Worldwide Facilities Group
Environmental & Regulatory Support
Remediation Team

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Project Coordinator for MID 041 793 340
RCRA Enforcement Branch (DE-9J)
U.S.EPA, Region 5
77 West Jackson Boulevard
Chicago, Illinois 60604-3590

Re: GMC Powertrain Saginaw Metal Casting Operations, MID 041-793-340
RCRA Facility Investigation Phase 1B
Amendment to the April 19, 2000, Phase 1A RCRA Facility Investigation (RFI) Report and Phase 1B RFI Work Plan

Dear Ms. Capiro:

This letter is to serve as an amendment to the April 19, 2000, Phase 1A RCRA Facility Investigation (RFI) Report and Phase 1B RFI Work Plan (Work Plan, EMCON, April 19, 2000). This Work Plan was approved by the United States Environmental Protection Agency (USEPA) on April 26, 2000. On May 10, 2001, GM submitted a request for extension of the RFI Report in order to complete additional investigative activities at the Site, based on review of the collected Phase 1B data.

The purpose of this Addendum is to provide documentation of modifications during the Phase 1B investigative activities to portions of the scope of work at General Motor's Saginaw Metal Casting Operations (SMCO), as presented in the April 19, 2000, Work Plan. In addition, this Addendum proposes additional investigative samples to be collected upon U.S. EPA approval.

Modifications to the Phase 1B Completed Scope of Work

The following presents completed modifications to the scope of work included in the April 19, 2000, Phase 1B Work Plan with each Section of the Work Plan referenced.

Site-Wide Activities (Section 5.4)

Quality Assurance Project Plan

Attachment I presents the modifications to the QAPP. These modifications reflect a change in analytical method for hexavalent chromium and the addition of fluoride analysis for the aqueous matrix (*please note that the revised Table 4 in Attachment I also includes the additional samples proposed under this Addendum, as well as the above-stated corrections).*

The April 19, 2000, amendments to the QAPP included the addition of hexavalent chromium, as well as other modifications to the analyte lists. Revision 2 of the Phase 1B Supplemental QAPP include the proposal of an alternative method for the preparation and analysis of aqueous samples only, for the quantification of hexavalent chromium. U.S. EPA Method 7196A, which is a colorimetric method, was included in the April 19, 2000, amendments for both soil and water matrices. However, the laboratory method detection limits listed in Table 3 could not be achieved in an aqueous matrix by using Method 7196A. As an alternative, U.S. EPA method 7195 was used in the original Phase 1B analysis for quantifying hexavalent chromium in water.

During implementation of the Phase 1B field investigation, a few discrepancies were noted between the text of the Work Plan and the investigative sample count included in Table 4 of the Phase 1B Supplemental QAPP – Revision 1. The following provides the explanation of each correction included on Table 4 by Investigative Unit, *prior* to any additions contained within this Work Plan Addendum:

- IU A: No corrections
- IU B No corrections
- IU D The total count for groundwater samples (all parameter groups) should be 7, rather than the 9 listed in Table 4. This is because two Phase 1A monitoring wells (MW-02418 and MW-12418) had been inadvertently damaged by on-site operations prior to implementation of the Phase 1B RFI and were inadvertently included in the sample count (U.S. EPA was notified of the damaged wells on June 8, 2000 (May 2000 Monthly Progress Report).
- IU E No corrections
- IU F No corrections
- IU G The investigative sample count from the Phase 1B Work Plan for groundwater samples should be 17 for VOCs and site-specific metals (instead of 24 and 20, respectively), and 11 for SVOCs, PCBs, cyanide,

and formaldehyde (instead of 17). This is due to an unintentional miscount included on the April 19, 2000, Table 4.

- IU H No corrections
- IU I No corrections
- IU J No corrections
- Saginaw River The sample count for both sediment and surface water for all parameters should be 33 (instead of 30 and 28, respectively). This is also due to an unintentional miscount included on the April 19, 2000, Table 4.

Previous Phase 1B Surface Water and Sediment Sampling (Section 5.5)

Sampling Sequence

The April 19, 2000, Phase 1B Work Plan called for a continuous surface water sampling event (estimated at six days duration) to precede the sediment sampling and be performed not less than three days following a storm event. After further consideration, the program was amended to allow for initiation of the sediment sampling, with the surface water sampling performed during a predicted dry spell at some point during the field program. The advantages of this modification were as follows:

- The initiation of the project was not delayed by recent or ongoing storm events (a particular concern given the stormy weather patterns that prevailed at the time the field program was initiated).

- Since the surface water program was timed to occur during a period of predicted fair weather, it was more likely to proceed uninterrupted by a storm event if sediment samples had already been collected and therefore, requiring less time per location.

- Since sediment sampling preceded surface water sampling, a station rejected during the sediment program due to unsuitable matrix (absence of soft sediment), did not require resampling for surface water in the relocated station.

Sample Analysis

In accordance with discussions with U.S.EPA, formaldehyde and unfiltered (dissolved) metals were added to the list of analytical parameters in surface water. Note as a clarification that head space analysis applies only to split spoon samples and was not performed for sediment samples because head space analysis will not provide an accurate screening in a sediment/water matrix. Table 4 of the April 19, 2001, QAPP provides contradictory information on this matter and has been revised.

The April 19, 2000, Phase 1B Work Plan called for three of the four substation samples to be held pending review of data from the one analyzed station. This approach was selected based on the original Phase IB inorganic parameter list. To adapt the program for more recently added analytes (specifically, to comply with the shorter analytical holding times for organics), the following protocols were used:

- An expedited turnaround time (less than the holding time) was requested for VOCs from the initial sample.
- All four substation samples were extracted for PCB and base neutral (benzo(a)pyrene - BaP) analysis, but only one sample was initially analyzed. This was completed to ensure any additional analyses were within the proper holding time, if the additional samples were needed for analysis.

The protocol for inorganics (hold, and analyze only if the initial sample is above background) remained unchanged. However, the above strategy for organics eliminated the need to wait for statistical analysis of the background data prior to performing additional analyses.

Sample Locations

Pursuant to later discussions with U.S.EPA regarding the selection of background stations, the proposed sampling station distribution was slightly modified. A revised Figure 5-12 is included as **Attachment II.** The principal changes involved addition of more upstream background locations and a more even distribution of upstream samples that is less biased toward identified outfalls.

In addition, the station SW/SD-9 is approximately 1000 feet in length (not 2000 feet, as previously incorrectly stated).

Investigative Unit G (Section 5.4.7)

Fluoride

On a July 28, 2000, conference call between General Motors (GM) and the U.S.EPA, U.S.EPA expressed a concern that two AOIs (G.4 and G.5) had historical groundwater concentrations of fluoride which had exceeded the maximum contaminant level (MCL). Fluoride had not been included either on the Phase 1A or the Phase 1B analyte lists provided in the approved June 1998 Quality Assurance Project Plan (QAPP), or the April 19, 2000, Phase 1B Amendments to the QAPP.

Pursuant to U.S. EPA's request, GM agreed to include fluoride for groundwater samples collected near and downgradient of the two former desulfurization slag RCRA treatment units (AOIs G.4 and G.5), as described herein.

Groundwater samples collected at monitoring wells MW-04040, MW-04836, and MW-05036 were additionally analyzed for dissolved fluoride concentrations (i.e., in addition to the parameters listed in the Work Plan). Two of the monitoring wells (MW-04040 and MW-05036) had already been sampled during the Phase 1B field activities. However, an additional sample was collected for analysis of fluoride at these two locations. In addition, GM added fluoride analysis to all useable, existing monitoring wells located at AOI G.5 (again, in addition to the parameters listed in the Work Plan). Further GM collected groundwater samples at all useable, existing monitoring wells at AOI G.4 for analysis of fluoride, and at MW-04250 for the analysis of fluoride in groundwater. Monitoring well MW-04250 is located in an approximate hydraulically downgradient location from AOI G.4. The term "useable", as used in this addendum, is defined as wells exhibiting competent integrity and the ability to obtain a representative groundwater sample from the well.

Proposed Additional Scope of Work Beyond the April 19, 2000, Phase 1B Work Plan Scope

The following presents the proposed additional scope of work to be completed under this Addendum. Each section of the Work Plan where additional investigation is being proposed is referenced.

Site-Wide Activities (Section 5.4)

Elevated pH in Groundwater

GM proposes to evaluate the elevated pH levels encountered during the Phase 1A and subsequent Phase 1B groundwater sampling within the upper-saturated zone through the northern portion of the site. The elevated pH readings from the Phase 1A data were presented on Figure 2-20 of the April 19, 2000, Phase 1B Work Plan. This area of elevated pH was confirmed during the Phase 1B investigation and extends through portions of IUs I, H, and G.

This evaluation will consist of historical records research of the property useage rage practices employed by SMCO at Investigative Unit (IU) I, historical plant (former Nodular Iron Plant) operations, potential for off-site sources, groundwater flow and isoconcentrations, and other potential sources of the elevated pH in this area. There are several existing wells in the area upgradient of the elevated pH in groundwater encountered on-site during the RFI. These wells were installed several years ago over concern of potential contaminants migrating onto the SMCO property from an off-site potential source. These wells will be opened, purged, and sampled, if possible (Figure 5-9c included as **Attachment III**). If it is not possible to sample these existing wells, groundwater grab samples will be collected in the same approximate locations.

In addition, groundwater grab samples will be collected at 12 additional locations in IUs G, H and I, one existing RFI monitoring well MW-07959 will be re-sampled, and five temporary monitoring wells will be installed and sampled (refer to Figure 5-9c included as **Attachment III**). The groundwater grab samples and the installation of the temporary monitoring wells will be completed using direct-push drilling technology within the upper, water-bearing zone, if present. Each temporary monitoring well will be abandoned by casing removal upon collection of a groundwater sample. The abandoned borehole will be allowed to collapse naturally, and any remaining open borehole will be filled with bentonite. All temporary monitoring wells will be sampled for pH until a minimum of two consecutive readings are within 0.1 standard units. The pH will be recorded on field forms and the location of the temporary monitoring wells will be located horizontally using a Global Positioning System.

All groundwater samples collected during this evaluation will be sampled for pH (field), dissolved oxygen (field), oxidation-reduction potential (field), bicarbonate alkalinity (lab), fluoride (lab), TDS (lab), and ammonia (lab) . Appropriate changes to the QAPP have been included in **Attachment I**).

The results of the review and groundwater sampling will be presented to the U.S. EPA upon completion. If the results of this analysis determines that an on-site source area(s) exists, GM may propose additional sampling to characterize the soil at that location(s).

