with subsurface values exceeding the NEC levels.

Reflecting on the objectives of the investigation as presented in the Scope of Work and Section 1.3 of this report it can be concluded that the investigation, including the SLERA presented in Section 4 and Appendix C, fully satisfies the study objectives. The principal conclusions of the investigation are:

1) There are no discernable impacts of the Facility on sediment quality in the river above those associated with typical urban sources based on comparison to relevant background values and the documented presence of numerous other non-GM sources adjacent to and downstream of the facility.

2) There is adequate information to conclude that ecological risks are low to negligible, and therefore, no need exists for further investigation or

remediation on the basis of ecological risk, regardless of the sources for observed sediment concentrations.

These conclusions are supported by the following specific findings of the investigation which have been previously document in Sections 3 and 4 of this report, as well as Appendix C, which contains the SLERA.

- The distribution of constituents in the river sediments reveals a general trend of increasing concentrations in the downstream direction through the urban Flint Area with the greatest concentrations occur at locations downstream of the facility that receive contributions from numerous non-GM sources located in the downstream reach.
- The maximum concentrations occur in the top 12-inches of the sediment column in nearly all cases and in most cases in the surface layer (0-2 inch layer). Based on these data, there is no substantial inventory at depth that would be potentially subject to erosion resulting in dispersal of constituents downstream, or contributing to any appreciable increase in exposure and risk as a result of potential erosional events. In general, the sediment core sample results together with the sediment probing results suggest that a high rate of sediment accumulation does not occur in the study area.
- Storm sewers that drain portions of the Facility also drain industrial, commercial, and residential areas outside the boundaries of the River Study Area. In addition, there are numerous non-Facility-related anthropogenic sources of metals and SVOCs to the river, including 50 non-GM-related outfalls within the Study Area and influences from tributaries.
- Comparison of CoPC concentrations to toxicity-based NECs and urban background values indicates a low potential for adverse effects to benthos, if any; and that observed sediment concentrations are generally within the ranges that would be expected in an urban waterway such as the river.

- Elevated levels of constituent concentrations in sediment are not associated exclusively with the locations of Facility-related outfalls, and in many cases, appear to have a greater association with non-GM-related outfalls and tributaries due to their location being downstream of non-GM outfalls and when lower concentrations have been observed upstream adjacent to the Facility.

- Ecological receptors’ exposure to subsurface sediment represents an unlikely worst-case scenario wherein scour would remove the overlying sediment without disturbing the subsurface layers where elevated constituents occur; risk from this potential exposure scenario is low. For this unlikely scenario, the SLERA weight of evidence indicates a minimal potential for relative increases in potential risks.

6. References

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Tables

Table 1
Flint River Sediment Investigation
GM NAO Flint Operations Site, Flint, MI

Flint River Surficial Sediment Sample Descriptions

Location Identification	River Width (feet)	Station Identification	Water Depth (feet)	Probing Depth (feet)	Sample Description
FRT 1A	115	0+29	9.2	1.3	Zebra mussels
FRT 1B	115	0+58	12.8	0.1	Brown fine to medium gravel, little brown medium sand.
FRT 1C	115	0+87	6.5	2.4	Brown fine to medium sand, little leaves, trace coarse sand, trace silt, trace zebra mussels.
FRT 2A	129	0+32	11.0	1.5	Zebra mussels.
FRT 2B	129	0+64	11.2	1.3	Grey brown fine to medium sand, trace coarse sand, trace fine gravel, trace silt, trace organics (leaves, zebra mussels).
FRT 2C	129	0+96	6.5	7.5	Brown very loose silt, little leaves, trace fine to coarse sand.
FRT 3A	150	0+37.5	6.6	3.1	Grey brown fine to medium sand, trace silt, trace organics (leaves)
FRT 3B	150	0+75	8.0	1.2	Grey brown fine to medium sand, trace coarse sand, trace silt, trace fine gravel, trace zebra mussels.
FRT 3C	150	1+12.5	10.0	0.8	Zebra mussels.
FRT 4A	155	0+39	8.6	3.0	Brown silty fine sand, trace medium to coarse sand, trace fine gravel, trace organics (zebra mussels, leaves).
FRT 4B	155	0+78	10.0	2.0	Dark grey brown fine to medium sand, trace coarse sand, trace fine gravel, trace silt, trace organics (zebra mussels, wood).
FRT 4C	155	1+17	10.7	0.2	Brown very loose silt, trace fine sand, trace organics (zebra mussels, leaves).
FRT 5A	159	0+40	8.4	2.6	Grey brown fine to medium sand, trace coarse sand, trace silt, trace organics (zebra mussels, shells).
FRT 5B	159	0+80	9.5	1.5	Grey brown fine sand, trace medium to coarse sand, trace silt, trace organics (leaves, zebra mussels).
FRT 5C	159	1+20	9.0	0.0	Gravel with trace zebra mussels.
FRT 6A	167	0+42	11.0	0.0	Gravel.
FRT 6B	167	0+84	9.7	2.0	Grey brown fine to medium sand, little coarse sand, trace fine to medium gravel, trace silt, trace organics (zebra mussels).
FRT 6C	167	1+26	8.0	2.5	Grey brown silty very fine sand, trace organics (leaves, zebra mussels), trace sheen
FRT 7A	189	0+63	11.0	0.1	Grey brown fine to medium sand, trace coarse sand, trace silt, trace organic (shells, leaves).
FRT 7B	189	1+26	7.0	3.2	Zebra mussels.
FRT 7C	189	1+89	2.1	8.9	Grey brown silty fine sand, trace organics (leaves, twigs).
FRT 8A	194	0+48.5	12.7	0.3	Grey brown fine to medium gravel, trace fine sand, trace silt, trace organics (shells, leaves)
FRT 8B	194	0+97	10.0	2.8	Grey brown fine to coarse sand, little fine to medium gravel, trace silt, trace organics (twigs, shells, wood), trace slag.

Table 1
Flint River Sediment Investigation
GM NAO Flint Operations Site, Flint, MI

Flint River Surficial Sediment Sample Descriptions

Location Identification	River Width (feet)	Station Identification	Water Depth (feet)	Probing Depth (feet)	Sample Description
FRT 8C	194	1+145.5	9.6	4.4	Brown fine sand, trace medium to coarse sand, trace fine gravel, trace organics (leaves).
FRT 9A	188	0+47	3.6	6.6	Brown fine sand, trace silt, leaves, organics (root mass).
FRT 9B	188	0+94	10.7	3.3	Brown fine sand, trace organics, trace medium to coarse sand, leaves, twigs, trace fine gravel.
FRT 9C	188	1+41	14.0	0.0	Gravel.
FRT 10A	185	0+46	7.9	3.3	Dark grey brown fine sand, little silt, trace organics (twigs, zebra mussels) sheen, slight odor.
FRT 10B	185	0+92	9.7	2.1	Grey brown fine to medium sand, trace coarse sand, trace silt, trace organics (shells).
FRT 10C	185	1+38	8.7	1.3	Grey brown fine to medium sand, little coarse sand, trace fine gravel, trace organics (twigs, zebra mussels).
FRT 11A	152	0+38	9.2	0.0	No recovery
FRT 11B	152	0+76	11.5	1.3	Dark grey brown fine to medium sand, trace coarse sand, trace silt, trace fine gravel, sheen present, slight odor.
FRT 11C	152	1+14	9.0	3.6	Grey brown fine to medium sand, trace silt, trace organics (leaves, zebra mussels) slight sheen.
FRT 12A	186	0+46	8.0	5.0	Brown very loose silt, little organic (leaves), trace very fine sand.
FRT 12B	186	0_92	10.1	2.2	Grey brown fine sand, trace medium to coarse sand, trace organic (wood, zebra mussels) trace fine gravel).
FRT 12C	186	1+38	10.0	0.2	Medium to coarse gravel, trace organic (zebra mussels).

NOTES:

1. Sampling was performed by representatives from ARCADIS of New York, Inc. and Exponent during the week of October 30, 2006

2. Station identification indicates total feet measured from the west bank of the river.

3. All Samples were screened in the field using a photoionization detector. All readings were indicated to be zero.

Table 2
Flint River Investigation
GM NAO Flint Operations Site, Flint, MI

Flint River Subsurface Sediment Core Sample Descriptions

Transect Location: FRT 2C	Probing Information (steel rod): 7.5
Penetration (lexan): 6.2	Recovery: 4.8

Sample ID	Sample Interval (inches below grade)	Description
FRT 2C (2-12)	2-12	Dark grey silty fine sand, trace medium to course sand, trace wood.
FRT 2C (12-24)	12-24	Interbedded dark grey fine sand and silt in 2 inch lenses.
FRT 2C (24-36)	24-36	Interbedded dark grey fine sand and silt in 2 inch lenses.
FRT 2C (36-48)	36-48	Interbedded dark grey fine sand and silt in 2 inch lenses.
FRT 2C (48-57)	48-57	Light grey brown fine to medium sand.

Transect Location: FRT 4A	Probing Information (steel rod): 3.0
Penetration (lexan): 3.0	Recovery: 2.5

Sample ID	Sample Interval (inches below grade)	Description
FRT 4A (2-12)	2-12	Dark grey brown fine to course sand, trace fine gravel, trace wood.
FRT 4A (12-24)	12-24	Grey brown fine sand, trace medium to course sand, trace wood.
FRT 4A (24-30)	24-30	Grey brown fine sand, trace medium to course sand, trace wood.

Transect Location: FRT 7C	Probing Information steel rod): 8.9
Penetration (lexan): 5.8	Recovery: 3.9

Sample ID	Sample Interval (inches below grade)	Description
FRT 7C (2-12)	2-12	Dark grey brown loose silt, trace fine sand, trace organics (rootlets) strong odor.
FRT 7C (12-24)	12-24	Dark grey brown loose silt, trace fine sand, trace organics (rootlets), strong odor.
FRT 7C (24-36)	24-36	Dark grey sandy silt, odor decreasing with depth.
FRT 7C (36-46)	36-46	Dark grey brown sand, little silt, trace odor.

Table 2
Flint River Investigation
GM NAO Flint Operations Site, Flint, MI

Flint River Subsurface Sediment Core Sample Descriptions

Transect Location: FRT 12C	Probing Information (steel rod): 5.0
Penetration (lexan): 4.0	Recovery: 3.0

Sample ID	Sample Interval (inches below grade)	Description
FRT 12C (2-12)	2-12	Dark grey silty fine sand, trace medium to course sand, trace wood.
FRT 12C (12-24)	12-24	Dark grey fin to medium sand , trace silt, trace organics (leaves twigs).
FRT 12C (24-36)	24-36	Dark grey fin to medium sand, trace silt, trace organics (leaves twigs), with silty lens containing a strong odor from 34-36.

NOTES:

1. Sampling was performed by representatives from ARCADIS of New York, Inc. and Exponent during the week of October 30, 2006

2. All Samples were screened in the field using a photoionization detector. All readings were indicated to be zero.

Table 3
Flint River Sediment Investigation, GM NAO Flint Operations Site, Flint, MI

Summary of Surface Sediment Analytical Results for Unbiased Sampling Transects

Sample ID:		FRT 1C	FRT 2B	FRT 2C	FRT 3A	FRT 3B	FRT 4A	FRT 4C	FRT 5A	FRT 5B	FRT 6B	FRT 7A	FRT 7C	FRT 8B	FRT 9A	FRT 9B
Sample Depth(inches BGS):		0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2
Date Collected:	Units	11/01/06	11/01/06	11/01/06	11/01/06	11/01/06	11/01/06	11/01/06	10/31/06	10/31/06	10/31/06	10/31/06	10/31/06	10/31/06	10/31/06	10/31/06
Semivolatile Organics (SVOCs)																
2,2'-oxybis(1-Chloropropane) (bis(2-chloroisopropyl) ether)	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 UJ	0.33 U	0.33 U [0.33 U]	0.33 U
2,4,5-Trichlorophenol	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 UJ	0.33 U	0.33 U [0.33 U]	0.33 U
2,4,6-Trichlorophenol	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 UJ	0.33 U	0.33 U [0.33 U]	0.33 U
2,4-Dichlorophenol	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 UJ	0.33 U	0.33 U [0.33 U]	0.33 U
2,4-Dimethylphenol	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 UJ	0.33 U	0.33 U [0.33 U]	0.33 U
2,4-Dinitrophenol	mg/kg	0.67 UJ	0.67 UJ	0.67 U	0.67 UJ	0.67 UJ	0.67 UJ	0.67 UJ	0.67 UJ	0.67 U	0.67 UJ	0.67 UJ	0.67 UJ	0.67 UJ	0.67 UJ [0.67 U]	0.67 UJ
2,4-Dinitrotoluene	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 UJ	0.33 U	0.33 U [0.33 U]	0.33 U
2,6-Dinitrotoluene	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 UJ	0.33 U	0.33 U [0.33 U]	0.33 U
2-Chloronaphthalene	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 UJ	0.33 U	0.33 U [0.33 U]	0.33 U
2-Chlorophenol	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 UJ	0.33 U	0.33 U [0.33 U]	0.33 U
2-Methylnaphthalene	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 UJ	0.33 U	0.33 U [0.33 U]	0.33 U
2-Methylphenol	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 UJ	0.33 U	0.33 U [0.33 U]	0.33 U
2-Nitroaniline	mg/kg	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 UJ	0.67 U	0.67 U [0.67 U]	0.67 U
2-Nitrophenol	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 UJ	0.33 U	0.33 U [0.33 U]	0.33 U
3,3'-Dichlorobenzidine	mg/kg	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 UJ	0.67 U	0.67 U [0.67 U]	0.67 U
3-Methylphenol	mg/kg	0.33 U	0.33 U	0.36	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 UJ	0.33 U	0.33 U [0.33 U]	0.33 U
3-Nitroaniline	mg/kg	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 UJ	0.67 U	0.67 U [0.67 U]	0.67 U
4,6-Dinitro-2-methylphenol	mg/kg	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 UJ	0.67 U	0.67 U [0.67 U]	0.67 U
4-Bromophenyl phenyl ether	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 UJ	0.33 U	0.33 U [0.33 U]	0.33 U
4-Chloro-3-methylphenol	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 UJ	0.33 U	0.33 U [0.33 U]	0.33 U
4-Chloroaniline	mg/kg	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 UJ	0.67 U	0.67 U [0.67 U]	0.67 U
4-Chlorophenyl phenyl ether	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 UJ	0.33 U	0.33 U [0.33 U]	0.33 U
4-Nitroaniline	mg/kg	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 UJ	0.67 U	0.67 U [0.67 U]	0.67 U
4-Nitrophenol	mg/kg	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 UJ	0.67 U	0.67 U [0.67 U]	0.67 U
Acenaphthene	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 UJ	0.33 U	0.33 U [0.33 U]	0.33 U
Acenaphthylene	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 UJ	0.33 U	0.03 J [0.33 U]	0.33 U
Acetophenone	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 UJ	0.33 U	0.33 U [0.33 U]	0.33 U
Anthracene	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.04 J	0.33 U	0.33 U	0.33 UJ	0.33 U	0.06 J [0.33 U]	0.04 J
Atrazine	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 UJ	0.33 U	0.33 U [0.33 U]	0.33 U
Benzaldehyde	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 UJ	0.33 U	0.33 U [0.33 UJ]	0.33 U
Benzo(a)anthracene	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.09 J	0.33 U	0.2 J	0.33 U	0.33 U	0.04 J	0.33 U	0.7 [0.1 J]	0.4
Benzo(a)pyrene	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.2 J	0.62 J	0.2 J	0.2 J	0.33 U	0.3 J	0.81 J	0.1 J	1.78 J [1.14]	1.07
Benzo(b)fluoranthene	mg/kg	0.33 UJ	0.33 UJ	0.33 UJ	0.33 UJ	0.33 UJ	0.2 J	0.75 J	0.33 UJ	0.2 J	0.33 UJ	0.3 J	0.89 J	0.33 UJ	2.09 J [1.28 J]	1.32 J
Benzo(g,h,i)perylene	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.1 J	0.47	0.1 J	0.2 J	0.33 U	0.2 J	0.62 J	0.08 J	1.28 [1.04]	0.75
Benzo(k)fluoranthene	mg/kg	0.33 UJ	0.33 UJ	0.33 UJ	0.33 UJ	0.33 UJ	0.2 J	0.53 J	0.2 J	0.2 J	0.07 J	0.3 J	0.82 J	0.33 UJ	1.58 J [1.09 J]	0.88 J
Biphenyl	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 UJ	0.33 U	0.33 U [0.33 U]	0.33 U
bis(2-Chloroethoxy)methane	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 UJ	0.33 U	0.33 U [0.33 U]	0.33 U
bis(2-Chloroethyl)ether	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 UJ	0.33 U	0.33 U [0.33 U]	0.33 U
bis(2-Ethylhexyl)phthalate	mg/kg	0.33 U	0.04 J	0.1 J	0.33 U	0.33 U	1.77	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.51 UJ	0.33 U	0.76 U [0.46]	0.64 U
Butyl benzylphthalate	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 UJ	0.33 U	0.33 U [0.33 U]	0.33 U
Caprolactam	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 UJ	0.33 U	0.33 U [0.33 U]	0.33 U
Carbazole	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 UJ	0.33 U	0.1 J [0.08 J]	0.09 J
Chrysene	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.2 J	0.54	0.1 J	0.3 J	0.06 J	0.3 J	0.66 J	0.1 J	1.48 [0.88]	0.94
Dibenz(a,h)anthracene	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 UJ	0.33 U	0.08 J [0.33 U]	0.33 U
Dibenzofuran	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 UJ	0.33 U	0.33 U [0.33 U]	0.33 U
Diethyl phthalate	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 UJ	0.33 U	0.33 U [0.33 U]	0.33 U
Dimethyl phthalate	mg/kg	0.33 U	0.33 U	0.33 U	0.05 J	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 UJ	0.33 U	0.06 J [0.33 U]	0.33 U
Di-n-butylphthalate	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 UJ	0.33 U	0.33 U [0.33 U]	0.33 U
Di-n-octyl phthalate	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 UJ	0.33 U	0.33 U [0.33 U]	0.33 U
Fluoranthene	mg/kg	0.33 U	0.33 U	0.03 J	0.33 U	0.33 U	0.3 J	1.08	0.2 J	0.48	0.1 J	0.44	1.2 J	0.1 J	2.83 J [1.57 J]	2.05
Fluorene	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.09 J	0.33 U	0.33 U	0.33 U	0.33 U	0.1 J	0.33 U	0.1 J [0.1 J]	0.1 J
Hexachlorobenzene	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 UJ	0.33 U	0.33 U [0.33 U]	0.33 U
Hexachlorobutadiene	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 UJ	0.33 U	0.33 U [0.33 U]	0.33 U
Hexachlorocyclopentadiene	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 UJ	0.33 U	0.33 U [0.33 UJ]	0.33 U
Hexachloroethane	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 UJ	0.33 U	0.33 U [0.33 U]	0.33 U
Indeno(1,2,3-cd)pyrene	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.1 J	0.39	0.1 J	0.1 J	0.33 U	0.2 J	0.52 J	0.06 J	1.21 [0.86]	0.67
Isophorone	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 UJ	0.33 U	0.33 U [0.33 U]	0.33 U
Naphthalene	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 UJ	0.33 U	0.33 U [0.33 U]	0.33 U
Nitrobenzene	mg/kg	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 UJ	0.2 U	0.2 U [0.2 U]	0.2 U
N-Nitrosodi-n-propylamine	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 UJ	0.33 U	0.33 U [0.33 U]	0.33 U
N-Nitrosodiphenylamine	mg/kg	0.33 UJ	0.33 UJ	0.33 UJ	0.33 UJ	0.33 UJ	0.33 UJ	0.33 UJ	0.33 UJ	0.33 UJ	0.33 UJ	0.33 UJ	0.33 UJ	0.33 UJ	0.33 UJ [0.33 UJ]	0.33 UJ
Pentachlorophenol	mg/kg	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 UJ	0.67 U	0.67 U [0.67 U]	0.67 U
Phenanthrene	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.2 J	0.33 U	0.33 U	0.33 UJ	0.33 U	0.44 [0.33 U]	0.3 J
Phenol	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 UJ	0.33 U	0.33 U [0.33 U]	0.33 U
Pyrene	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.46	0.33 U	0.35	0.33 U	0.33 U	0.41 J	0.33 U	1.94 [0.71]	1.25

Table 3

Flint River Sediment Investigation, GM NAO Flint Operations Site, Flint, MI

Summary of Surface Sediment Analytical Results for Unbiased Sampling Transects

Sample ID:		FRT 1C	FRT 2B	FRT 2C	FRT 3A	FRT 3B	FRT 4A	FRT 4C	FRT 5A	FRT 5B	FRT 6B	FRT 7A	FRT 7C	FRT 8B	FRT 9A	FRT 9B
Sample Depth(inches BGS):		0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2
Date Collected:	Units	11/01/06	11/01/06	11/01/06	11/01/06	11/01/06	11/01/06	11/01/06	10/31/06	10/31/06	10/31/06	10/31/06	10/31/06	10/31/06	10/31/06	10/31/06
Pesticides/Polychlorinated Biphenyls (PCBs)																
Aroclor-1016 (PCB-1016)	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U [0.33 U]	0.33 U
Aroclor-1221 (PCB-1221)	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U [0.33 U]	0.33 U
Aroclor-1232 (PCB-1232)	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U [0.33 U]	0.33 U
Aroclor-1242 (PCB-1242)	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U [0.33 U]	0.33 U
Aroclor-1248 (PCB-1248)	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U [0.33 U]	0.33 U
Aroclor-1254 (PCB-1254)	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U [0.33 U]	0.33 U
Aroclor-1260 (PCB-1260)	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.02 J	0.33 U	0.33 U [0.33 U]	0.33 U
Inorganics																
Antimony	mg/kg	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U [0.3 U]	0.3 U
Arsenic	mg/kg	2.41	2.09	12.1	1.61	1.51	3.2	6.62	3.31	3.51	2.98	4.28	3.83	2.32	15.8 J [8.86 J]	7.39
Barium	mg/kg	18.3 J	7.5 J	90.6 J	11.2 J	7.5 J	28.9 J	73.2 J	20.2 J	22.8 J	19.4 J	29.4 J	38.8 J	26.1 J	127 J [110]	52.6 J
Beryllium	mg/kg	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U [0.5 U]	0.5 U
Cadmium	mg/kg	0.2 U	0.2 U	0.99	0.2 U	0.2 U	0.26	0.33	0.3	0.2 U	0.2 U	0.23	0.45	0.2 U	1.69 [2.09]	0.88
Chromium (Total)	mg/kg	2 U	2 U	5.5	2 U	2 U	22.4	7	11.4	4.8	5.2	5.9	7.5	41.2	26 [22.6]	15.8
Cobalt	mg/kg	1.21	1.07	9.93	1	0.99	1.57	2.97	1.42	1.19	2.33	1.55	2.23	1.77	7.15 [4.94]	2.76
Copper	mg/kg	2.3	1 U	15.5	1.9	1 U	13.5	31.2	25.9	15.8	10.9	13.7	33	4.6	106 [66.3]	16.6
Cyanide (total)	mg/kg	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	1	0.1 U [0.1 U]	0.1 U
Lead	mg/kg	3.6	3.5	13.1	3	2.4	15.4	26	214	16.8	12.2	23.9	34	8.2	118 [116]	72.8
Manganese	mg/kg	195	107	872	121	104	550	596	265	207	498	331	164	1,430	663 [662]	584
Mercury	mg/kg	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.15 [0.094]	0.05 U
Nickel	mg/kg	1.5	1 U	10.7	1.5	1 U	4.2	6.5	2.6	2.1	3.2	3.2	4.7	3	14.1 [10.7]	7.3
Selenium	mg/kg	0.2 U	0.2 U	0.48	0.2 U	0.2 U	0.23	0.33	0.28	0.2 U	0.39	0.44	0.2 U	0.27	0.73 [0.82]	0.6
Silver	mg/kg	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.24 U [0.33 U]	0.1 U
Thallium	mg/kg	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U [0.5 U]	0.5 U
Vanadium	mg/kg	1.5	1 U	8.2	1.1	1 U	1.9	6.6	1.5	1.5	1.6	1.9	3.2	1.9	10.7 [9.6]	2.9
Zinc	mg/kg	11.7 J	8.2 J	42.9 J	10.9 J	8.2 J	28.2 J	72.3 J	43.1 J	37.6 J	30.6 J	49.8 J	94 J	30.8 J	324 J [281]	312 J
Miscellaneous																
Total Organic Carbon (TOC)	mg/kg	95	26	420	37	20	140	170	25	50	20	42	45	15 U	470 J [160 J]	89
Total Solids	%	72	81	40	75	79	64	47	77	73	86	60	57	75	23 [25]	54
Field Parameters																
Clay	%wt	(2)	(2)	(2)	4.84	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	51.48 [60.33]	(2)
Coarse Sand	%wt	7.16	6.21	26.63	0	2.52	11.34	6.24	3.04	0.93	10.88	3.15	0.24	26.2	0 [0]	7.81
Fine Sand	%wt	55.1	33.06	20.1	74.68	52.6	33.51	39.71	36.52	75.91	14.94	57.58	82.93	5.84	0 [0]	26.94
Grain Density	mm	0.361	0.51	1.269	0.315	0.407	0.577	0.362	0.523	0.31	0.867	0.352	0.149	1.751	0.005 [0.004]	0.632
Gravel	%wt	3.68	1.67	8.65	0	1.41	7.03	26.94	4.72	4.98	4.54	0.44	0	16.65	0 [0]	1.62
Medium Sand	%wt	32.89	58.68	40.7	14.46	43.03	45.16	13.78	53.94	14.91	68.39	34.94	3.27	50.42	0 [0]	56.01
Silt	%wt	(2)	(2)	(2)	6.01	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	48.52 [39.67]	(2)
Silt/Clay	%wt	1.17	0.38	3.92	10.85	0.44	2.97	13.32	1.78	3.26	1.26	3.89	13.56	0.9	100 [100]	7.61

NOTES:

1. Sampling was performed by representatives from ARCADIS of New York, Inc. and Exponent during the week of October 30, 2006.
2. All samples were screened in the field using a photoionization detector. All readings were indicated to be zero.
3. Samples were analyzed for semivolatile organic consitituents (SVOCs) polychlorinated biphenyls (PCBs), and metals, as well as total organic carbon and particle size distribution, by Merit Laboratories of East Lansing, MI.
4. U-Analyte was not detected at the presented detection limit.
5. J-The presented value is estimated.
6. [ ] - Field duplicate results are reflected using brackets.
7. (2) - Not differentiated.
8. Abbreviations:
    > mg/kg = milligrams per kilogram, dry weight
    > % = percent
    > % wt = percent by weight
    > mm = millimeters
    > BGS = below ground surface

Table 4
2006 Flint River Sediment Investigation, GM NAO Flint Operations Site, Flint, MI

Summary of Surface Sediment Analytical Results for Biased Sampling Transects Near GM Outfalls 003, 005, and 013

Sample ID:		**FRT 10A**	**FRT 10B**	**FRT 11B**	**FRT 11C**	**FRT 12B**	**FRT 12C**
Sample Depth(inches BGS):		**0 - 2**	**0 - 2**	**0 - 2**	**0 - 2**	**0 - 2**	**0 - 2**
Date Collected:	**Units**	**10/31/06**	**10/31/06**	**11/01/06**	**11/01/06**	**10/31/06**	**10/31/06**
Semivolitile Organics (SVOCs)							
2,2'-oxybis(1-Chloropropane) (bis(2-chloroisopropyl) ether)	mg/kg	0.33 U	0.33 U	0.33 U [0.33 U]	0.33 U	0.33 U	0.33 U
2,4,5-Trichlorophenol	mg/kg	0.33 U	0.33 U	0.33 U [0.33 U]	0.33 U	0.33 U	0.33 U
2,4,6-Trichlorophenol	mg/kg	0.33 U	0.33 U	0.33 U [0.33 U]	0.33 U	0.33 U	0.33 U
2,4-Dichlorophenol	mg/kg	0.33 U	0.33 U	0.33 U [0.33 U]	0.33 U	0.33 U	0.33 U
2,4-Dimethylphenol	mg/kg	0.33 U	0.33 U	0.33 U [0.33 U]	0.33 U	0.33 U	0.33 U
2,4-Dinitrophenol	mg/kg	0.67 U	0.67 UJ	0.67 U [0.67 U]	0.67 U	0.67 U	0.67 U
2,4-Dinitrotoluene	mg/kg	0.33 U	0.33 U	0.33 U [0.33 U]	0.33 U	0.33 U	0.33 U
2,6-Dinitrotoluene	mg/kg	0.33 U	0.33 U	0.33 U [0.33 U]	0.33 U	0.33 U	0.33 U
2-Chloronaphthalene	mg/kg	0.33 U	0.33 U	0.33 U [0.33 U]	0.33 U	0.33 U	0.33 U
2-Chlorophenol	mg/kg	0.33 U	0.33 U	0.33 U [0.33 U]	0.33 U	0.33 U	0.33 U
2-Methylnaphthalene	mg/kg	0.33 U	0.33 U	0.03 J [0.33 U]	0.33 U	0.33 U	0.33 U
2-Methylphenol	mg/kg	0.33 U	0.33 U	0.33 U [0.33 U]	0.33 U	0.33 U	0.33 U
2-Nitroaniline	mg/kg	0.67 U	0.67 U	0.67 U [0.67 U]	0.67 U	0.67 U	0.67 U
2-Nitrophenol	mg/kg	0.33 U	0.33 U	0.33 U [0.33 U]	0.33 U	0.33 U	0.33 U
3,3'-Dichlorobenzidine	mg/kg	0.67 U	0.67 U	0.67 U [0.67 U]	0.67 U	0.67 U	0.67 U
3-Methylphenol	mg/kg	0.33 U	0.33 U	0.33 U [0.33 U]	0.33 U	0.33 U	0.33 U
3-Nitroaniline	mg/kg	0.67 U	0.67 U	0.67 U [0.67 U]	0.67 U	0.67 U	0.67 U
4,6-Dinitro-2-methylphenol	mg/kg	0.67 U	0.67 U	0.67 U [0.67 U]	0.67 U	0.67 U	0.67 U
4-Bromophenyl phenyl ether	mg/kg	0.33 U	0.33 U	0.33 U [0.33 U]	0.33 U	0.33 U	0.33 U
4-Chloro-3-methylphenol	mg/kg	0.33 U	0.33 U	0.33 U [0.33 U]	0.33 U	0.33 U	0.33 U
4-Chloroaniline	mg/kg	0.67 U	0.67 U	0.67 U [0.67 U]	0.67 U	0.67 U	0.67 U
4-Chlorophenyl phenyl ether	mg/kg	0.33 U	0.33 U	0.33 U [0.33 U]	0.33 U	0.33 U	0.33 U
4-Nitroaniline	mg/kg	0.67 U	0.67 U	0.67 U [0.67 U]	0.67 U	0.67 U	0.67 U
4-Nitrophenol	mg/kg	0.67 U	0.67 U	0.67 U [0.67 U]	0.67 U	0.67 U	0.67 U
Acenaphthene	mg/kg	0.33 U	0.33 U	0.1 J [0.33 U]	0.33 U	0.33 U	0.33 U
Acenaphthylene	mg/kg	0.33 U	0.33 U	0.33 U [0.33 U]	0.33 U	0.33 U	0.33 U
Acetophenone	mg/kg	0.33 U	0.33 U	0.33 U [0.33 U]	0.33 U	0.33 U	0.33 U
Anthracene	mg/kg	0.33 U	0.33 U	0.3 J [0.33 U]	0.33 U	0.33 U	0.33 U
Atrazine	mg/kg	0.33 U	0.33 U	0.33 U [0.33 U]	0.33 U	0.33 U	0.33 U
Benzaldehyde	mg/kg	0.33 UJ	0.33 U	0.33 U [0.33 UJ]	0.33 UJ	0.33 UJ	0.33 UJ
Benzo(a)anthracene	mg/kg	0.33 U	0.33 U	0.62 [0.33 U]	0.33 U	0.33 U	0.09 J
Benzo(a)pyrene	mg/kg	0.73	0.2 J	1.14 [0.59]	0.2 J	0.3 J	0.83
Benzo(b)fluoranthene	mg/kg	0.88 J	0.33 UJ	1.09 [0.64 J]	0.3 J	0.3 J	0.88 J
Benzo(g,h,i)perylene	mg/kg	0.65	0.33 U	0.65 [0.47]	0.2 J	0.2 J	0.69
Benzo(k)fluoranthene	mg/kg	0.51 J	0.33 UJ	0.92 [0.47 J]	0.2 J	0.3 J	0.75 J
Biphenyl	mg/kg	0.33 U	0.33 U	0.04 J [0.33 U]	0.33 U	0.33 U	0.33 U
bis(2-Chloroethoxy)methane	mg/kg	0.33 U	0.33 U	0.33 U [0.33 U]	0.33 U	0.33 U	0.33 U
bis(2-Chloroethyl)ether	mg/kg	0.33 U	0.33 U	0.33 U [0.33 U]	0.33 U	0.33 U	0.33 U
bis(2-Ethylhexyl)phthalate	mg/kg	0.3 J	0.33 U	0.1 J [0.2 J]	0.05 J	0.05 J	0.38
Butyl benzylphthalate	mg/kg	0.33 U	0.33 U	0.33 U [0.33 U]	0.33 U	0.33 U	0.33 U

Table 4

2006 Flint River Sediment Investigation, GM NAO Flint Operations Site, Flint, MI

Summary of Surface Sediment Analytical Results for Biased Sampling Transects Near GM Outfalls 003, 005, and 013

Sample ID:		FRT 10A	FRT 10B	FRT 11B	FRT 11C	FRT 12B	FRT 12C
Sample Depth(inches BGS):		0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2
Date Collected:	Units	10/31/06	10/31/06	11/01/06	11/01/06	10/31/06	10/31/06
Semivolitile Organics (SVOCs) cont.							
Caprolactam	mg/kg	0.33 U	0.33 U	0.33 U [0.33 U]	0.33 U	0.33 U	0.33 U
Carbazole	mg/kg	0.05 J	0.33 U	0.3 J [0.04 J]	0.33 U	0.33 U	0.08 J
Chrysene	mg/kg	0.58	0.1 J	0.97 [0.46]	0.2 J	0.2 J	0.65
Dibenz(a,h)anthracene	mg/kg	0.33 U	0.33 U	0.33 U [0.33 U]	0.33 U	0.33 U	0.33 U
Dibenzofuran	mg/kg	0.33 U	0.33 U	0.1 J [0.33 U]	0.33 U	0.33 U	0.33 U
Diethyl phthalate	mg/kg	0.33 U	0.33 U	0.33 U [0.33 U]	0.33 U	0.33 U	0.33 U
Dimethyl phthalate	mg/kg	0.33 U	0.33 U	0.04 J [0.3 J]	0.33 U	0.33 U	0.33 U
Di-n-butylphthalate	mg/kg	0.33 U	0.33 U	0.33 U [0.33 U]	0.33 U	0.33 U	0.33 U
Di-n-octyl phthalate	mg/kg	0.33 U	0.33 U	0.33 U [0.33 U]	0.33 U	0.33 U	0.33 U
Fluoranthene	mg/kg	1.05	0.2 J	2.37 J [0.87 J]	0.38	0.37	1.29
Fluorene	mg/kg	0.1 J	0.33 U	0.2 J [0.1 J]	0.33 U	0.33 U	0.07 J
Hexachlorobenzene	mg/kg	0.33 U	0.33 U	0.33 U [0.33 U]	0.33 U	0.33 U	0.33 U
Hexachlorobutadiene	mg/kg	0.33 U	0.33 U	0.33 U [0.33 U]	0.33 U	0.33 U	0.33 U
Hexachlorocyclopentadiene	mg/kg	0.33 UJ	0.33 U	0.33 U [0.33 UJ]	0.33 UJ	0.33 UJ	0.33 UJ
Hexachloroethane	mg/kg	0.33 U	0.33 U	0.33 U [0.33 U]	0.33 U	0.33 U	0.33 U
Indeno(1,2,3-cd)pyrene	mg/kg	0.5	0.33 U	0.59 [0.42]	0.2 J	0.2 J	0.58
Isophorone	mg/kg	0.33 U	0.33 U	0.33 U [0.33 U]	0.33 U	0.33 U	0.33 U
Naphthalene	mg/kg	0.33 U	0.33 U	0.33 U [0.33 U]	0.33 U	0.33 U	0.33 U
Nitrobenzene	mg/kg	0.2 U	0.2 U	0.2 U [0.2 U]	0.2 U	0.2 U	0.2 U
N-Nitrosodi-n-propylamine	mg/kg	0.33 U	0.33 U	0.33 U [0.33 U]	0.33 U	0.33 U	0.33 U
N-Nitrosodiphenylamine	mg/kg	0.33 UJ	0.33 UJ	0.33 UJ [0.33 UJ]	0.33 UJ	0.33 UJ	0.33 UJ
Pentachlorophenol	mg/kg	0.67 U	0.67 U	0.67 U [0.67 U]	0.67 U	0.67 U	0.67 U
Phenanthrene	mg/kg	0.33 U	0.33 U	1.65 J [0.33 UJ]	0.33 U	0.33 U	0.33 U
Phenol	mg/kg	0.33 U	0.33 U	0.33 U [0.33 U]	0.33 U	0.33 U	0.33 U
Pyrene	mg/kg	0.2 J	0.33 U	1.55 [0.05 J]	0.33 U	0.33 U	0.46
Pesticides/Polychlorinated Biphenyls (PCBs)							
Aroclor-1016 (PCB-1016)	mg/kg	0.33 U	0.33 U	0.33 U [0.33 U]	0.33 U	0.33 U	0.33 U
Aroclor-1221 (PCB-1221)	mg/kg	0.33 U	0.33 U	0.33 U [0.33 U]	0.33 U	0.33 U	0.33 U
Aroclor-1232 (PCB-1232)	mg/kg	0.33 U	0.33 U	0.33 U [0.33 U]	0.33 U	0.33 U	0.33 U
Aroclor-1242 (PCB-1242)	mg/kg	0.33 U	0.33 U	0.33 U [0.33 U]	0.33 U	0.33 U	0.33 U
Aroclor-1248 (PCB-1248)	mg/kg	0.33 U	0.33 U	0.33 U [0.33 U]	0.33 U	0.33 U	0.33 U
Aroclor-1254 (PCB-1254)	mg/kg	0.33 U	0.33 U	0.33 U [0.33 U]	0.33 U	0.33 U	0.1 J
Aroclor-1260 (PCB-1260)	mg/kg	0.33 U	0.33 U	0.33 U [0.33 U]	0.33 U	0.33 U	0.33 U
Inorganics							
Antimony	mg/kg	0.3 U	0.3 U	0.3 U [0.3 U]	0.3 U	0.3 U	0.3 U
Arsenic	mg/kg	5.19	3.5	2.1 [2.55]	2.14	3.83	18.6
Barium	mg/kg	39.9	14.9 J	18.8 J [13.4]	18.5 J	30.9 J	146 J
Beryllium	mg/kg	0.5 U	0.5 U	0.5 U [0.5 U]	0.5 U	0.5 U	0.5 U
Cadmium	mg/kg	0.38	0.2 U	0.2 U [0.2 U]	0.2 U	0.2	1.41
Chromium (Total)	mg/kg	8.2	2.8	5.5 [2.7]	3	10.5	22.8
Cobalt	mg/kg	1.97	1.18	1.22 [1.09]	1.12	2.38	5.48
Copper	mg/kg	24.4	3.3	7 [7.4]	17.8	9.1	73.2
Cyanide (total)	mg/kg	0.1 U	0.1 U	0.1 U [0.1 U]	0.1 U	0.1 U	0.1 U
Lead	mg/kg	35.3	9.1	10.8 [11.1]	10.1	18.7	124
Manganese	mg/kg	321	204	262 J [151 J]	151	476	955
Mercury	mg/kg	0.05 U	0.05 U	0.05 U [0.05 U]	0.05 U	0.05 U	0.122
Nickel	mg/kg	4.7	3.6	2.3 [2.2]	1.8	4.5	16.2
Selenium	mg/kg	0.29	0.2 U	0.2 U [0.2 U]	0.2 U	0.2 U	1.08
Silver	mg/kg	0.1 U	0.1 U	0.1 U [0.1 U]	0.1 U	0.1 U	0.13 U
Thallium	mg/kg	0.5 U	0.5 U	0.5 U [0.5 U]	0.5 U	0.5 U	0.5 U
Vanadium	mg/kg	3.6	1.4	1.3 [1.2]	1.1	1.7	13.9
Zinc	mg/kg	105	18.1 J	42.4 J [32.5]	25.4 J	62 J	316 J

Table 4

2006 Flint River Sediment Investigation, GM NAO Flint Operations Site, Flint, MI

Summary of Surface Sediment Analytical Results for Biased Sampling Transects Near GM Outfalls 003, 005, and 013

Sample ID: Sample Depth(inches BGS): Date Collected:	Units	FRT 10A 0 - 2 10/31/06	FRT 10B 0 - 2 10/31/06	FRT 11B 0 - 2 11/01/06	FRT 11C 0 - 2 11/01/06	FRT 12B 0 - 2 10/31/06	FRT 12C 0 - 2 10/31/06
Miscellaneous							
Total Organic Carbon (TOC)	mg/kg	52	19	32 [28]	32	34	200
Total Solids	%	53	79	83 [77]	73	66	20
Field Parameters							
Clay	%wt	(2)	(2)	(2) [(2)]	(2)	(2)	57.92
Coarse Sand	%wt	1.38	0.44	11.73 [9.34]	0.2	6.42	0
Fine Sand	%wt	84.87	79.7	50.08 [50.22]	88.66	23.63	0
Grain Density	mm	0.201	0.325	0.407 [0.387]	0.294	0.605	0.004
Gravel	%wt	3.22	0	5.37 [12.14]	0	4.73	0
Medium Sand	%wt	3.81	19.31	31.2 [25.41]	8.24	63.58	0
Silt	%wt	(2)	(2)	(2) [(2)]	(2)	(2)	42.08
Silt/Clay	%wt	6.73	0.55	1.62 [2.89]	2.9	1.64	100

NOTES:

1. Sampling was performed by representatives from ARCADIS of New York, Inc. and Exponent during the week of October 30, 2006.
2. All samples were screened in the field using a photoionization detector. All readings were indicated to be zero.
3. Samples were analyzed for semivolatile organic consitituents (SVOCs) polychlorinated biphenyls (PCBs), and metals, as well as total organic carbon and particle size distribution, by Merit Laboratories of East Lansing, MI.
4. U-Analyte was not detected at the presented detection limit.
5. J-The presented value is estimated.
6. [ ] - Field duplicate results are reflected using brackets.
7. (2) - Not differentiated.
8. Abbreviations:
    - > mg/kg = milligrams per kilogram, dry weight
    - > % = percent
    - > % wt = percent by weight
    - > mm = millimeters
    - > BGS = below ground surface

Table 5
Flint River Sediment Investigation, GM NAO Flint Operations Site, Flint, MI

Summary of Subsurface Sediment Analytical Results for Unbiased Sampling Transects

Sample ID:		**FRT 2C**	**FRT 2C**	**FRT 2C**	**FRT 2C**	**FRT 2C**	**FRT 4A**	**FRT 4A**	**FRT 7C**	**FRT 7C**	**FRT 7C**	**FRT 7C**
Sample Depth(inches BGS):		**2 - 12**	**12 - 24**	**24 - 36**	**36 - 48**	**48 - 57**	**2 - 12**	**12 - 24**	**2 - 12**	**12 - 24**	**24 - 36**	**36 - 46**
Date Collected:	**Units**	**11/01/06**	**11/01/06**	**11/01/06**	**11/01/06**	**11/01/06**	**11/01/06**	**11/01/06**	**10/31/06**	**10/31/06**	**10/31/06**	**10/31/06**
Semivolitile Organics (SVOCs)												
2,2'-oxybis(1-Chloropropane) (bis(2-chloroisopropyl) ether)	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	1 U [1 U]	1 U	0.33 U	0.33 U
2,4,5-Trichlorophenol	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	1 U [1 U]	1 U	0.33 U	0.33 U
2,4,6-Trichlorophenol	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	1 U [1 U]	1 U	0.33 U	0.33 U
2,4-Dichlorophenol	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	1 U [1 U]	1 U	0.33 U	0.33 U
2,4-Dimethylphenol	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	1 U [1 U]	1 U	0.33 U	0.33 U
2,4-Dinitrophenol	mg/kg	0.67 U	0.67 U	0.67 U	0.67 UJ	0.67 UJ	0.67 U	0.67 U	1 U [1 U]	1 U	0.67 U	0.67 U
2,4-Dinitrotoluene	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	1 U [1 U]	1 U	0.33 U	0.33 U
2,6-Dinitrotoluene	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	1 U [1 U]	1 U	0.33 U	0.33 U
2-Chloronaphthalene	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	1 U [1 U]	1 U	0.33 U	0.33 U
2-Chlorophenol	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	1 U [1 U]	1 U	0.33 U	0.33 U
2-Methylnaphthalene	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.3 J [1 U]	1 U	0.33 U	0.33 U
2-Methylphenol	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	1 U [1 U]	1 U	0.33 U	0.33 U
2-Nitroaniline	mg/kg	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	1 U [1 U]	1 U	0.67 U	0.67 U
2-Nitrophenol	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	1 U [1 U]	1 U	0.33 U	0.33 U
3,3'-Dichlorobenzidine	mg/kg	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	1 U [1 U]	1 U	0.67 U	0.67 U
3-Methylphenol	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	1 U [1 U]	1 U	0.33 U	0.33 U
3-Nitroaniline	mg/kg	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	1 U [1 U]	1 U	0.67 U	0.67 U
4,6-Dinitro-2-methylphenol	mg/kg	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	1 U [1 U]	1 U	0.67 U	0.67 U
4-Bromophenyl phenyl ether	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	1 U [1 U]	1 U	0.33 U	0.33 U
4-Chloro-3-methylphenol	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	1 U [1 U]	1 U	0.33 U	0.33 U
4-Chloroaniline	mg/kg	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	1 U [1 U]	1 U	0.67 U	0.67 U
4-Chlorophenyl phenyl ether	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	1 U [1 U]	1 U	0.33 U	0.33 U
4-Nitroaniline	mg/kg	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	1 U [1 U]	1 U	0.67 U	0.67 U
4-Nitrophenol	mg/kg	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	1 U [1 U]	1 U	0.67 U	0.67 U
Acenaphthene	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	1 U [1 U]	0.8 J	0.05 J	0.33 U
Acenaphthylene	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	1 U [1 U]	2	0.05 J	0.33 U
Acetophenone	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	1 U [1 U]	1 U	0.33 U	0.33 U
Anthracene	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	1 U [1 U]	2	0.06 J	0.33 U
Atrazine	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	1 U [1 U]	1 U	0.33 U	0.33 U
Benzaldehyde	mg/kg	0.33 U	0.33 U	0.33 U	0.33 UJ	0.33 UJ	0.33 UJ	0.33 UJ	1 UJ [1 UJ]	1 UJ	0.33 UJ	0.33 UJ
Benzo(a)anthracene	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	1 U [1 U]	2	0.33 U	0.33 U
Benzo(a)pyrene	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.2 J	0.33 U	1 U [1 U]	7	0.53	0.33 U
Benzo(b)fluoranthene	mg/kg	0.33 UJ	0.33 UJ	0.33 UJ	0.33 UJ	0.33 UJ	0.1 J	0.33 UJ	2 J [1 J]	4 J	0.3 J	0.33 UJ
Benzo(g,h,i)perylene	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.1 J	0.33 U	1 U [1 U]	3 J	0.35	0.33 U
Benzo(k)fluoranthene	mg/kg	0.33 UJ	0.33 UJ	0.33 UJ	0.33 UJ	0.33 UJ	0.1 J	0.33 UJ	1 J [0.8 J]	4 J	0.3 J	0.33 UJ
Biphenyl	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	1 U [1 U]	1 U	0.33 U	0.33 U
bis(2-Chloroethoxy)methane	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	1 U [1 U]	1 U	0.33 U	0.33 U
bis(2-Chloroethyl)ether	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	1 U [1 U]	1 U	0.33 U	0.33 U
bis(2-Ethylhexyl)phthalate	mg/kg	0.09 J	0.07 J	0.09 J	0.33 U	0.33 U	0.33 U	0.33 U	13 J [7 J]	1 U	0.33 U	0.33 U
Butyl benzylphthalate	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	1 U [1 U]	1 U	0.33 U	0.33 U
Caprolactam	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	1 U [1 U]	1 U	0.33 U	0.33 U
Carbazole	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	1 U [1 U]	1 U	0.33 U	0.33 U
Chrysene	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.1 J	0.33 U	2 [1]	7	0.38	0.33 U

Table 5
Flint River Sediment Investigation, GM NAO Flint Operations Site, Flint, MI

Summary of Subsurface Sediment Analytical Results for Unbiased Sampling Transects

Sample ID:		**FRT 2C**	**FRT 2C**	**FRT 2C**	**FRT 2C**	**FRT 2C**	**FRT 4A**	**FRT 4A**	**FRT 7C**	**FRT 7C**	**FRT 7C**	**FRT 7C**
Sample Depth(inches BGS):		**2 - 12**	**12 - 24**	**24 - 36**	**36 - 48**	**48 - 57**	**2 - 12**	**12 - 24**	**2 - 12**	**12 - 24**	**24 - 36**	**36 - 46**
Date Collected:	**Units**	**11/01/06**	**11/01/06**	**11/01/06**	**11/01/06**	**11/01/06**	**11/01/06**	**11/01/06**	**10/31/06**	**10/31/06**	**10/31/06**	**10/31/06**
Semivolitile Organics (SVOCs) cont.												
Dibenz(a,h)anthracene	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	1 U [1 U]	1 U	0.33 U	0.33 U
Dibenzofuran	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	1 U [1 U]	1 U	0.33 U	0.33 U
Diethyl phthalate	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	1 U [1 U]	1 U	0.33 U	0.33 U
Dimethyl phthalate	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	1 U [1 U]	1 U	0.33 U	0.33 U
Di-n-butylphthalate	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	1 U [1 U]	1 U	0.33 U	0.33 U
Di-n-octyl phthalate	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	1 U [1 U]	1 U	0.33 U	0.33 U
Fluoranthene	mg/kg	0.03 J	0.33 U	0.33 U	0.33 U	0.33 U	0.2 J	0.33 U	2 [0.8 J]	7	0.39	0.33 U
Fluorene	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	1 U [1 U]	1 U	0.1 J	0.33 U
Hexachlorobenzene	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	1 U [1 U]	1 U	0.33 U	0.33 U
Hexachlorobutadiene	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	1 U [1 U]	1 U	0.33 U	0.33 U
Hexachlorocyclopentadiene	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 UJ	0.33 UJ	1 UJ [1 UJ]	1 UJ	0.33 UJ	0.33 UJ
Hexachloroethane	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	1 U [1 U]	1 UJ	0.33 U	0.33 U
Indeno(1,2,3-cd)pyrene	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.09 J	0.33 U	1 U [1 U]	3 J	0.3 J	0.33 U
Isophorone	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	1 U [1 U]	1 U	0.33 U	0.33 U
Naphthalene	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	1 U [1 U]	1 U	0.33 U	0.33 U
Nitrobenzene	mg/kg	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	1 U [1 U]	1 U	0.2 U	0.2 U
N-Nitrosodi-n-propylamine	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	1 U [1 U]	1 U	0.33 U	0.33 U
N-Nitrosodiphenylamine	mg/kg	0.33 UJ	0.33 UJ	0.33 UJ	0.33 U	0.33 U	0.33 UJ	0.33 UJ	1 UJ [1 UJ]	1 UJ	0.33 UJ	0.33 UJ
Pentachlorophenol	mg/kg	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	0.67 U	1 U [1 U]	1 U	0.67 U	0.67 U
Phenanthrene	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	1 U [1 U]	1	0.33 U	0.33 U
Phenol	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	1 U [1 U]	1 U	0.33 U	0.33 U
Pyrene	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	1 U [1 U]	12	0.33 U	0.33 U
Pesticides/Polychlorinated Biphenyls (PCBs)												
Aroclor-1016 (PCB-1016)	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U [0.33 U]	0.33 U	0.33 U	0.33 U
Aroclor-1221 (PCB-1221)	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U [0.33 U]	0.33 U	0.33 U	0.33 U
Aroclor-1232 (PCB-1232)	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U [0.33 U]	0.33 U	0.33 U	0.33 U
Aroclor-1242 (PCB-1242)	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U [0.33 U]	0.33 U	0.33 U	0.33 U
Aroclor-1248 (PCB-1248)	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U [0.33 U]	0.33 U	0.33 U	0.33 U
Aroclor-1254 (PCB-1254)	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.5 [0.2 J]	0.33 U	0.33 U	0.33 U
Aroclor-1260 (PCB-1260)	mg/kg	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U [0.33 U]	0.33 U	0.33 U	0.33 U