Groundwater Sampling Method

Several existing monitoring wells, and proposed temporary and permanent monitoring wells, are proposed to be sampled during implementation of this Addendum. Groundwater grab samples will be collected using a GeoProbe ScreenPoint Sampler, or similar discrete groundwater sampling device. The discrete groundwater sampler which will be driven approximately two feet below the water table surface and retracted (thus providing a water sample from the water table surface to two feet below)

Re-sampling of some wells is proposed due to the detection of PCBs and SVOCs in groundwater, likely resulting from turbid samples collected via bailers. All groundwater sampling for PCBs and SVOCs in monitoring wells (both permanent and temporary), described in each section below, will be completed using the low-flow purging/sampling methods, as described in the Standard Operating Procedures included in the Work Plan (April 19, 2001) to minimize turbidity.

Investigative Unit B (Section 5.4.2) Previous Phase 1B Sampling Results

VOCs (Vinyl chloride near MW00509)

VOC results from groundwater samples collected near RFI monitoring well MW-00509 indicate that the concentration of vinyl chloride is above Phase 1B Screening Levels (June 7, 2000, Part 201 Integrated Tables from MI Act 451).

PCBs and SVOCs (Samples near MW 00306)

Groundwater samples collected from MW-00306 show levels of PCBs, Benzo(a)anthracene and Benzo(b)fluoranthene that are above Phase 1B Screening Levels

Soil sampling at SB-00508 detected concentrations of PAHs that are above the Phase IB Screening Levels.

LNAPL (Near MW-00305)

A separate phase layer floating on the groundwater surface in Investigative Unit (IU) B was discovered during Phase 1B RFI investigative activities completed on July 7, 2000. One monitoring well (MW-00305) was installed at this location and is periodically checked for measurable amounts of oil. Notification was made to the USEPA, the MDEQ, and the National Response Center on July 7, 2000.

Once the well was installed, GM initially observed up to 0.30 feet of separate phase oily product in this monitoring well. Initial interim measures included the bailing of product from the well upon sufficient accumulation. On October 27, 2000, a passive, product collection canister was installed to more effectively collect the LNAPL and reduce the amount of water recovered. This canister is periodically checked and is emptied on an ongoing basis as appropriate. Separate phase thicknesses have gone down since the canister installation and product removal.

Proposed 1B Activities (Section 5.4.2.3) Investigative Unit B Based on Previous Phase 1B Results

VOCs (Vinyl chloride near MW00509)

GM proposes to collect two additional groundwater grab samples near the VOC contamination in the northern portion of IU B, near MW00509, to further define vinyl chloride in groundwater at this location. Continuous soil samples will be collected for descriptive purposes only. If visual, olfactory, or PID readings indicate the potential for soil contamination, soil samples will be submitted to the laboratory for analysis of VOCs and SVOCs. If field screening continues to indicate the presence of VOCs, additional temporary wells will be set further away to further characterize the source and extent.

In addition GM proposes to install four soil borings to further determine the extent of VOCs and SVOCs in the area (refer to Figure 5-2c in **Attachment IV** for the proposed well and boring locations). Soil samples will be collected and analyzed for VOCs and SVOCs.

PCBs and SVOCs (Samples near MW 00306)

GM proposes the resampling of MW-00306 for PCBs and SVOCs using the low-flow purging/sampling procedure (refer to Figure 5-2c in **Attachment IV** for the well location). As described in the preceeding paragraph, two soil borings will be advanced for the purpose of collecting additional soil samples for analysis of VOCs and SVOCs.

LNAPL (Near MW-00305)

Due to the presence of LNAPL in this IU, GM proposes to advance eight additional soil borings to determine the horizontal extent of product in the subsurface (Figure 5-2c is included as **Attachment IV**). The additional borings are proposed to be advanced by hydraulic-push techniques (e.g., GeoProbe or other similar rig) on an approximate grid spacing of 50 feet. Continuous samples will be collected to the bottom of the upper-saturated zone (top of the underlying clay) and will be visually inspected for the potential presence of separate phase liquid. If field observations from the initial eight borings indicate that the horizontal and/or vertical extent of product has not been defined, up to an additional six soil borings will be installed 50 feet further away from monitoring well MW-00305. Soil samples will not be submitted to the laboratory for analysis unless visual, olfactory, or elevated PID readings indicate the presence of potential contamination in the unsaturated zone. Upon completion of the product delineation, GM will determine the appropriate and effective corrective measures for product removal in this area. Meanwhile, GM will continue to collect the oil, via the product collection canister as an interim measure.

Once the LNAPL is believed to be delineated, GM will install three temporary wells at the perimeter of the LNAPL. These wells will be left in place for one week to confirm that delineation is complete and then abandoned if LNAPL is not observed. If LNAPL is observed in a well, additional temporary wells will be stepped out from that well until delineation is complete. Once the final temporary wells indicate that the extent of LNAPL has been delineated, groundwater samples will be collected from the delineation wells. The groundwater samples will be submitted to the laboratory for anlaysis of the TCL for organics and the site-specific metals.

If a soil sample collected for laboratory analysis during the LNAPL delineation will be submitted to the laboratory for analysis of the TCL for organics and the site-specific list for metals. In addition to the soil delineation, one sample of the separate-phase product will also be collected and submitted to the laboratory for analysis of the TCL organics and the site-specific list of metals.

Investigative Unit D (Section 5.4.4) Previous Phase 1B Sampling Results

Manganese and Formaldehyde (Near SB-02411 and SB-02510)

Results from soil samples collected in Investigative Unit D indicate manganese and formaldehyde were present at higher levels than other locations across the site. Sample results from locations SB-02411 and SB-02510 had manganese concentrations at 10,800 and 10,600 mg/Kg, respectively. Formaldehyde was detected at concentrations of 33 mg/Kg and 84 mg/Kg at soil boring SB-02510 from 0.7 to 2.7 feet bgs, and from 3.0 to 5.0 feet bgs, respectively.

PCBs (MW-02517)

Groundwater samples collected from MW-02517 had PCBs above Phase 1B Screening Levels.

Hexavalent Chromium (SB-02510)

During validation of the Phase 1B data, non-detect results for hexavalent chromium at soil boring SB-02510 (samples B10255: 0.7 to 2.7 ft, and B10256: 3 to 5 ft) were qualified as unusable due to low matrix spike recovery. The lack of these hexavalent chromium data does not allow distinction between the hexavalent and trivalent portions of the chromium content in soil at that location (i.e., the total chromium concentrations at these locations exceed the Phase 1B Screening Levels for hexavalent chromium).

Antimony (SB-00710)

The concentration of antimony detected in soil at boring SB-00710 (sample B10357) was elevated in comparison with concentrations detected in soil samples collected at borings in the same area (AOI D.7).

Proposed Additional Sampling Activities (Section 5.4.4.2) Investigative Unit D Based on Previous Phase 1B Sampling Results

Manganese and Formaldehyde (Near SB-02411 and SB-02510)

GM proposes to advance four additional soil borings to determine the extent of manganese and formaldehyde in soil along the eastern section of IU D (Figure 5-4e presents proposed soil boring locations and is included as **Attachment** V). Soil samples will be collected and analyzed for manganese and formaldehyde only. Two of the proposed soil boring locations will actually be advanced in the adjacent IU F.

PCBs (MW-02517)

GM proposes the collection and analysis of one groundwater sample from existing well MW-02517 for PCBs (Figure 5-4e presents the monitoring well location and is included as **Attachment** V). The samples will be collected using low flow purge and sampling techniques to minimize turbidity.

Hexavalent Chromium (SB-02510)

GM proposes to advance one additional soil boring in the direct vicinity of SB-02510 to allow analysis of total and hexavalent chromium for soil at 0.7 to 2.7 feet and 3 to 5 feet below ground surface (refer to Figure 5-4e in **Attachment V** for the boring location).

Antimony (SB-00710)

GM proposes to resample soil at the location of SB-00710 to confirm the concentration of antimony at this particular location.

Investigative Unit E (Section 5.4.5) Previous Phase 1B Sampling Results

On April 19, 2001, GM completed confirmatory test pits in Investigative Unit E. During this investigation, groundwater with an initial petroleum odor and slight sheen was discovered at test pit TP-18 (this sheen disappeared after a short period of time). Preliminary analytical results indicate the potential presence of petroleum products in the groundwater samples taken from this test pit.

Fluoride (Monitoring well MW-03746)

Fluoride was detected in the groundwater from samples collected at and downgradient of AOIs (G.4 and G.5) at concentrations which are above Phase 1B Screening Levels. However, a groundwater sample from monitoring well MW-03746 which is downgradient of those previous groundwater samples was not analyzed for fluoride during the Phase 1B RFI.

Proposed Additional Sampling Activities (Section 5.4.5.2) Based on Previous Phase 1B Sampling Results

Potential Petroleum Products near TP-18

GM proposes to install two additional temporary monitoring wells downgradient of test pit TP-18 (refer to Figure 5-5c in **Attachment** VI for the proposed locations). The temporary wells will be purged and the groundwater will be sampled for VOCs, SVOCs and PCBs.

Fluoride (MW-03746)

To further evaluate fluoride in groundwater, GM proposes to sample MW-03746 for fluoride (refer to Figure 5-5c included in **Atttachment VI** for the well location).

Investigative Unit G (Section 5.4.7) Previous Phase 1B Sampling Results

Oganics in Groundwater Near the Former Nodular Iron Oil House

Preliminary VOC results from groundwater samples collected near the former Nodular Iron Plant Oil House detected vinyl chloride at monitoring well MW-04434 during both phases of the RFI, at monitoring well MW-04435 during the Phase 1B RFI, and at temporary monitoring well SB-04435a during the Phase 1B RFI above Phase 1B Screening Levels (see Figure 5-7d included in **Attachment VII**). In addition, PCBs were detected in groundwater from monitoring wells in this location during both the Phase 1A and Phase 1B investigations above the Phase 1B Screening Levels.

The April 19, 2000, Phase 1B Work Plan had originally proposed twelve soil borings to investigate the soil related to several AOIs in this area (TCL organics). However, during implementation of the Phase 1B investigation, the area was flooded and unsaturated samples could not be collected.

<u>Dissolved Benzene, Ammonia, and Arsenic Near the Former (Replacement) Desulfurization Slag RCRA Treatment Unit</u>

Historically, trace amounts of dissolved benzene, ammonia, and arsenic have been identified within the upper-saturated zone in the vicinity of the the former southeast dewatering sump within the former Nodular Iron Plant building and at the former "Replacement" Calcium Carbide Desufurization Slag RCRA Treatment Bunker (G.5 from the DOCC). Groundwater results from the Phase 1A RFI and from the Phase 1B RFI also indicate trace amounts of these parameters (refer to **Table 1**).

Dissolved benzene was detected in the groundwater from the upper-saturated zone during the Phase 1A and Phase 1B RFIs, as well as from historical groundwater samples in this area (refer to Table 1 for the recent results). Historical concentrations have been reported (DOCC, 1995) up to 16,000 $\mu g/L$ at monitoring well MW-4 (no longer present). The source of the dissolved benzene in groundwater has not been determined. No known underground storage tank (UST) was located near this area that may have caused the benzene in the groundwater, and based on the known operations, the former calcium carbide desulfurization slag RCRA treatment unit (G.5) would not have been the source for the benzene.

Table 1
Phase 1A and Phase 1B Groundwater Analytical Summary
Benzene, Ammonia, and Arsenic (IU G)

MW ID	Sample ID	Date	Units	Benzene	Ammonia	Arsenic**
MW-3*	M30222	8/7/00	µg/L	<0.2	2,080	2.5
MW-8*	M30224	8/7/00	µg/L	5.6	19,100	28.1
MW-17	MW-17	6/4/98	µg/L	69 J	NA	22
MW-17*	M30225	8/7/00	µg/L	45 D	25,500	28
MW-18*	M30226	8/7/00	µg/L	5.9	29,100	38.6
MW-04836*	M10218	8/2/00	µg/L	0.2 J	2,030	2.2 B
MW-05036	M30024	12/3/00	µg/L	<0.5	NA	<5.0
MW-05036*	M10208	7/14/00	µg/L	<0..2	NA	8.9

NOTES:

1. NA = Not analyzed
2. * = Non-Validated Results
3. ** = Dissolved results are reported
4. < = Less than, followed by the Method Detection Limit
5. D = Diluted sample
6. J,B = Estimated value (concentration between MDL and EQL)
7. All units are µg/L (or ppb)

Ammonia has historically been detected in groundwater from the upper-saturated zone in this general area, as well as during Phases 1A and 1B of the RFI. The most likely source of the ammonia is believed to be from historical releases of ammonia from waste handling practices for a blueprint machine. This is based on documents describing strong ammonia odors within the basement (and high ammonia concentrations in groundwater seepage into the basement through the concrete walls (the 1987 RMT Report referencing the ammonia is included in **Attachment VII**). This area of the basement is immediately adjacent to an area corresponding to the former "back door" of the Nodular Iron Plant, prior to its last expansion (the area thought to the be the source area was covered by the building addition during the last expansion of the plant). Based on subsequent investigations in this area upgradient of the "back door", the potential discarding of the ammonia from the blueprint machine likely continued after plant expansion, or was discarded outside of the final basement wall area.

In 1994, the Dragun Corporation determined the horizontal extent of ammonia in groundwater (this document can be found in the Addendum to the DOCC, August 1997). It appeared at that time that the groundwater (and dissolved ammonia) was being captured by the nearest dewatering sump (located west of AOI G.5) from the former Nodular Iron Plant basement. This dewatering sump essentially acted as a capture mechanism for the dissolved ammonia.

During the Phase 1B RFI, GM collected soil samples of the unsaturated zone from the installation of monitoring well MW-04836 (within the suspected original source area). The ammonia (as nitrogen) analytical results from samples collected at 0 to 2' and 2 to 4' were 5.7 and 7.6 mg/Kg, respectively.

In 1999, GM completed demolition activities at the former Nodular Iron Plant and filled the former basement. Since that time, groundwater in this area appears to have slightly mounded within the basement. Groundwater flow outside of the basement now appears to flow to the east-southeast near AOI G.5.

Historical concentrations of dissolved arsenic in groundwater from samples collected near the Former (Replacement) Desulfurization Slag RCRA Treatment Unit (G.5) are presented in **Table 2**. As can be seen on **Table 1** compared to **Table 2**, dissolved arsenic concentrations have decreased in groundwater to below the Phase 1B Screening Level (50μg/L). However, additional sampling in this area is proposed in order to confirm previous analyses. Figure 5-7d (**Attachment VII**) presents the historical and proposed sampling locations.

Proposed 1B Activities in Investigative Unit G (Section 5.4.7.3) Based on Previous Phase 1B Sampling Results

Organics in Groundwater Near the Former Nodular Iron Oil House

GM proposes to install four additional temporary monitoring wells at the VOC contamination located near the former Nodular Iron Plant Oil House. The temporary wells will be purged and the groundwater will be sampled for VOCs, PCBs and Fluoride. (refer to Figure 5-7e in **Attachment VII** for the proposed locations). In addition MW-04434 will be resampled for these same constituents.

Because of the presence of standing water in this area, unsaturated soil samples could not be collected as proposed during the Phase 1B RFI. GM will attempt to collect the soil samples from the proposed twelve soil borings use during these additional investigation activities. However, if standing water is still present, SVOCs will be analyzed from the groundwater samples collected from the four temporary monitoring wells and the existing monitoring well MW-04434, described above.

Table 2
Summary of Historical Groundwater Arsenic Results
Former Calcium Carbide Desulfurization Slag RCRA Treatment Unit

Well	Date	Arsenic Concentration
MW-3	10-1-87	11
	3-7-88	14
	11-19-90	31
	12-17-90	17
	1-28-91	13
	2-14-91	15
MW-4	10-1-87	2,300
	1-11-88	5,500 (est)
	11-19-90	56
	12-17-90	42
	1-28-91	56
	2-14-91	49
MW-7	3-7-88	<4
	11-20-90	<10
	12-17-90	<10
	1-29-91	<10
	2-14-91	<10
MW-8	3-7-88	10
	11-19-90	27
	12-17-90	31
	1-28-91	26
	2-14-91	27
MW-9*	5-12-88	<8
MW-17	11-19-90	261
	12-17-90	178
	1-28-91	190
	2-14-91	171
MW-18	11-19-90	71
	12-17-90	89
	1-28-91	135
	2-14-91	96

NOTES:

1. All results are reported in μg/L (or ppb)
2. < = Less than, followed by the method detection limit
3. * = This well is screened within the clay located beneath the upper-saturated zone.
4. Data obtained from the Description of Current Conditions, August 1995

Dissolved Benzene, Ammonia, and Arsenic Near the Former (Replacement) Desulfurization Slag RCRA Treatment Unit

GM proposes the collection of seven groundwater grab samples and the advancement of approximately fourteen soil borings for the collection of soil samples (Figure 5-7d presents proposed soil boring and groundwater sampling locations and is included as Attachment VII). Additional groundwater samples will also be collected from six existing wells (MW-3, MW-8, MW-17, MW-18, MW-04836, and MW-05036). All groundwater samples will be submitted to the laboratory for analysis of benzene, dissolved arsenic, and total ammonia.

Soil sampling for is ammonia is proposed in the area of the suspected original ammonia source and outside of the former foundation to the east (borings are not proposed within the area that the former basement once occupied since this area was recently filled with inert fill material). Soil will also be analyzed for benzene and arsenic. This soil sampling is proposed to further evaluate if sources still exist and delineate the extent, if present.

Investigative Unit H (Section 5.4.8) Previous Phase 1B Sampling Results

Formaldehyde (Near soil boring SB-05542)

Results from soil samples collected in the southwest section of Investigative Unit H (soil boring SB-05542) indicate that some concentrations of formaldehyde above the Phase 1B Screening Level.

The groundwater sample collected from MW-04757 contained PCBs at a level above the Phase 1B Screening Level.

Proposed Additional Sampling Activities (5.4.8.2) in Investigative Unit H Based on Phase 1B Sampling Results

Formaldehyde (Near soil boring SB-05542)

In order to further evaluate the extent of formaldehyde present in the subsurface GM proposes the installation of two soil borings (refer to Figure 5-8c in **Attachment VIII** for the proposed locations). A minimum of two unsaturated soil samples will be collected and analyzed for formaldehyde.

PCBs (Near MW 04757)

To further evaluate the presence of PCBs in groundwater at this location, GM proposes to resample MW-04757 for PCBs utilizing low-flow groundwater purging and sampling techniques to minimize turbidity .

Investigative Unit I (Section 5.4.9) Previous Phase 1B Sampling Results

Hydrogeologic and Groundwater Characterization

Groundwater elevations measured during the Phase 1B suggest that groundwater flow in the shallow water bearing unit is away from the Saginaw River to the northeast. Samples collected during the Phase B suggest that the unit actually pinches out to the northeast and therefore flow could not be in that direction (north section of IU I at monitoring well MW-07959, refer to Figure 5-9c in **Attachment III** for the monitoring well location).

In addition, the analytical results from Phase 1B groundwater sample from monitoring well MW-07959 show 2,4-dimethylphenol, cyanide, and dissolved vanadium at concentrations above Phase 1B Screening Levels.

Proposed Additional Sampling Activities (5.4.9.2) in Investigative Unit I Based on Phase 1B Sampling Results

Hydrogeologic and Groundwater Characterization

In order to define the groundwater flow in Investigative Unit I, and to further characterize 2,4-dimethylphenol and cyanide detected in groundwater, GM proposes to utilize the five temporary monitoring wells that will be installed in shallow groundwater during the investigation of elevated pH (refer to Figure 5-9c in **Attachment III** for the locations). A hydrogeologic characterization will be conducted and will consist of logging continuous soil samples during advancement, surveying the temporary wells, and measuring the static water levels along with nearby existing RFI monitoring wells. In addition, groundwater samples will be collected from the five temporary wells and one existing monitoring well (MW-07959). All samples will be analyzed for 2,4-dimethylphenol, cyanide, and fluoride in addition to the parameters selected to investigate the apparent elevated pH in this area. If shallow groundwater is not encountered at a proposed location, the well will not be installed and a sample will not be collected.

Fluoride

As discussed earlier in this report, as a modification to Section 5.4.7 of the Work Plan, GM has included fluoride in groundwater samples collected in the upper, water-bearing zone near and downgradient of the two former desulfurization slag RCRA treatment units (AOIs G.4 and G.5). Fluoride analysis will also be included for the samples collected from the 17 groundwater grab samples and the 5 temporary wells installed in the upper saturated zone in IUs G,H and I during the elevated pH investigation (described above), and the existing shallow well MW-07959. In order to determine if fluoride is present in the bedrock aquifer, GM proposes to sample two existing bedrock wells in IU I (MW-97948 and MW-96939) for fluoride.