Table 5
Flint River Sediment Investigation, GM NAO Flint Operations Site, Flint, MI

Summary of Subsurface Sediment Analytical Results for Unbiased Sampling Transects

Sample ID:		**FRT 2C**	**FRT 2C**	**FRT 2C**	**FRT 2C**	**FRT 2C**	**FRT 4A**	**FRT 4A**	**FRT 7C**	**FRT 7C**	**FRT 7C**	**FRT 7C**
Sample Depth(inches BGS):		**2 - 12**	**12 - 24**	**24 - 36**	**36 - 48**	**48 - 57**	**2 - 12**	**12 - 24**	**2 - 12**	**12 - 24**	**24 - 36**	**36 - 46**
Date Collected:	**Units**	**11/01/06**	**11/01/06**	**11/01/06**	**11/01/06**	**11/01/06**	**11/01/06**	**11/01/06**	**10/31/06**	**10/31/06**	**10/31/06**	**10/31/06**
Inorganics												
Antimony	mg/kg	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U [0.3 U]	0.3 U	0.3 U	0.3 U
Arsenic	mg/kg	9.14	5.11	4.22	3.17	0.94	3.61	3.72	6.32 [6.19]	8.28	3.38	1.45
Barium	mg/kg	36	45.2	9.5	8.2	3.6	13.6	11.8	146 [106]	139	44.2	33.8
Beryllium	mg/kg	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U [0.5 U]	0.5 U	0.5 U	0.5 U
Cadmium	mg/kg	0.24	0.21	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	5.98 [5.47]	3.82	0.2 U	0.2 U
Chromium (Total)	mg/kg	8.9	6.5	2.1	2 U	2 U	2.5	2 U	153 [119]	64.4	6.5	2.3
Cobalt	mg/kg	2.86	3.43	1.05	1.46	0.65	1.2	1.48	4.86 [4.89]	11.2	2.45	1.61
Copper	mg/kg	7	8.1	1.7	1.2	1 U	7.3	1.7	138 [132]	127	7.9	3.4
Cyanide (total)	mg/kg	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U [0.1 U]	0.1 U	0.1 U	0.1 U
Lead	mg/kg	6.6	8.9	1.6	1.6	1 U	7.9	1.8	245 [197]	183	10.3	3.8
Manganese	mg/kg	569	389	78.2	31.3	22	162	50.3	396 [289]	336	189	167
Mercury	mg/kg	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.114 [0.112]	0.335	0.05 U	0.05 U
Nickel	mg/kg	5.3	5	1.4	1.2	1 U	2.1	1.5	49.8 [38.1]	34.7	3.9	2.2
Selenium	mg/kg	0.44	0.41	0.27	0.2 U	0.2 U	0.38	0.2 U	0.41 [0.39]	0.57	0.28	0.2 U
Silver	mg/kg	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	2.75 [1.99]	0.31 U	0.1 U	0.1 U
Thallium	mg/kg	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.51 [0.5 U]	0.5 U	0.5 U	0.5 U
Vanadium	mg/kg	8.4	6	1.9	1.5	1 U	1.6	2.2	6.4 [6.3]	9.5	5.2	3.3
Zinc	mg/kg	29.7	34.8	6	6.1	3.7	14.7	12.4	647 [643]	338	22.2	11.5
Miscellaneous												
Total Organic Carbon (TOC)	mg/kg	50	37	22	30	12 U	19	23	120 [100]	180	89	47
Total Solids	%	63	73	68	71	83	79	77	62 [63]	51	66	75
Field Parameters												
Clay	%wt	(2)	(2)	(2)	(2)	1.07	(2)	(2)	61.14 [58.15]	63.38	59.02	11.15
Coarse Sand	%wt	10.24	0.42	1.78	0.74	0	12.44	5.85	0 [0]	0	0	0
Fine Sand	%wt	47.24	65.36	56.15	80.52	64.29	42.39	68.42	0 [0]	0	0	53.45
Grain Density	mm	0.35	0.292	0.338	0.283	0.339	0.473	0.272	0.004 [0.004]	0.004	0.004	0.097
Gravel	%wt	6.82	0	7.11	2.9	0	16.88	7.33	0 [0]	0	0	0
Medium Sand	%wt	26.77	22.49	30.54	9.21	30.88	23.83	12.57	0 [0]	0	0	0.89
Silt	%wt	(2)	(2)	(2)	(2)	3.77	(2)	(2)	38.86 [41.85]	36.62	40.98	34.5
Silt/Clay	%wt	8.92	11.73	4.41	6.63	4.83	4.46	5.83	100 [100]	100	100	45.66

NOTES:

1. Sampling was performed by representatives from ARCADIS of New York, Inc. and Exponent during the week of October 30, 2006.
2. All samples were screened in the field using a photoionization detector. All readings were indicated to be zero.
3. Samples were analyzed for semivolatile organic consitituents (SVOCs) polychlorinated biphenyls (PCBs), and metals, as well as total organic carbon and particle size distribution, by Merit Laboratories of East Lansing, MI.
4. U-Analyte was not detected at the presented detection limit.
5. J-The presented value is estimated.
6. [ ] - Field duplicate results are reflected using brackets.
7. (2) - Not differentiated.
8. Abbreviations:
    > mg/kg = milligrams per kilogram, dry weight
    > % = percent
    > % wt = percent by weight
    > mm = millimeters
    > BGS = below ground surface

Table 6
Flint River Sediment Investigation, GM NAO Flint Operations Site, Flint, MI

Summary of Subsurface Sediment Analytical Results for Biased Transects Near GM Outfalls 003, 005, and 013

Sample ID:		**FRT 12C**	**FRT 12C**	**FRT 12C**
Sample Depth(in BGS):		**2 - 12**	**12 - 24**	**24 - 36**
Date Collected:	**Units**	**11/01/06**	**11/01/06**	**11/01/06**
Semivolitile Organics (SVOCs)				
2,2'-oxybis(1-Chloropropane) (bis(2-chloroisopropyl) ether)	mg/kg	0.33 U	0.33 U	0.33 U
2,4,5-Trichlorophenol	mg/kg	0.33 U	0.33 U	0.33 U
2,4,6-Trichlorophenol	mg/kg	0.33 U	0.33 U	0.33 U
2,4-Dichlorophenol	mg/kg	0.33 U	0.33 U	0.33 U
2,4-Dimethylphenol	mg/kg	0.33 U	0.33 U	0.33 U
2,4-Dinitrophenol	mg/kg	0.67 U	0.67 U	0.67 U
2,4-Dinitrotoluene	mg/kg	0.33 U	0.33 U	0.33 U
2,6-Dinitrotoluene	mg/kg	0.33 U	0.33 U	0.33 U
2-Chloronaphthalene	mg/kg	0.33 U	0.33 U	0.33 U
2-Chlorophenol	mg/kg	0.33 U	0.33 U	0.33 U
2-Methylnaphthalene	mg/kg	0.33 U	0.33 U	0.33 U
2-Methylphenol	mg/kg	0.33 U	0.33 U	0.33 U
2-Nitroaniline	mg/kg	0.67 U	0.67 U	0.67 U
2-Nitrophenol	mg/kg	0.33 U	0.33 U	0.33 U
3,3'-Dichlorobenzidine	mg/kg	0.67 U	0.67 U	0.67 U
3-Methylphenol	mg/kg	0.33 U	0.33 U	0.33 U
3-Nitroaniline	mg/kg	0.67 U	0.67 U	0.67 U
4,6-Dinitro-2-methylphenol	mg/kg	0.67 U	0.67 U	0.67 U
4-Bromophenyl phenyl ether	mg/kg	0.33 U	0.33 U	0.33 U
4-Chloro-3-methylphenol	mg/kg	0.33 U	0.33 U	0.33 U
4-Chloroaniline	mg/kg	0.67 U	0.67 U	0.67 U
4-Chlorophenyl phenyl ether	mg/kg	0.33 U	0.33 U	0.33 U
4-Nitroaniline	mg/kg	0.67 U	0.67 U	0.67 U
4-Nitrophenol	mg/kg	0.67 U	0.67 U	0.67 U
Acenaphthene	mg/kg	0.09 J	0.33 U	0.33 U
Acenaphthylene	mg/kg	0.33 U	0.33 U	0.33 U
Acetophenone	mg/kg	0.33 U	0.33 U	0.33 U
Anthracene	mg/kg	0.1 J	0.33 U	0.33 U
Atrazine	mg/kg	0.33 U	0.33 U	0.33 U
Benzaldehyde	mg/kg	0.33 UJ	0.33 UJ	0.33 UJ
Benzo(a)anthracene	mg/kg	0.74	0.2 J	0.33 U
Benzo(a)pyrene	mg/kg	1.77	0.99	0.2 J
Benzo(b)fluoranthene	mg/kg	2.2 J	1.18 J	0.3 J
Benzo(g,h,i)perylene	mg/kg	1.41	0.82	0.2 J
Benzo(k)fluoranthene	mg/kg	1.45 J	0.93 J	0.2 J
Biphenyl	mg/kg	0.33 U	0.33 U	0.33 U
bis(2-Chloroethoxy)methane	mg/kg	0.33 U	0.33 U	0.33 U
bis(2-Chloroethyl)ether	mg/kg	0.33 U	0.33 U	0.33 U
bis(2-Ethylhexyl)phthalate	mg/kg	0.8	0.6	0.66
Butyl benzylphthalate	mg/kg	0.33 U	0.33 U	0.33 U
Caprolactam	mg/kg	0.33 U	0.33 U	0.33 U
Carbazole	mg/kg	0.2 J	0.08 J	0.33 U
Chrysene	mg/kg	1.54	0.88	0.2 J

Table 6
Flint River Sediment Investigation, GM NAO Flint Operations Site, Flint, MI

Summary of Subsurface Sediment Analytical Results for Biased Transects Near GM Outfalls 003, 005, and 013

Sample ID: Sample Depth(in BGS): Date Collected:	Units	FRT 12C 2 - 12 11/01/06	FRT 12C 12 - 24 11/01/06	FRT 12C 24 - 36 11/01/06
Semivolitile Organics (SVOCs) cont.				
Dibenz(a,h)anthracene	mg/kg	0.33 U	0.33 U	0.33 U
Dibenzofuran	mg/kg	0.06 J	0.33 U	0.33 U
Diethyl phthalate	mg/kg	0.33 U	0.33 U	0.33 U
Dimethyl phthalate	mg/kg	0.33 U	0.33 U	0.33 U
Di-n-butylphthalate	mg/kg	0.33 U	0.33 U	0.33 U
Di-n-octyl phthalate	mg/kg	0.33 U	0.33 U	0.33 U
Fluoranthene	mg/kg	3.05	1.69	0.41
Fluorene	mg/kg	0.2 J	0.1 J	0.33 U
Hexachlorobenzene	mg/kg	0.33 U	0.33 U	0.33 U
Hexachlorobutadiene	mg/kg	0.33 U	0.33 U	0.33 U
Hexachlorocyclopentadiene	mg/kg	0.33 UJ	0.33 UJ	0.33 UJ
Hexachloroethane	mg/kg	0.33 U	0.33 U	0.33 U
Indeno(1,2,3-cd)pyrene	mg/kg	1.16	0.69	0.1 J
Isophorone	mg/kg	0.33 U	0.33 U	0.33 U
Naphthalene	mg/kg	0.33 U	0.33 U	0.33 U
Nitrobenzene	mg/kg	0.2 U	0.2 U	0.2 U
N-Nitrosodi-n-propylamine	mg/kg	0.33 U	0.33 U	0.33 U
N-Nitrosodiphenylamine	mg/kg	0.33 UJ	0.33 UJ	0.33 UJ
Pentachlorophenol	mg/kg	0.67 U	0.67 U	0.67 U
Phenanthrene	mg/kg	0.88	0.33 U	0.33 U
Phenol	mg/kg	0.33 U	0.33 U	0.33 U
Pyrene	mg/kg	2.02	0.84	0.33 U
Pesticides/Plolychlorinated Biphenyls (PCBs)				
Aroclor-1016 (PCB-1016)	mg/kg	0.33 U	0.33 U	0.33 U
Aroclor-1221 (PCB-1221)	mg/kg	0.33 U	0.33 U	0.33 U
Aroclor-1232 (PCB-1232)	mg/kg	0.33 U	0.33 U	0.33 U
Aroclor-1242 (PCB-1242)	mg/kg	0.33 U	0.33 U	0.33 U
Aroclor-1248 (PCB-1248)	mg/kg	0.33 U	0.33 U	0.33 U
Aroclor-1254 (PCB-1254)	mg/kg	0.33 U	0.33 U	0.33 U
Aroclor-1260 (PCB-1260)	mg/kg	0.33 U	0.33 U	0.33 U
Inorganics				
Antimony	mg/kg	0.3 U	0.3 U	0.3 U
Arsenic	mg/kg	7.38	1.74	1.88
Barium	mg/kg	75.7	9.8	23.9
Beryllium	mg/kg	0.5 U	0.5 U	0.5 U
Cadmium	mg/kg	0.83	0.2 U	0.4
Chromium (Total)	mg/kg	16	8.4	7.2
Cobalt	mg/kg	3	0.9	2.33
Copper	mg/kg	48	8.9	13.1
Cyanide (total)	mg/kg	0.1 U	0.1 U	0.1 U
Lead	mg/kg	72.3	14	20.8
Manganese	mg/kg	452	114	127
Mercury	mg/kg	0.089	0.05 U	0.05 U
Nickel	mg/kg	9.2	2.3	3.2
Selenium	mg/kg	0.47	0.2 U	0.2 U
Silver	mg/kg	0.11 U	0.1 U	0.1 U
Thallium	mg/kg	0.5 U	0.5 U	0.5 U
Vanadium	mg/kg	7.6	1 U	1 U
Zinc	mg/kg	229	41.2	44.1

Table 6
Flint River Sediment Investigation, GM NAO Flint Operations Site, Flint, MI

Summary of Subsurface Sediment Analytical Results for Biased Transects Near GM Outfalls 003, 005, and 013

Sample ID: Sample Depth(in BGS): Date Collected:	Units	FRT 12C 2 - 12 11/01/06	FRT 12C 12 - 24 11/01/06	FRT 12C 24 - 36 11/01/06
Miscellaneous				
Total Organic Carbon (TOC)	mg/kg	88	27	26
Total Solids	%	41	76	78
Field Parameters				
Clay	%wt	(2)	(2)	(2)
Coarse Sand	%wt	0.4	0.35	0.24
Fine Sand	%wt	54.18	82.09	80.87
Grain Density	mm	0.195	0.311	0.302
Gravel	%wt	0	0.86	0.22
Medium Sand	%wt	24.78	15.49	14.84
Silt	%wt	(2)	(2)	(2)
Silt/Clay	%wt	20.64	1.21	3.83

NOTES:

1. Sampling was performed by representatives from ARCADIS of New York, Inc. and Exponent during the week of October 30, 2006.
2. All samples were screened in the field using a photoionization detector. All readings were indicated to be zero.
3. Samples were analyzed for semivolatile organic consitituents (SVOCs) polychlorinated biphenyls (PCBs), and metals, as well as total organic carbon and particle size distribution, by Merit Laboratories of East Lansing, MI.
4. U-Analyte was not detected at the presented detection limit.
5. J-The presented value is estimated.
6. [ ] - Field duplicate results are reflected using brackets.
7. (2) - Not differentiated.
8. Abbreviations:
    - > mg/kg = milligrams per kilogram, dry weight
    - > % = percent
    - > % wt = percent by weight
    - > mm = millimeters
    - > BGS = below ground surface

Table 7

Flint River Sediment Investigation, GM NAO Flint Operations Site, Flint, MI

Statistics for Surface Sediment Analytical Results for Unbiased Transects

Constituent	Detection Frequency			Maximum Detected Value (mg/Kg)			Average Value (mg/Kg)		
	Upstream	Adjacent	Downstream	Upstream	Adjacent	Downstream	Upstream	Adjacent	Downstream
Semivolatile Organics (SVOCs)									
2,2'-oxybis(1-Chloropropane) (bis(2-chloroisopropyl) ether)	0 of 5	0 of 5	0 of 5	--	--	--	--	--	--
2,4,5-Trichlorophenol	0 of 5	0 of 5	0 of 5	--	--	--	--	--	--
2,4,6-Trichlorophenol	0 of 5	0 of 5	0 of 5	--	--	--	--	--	--
2,4-Dichlorophenol	0 of 5	0 of 5	0 of 5	--	--	--	--	--	--
2,4-Dimethylphenol	0 of 5	0 of 5	0 of 5	--	--	--	--	--	--
2,4-Dinitrophenol	0 of 5	0 of 5	0 of 5	--	--	--	--	--	--
2,4-Dinitrotoluene	0 of 5	0 of 5	0 of 5	--	--	--	--	--	--
2,6-Dinitrotoluene	0 of 5	0 of 5	0 of 5	--	--	--	--	--	--
2-Chloronaphthalene	0 of 5	0 of 5	0 of 5	--	--	--	--	--	--
2-Chlorophenol	0 of 5	0 of 5	0 of 5	--	--	--	--	--	--
2-Methylnaphthalene	0 of 5	0 of 5	0 of 5	--	--	--	--	--	--
2-Methylphenol	0 of 5	0 of 5	0 of 5	--	--	--	--	--	--
2-Nitroaniline	0 of 5	0 of 5	0 of 5	--	--	--	--	--	--
2-Nitrophenol	0 of 5	0 of 5	0 of 5	--	--	--	--	--	--
3,3'-Dichlorobenzidine	0 of 5	0 of 5	0 of 5	--	--	--	--	--	--
3-Methylphenol	1 of 5	0 of 5	0 of 5	0.36	--	--	0.20	--	--
3-Nitroaniline	0 of 5	0 of 5	0 of 5	--	--	--	--	--	--
4,6-Dinitro-2-methylphenol	0 of 5	0 of 5	0 of 5	--	--	--	--	--	--
4-Bromophenyl phenyl ether	0 of 5	0 of 5	0 of 5	--	--	--	--	--	--
4-Chloro-3-methylphenol	0 of 5	0 of 5	0 of 5	--	--	--	--	--	--
4-Chloroaniline	0 of 5	0 of 5	0 of 5	--	--	--	--	--	--
4-Chlorophenyl phenyl ether	0 of 5	0 of 5	0 of 5	--	--	--	--	--	--
4-Nitroaniline	0 of 5	0 of 5	0 of 5	--	--	--	--	--	--
4-Nitrophenol	0 of 5	0 of 5	0 of 5	--	--	--	--	--	--
Acenaphthene	0 of 5	0 of 5	0 of 5	--	--	--	--	--	--
Acenaphthylene	0 of 5	0 of 5	1 of 5	--	--	0.098 (J)	--	--	0.15
Acetophenone	0 of 5	0 of 5	0 of 5	--	--	--	--	--	--
Anthracene	0 of 5	1 of 5	2 of 5	--	0.04 (J)	0.11 (J)	--	0.14	0.13
Atrazine	0 of 5	0 of 5	0 of 5	--	--	--	--	--	--
Benzaldehyde	0 of 5	0 of 5	0 of 5	--	--	--	--	--	--
Benzo(a)anthracene	0 of 5	2 of 5	3 of 5	--	0.20 (J)	0.4 (J)	--	0.16	0.23
Benzo(a)pyrene	0 of 5	4 of 5	5 of 5	--	0.62 (J)	1.46 (J)	--	0.28	0.75
Benzo(b)fluoranthene	0 of 5	3 of 5	4 of 5	--	0.75 (J)	1.69 (J)	--	0.30	0.87
Benzo(g,h,i)perylene	0 of 5	4 of 5	5 of 5	--	0.47	1.16	--	0.21	0.56
Benzo(k)fluoranthene	0 of 5	5 of 5	4 of 5	--	0.53 (J)	1.34 (J)	--	0.24	0.70
Biphenyl	0 of 5	0 of 5	0 of 5	--	--	--	--	--	--
bis(2-Chloroethoxy)methane	0 of 5	0 of 5	0 of 5	--	--	--	--	--	--
bis(2-Chloroethyl)ether	0 of 5	0 of 5	0 of 5	--	--	--	--	--	--
bis(2-Ethylhexyl)phthalate	2 of 5	1 of 5	0 of 5	0.10 (J)	1.77	--	0.13	0.49	--
Butyl benzylphthalate	0 of 5	0 of 5	0 of 5	--	--	--	--	--	--
Caprolactam	0 of 5	0 of 5	0 of 5	--	--	--	--	--	--
Carbazole	0 of 5	0 of 5	2 of 5	--	--	0.10 (J)	--	--	0.14
Chrysene	0 of 5	5 of 5	5 of 5	--	0.54	1.18	--	0.24	0.64
Dibenz(a,h)anthracene	0 of 5	0 of 5	1 of 5	--	--	0.12 (J)	--	--	0.16
Dibenzofuran	0 of 5	0 of 5	0 of 5	--	--	--	--	--	--
Diethyl phthalate	0 of 5	0 of 5	0 of 5	--	--	--	--	--	--
Dimethyl phthalate	1 of 5	0 of 5	1 of 5	0.05 (J)	--	0.12 (J)	0.14	--	0.15
Di-n-butylphthalate	0 of 5	0 of 5	0 of 5	--	--	--	--	--	--
Di-n-octyl phthalate	0 of 5	0 of 5	0 of 5	--	--	--	--	--	--
Fluoranthene	1 of 5	5 of 5	5 of 5	0.03 (J)	1.08	2.2 (J)	0.14	0.43	1.20
Fluorene	0 of 5	1 of 5	3 of 5	--	0.09 (J)	0.10 (J)	--	0.15	0.13
Hexachlorobenzene	0 of 5	0 of 5	0 of 5	--	--	--	--	--	--
Hexachlorobutadiene	0 of 5	0 of 5	0 of 5	--	--	--	--	--	--
Hexachlorocyclopentadiene	0 of 5	0 of 5	0 of 5	--	--	--	--	--	--
Hexachloroethane	0 of 5	0 of 5	0 of 5	--	--	--	--	--	--
Indeno(1,2,3-cd)pyrene	0 of 5	4 of 5	5 of 5	--	0.39	1.04	--	0.17	0.50
Isophorone	0 of 5	0 of 5	0 of 5	--	--	--	--	--	--
Naphthalene	0 of 5	0 of 5	0 of 5	--	--	--	--	--	--

Table 7

Flint River Sediment Investigation, GM NAO Flint Operations Site, Flint, MI

Statistics for Surface Sediment Analytical Results for Unbiased Transects

Constituent	Detection Frequency			Maximum Detected Value (mg/Kg)			Average Value (mg/Kg)		
	Upstream	Adjacent	Downstream	Upstream	Adjacent	Downstream	Upstream	Adjacent	Downstream
Nitrobenzene	0 of 5	0 of 5	0 of 5	--	--		0.10	0.10	
N-Nitrosodi-n-propylamine	0 of 5	0 of 5	0 of 5	--	--	--	--	--	--
N-Nitrosodiphenylamine	0 of 5	0 of 5	0 of 5	--	--	--	--	--	--
Pentachlorophenol	0 of 5	0 of 5	0 of 5	--	--	--	--	--	--
Phenanthrene	0 of 5	1 of 5	2 of 5	--	0.2 (J)	0.30	--	0.17	0.22
Phenol	0 of 5	0 of 5	0 of 5	--	--	--	--	--	--
Pyrene	0 of 5	2 of 5	3 of 5	--	0.46	1.33	--	0.26	0.66
Total SVOC Detects	**5 of 325**	**38 or 325**	**51 of 325**						
Pesticides/Polychlorinated Biphenyls (PCBs)									
Aroclor-1016 (PCB-1016)	0 of 5	0 of 5	0 of 5	--	--	--	--	--	--
Aroclor-1221 (PCB-1221)	0 of 5	0 of 5	0 of 5	--	--	--	--	--	--
Aroclor-1232 (PCB-1232)	0 of 5	0 of 5	0 of 5	--	--	--	--	--	--
Aroclor-1242 (PCB-1242)	0 of 5	0 of 5	0 of 5	--	--	--	--	--	--
Aroclor-1248 (PCB-1248)	0 of 5	0 of 5	0 of 5	--	--	--	--	--	--
Aroclor-1254 (PCB-1254)	0 of 5	0 of 5	0 of 5	--	--	--	--	--	--
Aroclor-1260 (PCB-1260)	0 of 5	0 of 5	1 of 5	--	--	0.02 (J)	--	--	0.14
Total Pests/PCBs Detects	**0 of 35**	**0 of 35**	**1 of 35**						
Inorganics									
Antimony	0 of 5	0 of 5	0 of 5	--	--	--	--	--	--
Arsenic	5 of 5	5 of 5	5 of 5	12.10	6.62	12.33	3.94	3.92	6.03
Barium	5 of 5	5 of 5	5 of 5	90.6 (J)	73.2 (J)	118.5 (J)	27.02	32.90	53.08
Beryllium	0 of 5	0 of 5	0 of 5	--	--	--	--	--	--
Cadmium	1 of 5	3 of 5	4 of 5	0.99	0.33	1.89	0.28	0.22	0.71
Chromium (Total)	1 of 5	5 of 5	5 of 5	5.50	22.40	41.20	1.90	10.16	18.94
Cobalt	5 of 5	5 of 5	5 of 5	9.93	2.97	6.05	2.84	1.90	2.87
Copper	3 of 5	5 of 5	5 of 5	15.50	31.20	86.15	4.14	19.46	30.81
Cyanide (total)	0 of 5	0 of 5	1 of 5	--	--	1.00	--	--	0.24
Lead	5 of 5	5 of 5	5 of 5	13.10	214.00	117.00	5.12	56.88	51.18
Manganese	5 of 5	5 of 5	5 of 5	872.00	596.00	1430.00	279.80	423.20	634.30
Mercury	0 of 5	0 of 5	1 of 5	--	--	0.12	--	--	0.04
Nickel	3 of 5	5 of 5	5 of 5	10.70	6.50	12.40	2.94	3.72	6.12
Selenium	1 of 5	4 of 5	4 of 5	0.48	0.39	0.78	0.18	0.27	0.44
Silver	0 of 5	0 of 5	0 of 5	--	--	--	--	--	--
Thallium	0 of 5	0 of 5	0 of 5	--	--	--	--	--	--
Vanadium	3 of 5	5 of 5	5 of 5	8.20	6.60	10.15	2.36	2.62	4.01
Zinc	5 of 5	5 of 5	5 of 5	42.9 (J)	72.3 (J)	312 (J)	16.38	42.36	157.82
Total Inorganic Detects	**42 of 90**	**57 of 90**	**60 of 90**						

Notes:

1. Upstream = Transects FRT 1, 2, and 3;
   Adjacent = Transects FRT 4, 5, 6;
   Downstream = Transects FRT 7, 8, and 9.
2. -- = No detected values
3. J = Estimated value.
4. When computing averages, a value of half the detection limit was used for samples that were qualified as non-detect.
5. mg/Kg = milligram per kilogram

5/1/2007

Table 8
Flint River Sediment Investigation, GM NAO Flint Operations Site, Flint, MI

Summary of Statistical Tests on Surface Sediment Results for Unbiased Transects

	Mean			Median		
Constituent	**Upstream**	**Adjacent**	**Downstream**	**Upstream**	**Adjacent**	**Downstream**
Anthracene	0.17	0.14	0.13	0.17	0.17	0.17
Benzo(a)anthracene	0.17	0.16	0.24	0.17	0.17	0.17
Benzo(a)pyrene	0.17	0.28	0.75	0.17	0.2	0.81
Benzo(b)fluoranthene	0.17	0.3	0.87	0.17	0.2	0.89
Benzo(g,h,i)perylene	0.17	0.21	0.56*	0.17	0.17	0.62
Benzo(k)fluoranthene	0.17	0.24	0.7	0.17	0.2	0.82
bis(2-Ethylhexyl)phthalate	0.13	0.49	0.27	0.17	0.17	0.26
Carbazole	0.17	0.17	0.14	0.17	0.17	0.17
Chrysene	0.17	0.24	0.64	0.17	0.2	0.66
Fluoranthene	0.14	0.43	1.2*	0.17	0.3	1.2
Fluorene	0.17	0.15	0.13*	0.17	0.17	0.1
Indeno(1,2,3-cd)pyrene	0.17	0.17	0.5	0.17	0.1	0.52
Phenanthrene	0.17	0.18	0.24	0.17	0.17	0.17
Pyrene	0.17	0.26	0.67*	0.17	0.17	0.41
Arsenic	3.9	3.9	6	2.09	3.31	4.28
Barium	27	33	53	11.2	22.8	38.8
Cadmium	0.28	0.22	0.71	0.1	0.26	0.45
Chromium (Total)	1.9	10.2	18.9*	1	7	15.8
Cobalt	2.8	1.9	2.9	1.07	1.57	2.23
Copper	4.1	19.5	30.8	1.9	15.8	16.6
Lead	5.1	56.9	51.2	3.5	16.8	34
Manganese	280	423	634	121	498	584
Nickel	2.9	3.7	6.2	1.5	3.2	4.7
Selenium	0.17	0.27	0.44	0.1	0.28	0.44
Vanadium	2.4	2.6	4	1.1	1.6	2.9
Zinc	16.4	42.4	158	10.9	37.6	94

NOTES:

1. Shading indicates significant differences among groups at 95% confidence level.
2. * = Although Downstream mean is significantly different than Upstream mean, Downstream mean was not significantly different than Adjacent mean.
3. Means were compared using t-tests and ANOVA.
4. Medians were compared using Kruskal-Wallis Test.
5. All analyses were done using Statgraphics 5.1.

Table 9
Flint River Sediment Investigation, GM NAO Flint Operations Site, Flint, MI

Summary of Statistical Tests on Surface Sediment Results for Unbiased and Biasd Adjacent Transects

	Mean		Median	
Constituent	**Adjacent Unbiased**	**Adjacent Biased**	**Adjacent Unbiased**	**Adjacent Biased**
Anthracene	0.14	0.19	0.17	0.17
Benzo(a)anthracene	0.16	0.23	0.17	0.17
Benzo(a)pyrene	0.28	0.57	0.2	0.515
Benzo(b)fluoranthene	0.30	0.60	0.2	0.59
Benzo(g,h,i)perylene	0.21	0.43	0.17	0.425
Benzo(k)fluoranthene	0.24	0.48	0.2	0.405
bis(2-Ethylhexyl)phthalate	0.49	0.18	0.17	0.135
Carbazole	0.17	0.16	0.17	0.17
Chrysene	0.24	0.45	0.2	0.39
Fluoranthene	0.42	0.94	0.3	0.715
Fluorene	0.15	0.15	0.17	0.17
Indeno(1,2,3-cd)pyrene	0.17	0.37	0.1	0.35
Phenanthrene	0.18	0.42	0.17	0.17
Pyrene	0.26	0.45	0.17	0.185
Arsenic	3.9	5.9	3.31	3.665
Barium	33	45	22.8	24.85
Cadmium	0.22	0.37	0.26	0.1
Chromium (Total)	10	8.8	7	6.85
Cobalt	1.9	2.2	1.57	1.595
Copper	19	22	15.8	13.45
Lead	57	35	16.8	14.75
Manganese	423	395	498	291.5
Nickel	3.7	5.5	3.2	4.05
Selenium	0.27	0.30	0.28	0.1
Vanadium	2.6	3.8	1.6	1.55
Zinc	42	95	37.6	52.2

NOTES:

1. Shading indicates significant differences among groups at 95% confidence level.
2. Means were compared using t-tests and ANOVA.
3. Medians were compared using Kruskal-Wallis Test.
4. All analyses were done using Statgraphics 5.1.

Table 10
Flint River Sediment Investigation' GM NAO Flint Operations Site, Flint, MI

Comparison of Surface Sediment Analytical Results for Unbiased Transects to Regional and Urban Background Levels

						Upstream					
Sample ID:		Background Levels				FRT 1C	FRT 2B	FRT 2C	FRT 3A	FRT 3B	
Sample Depth (in BGS):		Urban		Statewide		0–2	0–2	0–2	0–2	0–2	
Date Collected:	Units	Min	Max	Min	Max	11/01/06	11/01/06	11/01/06	11/01/06	11/01/06	Mean
SVOCs											
Benzo[a]pyrene	mg/kg	0.165	0.22 [a]	--	--	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*
Benzo[b]fluoranthene	mg/kg	15	62 [a]	--	--	0.17 *UJ*	0.17 *UJ*	0.17 *UJ*	0.17 *UJ*	0.17 *UJ*	0.17 *UJ*
Benzo[g,h,i]perylene	mg/kg	0.9	47 [a]	--	--	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*
Benzo[k]fluoranthene	mg/kg	0.3	26 [a]	--	--	0.17 *UJ*	0.17 *UJ*	0.17 *UJ*	0.17 *UJ*	0.17 *UJ*	0.17 *UJ*
Chrysene	mg/kg	0.251	0.64 [a]	--	--	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*
Fluoranthene	mg/kg	0.2	166 [a]	--	--	0.17 *U*	0.17 *U*	0.03 *J*	0.17 *U*	0.17 *U*	0.14 *J*
Fluorene	mg/kg	--	--	--	--	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*
Indeno[1,2,3-cd]pyrene	mg/kg	8	61 [a]	--	--	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*
Pyrene	mg/kg	0.145	147 [a]	--	--	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*
Inorganics											
Chromium (Total)	mg/kg	27	55 [b]	<2	65 [c]	1.0 *U*	1.0 *U*	5.5	1.0 *U*	1.0 *U*	1.9
Copper	mg/kg	30	113 [b]	<2	25 [c]	2.3	0.5 *U*	15.5	1.9	0.5 *U*	4.1
Lead	mg/kg	93	160 [b]	<5	50 [c]	3.6	3.5	13.1	3.0	2.4	5.1
Zinc	mg/kg	120	257 [b]	<5	170 [c]	11.7 *J*	8.2 *J*	42.9 *J*	10.9 *J*	8.2 *J*	16.4 *J*

Table 10
Flint River Sediment Investigation' GM NAO Flint Operations Site, Flint, MI

Comparison of Surface Sediment Analytical Results for Unbiased Transects to Regional and Urban Background Levels

						Adjacent					
Sample ID:		Background Levels				FRT 4A	FRT 4C	FRT 5A	FRT 5B	FRT 6B	
Sample Depth (in BGS):		Urban		Statewide		0–2	0–2	0–2	0–2	0–2	
Date Collected:	Units	Min	Max	Min	Max	11/01/06	11/01/06	10/31/06	10/31/06	10/31/06	Mean
SVOCs											
Benzo[a]pyrene	mg/kg	0.165	0.22 [a]	--	--	0.20 *J*	0.62 *J*	0.20 *J*	0.20 *J*	0.17 *U*	0.28 *J*
Benzo[b]fluoranthene	mg/kg	15	62 [a]	--	--	0.20 *J*	0.75 *J*	0.17 *UJ*	0.20 *J*	0.17 *UJ*	0.30 *J*
Benzo[g,h,i]perylene	mg/kg	0.9	47 [a]	--	--	0.10 *J*	0.47	0.10 *J*	0.20 *J*	0.17 *U*	0.21 *J*
Benzo[k]fluoranthene	mg/kg	0.3	26 [a]	--	--	0.20 *J*	0.53 *J*	0.20 *J*	0.20 *J*	0.07 *J*	0.24 *J*
Chrysene	mg/kg	0.251	0.64 [a]	--	--	0.20 *J*	0.54	0.10 *J*	0.30 *J*	0.06 *J*	0.24 *J*
Fluoranthene	mg/kg	0.2	166 [a]	--	--	0.30 *J*	1.08	0.20 *J*	0.48	0.10 *J*	0.43 *J*
Fluorene	mg/kg	--	--	--	--	0.17 *U*	0.09 *J*	0.17 *U*	0.17 *U*	0.17 *U*	0.15 *J*
Indeno[1,2,3-cd]pyrene	mg/kg	8	61 [a]	--	--	0.10 *J*	0.39	0.10 *J*	0.10 *J*	0.17 *U*	0.17
Pyrene	mg/kg	0.145	147 [a]	--	--	0.17 *U*	0.46	0.17 *U*	0.35	0.17 *U*	0.26
Inorganics											
Chromium (Total)	mg/kg	27	55 [b]	<2	65 [c]	22.4	7	11.4	4.8	5.2	10.2
Copper	mg/kg	30	113 [b]	<2	25 [c]	13.5	**31.2**	**25.9**	15.8	10.9	19.5
Lead	mg/kg	93	160 [b]	<5	50 [c]	15.4	26	**214**	16.8	12.2	**56.9**
Zinc	mg/kg	120	257 [b]	<5	170 [c]	28.2 *J*	72.3 *J*	43.1 *J*	37.6 *J*	30.6 *J*	42.4 *J*

Table 10
Flint River Sediment Investigation' GM NAO Flint Operations Site, Flint, MI

Comparison of Surface Sediment Analytical Results for Unbiased Transects to Regional and Urban Background Levels

						Downstream					
									FRT 9A		
Sample ID:		Background Levels				FRT 7A	FRT 7C	FRT 8B	0–2	FRT 9B	
Sample Depth (in BGS):		Urban		Statewide		0–2	0–2	0–2	10/31/06	0–2	
Date Collected:	Units	Min	Max	Min	Max	10/31/06	10/31/06	10/31/06	AVE	10/31/06	Mean
SVOCs											
Benzo[a]pyrene	mg/kg	0.165	0.22 [a]	--	--	$\boxed{0.30}$ *J*	$\boxed{0.81}$ *J*	0.10 *J*	$\boxed{1.46}$ *J*	$\boxed{1.07}$	$\boxed{0.75}$ *J*
Benzo[b]fluoranthene	mg/kg	15	62 [a]	--	--	0.30 *J*	0.89 *J*	0.17 *UJ*	1.685 *J*	1.32 *J*	0.87 *J*
Benzo[g,h,i]perylene	mg/kg	0.9	47 [a]	--	--	0.20 *J*	0.62 *J*	0.08 *J*	1.16	0.75	0.56 *J*
Benzo[k]fluoranthene	mg/kg	0.3	26 [a]	--	--	0.30 *J*	0.82 *J*	0.17 *UJ*	1.335 *J*	0.88 *J*	0.70 *J*
Chrysene	mg/kg	0.251	0.64 [a]	--	--	0.30 *J*	$\boxed{0.66}$ *J*	0.10 *J*	$\boxed{1.18}$	$\boxed{0.94}$	0.64 *J*
Fluoranthene	mg/kg	0.2	166 [a]	--	--	0.44	1.20 *J*	0.10 *J*	2.2 *J*	2.05	1.20 *J*
Fluorene	mg/kg	--	--	--	--	0.17 *U*	0.10 *J*	0.17 *U*	0.1 *J*	0.10 *J*	0.13 *J*
Indeno[1,2,3-cd]pyrene	mg/kg	8	61 [a]	--	--	0.20 *J*	0.52 *J*	0.06 *J*	1.035	0.67	0.50 *J*
Pyrene	mg/kg	0.145	147 [a]	--	--	0.17 *U*	0.41 *J*	0.17 *U*	1.325	1.25	0.66 *J*
Inorganics											
Chromium (Total)	mg/kg	27	55 [b]	<2	65 [c]	5.9	7.5	41.2	24.3	15.8	18.9
Copper	mg/kg	30	113 [b]	<2	25 [c]	13.7	**33**	4.6	**86.2**	16.6	**30.8**
Lead	mg/kg	93	160 [b]	<5	50 [c]	23.9	34	8.2	**117**	**72.8**	**51.2**
Zinc	mg/kg	120	257 [b]	<5	170 [c]	49.8 *J*	94 *J*	30.8 *J*	$\boxed{\mathbf{302.5}}$ *J*	$\boxed{\mathbf{312}}$ *J*	157.8 *J*

Note: Sampling was performed by ARCADIS BBL and Exponent during the week of October 30, 2006.

Samples were analyzed for SVOCs, PCBs, and metals, as well as total organic carbon and particle size distribution, by Merit Laboratories of East Lansing, M

Non-detects shown at half the detection limit.

Boxed values exceed the upper range (max) of urban background values.[a,b]

Bold values exceed the upper range (max) of reference site background values.[c]

BGS - below ground surface
J - estimated value
mg/kg - milligrams per kilogram, dry weight
PAH - polycyclic aromatic hydrocarbon
PCB - polychlorinated biphenyl
SVOC - semivolatile organic compound
U - undetected at detection limit shown

[a] Background soil concentrations of PAHs in urban soil (ATSDR 1995).

[b] Mean concentrations of metals in Michigan surface soils for residential, commercial, and industrial land uses (Murray et al. 2004).

[c] Statewide reference sediment chemistry for all ecoregions (MDEQ 1999).

Table 11
Flint River Investigation, GM NAO Flint Operations Site, Flint, MI

Comparison of Surface Sediment Analytical Results for Biased Sampling Transects Regional and Urban Background Levels

						Adjacent						
								FRT 11B				
Sample ID:		Background Levels				FRT 10A	FRT 10B	0–2	FRT 11C	FRT 12B	FRT 12C	
Sample Depth (in BGS):		Urban		Statewide		0–2	0–2	11/01/06	0–2	0–2	0–2	
Date Collected:	Units	Min	Max	Min	Max	10/31/06	10/31/06	AVE	11/01/06	10/31/06	10/31/06	Mean
SVOCs												
Benzo[a]pyrene	mg/kg	0.165	0.22 [a]	--	--	0.73	0.20 *J*	0.865	0.20 *J*	0.30 *J*	0.83	0.52 *J*
Benzo[b]fluoranthene	mg/kg	15	62 [a]	--	--	0.88 *J*	0.17 *UJ*	0.865 *J*	0.30 *J*	0.30 *J*	0.88 *J*	0.57 *J*
Benzo[g,h,i]perylene	mg/kg	0.9	47 [a]	--	--	0.65	0.17 *U*	0.56	0.20 *J*	0.20 *J*	0.69	0.41 *J*
Benzo[k]fluoranthene	mg/kg	0.3	26 [a]	--	--	0.51 *J*	0.17 *UJ*	0.695 *J*	0.20 *J*	0.30 *J*	0.75 *J*	0.44 *J*
Chrysene	mg/kg	0.251	0.64 [a]	--	--	0.58	0.10 *J*	0.715	0.20 *J*	0.20 *J*	0.65	0.41 *J*
Fluoranthene	mg/kg	0.2	166 [a]	--	--	1.05	0.20 *J*	1.62 *J*	0.38	0.37	1.29	0.82 *J*
Fluorene	mg/kg	--	--	--	--	0.10 *J*	0.17 *U*	0.15 *J*	0.17 *U*	0.17 *U*	0.07 *J*	0.14 *J*
Indeno[1,2,3-cd]pyrene	mg/kg	8	61 [a]	--	--	0.50	0.17 *U*	0.505	0.20 *J*	0.20 *J*	0.58	0.36 *J*
Pyrene	mg/kg	0.145	147 [a]	--	--	0.20 *J*	0.17 *U*	0.8 *J*	0.17 *U*	0.17 *U*	0.46	0.33 *J*
Inorganics												
Chromium (Total)	mg/kg	27	55 [b]	<2	65 [c]	8.2	2.8	4.1	3.0	10.5	22.8	8.6
Copper	mg/kg	30	113 [b]	<2	25 [c]	24.4	3.3	7.2	17.8	9.1	**73.2**	22.5
Lead	mg/kg	93	160 [b]	<5	50 [c]	35.3	9.1	11	10.1	18.7	**124**	34.7
Zinc	mg/kg	120	257 [b]	<5	170 [c]	105	18.1 *J*	37.5 *J*	25.4 *J*	62 *J*	**316** *J*	94 *J*

Note: Sampling was performed by ARCADIS BBL and Exponent during the week of October 30, 2006.
Samples were analyzed for SVOCs, PCBs, and metals, as well as total organic carbon and particle size distribution, by Merit Laboratories of East Lansing, MI.
Non-detects shown at half the detection limit.
Boxed values exceed the upper range (max) of urban background values.[a,b]
Bold values exceed the upper range (max) of reference site background values.[c]

BGS - below ground surface
J - estimated value
mg/kg - milligrams per kilogram, dry weight
PAH - polycyclic aromatic hydrocarbon
PCB - polychlorinated biphenyl
SVOC - semivolatile organic compound
U - undetected at detection limit shown

[a] Background soil concentrations of PAHs in urban soil (ATSDR 1995).

[b] Mean concentrations of metals in Michigan surface soils for residential, commercial, and industrial land uses (Murray et al. 2004).

[c] Statewide reference sediment chemistry for all ecoregions (MDEQ 1999).

Table 12
Flint River Investigation, GM NAO Flint Operations Site, Flint, MI

Comparison of Subsurface Sediment Analytical Results for Unbiased Sampling Transects to Regional and Urban Background Levels

						Upstream					
						FRT 2C	FRT 2C	FRT 2C	FRT 2C	FRT 2C	
Sample ID:		Background Levels				2 - 12	12 - 24	24 - 36	36 - 48	48 - 57	
Sample Depth (in BGS):		Urban		Statewide		39022	39022	39022	39022	39022	
Date Collected:	Units	Min	Max	Min	Max						Mean
SVOCs											
Benzo[a]pyrene	mg/kg	0.165	0.22 [a]	--	--	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*
Benzo[b]fluoranthene	mg/kg	15	62 [a]	--	--	0.17 *UJ*	0.17 *UJ*	0.17 *UJ*	0.17 *UJ*	0.17 *UJ*	0.17 *UJ*
Benzo[g,h,i]perylene	mg/kg	0.9	47 [a]	--	--	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*
Benzo[k]fluoranthene	mg/kg	0.3	26 [a]	--	--	0.17 *UJ*	0.17 *UJ*	0.17 *UJ*	0.17 *UJ*	0.17 *UJ*	0.17 *UJ*
Chrysene	mg/kg	0.251	0.64 [a]	--	--	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*
Fluoranthene	mg/kg	0.2	166 [a]	--	--	0.03 *J*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.14 *U*
Fluorene	mg/kg	--	--	--	--	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*
Indeno[1,2,3-cd]pyrene	mg/kg	8	61 [a]	--	--	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*
Pyrene	mg/kg	0.145	147 [a]	--	--	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*
Inorganics											
Chromium (Total)	mg/kg	27	55 [b]	<2	65 [c]	8.9	6.5	2.1	1.0 *U*	1.0 *U*	3.9
Copper	mg/kg	30	113 [b]	<2	25 [c]	7.0	8.1	1.7	1.2	0.5 *U*	3.7
Lead	mg/kg	93	160 [b]	<5	50 [c]	6.6	8.9	1.6	1.6	0.5 *U*	3.8
Zinc	mg/kg	120	257 [b]	<5	170 [c]	30	35	6	6	4	16.1

Table 12
Flint River Investigation, GM NAO Flint Operations Site, Flint, MI

Comparison of Subsurface Sediment Analytical Results for Unbiased Sampling Transects to Regional and Urban Background Levels

						Adjacent			Downstream				
Sample ID:		Background Levels				FRT 4A	FRT 4A		FRT 7C	FRT 7C	FRT 7C	FRT 7C	
Sample Depth (in BGS):		Urban		Statewide		2–12	12–24		2–12	12–24	24–36	36–46	
Date Collected:	Units	Min	Max	Min	Max	11/01/06	11/01/06	Mean	10/31/06 AVE	10/31/06	10/31/06	10/31/06	Mean
SVOCs													
Benzo[a]pyrene	mg/kg	0.165	0.22 [a]	--	--	0.20 *J*	0.17 *U*	0.18 *J*	0.5 *U*	7.00	0.53	0.17 *U*	2.05
Benzo[b]fluoranthene	mg/kg	15	62 [a]	--	--	0.10 *J*	0.17 *UJ*	0.13 *J*	1.5 *J*	4.00 *J*	0.30 *J*	0.17 *UJ*	1.49
Benzo[g,h,i]perylene	mg/kg	0.9	47 [a]	--	--	0.10 *J*	0.17 *U*	0.13 *J*	0.5 *U*	3.00 *J*	0.35	0.17 *U*	1.00
Benzo[k]fluoranthene	mg/kg	0.3	26 [a]	--	--	0.10 *J*	0.17 *UJ*	0.13 *J*	0.9 *J*	4.00 *J*	0.30 *J*	0.17 *UJ*	1.34
Chrysene	mg/kg	0.251	0.64 [a]	--	--	0.10 *J*	0.17 *U*	0.13 *J*	1.5	7.00	0.38	0.17 *U*	2.26
Fluoranthene	mg/kg	0.2	166 [a]	--	--	0.20 *J*	0.17 *U*	0.18 *J*	1.4 *J*	7.00	0.39	0.17 *U*	2.24
Fluorene	mg/kg	--	--	--	--	0.17 *U*	0.17 *U*	0.17 *U*	0.5 *U*	0.50 *U*	0.10 *J*	0.17 *U*	0.32
Indeno[1,2,3-cd]pyrene	mg/kg	8	61 [a]	--	--	0.09 *J*	0.17 *U*	0.13 *J*	0.5 *U*	3.00 *J*	0.30 *J*	0.17 *U*	0.99
Pyrene	mg/kg	0.145	147 [a]	--	--	0.17 *U*	0.17 *U*	0.17 *U*	0.5 *U*	12.0	0.17 *U*	0.17 *U*	3.21
Inorganics													
Chromium (Total)	mg/kg	27	55 [b]	<2	65 [c]	2.5	1.0 *U*	1.8	**136**	64.4	6.5	2.3	52.3
Copper	mg/kg	30	113 [b]	<2	25 [c]	7.3	1.7	4.5	**135**	**127.0**	7.9	3.4	**68.3**
Lead	mg/kg	93	160 [b]	<5	50 [c]	7.9	1.8	4.9	**221**	**183.0**	10.3	3.8	**104.5**
Zinc	mg/kg	120	257 [b]	<5	170 [c]	15	12	13.6	**645**	**338**	22	12	**254.2**

Note: Sampling was performed by ARCADIS BBL and Exponent during the week of October 30, 2006.
Samples were analyzed for SVOCs, PCBs, and metals, as well as total organic carbon and particle size distribution, by Merit Laboratories of East Lansing, MI.
Non-detects shown at half the detection limit.
Boxed values exceed the upper range (max) of urban background values.[a,b]
Bold values exceed the upper range (max) of reference site background values.[c]

BGS	-	below ground surface
J	-	estimated value
mg/kg	-	milligrams per kilogram, dry weight
PAH	-	polycyclic aromatic hydrocarbon
PCB	-	polychlorinated biphenyl
SVOC	-	semivolatile organic compound
U	-	undetected at detection limit shown

[a] Background soil concentrations of PAHs in urban soil (ATSDR 1995).

[b] Mean concentrations of metals in Michigan surface soils for residential, commercial, and industrial land uses (Murray et al. 2004).

[c] Statewide reference sediment chemistry for all ecoregions (MDEQ 1999).