Project Schedule (Section 5.7)

Because additional investigative activities are being proposed under this Addendum to the April 19, 2000, Phase 1B RFI Work Plan, the project schedule will be adjusted accordingly. Revised Figure 5-14, included as **Attachment IX**, describes the progress to date and the anticipated future schedule for completion of the Phase 1B scope of work (February 8, 2002), dependent upon U.S. EPA's timely approval. Also, delays have been encountered with regard to the collection of unsaturated soil near the former Nodular Iron Oil House, which has not been possible due to standing water in this area during the previous sampling. The standing water in IU G will continue to be monitored, and unsaturated samples, as described in the April 19, 2000, Phase 1B RFI Work Plan, will be collected, if possible. If these samples still cannot be collected, GM will re-evaluate what information could be collected to satisfy the original information need (i.e., collection of SVOCs in nearby groundwater) and discuss the change with U.S.EPA.

Data Analysis and the Preliminary Risk Assessment will proceed on schedule for the collected data (**Attachment X** provides all of the Phase 1B Screening results to date). However, the schedule for final analysis and risk assessment preparation, based on all collected data, including the newly proposed investigation, will need to be extended. The additional investigation is currently projected to be completed by November 29, 2001 (this allows for approximately 4 weeks turnaround at the laboratory and approximately 4 weeks turnaround for data validation). A draft Phase 1B RFI Report will be submitted to the U.S.EPA by February 8, 2002.

Once U.S.EPA has reviewed the draft Phase 1B RFI Report, GM would welcome the opportunity to meet to discuss any questions or comments they may have. The Phase 1B Report will then be revised to address any U.S.EPA written comments (or any modification discussed in the meeting), and the Final Phase 1B Report will be submitted within 45 days following the meeting with the U.S.EPA.

Once you have had a chance to review the enclosed Addendum, please call me to set up a time to discuss the proposed scope of work. Also, if you have any questions or comments, or would like any additional information, please contact me at (313) 556-9032.

Sincerely,

Cheryl R. Hiatt
Project Coordinator

Attachments: I. Amendments to the Quality Assurance Project Plan
II. Revised Figure 5-12
III. Figure 5-9c
IV. Figure 5-2c
V. Figure 5-4e
VI. Figure 5-5c
VII. Figure 5-7d, 5-7e and RMT's 1987 Report on Basement Wall Leaks
VIII. Figure 5-8c
IX Revised Figure 5-14
X Phase 1B Soil and Groundwater Screening Results

cc: Mr. Brian Freeman, U.S. EPA
Mr. Jim Sygo, MDEQ-WMD Lansing
Mr. Ed Hapaala, MDEQ-WMD Bay City
Dr. Lisa Williams, U.S. DOI, Fish and Wildlife
Ms. Jean Caufield, GM WFG Remediation
Mr. Tony Thrubis, GM Legal Staff
Mr. James McGuigan, CRA Project Coordinator
Mr. Joe Toth/Mr. Ray Ilkka, SMCO

ATTACHMENT I

Amendments to the Quality Assurance Project Plan

QUALITY ASSURANCE PROJECT PLAN
for a
RCRA FACILITY INVESTIGATION
at
GENERAL MOTORS CORPORATION
SAGINAW METAL CASTING OPERATIONS
SAGINAW, MICHIGAN
USEPA I.D. NO. MID 041 793 340

PHASE 1B SUPPLEMENT QAPP, REVISION 2

June 4, 2001

PREPARED FOR:

GENERAL MOTORS CORPORATION
WORLDWIDE FACILITIES GROUP
REMEDIATION TEAM
DETROIT, MI

PREPARED BY:

CONESTOGA-ROVERS & ASSOCIATES
CHICAGO, ILLINOIS

GM Project Coordinator Date

CRA Project Coordinator Date

Environ QA Manager Date

CAS QA Officer Date

Not Applicable

EMCON Soils Laboratory QA Director Date

USEPA RCRA Project Coordinator Date

USEPA RCRA Enforcement QA Coordinator Date

LIST OF RECIPIENTS

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ENVIRON Human Health Risk Assessment	Stephen Song, Ph. D.
CAS Laboratory, Laboratory Operations Director	David Edelman, Ph.D. (1 copy)
Sampling Team	(1 copy)
Drilling Subcontractor	(1 copy)

1.4.2 Project Target Parameters and Intended Data Usage

The data collected during Phase 1A were used to develop the laboratory parameters for the Phase 1B investigation. The Phase 1B scope of work includes further investigation of specific areas identified during Phase 1A. The list of target parameters and the rationale for their selection are provided in **Table 2** and discussed below.

1.4.2.1 Organic Compounds

The Phase 1A list of parameters included 61 volatile organic compounds (VOCs) and 109 semivolatile organic compounds (SVOCs) from the Appendix IX groundwater monitoring list as specified in the Phase 1A Workplan and QAPP. The USEPA Contract Laboratory Program (CLP) target compound list (TCL) includes 33 VOCs and 64 SVOCs. **Table 2A** summarizes the non-TCL compounds detected during the Phase 1A investigation. Organic compounds detected in Phase 1A that are reported differently than on the TCL are 3- and 4-methylphenol coelution and *cis*- and *trans*-1,2-dichloroethene. The *cis*- and *trans*-1,2-dichloroethene isomers were reported as individual compounds for the Phase 1A volatile organic analyses as specified in the Phase 1A QAPP, instead of as total 1,2-dichloroethene, as specified in the TCL, because the two isomers are quantitated separately during the analysis. Similarly, because of spectral overlap, 3- and 4-methylphenol were reported as a coelution for the SVOC analyses, as specified in the Phase 1A QAPP, instead of as 4-methylphenol as specified in the TCL. The *cis*-1,2-dichloroethene isomer was the only non-TCL Appendix IX VOC compounds detected during Phase 1A. Acetophenone, which was detected in one soil sample, is the only SVOC included on the Phase 1A analyte list that is not included in USEPA's TCL. Formaldehyde, a carbonyl compound, which was included in the Phase 1A list of parameters, but is not included in USEPA's TCL or the Appendix IX groundwater monitoring list, was detected in some soil and groundwater samples.

Therefore, for the Phase 1B investigation scope of work, the TCL parameters were selected as the organic parameter list with the addition of formaldehyde, the 3- and 4-methylphenol coelution, and *cis*- and *trans*-1,2-dichloroethene. The 28 additional VOCs and 45 additional SVOCs that were included in the Phase 1A list of parameters will not be included in Phase 1B because they were never detected during the Phase 1A investigation. The Phase 1B list of parameters was revised to include the 34 TCL VOCs (note 34 VOCs instead of 33, as specified in TCL, because of reporting of individual *cis*- and *trans*-isomers for 1,2-dichloroethene (**Table 3A**) and 64 TCL SVOCs (**Table 3B**). The Phase 1B list of parameters for polychlorinated biphenyl (PCB) Aroclor® mixtures (**Table 3C**) and formaldehyde (**Table 3D**) remains unchanged from the Phase 1A parameter list.

The Phase 1A Workplan also required reporting of the top 10 tentatively identified compounds (TICs) (as ranked by concentration) for SVOC analyses in all matrices. A total of 205 TIC compounds and 2,454 TIC results were reported for the Phase 1A investigation. Of the 2,454 TIC results, 8 percent were rejected during validation. Of the 205 TIC compounds identified during Phase 1A, over 50 percent were unknown compounds (i.e., unknown PAH, dimethylnaphthalene isomer 2, substituted phenol) and were not used for data analysis or interpretation. The TIC results are difficult to assess because the identification of the compounds is qualitative and is selected using professional judgment when the mass spectrometer library search yields several candidate compounds. CAS registry numbers (CAS RN) were assigned to 68 of the 205 TICs based on the chemical names identified by the laboratory. Assuming that the laboratory's tentative identifications are correct, only 6 of the 68 compounds (1,2,3-trichloro-1-propene, benzoic acid, caprolactum, 2-(2-ethoxyethoxy)-ethanol, *o*-hydroxybiphenyl, and triphenyl ester phosphoric acid) have either USEPA-derived toxicity values or a screening level from USEPA Regions 9 or 3, or from MDEQ. Because toxicity information is also limited or nonexistent for the identified compounds, the data are not used in evaluating risk at the site. Including these TICs would also significantly increase data management requirements. Therefore, TICs for SVOC analysis will not be reported during Phase 1B activities, and this component of analysis does not appear in the Phase 1B QAPP.

1.4.2.2 Metals

The analyte list for metals (**Table 3E**) for Phase 1B was revised based on the results from the Phase 1A investigation. Calcium and iron were not included in the analyte list for Phase 1B as these naturally occurring elements are typically excluded from human health risk assessment evaluation because of their natural abundance and the fact that USEPA has not established human health toxicity values for these parameters. Silver and thallium were not included in the analyte list for Phase 1B, as they were not detected in any of the soil or groundwater samples during Phase 1A (**Table 2B**) and are not known to be related to onsite plant activities. Mercury was detected in only 10 of the 234 soil samples, with a mean concentration of 0.011 mg/kg and a maximum of 0.6 mg/kg, which is within typical background levels (Dragun 1991, Table 42). Total mercury was detected in 26 percent of the groundwater samples (21 of 82 samples) at a maximum concentration of 0.0002 mg/L (maximum contaminant level [MCL] is 0.002 mg/L). Dissolved mercury was not detected in any of the groundwater samples. Because mercury was not detected in the dissolved fraction of the groundwater, was detected infrequently in soil, and is not known to be related to onsite plant activities, mercury has been excluded from the Phase 1B parameter list. Cobalt, selenium, and tin were not included in the Phase 1B list of parameters because of the infrequency of detection for selenium and tin, and because the maximum concentrations detected in soil for all three of these analytes were well within typical background levels (Dragun 1991, Tables 19, 58, and 74). In addition, cobalt, selenium, and tin were not detected in the dissolved fraction of the groundwater samples in any Phase 1A sample and total cobalt, selenium, and tin were detected in 58, 2, and 9 percent of the groundwater samples, respectively, at concentrations well below Phase 1A screening levels. **Table 4** identifies the selected metals for which each matrix will be analyzed related to each IU.

1.4.2.3 Additional Parameters

Chromium speciation was added to the list of parameters for Phase 1B to support interpretation of data for human health risk assessment, because the human health toxicity and mobility of chromium varies by valence (the Standard Operating Procedure and Table 3D have been revised to reflect the appropriate analytical method for the aqueous matrix). Ammonia-nitrogen was added to the Phase 1B list for analysis of selected soil and groundwater samples near the calcium carbide replacement pads to confirm the source of ammonia detected during previous investigations. Acid-volatile sulfide and sequentially extractable metals were not included in the Phase 1B analyte list because the scope of Phase 1B does not include the collection of additional sediment samples for analysis. Total Kjeldahl nitrogen and sulfide were not included in the Phase 1B list of parameters because analyses for these parameters are not required to satisfy the objectives of the Phase 1B investigation, and USEPA has not established human health toxicity values for these parameters; therefore, additional data are not useful for conducting the human health risk assessment.

Fluoride has been added to the list of parameters in groundwater for Phase 1B to evaluate potential impact from former operations at the Nodular Iron Plant (Table 3D has been revised). Fluoride analysis in groundwater is added to the selected monitoring wells, as described in Table 4. The Standard Operating Procedure for fluoride analysis is added to this revision of the Phase 1B Supplemental QAPP.

1.4.2.4 Field Parameters

The field parameters for groundwater and surface water sampling during Phase 1B will include the measurement of:

- pH;
- Specific conductance;
- Dissolved oxygen (DO);
- Eh;
- Temperature;
- Turbidity;
- Groundwater levels; and
- Groundwater levels as a function of time.

Survey measurements recorded during establishment of control points and a site grid, as well as specific sample location (areal and elevation) survey measurements, will comprise field measurements for soil sampling.

VOC headspace screening will be performed on soil samples by inserting a PID into a jar partially filled with sample material, as described in the "Subsurface Soil Sampling" standard operating procedure (SOP) (Appendix A). The PID to be utilized will be equipped with an 11.7-eV lamp to ensure that volatile compounds with an ionization potential above the typical 10.6-eV lamp range are detected (i.e., 1,1,1-TCA, which has an ionization potential of 11.00 eV).

At investigative units B and G, groundwater samples collected using direct-push equipment will be analyzed in the field for selected VOCs (vinyl chloride, 1,1-dichloroethane, benzene, toluene, and chlorobenzene) by an onsite mobile laboratory, using a method equivalent to SW-846 Method 8021B. The onsite laboratory SOP will be provided separately to EPA from this QAPP following selection of a specific contractor.

Additional ambient air monitoring may be performed for health and safety purposes based on requirements of Part VI: Health and Safety Plan.

1.4.2.5 Laboratory Parameters

A summary of the analyses to be performed during Phase 1B is presented in **Tables 3A through 3F**. The parameters on these lists have been selected to assess the potential presence of hazardous constituents based on knowledge of site operations, anticipated conditions, and the evaluation of the Phase 1A data.

1.4.3 Data Quality Objectives

Target parameters, method detection limits (MDLs), and estimated quantitation limits (EQLs) for analyses are summarized in **Tables 3A through 3F**. Additional DQOs are summarized in **Tables 2 through 6E.**

TABLE 1
FIELD MONITORING EQUIPMENT

Equipment	Sensitivity	QC Samples	Acceptability Criteria
Soil/Air Monitoring			
Photoionization Detector Meter (11.7 eV lamp)	2 ppm	Duplicate sample	± 2 ppm
Aqueous Monitoring			
pH meter	0.1 std. unit	Standard buffers	± 0.1 std. unit
Specific conductance meter	1 μmhos/cm	Calibration standard	± 5% from standard
Eh meter	0.1 millivolts	Calibration standard	± 10% of standard
DO meter	1 ppm	Calibrate against moist air	± 15% from standard
Thermometer	0.1° C	Calibrate against NIST traceable thermometer	± 10% of traceable thermometer
Turbidity meter	0.02 NTU	Calibration standard	± 10% from standard
Depth-to-water meter	0.1 ft	Calibrate against steel measuring tape	± 0.05 ft
Interface probe	0.1 ft	Calibrate against steel measuring tape	± 0.05 ft
Water level recorder transducer	0.01 ft	Calibrate against steel measuring tape	± 0.01 ft
Gas chromatograph	0.01-0.1 μg/L	Calibration standards, Duplicate samples	Linearity ± 20 RSD, COD ≥ 0.98 ± 35%
Surveying			
Horizontal control	0.1 ft	Reference check	± 0.1 ft
Vertical control	0.01 ft	Reference check	± 0.01 ft

TABLE 2
CHEMICAL ANALYTICAL PARAMETERS AND RATIONALE$^{(a)}$

Phase 1B Parameter	Matrix	Rationale
Total Metals (soils and water) and Total and Dissolved Metals (Water)	Soils Groundwater	13 metals potentially associated with constituents/components from long-term foundry operations, paint, and contaminated oil components
Total Organic Carbon (TOC)	Soil	Used to evaluate carbon content of soils for assessment of degradation of selected compounds
Volatile Organic Compounds (VOCs)	Soils Groundwater	35 compounds (TCL) potentially associated with solvents, petroleum products, thinners, and paints
Semivolatile Organic Compounds (SVOCs)	Soils Groundwater	64 compounds (TCL) potentially associated with petroleum products, paints, solvents, and wastes
Polychlorinated Biphenyls (PCBs)	Soils Groundwater	7 Aroclor® products potentially associated with hydraulic fluids and transformers
Cyanide	Soils Groundwater	Total cyanide potentially associated with former cyanide operations
Formaldehyde	Soils Groundwater	Detected in Phase 1A and potentially associated with manufacturing process
Ammonia Nitrogen	Soils Groundwater	Used to determine whether a source of ammonia is present
Fluoride	Groundwater	Used to evaluate potential influence on groundwater from former operations at the Nodular Iron Plant
Chromium Speciation (Total and Hexavalent)	Soils Groundwater	Used to evaluate human health toxicity and mobility of chromium

Notes:
TCL – target compound list
(a) Lists of specific compounds and methods are shown in Tables 3A through 3F.

▨ Change since last revision

TABLE 3A
COMPOUND LIST FOR VOLATILE ORGANIC COMPOUND ANALYSIS

Compound	Chemical Abstracts Service Registry Number	Method Reference	Description/ Instrument	Laboratory SOP	MDL		Estimated Quantitation Limit	
					Water (µg/L)	Soil (µg/kg) dry weight[a]	Water (µg/L)	Soil (µg/kg) dry weight[a]
Acetone	67-64-1	SW-846/EPA 8260B[b], 5030B, 5035	GC/MS Purge and Trap	CAS SOP VOC8260B	[illegible]	[illegible]	20	2000
Benzene	71-43-2	SW-846/EPA 8260B[b], 5030B, 5035	GC/MS Purge and Trap	CAS SOP VOC8260B	0.2	20	0.5	50
Bromodichloromethane	75-27-4	SW-846/EPA 8260B[b], 5030B, 5035	GC/MS Purge and Trap	CAS SOP VOC8260B	0.2	20	0.5	50
Bromoform	75-25-2	SW-846/EPA 8260B[b], 5030B, 5035	GC/MS Purge and Trap	CAS SOP VOC8260B	0.3	30	0.5	50
Bromomethane	74-83-9	SW-846/EPA 8260B[b], 5030B, 5035	GC/MS Purge and Trap	CAS SOP VOC8260B	0.3	30	0.5	50
2-Butanone (MEK)	78-93-3	SW-846/EPA 8260B[b], 5030B, 5035	GC/MS Purge and Trap	CAS SOP VOC8260B	[illegible]	[illegible]	20	2000
Carbon disulfide	75-15-0	SW-846/EPA 8260B[b], 5030B, 5035	GC/MS Purge and Trap	CAS SOP VOC8260B	0.2	20	0.5	50
Carbon tetrachloride	56-23-5	SW-846/EPA 8260B[b], 5030B, 5035	GC/MS Purge and Trap	CAS SOP VOC8260B	0.2	20	0.5	50
Chlorobenzene	108-90-7	SW-846/EPA 8260B[b], 5030B, 5035	GC/MS Purge and Trap	CAS SOP VOC8260B	0.2	20	0.5	50
Chloroethane	75-00-3	SW-846/EPA 8260B[b], 5030B, 5035	GC/MS Purge and Trap	CAS SOP VOC8260B	0.2	20	0.5	50
Chloroform	67-66-3	SW-846/EPA 8260B[b], 5030B, 5035	GC/MS Purge and Trap	CAS SOP VOC8260B	0.2	20	0.5	50
Chloromethane	74-87-3	SW-846/EPA 8260B[b], 5030B, 5035	GC/MS Purge and Trap	CAS SOP VOC8260B	0.2	20	0.5	50
Dibromochloromethane	124-48-1	SW-846/EPA 8260B[b], 5030B, 5035	GC/MS Purge and Trap	CAS SOP VOC8260B	0.2	20	0.5	50
1,1-Dichloroethane	75-34-3	SW-846/EPA 8260B[b], 5030B, 5035	GC/MS Purge and Trap	CAS SOP VOC8260B	0.2	20	0.5	50
1,2-Dichloroethane (EDC)	107-06-2	SW-846/EPA 8260B[b], 5030B, 5035	GC/MS Purge and Trap	CAS SOP VOC8260B	0.2	20	0.5	50
1,1-Dichloroethene	75-35-4	SW-846/EPA 8260B[b], 5030B, 5035	GC/MS Purge and Trap	CAS SOP VOC8260B	0.2	20	0.5	50
cis-1,2-Dichloroethene	156-59-2	SW-846/EPA 8260B[b], 5030B, 5035	GC/MS Purge and Trap	CAS SOP VOC8260B	0.3	30	0.5	50
trans-1,2-Dichloroethene	156-60-5	SW-846/EPA 8260B[b], 5030B, 5035	GC/MS Purge and Trap	CAS SOP VOC8260B	0.2	20	0.5	50
Dichloromethane	75-09-2	SW-846/EPA 8260B[b], 5030B, 5035	GC/MS Purge and Trap	CAS SOP VOC8260B	0.3	30	5	250
1,2-Dichloropropane	78-87-5	SW-846/EPA 8260B[b], 5030B, 5035	GC/MS Purge and Trap	CAS SOP VOC8260B	0.2	20	0.5	50
cis-1,3-Dichloropropene	10061-01-5	SW-846/EPA 8260B[b], 5030B, 5035	GC/MS Purge and Trap	CAS SOP VOC8260B	0.2	20	0.5	50
trans-1,3-Dichloropropene	10061-02-6	SW-846/EPA 8260B[b], 5030B, 5035	GC/MS Purge and Trap	CAS SOP VOC8260B	0.2	20	0.5	50
Ethylbenzene	100-41-4	SW-846/EPA 8260B[b], 5030B, 5035	GC/MS Purge and Trap	CAS SOP VOC8260B	0.2	20	0.5	50
2-Hexanone	591-78-6	SW-846/EPA 8260B[b], 5030B, 5035	GC/MS Purge and Trap	CAS SOP VOC8260B	[illegible]	[illegible]	20	1000
4-Methyl-2-pentanone (MIBK	108-10-1	SW-846/EPA 8260B[b], 5030B, 5035	GC/MS Purge and Trap	CAS SOP VOC8260B	[illegible]	[illegible]	20	1000
Styrene	100-42-5	SW-846/EPA 8260B[b], 5030B, 5035	GC/MS Purge and Trap	CAS SOP VOC8260B	0.2	20	0.5	50
1,1,2,2-Tetrachloroethane	79-34-5	SW-846/EPA 8260B[b], 5030B, 5035	GC/MS Purge and Trap	CAS SOP VOC8260B	0.2	20	0.5	50
Tetrachloroethene (PCE)	127-18-4	SW-846/EPA 8260B[b], 5030B, 5035	GC/MS Purge and Trap	CAS SOP VOC8260B	0.2	20	0.5	50
Toluene	108-88-3	SW-846/EPA 8260B[b], 5030B, 5035	GC/MS Purge and Trap	CAS SOP VOC8260B	0.2	20	0.5	50
1,1,1-Trichloroethane (TCA)	71-55-6	SW-846/EPA 8260B[b], 5030B, 5035	GC/MS Purge and Trap	CAS SOP VOC8260B	0.3	30	0.5	50
1,1,2-Trichloroethane	79-00-5	SW-846/EPA 8260B[b], 5030B, 5035	GC/MS Purge and Trap	CAS SOP VOC8260B	0.3	30	0.5	50
Trichloroethene (TCE)	79-01-6	SW-846/EPA 8260B[b], 5030B, 5035	GC/MS Purge and Trap	CAS SOP VOC8260B	0.3	30	0.5	50
Vinyl chloride	75-01-4	SW-846/EPA 8260B[b], 5030B, 5035	GC/MS Purge and Trap	CAS SOP VOC8260B	0.3	30	0.5	50
Total xylenes	[c]	SW-846/EPA 8260B[b], 5030B, 5035	GC/MS Purge and Trap	CAS SOP VOC8260B	0.4	40	1	100