Table 13
Flint River Investigation, GM NAO Flint Operations Site, Flint, MI

Comparison of Subsurface Sediment Analytical Results for Biased Sampling Transects to Regional and Urban Background Levels

						Adjacent			
Sample ID:		Background Levels				FRT 12C	FRT 12C	FRT 12C	
Sample Depth (in BGS):		Urban		Statewide		2–12	12–24	24–36	
Date Collected:	Units	Min	Max	Min	Max	11/01/06	11/01/06	11/01/06	Mean
SVOCs									
Benzo[a]pyrene	mg/kg	0.165	0.22 [a]	--	--	1.77	0.99	0.20 *J*	0.99 *J*
Benzo[b]fluoranthene	mg/kg	15	62 [a]	--	--	2.20 *J*	1.18 *J*	0.30 *J*	1.23 *J*
Benzo[ghi]perylene	mg/kg	0.9	47 [a]	--	--	1.41	0.82	0.20 *J*	0.81 *J*
Benzo[k]fluoranthene	mg/kg	0.3	26 [a]	--	--	1.45 *J*	0.93 *J*	0.20 *J*	0.86 *J*
Chrysene	mg/kg	0.251	0.64 [a]	--	--	1.54	0.88	0.20 *J*	0.87 *J*
Fluoranthene	mg/kg	0.2	166 [a]	--	--	3.05	1.69	0.41	1.72
Fluorene	mg/kg	--	--	--	--	0.20 *J*	0.10 *J*	0.17 *U*	0.16 *J*
Indeno[1,2,3-cd]pyrene	mg/kg	8	61 [a]	--	--	1.16	0.69	0.10 *J*	0.65 *J*
Pyrene	mg/kg	0.145	147 [a]	--	--	2.02	0.84	0.17 *U*	1.01
Inorganics									
Chromium (Total)	mg/kg	27	55 [b]	<2	65 [c]	16.0	8.4	7.2	10.5
Copper	mg/kg	30	113 [b]	<2	25 [c]	**48.0**	8.9	13.1	23.3
Lead	mg/kg	93	160 [b]	<5	50 [c]	**72.3**	14.0	20.8	35.7
Zinc	mg/kg	120	257 [b]	<5	170 [c]	**229**	41	44	104.8

Note: Sampling was performed by ARCADIS BBL and Exponent during the week of October 30, 2006.

Samples were analyzed for SVOCs, PCBs, and metals, as well as total organic carbon and particle size distribution, by Merit Laboratories of East Lansing, MI.

Non-detects shown at half the detection limit.

Boxed values exceed the upper range (max) of urban background values. [a,b]

Bold values exceed the upper range (max) of reference site background values. [c]

BGS - below ground surface
J - estimated value
mg/kg - milligrams per kilogram, dry weight
PAH - polycyclic aromatic hydrocarbon
PCB - polychlorinated biphenyl
SVOC - semivolatile organic compound
U - undetected at detection limit shown

[a] Background soil concentrations of PAHs in urban soil (ATSDR 1995).

[b] Mean concentrations of metals in Michigan surface soils for residential, commercial, and industrial land uses (Murray et al. 2004).

[c] Statewide reference sediment chemistry for all ecoregions (MDEQ 1999).

Figures

1/30/07 SYR-85 EAB KEW PGL
GM Flint (64410.00184)
Q: General Motors\Flint\CCR_Report\mxd\2005MDEQSamplingResults.mxd

Sample Location:		Outfall 005				
MDEQ/GM:		MDEQ				GM
Sample ID:		OFC0051	OFC0052	OFP0052	OFP0052D	Outfall 005
Depth (in):	Units	0-6	6-12	surficial	surficial	surficial
Inorganic						
Arsenic	mg/kg	NA	NA	12.8	12.8	10
Barium	mg/kg	NA	NA	130	130	170
Cadmium	mg/kg	NA	NA	ND (2)	ND (2)	1.2
Chromium Total	mg/kg	NA	NA	26	25	17
Copper	mg/kg	NA	NA	52	57	48
Lead	mg/kg	NA	NA	72	66	76
Mercury	mg/kg	NA	NA	ND (0.05)	0.12	0.11
Selenium	mg/kg	NA	NA	0.7	ND (0.5)	0.68
Silver	mg/kg	NA	NA	ND (0.25)	ND (0.25)	0.24
Zinc	mg/kg	NA	NA	230	230	240
Miscellaneous						
Total Solids	%	64.5	80.7	43.0	43.3	32
PCB						
Aroclor-1232 (PCB-1232)	mg/kg	ND(0.16)	ND(0.12)	ND(0.23)	ND(0.23)	ND (0.33)
Aroclor-1242 (PCB-1242)	mg/kg	ND(0.16)	ND(0.12)	ND(0.23)	ND(0.23)	ND (0.33)
Aroclor-1254 (PCB-1254)	mg/kg	0.18	ND(0.12)	ND(0.23)	ND(0.23)	0.04 J
SVOC						
Anthracene	mg/kg	ND (0.16)	ND (0.12)	ND (0.23)	ND (0.23)	0.1 J
Benzo(a)anthracene	mg/kg	0.27	0.24	0.59	0.65	0.7
Benzo(a)pyrene	mg/kg	ND (0.31)	0.26	0.72	0.75	0.8
Benzo(b)fluoranthene	mg/kg	0.43	0.37	1.2	1.2	0.8
Benzo(g,h,i)perylene	mg/kg	ND (0.31)	ND (0.25)	0.59	0.7	ND (0.5 J)
Benzo(k)fluoranthene	mg/kg	ND (0.31)	ND (0.25)	ND (0.47)	ND (0.46)	0.6
bis(2-Ethylhexyl)phthalate	mg/kg	ND (0.31)	ND (0.25)	0.76	0.59	0.6
Butyl benzylphthalate	mg/kg	ND (0.16)	ND (0.12)	ND (0.23)	ND (0.23)	ND (0.5)
Carbazole	mg/kg	ND (0.51)	ND (0.41)	ND (0.77)	ND (0.76)	0.1 J
Chrysene	mg/kg	ND (0.16)	ND (0.12)	0.86	0.93	0.9
Diethyl phthalate	mg/kg	0.49	0.34	0.68 M	0.76 M	ND (0.5)
Fluoranthene	mg/kg	0.74	0.54	1.9	2	1.6
Indeno(1,2,3-cd)pyrene	mg/kg	ND (0.31)	ND (0.25)	0.53	0.62	1.2 J
Naphthalene	mg/kg	ND (0.16)	ND (0.12)	ND (0.23)	ND (0.23)	ND (0.5)
Phenanthrene	mg/kg	0.37	0.29	0.8	0.87	0.7
Pyrene	mg/kg	0.77	0.5	2	2.2	1.3
VOC						
Methyl acetate	mg/kg	NA	NA	NA	NA	0.8 J
Methylene chloride	mg/kg	NA	NA	NA	NA	0.8
Toluene	mg/kg	NA	NA	NA	NA	0.04 J

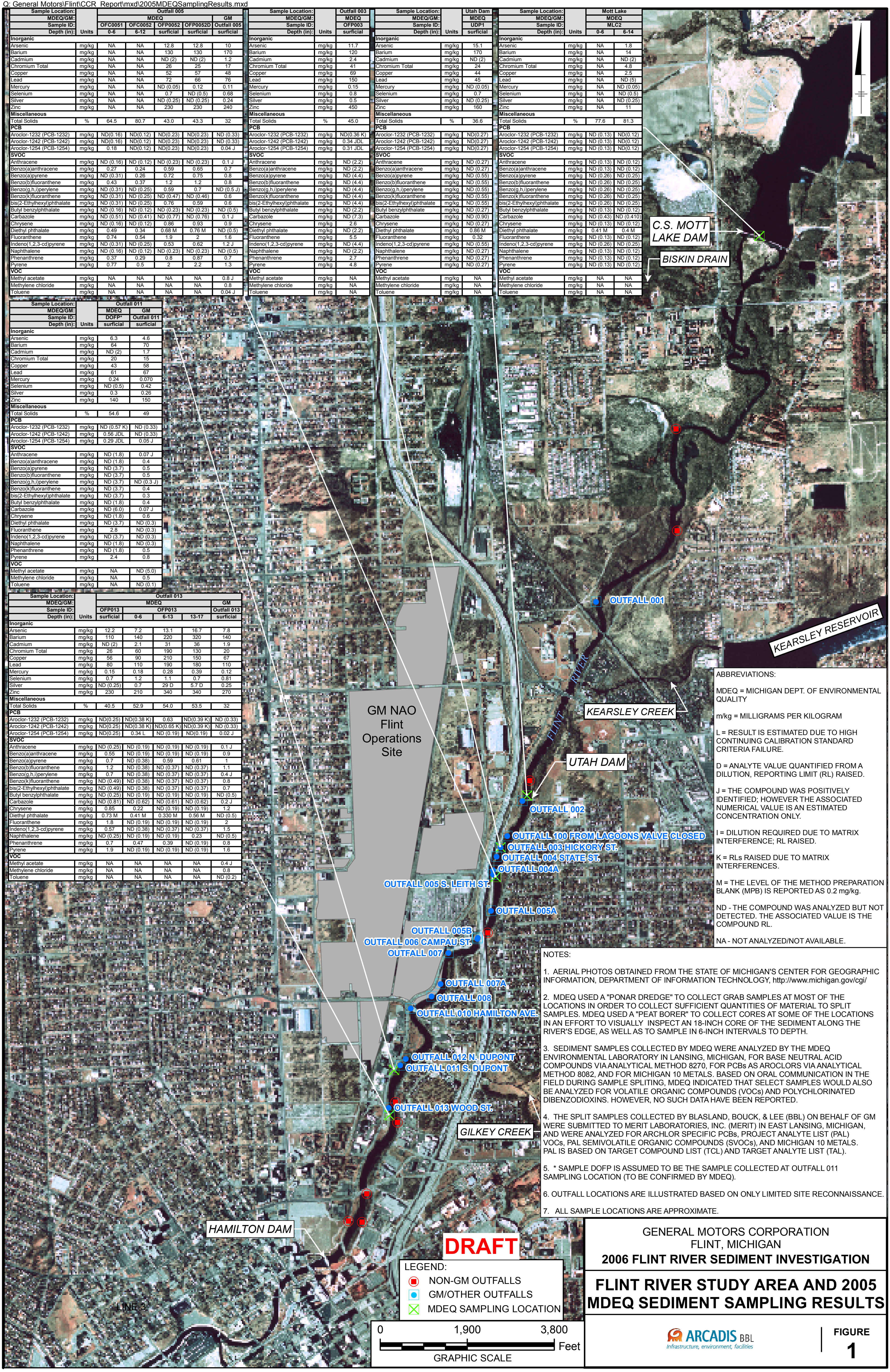
Sample Location:		Outfall 003
MDEQ/GM:		MDEQ
Sample ID:		OFP003
Depth (in):	Units	surficial
Inorganic		
Arsenic	mg/kg	11.7
Barium	mg/kg	120
Cadmium	mg/kg	2.4
Chromium Total	mg/kg	41
Copper	mg/kg	69
Lead	mg/kg	150
Mercury	mg/kg	0.15
Selenium	mg/kg	0.8
Silver	mg/kg	0.5
Zinc	mg/kg	450
Miscellaneous		
Total Solids	%	45.0
PCB		
Aroclor-1232 (PCB-1232)	mg/kg	ND(0.36 K)
Aroclor-1242 (PCB-1242)	mg/kg	0.34 JDL
Aroclor-1254 (PCB-1254)	mg/kg	0.31 JDL
SVOC		
Anthracene	mg/kg	ND (2.2)
Benzo(a)anthracene	mg/kg	ND (2.2)
Benzo(a)pyrene	mg/kg	ND (4.4)
Benzo(b)fluoranthene	mg/kg	ND (4.4)
Benzo(g,h,i)perylene	mg/kg	ND (4.4)
Benzo(k)fluoranthene	mg/kg	ND (4.4)
bis(2-Ethylhexyl)phthalate	mg/kg	ND (4.4)
Butyl benzylphthalate	mg/kg	ND (2.2)
Carbazole	mg/kg	ND (7.3)
Chrysene	mg/kg	2.6
Diethyl phthalate	mg/kg	ND (2.2)
Fluoranthene	mg/kg	5.5
Indeno(1,2,3-cd)pyrene	mg/kg	ND (4.4)
Naphthalene	mg/kg	ND (2.2)
Phenanthrene	mg/kg	2.7
Pyrene	mg/kg	4.8
VOC		
Methyl acetate	mg/kg	NA
Methylene chloride	mg/kg	NA
Toluene	mg/kg	NA

Sample Location:		Utah Dam
MDEQ/GM:		MDEQ
Sample ID:		UDP1
Depth (in):	Units	surficial
Inorganic		
Arsenic	mg/kg	15.1
Barium	mg/kg	170
Cadmium	mg/kg	ND (2)
Chromium Total	mg/kg	24
Copper	mg/kg	44
Lead	mg/kg	45
Mercury	mg/kg	ND (0.05)
Selenium	mg/kg	0.7
Silver	mg/kg	ND (0.25)
Zinc	mg/kg	160
Miscellaneous		
Total Solids	%	36.6
PCB		
Aroclor-1232 (PCB-1232)	mg/kg	ND(0.27)
Aroclor-1242 (PCB-1242)	mg/kg	ND(0.27)
Aroclor-1254 (PCB-1254)	mg/kg	ND(0.27)
SVOC		
Anthracene	mg/kg	ND (0.27)
Benzo(a)anthracene	mg/kg	ND (0.27)
Benzo(a)pyrene	mg/kg	ND (0.55)
Benzo(b)fluoranthene	mg/kg	ND (0.55)
Benzo(g,h,i)perylene	mg/kg	ND (0.55)
Benzo(k)fluoranthene	mg/kg	ND (0.55)
bis(2-Ethylhexyl)phthalate	mg/kg	ND (0.55)
Butyl benzylphthalate	mg/kg	ND (0.27)
Carbazole	mg/kg	ND (0.90)
Chrysene	mg/kg	ND (0.27)
Diethyl phthalate	mg/kg	0.86 M
Fluoranthene	mg/kg	0.32
Indeno(1,2,3-cd)pyrene	mg/kg	ND (0.55)
Naphthalene	mg/kg	ND (0.27)
Phenanthrene	mg/kg	ND (0.27)
Pyrene	mg/kg	ND (0.27)
VOC		
Methyl acetate	mg/kg	NA
Methylene chloride	mg/kg	NA
Toluene	mg/kg	NA

Sample Location:		Mott Lake	
MDEQ/GM:		MDEQ	
Sample ID:		MLC2	
Depth (in):	Units	0-6	6-14
Inorganic			
Arsenic	mg/kg	NA	1.8
Barium	mg/kg	NA	14
Cadmium	mg/kg	NA	ND (2)
Chromium Total	mg/kg	NA	4.8
Copper	mg/kg	NA	2.5
Lead	mg/kg	NA	ND (5)
Mercury	mg/kg	NA	ND (0.05)
Selenium	mg/kg	NA	ND (0.5)
Silver	mg/kg	NA	ND (0.25)
Zinc	mg/kg	NA	11
Miscellaneous			
Total Solids	%	77.6	81.3
PCB			
Aroclor-1232 (PCB-1232)	mg/kg	ND (0.13)	ND(0.12)
Aroclor-1242 (PCB-1242)	mg/kg	ND (0.13)	ND(0.12)
Aroclor-1254 (PCB-1254)	mg/kg	ND (0.13)	ND(0.12)
SVOC			
Anthracene	mg/kg	ND (0.13)	ND (0.12)
Benzo(a)anthracene	mg/kg	ND (0.13)	ND (0.12)
Benzo(a)pyrene	mg/kg	ND (0.26)	ND (0.25)
Benzo(b)fluoranthene	mg/kg	ND (0.26)	ND (0.25)
Benzo(g,h,i)perylene	mg/kg	ND (0.26)	ND (0.25)
Benzo(k)fluoranthene	mg/kg	ND (0.26)	ND (0.25)
bis(2-Ethylhexyl)phthalate	mg/kg	ND (0.26)	ND (0.25)
Butyl benzylphthalate	mg/kg	ND (0.13)	ND (0.12)
Carbazole	mg/kg	ND (0.43)	ND (0.410)
Chrysene	mg/kg	ND (0.13)	ND (0.12)
Diethyl phthalate	mg/kg	0.41 M	0.4 M
Fluoranthene	mg/kg	ND (0.13)	ND (0.12)
Indeno(1,2,3-cd)pyrene	mg/kg	ND (0.26)	ND (0.25)
Naphthalene	mg/kg	ND (0.13)	ND (0.12)
Phenanthrene	mg/kg	ND (0.13)	ND (0.12)
Pyrene	mg/kg	ND (0.13)	ND (0.12)
VOC			
Methyl acetate	mg/kg	NA	NA
Methylene chloride	mg/kg	NA	NA
Toluene	mg/kg	NA	NA

Sample Location:		Outfall 011	
MDEQ/GM:		MDEQ	GM
Sample ID:		DOFP*	Outfall 011
Depth (in):	Units	surficial	surficial
Inorganic			
Arsenic	mg/kg	6.3	4.6
Barium	mg/kg	64	70
Cadmium	mg/kg	ND (2)	1.7
Chromium Total	mg/kg	20	15
Copper	mg/kg	43	58
Lead	mg/kg	61	67
Mercury	mg/kg	0.24	0.070
Selenium	mg/kg	ND (0.5)	0.42
Silver	mg/kg	0.3	0.26
Zinc	mg/kg	140	150
Miscellaneous			
Total Solids	%	54.6	49
PCB			
Aroclor-1232 (PCB-1232)	mg/kg	ND (0.57 K)	ND (0.33)
Aroclor-1242 (PCB-1242)	mg/kg	0.56 JDL	ND (0.33)
Aroclor-1254 (PCB-1254)	mg/kg	0.29 JDL	0.05 J
SVOC			
Anthracene	mg/kg	ND (1.8)	0.07 J
Benzo(a)anthracene	mg/kg	ND (1.8)	0.4
Benzo(a)pyrene	mg/kg	ND (3.7)	0.5
Benzo(b)fluoranthene	mg/kg	ND (3.7)	0.5
Benzo(g,h,i)perylene	mg/kg	ND (3.7)	ND (0.3 J)
Benzo(k)fluoranthene	mg/kg	ND (3.7)	0.4
bis(2-Ethylhexyl)phthalate	mg/kg	ND (3.7)	0.3
Butyl benzylphthalate	mg/kg	ND (1.8)	0.4
Carbazole	mg/kg	ND (6.0)	0.07 J
Chrysene	mg/kg	ND (1.8)	0.6
Diethyl phthalate	mg/kg	ND (3.7)	ND (0.3)
Fluoranthene	mg/kg	2.8	ND (0.3)
Indeno(1,2,3-cd)pyrene	mg/kg	ND (3.7)	ND (0.3)
Naphthalene	mg/kg	ND (1.8)	ND (0.3)
Phenanthrene	mg/kg	ND (1.8)	0.5
Pyrene	mg/kg	2.4	0.8
VOC			
Methyl acetate	mg/kg	NA	ND (5.0)
Methylene chloride	mg/kg	NA	0.5
Toluene	mg/kg	NA	ND (0.1)

Sample Location:		Outfall 013				
MDEQ/GM:		MDEQ				GM
Sample ID:		OFP013	OFP013			Outfall 013
Depth (in):	Units	surficial	0-6	6-13	13-17	surficial
Inorganic						
Arsenic	mg/kg	12.2	7.2	13.1	16.7	7.8
Barium	mg/kg	110	140	220	320	140
Cadmium	mg/kg	ND (2)	2.1	31	36	1.9
Chromium Total	mg/kg	26	60	190	130	20
Copper	mg/kg	56	90	210	150	67
Lead	mg/kg	80	110	190	180	110
Mercury	mg/kg	0.15	0.18	0.28	0.39	0.12
Selenium	mg/kg	0.7	1.2	1.1	0.7	0.81
Silver	mg/kg	ND (0.25)	0.7	29 D	5.7 D	0.25
Zinc	mg/kg	230	210	340	340	270
Miscellaneous						
Total Solids	%	40.5	52.9	54.0	53.5	32
PCB						
Aroclor-1232 (PCB-1232)	mg/kg	ND(0.25)	ND(0.38 K)	0.63	ND(0.39 K)	ND (0.33)
Aroclor-1242 (PCB-1242)	mg/kg	ND(0.25)	ND(0.38 K)	ND(0.65 K)	ND(0.39 K)	ND (0.33)
Aroclor-1254 (PCB-1254)	mg/kg	ND(0.25)	0.34 L	ND (0.19)	ND(0.19)	0.02 J
SVOC						
Anthracene	mg/kg	ND (0.25)	ND (0.19)	ND (0.19)	ND (0.19)	0.1 J
Benzo(a)anthracene	mg/kg	0.55	ND (0.19)	ND (0.19)	ND (0.19)	0.9
Benzo(a)pyrene	mg/kg	0.7	ND (0.38)	0.59	0.61	1
Benzo(b)fluoranthene	mg/kg	1.2	ND (0.38)	ND (0.37)	ND (0.37)	1.1
Benzo(g,h,i)perylene	mg/kg	0.7	ND (0.38)	ND (0.37)	ND (0.37)	0.4 J
Benzo(k)fluoranthene	mg/kg	ND (0.49)	ND (0.38)	ND (0.37)	ND (0.37)	0.8
bis(2-Ethylhexyl)phthalate	mg/kg	ND (0.49)	ND (0.38)	ND (0.37)	ND (0.37)	0.7
Butyl benzylphthalate	mg/kg	ND (0.25)	ND (0.19)	ND (0.19)	ND (0.19)	ND (0.5)
Carbazole	mg/kg	ND (0.81)	ND (0.62)	ND (0.61)	ND (0.62)	0.2 J
Chrysene	mg/kg	0.85	0.22	ND (0.19)	ND (0.19)	1.2
Diethyl phthalate	mg/kg	0.73 M	0.41 M	0.330 M	0.56 M	ND (0.5)
Fluoranthene	mg/kg	1.8	ND (0.19)	ND (0.19)	ND (0.19)	2
Indeno(1,2,3-cd)pyrene	mg/kg	0.57	ND (0.38)	ND (0.37)	ND (0.37)	1.5
Naphthalene	mg/kg	ND (0.25)	ND (0.19)	ND (0.19)	0.23	ND (0.5)
Phenanthrene	mg/kg	0.7	0.47	0.39	ND (0.19)	0.8
Pyrene	mg/kg	1.9	ND (0.19)	ND (0.19)	ND (0.19)	1.6
VOC						
Methyl acetate	mg/kg	NA	NA	NA	NA	0.4 J
Methylene chloride	mg/kg	NA	NA	NA	NA	0.8
Toluene	mg/kg	NA	NA	NA	NA	ND (0.2)



ABBREVIATIONS:

MDEQ = MICHIGAN DEPT. OF ENVIRONMENTAL QUALITY

m/kg = MILLIGRAMS PER KILOGRAM

L = RESULT IS ESTIMATED DUE TO HIGH CONTINUING CALIBRATION STANDARD CRITERIA FAILURE.

D = ANALYTE VALUE QUANTIFIED FROM A DILUTION, REPORTING LIMIT (RL) RAISED.

J = THE COMPOUND WAS POSITIVELY IDENTIFIED; HOWEVER THE ASSOCIATED NUMERICAL VALUE IS AN ESTIMATED CONCENTRATION ONLY.

I = DILUTION REQUIRED DUE TO MATRIX INTERFERENCE; RL RAISED.

K = RLs RAISED DUE TO MATRIX INTERFERENCES.

M = THE LEVEL OF THE METHOD PREPARATION BLANK (MPB) IS REPORTED AS 0.2 mg/kg.

ND - THE COMPOUND WAS ANALYZED BUT NOT DETECTED. THE ASSOCIATED VALUE IS THE COMPOUND RL.

NA - NOT ANALYZED/NOT AVAILABLE.

NOTES:

1. AERIAL PHOTOS OBTAINED FROM THE STATE OF MICHIGAN'S CENTER FOR GEOGRAPHIC INFORMATION, DEPARTMENT OF INFORMATION TECHNOLOGY, http://www.michigan.gov/cgi/

2. MDEQ USED A "PONAR DREDGE" TO COLLECT GRAB SAMPLES AT MOST OF THE LOCATIONS IN ORDER TO COLLECT SUFFICIENT QUANTITIES OF MATERIAL TO SPLIT SAMPLES. MDEQ USED A "PEAT BORER" TO COLLECT CORES AT SOME OF THE LOCATIONS IN AN EFFORT TO VISUALLY INSPECT AN 18-INCH CORE OF THE SEDIMENT ALONG THE RIVER'S EDGE, AS WELL AS TO SAMPLE IN 6-INCH INTERVALS TO DEPTH.

3. SEDIMENT SAMPLES COLLECTED BY MDEQ WERE ANALYZED BY THE MDEQ ENVIRONMENTAL LABORATORY IN LANSING, MICHIGAN, FOR BASE NEUTRAL ACID COMPOUNDS VIA ANALYTICAL METHOD 8270, FOR PCBs AS AROCLORS VIA ANALYTICAL METHOD 8082, AND FOR MICHIGAN 10 METALS. BASED ON ORAL COMMUNICATION IN THE FIELD DURING SAMPLE SPLITING, MDEQ INDICATED THAT SELECT SAMPLES WOULD ALSO BE ANALYZED FOR VOLATILE ORGANIC COMPOUNDS (VOCs) AND POLYCHLORINATED DIBENZODIOXINS. HOWEVER, NO SUCH DATA HAVE BEEN REPORTED.

4. THE SPLIT SAMPLES COLLECTED BY BLASLAND, BOUCK, & LEE (BBL) ON BEHALF OF GM WERE SUBMITTED TO MERIT LABORATORIES, INC. (MERIT) IN EAST LANSING, MICHIGAN, AND WERE ANALYZED FOR ARCHLOR SPECIFIC PCBs, PROJECT ANALYTE LIST (PAL) VOCs, PAL SEMIVOLATILE ORGANIC COMPOUNDS (SVOCs), AND MICHIGAN 10 METALS. PAL IS BASED ON TARGET COMPOUND LIST (TCL) AND TARGET ANALYTE LIST (TAL).

5. * SAMPLE DOFP IS ASSUMED TO BE THE SAMPLE COLLECTED AT OUTFALL 011 SAMPLING LOCATION (TO BE CONFIRMED BY MDEQ).

6. OUTFALL LOCATIONS ARE ILLUSTRATED BASED ON ONLY LIMITED SITE RECONNAISSANCE.

7. ALL SAMPLE LOCATIONS ARE APPROXIMATE.

GENERAL MOTORS CORPORATION
FLINT, MICHIGAN
2006 FLINT RIVER SEDIMENT INVESTIGATION

FLINT RIVER STUDY AREA AND 2005 MDEQ SEDIMENT SAMPLING RESULTS

ARCADIS BBL
Infrastructure, environment, facilities

FIGURE
1

[SYR-85-MTK] SYR-85 EAB PGL KEW
GM FLINT(64410.18400)
Q:\GeneralMotors\Flint\2006SedimentSamplingResults\mxd\UpperReach.mxd - 4/23/2007 @ 4:58:59 PM

LEGEND:
- ● GM/OTHER OUTFALLS
- ● NON-GM OUTFALLS
- ● SAMPLING LOCATION

NOTES:

1. AERIAL PHOTOS OBTAINED FROM THE STATE OF MICHIGAN'S CENTER FOR GEOGRAPHIC INFORMATION, DEPARTMENT OF INFORMATION TECHNOLOGY, http://www.michigan.gov/cgi/
2. SAMPLE LOCATIONS ARE APPROXIMATE.
3. TRANSECT END POINTS WERE SURVEYED BY BMJ ENGINEERS AND SURVEYORS OF PORT HURON, MICHIGAN

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FLINT RIVER SEDIMENT INVESTIGATION

2006 UPPER REACH OUTFALL AND SAMPLING LOCATIONS

ARCADIS BBL
Infrastructure, environment, facilities

FIGURE
2

NOTES:

1. AERIAL PHOTOS OBTAINED FROM THE STATE OF MICHIGAN'S CENTER FOR GEOGRAPHIC INFORMATION, DEPARTMENT OF INFORMATION TECHNOLOGY, http://www.michigan.gov/cgi/
2. SAMPLE LOCATIONS ARE APPROXIMATE.
3. WITH THE EXCEPTION OF TRANSECT 11, TRANSECT END POINTS WERE SURVEYED BY BMJ ENGINEERS AND SURVEYORS OF PORT HURON, MICHIGAN. THE LOCATION OF TRANSECT 11 IS BASED ON MEASURED DISTANCES TO PHYSICAL FEATURES IN THE AREA.

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FLINT RIVER SEDIMENT INVESTIGATION

2006 MIDDLE REACH OUTFALL AND SAMPLING LOCATIONS

ARCADIS BBL
Infrastructure, environment, facilities

FIGURE
3

[SYR-85-MTK] SYR-85 EAB PGL KEW
GM FLINT(64410.18400)
Q:\GeneralMotors\Flint\2006SedimentSamplingResults\mxd\LowerReach.mxd - 4/23/2007 @ 4:58:19 PM

LEGEND:
- ● GM/OTHER OUTFALLS
- ● NON-GM OUTFALLS
- ● SAMPLING LOCATION

NOTES:

1. AERIAL PHOTOS OBTAINED FROM THE STATE OF MICHIGAN'S CENTER FOR GEOGRAPHIC INFORMATION, DEPARTMENT OF INFORMATION TECHNOLOGY, http://www.michigan.gov/cgi/
2. SAMPLE LOCATIONS ARE APPROXIMATE.
3. TRANSECT END POINTS WERE SURVEYED BY BMJ ENGINEERS AND SURVEYORS OF PORT HURON, MICHIGAN

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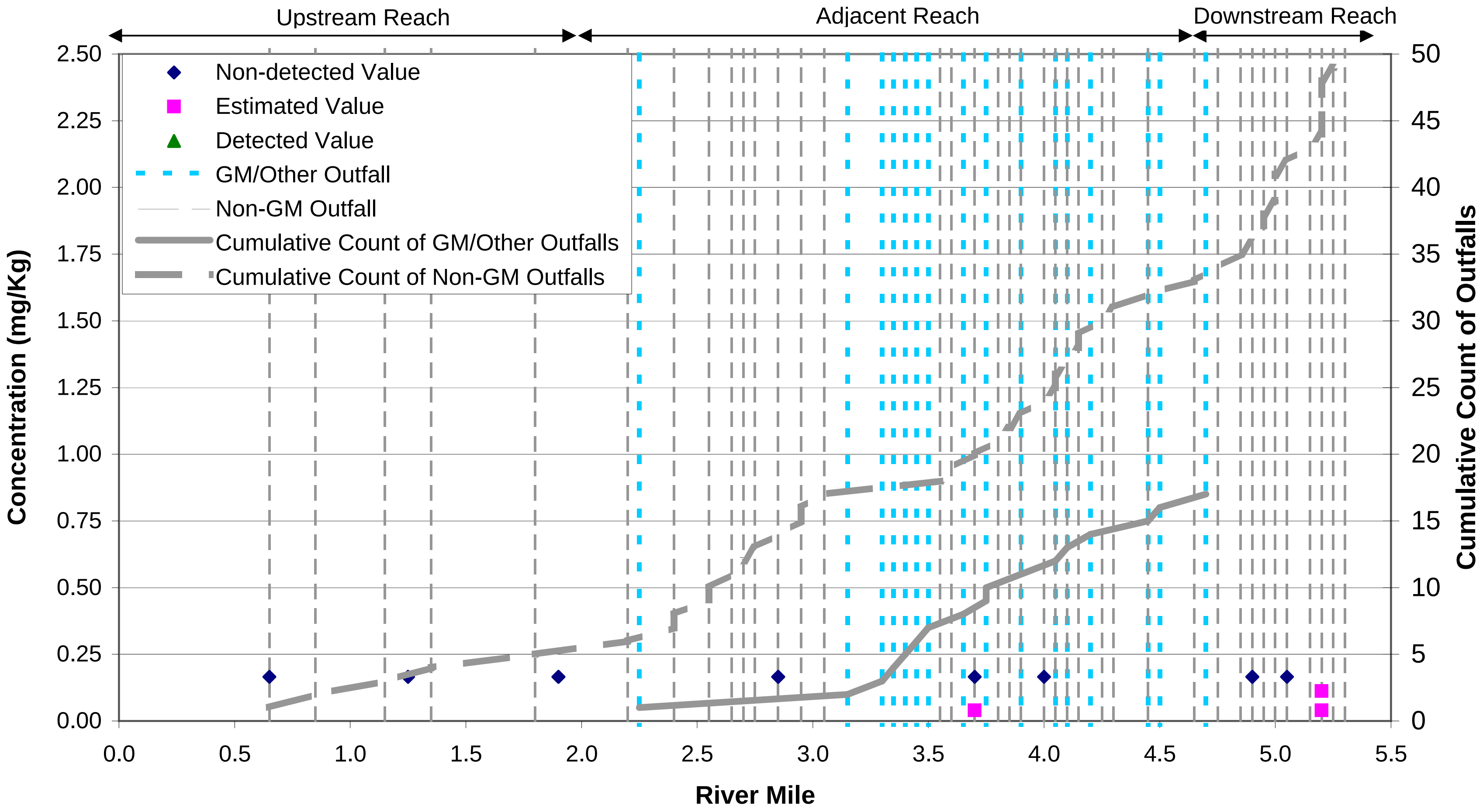
FLINT, MICHIGAN

FLINT RIVER SEDIMENT INVESTIGATION

2006 LOWER REACH OUTFALL AND SAMPLING LOCATIONS

ARCADIS BBL
Infrastructure, environment, facilities

FIGURE 4



Notes:

1. Sampling was performed by representatives from ARCADIS of New York, Inc. and Exponent during the week of October 30, 2006.
2. Samples were analyzed by Merit Laboratories of East Lansing, MI.
3. All samples were unbiased surface samples taken at a depth of 0-2 inches.
4. Non-detected values were plotted at one-half the detection limit.
5. Field blind duplicate samples were averaged with their corresponding field samples.
6. mg/Kg = milligrams per kilograms

GENERAL MOTORS CORPORATION
FLINT, MICHIGAN

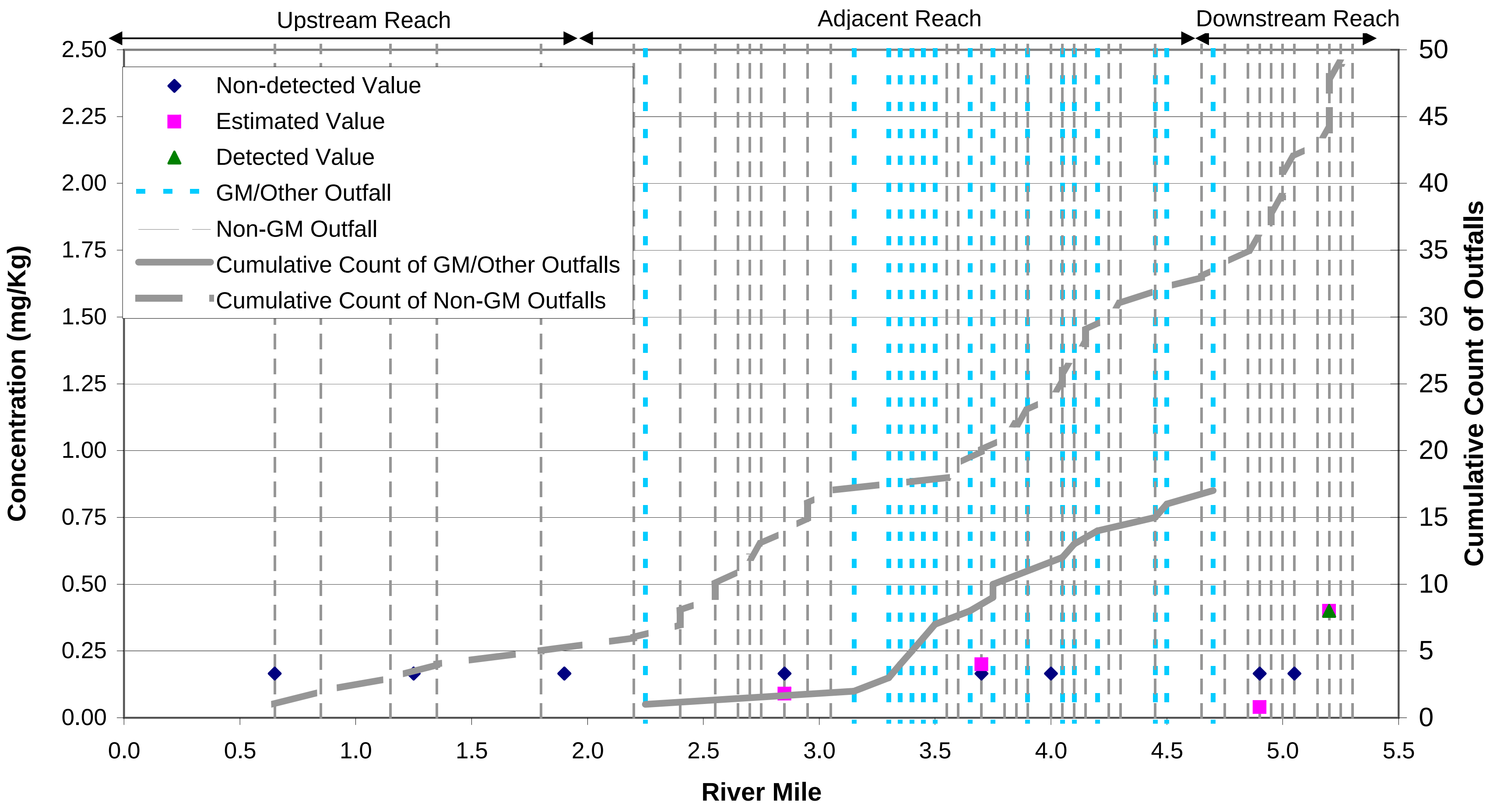
FLINT RIVER SEDIMENT INVESTIGATION

ANTHRACENE CONCENTRATIONS FOR SURFACE SAMPLES BY RIVER MILE

ARCADIS BBL
Infrastructure, environment, facilities

FIGURE

5



Notes:

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3. All samples were unbiased surface samples taken at a depth of 0-2 inches.
4. Non-detected values were plotted at one-half the detection limit.
5. Field blind duplicate samples were averaged with their corresponding field samples.
6. mg/Kg = milligrams per kilograms

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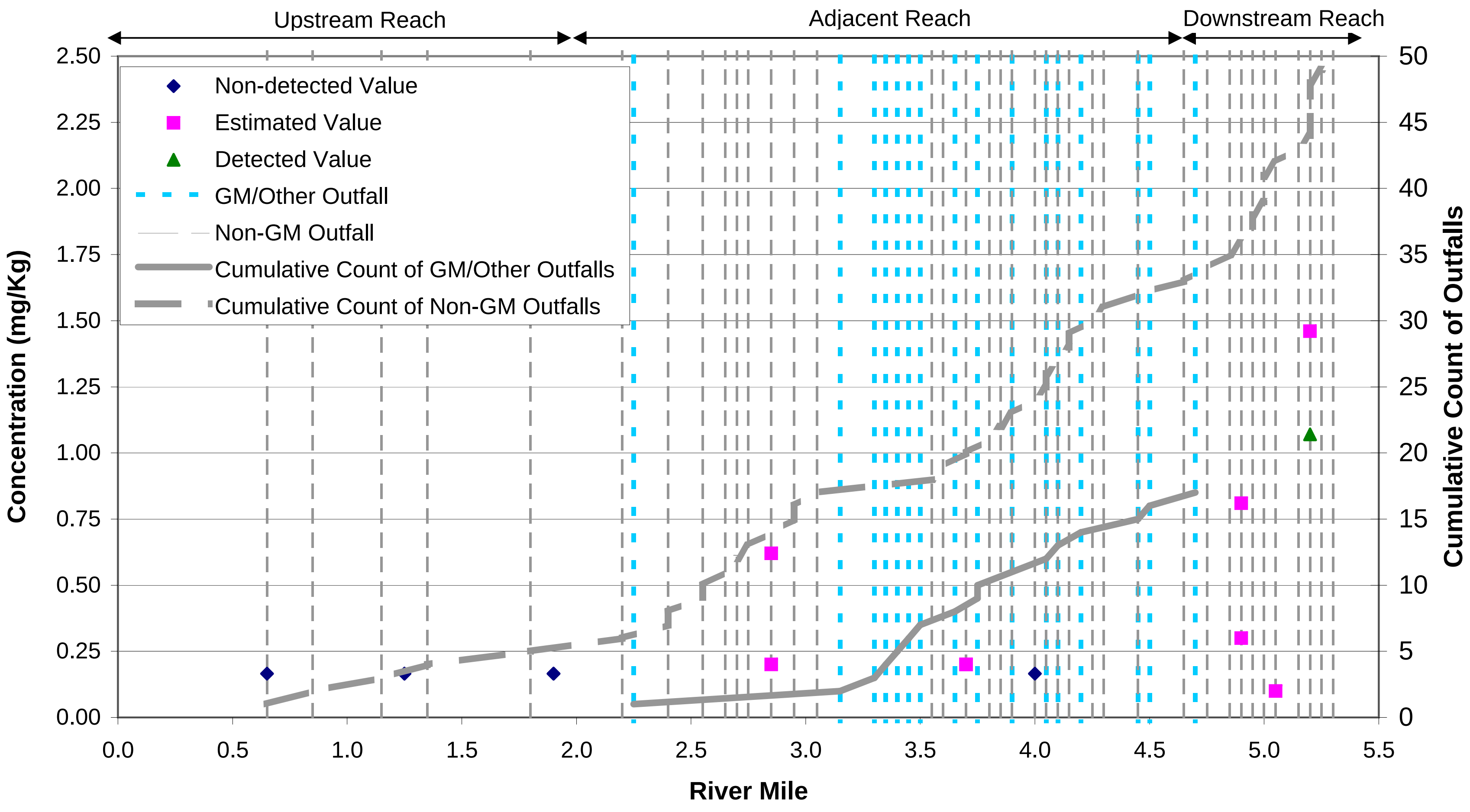
FLINT RIVER SEDIMENT INVESTIGATION

BENZO(a)ANTHRACENE CONCENTRATIONS FOR SURFACE SAMPLES BY RIVER MILE

ARCADIS BBL
Infrastructure, environment, facilities

FIGURE
6



Notes:

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2. Samples were analyzed by Merit Laboratories of East Lansing, MI.
3. All samples were unbiased surface samples taken at a depth of 0-2 inches.
4. Non-detected values were plotted at one-half the detection limit.
5. Field blind duplicate samples were averaged with their corresponding field samples.
6. mg/Kg = milligrams per kilograms

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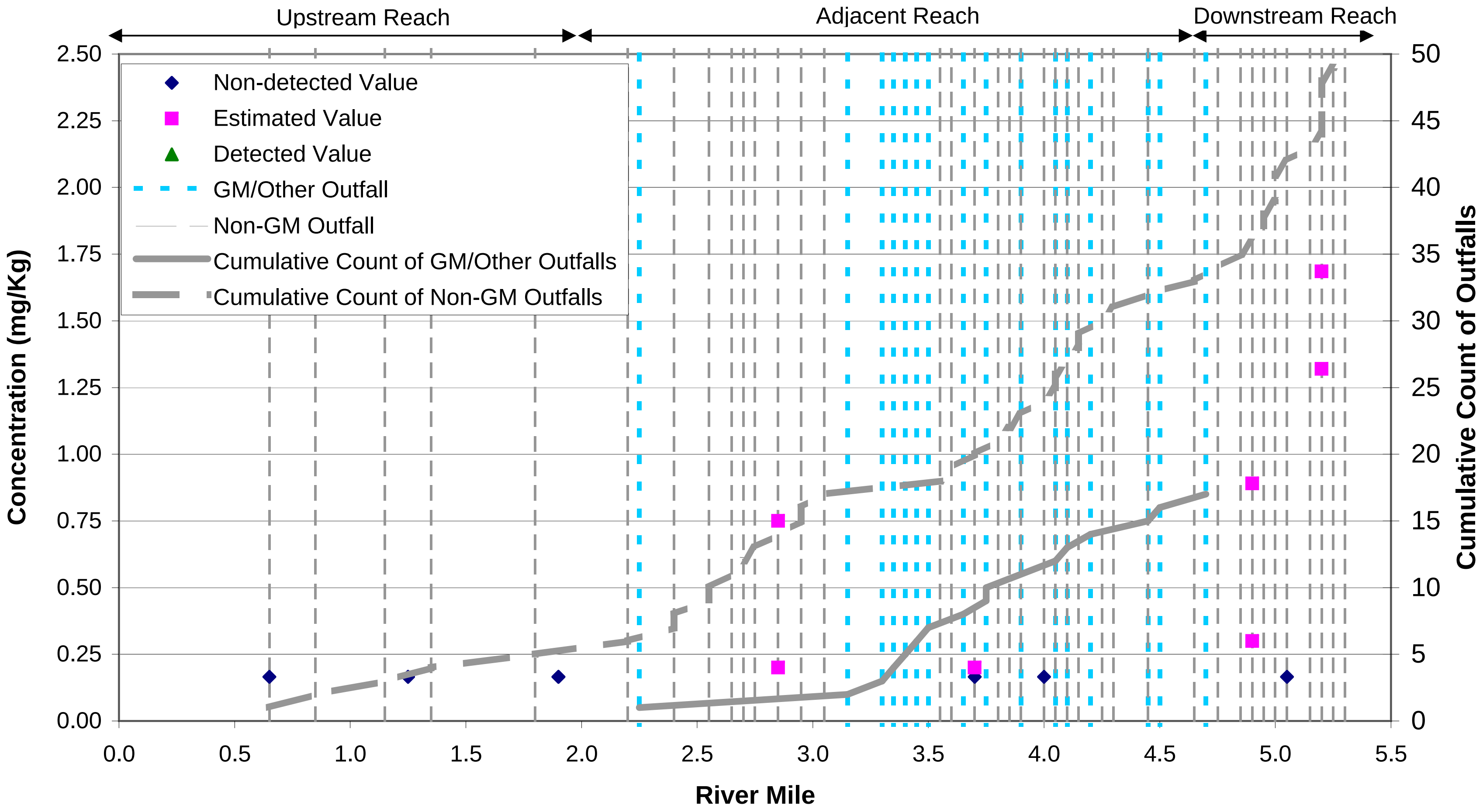
FLINT RIVER SEDIMENT INVESTIGATION

BENZO(a)PYRENE CONCENTRATIONS FOR SURFACE SAMPLES BY RIVER MILE

ARCADIS BBL
Infrastructure, environment, facilities

FIGURE

7



Notes:

1. Sampling was performed by representatives from ARCADIS of New York, Inc. and Exponent during the week of October 30, 2006.
2. Samples were analyzed by Merit Laboratories of East Lansing, MI.
3. All samples were unbiased surface samples taken at a depth of 0-2 inches.
4. Non-detected values were plotted at one-half the detection limit.
5. Field blind duplicate samples were averaged with their corresponding field samples.
6. mg/Kg = milligrams per kilograms

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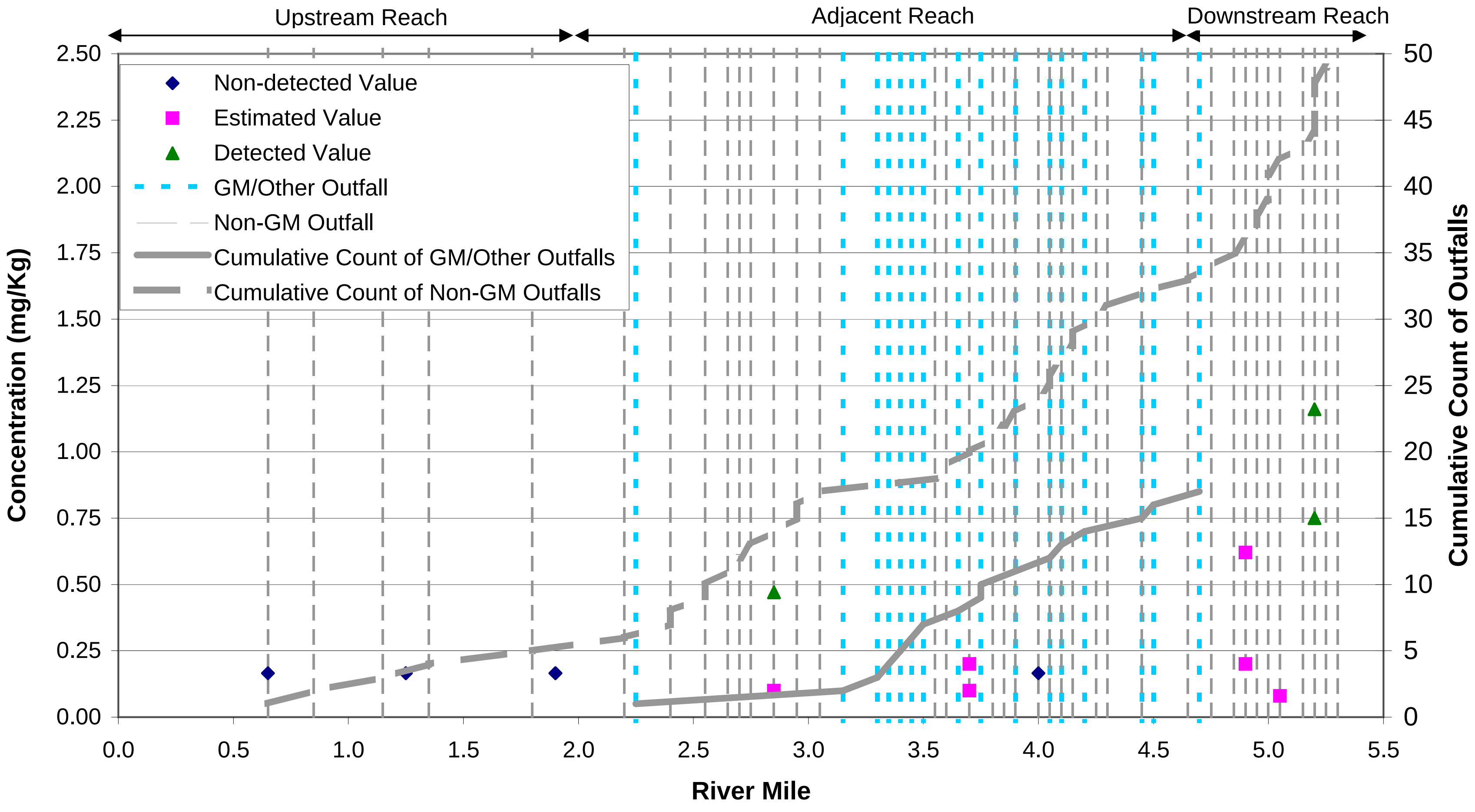
FLINT RIVER SEDIMENT INVESTIGATION

BENZO(b)FLUORANTHENE CONCENTRATIONS FOR SURFACE SAMPLES BY RIVER MILE

ARCADIS BBL
Infrastructure, environment, facilities

FIGURE

8



Notes:
1. Sampling was performed by representatives from ARCADIS of New York, Inc. and Exponent during the week of October 30, 2006.
2. Samples were analyzed by Merit Laboratories of East Lansing, MI.
3. All samples were unbiased surface samples taken at a depth of 0-2 inches.
4. Non-detected values were plotted at one-half the detection limit.
5. Field blind duplicate samples were averaged with their corresponding field samples.
6. mg/Kg = milligrams per kilograms

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FLINT RIVER SEDIMENT INVESTIGATION