[a] Results reported on a dry weight basis unless excessive moisture is present in sample.

[b] Preparation method EPA 5030B will be used for aqueous matrices and EPA 5035 (methanol preservation) will be used for soil/sediment matrices.

[c] o-xylene (CAS#95-47-6); m-xylene (CAS#108-38-3); p-xylene (CAS#106-42-3)

▨ = Change since last revision

TABLE 3B
COMPOUND LIST FOR SEMIVOLATILE ORGANIC COMPOUND ANALYSIS

Compound	Chemical Abstracts Service Registry Number	Method Reference	Description/ Instrument	Laboratory SOP	MDL		Estimated Quantitation Limit	
					Water (µg/L)	Soil (µg/kg) dry weight[a]	Water (µg/L)	Soil (µg/kg) dry weight[a]
Acenaphthene	82-32-9	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	0.8	30	10	330
Acenaphthylene	208-96-8	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	0.6	30	10	330
Anthracene	120-12-7	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	[illegible]	20	10	330
Benz(a)anthracene	56-55-3	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	0.7	30	10	330
Benzo(a)pyrene	50-32-8	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	0.7	[illegible]	10	330
Benzo(b)fluoranthene	205-99-2	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	0.8	30	10	330
Benzo(g,h,i)perylene	191-24-2	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	[illegible]	30	10	330
Benzo(k)fluoranthene	207-08-9	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	[illegible]	30	10	330
Bis(2-chloroethoxy)methane	111-91-1	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	0.8	30	10	330
Bis(2-chloroethyl) ether	111-44-4	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	0.5	20	10	330
Bis(2-chloroisopropyl) ether	108-60-1	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	0.8	20	10	330
Bis(2-ethylhexyl) phthalate	117-81-7	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	[illegible]	40	10	330
4-Bromophenyl phenyl ether	101-55-3	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	0.8	30	10	330
Butyl benzyl phthalate	85-68-7	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	[illegible]	50	10	330
Carbazole	86-74-8	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	[illegible]	20	10	330
4-Chloroaniline	106-47-8	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	[illegible]	[illegible]	10	330
4-Chloro-3-methylphenol	59-50-7	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	0.8	40	10	330
2-Chloronaphthalene	91-58-7	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	0.6	30	10	330
2-Chlorophenol	95-57-8	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	0.7	30	10	330
4-Chlorophenyl phenyl ether	7005-72-3	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	0.6	[illegible]	10	330
Chrysene	218-01-9	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	[illegible]	30	10	330
Dibenz(a,h)anthracene	53-70-3	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	[illegible]	[illegible]	10	330
Dibenzofuran	132-64-9	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	0.5	30	10	330
Di-*n*-butyl phthalate	84-74-2	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	[illegible]	30	10	330
3,3'-Dichlorobenzidine	91-94-1	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	[illegible]	[illegible]	25	2000
1,3-Dichlorobenzene	541-73-1	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	0.3	30	10	330
1,4-Dichlorobenzene	106-46-7	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	0.4	40	10	330
1,2-Dichlorobenzene	95-50-1	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	[illegible]	40	10	330
2,4-Dichlorophenol	120-83-2	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	[illegible]	[illegible]	10	330
Diethyl phthalate	84-66-2	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	1	30	10	330
2,4-Dimethylphenol	105-67-9	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	[illegible]	[illegible]	10	330
Dimethyl phthalate	131-11-3	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	[illegible]	30	10	330
2-Methyl-4,6-dinitrophenol	534-52-1	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	[illegible]	[illegible]	25	2000
2,4-Dinitrophenol	51-28-5	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	6	[illegible]	25	2000
2,4-Dinitrotoluene	121-14-2	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	[illegible]	30	10	330

TABLE 3B. (cont.)

Compound	Chemical Abstracts Service Registry Number	Method Reference	Description/ Instrument	Laboratory SOP	MDL		Estimated Quantitation Limit	
					Water (µg/L)	Soil/Sediment (µg/kg) dry weight[a]	Water (µg/L)	Soil/Sediment (µg/kg) dry weight[a]
2,6-Dinitrotoluene	606-20-2	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	1.4	30	10	330
Di-*n*-octyl phthalate	117-84-0	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	1.4	70	10	330
Fluoranthene	206-44-0	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	1.1	30	10	330
Fluorene	86-73-7	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	0.9	30	10	330
Hexachlorobenzene	118-74-1	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	1	30	10	330
Hexachlorobutadiene	87-68-3	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	0.7	30	10	330
Hexachlorocyclopentadiene	77-47-4	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	5.5	30	10	330
Hexachloroethane	67-72-1	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	0.8	30	10	330
Indeno(1,2,3-cd)pyrene	193-39-5	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	1.1	30	10	330
Isophorone	78-59-1	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	0.6	30	10	330
2-Methylphenol	95-48-7	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	0.9	30	10	330
3- and 4-Methylphenol[c]	[d]	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	0.5	40	10	330
2-Methylnaphthalene	91-57-6	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	0.9	30	10	330
N-Nitrosodi-*n*-propylamine	621-64-7	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	0.7	30	10	330
N-Nitrosodiphenylamine	86-30-6	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	1	30	10	330
Naphthalene	91-20-3	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	0.7	30	10	330
2-Nitroaniline	88-74-4	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	1.1	30	25	2000
3-Nitroaniline	99-09-2	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	1.2	50	25	2000
4-Nitroaniline	100-01-6	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	1.4	40	25	2000
Nitrobenzene	98-95-3	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	0.6	30	10	330
2-Nitrophenol	88-75-5	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	0.8	30	10	330
4-Nitrophenol	100-02-7	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	1.5	60	25	2000
Pentachlorophenol	87-86-5	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	1.1	40	25	2000
Phenanthrene	85-01-8	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	0.7	20	10	330
Phenol	108-95-2	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	0.5	30	10	330
Pyrene	129-00-0	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	1.2	50	10	330
1,2,4-Trichlorobenzene	120-82-1	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	0.6	20	10	330
2,4,5-Trichlorophenol	95-95-4	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	0.5	30	10	330
2,4,6-Trichlorophenol	88-06-2	SW-846/EPA 8270C[b], 3520C, 3550B	GC/MS	CAS SOP SOC8270C	0.7	30	10	330

[a] Results reported on a dry weight basis unless excessive moisture is present in sample.

[b] Preparation method EPA 3520C (continuous liquid-liquid extraction) will be used for aqueous matrices and EPA 3550B (ultra-sonic extraction) will be used for soil/sediment m

[c] These compounds coelute; therefore, results are reported as the combined concentration

[d] 3-Methyl phenol (CAS#108-39-4); 4-methyl phenol (CAS#106-44-5)

▨ = Change since last revision

TABLE 3C
COMPOUND LIST FOR POLYCHLORINATED BIPHENYL ANALYSIS

Compound	Chemical Abstracts Service Registry Number	Method Reference	Description/ Instrument	Laboratory SOP	MDL		Estimated Quantitation Limit	
					Water (µg/L)	Soil (µg/kg) dry weight[b]	Water (µg/L)	Soil (µg/kg) dry weight[b]
Aroclor® 1016	12674-11-2	SW-846/EPA 8082[a], 3510C, 3545	GC/ECD	CAS SOP SOC8082	[illegible]	20	0.2	100
Aroclor® 1221	1104-28-2	SW-846/EPA 8082[a], 3510C, 3545	GC/ECD	CAS SOP SOC8082	[illegible]	20	0.4	[illegible]
Aroclor® 1232	11141-16-5	SW-846/EPA 8082[a], 3510C, 3545	GC/ECD	CAS SOP SOC8082	[illegible]	20	0.2	100
Aroclor® 1242	53469-21-9	SW-846/EPA 8082[a], 3510C, 3545	GC/ECD	CAS SOP SOC8082	[illegible]	20	0.2	100
Aroclor® 1248	12672-29-6	SW-846/EPA 8082[a], 3510C, 3545	GC/ECD	CAS SOP SOC8082	[illegible]	20	0.2	100
Aroclor® 1254	11097-69-1	SW-846/EPA 8082[a], 3510C, 3545	GC/ECD	CAS SOP SOC8082	[illegible]	20	0.2	100
Aroclor® 1260	11096-82-5	SW-846/EPA 8082[a], 3510C, 3545	GC/ECD	CAS SOP SOC8082	[illegible]	20	0.2	100
Decachlorobiphenyl (surrogate compound	2051-24-3	SW-846/EPA 8082[a], 3510C, 3545	GC/ECD	CAS SOP SOC8082	NA	NA	NA	NA

[a] Preparation method EPA 3510C (separtory funnel liquid-liquid extraction) will be used for aqueous matrices and EPA 3545 (pressurized fluid extraction) will be used for soil/sediment matric

[b] Results reported on a dry weight basis unless excessive moisture is present in sample.

▨ = Change since last revision

TABLE 3D
ANALYTE LIST FOR ADDITIONAL PARAMETERS

Parameter	Chemical Abstracts Service Registry Number	Method Reference	Description/ Instrument	Laboratory SOP	MDL		Estimated Quantitation Limit	
					Water (mg/L)	Soil (mg/kg) dry weight[a]	Water (mg/L)	Soil (mg/kg) dry weight[a]
Formaldehyde	50-00-0	SW-846/EPA 8315A[b]	HPLC	CAS SOP SO38315A	0.03	0.6	0.05	10
Fluoride	16984-48-8	SW846/EPA 300.0	Ion Chromatography	CAS SOP GEN-300	[illegible]	[illegible]	0.2	[illegible]
Total solids	NA	EPA 160.3	Gravimetric	CAS SOP GEN-160.3	5	NA	5	NA
Ammonia nitrogen	7664-41-7	EPA 350.1	Colorimetric	CAS SOP GEN-350.1	0.04	NA	0.05	NA
Total cyanide	57-12-5	SW846/EPA 9010B[b]	Distillation	CAS SOP GEN-335	0.003	0.6	0.01	10
Hexavalent Cr		SW846/EPA3060A/7196A[d]	Colorimetric	CAS SOP GEN-Cr6	[illegible]	0.2	0.05	4
Dissolved Hexavalent Cr		SW846/EPA7195/6010B	Separation/Co-precipitation	CAS SOP MET-7195	0.005	NA	0.05	NA
Total organic carbon	NA	ASTM D4129-82M[b]	Oxidation/ Coulometric detection	CAS SOP GEN-TOC	NA	0.01%	NA	0.05%

[a] Results reported on a dry weight basis unless excessive moisture is present in sample.
[b] Preparation procedures included in the referenced method for aqueous and solid matrices.
[c] Modified for solid matrix analysis.
▨ = Change since last revision

TABLE 3E
ANALYTE LIST FOR METALS ANALYSIS

Metal	Chemical Abstracts Service Registry Number	Method Reference	Instrument	Laboratory SOP	MDL		Estimated Quantitation Limit	
					Water (µg/L)	Soil (mg/kg) dry weight[a]	Water (µg/L)	Soil (mg/kg) dry weight[a]
Aluminum	7429-90-5	SW-846/EPA 6010B, 3010A, 3050B	ICP	CAS SOP MET-ICP	30	1	50	10
Antimony	7440-36-0	SW-846/EPA 6010B, 3010A, 3050B	ICP	CAS SOP MET-ICP	20	4	50	10
Arsenic	7440-38-2	SW-846/EPA 7060A, 3020A, 3050B	GFAA	CAS SOP MET-GFAA	1	0.2	5	1
Barium	7440-39-3	SW-846/EPA 6010B, 3010A, 3050B	ICP	CAS SOP MET-ICP	4	0.9	5	1
Beryllium	7440-41-7	SW-846/EPA 6010B, 3010A, 3050B	ICP	CAS SOP MET-ICP	0.3	0.3	5	1
Cadmium	7440-43-9	SW-846/EPA 6010B, 3010A, 3050B	ICP	CAS SOP MET-ICP	3	0.9	4	1
Chromium	7440-47-3	SW-846/EPA 6010B, 3010A, 3050B	ICP	CAS SOP MET-ICP	4	0.6	5	2
Copper	7440-48-4	SW-846/EPA 6010B, 3010A, 3050B	ICP	CAS SOP MET-ICP	3	2	10	2
Lead	7439-92-1	SW-846/EPA 7421, 3020A, 3050B	GFAA	CAS SOP MET-GFAA	0.1	0.2	2	1
Manganese	7439-96-5	SW-846/EPA 6010B, 3010A, 3050B	ICP	CAS SOP MET-ICP	2	0.3	5	1
Nickel	7440-02-0	SW-846/EPA 6010B, 3010A, 3050B	ICP	CAS SOP MET-ICP	20	7	20	4
Vanadium	7440-62-2	SW-846/EPA 6010B, 3010A, 3050B	ICP	CAS SOP MET-ICP	4	0.8	10	2
Zinc	7440-66-6	SW-846/EPA 6010B, 3010A, 3050B	ICP	CAS SOP MET-ICP	2	0.4	10	2

[a] Results reported on a dry weight basis unless excessive moisture is present in sample.

▨ = Change since last revision

TABLE 3F
ANALYTE LIST FOR SOIL PHYSICAL CHARACTERISTICS

Parameter	Method Reference	Description/ Instrument	Estimated Quantitation Limit
Permeability	ASTM D-5084	Flexible wall permeameter	Can measure $<10^{-5}$ m/s
Bulk density	ASTM D-2937	Drive cylinder method	NA
Specific gravity	ASTM D-854	Pycnometer	NA
Cation exchange capacity	EPA 9081	Sodium acetate exchange	0.1 meq/ 100g
Particle size distribution	ASTM D-422	Sieving and sedimentation	Sieving: <75µm sedimentation: <0.001mm
Moisture content	ASTM D-2216	Gravimetric	NA

NA - not applicable.

Table 4
Summary of Phase 1B Sample Collection and Analysis

Unit ID/ Name	Sample Matrix	Field Parameters[e]	Lab Parameters[a,b]	Investigative Samples		Matrix Spike[c]		Matrix Spike Duplicate/ Laboratory Duplicate[c,d]		Field Duplicates[g]		Field Blanks[g]		Matrix Total
				No.	Total	No.	Total	No.	Total	No.	Total	No.	Total	
A. Sluice Sand Staging Area	Soil	VOC Headspace[a,f]	Cyanide	8	8									
			Formaldehyde	8	8									
			Polychlorinated Biphenyls (PCBs)	9	9									
			Semi-Volatile Organic Compounds (SVOCs)	9	9									
			Site-Specific Metals	9	9									
			Volatile Organic Compounds (VOCs)	8	8									
	Ground Water	D.O., E_h^o, pH, Sp.Cond., Temp., Turbidity, & Water Level	Cyanide	10	10									
			Formaldehyde	10	10									
			Polychlorinated Biphenyls (PCBs)	10	10									
			Semi-Volatile Organic Compounds (SVOCs)	10	10									
			Site-Specific Total and Dissolved Metals	10	10									
			Volatile Organic Compounds (VOCs)	10	10									
B. Former Parts Plant	Soil	VOC Headspace[a,f]	Cyanide	8	8									
			Formaldehyde	8	8									
			Polychlorinated Biphenyls (PCBs)	8	8									
			Semi-Volatile Organic Compounds (SVOCs)	[redacted]	[redacted]									
			Site-Specific Metals	8	8									
			Volatile Organic Compounds (VOCs)	[redacted]	[redacted]									
	Ground Water	D.O., E_h^o, pH, Sp.Cond., Temp., Turbidity, & Water Level	Cyanide	4	4									
			Formaldehyde	4	4									
			Polychlorinated Biphenyls (PCBs)	[redacted]	[redacted]									
			Semi-Volatile Organic Compounds (SVOCs)	[redacted]	[redacted]									
			Site-Specific Total and Dissolved Metals	4	4									
			Volatile Organic Compounds (VOCs)	[redacted]	[redacted]									
			[redacted]	[redacted]	[redacted]									
			[redacted]	[redacted]	[redacted]									
D. Grey Iron Plant	Soil	VOC Headspace[a,f]	[redacted]	[redacted]	[redacted]									
			[redacted]	[redacted]	[redacted]									
			Cyanide	12	12									
			Formaldehyde	[redacted]	[redacted]									
			[redacted]	[redacted]	[redacted]									
			Polychlorinated Biphenyls (PCBs)	73	73									
			Semi-Volatile Organic Compounds (SVOCs)	55	55									
			Site-Specific Metals	23	23									
			Volatile Organic Compounds (VOCs)	38	38									
	Ground Water	D.O., E_h^o, pH, Sp.Cond., Temp., Turbidity, & Water Level	Cyanide	7	7									
			Formaldehyde	7	7									
			Polychlorinated Biphenyls (PCBs)	[redacted]	[redacted]									
			Semi-Volatile Organic Compounds (SVOCs)	7	7									
			Site-Specific Total and Dissolved Metals	7	7									
			Volatile Organic Compounds (VOCs)	7	7									

Table 4
Summary of Phase 1B Sample Collection and Analysis

Unit ID/ Name	Sample Matrix	Field Parameters[e]	Lab Parameters[a,b]	Investigative Samples		Matrix Spike[c]		Matrix Spike Duplicate/ Laboratory Duplicate[c,d]		Field Duplicates[g]		Field Blanks[g]		Matrix Total
				No.	Total	No.	Total	No.	Total	No.	Total	No.	Total	
E. Riverdock Area														
	Soil	VOC Headspace[a,f]	Cyanide	2	2									
			Formaldehyde	4	4									
			Manganese	8	8									
			Polychlorinated Biphenyls (PCBs)	26	26									
			Semi-Volatile Organic Compounds (SVOCs)	22	22									
			Site-Specific Metals	30	30									
			Volatile Organic Compounds (VOCs)	14	14									
	Ground Water	D.O., E_h^o, pH, Sp.Cond., Temp., Turbidity, & Water Level	Cyanide	14	14									
			[illegible]	[illegible]	[illegible]									
			Formaldehyde	14	14									
			Polychlorinated Biphenyls (PCBs)	[illegible]	[illegible]									
			Semi-Volatile Organic Compounds (SVOCs)	[illegible]	[illegible]									
			Site-Specific Total and Dissolved Metals	14	14									
			Volatile Organic Compounds (VOCs)	[illegible]	[illegible]									
F. AMDC and Administration Building														
	Ground Water	D.O., E_h^o, pH, Sp.Cond., Temp., Turbidity, & Water Level	Cyanide	5	5									
			Formaldehyde	5	5									
			Polychlorinated Biphenyls (PCBs)	5	5									
			Semi-Volatile Organic Compounds (SVOCs)	5	5									
			Site-Specific Total and Dissolved Metals	5	5									
			Volatile Organic Compounds (VOCs)	5	5									
G. Former Nodular Iron Plant														
	Soil	VOC Headspace[a,f]	Ammonia	[illegible]	[illegible]									
			[illegible]	[illegible]	[illegible]									
			[illegible]	[illegible]	[illegible]									
			Formaldehyde	8	8									
			Polychlorinated Biphenyls (PCBs)	32	32									
			Semi-Volatile Organic Compounds (SVOCs)	24	24									
			Site-Specific Metals	9	9									
			Volatile Organic Compounds (VOCs)	32	32									
	Ground Water	D.O., E_h^o, pH, Sp.Cond., Temp., Turbidity, & Water Level	Ammonia	[illegible]	[illegible]									
			[illegible]	[illegible]	[illegible]									
			[illegible]	[illegible]	[illegible]									
			Cyanide	11	11									
			[illegible]	[illegible]	[illegible]									
			Formaldehyde	11	11									
			Polychlorinated Biphenyls (PCBs)	[illegible]	[illegible]									
			Semi-Volatile Organic Compounds (SVOCs)	[illegible]	[illegible]									
			Site-Specific Total and Dissolved Metals	11	11									
			Volatile Organic Compounds (VOCs)	[illegible]	[illegible]									
H. Wastewater Treatment System														
	Soil	VOC Headspace[a,f]	Formaldehyde	[illegible]	[illegible]									
			Site-Specific Metals	8	8									
	Ground Water	D.O., E_h^o, pH, Sp.Cond., Temp., Turbidity, & Water Level	[illegible]	[illegible]	[illegible]									
			Cyanide	8	8									
			[illegible]	[illegible]	[illegible]									
			Formaldehyde	8	8									
			Polychlorinated Biphenyls (PCBs)	[illegible]	[illegible]									
			Semi-Volatile Organic Compounds (SVOCs)	8	8									
			Site-Specific Total and Dissolved Metals	8	8									
			Volatile Organic Compounds (VOCs)	8	8									