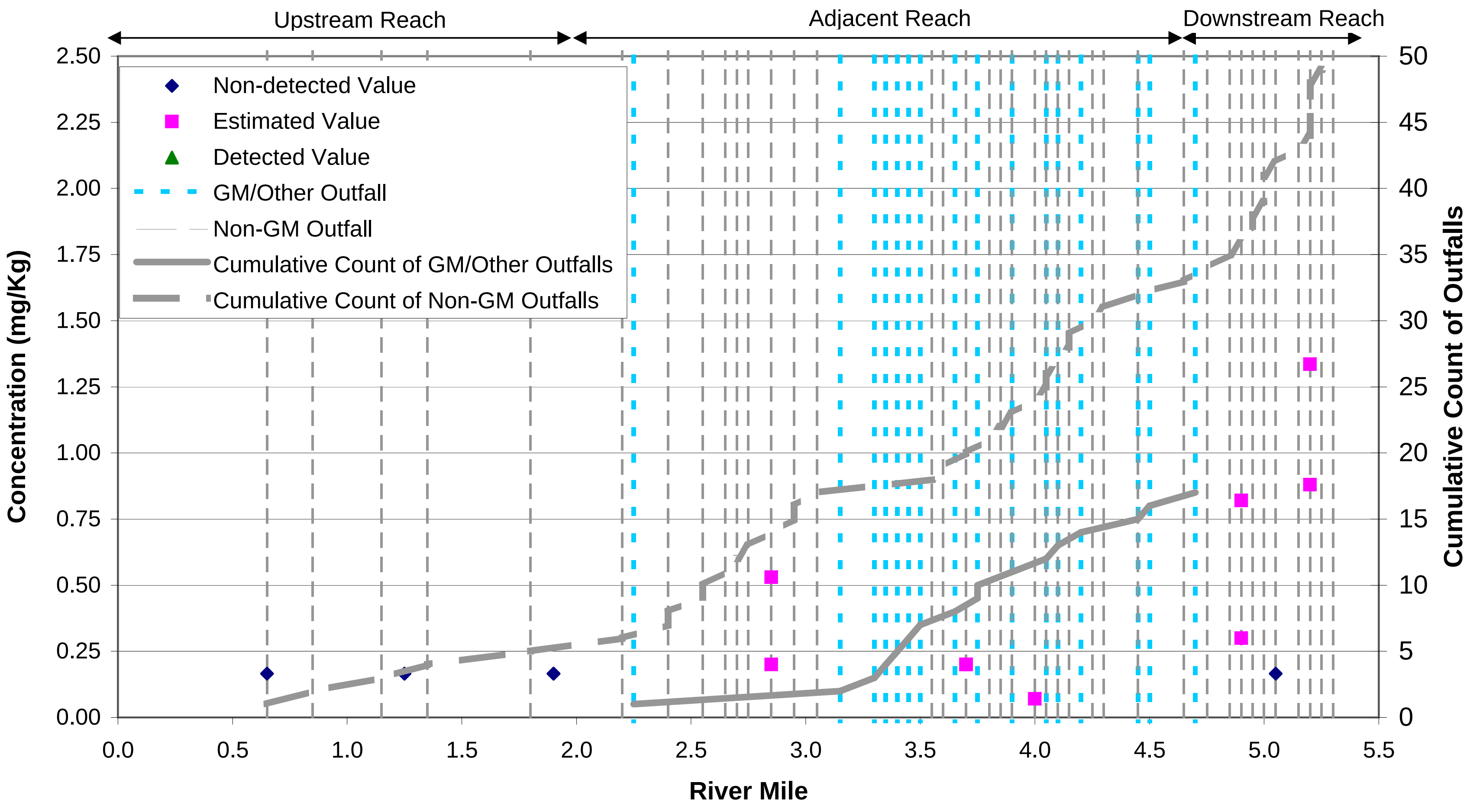
BENZO(g,h,i)PERYLENE CONCENTRATIONS FOR SURFACE SAMPLES BY RIVER MILE

ARCADIS BBL
Infrastructure, environment, facilities

FIGURE

9

4/26/2007
G:\COMMON\64410\Flint River\Sediment Report - 2007\RM Figures_Nonbiased_041107-Figs 5 thru 30.xlsBenzo(k)fluoranthene



Notes:

1. Sampling was performed by representatives from ARCADIS of New York, Inc. and Exponent during the week of October 30, 2006.
2. Samples were analyzed by Merit Laboratories of East Lansing, MI.
3. All samples were unbiased surface samples taken at a depth of 0-2 inches.
4. Non-detected values were plotted at one-half the detection limit.
5. Field blind duplicate samples were averaged with their corresponding field samples.
6. mg/Kg = milligrams per kilograms

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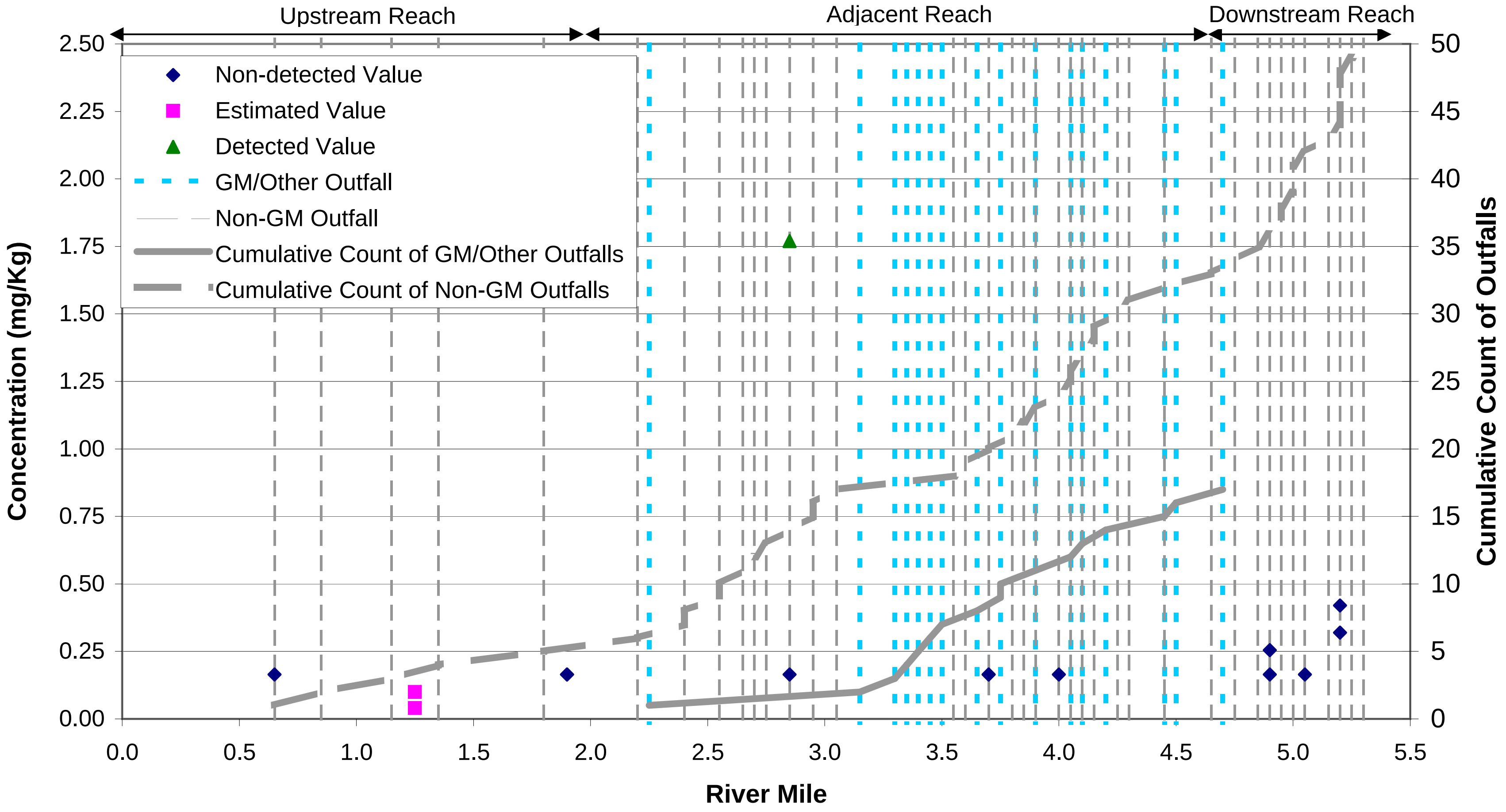
FLINT RIVER SEDIMENT INVESTIGATION

BENZO(k)FLUORANTHENE CONCENTRATIONS FOR SURFACE SAMPLES BY RIVER MILE

ARCADIS BBL
Infrastructure, environment, facilities

FIGURE
10



Notes:

1. Sampling was performed by representatives from ARCADIS of New York, Inc. and Exponent during the week of October 30, 2006.
2. Samples were analyzed by Merit Laboratories of East Lansing, MI.
3. All samples were unbiased surface samples taken at a depth of 0-2 inches.
4. Non-detected values were plotted at one-half the detection limit.
5. Field blind duplicate samples were averaged with their corresponding field samples.
6. mg/Kg = milligrams per kilograms

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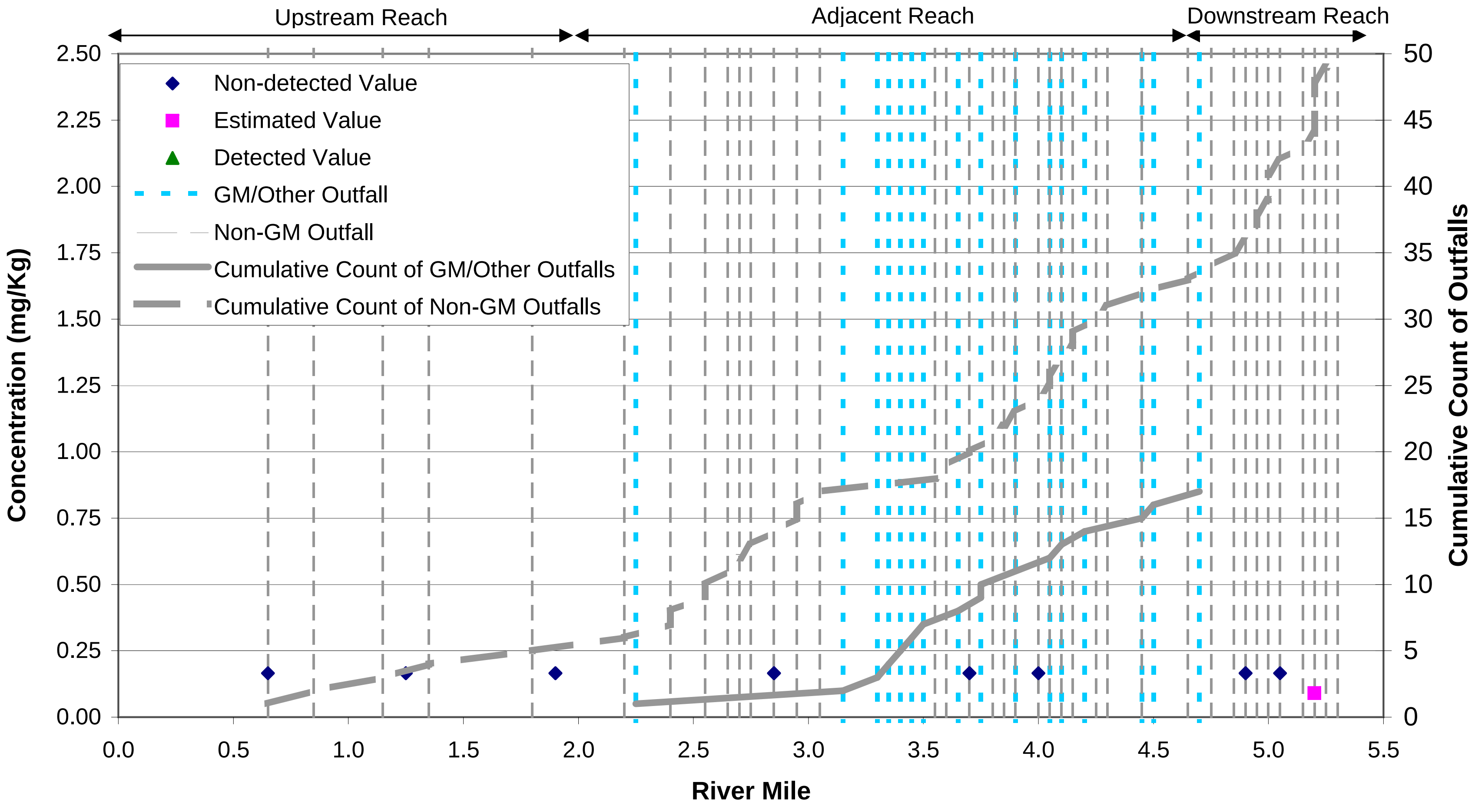
FLINT RIVER SEDIMENT INVESTIGATION

BIS(2-ETHYLHEXYL)PHTHALATE CONCENTRATIONS FOR SURFACE SAMPLES BY RIVER MILE

ARCADIS BBL
Infrastructure, environment, facilities

FIGURE

11



Notes:

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2. Samples were analyzed by Merit Laboratories of East Lansing, MI.
3. All samples were unbiased surface samples taken at a depth of 0-2 inches.
4. Non-detected values were plotted at one-half the detection limit.
5. Field blind duplicate samples were averaged with their corresponding field samples.
6. mg/Kg = milligrams per kilograms

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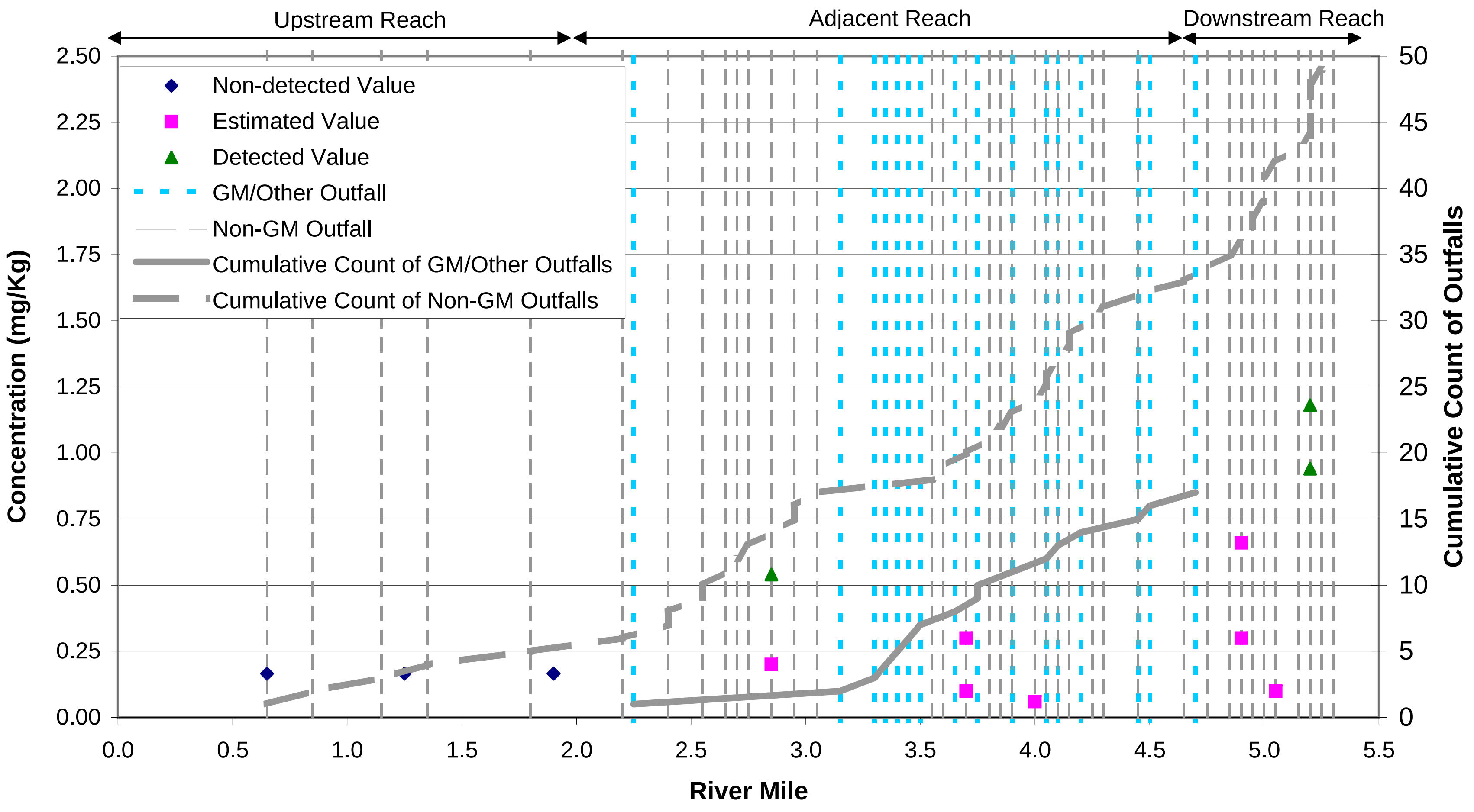
FLINT RIVER SEDIMENT INVESTIGATION

CARBAZOLE CONCENTRATIONS FOR SURFACE SAMPLES BY RIVER MILE

ARCADIS BBL
Infrastructure, environment, facilities

FIGURE

12



Notes:

1. Sampling was performed by representatives from ARCADIS of New York, Inc. and Exponent during the week of October 30, 2006.
2. Samples were analyzed by Merit Laboratories of East Lansing, MI.
3. All samples were unbiased surface samples taken at a depth of 0-2 inches.
4. Non-detected values were plotted at one-half the detection limit.
5. Field blind duplicate samples were averaged with their corresponding field samples.
6. mg/Kg = milligrams per kilograms

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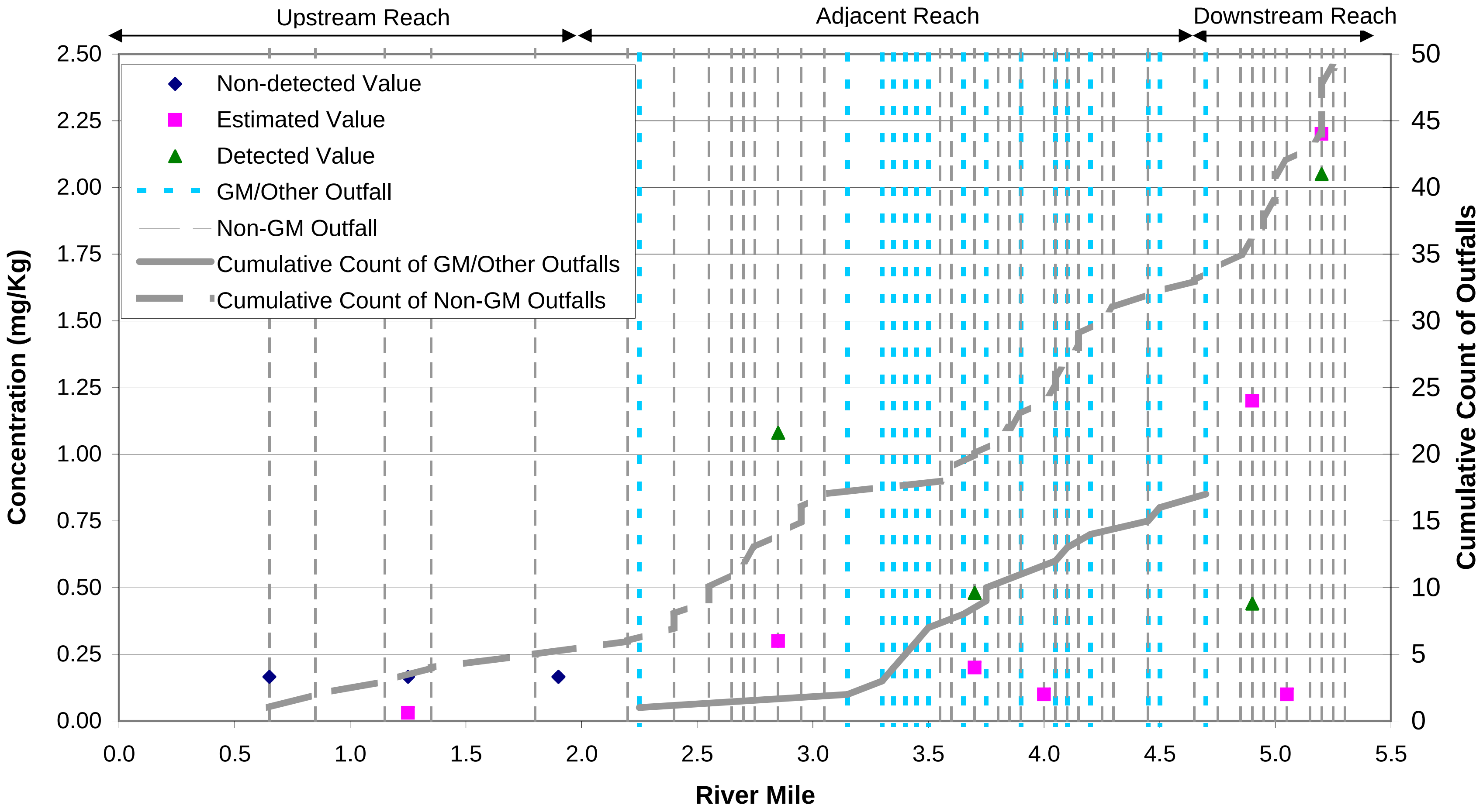
FLINT RIVER SEDIMENT INVESTIGATION

CHRYSENE CONCENTRATIONS FOR SURFACE SAMPLES BY RIVER MILE

ARCADIS BBL
Infrastructure, environment, facilities

FIGURE
13



Notes:

1. Sampling was performed by representatives from ARCADIS of New York, Inc. and Exponent during the week of October 30, 2006.
2. Samples were analyzed by Merit Laboratories of East Lansing, MI.
3. All samples were unbiased surface samples taken at a depth of 0-2 inches.
4. Non-detected values were plotted at one-half the detection limit.
5. Field blind duplicate samples were averaged with their corresponding field samples.
6. mg/Kg = milligrams per kilograms

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FLINT, MICHIGAN

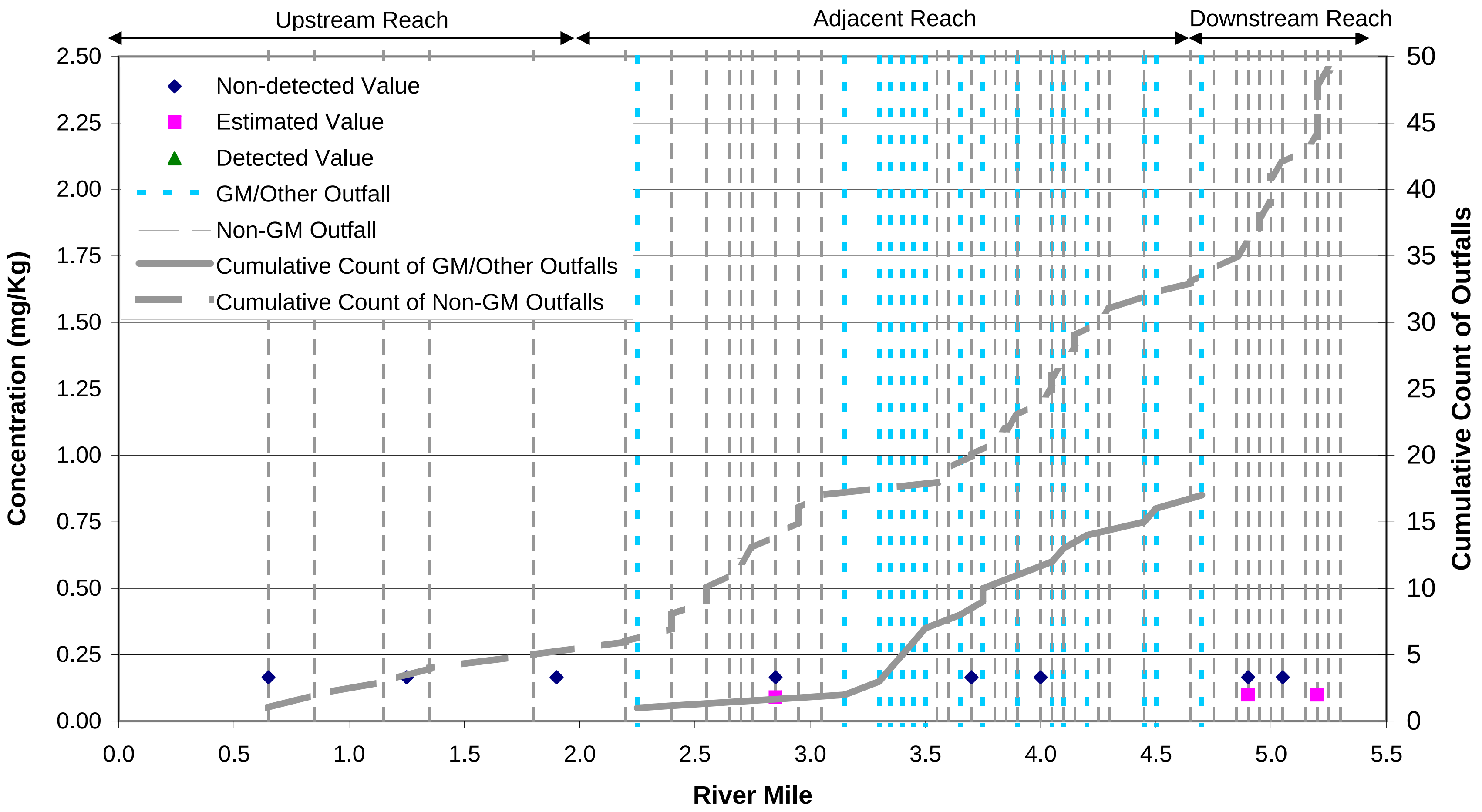
FLINT RIVER SEDIMENT INVESTIGATION

FLUORANTHENE CONCENTRATIONS FOR SURFACE SAMPLES BY RIVER MILE

ARCADIS BBL
Infrastructure, environment, facilities

FIGURE

14



Notes:

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3. All samples were unbiased surface samples taken at a depth of 0-2 inches.
4. Non-detected values were plotted at one-half the detection limit.
5. Field blind duplicate samples were averaged with their corresponding field samples.
6. mg/Kg = milligrams per kilograms

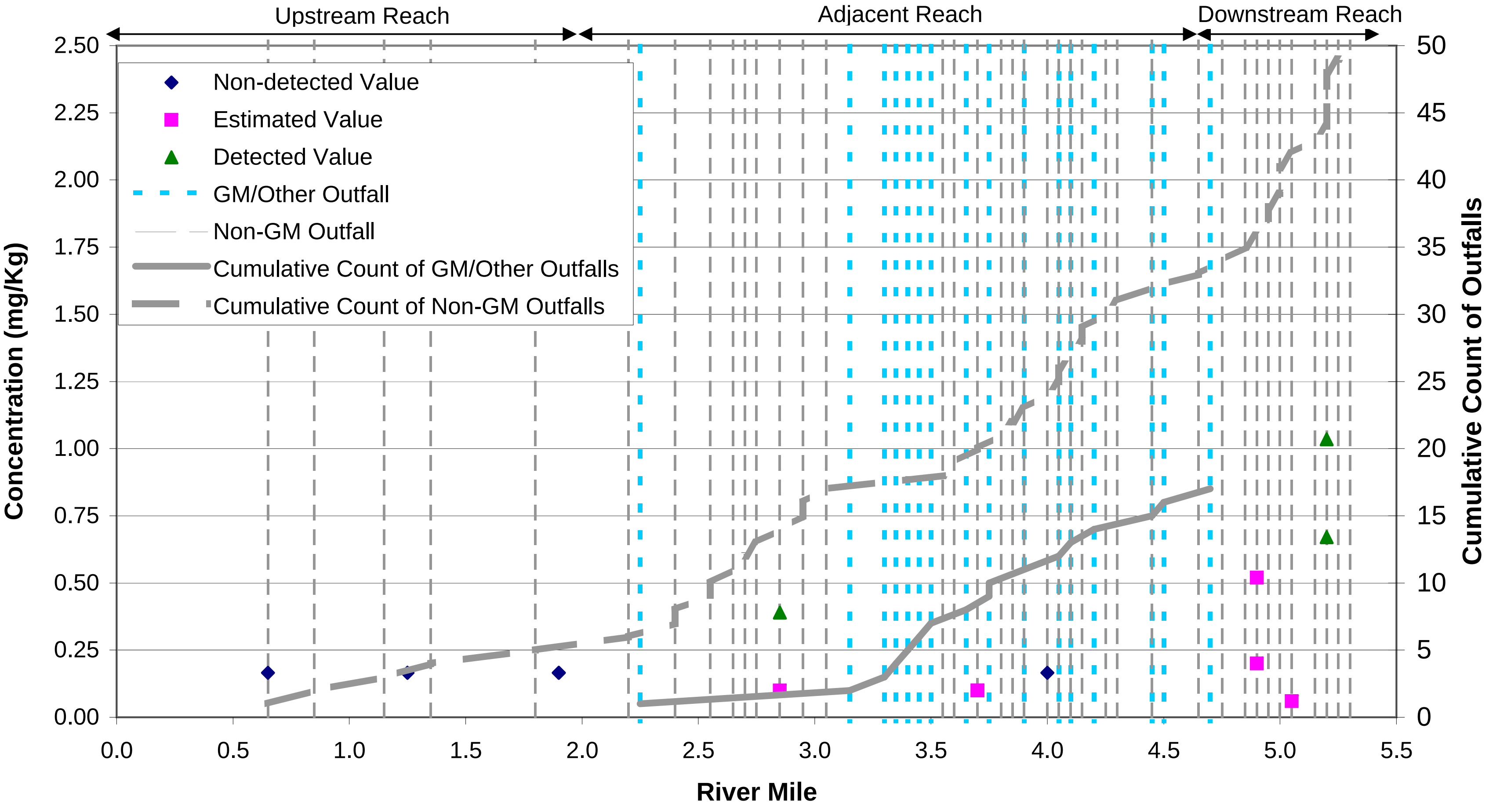
GENERAL MOTORS CORPORATION
FLINT, MICHIGAN

FLINT RIVER SEDIMENT INVESTIGATION

FLUORENE CONCENTRATIONS FOR SURFACE SAMPLES BY RIVER MILE

ARCADIS BBL
Infrastructure, environment, facilities

FIGURE
15



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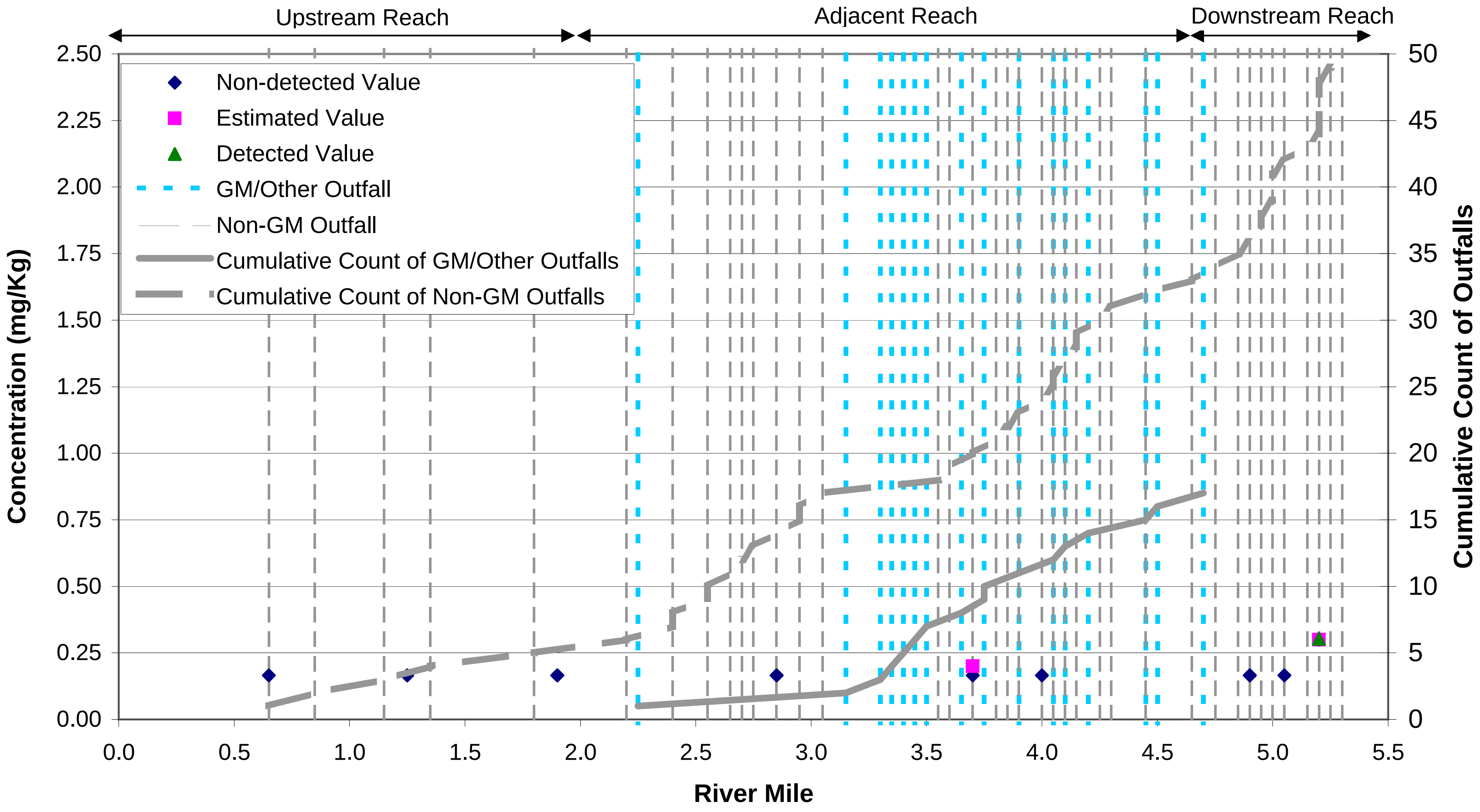
FLINT RIVER SEDIMENT INVESTIGATION

INDENO(1,2,3-cd)PYRENE CONCENTRATIONS FOR SURFACE SAMPLES BY RIVER MILE

ARCADIS BBL
Infrastructure, environment, facilities

FIGURE

16



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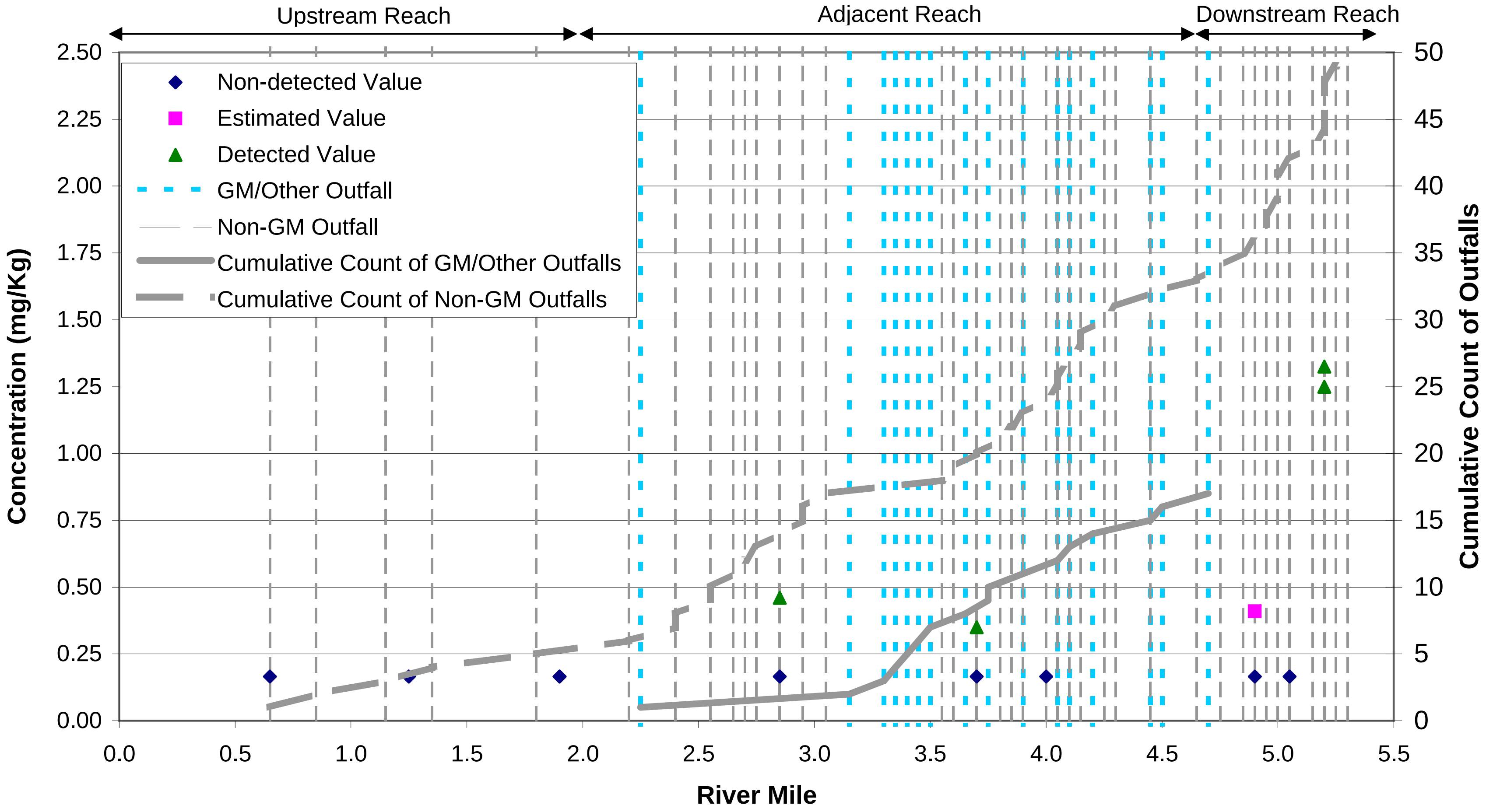
FLINT RIVER SEDIMENT INVESTIGATION

PHENANTHRENE CONCENTRATIONS FOR SURFACE SAMPLES BY RIVER MILE

ARCADIS BBL
Infrastructure, environment, facilities

FIGURE

17



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4. Non-detected values were plotted at one-half the detection limit.
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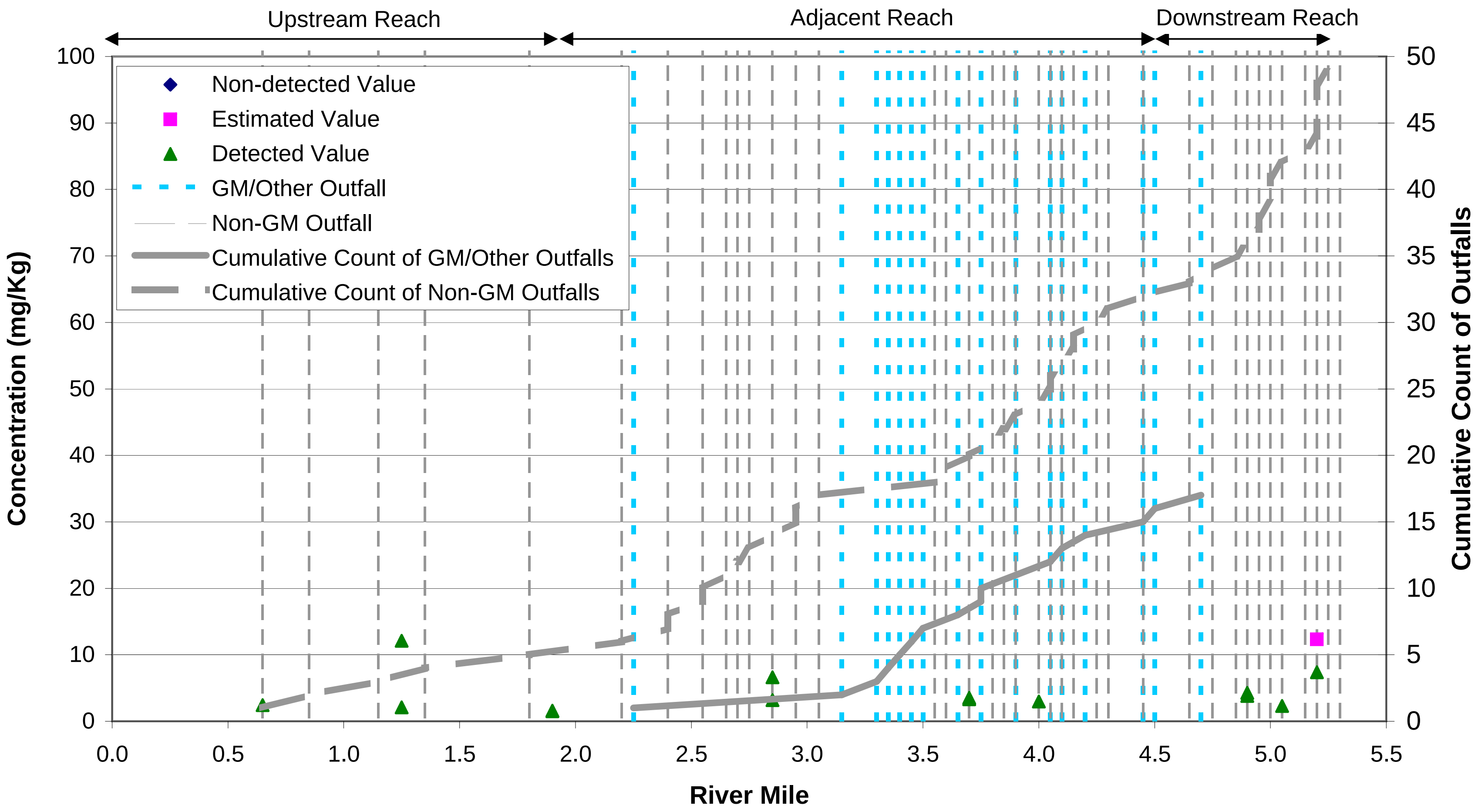
FLINT RIVER SEDIMENT INVESTIGATION

PYRENE CONCENTRATIONS FOR SURFACE SAMPLES BY RIVER MILE

ARCADIS BBL
Infrastructure, environment, facilities

FIGURE
18



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5. Field blind duplicate samples were averaged with their corresponding field samples.
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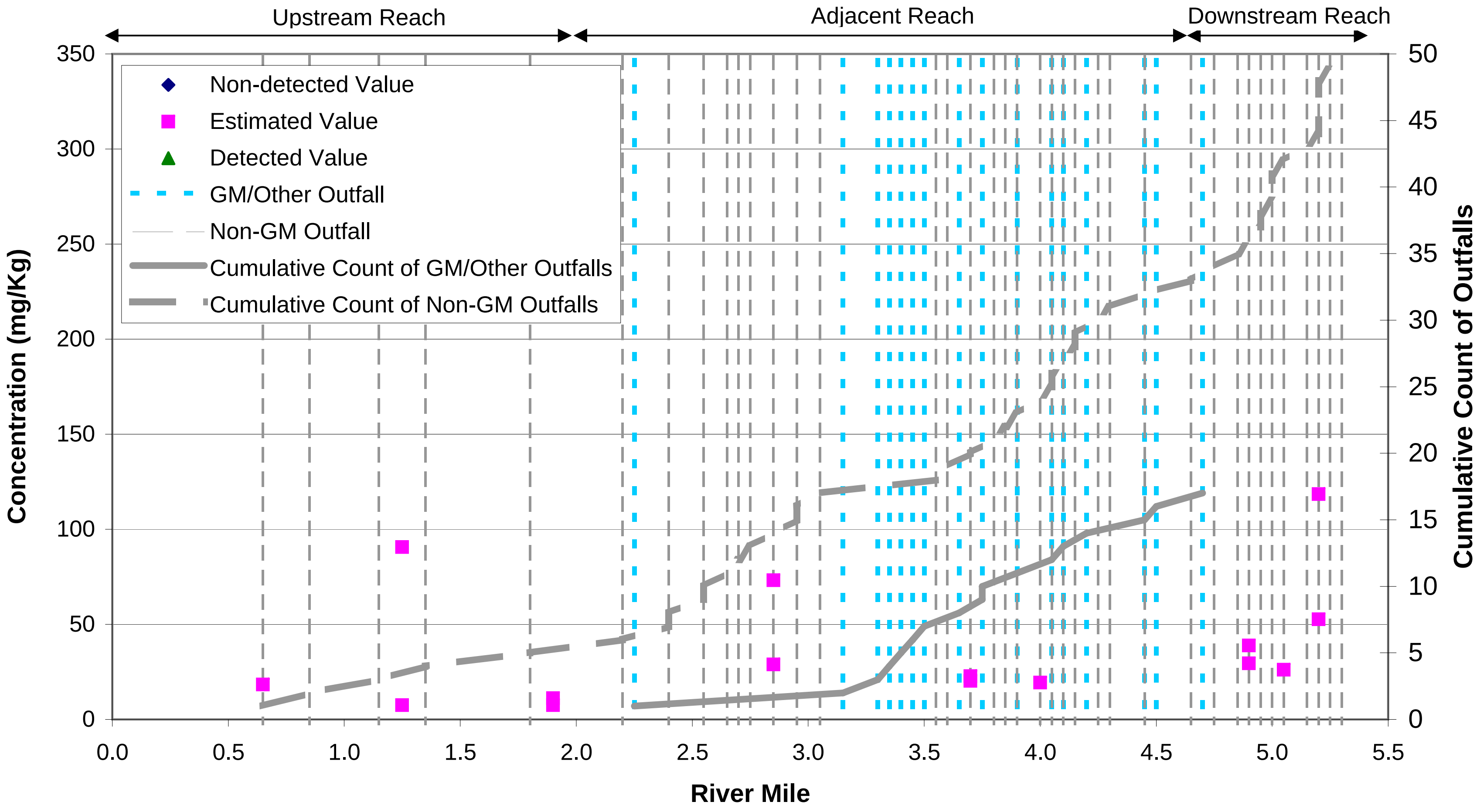
FLINT RIVER SEDIMENT INVESTIGATION

ARSENIC CONCENTRATIONS FOR SURFACE SAMPLES BY RIVER MILE

ARCADIS BBL
Infrastructure, environment, facilities

FIGURE
19



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FLINT, MICHIGAN

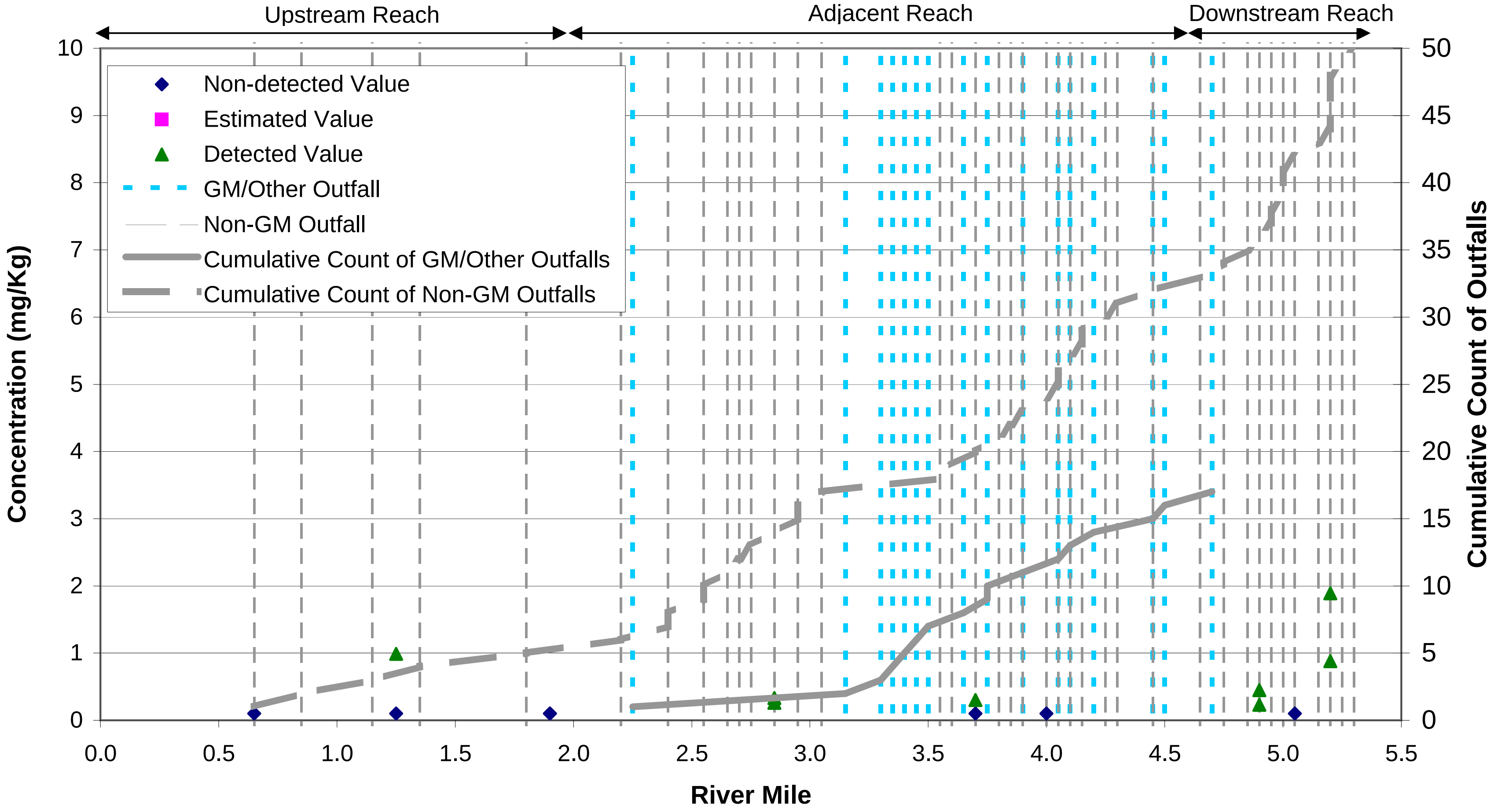
FLINT RIVER SEDIMENT INVESTIGATION

BARIUM CONCENTRATIONS FOR SURFACE SAMPLES BY RIVER MILE

ARCADIS BBL
Infrastructure, environment, facilities

FIGURE

20



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FLINT, MICHIGAN

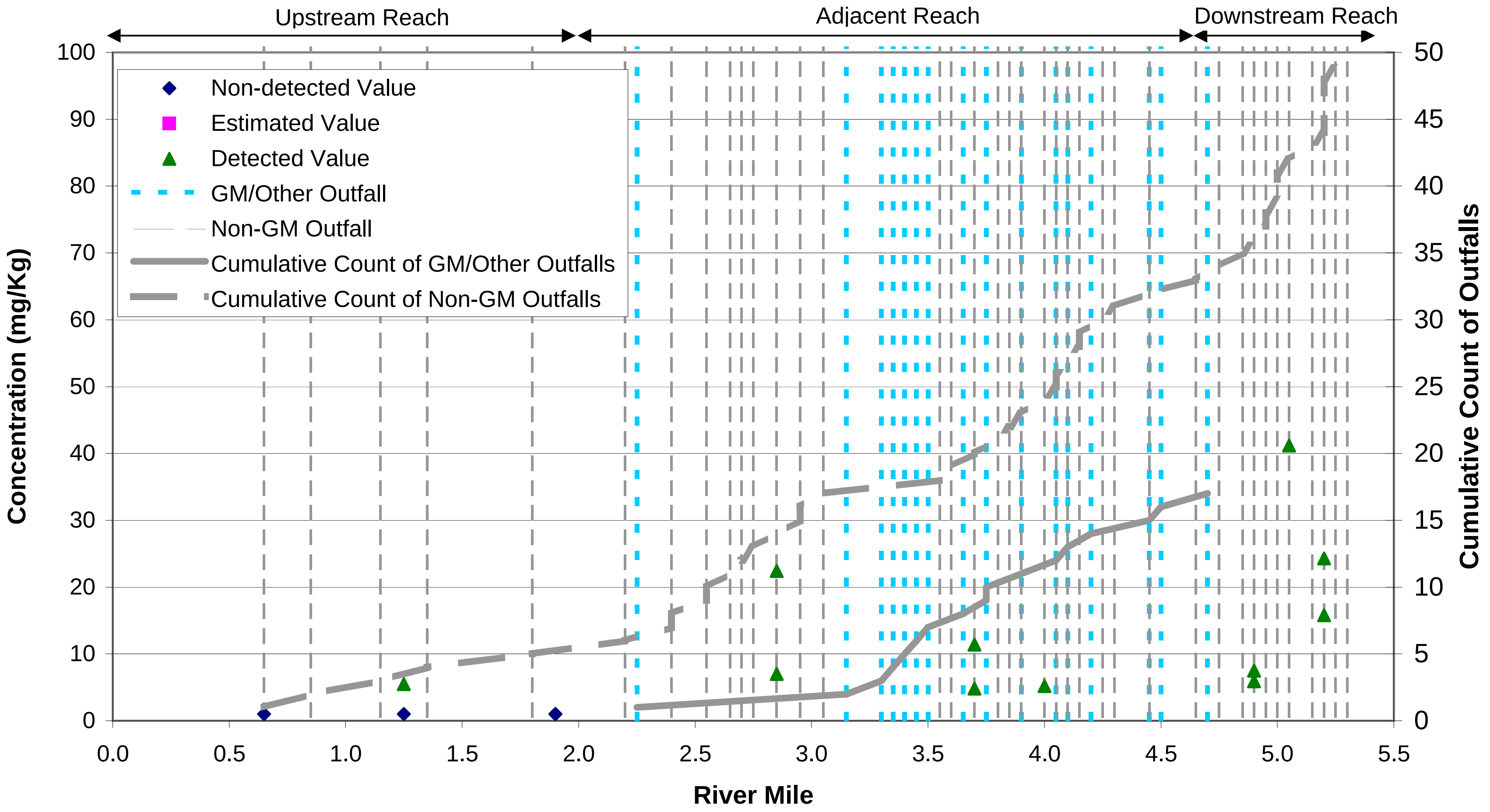
FLINT RIVER SEDIMENT INVESTIGATION

CADMIUM CONCENTRATIONS FOR SURFACE SAMPLES BY RIVER MILE

ARCADIS BBL
Infrastructure, environment, facilities

FIGURE

21



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4. Non-detected values were plotted at one-half the detection limit.
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FLINT, MICHIGAN

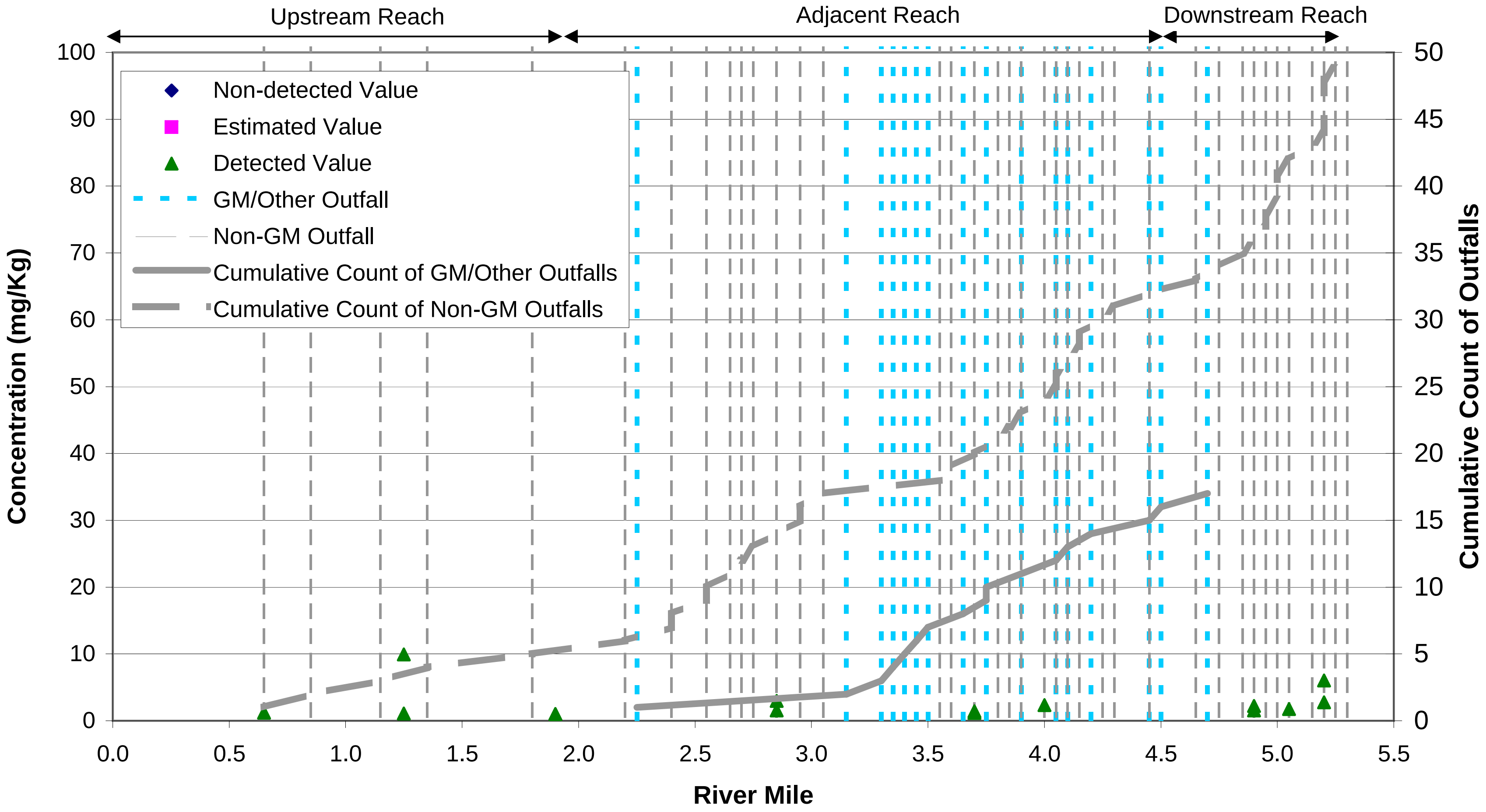
FLINT RIVER SEDIMENT INVESTIGATION

CHROMIUM (TOTAL) CONCENTRATIONS FOR SURFACE SAMPLES BY RIVER MILE

ARCADIS BBL
Infrastructure, environment, facilities

FIGURE

22



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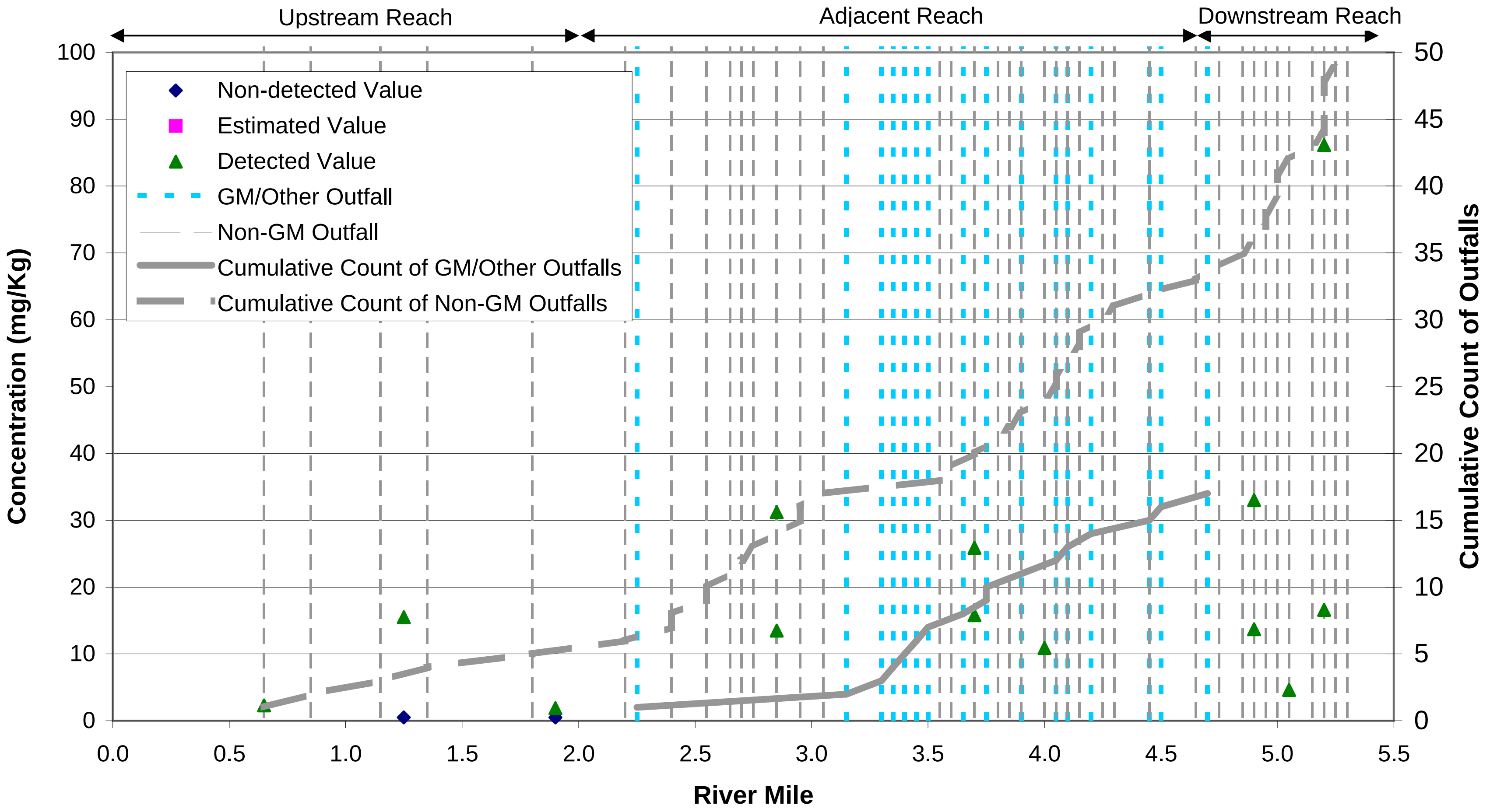
FLINT RIVER SEDIMENT INVESTIGATION

COBALT CONCENTRATIONS FOR SURFACE SAMPLES BY RIVER MILE

ARCADIS BBL
Infrastructure, environment, facilities

FIGURE
23



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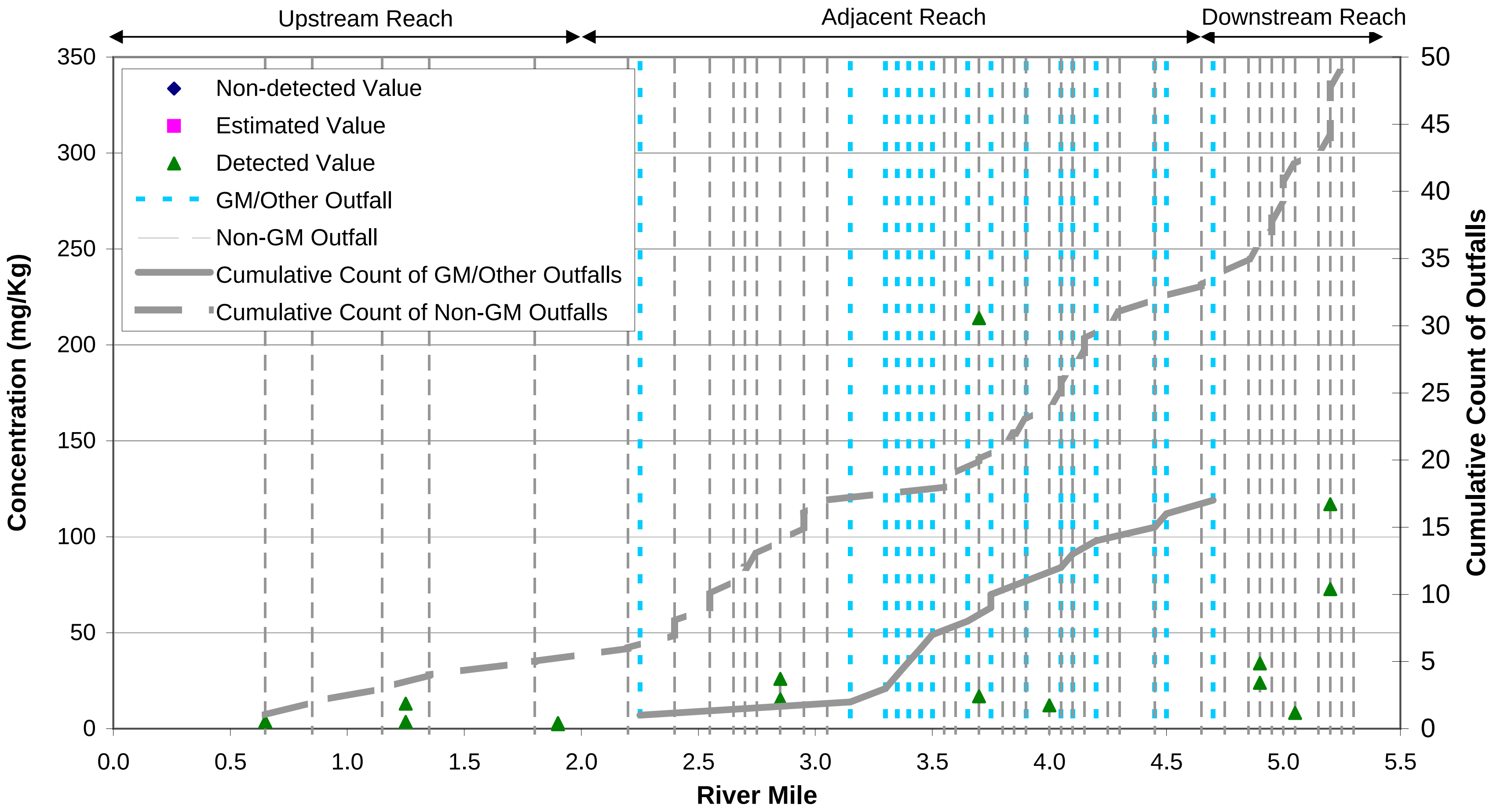
FLINT RIVER SEDIMENT INVESTIGATION

COPPER CONCENTRATIONS FOR SURFACE SAMPLES BY RIVER MILE

ARCADIS BBL
Infrastructure, environment, facilities

FIGURE

24



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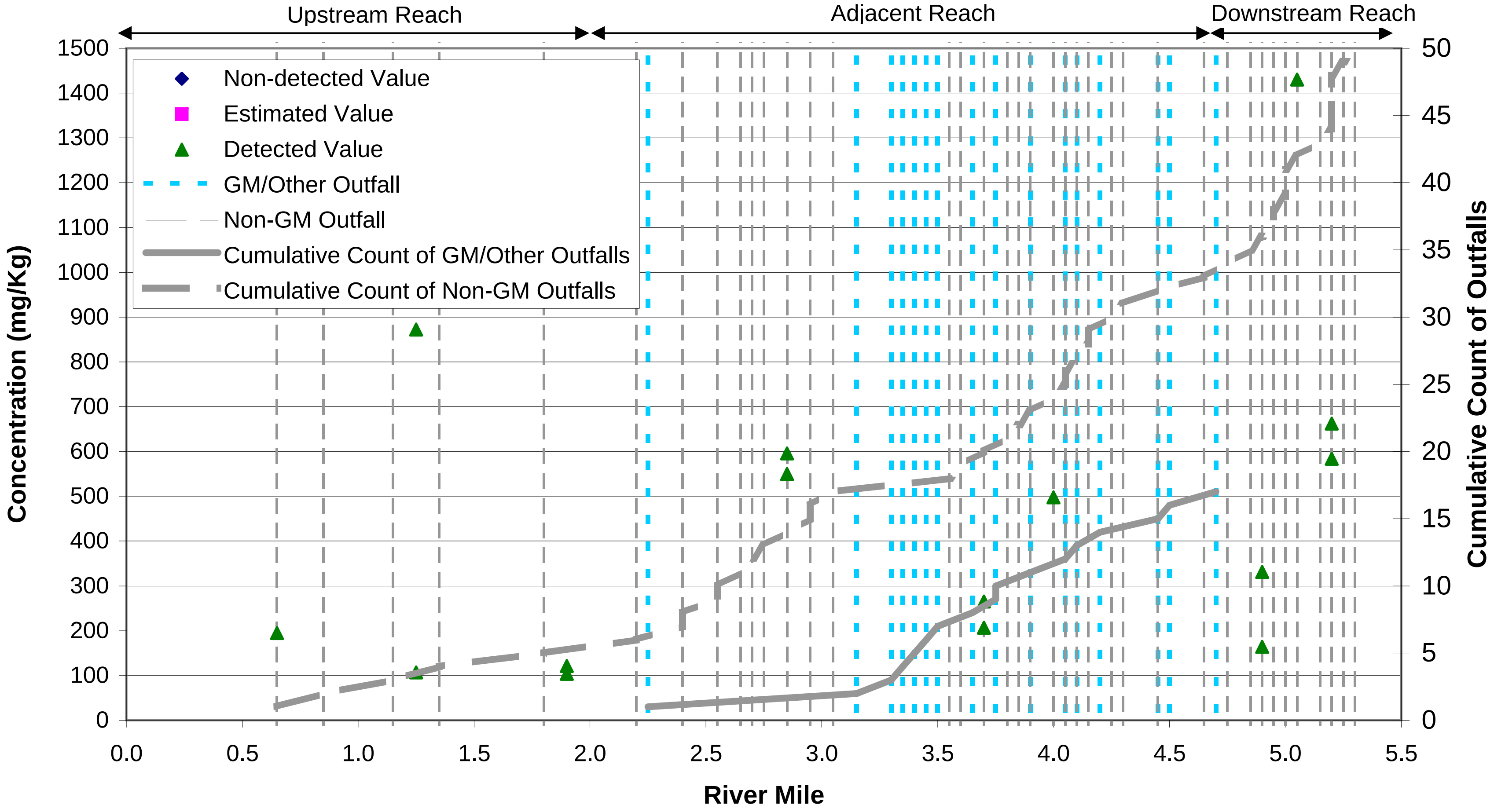
FLINT, MICHIGAN

FLINT RIVER SEDIMENT INVESTIGATION

LEAD CONCENTRATIONS FOR SURFACE SAMPLES BY RIVER MILE

ARCADIS BBL
Infrastructure, environment, facilities

FIGURE
25



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FLINT, MICHIGAN

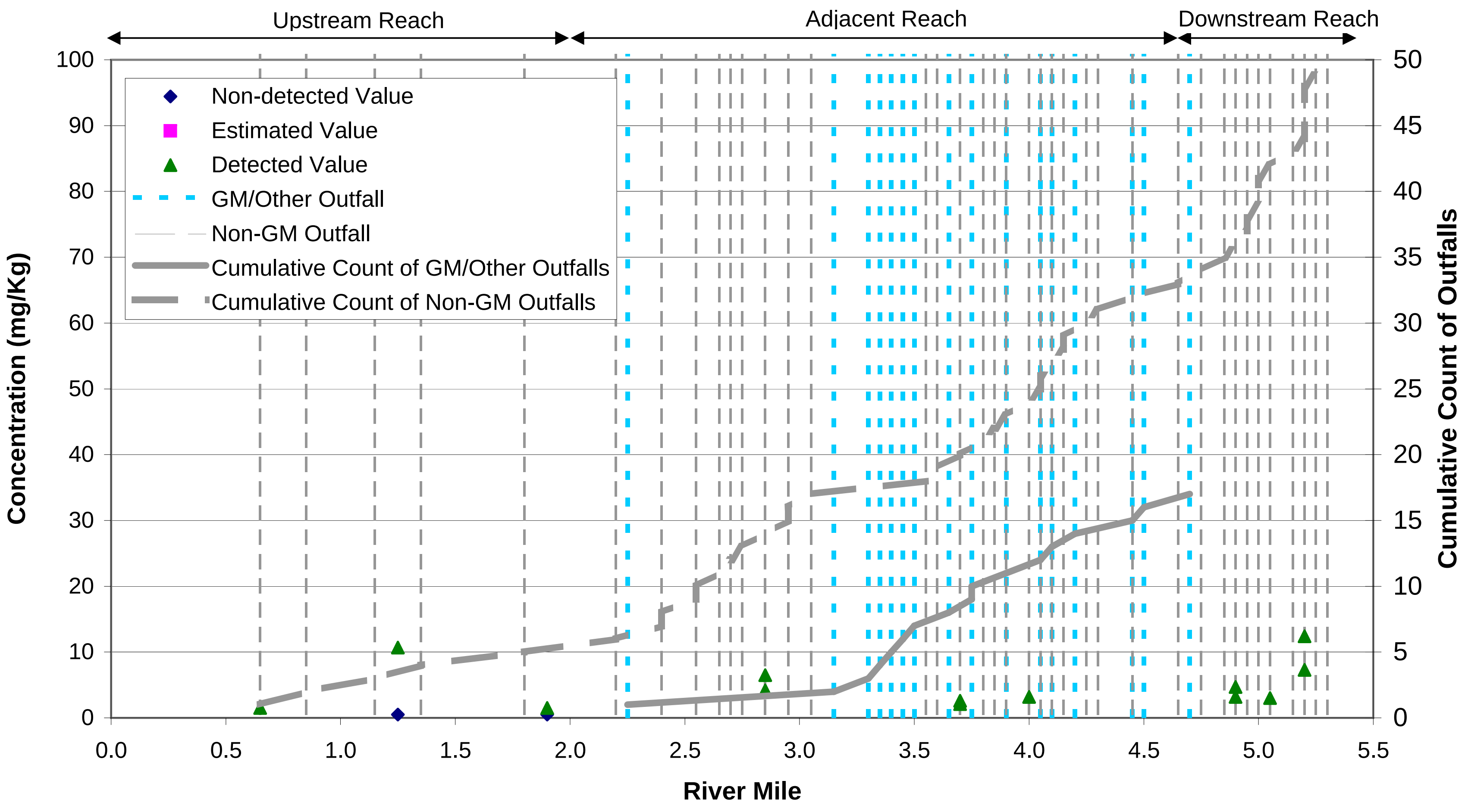
FLINT RIVER SEDIMENT INVESTIGATION

MANGANESE CONCENTRATIONS FOR SURFACE SAMPLES BY RIVER MILE

ARCADIS BBL
Infrastructure, environment, facilities

FIGURE

26



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6. mg/Kg = milligrams per kilograms

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FLINT, MICHIGAN

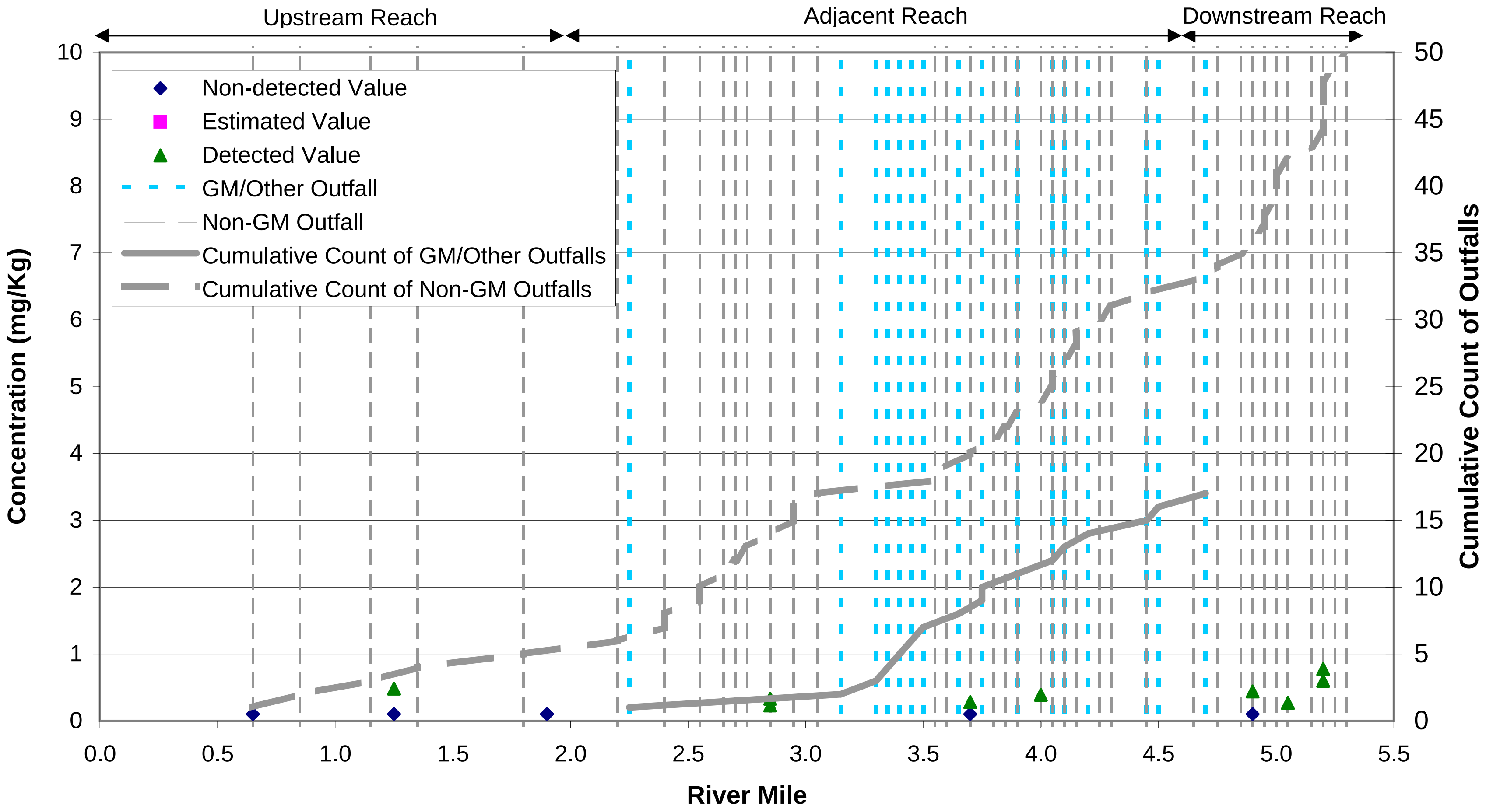
FLINT RIVER SEDIMENT INVESTIGATION

NICKEL CONCENTRATIONS FOR SURFACE SAMPLES BY RIVER MILE

ARCADIS BBL
Infrastructure, environment, facilities

FIGURE

27



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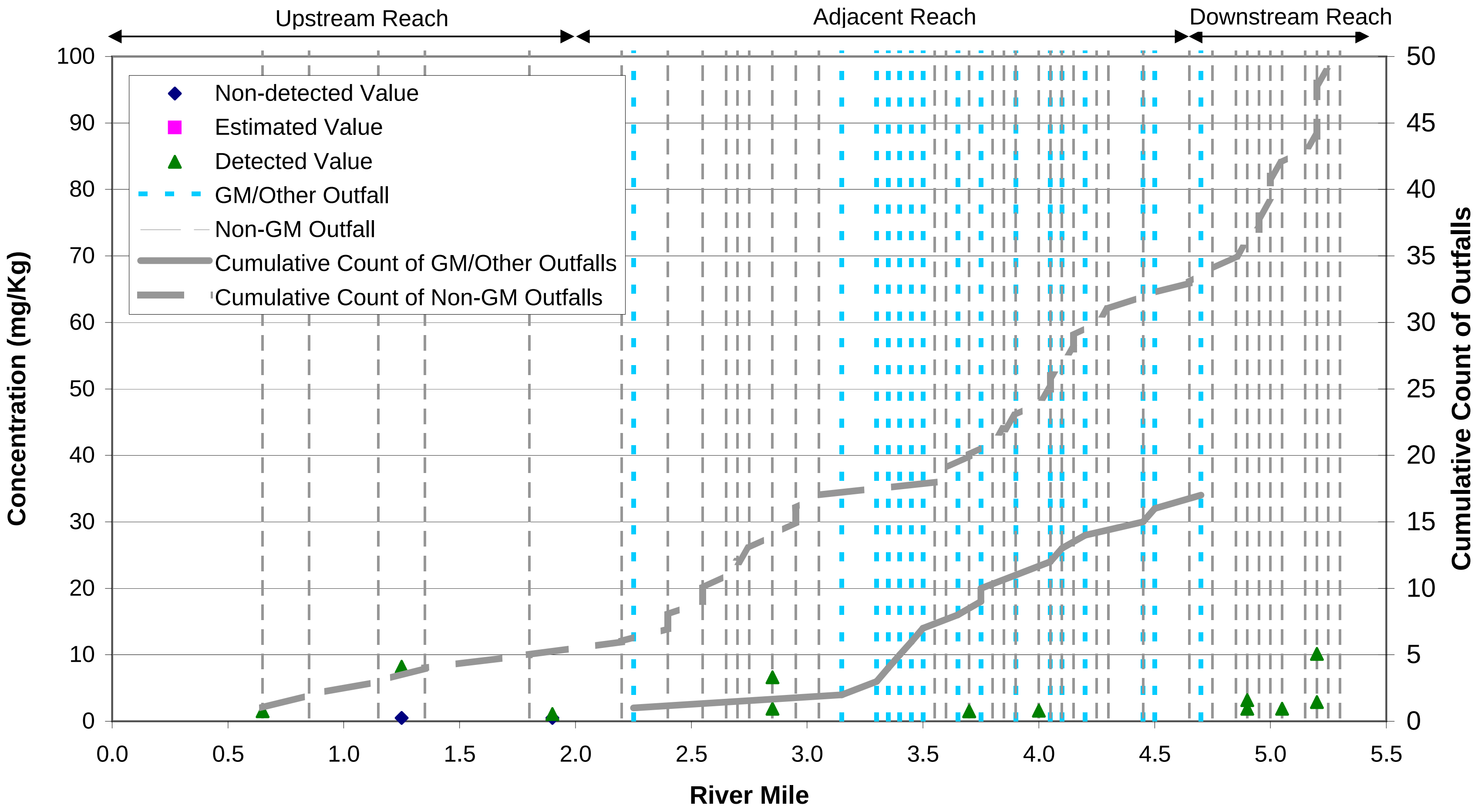
FLINT RIVER SEDIMENT INVESTIGATION

SELENIUM CONCENTRATIONS FOR SURFACE SAMPLES BY RIVER MILE

ARCADIS BBL
Infrastructure, environment, facilities

FIGURE

28



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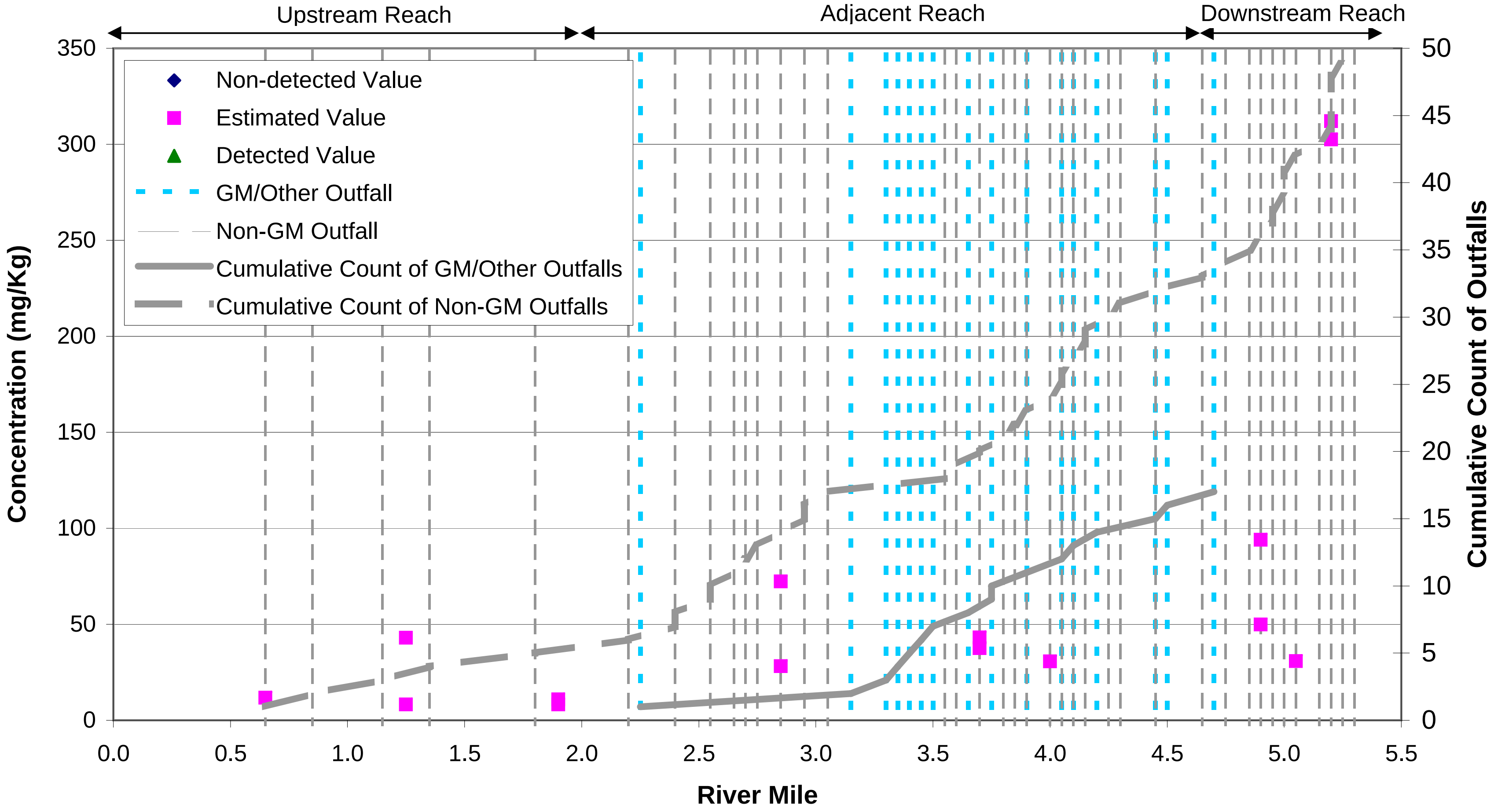
FLINT RIVER SEDIMENT INVESTIGATION

VANADIUM CONCENTRATIONS FOR SURFACE SAMPLES BY RIVER MILE

ARCADIS BBL
Infrastructure, environment, facilities

FIGURE

29



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FLINT RIVER SEDIMENT INVESTIGATION

ZINC CONCENTRATIONS FOR SURFACE SAMPLES BY RIVER MILE

ARCADIS BBL
Infrastructure, environment, facilities

FIGURE

30

Appendix A

Field Notes and Photographs

PERSONNEL:

Brian Loomis - BBL
IAN IPPOLITO - EXPONENT
MATT LUPO - BMJ

10/30/06

0800
Meet w/ Ian Ippolito (ITI) OF EXPONENT.

0940 BMJ on site.
BTL, ITI marked locations along both banks from downstream to UPSTREAM.
BMJ surveyed locations
Started at FRT 12, FRT 7, FRT 8, FRT 9.

1330 BMJ, BTC, & ITI located to upper stretch to survey points. BMJ able to survey points FRT 4 thru FRT 12 from land.

10.30.06

Outfall Observation

Location	Shore	Dia	Construction
1	A	36	concrete
2	B	12	steel
3	B	16	corrugated steel
4	B	16	steel
5	A		water make up City of Flint WWTP
6	A		water make up city of Flint WWTP
7	A		"
8	A	24	Concrete w bars
9	A	24	concrete w/ rip rap
10	B	24	concrete
11	A	36	Concrete
12	A	12	concrete - pipe full of debris
13	A	12	PVC corrugated
14	B	36	Concrete set back in inlet
~~15~~	~~B~~	~~10~~	
15	B	10	Steel
16	B	36	corrugated steel
17	B	24	steel

10-30-06

20	A		Intake
21	A	18	concrete
22	B	24	PVC corrugated
23	B	10	steel
24	A		
25	B		submerged
26	B		submerged
27	B	12	steel
28	B	12	submerged
30	A	48	~~st~~ concrete
29	B		
31	B		PVC corrugated
32	A	24	concrete
33	B	8	steel
34	B	18	concrete
35	B	18	concrete
36	A	12	steel
37	B		submerged
38	A	24	submerged concrete
39	A	24	sub concrete
40	B	12	PVC corrugated
41	B	18	concrete

10.31.06

0700 BBL & EXPONENT @ SITE
PREP BOAT, DISCUSS HOSPITAL
ROUTE. PERSONNEL ON SITE
B. LOOMIS - BBL
R. KUHN - BBL
I. IPPOLITO - EXPONENT

0800 Launch boat for FRT-9

Measurements from left bank
facing upstream

0900 Set up @ FRT-8

Heath & Safety topic: boater safety,
'jackets' required @ all times
on boat

1015 K. Blizzard @ launch area

1030 Set up @ FRT-7. K. Blizzard
requested we hold off as governor
is expected to be @ Farmers Mkt

FRT 9 10.31.06

WIDTH: 188
LOCATIONS: 47, 94, 141

Time: 0800
water 14.0
PID —

0+141 FRT-9C
No sediment grab.
Rock Bottom

Time: 0810
PID: 0.0

0+94 FRT-9B water 10.7
Brown fine sand, tr organics
tr med to course sand, leafs
twigs, tr fine gravel

Probing Info: 3.3
sand

Time: 0830
PID: 0.0

0+47 FRT 9A water: 3.6
Brown fine sand, tr silt, leafs
organics, root mass
Probing Info: 6.6

FRT DUP 1

FRT-8

10.31.06

River Width: 194

Stations:: 48.5, 97, 145.5

1+45.5 FRT 8-C

Time: 0900
water depth: 9.6
PID: 0.0

Brown fine sand, tr med to course sand, tr fine gravel tr organics (leaves)

Probe: 4.4

0+97 FRT 8-B

Time: 0910
water depth: 10.0
PID 0.0

Gray brown fine to course sand, little fine to medium gravel, tr silt, tr organics (twigs, shells, wood), tr slag

Probe = 2.8

0+48.5 FRT 8-A

Time: 0920
water depth: 12.7
PID: 0.0

Gray brown fine to med gravel, tr fine sand, tr silt, tr organic (shells, leaves)

PROBE: 0.3

10.31.06

FRT-7

RIVER WIDTH: 252

STATIONS: 63, 126, 189

TIME: 1210

1+89 FRT-7C water depth: 2.1

PID: 0.0

~~DK Brown~~ Gray brown silty fine sand
tr organic (leaves, twigs)
Probing Info: 8.9
MS/MSD

FRT-7B TIME: 1220 PID: 0.0

1+26 WATER DEPTH: 7.0

No recovery of sediment
all zebra mussels
Probing Info: 3.2

FRT-7A TIME: 1230 PID 0.0

WATER DEPTH: 11.0

0+63

Gray brown fine to med sand, tr
course sand, tr silt, tr organic (shells
leaves)
Probing Info: 0.1

10.31.06

LOWER REACH SAMPLES

Core collected from FRT 7C
Penetrate : 4.6
Recovery : 3.9
Hydrocarbon like odor present w/core

10.31.06

FRT-12

RIVER WIDTH: 186
STATIONS: 46, 92, 138

FRT-12C TIME: 1330 PID: 0.0
1+38 WATER DEPTH: 8.0
Brown very loose silt, little organic (leaves) tr very fine sand
Probing Info: 5.0

FRT-12B TIME: 1337 PID: 0.0
0+92 WATER DEPTH = 10.1
Grey brown fine sand, tr med to course sand, tr organic (wood zebra mussles) tr fine gravel
Probing Info: 2.2

FRT-12A TIME: 1340 PID - 0.0
0+46 WATER DEPTH: 10.0
Med to course gravel, tr organic (zebra mussles)
Probing Info: 0.2

10.31.06

FRT-6

River Width: 167

Stations: 42, 84, 126

FRT 6-C

1+26

Time: 1420 PID: 0.0

Water Depth: 8.0

Gray brown silty very fine sand, tr organic (leaves, zebra mussels) tr sheen

Probing Info: 2.5

FRT 6-B

0+84

Time: ~~1435~~ 1430 PID: 0.0

Water Depth: 9.7

Gray brown fine to med sand, little course sand, tr fine to med gravel, tr silt, tr organic (zebra mussels)

Probing Info: 2.0

FRT 6-A

0+42

Time: 1435

Water: 11.0

No sediment recovered:
All rock/gravel

Probeing info: 0.0

10.31.06

FRT-5

River Width: 159
Stations: 40, 80, 120

1+20 FRT-5C TIME: 1455 ~~1555~~ PID: —
WATER DEPTH: 9.0
No sample recovered, all
rock w/ tr zebra mussels
PROBING INFO: 0.0

0+80 FRT-5B TIME: 1503 ~~1600~~ PID: 0.0
water depth: 9.5
Grey brown fine sand, tr med to course
sand, tr silt, tr organics (leaves,
zebra mussels)
Probing Info: 1.5

0+40 FRT-5A water: 8.4
TIME: 1503 PID: 0.0
Grey brown fine to med sand,
tr couse sand, tr silt, tr organics
(zebra mussels, shells)
Probing Info: 2.6

10.31.06

FRT-10 (Actually FRT 10)

RIVER WIDTH: 185

STATIONS: 46, 92, 138

FRT-10 A

T.

TIME: 1535 PID: 0.0

0+46

WATER DEPTH: 7.9

DK gray brown fine sand, little silt, tr organics (twigs, Zebra mussels), sheen, slight odor

Probing Info: 3.3

0+92 FRT-10B

Time: 1545 PID: 0.0

Water Depth: 9.7

Grey brown fine to med sand, tr course sand, tr silt, tr organic (shells)

Probing Info: 2.1

1+38 FRT-10C

TIME: 1550 PID 0.0

water depth 8.7

Grey brown fine to med sand, little course sand, tr fine gravel, tr organic (twigs, zebra mussels) tr silt

PROBING INFO: 1.3

10.31.06

FRT-7C
Recovered : 3.9   Pen: 5.8
Probe : 8.9
0-0.2 Sampled w/ surficial

0.2-12 - DK GREY BROWN LOOSE
PID 0.0 silt, tr fine sand, tr
organics (rootlets) strong odor
FRT DUP 2, FRT-7C 2-12

12-24 - DK grey Brown loose
PID 0.0 silt, tr fine sand, tr organics
(rootlets) strong odor
FRT 7C 12-24

PID 0.0
24-36 - Dk grey brown sandy silt. Odor
decreasing w/ depth
FRT 7C 24-36

PID 0.0
36-46 - Dk grey brown sand, little
silt, trace odor
FRT 7C 36-46

11.1.06

FRT-10

~~River Width: 117~~
~~Stations: 39, 78, 117~~

VOID

~~0+39 FRT-10 A Time: ~~9.0~~ 0750 PID: 0.0~~
~~Water Depth: 9.0~~

~~Grey brown very loose silt, tr fine~~
~~Sand tr organics (leaves, twigs), sl. sheen~~
~~Probing Info: 3.5~~
~~FRT Dup 3~~

~~0+78 FRT-10 B Time: 0800 PID: 0.0~~
~~water Depth: 10.0~~

~~Grey brown fine med sand, tr silt,~~
~~tr organics (leaves twigs) slight sheen~~
~~PROBING INFO: 2.5~~

~~1+17 FRT-10 C Time: 0815 PID: 0.0~~
~~water depth: 11.0~~

~~Grey brown fine to med sand, little~~
~~course sand tr fine gravel,~~
~~tr organics (zebra mussels, wood)~~
Probing info: 1.0

11-1-06

FRT-11

River Width: 152
Stations: 38, 76, 114

0+38 FRT-11A Time: 0855 PID: 0.0
water depth: 9.2

No sediment
Probing Info: 0.0

0+76 FRT-11B Time: 0900 PID: 0.0
water depth: 11.5

Dk grey brown fine to med sand
tr course sand, tr silt, tr fine
gravel, sheen present, slight odor
probing info: 1.3
FRT-DUP3

1+14 FRT-11C Time: 0905 PID 0.0
water depth: 9.0

Grey brown fine to med sand
tr silt, tr organics (leaves zebra
mussels) slight sheen.
Probing Info: 36

11.1.06

FRT 4

River Width: 155
Stations: 39, 78, 117

1+17 FRT-4C TIME: 0935 PID:
WATER DEPTH: 10.7

Brown very loose silt, tr fine sand, tr organic (zebra mussels, leaves)
Probing Info: 0.2

0+78 FRT-4B TIME: 0940 PID 0.0
water: 10

Dk Gray brown fine to med sand tr course sand, tr fine gravel, tr silt, tr organic (zebra mussels, wood)
Probing Info: 2.0

0+39 FRT-4A TIME: 0945 PID: 0.0
WATER: 8.6

Brown silty fine sand, tr med course sand, tr fine gravel, tr organics (zebra mussels, leaves)
Probing Info: ~~2.6~~ 3.0

FACILITY REACH CORE COLLECTED FROM 4A

Pen 3.0
REC 2.6

11.1.06

FRT-3

River Width: 150
Stations: 37.5, 75, 112.5

1+12.5 FRT 3C TIME: 1030 PID: 0.0
water depth: 10.0

No sediment all zebra mussel
Probing INFO: 0.8

0+75 FRT-3B TIME: 1035 PID: 0.0
water depth: 8.0

Gray brown fine to med sand, tr course sand, tr silt, tr fine gravel, tr zebra mussels
PROBE INFO: 1.2

0+37.5 FRT-3A TIME: 1040 PID: 0.0
water: 6.6

Gray brown fine to med sand, tr silt tr organics (leaves)
PROBING INFO: 3.1

11.1.06

FRT-Z

RIVER WIDTH: 129
STATIONS: 32, 64, 96

0+32 FRT-Z A TIME: 1115 PID: —
WATER DEPTH: 11.0

No sediment, zebra mussels
Probing Info: 1.5'

0+64 FRT-ZB TIME: 1120 PID: 0.0
water depth: 11.2
Grey brown fine to med sand, tr course sand, tr fine gravel, tr silt, tr organic (leaves, zebra mussels)
Probing Info: 1.3'

0+96 FRT-ZC TIME: 1230 PID: 0.0
water depth: 6.5
Brown very loose silt, little leaves, tr fine to course sand
Probing Info: 7.5

11.1.06

FRT-1

River Width: 115
Stations: 29, 58, 87

0+87 FRT-1C TIME: 1200 PID: 0.0
WATER DEPTH: 6.5
Brown fine med sand, little leaves,
tr course sand, tr silt, tr zebra
mussels
PROBING INFO: 2.4

0+58 FRT-1B TIME: 1205 PID: 0.0
water depth 12.8
Brown fine to medium gravel
little brown med sand
Not enough sediment for a sample
PROBING INFO: 0.1

0+29 FRT-1A TIME: 1210 PID:
water depth: 9.2
No sample - all zebra mussels
recovered
Probing Info: 1.3 - all zebra mussels

FRT -12 C

11.1.06
time : 1300

2"-12"
PID: 0.0
DK grey brown very loose silt
tr fine sand, light odor,
tr sheen
FRT-12 C (2-12)

12"-24"
PID: 0.0
DK grey brown fine to med sand
tr silt, tr organic (leaves, twigs)
FRT-12 C (12-24)

PID: 0.0
24"-36" SAA 34-36" SILTY LENS w/
FRT-12 C (24-36) strong odor.

Probe : 5
Pen : 4
Rec : 3

11.1.06

FRT 4A

Probe - 3
Pen - 3
Rec - 2.5

PID: 0.0
2-12 - Dk grey brown fine to course sand, to fine gravel to wood

PID 0.0
12-24 - Grey brown fine to med sand to course sand to wood

PID 0.0
24-30 Grey brown fine sand to med to course sand, to wood

FRT 4A (2-12)
FRT 4A (12-24)
FRT 4A (24-30) 1 jar due to volume

11.1.06

FRT 2C

PROBE: 7.5
PEN: 6.2
REC: 4' 9"

PID 0.0

2-12 DK grey silty fine sand, trace med to coarse sand to wood FRT-2C (2-12)

PID 0.0

12-24 Interbedded dk grey fine sand and silt. 2 inch lenses. FRT-2C (12-24)

PID 0.0

24-36 SAA w/ trace wood FRT-2C (24-36)

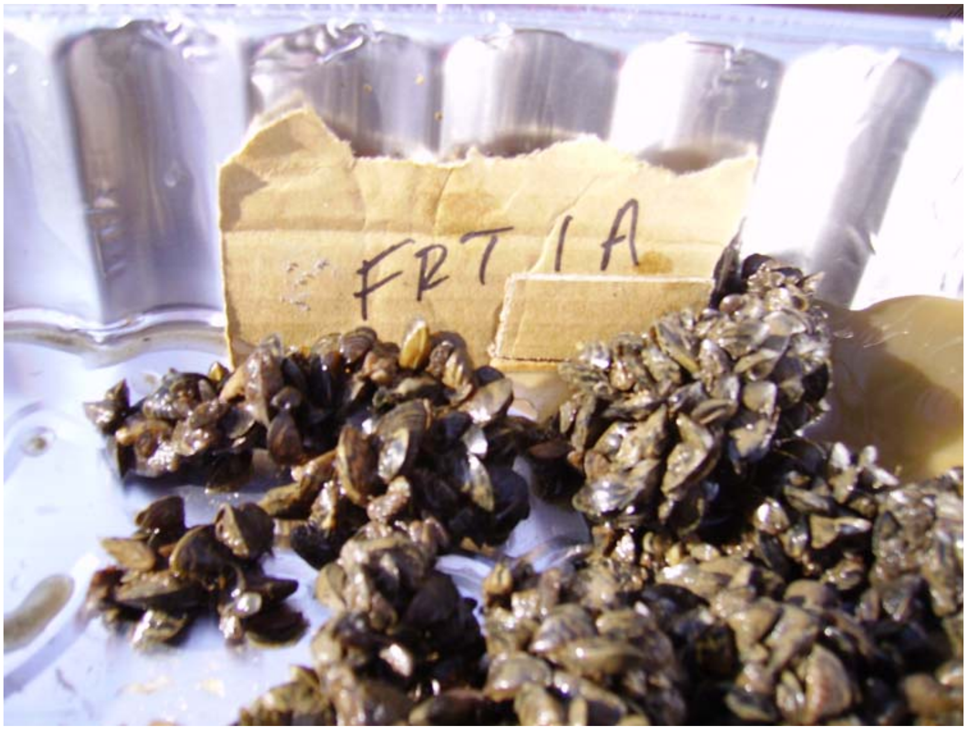
36-48 SAA

PID 0.0

FRT-2C (36-48)

PID 0.0

48-57 Light grey brown fine to med sand.



Sediment Grab Samples Collected from Transect FRT 1 Station A

Sediment Grab Samples Collected from Transect FRT 1 Station A

Sediment Grab Samples Collected at Transect FRT 1 Station C

Sediment Grab Samples Collected at Transect FRT 2 Station A

Sediment Grab Samples Collected at Transect FRT 2 Station B

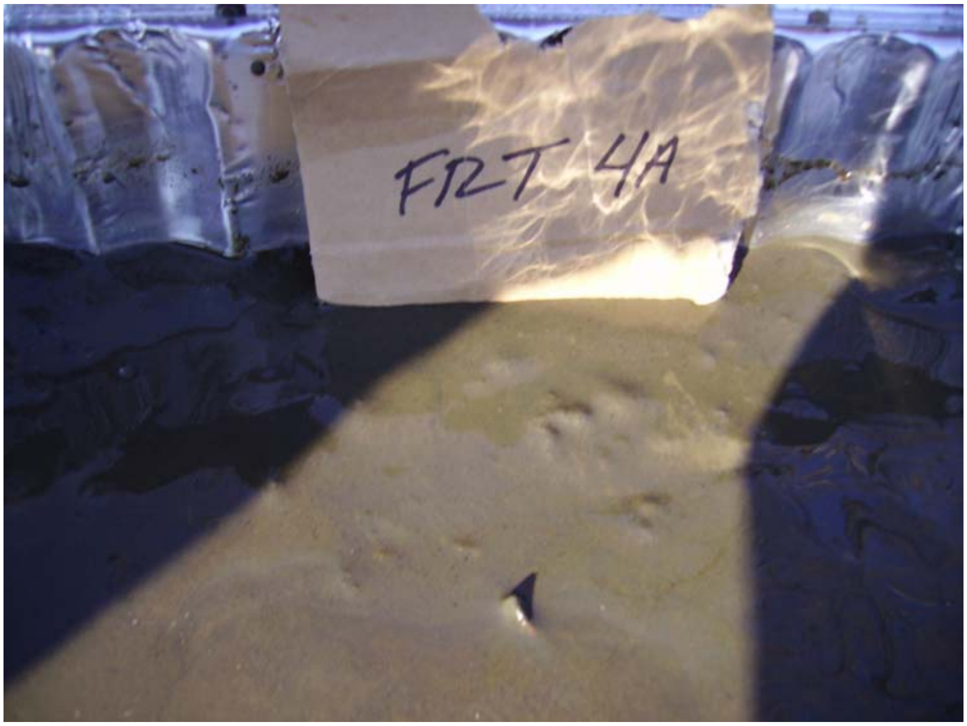
Sediment Grab Samples Collected at Transect FRT 2 Station C

Sediment Core Samples Collected at Flint River from Transect FRT 2 Station C, Transect FRT 4 Station A, and Transect FRT 12 Station C

Sediment Grab Samples Collected at Transect FRT 3 Station A

Sediment Grab Samples Collected at Transect FRT 3 Station B

Sediment Grab Samples Collected at Transect FRT 3 Station C



Sediment Grab Samples Collected at Transect FRT 4 Station A

Sediment Grab Samples Collected at Transect FRT 4 Station B

Sediment Grab Samples Collected at Transect FRT 4 Station C

Sediment Grab Samples Collected at Transect FRT 5 Station A

Sediment Grab Samples Collected at Transect FRT 5 Station B

Sediment Grab Samples Collected at Transect FRT 6 Station B

Sediment Grab Samples Collected at Transect FRT 6 Station C

Sediment Grab Samples Collected at Transect FRT 7 Station A

Sediment Grab Samples Collected at Transect FRT 7 Station B

Sediment Core Samples Collected from Flint River Transect FRT 7 Station C

Sediment Grab Samples Collected at Transect FRT 7 Station C

Sediment Grab Samples Collected at Transect FRT 8 Station A

Sediment Grab Samples Collected at Transect FRT 8 Station B

Sediment Grab Samples Collected at Transect FRT 8 Station C

Sediment Grab Samples Collected at Transect FRT 9 Station A

Sediment Grab Samples Collected at Transect FRT 9 Station B

Sediment Grab Samples Collected at Transect FRT 10 Station A

Sediment Grab Samples Collected at Transect FRT 11 Station B

Sediment Grab Samples Collected at Transect FRT 11 Station C

Sediment Grab Samples Collected at Transect FRT 11 Station B

Sediment Grab Samples Collected at Transect FRT 11 Station C

Sediment Grab Samples Collected at Transect FRT 12 Station B

Sediment Grab Samples Collected at Transect FRT 12 Station C

Appendix B

Laboratory Validation Reports

CONESTOGA-ROVERS
& ASSOCIATES

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MEMORANDUM

TO:	Derek Kaiding [dck@bbl-inc.com]	REF. NO.:	017307-195017
FROM:	Paul McMahon/jbh/1 PM	DATE:	December 20, 2006
C.C.:	Michael Scoville [mds@bbl-inc.com]		**Send Via E-Mail and Regular Mail**

RE: **Data Quality Assessment and Validation**
Flint River Site Investigation
General Motors, Flint, Michigan
October-November 2006

PREVIOUSLY TRANSMITTED BY E-MAIL

The following details a quality assessment and validation of the analytical data resulting from the collection of 35 soil, one equipment blank, and three field duplicate samples from the General Motors Site (Site) in Flint, Michigan, from October 31 to November 1, 2006. The sample summary detailing sample identification, sample location, quality control (QC) samples, and analytical parameters is presented in Table 1. Sample analysis was completed at Merit Laboratories, Inc. in East Lansing, Michigan (Merit), in accordance with the methodologies presented in Table 2. The total organic carbon (TOC) and grain size analyses were subcontracted. The QC criteria used to assess the data were established by the methods and following documents:

i) "USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review", United States Environmental Protection Agency (USEPA) 540/R-99/008, October 1999; and

ii) "USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review", USEPA 540/R-94-013, February 1994.

Due to the nature of the analyses, the grain size data were not evaluated. Full Contract Laboratory Program (CLP)-equivalent raw data deliverables were provided by the laboratory for all other analyses. The data quality assessment and validation presented in the following subsections were performed based on the sample results and supporting quality assurance/quality control (QA/QC) provided.

Holding Time Period and Sample Analysis

The holding time periods are presented in the analytical methods. All samples were prepared and analyzed within the method-required holding times. All samples were cooled after collection and upon receipt at the laboratory.

Gas Chromatography/Mass Spectrometer (GC/MS) Mass Calibration

Prior to analysis, GC/MS instrumentation is tuned to ensure optimization over the mass range of interest. To evaluate instrument tuning, the semi-volatile organic compound (SVOC) method requires the analysis of the specific tuning compound decafluorotriphenylphosphine (DFTPP). The resulting spectra must meet the criteria cited in the method before analysis is initiated. Analysis of the tuning compound must then be repeated every 12 hours throughout sample analysis to ensure the continued optimization of the instrument.

Instrument tuning data were reviewed. Tuning compounds were analyzed at the required frequency throughout the SVOC analysis periods. All tuning criteria were met for the analyses, indicating proper optimization of the instrumentation.

Initial Calibration - Organic Analyses, GC/MS

To quantify compounds of interest in samples, calibration of the GC/MS over a specific concentration range must be performed. Initially, a minimum of a five-point calibration curve containing all compounds of interest is analyzed to characterize instrument response for each analyte over a specific concentration range.

Calibration data were reviewed for all samples. Linearity of the calibration curve and instrument sensitivity were evaluated against the following criteria:

i) all relative response factors (RRFs) must be greater than or equal to 0.05; and
ii) percent relative standard deviation (%RSD) values must not exceed 30 percent or if quadratic/linear regression is used, the correlation coefficient (R^2) value must be at least 0.990.

Initial calibration standards were analyzed as required and all data showed acceptable sensitivity and linearity.

Initial Calibration - Organics, GC

To quantify compounds of interest, calibration of the GC over a specific concentration range must be performed. Initially, a minimum of a five-point calibration curve is analyzed for Aroclors 1254, 1016, and 1260, while the other Aroclors are calibrated using one point.

Linearity of the calibration curves are acceptable if %RSD values are less than or equal to 20 percent or if the correlation coefficient is greater than 0.995. Retention time windows are also calculated from the initial calibration analyses. These windows are then used to identify all compounds of interest in subsequent analyses.

Initial calibration standards were analyzed at the required frequencies. All retention time and linearity criteria were satisfied.

Initial Calibration - Inorganic Analyses

To calibrate the inductively coupled plasma/mass spectrometer (ICP/MS), a calibration blank and at least one standard must be analyzed at each wavelength to establish the analytical curve. For mercury, cyanide, and TOC analyses, a calibration blank and a minimum of five standards must be analyzed to establish the analytical curve. Resulting correlation coefficients for mercury, cyanide, and TOC curves must be at least 0.995.

After calibration, an initial calibration verification (ICV) standard must be analyzed to verify the analytical accuracy of the calibration curves within a method-specific percent recovery of the accepted or true value.

A review of the data showed that all calibration curves and ICVs were analyzed at the proper frequencies and were within the acceptance criteria.

Continuing Calibration - Organics, GC/MS

To ensure that instrument calibration is acceptable throughout the sample analysis period, continuing calibration standards must be analyzed and compared to the initial calibration curve every 12 hours.

The following criteria were employed to evaluate continuing calibration data:

i) all RRF values must be greater than or equal to 0.05; and
ii) percent difference (%D) values must not exceed 25 percent.

Calibration standards were analyzed at the required frequency and all results met the above criteria for instrument sensitivity. Some SVOCs exhibited variability in instrument response. Associated sample data for these compounds were qualified as estimated (see Table 3).

Continuing Calibration - Organics, GC

To ensure that the calibration of the instrument is valid throughout the sample analysis period, continuing calibration standards are analyzed and evaluated on a regular basis. To evaluate the continued linearity of the calibration, %D values are calculated for each compound in all continuing standards and assessed against an acceptance criterion of 15 percent.

To ensure that compound retention times do not vary over the analysis period, all retention times must fall within the established retention time windows.

Continuing calibration standards were analyzed at the required frequency and all method criteria were met for analyte linearity.

Continuing Calibration – Inorganics

Continuing calibration criteria for inorganic analyses were the same criteria as used for assessing the initial calibration data. The continuing calibration verification data were within the acceptance criteria.

Laboratory Blank Samples

Laboratory blanks are prepared and analyzed with investigative samples to determine the existence and magnitude of sample contamination introduced during the procedures.

For this study, method blanks were analyzed at a minimum frequency of one per analytical batch. The laboratory blank results were non-detect for most analytes of interest. TOC and some SVOCs were present in the laboratory blanks, and associated detected sample results with similar concentrations were qualified as non-detect (see Table 4).

Surrogate Compound Percent Recoveries (Surrogate Recoveries)

In accordance with the methods employed, all samples, blanks, and standards analyzed for SVOCs and polychlorinated biphenyls (PCBs) were spiked with surrogate compounds prior to sample extraction and analysis. Surrogate recoveries provide a means to evaluate the effects of individual sample matrices on analytical efficiency and are assessed against laboratory control limits. For the SVOC method, it is acceptable for one surrogate recovery per fraction (base neutral or acid phenolic) to fall outside of these limits, provided it is greater than 10 percent. All surrogate recoveries were within the laboratory specified control limits, demonstrating acceptable analytical accuracy.

Laboratory Control Sample (LCS) Analysis

The LCS serves as a measure of overall analytical performance. LCSs are prepared with all analytes of interest and analyzed with each sample batch.

LCSs were prepared and analyzed for all parameters. The LCS recoveries were within the laboratory specified control limits for all analytes of interest except one high and one low SVOC recovery. All SVOC results associated with the high recovery were non-detect and were not impacted by the indicated high bias. SVOC sample results associated with the low recovery were qualified as estimated (see Table 5).

Matrix Spike/Matrix Spike Duplicate (MS/MSD) Analyses

MS/MSD samples are prepared for each parameter and analyzed with each sample batch for the organic parameters. MS/MSD samples are prepared and analyzed with the samples for each inorganic analyte. The recoveries of spike analyses are used to assess the analytical accuracy achieved on individual sample matrices. If the original sample concentration is significantly greater than the spike concentration, the recovery is not assessed. The relative percent difference (RPD) between the MS and MSD is used to assess analytical precision.

MS/MSD analyses were performed as shown in Table 1. The laboratory performed additional analyses internally. Most MS/MSD recoveries were within laboratory control limits demonstrating acceptable overall analytical accuracy and precision. Outlying recoveries and RPDs were reported for PCBs and SVOCs. Non-detect results associated with outlying RPDs or high MS/MSD recoveries were not impacted, and no qualification was performed. Results impacted by outlying recoveries or RPDs were qualified as estimated (see Table 6).

Inductively Coupled Plasma (ICP) Interference Check Sample (ICS) Analysis

To verify that proper inter-element and background correction factors have been established by the laboratory, ICSs are analyzed. These samples contain high concentrations of aluminum, calcium, magnesium, and iron and are analyzed at the beginning and end of each sample analysis period.

ICS analysis results were evaluated for all samples. All ICS recoveries were within the established control limits of 80 to 120 percent.

Serial Dilution - Inorganic Analyses

The serial dilution determines whether significant physical or chemical interferences exist due to sample matrix. A minimum of one per 20 investigative samples is analyzed at a five-fold dilution. For samples with sufficient analyte concentrations, the serial dilution results must agree within 10 percent of the original results.

Serial dilution analyses were performed and most results were acceptable. Sample results associated with outlying analyses were qualified as estimated (see Table 7).

Internal Standard (IS) Summaries

To correct for changes in GC/MS response and sensitivity, IS compounds are added to investigative samples and QC samples prior to SVOC analyses. All results are calculated as a ratio of the IS response. The criteria by which the IS results are assessed are as follows:

i) IS area counts must not vary by more than a factor of two (-50 percent to +100 percent) from the associated calibration standard; and

ii) the retention time of the IS must not vary more than ±30 seconds from the associated calibration standard.

All sample IS results met the above criteria and all were correctly used to calculate sample results.

Target Compound Identification

To minimize erroneous compound identification during organic analyses, qualitative criteria including compound retention time and mass spectra (if applicable) were evaluated according to identification criteria established by the methods. The samples identified in Table 1 were reviewed. The organics reported adhered to the specified identification criteria.

Field Duplicates

Three samples were collected in duplicate as summarized in Table 1 and submitted to the laboratory for analysis. Most sample results showed acceptable sampling and analytical precision. Some data did exhibit variability, and the results were qualified as estimated (see Table 8).

Equipment Blank

To assess contamination from field equipment cleaning activities, equipment blank was collected in as identified in Table 1. Most sample results were non-detect for the analytes of interest. SVOCs and some inorganics were detected in the blank. Most associated sample results were either non-detect or were significantly greater in concentration, and were not impacted. Associated sample results with comparable concentrations were qualified as non-detect (see Table 9).

System Performance

System performance between various QC checks was evaluated to monitor for changes that may have caused the degradation of data quality. The samples identified in Table 1 were reviewed. No technical problems or chromatographic anomalies were observed which require qualification of the data.

Overall Assessment

The data were found to exhibit acceptable levels of accuracy and precision, based on the provided information, and may be used as reported with the noted qualifications.

TABLE 1

SAMPLE COLLECTION AND ANALYSIS SUMMARY
SITE INVESTIGATION
GENERAL MOTORS
FLINT, MICHIGAN
OCTOBER - NOVEMBER 2006

				Analysis/Parameters				
Sample ID	*Location ID*	*Collection Date (mm/dd/yy)*	*Collection Time (hr:min)*	*TOC/Particle size*	*Total Metals/Cyanide*	*SVOCs*	*PCBs*	*Comments*
FRT 1C	FRT 1C	11/01/06	12:00	X	X	X	X	
FRT 2B	FRT 2B	11/01/06	11:20	X	X	X	X	
FRT 2C	FRT 2C	11/01/06	11:30	X	X	X	X	
FRT 3A	FRT 3A	11/01/06	10:40	X	X	X	X	
FRT 3B	FRT 3B	11/01/06	10:35	X	X	X	X	
FRT 4A	FRT 4A	11/01/06	9:45	X	X	X	X	
FRT 4C	FRT 4C	11/01/06	9:35	X	X	X	X	
FRT 5A	FRT 5A	10/31/06	15:03	X	X	X	X	
FRT 5B	FRT 5B	10/31/06	15:03	X	X	X	X	
FRT 6B	FRT 6B	10/31/06	14:30	X	X	X	X	
FRT 7A	FRT 7A	10/31/06	12:30	X	X	X	X	
FRT 7C	FRT 7C	10/31/06	12:10	X	X	X	X	MS/MSD / Duplicate
FRT 8B	FRT 8B	10/31/06	9:10	X	X	X	X	
FRT 9A	FRT 9A	10/31/06	8:30	X	X	X	X	
FRT DUP1	FRT 9A	10/31/06	-	X	X	X	X	Duplicate of FRT 9A
FRT 9B	FRT 9B	10/31/06	8:10	X	X	X	X	
FRT 10B	FRT 10B	10/31/06	15:45	X	X	X	X	
FRT 11B	FRT 11B	11/01/06	9:00	X	X	X	X	
FRT DUP3	FRT 11B	11/01/06	-	X	X	X	X	Duplicate of FRT 11B
FRT 11C	FRT 11C	11/01/06	9:05	X	X	X	X	
FRT 12B	FRT 12B	10/31/06	13:37	X	X	X	X	
FRT 12C	FRT 12C	10/31/06	13:30	X	X	X	X	
FRT RB1	-	11/01/06	17:00		X	X	X	Equipment Blank
FRT 10A	FRT 10A	11/01/06	15:35	X	X	X	X	
FRT 7C (2-12)	FRT 7C	10/31/06	12:40	X	X	X	X	
FRT DUP2	FRT 7C	11/01/06	-	X	X	X	X	Duplicate of FRT 7C (2-12)
FRT 7C (12-24)	FRT 7C	10/31/06	12:40	X	X	X	X	MS/MSD / Duplicate
FRT 7C (24-36)	FRT 7C	10/31/06	12:40	X	X	X	X	
FRT 7C (36-46)	FRT 7C	10/31/06	12:40	X	X	X	X	
FRT 4A (2-12)	FRT 4A	11/01/06	12:45	X	X	X	X	
FRT 4A (12-24)	FRT 4A	11/01/06	12:45	X	X	X	X	
FRT 12C (2-12)	FRT 12C	11/01/06	13:00	X	X	X	X	
FRT 12C (12-24)	FRT 12C	11/01/06	13:00	X	X	X	X	
FRT 12C (24-36)	FRT 12C	11/01/06	13:00	X	X	X	X	
FRT 2C (2-12)	FRT 2C	11/01/06	12:30	X	X	X	X	
FRT 2C (12-24)	FRT 2C	11/01/06	12:30	X	X	X	X	
FRT 2C (24-36)	FRT 2C	11/01/06	12:30	X	X	X	X	
FRT 2C (36-48)	FRT 2C	11/01/06	12:30	X	X	X	X	
FRT 2C (48-57)	FRT 2C	11/01/06	12:30	X	X	X	X	

Notes:

MS	Matrix Spike.
MSD	Matrix Spike Duplicate.
PCBs	Polychlorinated biphenyls.
SVOCs	Semi-Volatile Organic Compounds.
TOC	Total Organic Carbon.

TABLE 2

SUMMARY OF ANALYTICAL METHODOLOGIES
SITE INVESTIGATION
GENERAL MOTORS
FLINT, MICHIGAN
OCTOBER - NOVEMBER 2006

Parameter	*Method*
TCL SVOCs	SW-846 8270 [1]
TCL PCBs	SW-846 8082 [1]
Metals	SW-846 6020 [1]/7471 [1]
Cyanide	SW-846 9010 [1]
TOC	415.1 [2]
Particle Size	ASTM F312

Notes:

1	"Test Methods for Solid Waste Physical/Chemical Methods", SW-846, 3rd Edition, September 1986 (with subsequent revisions).
2	Referenced from "Methods for Chemical Analysis of Water and Wastes", USEPA 600/4-79-020, March 1983, with all subsequent revisions.
ASTM	American Society for Testing and Materials.
PCBs	Polychlorinated Biphenyls.
TCL	Target Compound List.
TOC	Total Organic Carbon.

TABLE 3

QUALIFIED SAMPLE RESULTS DUE TO OUTLYING CONTINUING CALIBRATION RESULTS
SITE INVESTIGATION
GENERAL MOTORS CORPORATION
FLINT, MICHIGAN
OCTOBER - NOVEMBER 2006

Parameter	*Calibration Date*	*Compound*	*%D*	*Associated Sample ID*	*Sample Results*	*Units*	*Qualifier*
SVOCs	11/11/06	Benzaldehyde	38	FRT 2C (36-48)	330 U	µg/Kg	UJ
				FRT 2C (48-57)	330 U	µg/Kg	UJ
		2,4-Dinitrophenol	27	FRT 2C (36-48)	670 U	µg/Kg	UJ
				FRT 2C (48-57)	670 U	µg/Kg	UJ
		Benzo(b)fluoranthene	58	FRT 2C (36-48)	330 U	µg/Kg	UJ
				FRT 2C (48-57)	330 U	µg/Kg	UJ
		Benzo(K)fluoranthene	58	FRT 2C (36-48)	330 U	µg/Kg	UJ
				FRT 2C (48-57)	330 U	µg/Kg	UJ
SVOCs	11/11/06	Benzo(K)fluoranthene	30	FRT 10B	330 U	µg/Kg	UJ
				FRT 1C	330 U	µg/Kg	UJ
				FRT 2B	330 U	µg/Kg	UJ
				FRT 3A	330 U	µg/Kg	UJ
				FRT 3B	330 U	µg/Kg	UJ
				FRT 4A	200 J	µg/Kg	J
				FRT 4C	530	µg/Kg	J
				FRT 5A	200 J	µg/Kg	J
				FRT 6B	70 J	µg/Kg	J
				FRT 7A	300 J	µg/Kg	J
				FRT 7C	820	µg/Kg	J
				FRT 8B	330 U	µg/Kg	UJ
				FRT 9A	1580	µg/Kg	J
				FRT 9B	880	µg/Kg	J
SVOCs	11/11/06	2,4-Dinitrophenol	26	FRT 10B	670 U	µg/Kg	UJ
				FRT 1C	670 U	µg/Kg	UJ
				FRT 2B	670 U	µg/Kg	UJ
				FRT 3A	670 U	µg/Kg	UJ
				FRT 3B	670 U	µg/Kg	UJ
				FRT 4A	670 U	µg/Kg	UJ
				FRT 4C	670 U	µg/Kg	UJ
				FRT 5A	670 U	µg/Kg	UJ
				FRT 6B	670 U	µg/Kg	UJ
				FRT 7A	670 U	µg/Kg	UJ
				FRT 7C	670 U	µg/Kg	UJ
				FRT 8B	670 U	µg/Kg	UJ
				FRT 9A	670 U	µg/Kg	UJ
				FRT 9B	670 U	µg/Kg	UJ
SVOCs	11/11/06	Benzo(b)fluoranthene	47	FRT 10B	330 U	µg/Kg	UJ
				FRT 1C	330 U	µg/Kg	UJ
				FRT 2B	330 U	µg/Kg	UJ
				FRT 3A	330 U	µg/Kg	UJ
				FRT 3B	330 U	µg/Kg	UJ
				FRT 4A	200 J	µg/Kg	J
				FRT 4C	750	µg/Kg	J
				FRT 5A	330 U	µg/Kg	UJ
				FRT 6B	330 U	µg/Kg	UJ
				FRT 7A	300 J	µg/Kg	J
				FRT 7C	890	µg/Kg	J
				FRT 8B	330 U	µg/Kg	UJ
				FRT 9A	2090	µg/Kg	J
				FRT 9B	1320	µg/Kg	J

TABLE 3

QUALIFIED SAMPLE RESULTS DUE TO OUTLYING CONTINUING CALIBRATION RESULTS
SITE INVESTIGATION
GENERAL MOTORS CORPORATION
FLINT, MICHIGAN
OCTOBER - NOVEMBER 2006

Parameter	*Calibration Date*	*Compound*	*%D*	*Associated Sample ID*	*Sample Results*	*Units*	*Qualifier*
SVOCs	11/13/06	Benzaldehyde	29	FRT 10A	330 U	µg/Kg	UJ
				FRT 11C	330 U	µg/Kg	UJ
				FRT 12B	330 U	µg/Kg	UJ
				FRT 12C	330 U	µg/Kg	UJ
				FRT 12C (12-24)	330 U	µg/Kg	UJ
				FRT 12C (2-12)	330 U	µg/Kg	UJ
				FRT 12C (24-36)	330 U	µg/Kg	UJ
				FRT 4A (12-24)	330 U	µg/Kg	UJ
				FRT 4A (2-12)	330 U	µg/Kg	UJ
				FRT 7C (12-24)	1000 U	µg/Kg	UJ
				FRT 7C (2-12)	1000 U	µg/Kg	UJ
				FRT 7C (24-36)	330 U	µg/Kg	UJ
				FRT 7C (36-46)	330 U	µg/Kg	UJ
				FRT DUP1	330 U	µg/Kg	UJ
				FRT DUP2	1000 U	µg/Kg	UJ
				FRT DUP3	330 U	µg/Kg	UJ
SVOCs	11/13/06	Hexachlorocyclopentadiene	42	FRT 10A	330 U	µg/Kg	UJ
				FRT 11C	330 U	µg/Kg	UJ
				FRT 12B	330 U	µg/Kg	UJ
				FRT 12C	330 U	µg/Kg	UJ
				FRT 12C (12-24)	330 U	µg/Kg	UJ
				FRT 12C (2-12)	330 U	µg/Kg	UJ
				FRT 12C (24-36)	330 U	µg/Kg	UJ
				FRT 4A (12-24)	330 U	µg/Kg	UJ
				FRT 4A (2-12)	330 U	µg/Kg	UJ
				FRT 7C (12-24)	1000 U	µg/Kg	UJ
				FRT 7C (2-12)	1000 U	µg/Kg	UJ
				FRT 7C (24-36)	330 U	µg/Kg	UJ
				FRT 7C (36-46)	330 U	µg/Kg	UJ
				FRT DUP1	330 U	µg/Kg	UJ
				FRT DUP2	1000 U	µg/Kg	UJ
				FRT DUP3	330 U	µg/Kg	UJ
SVOCs	11/13/06	Benzo(b)fluoranthene	47	FRT 10A	880	µg/Kg	J
				FRT 11C	300 J	µg/Kg	J
				FRT 12B	300 J	µg/Kg	J
				FRT 12C	880	µg/Kg	J
				FRT 12C (12-24)	1180	µg/Kg	J
				FRT 12C (2-12)	2200	µg/Kg	J
				FRT 12C (24-36)	300 J	µg/Kg	J
				FRT 4A (12-24)	330 U	µg/Kg	UJ
				FRT 4A (2-12)	100 J	µg/Kg	J
				FRT 7C (12-24)	4000	µg/Kg	J
				FRT 7C (2-12)	2000	µg/Kg	J
				FRT 7C (24-36)	300 J	µg/Kg	J
				FRT 7C (36-46)	330 U	µg/Kg	UJ
				FRT DUP1	1280	µg/Kg	J
				FRT DUP2	1000	µg/Kg	J
				FRT DUP3	640	µg/Kg	J
SVOCs	11/13/06	Benzo(k)fluoranthene	59	FRT 10A	510	µg/Kg	J
				FRT 11C	200 J	µg/Kg	J
				FRT 12B	300 J	µg/Kg	J
				FRT 12C	750	µg/Kg	J
				FRT 12C (12-24)	930	µg/Kg	J
				FRT 12C (2-12)	1450	µg/Kg	J
				FRT 12C (24-36)	200 J	µg/Kg	J
				FRT 4A (12-24)	330 U	µg/Kg	UJ
				FRT 4A (2-12)	100 J	µg/Kg	J

TABLE 3

QUALIFIED SAMPLE RESULTS DUE TO OUTLYING CONTINUING CALIBRATION RESULTS
SITE INVESTIGATION
GENERAL MOTORS CORPORATION
FLINT, MICHIGAN
OCTOBER - NOVEMBER 2006

Parameter	*Calibration Date*	*Compound*	*%D*	*Associated Sample ID*	*Sample Results*	*Units*	*Qualifier*
SVOCs (Cont'd.)	11/13/06	Benzo(k)fluoranthene	59	FRT 7C (12-24)	4000	µg/Kg	J
				FRT 7C (2-12)	1000	µg/Kg	J
				FRT 7C (24-36)	300 J	µg/Kg	J
				FRT 7C (36-46)	330 U	µg/Kg	UJ
				FRT DUP1	1090	µg/Kg	J
				FRT DUP2	800	µg/Kg	J
				FRT DUP3	470	µg/Kg	J
SVOCs	11/14/06	Benzo(b)fluoranthene	46	FRT 2C	330 U	µg/Kg	UJ
				FRT 2C (12-24)	330 U	µg/Kg	UJ
				FRT 2C (2-12)	330 U	µg/Kg	UJ
				FRT 2C (24-36)	330 U	µg/Kg	UJ
				FRT 5B	220 J	µg/Kg	J
SVOCs	11/14/06	Benzo(K)fluoranthene	46	FRT 2C	330 U	µg/Kg	UJ
				FRT 2C (12-24)	330 U	µg/Kg	UJ
				FRT 2C (2-12)	330 U	µg/Kg	UJ
				FRT 2C (24-36)	330 U	µg/Kg	UJ
				FRT 5B	220 J	µg/Kg	J

Notes:

% D	Percent Difference.
J	Estimated.
SVOCs	Semi-Volatile Organic Compounds.
U	Non-detect at associated value.
UJ	The analyte was not detected above the sample quantitation limit. The reported quantitation limit is an estimated quantity.

TABLE 4

QUALIFIED SAMPLE RESULTS DUE TO ANALYTE CONCENTRATIONS IN THE LABORATORY BLANKS
SITE INVESTIGATION
GENERAL MOTORS CORPORATION
FLINT, MICHIGAN
OCTOBER - NOVEMBER 2006

Parameter	*Analysis Date*	*Analyte*	*Blank Result*	*Sample ID*	*Sample Result*	*Qualified Sample Result*	*Units*
SVOCs	11/08/06	Di-n-butylphthalate	35J	FRT 2C	60 J	330 U	µg/Kg
				FRT 5B	60 J	330 U	µg/Kg
				FRT 12C	70 J	330 U	µg/Kg
				FRT 2C (12-24)	30 J	330 U	µg/Kg
				FRT 2C (2-12)	40 J	330 U	µg/Kg
				FRT 2C (24-36)	40 J	330 U	µg/Kg
SVOCs	11/08/06	bis(2-Ethylhexyl)phthalate	137J	FRT 3A	100 J	330 U	µg/Kg
				FRT 3B	60 J	330 U	µg/Kg
				FRT 4C	100 J	330 U	µg/Kg
				FRT 5B	200 J	330 U	µg/Kg
				FRT 7A	300 J	330 U	µg/Kg
				FRT 7C	510 J	510 U	µg/Kg
				FRT 8B	60 J	330 U	µg/Kg
				FRT 9A	760	760 U	µg/Kg
				FRT 9B	640	640 U	µg/Kg
SVOCs	11/08/06	Benzo(b)fluoranthene	20J	FRT 5A	100 J	330 U	µg/Kg
				FRT 6B	70 J	330 U	µg/Kg
				FRT 8B	100 J	330 U	µg/Kg
				FRT 10B	100 J	330 U	µg/Kg
SVOCs	11/08/06	Benzo(K)fluoranthene	27J	FRT 10B	100 J	330 U	µg/Kg
				FRT 8B	70 J	330 U	µg/Kg
SVOCs	11/08/06	Benzo(a)pyrene	20J	FRT 6B	70 J	330 U	µg/Kg
SVOCs	11/09/06	Di-n-butylphthalate	51J	FRT 2C (36-48)	30 J	330 U	µg/Kg
SVOCs	11/09/06	bis(2-Ethylhexyl)phthalate	580	FRT 2C (36-48)	60 J	330 U	µg/Kg
				FRT 2C (48-57)	30 J	330 U	µg/Kg
SVOCs	11/08/06	Diethyl phthalate	35J	FRT 12C	100 J	330 U	µg/Kg
				FRT 12C (2-12)	70 J	330 U	µg/Kg
				FRT 2C (12-24)	40 J	330 U	µg/Kg
				FRT 2C (2-12)	40 J	330 U	µg/Kg
				FRT 2C (24-36)	50 J	330 U	µg/Kg
				FRT DUP1	70 J	330 U	µg/Kg
TOC	11/16/06	Total Organic Carbon	3.6 J	FRT 2C (48-57)	10 J	12 U	mg/kg
				FRT 8B	15	15 U	mg/kg

Notes:

J	Estimated.
SVOCs	Semi-Volatile Organic Compounds.
TOC	Total Organic Carbon.
U	Non-detect at associated value.

TABLE 5

QUALIFIED SAMPLE RESULTS DUE TO OUTLYING LABORATORY CONTROL SAMPLE RESULTS
SITE INVESTIGATION
GENERAL MOTORS CORPORATION
FLINT, MICHIGAN
OCTOBER - NOVEMBER 2006

Parameter	*Compound*	*Preparation Date*	*Percent Recovery*	*Control Limits (percent)*	*Associated Sample ID*	*Sample Results*	*Units*	*Qualifier*
SVOCs	N-Nitrosodiphenylamine	11/08/06	26	39 - 138	FRT 10A	330 U	µg/Kg	UJ
					FRT 10B	330 U	µg/Kg	UJ
					FRT 11B	330 U	µg/Kg	UJ
					FRT 11C	330 U	µg/Kg	UJ
					FRT 12B	330 U	µg/Kg	UJ
					FRT 12C	330 U	µg/Kg	UJ
					FRT 12C (12-24)	330 U	µg/Kg	UJ
					FRT 12C (2-12)	330 U	µg/Kg	UJ
					FRT 12C (24-36)	330 U	µg/Kg	UJ
					FRT 1C	330 U	µg/Kg	UJ
					FRT 2B	330 U	µg/Kg	UJ
					FRT 2C	330 U	µg/Kg	UJ
					FRT 2C (12-24)	330 U	µg/Kg	UJ
					FRT 2C (2-12)	330 U	µg/Kg	UJ
					FRT 2C (24-36)	330 U	µg/Kg	UJ
					FRT 3A	330 U	µg/Kg	UJ
					FRT 3B	330 U	µg/Kg	UJ
					FRT 4A	330 U	µg/Kg	UJ
					FRT 4A (12-24)	330 U	µg/Kg	UJ
					FRT 4A (2-12)	330 U	µg/Kg	UJ
					FRT 4C	330 U	µg/Kg	UJ
					FRT 5A	330 U	µg/Kg	UJ
					FRT 5B	330 U	µg/Kg	UJ
					FRT 6B	330 U	µg/Kg	UJ
					FRT 7A	330 U	µg/Kg	UJ
					FRT 7C	330 U	µg/Kg	UJ
					FRT 7C (12-24)	1000 U	µg/Kg	UJ
					FRT 7C (2-12)	1000 U	µg/Kg	UJ
					FRT 7C (24-36)	330 U	µg/Kg	UJ
					FRT 7C (36-46)	330 U	µg/Kg	UJ
					FRT 8B	330 U	µg/Kg	UJ
					FRT 9A	330 U	µg/Kg	UJ
					FRT 9B	330 U	µg/Kg	UJ
					FRT DUP1	330 U	µg/Kg	UJ
					FRT DUP2	1000 U	µg/Kg	UJ
					FRT DUP3	330 U	µg/Kg	UJ

Notes:

SVOCs	Semi-Volatile Organic Compounds.
U	Non-detect at associated value.
UJ	The analyte was not detected above the sample quantitation limit. The reported quantitation limit is an estimated quantity.

TABLE 6

QUALIFIED SAMPLE RESULTS DUE TO OUTLYING MATRIX SPIKE/MATRIX SPIKE DUPLICATE RECOVERIES
SITE INVESTIGATION
GENERAL MOTORS CORPORATION
FLINT, MICHIGAN
OCTOBER - NOVEMBER 2006

Parameter	*Associated Sample ID*	*Analyte*	*MS Recovery (percent)*	*MSD Recovery (percent)*	*RPD (percent)*	*Control Limits*		*Sample Result*	*Units*	*Qualifier*
						Recovery (percent)	*RPD (percent)*			
PCBs	FRT 7C	Aroclor 1260	59	112	46	53 - 123	20	20 J	µg/Kg	J
SVOC	FRT 7C	all SVOCs	variable	variable	>25	variable	25	Variable	µg/Kg	J
	FRT 7C (12-24)	Benzaldehyde	27	48	55	37 - 126	25	1000 U	µg/Kg	UJ
		Hexachloroethane	11	15	23	35 - 120	25	1000 U	µg/Kg	UJ
		Acenaphthene	127	129	2	37 - 124	25	800 J	µg/Kg	J
		Benzo(b)fluoranthene	183	171	4	29 - 153	25	4000	µg/Kg	J
		Indeno(1,2,3-cd)pyrene	156	171	6	39 - 137	25	3000	µg/Kg	J
		Benzo(g,h,i)perylene	142	163	9	45 - 131	25	3000	µg/Kg	J

Notes

J	Estimated.
MS	Matrix Spike.
MSD	Matrix Spike Duplicate.
PCBs	Polychlorinated Biphenyls.
RPD	Relative Percent Difference.
SVOCs	Semi-Volatile Organic Compounds.
U	Non-detect at associated value.
UJ	The analyte was not detected above the sample quantitation limit. The reported quantitation limit is an estimated quantity.

TABLE 7

QUALIFIED SAMPLE RESULTS DUE TO OUTLYING SERIAL DILUTION RESULTS
SITE INVESTIGATION
GENERAL MOTORS CORPORATION
FLINT, MICHIGAN
OCTOBER - NOVEMBER 2006

Parameter	*Analyte*	*Serial Dilution Sample ID*	*%D*	*Associated Samples*	*Sample Results*	*Units*	*Qualifier*
Metals	Barium	FRT 1C	23	FRT 10B	14.9	mg/Kg	J
				FRT 11B	18.8	mg/Kg	J
				FRT 11C	18.5	mg/Kg	J
				FRT 12B	30.9	mg/Kg	J
				FRT 12C	146	mg/Kg	J
				FRT 1C	18.3	mg/Kg	J
				FRT 2B	7.5	mg/Kg	J
				FRT 2C	90.6	mg/Kg	J
				FRT 3A	11.2	mg/Kg	J
				FRT 3B	7.5	mg/Kg	J
				FRT 4A	28.9	mg/Kg	J
				FRT 4C	73.2	mg/Kg	J
				FRT 5A	20.2	mg/Kg	J
				FRT 5B	22.8	mg/Kg	J
				FRT 6B	19.4	mg/Kg	J
				FRT 7A	29.4	mg/Kg	J
				FRT 7C	38.8	mg/Kg	J
				FRT 8B	26.1	mg/Kg	J
				FRT 9A	127	mg/Kg	J
				FRT 9B	52.6	mg/Kg	J
Metals	Zinc	FRT 1C	15	FRT 10B	18.1	mg/Kg	J
				FRT 11B	42.4	mg/Kg	J
				FRT 11C	25.4	mg/Kg	J
				FRT 12B	62.0	mg/Kg	J
				FRT 12C	316	mg/Kg	J
				FRT 1C	11.7	mg/Kg	J
				FRT 2B	8.2	mg/Kg	J
				FRT 2C	42.9	mg/Kg	J
				FRT 3A	10.9	mg/Kg	J
				FRT 3B	8.2	mg/Kg	J
				FRT 4A	28.2	mg/Kg	J
				FRT 4C	72.3	mg/Kg	J
				FRT 5A	43.1	mg/Kg	J
				FRT 5B	37.6	mg/Kg	J
				FRT 6B	30.6	mg/Kg	J
				FRT 7A	49.8	mg/Kg	J
				FRT 7C	94.0	mg/Kg	J
				FRT 8B	30.8	mg/Kg	J
				FRT 9A	324	mg/Kg	J
				FRT 9B	312	mg/Kg	J

Notes:

%D	Percent Difference.
J	Estimated.

TABLE 8

QUALIFIED SAMPLE RESULTS DUE TO VARIABILITY IN FIELD DUPLICATE RESULTS
SITE INVESTIGATION
GENERAL MOTORS
FLINT, MICHIGAN
OCTOBER - NOVEMBER 2006

Parameter	*Analyte*	*Original Sample ID*	*Original Result*	*Duplicate Sample ID*	*Duplicate Result*	*RPD*	*Units*	*Qualifier* [(1)]
Metals	Arsenic	FRT 9A	15.8	FRT DUP1	8.86	56	mg/Kg	J
Metals	Manganese	FRT 11B	262	FRT DUP3	151	54	mg/Kg	J
TOC	TOC	FRT 9A	470	FRT DUP1	160	98	mg/Kg	J
SVOCs	Fluoranthene	FRT 9A	2830	FRT DUP1	1570	57	µg/Kg	J
SVOCs	Fluoranthene	FRT 11B	2370	FRT DUP3	870	93	µg/Kg	J
SVOCs	Phenanthrene	FRT 11B	1650	FRT DUP3	330 U	133	µg/Kg	J
SVOCs	bis(2-Ethylhexyl)phthalate	FRT 7C (2-12)	13000	FRT DUP2	7000	60	µg/Kg	J

Notes:

(1)	Qualifier is associated with both the original and duplicate sample.
J	Estimated.
RPD	Relative Percent Difference.
SVOCs	Semi-Volatile Organic Compounds.
TOC	Total Organic Carbon.

TABLE 9

QUALIFIED SAMPLE RESULTS DUE TO ANALYTE CONCENTRATIONS IN THE EQUIPMENT BLANK
SITE INVESTIGATION
GENERAL MOTORS CORPORATION
FLINT, MICHIGAN
OCTOBER - NOVEMBER 2006

Parameter	*Analysis Date*	*Analyte*	*Blank Result* [(1)]	*Sample ID*	*Sample Result*	*Qualified Sample Result*	*Units*
Metals	11/10/06	Silver	0.324	FRT 12C	0.13	0.13 U	mg/Kg
			0.186	FRT 12C (2-12)	0.11	0.11 U	mg/Kg
			0.184	FRT 7C (12-24)	0.31	0.31 U	mg/Kg
			0.321	FRT 9A	0.24	0.24 U	mg/Kg
			0.259	FRT DUP1	0.33	0.33 U	mg/Kg

Notes:

(1) Blank results have been adjusted to reflect individual sample dry weights, percent solids, and preparation factors.

U Non-detect at associated value.

Appendix C

Screening-Level Ecological Risk
Assessment for the Flint River

Screening-Level Ecological Risk Assessment for the Flint River at General Motors Corporation NAO Flint, Flint, Michigan

Screening-Level Ecological Risk Assessment for the Flint River at General Motors Corporation NAO Flint, Flint, Michigan

Prepared for

General Motors Corporation

Prepared by

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April 2007

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Acronyms and Abbreviations

CoPC	chemical of potential concern
CSM	conceptual site model
EPA	U.S. Environmental Protection Agency
ERA	ecological risk assessment
ESL	ecological screening level
Facility	GM NAO Flint Operations facility in Flint, Michigan
GM	General Motors Corporation
MDEQ	Michigan Department of Environmental Quality
MFO	mixed-function oxidase
NAO	GM North American Operations
NEC	no-effects concentrations
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
RCRA	Resource Conservation and Recovery Act
SLERA	screening-level ecological risk assessment
SVOC	semivolatile organic compound
TOC	total organic carbon
VOC	volatile organic compound

1 Introduction

This screening-level ecological risk assessment (SLERA) for the Flint River was conducted as part of the Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) for the General Motors Corporation (GM) North American Operations (NAO) Flint Operations facility in Flint, Michigan (the Facility). The SLERA was conducted to address U.S. Environmental Protection Agency (EPA) concerns regarding potential ecological impacts resulting from stormwater discharges from the Facility to the Flint River. The SLERA was designed to support decision-making regarding the necessity for further ecological investigation of the Flint River in the vicinity of the Facility. Background information regarding GM's Flint River sediment investigation and the agreement to conduct a SLERA is provided in the Flint River Sediment Investigation report, to which this SLERA report is appended.

1.1 Objectives and Approach

This SLERA was conducted in accordance with EPA guidance (U.S. EPA 1997). The initial elements of a SLERA are the screening-level problem formulation and the ecological effects evaluation. A screening-level exposure estimate and risk calculation was also conducted to address risk for Flint River aquatic receptors with potentially complete exposure pathways.

The objective of a SLERA is to determine whether ecological risks are negligible, or to eliminate certain contaminants and exposure pathways from further consideration in the ERA process (U.S. EPA 1997). The EPA guidance (U.S. EPA 1997) states that the conclusions of a SLERA may be:

- There is adequate information to conclude that ecological risks are negligible, and therefore, no need exists for remediation on the basis of ecological risk;
- The information is not adequate to make a decision at this point, and the ERA process will continue; or
- The information indicates a potential for adverse ecological effects, and a more thorough assessment is warranted.

If a screening assessment supports the first decision (i.e., negligible risk), the ERA process ends there, with appropriate documentation to support this decision.

The process used in this assessment included sampling of sediment in the Flint River upstream, adjacent to, and downstream of the Facility; development of a conceptual site model (CSM) for aquatic receptors in the Flint River Study Area; a comparison of sediment concentrations to ecological screening levels (ESLs) to identify constituents of potential concern (CoPCs); and comparisons of sediment concentrations to alternative screening values and background concentrations in the context of an uncertainty assessment.

1.2 SLERA Organization

The remainder of this ERA is presented in six sections. Section 2 presents the screening-level problem formulation, which describes the environmental setting, identifies the hazardous constituents, presents the CSM, and identifies the ecological exposure pathways and the assessment and measurement endpoints for the SLERA. Section 3 presents the screening-level ecological effects characterization, which discusses the ecological screening levels and describes the adverse ecological effects of the hazardous constituents of concern. Section 4 presents the screening-level exposure estimation and risk characterization, which provides the results of the screening assessment as an estimate of risk. Section 5, the uncertainty analysis, provides a discussion of the sources of uncertainty in the SLERA, including a comparison to alternative screening values and background concentrations, and identifies any data gaps. Section 6 presents the summary and conclusions. Section 7 provides the list of references cited.

2 Screening-Level Problem Formulation

This section describes the environmental setting of the Flint River in the vicinity of the Facility, the surrounding terrestrial environs, the nature and extent of contamination, habitats, and potential ecological receptors. These elements are brought together, along with consideration of potential exposure pathways, in the context of developing a conceptual site model (CSM) and the assessment and measurement endpoints for this SLERA.

2.1 Environmental Setting

The environmental setting of the Flint River Study Area, including information on tributaries and outfalls, is described in Section 1.2 of the Sediment Investigation report. The Study Area extends approximately 5.2 miles, from the C.S. Mott Lake Dam, upstream of the Facility, to the Hamilton Dam, downstream of the Facility in downtown Flint (refer to Figure 1 of the Sediment Investigation report). The Study Area comprises the following three reaches:

- Upstream of the Facility (from C.S. Mott Lake Dam to 1.9 miles downstream of this dam) (refer to Figure 2 of the Sediment Investigation)
- Adjacent to the Facility (2.6 miles) (refer to Figure 3 of the Sediment Investigation)
- Downstream of the Facility and associated storm sewer outfalls to Hamilton Dam (0.7 miles) (refer to Figure 4 of the Sediment Investigation).

The upstream reach is non-urbanized, with the riparian area consisting of a wooded stretch containing mature floodplain species, with an abundant understory and groundcover. The overall undeveloped nature of the riverbanks in this reach can be seen in the aerial photo on Figure 2 of the Sediment Investigation. Several backwaters are located on both the east and west shores along the upstream reach.

The middle, or adjacent, reach is a mix of residential, commercial, and industrial properties, including the GM Facility, bordering the river with very little terrestrial habitat (refer to Figure 3 of the Sediment Investigation). Along this stretch is the Utah Dam, which is an old, inactive concrete dam with metal doors that remain partially open.

The lower, or downstream, reach is a mix of residential and commercial properties bordering the river with very little terrestrial habitat (Figure 4 of the Sediment Investigation). Along this stretch is the Hamilton Dam which is an active dam that is used to control river levels.

Storm sewers that drain portions of the Facility also drain industrial, commercial, and residential areas outside the boundaries of the Study Area. In addition, numerous storm-sewer outfalls that are unrelated to the Facility drain into the Flint River within the Study Area. Tributary drainages and runoff from industrial, commercial, and residential properties, as well as roads and railroads in the Flint metropolitan area, contribute to the sediment and contaminant load of the Flint River Study Area. These sources and the Flint River flow-control structures are described in more detail in Section 1.2 of the Sediment Investigation.

2.2 Identification of Hazardous Constituents

Consideration of the 2005 Michigan Department of Environmental Quality (MDEQ) data set, and the results of the 2006 Flint River Sediment Investigation were used to identify the hazardous constituents that are assessed in this SLERA.

Hazardous constituents for inclusion in the SLERA were identified based on several criteria, including 1) whether they are site-related, 2) whether they were detected, and 3) whether they are present in sediment at elevated concentrations based on the results of statistical analyses presented in Section 3.2 of the Sediment Investigation.

2.2.1 MDEQ 2005 Sediment Sampling

In April 2005, MDEQ, accompanied by EPA, conducted biased sediment sampling in the Flint River at a total of six locations upstream, adjacent to, and downstream of the Facility. The sediment samples were analyzed for inorganics, polychlorinated biphenyls (PCBs), semi-volatile organic compounds (SVOCs), and volatile organic compounds (VOCs). Low levels of PCBs, metals, and polycyclic aromatic hydrocarbons (PAHs) were detected. As described above, there are multiple sources of contaminants to the river. Consistent with observations in other urban watersheds, this combination of sources (both Facility-influenced sources and those unrelated to the GM Facility) would be expected to result in low-level concentrations of constituents in sediment, such as those that were seen in the MDEQ Flint River data set.

2.2.2 GM 2006 Sediment Sampling

In October 2006, ARCADIS BBL and Exponent collected sediment samples from each of three reaches of the river. Nine transects were established along the Flint River throughout the 5.2-mile Study Area. Three transects were evenly spaced along each of three reaches (i.e., upstream, adjacent, and downstream) to establish "unbiased" sampling locations, which were intended to represent areas not unduly influenced by any single discharge or group of discharges. Three additional "biased" transects were established to coincide with locations of Facility storm-sewer outfalls 003, 005, and 013. The locations of these twelve transects are illustrated on Sediment Investigation Figures 2 through 4. The individual station locations are described below. Section 1.2 of the Sediment Investigation discusses the prevalence of Facility-related and non-Facility-related outfalls throughout each Study Area reach.

Stations FRT 1, 2, and 3 are located in the upper reach of the Study Area, which is a non-urbanized, wooded stretch of the river with a few houses situated along the eastern shore (Figure 2 of the Sediment Investigation). Throughout this reach, there are five non-GM outfalls.

Stations FRT 4, 5, 6, 10, 11, and 12 are located in the middle, or adjacent, reach of the Study Area, which is a mix of residential, commercial and industrial properties along the western shore, and mostly residential properties along the eastern shore (Figure 3 of the Sediment Investigation). Throughout this reach there are 17 GM-influenced outfalls and 27 non-GM outfalls. Station FRT 4 is the only station above the Utah Dam in this reach of the river.

Stations FRT 7, 8, and 9 are located in the lower, downstream, reach of the Study Area, which is a mix of commercial and industrial properties along the western and eastern shores (Figure 4 of the Sediment Investigation). The Hamilton Dam is at the southern end of this reach. Throughout this reach there are 18 non-GM outfalls.

A total of 21 surficial (0- to 2-inch) sediment samples were submitted for laboratory analysis. In addition, four sediment cores were collected for sediment probing and sampling. A total of 14 subsurface (>2 inches deep) samples were submitted for analysis. Samples were analyzed for SVOCs, PCBs, total organic carbon (TOC), metals, and particle size. Further details of the 2006 sampling are provided in Section 2 of the Sediment Investigation report.

Section 3.2.2 of the sediment investigation provides statistical analyses in which concentrations of constituents in surface sediment were compared between the river reaches. A total of 13 constituents showed statistically higher mean and/or median concentrations between the upstream and adjacent or downstream reaches. Thus, the following 13 constituents were retained for the SLERA:

- Benzo(a)pyrene
- Benzo(b)fluoranthene
- Benzo(g,h,i)perylene
- Benzo(k)fluoranthene
- Chrysene
- Fluoranthene
- Fluorene
- Indeno(1,2,3-cd)pyrene
- Pyrene
- Chromium
- Copper
- Lead
- Zinc

2.3 Conceptual Site Model

The preliminary CSM for the Flint River Study Area describes the plausible links between Facility-related hazardous constituents and potential ecological receptors in the Flint River. The CSM integrates and provides a framework for the information that will be used to form the basis of assessment and measurement endpoints for evaluation of ecological risk in the Flint River Study Area and traces the movement of hazardous constituents from their sources to the ecological receptors in the Flint River. The CSM, shown in Figure 1, identifies potential sources of contaminants, potentially exposed receptor communities, and the mechanisms by which contaminants may affect the exposed communities.

As illustrated in the CSM (Figure 1), potential sources of Facility-related hazardous constituents to the Flint River include stormwater runoff or discharge, historic discharges and/or spills, and groundwater discharge to the river. These sources are described in Section 1.2 of the Sediment Investigation.

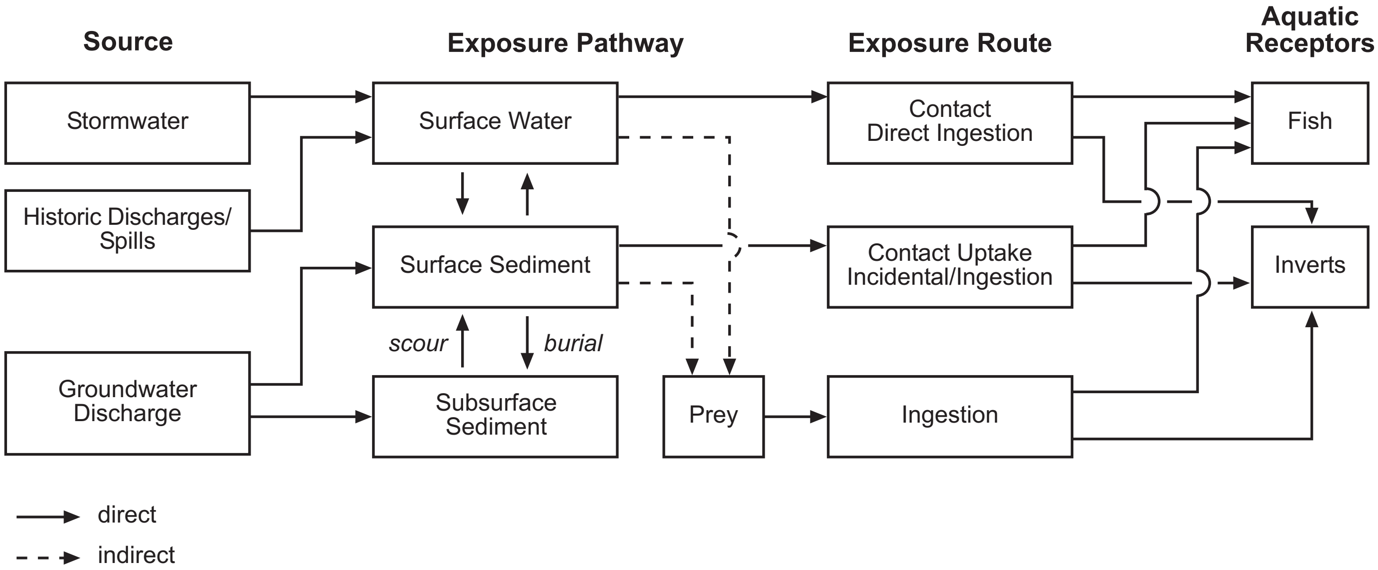

Figure 1. Conceptual site model for Flint River Study Area

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2.3.1 Transport and Fate

Contaminant transport and fate are functions of the physical and chemical characteristics of a contaminant, as well as the environmental media through which it has potential to be transported or transformed. This section provides an overview of potential contaminant transport and fate processes for hazardous constituents in the Flint River. Contaminant migration into surface water can occur through surface water runoff, groundwater discharge, and directly via point sources such as outfalls. In surface water, contaminants may be transformed, remain dissolved in the water column, volatilize to air, or sorb to bottom or suspended sediments.

An important chemical property that influences the transport and fate of contaminants in aquatic systems is the chemical's solubility. Constituents potentially associated with the Facility detected in the Flint River sediment include a number of relatively insoluble metals (i.e., chromium, copper, lead, and zinc) and organic chemicals (i.e., PAHs). These specific metals and PAHs have high affinity for organic matter and partition primarily onto the organic matter contained in suspended solids within the water column and sediments (Eisler 2000; Bourg 1981). In regard to the metals, other environmental factors that affect the ability of the suspended solids and sediment to bind the metals, which include the proportion of other absorbent materials such as clays and metals oxides, and the pH of the environment. More binding of these metals is expected to occur at neutral pH, and less binding will occur as the pH in the environment decreases. The transport and fate of inorganic constituents is influenced by pH, temperature, and water hardness.

The transport and fate of these insoluble constituents parallels the transport of the soil or sediment particles to which these compounds are adsorbed. Therefore, in the upland environment, the rate of erosion of soils containing these constituents and transport by overland flow to discharge points adjacent to the river is a key factor in controlling the rate of discharge of these constituents into the aquatic environment. Once introduced to the aquatic environment, these insoluble constituents (i.e., PAHs and metals), can be carried downstream on particles before settling out in depositional areas and becoming part of the sediment. The characteristics of sediment-particle transport depend on the hydrologic characteristics of the surface water body. If the discharge occurs in low-energy areas of the surface water body, deposition will likely occur near the point of discharge. If the discharge occurs in higher energy areas of the surface water body (e.g., high flow rate), the sediment may be carried downstream some distance until lower energy depositional areas are reached. In the case of PAHs, it has been reported that, in most cases, the deposition of the PAHs in sediment within the aquatic environment appears to occur near the source (Neff 1979). This would be expected to be the case for the metals too, because they behave in a manner similar to the PAHs.

Within depositional regions where sources have been curtailed, contaminants can become buried by continual deposition of clean sediment. Conversely, contaminated sediment may have the potential to become resuspended and transported downstream during high flow events or by ice scour.

The PAHs released to the environment can be degraded by a number of environmental processes. The most important environmental processes controlling the fate and degradation of

PAHs in the aquatic environment are photo-oxidation, chemical oxidation, and biological transformation by microbes and animals (Neff 1979). The low-molecular-weight PAHs (e.g., fluorene) generally are more water soluble, and thus have a higher potential for environmental degradation, than the higher-molecular-weight PAHs, such as benzo(a)pyrene. This tends to be related in part to the increased bioavailability of the more water-soluble PAHs as they are released more readily into the pore water of the sediments and, thus, are more accessible to microbes. In some cases, animals and microbes can degrade the PAHs to metabolites that will ultimately be completely degraded (Eisler 2000). However, within animals, the PAHs may be bioactivated in the liver by specific enzyme systems to carcinogenic metabolites. This is the case with some of the higher-molecular-weight PAHs such as benzo(a)pyrene, which is not carcinogenic until it is bioactivated by these enzyme systems. The amount of activation and metabolism varies from species to species (Eisler 2000). Mammals tend to metabolize PAHs more efficiently than fish, and fish more efficiently than benthic invertebrates.

Of the hazardous constituents within the Flint River Study Area, metals are not able to be degraded like organic constituents and therefore will be more persistent than PAHs. As discussed above, low-molecular-weight PAHs (e.g., fluorene) generally have a high potential for environmental degradation. However, in sediments where little oxygen or light is present, the rate of PAH degradation is expected to be slow (Neff 1979).

2.3.2 Ecological Exposure Pathways

Potential exposure pathways to aquatic receptors (fish and invertebrates) in the Flint River include both direct pathways (i.e., contact with and direct ingestion of surface water and incidental ingestion of surface sediment) and indirect pathways (i.e., ingestion of contaminated prey such as benthic invertebrates). Exposure to sediment by ecological receptors is generally of concern at the surface interval (e.g., 0–2 inches). However, deeper sediment might also be exposed during extreme flow events or from ice scour. Although there is no direct exposure pathway for constituents in subsurface sediment to ecological receptors, subsurface sediment was evaluated at EPA’s request, to illustrate worst-case potential ecological exposure during deep sediment mixing that might occur during a flood event or as a result of ice scour.

2.3.3 Assessment and Measurement Endpoints

An assessment endpoint is “an explicit expression of the environmental value that is to be protected,” and it should define “both the valued ecological entity at the site (e.g., a species, ecological resource, or habitat type) and a characteristic(s) of the entity to protect (e.g., reproductive success, production per unit area, areal extent)” (U.S. EPA 1997). A measurement endpoint measures the effect of a CoPC on a representative receptor to make inferences about the population or community represented by the assessment endpoint.

- Because benthic macroinvertebrates have an intimate association with sediment, and due to their importance in the aquatic food chain, the assessment endpoint selected for this SLERA is survival, growth, and reproduction of benthic macroinvertebrates.

- The measurement endpoint used to evaluate the assessment endpoint is the chemical concentrations in Flint River sediment compared to ecological screening benchmarks for the protection of aquatic life.

3 Screening-Level Ecological Effects Characterization

The screening-level ecological effects characterization establishes conservative thresholds for adverse ecological effects, or ecological screening levels. These screening levels are used in the screening-level exposure and risk characterization (Section 4) to identify the ecological CoPCs. This section also provides toxicity profiles that describe what is known about the ecological effects of the hazardous constituents.

3.1 Ecological Screening Levels

Chemical constituents in sediment are screened to identify CoPCs to ecological receptors. This is accomplished in Section 4 by comparing chemical concentrations in sediment to available and appropriate ecological risk-based screening criteria. The criteria used for this screening are the U.S. EPA Region 5 (2003) RCRA Ecological Screening Levels (ESLs). According to EPA,[1] the ESLs are initial screening levels to use in ecological risk assessments, and they are not intended to serve as cleanup levels. Screening using conservative screening values such as ESLs is intended to identify CoPCs, and to eliminate constituents that pose negligible risk from further evaluation in the ecological risk assessment process.

3.2 Adverse Effects of PAHs

PAHs are formed during incomplete combustion of fossil fuels and other organic substances. Sources of PAHs to the aquatic environment include municipal runoff, atmospheric deposition of combustion products, oil spills and petroleum industrial operations, and natural oil seeps (e.g., NRC 1985).

Toxicological effects of SVOCs, including PAHs, are highly variable. PAHs consist of hydrogen and carbon arranged in the form of two or more fused benzene rings. PAH compounds differ in the number and position of aromatic rings and in the position of substituents on the basic ring system. Unsubstituted two- or three-ring (lower molecular weight) PAHs such as naphthalene, fluorene, phenanthrene, and anthracene can be acutely toxic to aquatic organisms, but are noncarcinogenic. Four- to seven-ring (higher molecular weight) PAHs, such as chrysene and benzo(a)pyrene are significantly less toxic, but can be carcinogenic, mutagenic, or teratogenic to a variety of organisms, including fish. The lighter PAHs are generally available for microbial degradation in sediment, and the heavier PAHs are not (API 2000).

Accumulation of PAHs is largely related to an organisms’ ability to metabolize the compounds. The ability to biotransform PAHs is due to the cytochrome P-450 mixed-function oxidase (MFO) system in living organisms. The MFO system is well developed in many birds, mammals, and fish and allows PAHs to be readily metabolized (Kalf et al. 1995). Therefore, direct toxicity to these receptors is unlikely at most environmental concentrations. In addition,

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[1] http://www.epa.gov/reg5rcra/ca/edql.htm

PAHs show little tendency to biomagnify in food chains, primarily because of this rapid metabolism. Controlled studies of aquatic food chains have shown that tissue concentrations of PAHs decrease with an increase in trophic level (Broman et al. 1990). Therefore, PAHs are not passed along in the food chain, and do not accumulate to appreciable levels in predatory fish and birds. However, direct toxicity may result from metabolism (Suedel et al. 1994; U.S. EPA 1991). Chronic dietary exposure to PAHs can cause adverse effects in birds and mammals, including body-weight loss, liver damage, cancer, reproductive failure, and developmental defects (Eisler 1987, 1988).

In aquatic food chains, fish have the best capacity to metabolize PAHs, crustaceans are intermediate, and molluscs have the poorest metabolic capacity (James 1989; Stegeman and Lech 1991). Even in highly contaminated areas, only low to moderate PAH concentrations are typically found in fish (Dawe 1990; Varanasi et al. 1990). However, species at lower trophic levels with less developed MFO systems, such as benthic invertebrates, can accumulate PAHs in their tissues.

PAH metabolism varies with species and compounds. Amphipods have the ability to metabolize benzo(a)pyrene to intermediate compounds (Reichert et al. 1985). Tests with chironomids (*C. riparius*) demonstrated that benzo(a)pyrene is rapidly and completely transformed (Giesy et al. 1983). English sole (*Parophrys vetulus*) collected from polluted sites in Puget Sound, Washington, were found to contain metabolites of fluorene, dibenzofuran, phenanthrene, fluoranthene, pyrene, and benzo(a)pyrene (Krahn et al. 1987). Benzo(a)pyrene, fluoranthene, and benzo[a]anthracene were metabolized in the fish species *Pimephales promelas, Poecilisa reticulata*, and *Brachydanio rerio*, but naphthalene, anthracene, and phenanthrene were not (Kalf et al. 1995).

The metabolites of PAHs include intermediates that can bind covalently to DNA, RNA, and proteins and become toxic, mutagenic, or carcinogenic. Metabolites include PAH diols, phenols, quinone, and PAH conjugates with sulfate, monosaccharide, glucoronate, and glutathione (Neff 1978). The toxicity of PAHs varies, because PAHs and their metabolites exhibit different toxicodynamics. In some cases, the polar metabolites of PAHs are excreted more slowly than the parent compound (Kalf et al. 1995). For example, the metabolite of benzo(a)pyrene, 7,8-diolepoxide, has a higher carcinogenic capacity than its parent (Kalf et al. 1995).

Several studies have demonstrated adverse effects of PAH in water, especially benzo[a]pyrene, on hatching, larval development, and viability, primarily with fish, but also with invertebrates in a few cases. Typical reproductive effects noted in fish were delayed or decreased hatching (Hose et al. 1981, 1982; Winkler et al. 1983; Hall and Oris 1991), increased incidence of larval malformations (Hose et al. 1981, 1982; Hannah et al. 1982; Winkler et al. 1983), cell and tissue lesions in yolk sac fry (Hose et al. 1984), or reduced larval growth (Hannah et al. 1982). In general, effects are seen only at very high, environmentally unrealistic concentrations. For example, Hall and Oris (1991) found reductions in the number of eggs in fish exposed to anthracene at 6 μg/L for 6 weeks, and a lowering of hatching success at 12 μg/L. However, Hose et al. (1982, 1984) found effects in fish at concentrations as low as 0.1 μg/L.

Adverse effects of PAHs on benthic invertebrates include inhibited reproduction, delayed emergence, sediment avoidance, and mortality (Eisler 1987). In fish, threshold concentrations of PAHs in sediment associated with effects in English sole range from 54 μg/kg dry weight, for liver neoplasms, to about 2,800 μg/kg for hepatic preneoplastic foci of cellular alteration (Johnson 2000). Based on these data, the National Marine Fisheries Service suggests a sediment quality guideline of 1,000 μg/kg for total PAHs to protect estuarine fish from adverse effects. This guideline and the ESLs for individual PAH compounds are lower than PAH concentrations typically found in urban areas as a result of stormwater runoff and atmospheric deposition. This will be discussed in the Uncertainty Analysis, Section 5.

3.3 Adverse Effects of Metals

Organisms have evolved homeostatic mechanisms that regulate the uptake and excretion of metals to maintain tissue concentrations within desirable ranges, as well as to prevent toxic effects (Kapustka et al. 2003). For certain elements and organisms, bioaccumulation is required to maintain the organism's health and normal function; this is the case for essential trace elements such as copper and zinc. In other situations, bioaccumulation of metals produces residues that cause direct toxicity (e.g., copper toxicity to aquatic organisms) or indirect toxicity to consumers (as in selenium accumulation by plants). To further complicate understanding the bioaccumulation and metabolism of metals, the metabolism of an essential element can affect the metabolism of a non-essential toxic metal, as in the case of calcium and lead in the central nervous system (Kern et al. 2000). Nonessential metals, such as arsenic and lead, are not required for biological processes and are therefore not naturally regulated by the body. These metals cause toxicity at various exposure levels.

In aquatic systems, the toxic effects of metals can range from reductions in growth to mortality. Water hardness affects the degree of toxicity of cadmium, chromium, copper, lead, nickel, silver, and zinc, with toxicity decreasing with increasing water hardness. The aquatic organisms that are most sensitive to the effects of exposure to metals are early life stages of benthic organisms and fish.

EPA Region 5 provides toxicity profiles for inorganic constituents on their ecological risk assessment website (http://www.epa.gov/R5Super/ecology/html/toxprofiles.htm). The information from these profiles for the inorganic constituents of concern—chromium, copper, lead, and zinc—is summarized below and supplemented with information on these constituents from the available ATSDR toxicological profiles.

3.3.1 Chromium

Chromium exists in two oxidation states in the environment: trivalent ($^{+}$3) and hexavalent ($^{+}$6). The more toxic hexavalent chromium is readily converted to trivalent chromium in animals; this appears to protect higher organisms from adverse effects of low-level exposures to chromium. Lower-trophic-level organisms, however, are generally more susceptible to the toxic effects of chromium. Aquatic ecological impacts from chromium result from direct exposure of benthic invertebrates and early life stages of freshwater fish. Chromium bioaccumulates in algae and other aquatic vegetation, and also in aquatic invertebrates. However, it does not biomagnify in aquatic food webs. The ecological effects of chromium include inhibited growth in aquatic plants (e.g., duckweed and algae), reduced fecundity and survival of benthic invertebrates, and reduced growth of freshwater fish. Chromium is a known carcinogen, mutagen, and teratogen.

The most significant anthropogenic sources of chromium in surface water and groundwater are wastewaters from electroplating operations, leather tanning industries, residential treatment plants, textile manufacturing, and deposition of airborne chromium. In a 1972 survey, the contribution of different sources to chromium load in the influent wastewater of a treatment plant in New York City was estimated to be as follows: electroplating industry, 43%; residential wastewater, 28%; other industries, 9%; runoff, 9%; and unknown, 11% (Klein et al. 1974, as cited in ATSDR 2000). On a worldwide basis, the major chromium source in aquatic ecosystems is domestic wastewater effluents (32.2% of the total). Atmospheric fallout also contributes about 6.4% (Nriagu and Pacyna 1988, as cited in ATSDR 2000).

Significant sources of chromium released into soil include disposal of commercial products that contain chromium (51%), disposal of coal fly ash and bottom fly ash from electric utilities and other industries (33.1%), agricultural and food wastes (5.3%), animal wastes (3.9%), and atmospheric fallout (2.4%) (Nriagu and Pacyna 1988, as cited in ATSDR 2000).

The chromium level in soils varies greatly and depends on the composition of the parent rock from which the soils were formed. Basalt and serpentine soils, ultramafic rocks, and phosphorites may contain chromium as high as a few thousand mg/kg (Merian 1984, as cited in ATSDR 2000), whereas soils derived from granite or sandstone will have lower concentrations of chromium (Swaine and Mitchell 1960, as cited in ATSDR 2000). The concentration range of chromium in 1,319 samples of soils and other surficial materials collected in the conterminous United States was 1–2,000 mg/kg, with a geometric mean of 37 mg/kg (USGS 1984).

3.3.2 Copper

Copper is an essential micronutrient, and bioaccumulates in both fish and mollusks; however, it can be toxic at higher levels. Copper can be highly toxic in aquatic environments and has demonstrated adverse effects in both fish and invertebrates. Copper is also an algaecide, with single-cell and filamentous algae, and cyanobacteria being particularly susceptible to acute effects at low concentrations. Copper adsorbs strongly to organic matter, carbonates, and clay in sediment, thereby reducing its bioavailability.

Copper is a natural constituent of soil and can be transported into streams and waterways in runoff, either due to natural weathering or anthropogenic soil disturbances. Copper in runoff that is obtained from the natural weathering of soil or is released from disturbed soils contributes 68% of the copper released to waterways (Georgopoulos et al. 2001, as cited in ATSDR 2004). Other sources of copper include urban runoff and the use of copper sulfate. In the absence of specific industrial sources, urban stormwater runoff is the major factor contributing to elevated copper levels in river water (Nolte 1988, as cited in ATSDR 2004). Copper in stormwater runoff originates from the sides and roofs of buildings, various emissions (such as from automobiles), and wet and dry depositional processes (Davis et al. 2001, as cited in ATSDR 2004). Stormwater runoff normally contributes approximately 2% to the total copper released to waterways. Concentrations of between 1 and 100 μg/L of copper in stormwater runoff have been measured (Georgopoulos et al. 2001, as cited in ATSDR 2004).

An estimated 97% of copper released from all sources into the environment is released to land, primarily in the form of tailings and overburdens from copper mines and tailings from mills (Perwak et al. 1980, as cited in ATSDR 2004). Other releases to land include sludge from publicly owned treatment works, municipal refuse, waste from electroplating, iron and steel producers, and discarded copper products (e.g., plumbing, wiring) that are not recycled. Sludge from sewage treatment plants is a major source of copper released to land (Nriagu and Pacyna 1988, as cited in ATSDR 2004). In addition, agricultural products are believed to constitute 2% of the copper released to soil (Perwak et al. 1980, as cited in ATSDR 2004).

3.3.3 Lead

In the aquatic environment, lead partitions primarily to sediments, but can become mobile and thus more bioavailable under conditions of low pH, hardness, and organic matter content. Lead bioaccumulates in aquatic plants and benthic organisms, but does not biomagnify in aquatic food webs. Lead is a known carcinogen and can also adversely affect reproduction, liver and thyroid function, and disease resistance. Lead has shown adverse effects in algae, invertebrates, and fish. Fish exposed to high concentrations of lead have demonstrated a wide range of effects, including muscular and neurological degeneration, growth inhibition, mortality, reproductive effects, and paralysis. Lead also can adversely affect invertebrate reproduction and algal growth.

Of the known aquatic releases of lead, the largest ones are from the steel and iron industries, and lead production and processing operations (U.S. EPA 1982, as cited in ATSDR 2005a). Urban runoff and atmospheric deposition are also significant indirect sources of lead found in the aquatic environment. Lead reaching surface waters is sorbed to suspended solids and sediments (U.S. EPA 1982). Lead is also released into surface water from the use of lead shot and lead sinkers. In 1991, the U.S. Fish and Wildlife Service banned the use of lead shot when hunting waterfowl, such as geese or ducks, to avoid releasing lead directly to surface water.

While the majority of lead releases are to land, they constitute much lower exposure risks than releases to air and water. Metal mining, coal mining, electrical utilities, and hazardous waste facilities’ solvent recovery facilities are the industrial sectors that contribute most heavily to releases of lead to land. Most of the lead released to land, however, becomes tightly bound and immobile.

3.3.4 Zinc

Anthropogenic sources of zinc come from discharges from smelters, mine tailings, coal and bottom fly ash, and the use of commercial products such as fertilizers and wood preservatives that contain zinc (ATSDR 2005b). In aquatic systems, zinc primarily partitions to sediment and less frequently exists in dissolved form as hydrated zinc ions and organic and inorganic complexes. Zinc is an essential nutrient, but at high concentrations, exhibits adverse effects on growth, survival, and reproduction. Zinc bioaccumulates moderately in aquatic organisms, and bioconcentration rates are higher in crustaceans and bivalves than in fish. However, biota contain relatively little zinc compared to sediments (ATSDR 2005b).

Zinc and its compounds are found in the earth's crust and are present in most rocks, certain minerals, and some carbonate sediments. As a result of weathering of these materials, soluble compounds of zinc are formed and may be released to water (NAS 1977, as cited in ATSDR 2005b). The largest input of zinc to water results from erosion of soil particles containing natural traces of zinc (45,400 metric tons/year) (U.S. EPA 1980, as cited in ATSDR 2005b). Urban runoff, mine drainage, and municipal and industrial effluents are smaller but more concentrated sources of zinc in water. Davis et al. (2001) estimated the zinc loadings in urban stormwater runoff. In this study, buildings and automobiles were found to contribute 95% of loadings (0.646 kg/ha/year) to stormwater runoff in urban environments.

Limited information is available on total releases of zinc to soil. Zinc is often present in soils and grasses as a result of atmospheric deposition. Furthermore, approximately 22,000 tons (20,000 metric tons) of zinc is used in fertilizers each year in the United States (NAS 1977, as cited in ATSDR 2005b). Municipal sludges applied to cropland soils can also be an important source of trace metals, including zinc (Chang et al. 1987, as cited in ATSDR 2005b). The four most important sources of zinc in soil were estimated to be smelter slugs and wastes, mine tailings, coal and bottom fly ash, and the discharge of commercial products such as fertilizers (Nriagu and Pacyna 1988, as cited in ATSDR 2005b).

4 Screening-Level Exposure and Risk Characterization

The screening-level risk characterization includes the results of the sediment screening, identifies the CoPCs, and provides input, along with the uncertainty analysis (Section 5), for making a decision regarding whether or not risks are negligible for aquatic ecological receptors in the Flint River Study Area.

4.1 Results of Screening Assessment

The 13 hazardous constituents that were identified in Section 2.2 were evaluated in the screening assessment. Of these constituents, chemicals that are present in sediment at concentrations that exceed the ESLs, and chemicals for which no screening values are available, were identified as CoPCs. Constituents that did not exceed the ESLs in any sample were eliminated from further consideration in the ecological risk assessment process. In the screening assessment, duplicate samples were averaged using one-half the detection limit for non-detects. The results of the screening are summarized below for the biased and unbiased surface and subsurface sediment samples.

4.1.1 Unbiased Surface Samples

Table 1 provides the screening of surface sediment for the unbiased sampling transects. PAHs were not detected in the upstream samples. PAHs and metals were found at higher concentrations in the samples from the adjacent and downstream reaches, compared to the upstream reach. This trend in concentrations would be expected based on the prevalence of outfalls and the urbanized nature of the watershed in the adjacent and downstream reaches (refer to Section 3.2 and Figures 5 through 30 of the Sediment Investigation report).

No detected chemicals exceeded ESLs for unbiased surface samples in the upstream reach.

In the adjacent reach, all of the PAHs except benzo(b)fluoranthene exceeded ESLs. Station FRT 4C exhibited the highest concentrations of these PAHs; however, all except fluoranthene were less than 1 part per million (ppm). Lead at station FRT 5A is the only inorganic constituent that exceeded its ESL in the adjacent reach. Mean concentrations of six PAHs and lead exceeded ESLs in this reach.

In the downstream reach, all of the PAHs except benzo(b)fluoranthene exceeded ESLs. Copper, lead, and zinc also exceeded ESLs. Station FRT 9A had the highest detected concentrations of PAHs and metals. This sample also had the highest concentration of TOC and the highest proportion of clay of all unbiased samples. Most other stations (in all reaches) had very low TOC and were predominantly sand. Mean concentrations of eight PAHs, lead, and zinc exceeded ESLs in the downstream reach.

Benzo(b)fluoranthene and chromium were eliminated from further consideration in the ecological risk assessment process for the unbiased surface sediment, because these chemicals did not exceed ESLs in any sample within this data set.

4.1.2 Biased Surface Samples

Table 2 provides the screening of surface sediment for the sampling transects that were biased to the Facility-influenced outfalls (003, 005, and 013). As with the unbiased surface samples, all PAHs except benzo(b)fluoranthene, as well as copper, lead, and zinc, exceeded ESLs. The highest concentrations of PAHs were found at station FRT 11B. Metals exceeded ESLs only at station FRT 12C. This station had the highest clay content and TOC of all biased surface samples. Mean concentrations of eight PAHs exceeded ESLs for this data set.

Benzo(b)fluoranthene and chromium were the only constituents of the 13 chemicals identified for the SLERA that were eliminated from further consideration in the ecological risk assessment process for the biased surface sediment data set.

4.1.3 Unbiased Subsurface Samples

Table 3 provides the screening of subsurface sediment for the unbiased sampling transects. As with the surface samples, PAHs were not detected in the upstream samples, and PAHs and metals were found at higher concentrations in the samples from the adjacent and downstream reaches, compared to the upstream reach. Clay and silt content, and TOC, were higher in the subsurface samples from the downstream reach compared to the other reaches.

In the upstream or adjacent reaches, no detected chemicals in subsurface sediment exceeded ESLs. In the adjacent reach, one low estimated concentration of benzo(a)pyrene (station FRT 4A) exceeded the ESL for this chemical.

In the downstream reach, all PAHs except benzo(b)fluoranthene, as well as chromium, copper, lead, and zinc, exceeded ESLs. PAHs were detected at the highest concentrations in the 12- to 24-inch interval at station FRT 7C. Metals were also detected at elevated concentrations in this sample, as well as in the shallower interval (2–12 inches) for this station. TOC was also higher at these intervals than in the other subsurface unbiased samples. Mean concentrations for eight PAHs and the four metals exceeded ESLs in the downstream reach.

Benzo(b)fluoranthene was the only chemical that was eliminated from further consideration in the ecological risk assessment process for the unbiased subsurface sediment data set, because this chemical did not exceed the ESL in any sample.

4.1.4 Biased Subsurface Samples

Table 4 provides the screening of subsurface sediment samples that were biased to the Facility-influenced outfalls. All PAHs except benzo(b)fluoranthene, as well as copper, lead, and zinc, exceeded ESLs. The highest concentrations of chemicals were found at station FRT 12C in the 2- to 12-inch depth interval. Metals exceeded ESLs in this sample only. This station had the highest silt/clay content and TOC of all biased subsurface sediment samples. Mean concentrations of eight PAHs exceeded ESLs for this data set.

Benzo(b)fluoranthene and chromium did not exceed ESLs in any biased subsurface sample, and therefore, were eliminated from further consideration in the ecological risk assessment process for this data set.

4.2 Screening-Level Risk Characterization

The screening-level risk characterization is conducted to “ensure that potential ecological threats are not overlooked” (U.S. EPA 1997). In addition, contaminants that are identified as negligible risk are eliminated from consideration in the ecological risk assessment process.

Based on the screening vs. ESLs, the following chemicals were identified as ecological CoPCs for Flint River sediment:

- **Surface Sediment:** Benzo(a)pyrene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, pyrene, copper, lead, and zinc were identified as the CoPCs for unbiased samples in the adjacent and downstream reaches, as well as for the biased surface sediment samples (adjacent reach). Benzo(b)fluoranthene and chromium were eliminated from further consideration in the ecological risk assessment process for all surface sediment.
- **Subsurface Sediment:** Benzo(a)pyrene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, pyrene, chromium, copper, lead, and zinc were identified as the CoPCs for the unbiased subsurface sediment in the downstream reach. These same chemicals, with the exception of chromium, were identified as the CoPCs for the biased subsurface sediment (adjacent reach). Benzo(b)fluoranthene was eliminated from further consideration in the ecological risk assessment process for all subsurface sediment, and chromium was eliminated from the biased (adjacent) subsurface data set.

According to U.S. EPA (1997), screening ecotoxicity assessments are conducted to avoid underestimating risk. Uncertainties associated with the screening process are taken into consideration in the next section to allow conclusions to be made regarding ecological risk from exposure to the sediment CoPCs.

5 Uncertainty Analysis

Analyses of scientific data for risk assessment purposes depend on professional judgment. Professional judgment is needed to draw conclusions regarding ecological risk, and specifically to determine the relevance of available data, develop assumptions to fill data gaps, and to interpret the ecological significance of predicted effects (U.S. EPA 1992). Therefore, this SLERA includes an uncertainty analysis.

Uncertainty in ecological risk assessment is due, in part, to natural variability, and therefore, many uncertainties are due to the limits of scientific knowledge about the responses of ecological receptors to environmental contaminants. Uncertainty is also due to the assumptions used in the ecological risk assessment process. Uncertainty can result in either an over- or under-estimation of risk. Conclusions regarding ecological risk must take into account the factors contributing to this uncertainty. The sources of uncertainty and their potential influence on conclusions regarding risk are summarized in this section. Uncertainty in this SLERA is associated with the sampling data and the screening values, as well as with data gaps, as discussed below.

One source of uncertainty is the selection of CoPCs based on the sampling data and available toxicity information (e.g., ESLs). Additional uncertainties result from the exposure assessment, as a consequence of the uncertainty due to the heterogeneity of the chemical monitoring data. Other uncertainties pertain to the bioavailability and bioaccessibility of the CoPCs and the distribution of ecological receptors. In addition, the SLERA does not account for simultaneous exposures to multiple substances in the screening stages of the assessment. Each of these sources of uncertainty may result in either an over- or underestimation of risk.

5.1 Uncertainties Associated with Ecological Screening Levels

A major source of uncertainty for the SLERA is associated with the use of conservative screening levels (i.e., ESLs). ESLs, as with all screening benchmarks, are intended to be conservative, such that a risk assessor or risk manager has a high level of confidence that a reported concentration of a CoPC that is below a screening value does not pose an unacceptable ecological risk. Conversely, an exceedance of a screening benchmark does not necessarily indicate an unacceptable ecological risk; rather, only that additional evaluation is needed. This uncertainty analysis provides the additional evaluation needed to appropriately interpret the exceedances of ESLs noted in Section 4.

Screening-level benchmarks, including ESLs, are significant sources of uncertainty in ERAs for the following reasons:

- Test conditions on which some of the ESLs are based most likely do not mimic natural exposure and may overestimate bioavailability

- Relative sensitivity of the receptor compared to the test species is likely unknown

- Identification of no-effect thresholds is imprecise and dependent on selected dose intervals
- Chronic no-effect thresholds have not been measured for many hazardous constituents and may have been estimated from low-effect thresholds or acute exposure studies
- Uncertainty factors that are often applied in calculating some screening benchmarks are generalized and ignore species-specific sensitivities
- In many cases, screening values are lower than detection limits and often lower than background concentrations.

The analytical data for the Flint River sediment were compared to Region 5 sediment ESLs. The toxicological basis of these screening values is variable, and as mentioned above, many of the screening values are lower than detection limits. The conservative nature of these screening values may result in an over-prediction of risk.

5.2 Consideration of Alternate Screening Values and Regional Background Concentrations

As an aid to interpreting the potential ecological significance of the exceedances of ESLs, the Flint River sediment data were compared to sediment no-effects concentrations (NECs) (Tables 5 through 8), and to regional and urban background values (Tables 9 through 12). This analysis was conducted only for the CoPCs, or those analytes that exceeded the ESLs in the Screening-Level Exposure and Risk Characterization (Section 4). The NECs, reported by Ingersoll et al. (1996), were derived from freshwater sediment toxicity tests on amphipods and represent threshold values below which adverse effects to benthic organisms would not be expected.

The background values that were used in this analysis were the typical urban background concentrations for PAHs that were compiled by ATSDR (1995), and the MDEQ (1999) Statewide reference sediment chemistry for selected metals. The ATSDR values are the background urban soil concentrations that were derived from a variety of sources for individual PAHs. Appropriate urban background PAH concentrations for sediment would be preferable to soil data, but are not available. Soil PAH compiled by ATSDR (1995) are deemed to be a suitable surrogate for sediment data in this case, because sediment in Study Area reaches of the Flint River are expected to be of local terrigenous origin. The MDEQ values for inorganics were derived from sediment samples collected in 1994, 1997, and 1998 from reference rivers and streams in Michigan where the biological communities were categorized as excellent.

To provide an additional perspective, the mean concentrations of metals in soils from an urban watershed in southeastern Michigan (the Rouge River watershed; Murray et al. 2004) were also added to the background comparison tables.

5.2.1 Results for Alternate Screening Values

NECs, reported by Ingersoll et al. (1996), were developed for sensitive and representative freshwater benthic species. Several features of the NEC derivation process make NECs useful as toxicity benchmarks for secondary screening purposes. NECs were developed from empirical toxicity data, as opposed to predicted concentrations. Finally, an NEC is the sediment concentration of a given chemical above which a statistically significant effect is observed, and thus represents a more realistic effects level than the conservative sediment screening benchmarks used in ESLs.

The results of the comparisons to the NECs as alternate screening values, which are more likely to have a relevant toxicological basis than ESLs, are presented below. As can be seen from Tables 5 through 8, NEC exceedances were infrequent and often associated with individual samples, suggesting that any adverse effects to benthic organisms would be spatially limited within the Flint River Study Area.

5.2.1.1 Surface Samples

Table 5 compares the data for CoPCs identified in unbiased surface sediment to the NECs. Only lead at station FRT 5A exceeded the NEC in the adjacent reach. In the downstream reach, two PAHs exceeded their NECs at stations FRT 9A and B for benzo(a)pyrene, and at station FRT 9A for indeno(1,2,3-cd)pyrene. These exceedances were slight (i.e., less than a factor of two), and the mean concentrations of these PAHs for the downstream reach did not exceed the NECs.

Table 6 compares the data for CoPCs identified in surface sediment samples that are biased to the GM outfalls to the NECs. No CoPCs in biased samples exceeded NECs.

Mean concentrations of CoPCs did not exceed the NEC values in the adjacent or downstream reaches for the unbiased data set, and no chemicals exceeded NECs in the biased surface sediment samples. This suggests that any potential effects (as predicted by the exceedance of an NEC) would be spatially limited.

5.2.1.2 Subsurface Samples

Table 7 compares the data for CoPCs identified in unbiased subsurface sediment to the NECs. No unbiased subsurface samples exceeded NECs in the reach adjacent to the Facility. Chromium and lead exceeded NECs in the subsurface sample FRT 7C at the 2- to 12-inch interval, and five PAHs and lead exceeded NECs at the 12- to 24-inch interval. Mean concentrations across all subsurface depths (2–-46 inches) exceeded NECs for benzo(a)pyrene and indeno(1,2,3-cd)pyrene. With the exception of benzo(a)pyrene (7 times the NEC) and benzo(g,h,i)perylene (2.5 times the NEC) in the 12- to 24-inch sample from FRT 7C, all exceedances were within a factor of 2 of the NEC value.

Table 8 compares the biased subsurface samples to NECs. Three PAHs—benzo(a)pyrene, benzo(g,h,i)perylene, and indeno(1,2,3-cd)pyrene—exceeded NECs in the 2- to 12 inch interval, all by less than a factor of two.

NEC exceedances in the subsurface samples were limited to two samples (FRT 7C and FRT 12C), and in the 2- to 24inch interval.

5.2.2 Results for Regional and Urban Background Screening

Samples where CoPCs were identified in the initial screening (comparison to ESLs) were also compared to regional reference-site background values for inorganics and typical urban concentrations for inorganics and PAHs to provide an additional perspective by which to interpret the ecological significance of the ESL exceedances. The background values that were used in this analysis were the typical urban background soil concentrations for PAHs, reported by the ATSDR (1995); statewide reference sediment chemistry for all ecological regions, reported by the MDEQ (1999); and the mean concentrations of metals in Michigan surface soils for residential, commercial, and industrial land uses in an urban watershed (Murray et al. 2004).

5.2.2.1 Surface Samples

Table 9 presents the results of the comparison of unbiased surface samples to regional and urban background concentrations. An estimated concentration of benzo(a)pyrene (at station FRT 4C) and a detected concentration for lead (at FRT 5A) exceeded the urban background concentrations. Copper concentrations exceeded the regional background concentrations for reference rivers at stations FRT 4C and 5A. Lead also exceeded the regional reference site background value at station FRT 5A.

The mean concentration for benzo(a)pyrene exceeded the urban background value for unbiased surface samples in the adjacent reach. However, the exceedance was slight and based on an estimated detection. The mean concentration of lead exceeded the regional reference-site values, but was within the range of reported urban background concentrations for southeast Michigan.

In the downstream reach, benzo(a)pyrene, chrysene, copper, lead, and zinc exceeded background levels in unbiased surface sediment samples. Only zinc at stations FRT 9A and B exceeded the urban watershed values for inorganics in southeast Michigan, and the mean concentrations of the other inorganics (copper and lead) only slightly exceeded the reference-site background values.

Table 10 presents the background screening for surface samples collected at stations that were biased to the GM-influenced outfalls. Benzo(a)pyrene, chrysene, copper, lead, and zinc exceeded background levels in the biased surface sediment samples. Only zinc at station FRT 12C exceeded the urban watershed value, and the mean concentrations of the inorganics did not exceed any of the background levels. The mean concentration of benzo(a)pyrene exceeded the urban background level for this constituent, but only by a factor of 2 to 3.

5.2.2.2 Subsurface Samples

Table 11 presents the background screening for unbiased subsurface samples. Benzo(a)pyrene, chrysene, chromium, copper, lead, and zinc exceeded background levels in the downstream samples. Across all depth intervals, mean concentrations of benzo(a)pyrene, chrysene, copper, lead, and zinc exceeded the urban background levels, albeit by small margins.

Table 12 presents the background screening for subsurface samples collected at stations that were biased to the GM-influenced outfalls. Benzo(a)pyrene, chrysene, copper, lead, and zinc exceeded background levels in the biased subsurface sediment samples. No metals exceeded the urban watershed values, and the mean concentrations of the inorganics did not exceed any of the background levels. The mean concentrations of benzo(a)pyrene and chrysene across all depth intervals exceeded the range of urban background levels for these constituents, also by a small margin.

6 Summary and Conclusions

This SLERA was performed to develop the information necessary to support a risk management decision regarding potential releases from the NAO Flint Facility. This section summarizes the results of the risk characterization and uncertainty analysis, and assesses the ecological significance of these results. These elements are brought together with the statistical and trends analyses conducted in the Sediment Investigation (Section 3.2 of Sediment Investigation report) as the weight of evidence to draw conclusions regarding ecological risk.

The objective of the SLERA was to determine whether ecological risks are negligible, or to eliminate certain contaminants and exposure pathways from further consideration in the ERA process. According to the U.S. EPA (1997) guidance, the conclusions of a SLERA may be:

- There is adequate information to conclude that ecological risks are negligible, and therefore, no need exists for remediation on the basis of ecological risk;
- The information is not adequate to make a decision at this point, and the ERA process will continue; or
- The information indicates a potential for adverse ecological effects, and a more thorough assessment is warranted.

The process for the Flint River SLERA can be summarized as follows: the 13 constituents identified in the Sediment Investigation were screened against conservative screening values (i.e., ESLs) to identify ecological CoPCs, concentrations of CoPCs were compared to alternative toxicology-based screening values (i.e., NECs) and background levels as part of the uncertainty analysis, to provide additional lines of evidence from which to draw conclusions regarding ecological risk. The results for each of these lines of evidence are summarized in Tables 13 and 14 for surface sediment and subsurface sediment, respectively. If a constituent and an exposure area (i.e., upstream, adjacent, or downstream reach) were eliminated in the early stages of the screening process, they are not included in Tables 13 and 14. For example, no upstream sediment concentrations for any constituent exceeded ESLs; therefore, the upstream exposure area was not evaluated in the secondary screening or background comparisons. Similarly, the ESL for benzo(b)fluoranthene was not exceeded in any sample; therefore, this constituent was eliminated from further evaluation in the SLERA.

Table 13 summarizes the weight of evidence regarding ecological risk from exposure to both unbiased and biased sets of surface sediment samples. The CoPCs in surface sediment include eight PAHs, and copper, lead, and zinc. These chemicals were compared to the NECs, which were derived by Ingersoll et al. (1996) from freshwater sediment toxicity tests on amphipods and represent threshold values below which adverse effects to sensitive benthic organisms would not be expected. Only copper in the adjacent reach and two PAHs (benzo(a)pyrene and indeno(1,2,3-cd)pyrene) in the downstream reach exceeded NECs for surface sediment. The NEC exceedances for these CoPCs were small (less than a factor of 2) and were limited to three stations, FRT 5A in the adjacent reach for lead, and FRT 9A and B in the downstream reach for

PAHs. Stations FRT 9A and B are the farthest downstream stations, and are located immediately downstream of five non-GM outfalls. In the background screening, the exceedances were again small for the surface sediments (generally within a factor of 2 or 3).

There is no direct exposure pathway for constituents in subsurface sediment to ecological receptors, and therefore, these sediments do not pose a meaningful present risk. However, subsurface sediments were evaluated at EPA's request to illustrate worst-case potential ecological exposure during deep sediment mixing that might occur during a flood event or as a result of ice scour. Table 14 summarizes the weight of evidence regarding ecological risk from exposure to both unbiased and biased subsurface sediment. The CoPCs in subsurface sediment include eight PAHs, chromium, copper, lead, and zinc. These chemicals were also compared to the NECs. Three PAHs in the adjacent reach, and five PAHs, chromium, and lead in the downstream reach, exceeded NECs for subsurface sediment. Mean concentrations of benzo(a)pyrene and indeno(1,2,3-cd) pyrene exceeded the NECs in the downstream reach for unbiased samples; however, these exceedances were small, within a factor of 2. NEC exceedances for metals in the subsurface were also small (less than a factor of 2), and were limited to downstream station FRT 7C. In the background screening, the exceedances were within a factor of 2 or 3 for the metals and were somewhat larger for the PAHs benzo(a)pyrene and chrysene, and were primarily related to concentrations of CoPCs that were detected at station FRT 7C. This station is located adjacent to a non-GM-related outfall and near the mouth of Gilkey Creek, on the western shoreline (opposite the Facility, and one-half mile downstream). FRT 7C also had the highest proportions of clay and organic matter of all unbiased subsurface samples, which may also partially explain the higher concentrations of CoPCs at this station based on what is known about the transport and fate properties of these chemicals (affinity for binding to organic matter and clay).

NEC exceedances for both surface and subsurface sediment were generally infrequent and were often associated with individual samples, suggesting that any adverse effects to benthic organisms would be spatially limited within the Flint River Study Area. The constituents that were identified as CoPCs in the screening process are PAHs and metals. These chemicals have many anthropogenic sources, including atmospheric deposition and other sources that are unrelated to the GM Facility, such as municipal wastewater treatment plants and road runoff. The levels that were detected in the Flint River Study Area sediment are generally within the range of concentrations that would be considered typical for an urban waterway.

In the unbiased data set, surface sediment concentrations were highest at stations FRT 9A and B, located farthest downstream of the Facility and immediately downstream of five non-GM outfalls. Subsurface sediment concentrations were highest in station FRT 7C in the downstream reach near Gilkey Creek and adjacent to a non-GM outfall. The spatial distribution of NEC exceedances indicates that exposure to the CoPCs, and adverse effects, if any, would occur over small areas. The locations of the stations with the highest CoPC concentrations indicate little or no association with the Facility-influenced outfalls, and a greater association with non-GM outfalls and tributaries such as Gilkey Creek (i.e., FRT 7C).

It is also important to consider the toxicological endpoint represented by the screening values. In the case of the NECs, these are no-effect concentrations below which adverse effects to benthic organisms are not likely, and it is not known whether a slight exceedance would result in any observed toxicity. Because the NEC exceedances were generally small, if any adverse effects were to occur at the concentrations observed, it is likely that these effects would be manifested as reductions in benthic invertebrate growth or reproduction, rather than direct mortality.

The following factors suggest that the available information is adequate to conclude that ecological risks are low to negligible, and therefore, no need exists for further investigation or remediation within the Flint River on the basis of ecological risk:

- Comparison of CoPC concentrations to NECs and urban background values indicates a very low potential for adverse effects to benthos, if any, and that that CoPC concentrations are generally within the ranges that would be expected in an urban waterway such as the Flint River
- Exceedances are not widespread throughout the Study Area, and in some cases, are even limited to one or two samples, indicating that adverse effects to benthos, if any, are spatially limited and more likely than not, are not ecologically significant
- Elevated levels of CoPCs are not associated exclusively with the locations of Facility-related outfalls, and in many cases, appear to have a greater association with non-GM-related outfalls and tributaries
- Ecological receptors' exposure to subsurface sediment represents an unlikely worst-case scenario wherein ice scour would remove the overlying sediment without disturbing the subsurface layers where elevated constituents occur.

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Tables

Table 1. Screening of surface sediment analytical results for unbiased sampling transects

			Upstream						Adjacent		
Sample ID:			FRT 1C	FRT 2B	FRT 2C	FRT 3A	FRT 3B		FRT 4A	FRT 4C	FRT 5A
Sample Depth (in BGS):			0–2	0–2	0–2	0–2	0–2		0–2	0–2	0–2
Date Collected:	Units	ESL	11/01/06	11/01/06	11/01/06	11/01/06	11/01/06	Mean	11/01/06	11/01/06	10/31/06
SVOCs											
Benzo[a]pyrene	mg/kg	0.15	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.20 *J*	0.62 *J*	0.20 *J*
Benzo[b]fluoranthene	mg/kg	10.4	0.17 *UJ*	0.17 *UJ*	0.17 *UJ*	0.17 *UJ*	0.17 *UJ*	0.17 *UJ*	0.20 *J*	0.75 *J*	0.17 *UJ*
Benzo[g,h,i]perylene	mg/kg	0.17	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.10 *J*	0.47	0.10 *J*
Benzo[k]fluoranthene	mg/kg	0.24	0.17 *UJ*	0.17 *UJ*	0.17 *UJ*	0.17 *UJ*	0.17 *UJ*	0.17 *UJ*	0.20 *J*	0.53 *J*	0.20 *J*
Chrysene	mg/kg	0.166	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.20 *J*	0.54	0.10 *J*
Fluoranthene	mg/kg	0.423	0.17 *U*	0.17 *U*	0.03 *J*	0.17 *U*	0.17 *U*	0.14 *J*	0.30 *J*	1.08	0.20 *J*
Fluorene	mg/kg	0.0774	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.09 *J*	0.17 *U*
Indeno[1,2,3-cd]pyrene	mg/kg	0.2	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.10 *J*	0.39	0.10 *J*
Pyrene	mg/kg	0.195	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.46	0.17 *U*
Inorganics											
Chromium (total)	mg/kg	43.4	1.0 *U*	1.0 *U*	5.5	1.0 *U*	1.0 *U*	1.9 *U*	22.4	7.0	11.4
Copper	mg/kg	31.6	2.3	0.5 *U*	15.5	1.9	0.5 *U*	4.1	13.5	31.2	25.9
Lead	mg/kg	35.8	3.6	3.5	13.1	3.0	2.4	5.1	15.4	26.0	214.0
Zinc	mg/kg	121	12 *J*	8 *J*	43 *J*	11 *J*	8 *J*	16.4 *J*	28 *J*	72 *J*	43 *J*
Miscellaneous											
TOC	mg/kg	--	95	26	420	37	20	--	140	170	25
Total Solids	%	--	72	81	40	75	79	--	64	47	77
Field Parameters											
Clay	%wt	--	ND	-2	-2	4.84	-2	--	-2	-2	-2
Coarse Sand	%wt	--	7.16	6.21	26.63	0	2.52	--	11.34	6.24	3.04
Fine Sand	%wt	--	55.1	33.06	20.1	74.68	52.6	--	33.51	39.71	36.52
Grain Density	mm	--	0.361	0.51	1.27	0.32	0.407	--	0.577	0.362	0.523
Gravel	%wt	--	3.68	1.67	8.65	0	1.41	--	7.03	26.94	4.72
Medium Sand	%wt	--	32.89	58.68	40.7	14.46	43.03	--	45.16	13.78	53.94
Silt	%wt	--	ND	-2	-2	6.01	-2	--	-2	-2	-2
Silt/Clay	%wt	--	1.17	0.38	3.92	10.85	0.44	--	2.97	13.32	1.78

Table 1. (cont.)

			Adjacent			Downstream					
									FRT 9A		
Sample ID:			FRT 5B	FRT 6B		FRT 7A	FRT 7C	FRT 8B	0 - 2	FRT 9B	
Sample Depth (in BGS):			0–2	0–2		0–2	0–2	0–2	10/31/06	0 - 2	
Date Collected:	Units	ESL	10/31/06	10/31/06	Mean	10/31/06	10/31/06	10/31/06	AVE	10/31/06	Mean
SVOCs											
Benzo[a]pyrene	mg/kg	0.15	0.20 *J*	0.17 *U*	0.28 *J*	0.30 *J*	0.81 *J*	0.10 *J*	1.46 *J*	1.07	0.75 *J*
Benzo[b]fluoranthene	mg/kg	10.4	0.20 *J*	0.17 *UJ*	0.30 *J*	0.30 *J*	0.89 *J*	0.17 *UJ*	1.685 *J*	1.32 *J*	0.87 *J*
Benzo[g,h,i]perylene	mg/kg	0.17	0.20 *J*	0.17 *U*	0.21 *J*	0.20 *J*	0.62 *J*	0.08 *J*	1.16	0.75	0.56 *J*
Benzo[k]fluoranthene	mg/kg	0.24	0.20 *J*	0.07 *J*	0.24 *J*	0.30 *J*	0.82 *J*	0.17 *UJ*	1.335 *J*	0.88 *J*	0.70 *J*
Chrysene	mg/kg	0.166	0.30 *J*	0.06 *J*	0.24 *J*	0.30 *J*	0.66 *J*	0.10 *J*	1.18	0.94	0.64 *J*
Fluoranthene	mg/kg	0.423	0.48	0.10 *J*	0.43 *J*	0.44	1.20 *J*	0.10 *J*	2.2 *J*	2.05	1.20 *J*
Fluorene	mg/kg	0.0774	0.17 *U*	0.17 *U*	0.15 *J*	0.17 *U*	0.10 *J*	0.17 *U*	0.1 *J*	0.10 *J*	0.13 *J*
Indeno[1,2,3-cd]pyrene	mg/kg	0.2	0.10 *J*	0.17 *U*	0.17 *J*	0.20 *J*	0.52 *J*	0.06 *J*	1.035	0.67	0.50 *J*
Pyrene	mg/kg	0.195	0.35	0.17 *U*	0.26	0.17 *U*	0.41 *J*	0.17 *U*	1.325	1.25	0.66 *J*
Inorganics											
Chromium (total)	mg/kg	43.4	4.8	5.2	10.2	5.9	7.5	41.2	24.3	15.8	18.9
Copper	mg/kg	31.6	15.8	10.9	19.5	13.7	33.0	4.6	86.15	16.6	30.8
Lead	mg/kg	35.8	16.8	12.2	56.9	23.9	34.0	8.2	117	72.8	51.2
Zinc	mg/kg	121	38 *J*	31 *J*	42.4 *J*	50 *J*	94 *J*	31 *J*	302.5 *J*	312 *J*	157.8 *J*
Miscellaneous											
TOC	mg/kg	--	50	20	--	42	45	15 *U*	315 *J*	89	--
Total Solids	%	--	73	86	--	60	57	75	24	54	--
Field Parameters											
Clay	%wt	--	-2	-2	--	-2	-2	-2	55.905	-2	--
Coarse Sand	%wt	--	0.93	10.88	--	3.15	0.24	26.2	0	7.81	--
Fine Sand	%wt	--	75.91	14.94	--	57.58	82.93	5.84	0	26.94	--
Grain Density	mm	--	0.31	0.867	--	0.352	0.15	1.751	0.0045	0.632	--
Gravel	%wt	--	4.98	4.54	--	0.44	0	16.65	0	1.62	--
Medium Sand	%wt	--	14.91	68.39	--	34.94	3.27	50.42	0	56.01	--
Silt	%wt	--	-2	-2	--	-2	-2	-2	44.095	-2	--
Silt/Clay	%wt	--	3.26	1.26	--	3.89	13.56	0.9	100	7.61	--

Note:

--	- not available, or not applicable	ND	- not differentiated
% wt	- percent by weight	PCB	- polychlorinated biphenyl
AVE	- average of duplicate sample	SLERA	- screening level ecological risk assessment
BGS	- below ground surface	SVOC	- semivolatile organic compound
ESL	- ecological screening level (U.S. EPA 2003)	TOC	- total organic carbon
J	- estimated value	*U*	- undetected
mg/kg	- milligrams per kilogram, dry weight		

Sampling was performed by ARCADIS BBL and Exponent during the week of October 30, 2006.

Samples were analyzed for SVOCs, PCBs, and metals, as well as TOC and particle size distribution, by Merit Laboratories of East Lansing, MI.

The 13 constituents that showed statistically higher mean and/or median concentrations between the 3 reaches sampled were retained for the SLERA (refer to Section 3.2 of Flint River Sediment Investigation).

Non-detects shown at half the detection limit.

Boxed values exceed ESL screening value.

Table 2. Screening of surface sediment analytical results for biased sampling transects near GM Outfalls 003, 005, and 013

			Adjacent						
					FRT 11B				
Sample ID:			FRT 10A	FRT 10B	0–2	FRT 11C	FRT 12B	FRT 12C	
Sample Depth (in BGS):			0–2	0–2	11/01/06	0–2	0–2	0–2	
Date Collected:	Units	ESL	10/31/06	10/31/06	AVE	11/01/06	10/31/06	10/31/06	Mean
SVOCs									
Benzo[a]pyrene	mg/kg	0.15	$\boxed{0.73}$	$\boxed{0.20}$ *J*	$\boxed{0.865}$	$\boxed{0.20}$ *J*	$\boxed{0.30}$ *J*	$\boxed{0.83}$	$\boxed{0.52}$ *J*
Benzo[b]fluoranthene	mg/kg	10.4	0.88 *J*	0.17 *UJ*	0.865 *J*	0.30 *J*	0.30 *J*	0.88 *J*	0.57 *J*
Benzo[g,h,i]perylene	mg/kg	0.17	$\boxed{0.65}$	0.17 *U*	$\boxed{0.56}$	$\boxed{0.20}$ *J*	$\boxed{0.20}$ *J*	$\boxed{0.69}$	$\boxed{0.41}$ *J*
Benzo[k]fluoranthene	mg/kg	0.24	$\boxed{0.51}$ *J*	0.17 *UJ*	$\boxed{0.695}$ *J*	0.20 *J*	$\boxed{0.30}$ *J*	$\boxed{0.75}$ *J*	$\boxed{0.44}$ *J*
Chrysene	mg/kg	0.166	$\boxed{0.58}$	0.10 *J*	$\boxed{0.715}$	$\boxed{0.20}$ *J*	$\boxed{0.20}$ *J*	$\boxed{0.65}$	$\boxed{0.41}$ *J*
Fluoranthene	mg/kg	0.423	$\boxed{1.05}$	0.20 *J*	$\boxed{1.62}$ *J*	0.38	0.37	$\boxed{1.29}$	$\boxed{0.82}$ *J*
Fluorene	mg/kg	0.0774	$\boxed{0.10}$ *J*	$\boxed{0.17}$ *U*	$\boxed{0.15}$ *J*	$\boxed{0.17}$ *U*	$\boxed{0.17}$ *U*	0.07 *J*	$\boxed{0.14}$ *J*
Indeno[1,2,3-cd]pyrene	mg/kg	0.2	$\boxed{0.50}$	0.17 *U*	$\boxed{0.505}$	0.20 *J*	0.20 *J*	$\boxed{0.58}$	$\boxed{0.36}$ *J*
Pyrene	mg/kg	0.195	$\boxed{0.20}$ *J*	0.17 *U*	$\boxed{0.8}$ *J*	0.17 *U*	0.17 *U*	$\boxed{0.46}$	$\boxed{0.33}$ *J*
Inorganics									
Chromium (total)	mg/kg	43.4	8.2	2.8	4.1	3.0	10.5	22.8	8.6
Copper	mg/kg	31.6	24.4	3.3	7.2	17.8	9.1	$\boxed{73.2}$	22.5
Lead	mg/kg	35.8	35.3	9.1	10.95	10.1	18.7	$\boxed{124.0}$	34.7
Zinc	mg/kg	121	105	18 *J*	37.45 *J*	25 *J*	62 *J*	$\boxed{316}$ *J*	94.0 *J*
Miscellaneous									
TOC	mg/kg	--	52	19	30	32	34	200	--
Total Solids	%	--	53	79	80	73	66	20	--
Field Parameters									
Clay	%wt	--	-2	-2	-2	-2	-2	57.92	--
Coarse Sand	%wt	--	1.38	0.44	10.535	0.20	6.42	0	--
Fine Sand	%wt	--	84.87	79.7	50.15	88.66	23.63	0	--
Grain Density	mm	--	0.201	0.325	0.397	0.294	0.605	0.004	--
Gravel	%wt	--	3.22	0	8.755	0	4.73	0	--
Medium Sand	%wt	--	3.81	19.31	28.305	8.24	63.58	0	--
Silt	%wt	--	-2	-2	-2	-2	-2	42.08	--
Silt/Clay	%wt	--	6.73	0.55	2.255	2.9	1.64	100	--

Note:

--	- not available, or not applicable		mg/kg	- milligrams per kilogram, dry weight
% wt	- percent by weight		PCB	- polychlorinated biphenyl
AVE	- average of duplicate sample		SLERA	- screening level ecological risk assessment
BGS	- below ground surface		SVOC	- semivolatile organic compound
ESL	- ecological screening level (U.S. EPA 2003)		TOC	- total organic carbon
J	- estimated value		*U*	- undetected

Sampling was performed by ARCADIS BBL and Exponent during the week of October 30, 2006.

Samples were analyzed for SVOCs, PCBs, and metals, as well as TOC and particle size distribution, by Merit Laboratories of East Lansing, MI.

The 13 constituents that showed statistically higher mean and/or median concentrations between the 3 reaches sampled were retained for the SLERA (refer to Section 3.2 of Flint River Sediment Investigation).

Non-detects shown at half the detection limit.

Boxed values exceed ESL screening value.

Table 3. Screening of subsurface sediment analytical results for unbiased sampling transects

			Upstream						Adjacent		
Sample ID:			FRT 2C	FRT 2C	FRT 2C	FRT 2C	FRT 2C		FRT 4A	FRT 4A	
Sample Depth (in BGS):			2–12	12–24	24–36	36–48	48–57		2–12	12–24	
Date Collected:	Units	ESL	11/01/06	11/01/06	11/01/06	11/01/06	11/01/06	Mean	11/01/06	11/01/06	Mean
SVOCs											
Benzo[a]pyrene	mg/kg	0.15	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.20 *J*	0.17 *U*	0.18 *J*
Benzo[b]fluoranthene	mg/kg	10.4	0.17 *UJ*	0.17 *UJ*	0.17 *UJ*	0.17 *UJ*	0.17 *UJ*	0.17 *UJ*	0.10 *J*	0.17 *UJ*	0.13 *J*
Benzo[g,h,i]perylene	mg/kg	0.17	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.10 *J*	0.17 *U*	0.13 *J*
Benzo[k]fluoranthene	mg/kg	0.24	0.17 *UJ*	0.17 *UJ*	0.17 *UJ*	0.17 *UJ*	0.17 *UJ*	0.17 *UJ*	0.10 *J*	0.17 *UJ*	0.13 *J*
Chrysene	mg/kg	0.166	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.10 *J*	0.17 *U*	0.13 *J*
Fluoranthene	mg/kg	0.423	0.03 *J*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.14 *J*	0.20 *J*	0.17 *U*	0.18 *J*
Fluorene	mg/kg	0.0774	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*
Indeno[1,2,3-cd]pyrene	mg/kg	0.2	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.09 *J*	0.17 *U*	0.13 *J*
Pyrene	mg/kg	0.195	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*	0.17 *U*
Inorganics											
Chromium (total)	mg/kg	43.4	8.9	6.5	2.1	1.0 *U*	1.0 *U*	3.9	2.5	1.0 *U*	1.8
Copper	mg/kg	31.6	7.0	8.1	1.7	1.2	0.5 *U*	3.7	7.3	1.7	4.5
Lead	mg/kg	35.8	6.6	8.9	1.6	1.6	0.5 *U*	3.8	7.9	1.8	4.9
Zinc	mg/kg	121	30	35	6	6	4	16.1	15	12	13.6
Miscellaneous											
TOC	mg/kg	--	50	37	22	30	12 *U*	--	19	23	--
Total Solids	%	--	63	73	68	71	83	--	79	77	--
Field Parameters											
Clay	%wt	--	-2	-2	-2	-2	1.07	--	-2	-2	--
Coarse Sand	%wt	--	10.24	0.42	1.78	0.74	0	--	12.44	5.85	--
Fine Sand	%wt	--	47.24	65.36	56.15	80.52	64.29	--	42.39	68.42	--
Grain Density	mm	--	0.35	0.292	0.338	0.283	0.339	--	0.473	0.272	--
Gravel	%wt	--	6.82	0	7.11	2.9	0	--	16.88	7.33	--
Medium Sand	%wt	--	26.77	22.49	30.54	9.21	30.88	--	23.83	12.57	--
Silt	%wt	--	-2	-2	-2	-2	3.77	--	-2	-2	--
Silt/Clay	%wt	--	8.92	11.73	4.41	6.63	4.83	--	4.46	5.83	--

Table 3. (cont.)

			Downstream				
			FRT 7C				
Sample ID:			2–12	FRT 7C	FRT 7C	FRT 7C	
Sample Depth (in BGS):			39021	12–24	24–36	36–46	
Date Collected:	Units	ESL	AVE	10/31/06	10/31/06	10/31/06	Mean
SVOCs							
Benzo[a]pyrene	mg/kg	0.15	0.5 *U*	7.00	0.53	0.17 *U*	2.05
Benzo[b]fluoranthene	mg/kg	10.4	1.5 *J*	4.00 *J*	0.30 *J*	0.17 *UJ*	1.49 *J*
Benzo[g,h,i]perylene	mg/kg	0.17	0.5 *U*	3.00 *J*	0.35	0.17 *U*	1.00 *J*
Benzo[k]fluoranthene	mg/kg	0.24	0.9 *J*	4.00 *J*	0.30 *J*	0.17 *UJ*	1.34 *J*
Chrysene	mg/kg	0.166	1.5	7.00	0.38	0.17 *U*	2.26
Fluoranthene	mg/kg	0.423	1.4 *J*	7.00	0.39	0.17 *U*	2.24 *J*
Fluorene	mg/kg	0.0774	0.5 *U*	0.50 *U*	0.10 *J*	0.17 *U*	0.32 *J*
Indeno[1,2,3-cd]pyrene	mg/kg	0.2	0.5 *U*	3.00 *J*	0.30 *J*	0.17 *U*	0.99 *J*
Pyrene	mg/kg	0.195	0.5 *U*	12.0	0.17 *U*	0.17 *U*	3.21
Inorganics							
Chromium (total)	mg/kg	43.4	136	64.4	6.5	2.3	52.3
Copper	mg/kg	31.6	135	127.0	7.9	3.4	68.3
Lead	mg/kg	35.8	221	183.0	10.3	3.8	104.5
Zinc	mg/kg	121	645	338	22	12	254.2
Miscellaneous							
TOC	mg/kg	--	110	180	89	47	--
Total Solids	%	--	62.5	51	66	75	--
Field Parameters							
Clay	%wt	--	59.645	63.38	59.02	11.15	--
Coarse Sand	%wt	--	0	0	0	0	--
Fine Sand	%wt	--	0	0	0	53.45	--
Grain Density	mm	--	0.004	0.004	0.004	0.097	--
Gravel	%wt	--	0	0	0	0	--
Medium Sand	%wt	--	0	0	0	0.89	--
Silt	%wt	--	40.355	36.62	40.98	34.5	--
Silt/Clay	%wt	--	100	100	100	45.66	--

Note:					
--	-	not available, or not applicable	mg/kg	-	milligrams per kilogram, dry weight
% wt	-	percent by weight	PCB	-	polychlorinated biphenyl
AVE	-	average of duplicate sample	SLERA	-	screening level ecological risk assessment
BGS	-	below ground surface	SVOC	-	semivolatile organic compound
ESL	-	ecological screening level (U.S. EPA 2003)	TOC	-	total organic carbon
J	-	estimated value	*U*	-	undetected

Sampling was performed by ARCADIS BBL and Exponent during the week of October 30, 2006.

Samples were analyzed for SVOCs, PCBs, and metals, as well as TOC and particle size distribution, by Merit Laboratories of East Lansing, MI.

The 13 constituents that showed statistically higher mean and/or median concentrations between the 3 reaches sampled were retained for the SLERA (refer to Section 3.2 of Flint River Sediment Investigation).

Non-detects shown at half the detection limit.

Boxed values exceed ESL screening value.

Table 4. Screening of subsurface sediment analytical results for biased transects near GM Outfalls 003, 005, and 013

			Adjacent			
Sample ID:			FRT 12C	FRT 12C	FRT 12C	
Sample Depth (in BGS):			2–12	12–24	24–36	
Date Collected:	Units	ESL	11/01/06	11/01/06	11/01/06	Mean
SVOCs						
Benzo[a]pyrene	mg/kg	0.15	1.77	0.99	0.20 *J*	0.99 *J*
Benzo[b]fluoranthene	mg/kg	10.4	2.20 *J*	1.18 *J*	0.30 *J*	1.23 *J*
Benzo[g,h,i]perylene	mg/kg	0.17	1.41	0.82	0.20 *J*	0.81 *J*
Benzo[k]fluoranthene	mg/kg	0.24	1.45 *J*	0.93 *J*	0.20 *J*	0.86 *J*
Chrysene	mg/kg	0.166	1.54	0.88	0.20 *J*	0.87 *J*
Fluoranthene	mg/kg	0.423	3.05	1.69	0.41	1.72
Fluorene	mg/kg	0.0774	0.20 *J*	0.10 *J*	0.17 *U*	0.16 *J*
Indeno[1,2,3-cd]pyrene	mg/kg	0.2	1.16	0.69	0.10 *J*	0.65
Pyrene	mg/kg	0.195	2.02	0.84	0.17 *U*	1.01
Inorganics						
Chromium (total)	mg/kg	43.4	16.0	8.4	7.2	10.5
Copper	mg/kg	31.6	48.0	8.9	13.1	23.3
Lead	mg/kg	35.8	72.3	14.0	20.8	35.7
Zinc	mg/kg	121	229	41	44	104.8
Miscellaneous						
TOC	mg/kg	--	88	27	26	--
Total Solids	%	--	41	76	78	--
Field Parameters						
Clay	%wt	--	-2	-2	-2	--
Coarse Sand	%wt	--	0.4	0.35	0.24	--
Fine Sand	%wt	--	54.18	82.09	80.87	--
Grain Density	mm	--	0.195	0.311	0.302	--
Gravel	%wt	--	0	0.86	0.22	--
Medium Sand	%wt	--	24.78	15.49	14.84	--
Silt	%wt	--	-2	-2	-2	--
Silt/Clay	%wt	--	20.64	1.21	3.83	--

Note:	--	-	not available, or not applicable
	% wt	-	percent by weight
	AVE	-	average of duplicate sample
	BGS	-	below ground surface
	ESL	-	ecological screening level (U.S. EPA 2003)
	J	-	estimated value
	mg/kg	-	milligrams per kilogram, dry weight
	PCB	-	polychlorinated biphenyl
	SLERA	-	screening level ecological risk assessment
	SVOC	-	semivolatile organic compound
	TOC	-	total organic carbon
	U	-	undetected

Sampling was performed by ARCADIS BBL and Exponent during the week of October 30, 2006.

Samples were analyzed for SVOCs, PCBs, and metals, as well as TOC and particle size distribution, by Merit Laboratories of East Lansing, MI.

The 13 constituents that showed statistically higher mean and/or median concentrations between the 3 reaches sampled were retained for the SLERA (refer to Section 3.2 of Flint River Sediment Investigation).

Non-detects shown at half the detection limit.

Boxed values exceed ESL screening value.

Table 5. Secondary screening of surface sediment analytical results for unbiased sampling transects

			Adjacent					
Sample ID:			FRT 4A	FRT 4C	FRT 5A	FRT 5B	FRT 6B	
Sample Depth (in BGS):			0–2	0–2	0–2	0–2	0–2	
Date Collected:	Units	NEC	11/01/06	11/01/06	10/31/06	10/31/06	10/31/06	Mean
SVOCs								
Benzo[a]pyrene	mg/kg	1	0.20 *J*	0.62 *J*	0.20 *J*	0.20 *J*	0.17 *U*	0.28 *J*
Benzo[g,h,i]perylene	mg/kg	1.2	0.10 *J*	0.47	0.10 *J*	0.20 *J*	0.17 *U*	0.21 *J*
Benzo[k]fluoranthene	mg/kg	4	0.20 *J*	0.53 *J*	0.20 *J*	0.20 *J*	0.07 *J*	0.24 *J*
Chrysene	mg/kg	3	0.20 *J*	0.54	0.10 *J*	0.30 *J*	0.06 *J*	0.24 *J*
Fluoranthene	mg/kg	10	0.30 *J*	1.08	0.20 *J*	0.48	0.10 *J*	0.43 *J*
Fluorene	mg/kg	3	0.17 *U*	0.09 *J*	0.17 *U*	0.17 *U*	0.17 *U*	0.15 *J*
Indeno[1,2,3-cd]pyrene	mg/kg	0.77	0.10 *J*	0.39	0.10 *J*	0.10 *J*	0.17 *U*	0.17 *J*
Pyrene	mg/kg	9	0.17 *U*	0.46	0.17 *U*	0.35	0.17 *U*	0.26
Inorganics								
Copper	mg/kg	580	13.5	31.2	25.9	15.8	10.9	19.5
Lead	mg/kg	130	15.4	26.0	214.0	16.8	12.2	56.9
Zinc	mg/kg	1,300	28 *J*	72 *J*	43 *J*	38 *J*	31 *J*	42.4 *J*

Table 5. (cont.)

			Downstream					
Sample ID:			FRT 7A	FRT 7C	FRT 8B	FRT 9A	FRT 9B	
Sample Depth (in BGS):			0–2	0–2	0–2	0–2	0–2	
Date Collected:	Units	NEC	10/31/06	10/31/06	10/31/06	10/31/06 AVE	10/31/06	Mean
SVOCs								
Benzo[a]pyrene	mg/kg	1	0.30 *J*	0.81 *J*	0.10 *J*	1.46 *J*	1.07	0.75 *J*
Benzo[g,h,i]perylene	mg/kg	1.2	0.20 *J*	0.62 *J*	0.08 *J*	1.16	0.75	0.56 *J*
Benzo[k]fluoranthene	mg/kg	4	0.30 *J*	0.82 *J*	0.17 *UJ*	1.335 *J*	0.88 *J*	0.70 *J*
Chrysene	mg/kg	3	0.30 *J*	0.66 *J*	0.10 *J*	1.18	0.94	0.64 *J*
Fluoranthene	mg/kg	10	0.44	1.20 *J*	0.10 *J*	2.2 *J*	2.05	1.20 *J*
Fluorene	mg/kg	3	0.17 *U*	0.10 *J*	0.17 *U*	0.1 *J*	0.10 *J*	0.13 *J*
Indeno[1,2,3-cd]pyrene	mg/kg	0.77	0.20 *J*	0.52 *J*	0.06 *J*	1.035	0.67	0.50 *J*
Pyrene	mg/kg	9	0.17 *U*	0.41 *J*	0.17 *U*	1.325	1.25	0.66 *J*
Inorganics								
Copper	mg/kg	580	13.7	33.0	4.6	86.15	16.6	30.8
Lead	mg/kg	130	23.9	34.0	8.2	117	72.8	51.2
Zinc	mg/kg	1300	50 *J*	94 *J*	31 *J*	302.5 *J*	312 *J*	158 *J*

Note:		
	AVE	- average of duplicate sample
	BGS	- below ground surface
	ESL	- ecological screening level
	J	- estimated value
	mg/kg	- milligrams per kilogram, dry weight
	NEC	- no effects concentration (Ingersoll et al. 1996)
	PCB	- polychlorinated biphenyl
	SVOC	- semivolatile organic compound
	U	- undetected

Sampling was performed by ARCADIS BBL and Exponent during the week of October 30, 2006.

Samples were analyzed for SVOCs, PCBs, and metals, as well as total organic carbon and particle size distribution, by Merit Laboratories of East Lansing, MI.

Chemicals that exceeded ESLs, or for which no ESLs were available, were retained for secondary screening (refer to Table 1).

Non-detects shown at half the detection limit.

Boxed values exceed NEC screening value.

Table 6. Secondary screening of surface sediment analytical results for biased sampling transects near GM Outfalls 003, 005, and 013

			Adjacent						
Sample ID:			FRT 10A	FRT 10B	FRT 11B	FRT 11C	FRT 12B	FRT 12C	
Sample Depth(in BGS):			0–2	0–2	0–2	0–2	0–2	0–2	
Date Collected:	Units	NEC	10/31/06	10/31/06	11/01/06 AVE	11/01/06	10/31/06	10/31/06	Mean
SVOCs									
Benzo[a]pyrene	mg/kg	1	0.73	0.20 *J*	0.865	0.20 *J*	0.30 *J*	0.83	0.52 *J*
Benzo[g,h,i]perylene	mg/kg	1.2	0.65	0.17 *U*	0.56	0.20 *J*	0.20 *J*	0.69	0.41 *J*
Benzo[k]fluoranthene	mg/kg	4	0.51 *J*	0.17 *UJ*	0.695 *J*	0.20 *J*	0.30 *J*	0.75 *J*	0.44 *J*
Chrysene	mg/kg	3	0.58	0.10 *J*	0.715	0.20 *J*	0.20 *J*	0.65	0.41 *J*
Fluoranthene	mg/kg	10	1.05	0.20 *J*	1.62 *J*	0.38	0.37	1.29	0.82 *J*
Fluorene	mg/kg	3	0.10 *J*	0.17 *U*	0.15 *J*	0.17 *U*	0.17 *U*	0.07 *J*	0.14 *J*
Indeno[1,2,3-cd]pyrene	mg/kg	0.77	0.50	0.17 *U*	0.505	0.20 *J*	0.20 *J*	0.58	0.36 *J*
Pyrene	mg/kg	9	0.20 *J*	0.17 *U*	0.8 *J*	0.17 *U*	0.17 *U*	0.46	0.33 *J*
Inorganics									
Copper	mg/kg	580	24.4	3.3	7.2	17.8	9.1	73.2	22.5
Lead	mg/kg	130	35.3	9.1	10.95	10.1	18.7	124.0	34.7
Zinc	mg/kg	1,300	105	18 *J*	37.45 *J*	25 *J*	62 *J*	316 *J*	94 *J*

Note:

AVE	-	average of duplicate sample
BGS	-	below ground surface
ESL	-	ecological screening level
J	-	estimated value
mg/kg	-	milligrams per kilogram, dry weight
NEC	-	no effects concentration (Ingersoll et al. 1996)
PCB	-	polychlorinated biphenyl
SVOC	-	semivolatile organic compound
U	-	undetected

Sampling was performed by ARCADIS BBL and Exponent during the week of October 30, 2006.

Samples were analyzed for SVOCs, PCBs, and metals, as well as total organic carbon and particle size distribution, by Merit Laboratories of East Lansing, MI.

Chemicals that exceeded ESLs, or for which no ESLs were available, were retained for secondary screening (refer to Table 2).

Non-detects shown at half the detection limit.

Boxed values exceed NEC screening value.

Table 7. Secondary screening of subsurface sediment analytical results for unbiased sampling transects

			Adjacent			Downstream				
Sample ID:			FRT 4A	FRT 4A		FRT 7C	FRT 7C	FRT 7C	FRT 7C	
Sample Depth (in BGS):			2–12	12–24		2–12	12–24	24–36	36–46	
Date Collected:	Units	NEC	11/01/06	11/01/06	Mean	10/31/06 AVE	10/31/06	10/31/06	10/31/06	Mean
SVOCs										
Benzo[a]pyrene	mg/kg	1	0.20 *J*	0.17 *U*	0.18 *J*	0.5 *U*	$\boxed{7.00}$	0.53	0.17 *U*	$\boxed{2.05}$
Benzo[g,h,i]perylene	mg/kg	1.2	0.10 *J*	0.17 *U*	0.13 *J*	0.5 *U*	$\boxed{3.00}$ *J*	0.35	0.17 *U*	1.00 *J*
Benzo[k]fluoranthene	mg/kg	4	0.10 *J*	0.17 *UJ*	0.13 *J*	0.9 *J*	4.00 *J*	0.30 *J*	0.17 *UJ*	1.34 *J*
Chrysene	mg/kg	3	0.10 *J*	0.17 *U*	0.13 *J*	1.5	$\boxed{7.00}$	0.38	0.17 *U*	2.26
Fluoranthene	mg/kg	10	0.20 *J*	0.17 *U*	0.18 *J*	1.4 *J*	7.00	0.39	0.17 *U*	2.24 *J*
Fluorene	mg/kg	3	0.17 *U*	0.17 *U*	0.17 *U*	0.5 *U*	0.50 *U*	0.10 *J*	0.17 *U*	0.32 *J*
Indeno[1,2,3-cd]pyrene	mg/kg	0.77	0.09 *J*	0.17 *U*	0.13 *J*	0.5 *U*	$\boxed{3.00}$ *J*	0.30 *J*	0.17 *U*	$\boxed{0.99}$ *J*
Pyrene	mg/kg	9	0.17 *U*	0.17 *U*	0.17 *U*	0.5 *U*	$\boxed{12.0}$	0.17 *U*	0.17 *U*	3.21
Inorganics										
Chromium (total)	mg/kg	95	2.5	1.0 *U*	1.8	$\boxed{136}$	64.4	6.5	2.3	52.3
Copper	mg/kg	580	7.3	1.7	4.5	135	127.0	7.9	3.4	68.3
Lead	mg/kg	130	7.9	1.8	4.9	$\boxed{221}$	$\boxed{183.0}$	10.3	3.8	104.5
Zinc	mg/kg	1,300	15	12	14	645	338	22	12	254

Note:

AVE	-	average of duplicate sample
BGS	-	below ground surface
ESL	-	ecological screening level
J	-	estimated value
mg/kg	-	milligrams per kilogram, dry weight
NEC	-	no effects concentration (Ingersoll et al. 1996)
PCB	-	polychlorinated biphenyl
SVOC	-	semivolatile organic compound
U	-	undetected

Sampling was performed by ARCADIS BBL and Exponent during the week of October 30, 2006.

Samples were analyzed for SVOCs, PCBs, and metals, as well as total organic carbon and particle size distribution, by Merit Laboratories of East Lansing, MI.

Chemicals that exceeded ESLs, or for which no ESLs were available, were retained for secondary screening (refer to Table 3).

Non-detects shown at half the detection limit.

Boxed values exceed NEC screening value.

Table 8. Secondary screening of subsurface sediment analytical results for biased transects near GM Outfalls 003, 005, and 013

			Adjacent			
Sample ID:			FRT 12C	FRT 12C	FRT 12C	
Sample Depth (in BGS):			2–12	12–24	24–36	
Date Collected:	Units	NEC	11/01/06	11/01/06	11/01/06	Mean
SVOCs						
Benzo[a]pyrene	mg/kg	1	$\boxed{1.77}$	0.99	0.20 *J*	0.99 *J*
Benzo[g,h,i]perylene	mg/kg	1.2	$\boxed{1.41}$	0.82	0.20 *J*	0.81 *J*
Benzo[k]fluoranthene	mg/kg	4	1.45 *J*	0.93 *J*	0.20 *J*	0.86 *J*
Chrysene	mg/kg	3	1.54	0.88	0.20 *J*	0.87 *J*
Fluoranthene	mg/kg	10	3.05	1.69	0.41	1.72
Fluorene	mg/kg	3	0.20 *J*	0.10 *J*	0.17 *U*	0.16 *J*
Indeno[1,2,3-cd]pyrene	mg/kg	0.77	$\boxed{1.16}$	0.69	0.10 *J*	0.65
Pyrene	mg/kg	9	2.02	0.84	0.17 *U*	1.01
Inorganics						
Copper	mg/kg	580	48.0	8.9	13.1	23.3
Lead	mg/kg	130	72.3	14.0	20.8	35.7
Zinc	mg/kg	1300	229	41	44	105

Note: AVE - average of duplicate sample
BGS - below ground surface
ESL - ecological screening level
J - estimated value
mg/kg - milligrams per kilogram, dry weight
NEC - no effects concentration (Ingersoll et al. 1996)
PCB - polychlorinated biphenyl
SVOC - semivolatile organic compound
U - undetected

Sampling was performed by ARCADIS BBL and Exponent during the week of October 30, 2006.

Samples were analyzed for SVOCs, PCBs, and metals, as well as total organic carbon and particle size distribution, by Merit Laboratories of East Lansing, MI.

Chemicals that exceeded ESLs, or for which no ESLs were available, were retained for secondary screening (refer to Table 4).

Non-detects shown at half the detection limit.

Boxed values exceed NEC screening value.

Table 9. Comparison of surface sediment analytical results for unbiased sampling transects to regional and urban background levels

						Adjacent					
Sample ID:		Background Levels				FRT 4A	FRT 4C	FRT 5A	FRT 5B	FRT 6B	
Sample Depth (in BGS):		Urban		Statewide		0–2	0–2	0–2	0–2	0–2	
Date Collected:	Units	Min	Max	Min	Max	11/01/06	11/01/06	10/31/06	10/31/06	10/31/06	Mean
SVOCs											
Benzo[a]pyrene	mg/kg	0.165	0.22 [a]	--	--	0.20 *J*	0.62 *J*	0.20 *J*	0.20 *J*	0.17 *U*	0.28 *J*
Benzo[g,h,i]perylene	mg/kg	0.9	47 [a]	--	--	0.10 *J*	0.47	0.10 *J*	0.20 *J*	0.17 *U*	0.21 *J*
Benzo[k]fluoranthene	mg/kg	0.3	26 [a]	--	--	0.20 *J*	0.53 *J*	0.20 *J*	0.20 *J*	0.07 *J*	0.24 *J*
Chrysene	mg/kg	0.251	0.64 [a]	--	--	0.20 *J*	0.54	0.10 *J*	0.30 *J*	0.06 *J*	0.24 *J*
Fluoranthene	mg/kg	0.2	166 [a]	--	--	0.30 *J*	1.08	0.20 *J*	0.48	0.10 *J*	0.43 *J*
Fluorene	mg/kg	--	--	--	--	0.17 *U*	0.09 *J*	0.17 *U*	0.17 *U*	0.17 *U*	0.15 *J*
Indeno[1,2,3-cd]pyrene	mg/kg	8	61 [a]	--	--	0.10 *J*	0.39	0.10 *J*	0.10 *J*	0.17 *U*	0.17
Pyrene	mg/kg	0.145	147 [a]	--	--	0.17 *U*	0.46	0.17 *U*	0.35	0.17 *U*	0.26
Inorganics											
Copper	mg/kg	30	113 [b]	<2	25 [c]	13.5	**31.2**	**25.9**	15.8	10.9	19.5
Lead	mg/kg	93	160 [b]	<5	50 [c]	15.4	26.0	**214.0**	16.8	12.2	**56.9**
Zinc	mg/kg	120	257 [b]	<5	170 [c]	28.2 *J*	72.3 *J*	43.1 *J*	38 *J*	31 *J*	42.4 *J*

Table 9. (cont.)

		Background Levels				Downstream					
									FRT 9A		
Sample ID:		Urban		Statewide		FRT 7A	FRT 7C	FRT 8B	0–2	FRT 9B	
Sample Depth (in BGS):						0–2	0–2	0–2	10/31/06	0–2	
Date Collected:	Units	Min	Max	Min	Max	10/31/06	10/31/06	10/31/06	AVE	10/31/06	Mean
SVOCs											
Benzo[a]pyrene	mg/kg	0.165	0.22 [a]	--	--	$\boxed{0.30}$ *J*	$\boxed{0.81}$ *J*	0.10 *J*	$\boxed{1.46}$ *J*	$\boxed{1.07}$	$\boxed{0.75}$ *J*
Benzo[g,h,i]perylene	mg/kg	0.9	47 [a]	--	--	0.20 *J*	0.62 *J*	0.08 *J*	1.16	0.75	0.56 *J*
Benzo[k]fluoranthene	mg/kg	0.3	26 [a]	--	--	0.30 *J*	0.82 *J*	0.17 *UJ*	1.335 *J*	0.88 *J*	0.70 *J*
Chrysene	mg/kg	0.251	0.64 [a]	--	--	0.30 *J*	$\boxed{0.66}$ *J*	0.10 *J*	$\boxed{1.18}$	$\boxed{0.94}$	0.64 *J*
Fluoranthene	mg/kg	0.2	166 [a]	--	--	0.44	1.20 *J*	0.10 *J*	2.2 *J*	2.05	1.20 *J*
Fluorene	mg/kg	--	--	--	--	0.17 *U*	0.10 *J*	0.17 *U*	0.1 *J*	0.10 *J*	0.13 *J*
Indeno[1,2,3-cd]pyrene	mg/kg	8	61 [a]	--	--	0.20 *J*	0.52 *J*	0.06 *J*	1.035	0.67	0.50 *J*
Pyrene	mg/kg	0.145	147 [a]	--	--	0.17 *U*	0.41 *J*	0.17 *U*	1.325	1.25	0.66 *J*
Inorganics											
Copper	mg/kg	30	113 [b]	<2	25 [c]	13.7	**33.0**	4.6	**86.15**	16.6	**30.8**
Lead	mg/kg	93	160 [b]	<5	50 [c]	23.9	34.0	8.2	**117**	**72.8**	**51.2**
Zinc	mg/kg	120	257 [b]	<5	170 [c]	50 *J*	94 *J*	31 *J*	$\boxed{\mathbf{302.5}}$ *J*	$\boxed{\mathbf{312}}$ *J*	157.8 *J*

Note:

AVE - average of duplicate sample
BGS - below ground surface
J - estimated value
mg/kg - milligrams per kilogram, dry weight
PCB - polychlorinated biphenyl
SLERA - screening level ecological risk assessment
SVOC - semivolatile organic compound
U - undetected at detection limit shown

Sampling was performed by ARCADIS BBL and Exponent during the week of October 30, 2006.

Samples were analyzed for SVOCs, PCBs, and metals, as well as total organic carbon and particle size distribution, by Merit Laboratories of East Lansing, MI.

Chemicals that exceeded ESLs, or for which no ESLs were available, were retained for background screening (refer to Table 1).

Non-detects shown at half the detection limit.

Boxed values exceed the upper range (max) of urban background values.[a,b]

Bold values exceed the upper range (max) of reference site background values.[c]

[a] Background soil concentrations of PAHs in urban soil (ATSDR 1995).

[b] Mean concentrations of metals in Michigan surface soils for residential, commercial, and industrial land uses (Murray et al. 2004)

[c] Statewide reference sediment chemistry for all ecoregions (MDEQ 1999)

Table 10. Comparison of surface sediment analytical results for biased sampling transects near GM Outfalls 003, 005, and 013 to regional and urban background levels

						Adjacent						
Sample ID:		Background Levels				FRT 10A	FRT 10B	FRT 11B	FRT 11C	FRT 12B	FRT 12C	
Sample Depth (in BGS):		Urban		Statewide		0–2	0–2	0–2	0–2	0–2	0–2	
Date Collected:	Units	Min	Max	Min	Max	10/31/06	10/31/06	11/01/06 AVE	11/01/06	10/31/06	10/31/06	Mean
SVOCs												
Benzo[a]pyrene	mg/kg	0.165	0.22 [a]	--	--	$\boxed{0.73}$	0.20 *J*	$\boxed{0.865}$	0.20 *J*	$\boxed{0.30}$ *J*	$\boxed{0.83}$	$\boxed{0.52}$ *J*
Benzo[g,h,i]perylene	mg/kg	0.9	47 [a]	--	--	0.65	0.17 *U*	0.56	0.20 *J*	0.20 *J*	0.69	0.41 *J*
Benzo[k]fluoranthene	mg/kg	0.3	26 [a]	--	--	0.51 *J*	0.17 *UJ*	0.695 *J*	0.20 *J*	0.30 *J*	0.75 *J*	0.44 *J*
Chrysene	mg/kg	0.251	0.64 [a]	--	--	0.58	0.10 *J*	$\boxed{0.715}$	0.20 *J*	0.20 *J*	$\boxed{0.65}$	0.41 *J*
Fluoranthene	mg/kg	0.2	166 [a]	--	--	1.05	0.20 *J*	1.62 *J*	0.38	0.37	1.29	0.82 *J*
Fluorene	mg/kg	--	--	--	--	0.10 *J*	0.17 *U*	0.15 *J*	0.17 *U*	0.17 *U*	0.07 *J*	0.14 *J*
Indeno[1,2,3-cd]pyrene	mg/kg	8	61 [a]	--	--	0.50	0.17 *U*	0.505	0.20 *J*	0.20 *J*	0.58	0.36 *J*
Pyrene	mg/kg	0.145	147 [a]	--	--	0.20 *J*	0.17 *U*	0.8 *J*	0.17 *U*	0.17 *U*	0.46	0.33 *J*
Inorganics												
Copper	mg/kg	30	113 [b]	<2	25 [c]	24.4	3.3	7.2	17.8	9.1	**73.2**	22.5
Lead	mg/kg	93	160 [b]	<5	50 [c]	35.3	9.1	10.95	10.1	18.7	**124.0**	34.7
Zinc	mg/kg	120	257 [b]	<5	170 [c]	105	18 *J*	37.45 *J*	25 *J*	62 *J*	$\boxed{\mathbf{316}}$ *J*	94 *J*

Note:

AVE	- average of duplicate sample	PCB	- polychlorinated biphenyl
BGS	- below ground surface	SLERA	- screening level ecological risk assessment
J	- estimated value	SVOC	- semivolatile organic compound
mg/kg	- milligrams per kilogram, dry weight	*U*	- undetected at detection limit shown

Sampling was performed by ARCADIS BBL and Exponent during the week of October 30, 2006.

Samples were analyzed for SVOCs, PCBs, and metals, as well as total organic carbon and particle size distribution, by Merit Laboratories of East Lansing, MI.

Chemicals that exceeded ESLs, or for which no ESLs were available, were retained for background screening (refer to Table 2).

Non-detects shown at half the detection limit.

Boxed values exceed the upper range (max) of urban background values.[a,b]

Bold values exceed the upper range (max) of reference site background values.[c]

[a] Background soil concentrations of PAHs in urban soil (ATSDR 1995).

[b] Mean concentrations of metals in Michigan surface soils for residential, commercial, and industrial land uses (Murray et al. 2004)

[c] Statewide reference sediment chemistry for all ecoregions (MDEQ 1999)

Table 11. Comparison of subsurface sediment analytical results for unbiased sampling transects to regional and urban background levels

		Background Levels				Adjacent			Downstream				
Sample ID:		Urban		Statewide		FRT 4A	FRT 4A		FRT 7C	FRT 7C	FRT 7C	FRT 7C	
Sample Depth (in BGS):						2–12	12–24		2–12	12–24	24–36	36–46	
Date Collected:	Units	Min	Max	Min	Max	11/01/06	11/01/06	Mean	10/31/06 AVE	10/31/06	10/31/06	10/31/06	Mean
SVOCs													
Benzo[a]pyrene	mg/kg	0.165	0.22 [a]	--	--	0.20 *J*	0.17 *U*	0.18 *J*	$\boxed{0.5}$ *U*	$\boxed{7.00}$	$\boxed{0.53}$	0.17 *U*	$\boxed{2.05}$
Benzo[g,h,i]perylene	mg/kg	0.9	47 [a]	--	--	0.10 *J*	0.17 *U*	0.13 *J*	0.5 *U*	3.00 *J*	0.35	0.17 *U*	1.00
Benzo[k]fluoranthene	mg/kg	0.3	26 [a]	--	--	0.10 *J*	0.17 *UJ*	0.13 *J*	0.9 *J*	4.00 *J*	0.30 *J*	0.17 *UJ*	1.34
Chrysene	mg/kg	0.251	0.64 [a]	--	--	0.10 *J*	0.17 *U*	0.13 *J*	$\boxed{1.5}$	$\boxed{7.00}$	0.38	0.17 *U*	$\boxed{2.26}$
Fluoranthene	mg/kg	0.2	166 [a]	--	--	0.20 *J*	0.17 *U*	0.18 *J*	1.4 *J*	7.00	0.39	0.17 *U*	2.24
Fluorene	mg/kg	--	--	--	--	0.17 *U*	0.17 *U*	0.17 *U*	0.5 *U*	0.50 *U*	0.10 *J*	0.17 *U*	0.32
Indeno[1,2,3-cd]pyrene	mg/kg	8	61 [a]	--	--	0.09 *J*	0.17 *U*	0.13 *J*	0.5 *U*	3.00 *J*	0.30 *J*	0.17 *U*	0.99
Pyrene	mg/kg	0.145	147 [a]	--	--	0.17 *U*	0.17 *U*	0.17 *U*	0.5 *U*	12.0	0.17 *U*	0.17 *U*	3.21
Inorganics													
Chromium (Total)	mg/kg	27	55 [b]	<2	65 [c]	2.5	1.0 *U*	1.8	**$\boxed{136}$**	$\boxed{64.4}$	6.5	2.3	52.3
Copper	mg/kg	30	113 [b]	<2	25 [c]	7.3	1.7	4.5	**$\boxed{135}$**	**$\boxed{127.0}$**	7.9	3.4	**68.3**
Lead	mg/kg	93	160 [b]	<5	50 [c]	7.9	1.8	4.9	**$\boxed{221}$**	**$\boxed{183.0}$**	10.3	3.8	**104.5**
Zinc	mg/kg	120	257 [b]	<5	170 [c]	15	12	13.6	**$\boxed{645}$**	**$\boxed{338}$**	22	12	**254.2**

Note: AVE - average of duplicate sample
BGS - below ground surface
J - estimated value
mg/kg - milligrams per kilogram, dry weight
PCB - polychlorinated biphenyl
SLERA - screening level ecological risk assessment
SVOC - semivolatile organic compound
U - undetected at detection limit shown

Sampling was performed by ARCADIS BBL and Exponent during the week of October 30, 2006.

Samples were analyzed for SVOCs, PCBs, and metals, as well as total organic carbon and particle size distribution, by Merit Laboratories of East Lansing, MI.

Chemicals that exceeded ESLs, or for which no ESLs were available, were retained for background screening (refer to Table 3).

Non-detects shown at half the detection limit.

Boxed values exceed the upper range (max) of urban background values.[a,b]

Bold values exceed the upper range (max) of reference site background values.[c]

[a] Background soil concentrations of PAHs in urban soil (ATSDR 1995).

[b] Mean concentrations of metals in Michigan surface soils for residential, commercial, and industrial land uses (Murray et al. 2004)

[c] Statewide reference sediment chemistry for all ecoregions (MDEQ 1999)

Table 12. Comparison of subsurface sediment analytical results for biased transects Near GM Outfalls 003, 005, and 013 to regional and urban background levels

						Adjacent			
Sample ID:		Background Levels				FRT 12C	FRT 12C	FRT 12C	
Sample Depth (in BGS):		Urban		Statewide		2–12	12–24	24–36	
Date Collected:	Units	Min	Max	Min	Max	11/01/06	11/01/06	11/01/06	Mean
SVOCs									
Benzo[a]pyrene	mg/kg	0.165	0.22 [a]	--	--	$\boxed{1.77}$	$\boxed{0.99}$	0.20 *J*	$\boxed{0.99}$ *J*
Benzo[g,h,i]perylene	mg/kg	0.9	47 [a]	--	--	1.41	0.82	0.20 *J*	0.81 *J*
Benzo[k]fluoranthene	mg/kg	0.3	26 [a]	--	--	1.45 *J*	0.93 *J*	0.20 *J*	0.86 *J*
Chrysene	mg/kg	0.251	0.64 [a]	--	--	$\boxed{1.54}$	$\boxed{0.88}$	0.20 *J*	$\boxed{0.87}$ *J*
Fluoranthene	mg/kg	0.2	166 [a]	--	--	3.05	1.69	0.41	1.72
Fluorene	mg/kg	--	--	--	--	0.20 *J*	0.10 *J*	0.17 *U*	0.16 *J*
Indeno[1,2,3-cd]pyrene	mg/kg	8	61 [a]	--	--	1.16	0.69	0.10 *J*	0.65 *J*
Pyrene	mg/kg	0.145	147 [a]	--	--	2.02	0.84	0.17 *U*	1.01
Inorganics									
Copper	mg/kg	30	113 [b]	<2	25 [c]	**48.0**	8.9	13.1	23.3
Lead	mg/kg	93	160 [b]	<5	50 [c]	**72.3**	14.0	20.8	35.7
Zinc	mg/kg	120	257 [b]	<5	170 [c]	**229**	41	44	104.8

Note:

AVE	-	average of duplicate sample
BGS	-	below ground surface
J	-	estimated value
mg/kg	-	milligrams per kilogram, dry weight
PCB	-	polychlorinated biphenyl
SLERA	-	screening level ecological risk assessment
SVOC	-	semivolatile organic compound
U	-	undetected at detection limit shown

Sampling was performed by ARCADIS BBL and Exponent during the week of October 30, 2006.

Samples were analyzed for SVOCs, PCBs, and metals, as well as total organic carbon and particle size distribution, by Merit Laboratories of East Lansing, MI.

Chemicals that exceeded ESLs, or for which no ESLs were available, were retained for background screening (refer to Table 4).

Non-detects shown at half the detection limit.

Boxed values exceed the upper range (max) of urban background values.[a,b]

Bold values exceed the upper range (max) of reference site background values.[c]

[a] Background soil concentrations of PAHs in urban soil (ATSDR 1995).

[b] Mean concentrations of metals in Michigan surface soils for residential, commercial, and industrial land uses (Murray et al. 2004)

[c] Statewide reference sediment chemistry for all ecoregions (MDEQ 1999)

Table 13. Weight-of-evidence summary for unbiased and biased surface sediment samples

	Exceeds ESLs			Exceeds NECs		Exceeds Regional Background		Exceeds Urban Background	
	UP	ADJ	DOWN	ADJ	DOWN	ADJ	DOWN	ADJ	DOWN
SVOCs									
Benzo[a]pyrene		X	X		X	--	--	X	X
Benzo[g,h,i]perylene		X	X			--	--		
Benzo[k]fluoranthene		X	X			--	--		
Chrysene		X	X			--	--	X	X
Fluoranthene		X	X			--	--		
Fluorene		X	X			--	--		
Indeno[1,2,3-cd]pyrene		X	X		X	--	--		
Pyrene		X	X			--	--		
Inorganics									
Copper		X	X			X	X		
Lead		X	X	X		X	X	X	
Zinc		X	X			X	X	X	X

Note:		
--	-	not applicable
ADJ	-	adjacent
DOWN	-	downstream
ESL	-	ecological screening level (U.S. EPA 2003)
NEC	-	no effects concentration (Ingersoll et al. 1996)
UP	-	upstream
X	-	exceeds detected or estimated concentration in one or more samples

Boxed cells indicate the mean concentration exceeds.

Table 14. Weight-of-evidence summary for unbiased and biased subsurface sediment samples

	Exceeds ESLs			Exceeds NECs		Exceeds Regional Background		Exceeds Urban Background	
	UP	ADJ	DOWN	ADJ	DOWN	ADJ	DOWN	ADJ	DOWN
SVOCs									
Benzo[a]pyrene		$\boxed{X}$	$\boxed{X}$	X	$\boxed{X}$	--	--		$\boxed{X}$
Benzo[g,h,i]perylene		$\boxed{X}$	$\boxed{X}$	X	X	--	--		
Benzo[k]fluoranthene		$\boxed{X}$	$\boxed{X}$			--	--		
Chrysene		$\boxed{X}$	$\boxed{X}$		X	--	--		$\boxed{X}$
Fluoranthene		$\boxed{X}$	$\boxed{X}$			--	--		
Fluorene		$\boxed{X}$	$\boxed{X}$			--	--		
Indeno[1,2,3-cd]pyrene		$\boxed{X}$	$\boxed{X}$	X	$\boxed{X}$	--	--		
Pyrene		$\boxed{X}$	$\boxed{X}$		X	--	--		
Inorganics									
Chromium (total)			$\boxed{X}$		X		X		X
Copper		X	$\boxed{X}$				$\boxed{X}$		X
Lead		X	$\boxed{X}$		X		$\boxed{X}$		X
Zinc		X	$\boxed{X}$				$\boxed{X}$		X

Note:

-- - not applicable
ADJ - adjacent
DOWN - downstream
ESL - ecological screening level (U.S. EPA 2003)
NEC - no effects concentration (Ingersoll et al. 1996)
UP - upstream
X - exceeds detected or estimated concentration in one or more samples

Boxed cells indicate the mean concentration exceeds.