Table 4
Summary of Phase 1B Sample Collection and Analysis

Unit ID/ Name	Sample Matrix	Field Parameters [e]	Lab Parameters [a,b]	Investigative Samples		Matrix Spike [c]		Matrix Spike Duplicate/ Laboratory Duplicate [c,d]		Field Duplicates [g]		Field Blanks [g]		Matrix Total
				No.	Total	No.	Total	No.	Total	No.	Total	No.	Total	
I. Classified Sand Staging Area	Soil	VOC Headspace [a,f]	Cyanide	2	2									
			Formaldehyde	10	10									
			Polychlorinated Biphenyls (PCBs)	2	2									
			Semi-Volatile Organic Compounds (SVOCs)	2	2									
			Site-Specific Metals	10	10									
			Volatile Organic Compounds (VOCs)	2	2									
	Ground Water	D.O., E_h°, pH, Sp.Cond., Temp., Turbidity, & Water Level	[redacted]	[redacted]	[redacted]									
			Cyanide	[redacted]	[redacted]									
			[redacted]	[redacted]	[redacted]									
			Formaldehyde	8	8									
			Polychlorinated Biphenyls (PCBs)	8	8									
			Semi-Volatile Organic Compounds (SVOCs)	8	8									
			Site-Specific Total and Dissolved Metals	8	8									
			Sulfide	8	8									
			Volatile Organic Compounds (VOCs)	8	8									
J. On-Site Landfill	Ground Water	D.O., E_h°, pH, Sp.Cond., Temp., Turbidity, & Water Level	Cyanide	2	2									
			Formaldehyde	2	2									
			Polychlorinated Biphenyls (PCBs)	2	2									
			Semi-Volatile Organic Compounds (SVOCs)	2	2									
			Site-Specific Total and Dissolved Metals	2	2									
			Volatile Organic Compounds (VOCs)	2	2									
Saginaw River	Surface Water	D.O., E_h°, pH, Sp.Cond., Temp., Turbidity, & Water Level	1,1-Dichloroethane	29	29									
			1,1-Dichloroethene	29	29									
			1,2-Dichloropropane	29	29									
			Benzo(a)pyrene	29	29									
			Chloroethane	29	29									
			Site-Specific Total and Dissolved Metals	29	29									
			Vinyl Chloride	29	29									
	Sediment		1,1-Dichloroethane	29	29									
			1,1-Dichloroethene	29	29									
			1,2-Dichloropropane	29	29									
			Benzo(a)pyrene	29	29									
			Chloroethane	29	29									
			Site-Specific Metals	29	29									
			Vinyl Chloride	29	29									
			TOTAL SOIL		196	10	10	10	10	20	19	20	20	235
			TOTAL GROUND WATER		99	5	5	5	5	10	10	10	10	119
			TOTAL SURFACE WATER		29	2	2	2	2	3	3	3	3	36
			TOTAL SEDIMENT		29	2	2	2	2	3	3	3	3	36

NOTES:

a = Samples for laboratory will be collected separately from the field screen samples.

b = List of specific compounds and methods are shown in Tables 3A - 3F.

c = Frequency shall be 1 for each 20 field samples collected (refer to Table 10).

d = Field parameter measurements will be performed one for every ten consecutive measurements and field measurements equipment will be calibrated as provided for in the associated operating manuals.

e = Field measurements for E_h° and D.O. will be performed during well sampling only.

f = VOC headspace analysis to be conducted on each split-barrel sample collected utilizing a photoionization detector (PID) equipped with a 11.7 eV lamp.

g = Additional field duplicates and blanks may be collected to satisfy the QAPP requirements of a minimum of 1 in 10 (or a minimum of 1 per day for field duplicates). Trip blanks will be included for VOC analysis at rate one per cooler for coolers containing VOC samples.

h = Includes one sample of separate-phase product in addition to groundwater samples.

TABLE 6D
QUALITY CONTROL PERFORMANCE CRITERIA FOR MATRIX SPIKES/LABORATORY DUPLICATES FOR ADDITIONAL PARAMETERS

	Matrix Spike Percent Recovery		Laboratory Duplicate RPD		Laboratory Control Sample Percent Recovery	
Parameter	Aqueous	Solid	Aqueous	Solid	Aqueous	Solid
Formaldehyde	39-153	39-153	30	40	39-153	39-153
[illegible]	80-120	80-120	[illegible]	[illegible]	83-110	[illegible]
Total solids	NA	NA	20	20	85-115	85-115
Ammonia nitrogen	75-125	75-125	20	20	85-115	85-115
Total cyanide	75-125	75-125	20[a]	20[a]	85-115	72-134
Hexavalent Chromium	75-125	75-125	20	30	85-115	85-115
Total organic carbon	NA	75-125	NA	20	NA	85-115

Note: NA - Not applicable.

[a] Control limit applies to results ≥ to 5 times the EQL. If one or both sample or duplicate is <5 times the EQL, then the RPD criteria is not applicable.

[b] Note that the matrix spike for AVS is performed on the sediment sample and the matrix spike for the SEM metals is performed on the aqueous extract. AVS control limits included here. See Table 6E for SEM metals control limits.

▨ = Change since last revision

4.1.1 Subsurface Soil and Fill Sampling Procedures

Subsurface soil samples will be collected continuously to a designated depth. To collect the samples, a standard split-spoon drive head assembly will be used through 4-in. I.D. or greater hollow-stem augers. The weight of the drive head will be recorded (typically 140 lbs with a 30-in. drop distance) and the blow counts will be documented for every 6 in. of penetration.

Immediately upon opening the split-spoon, a sample of soil from one half of the split spoon will be placed into laboratory-supplied sample containers (**Table 8**) using a decontaminated stainless steel trowel or scoop. During collection of the material, which is potentially heterogeneous, any large (nonsoil) materials will be removed from the sample prior to placing the sample in laboratory jars. Removal of such material will be noted in field logbooks. The order for filling sample jars for various parameter groups will always begin with filling of the sample jar for VOC analyses to minimize the potential for volatilization of constituents prior to the analysis. The order for filling sample containers for all matrices will be:

1) VOC/VOC headspace;
2) SVOC;
3) PCB;
4) Formaldehyde, as applicable;
5) Ammonia-Nitrogen;
6) Remaining parameters; and
7) Remaining sample will be placed in a clean container for possible future analysis.

A separate headspace analysis jar will be filled and capped with aluminum foil and the sample will be allowed to equilibrate in the jar for 1–2 minutes. After equilibration, the headspace will be measured for VOCs using a PID equipped with an 11.7 eV lamp. The readings will be recorded on a boring log.

The PID utilizes an electronic light source to measure the volatile compounds through use of the ionization potential (measured in electron-volt units, eV). It is necessary that the PID be equipped with an 11.7 eV lamp, capable of detecting compounds with ionization potentials up to 11.7 eV.

The remaining half of the soil from the split spoon will be left in place to allow the EMCON sampling team geologist to properly describe the soils and observe significant characteristics such as grain size and composition, sorting, color, density, odor, presence of layering and discoloration, and other relevant observations.

In the event that it becomes necessary to terminate a borehole short of its intended completion depth due to the presence of a buried obstacle, the borehole will be abandoned and grouted to the surface with a bentonite cement slurry. A new borehole will be advanced within approximately 5 ft, or as close as possible, from the abandoned borehole. Scheduled split-spoon sampling will be resumed below the abandoned borehole termination depth.

Boreholes that are not converted to wells or piezometers will be grouted to grade. Cuttings will not be returned to the borehole. Bentonite will be used to fill the annular space in the saturated zone. Bentonite cement grout will be used to fill the annular space above the bentonite seal in the unsaturated zone.

TABLE 8
SOLID SAMPLE CONTAINER, PRESERVATION, AND HOLDING TIME REQUIREMENTS

Parameter	Container	Preservative	Holding Time*
Volatile organic compounds	One 4 oz. glass jar with Teflon®-lined cap	Methanol preservation; cool 4°C	14 days
VOC headspace[a]	One 16 oz. jar, capped with aluminum foil	None	15 minutes
Formaldehyde	8-oz. wide-mouth glass jar	Cool 4°C	7 days to leaching; 3 days (from leaching to extraction); 3 days (from extraction to analysis)
Total organic carbon	One 8-oz. wide-mouth glass jar with Teflon®-lined cap	Minimal headspace; cool 4° C	Not established (30 days)
Metals	One 16 oz. wide-mouth glass jar with Teflon®-lined cap	Cool 4°C	6 months
Semivolatile organic compounds	One 16 oz. wide-mouth glass jar with Teflon®-lined cap	Cool 4°C	14 days (until extraction); 40 days (from extraction to analysis)
PCBs	One 16 oz. wide-mouth glass jar with Teflon®-lined cap	Cool 4°C	14 days (until extraction); 40 days (from extraction to analysis)
Cyanide	One 4 oz. wide-mouth glass jar with Teflon®-lined cap	Cool 4°C	14 days[b]
Ammonia Nitrogen	One 8-oz wide-mouth glass jar with Teflon®-lined cap	Cool 4°C	28 days
Chromium Speciation	One 8-oz wide-mouth glass jar with Teflon®-lined cap	Cool 4°C	30 days sampling to digestion; 7 days digestion to analysis

Notes:
Holding Time - from time of sample collection
[a] Field Measurement
[b] U.S. EPA holding time provided. Referenced method suggests that analysis be completed as soon as possible after collection.

TABLE 9
AQUEOUS SAMPLE CONTAINER, PRESERVATION, AND HOLDING TIME REQUIREMENTS

Parameter	Container	Preservative	Holding Time*
Volatile organic compounds	Three 40-mL vials with Teflon®-lined caps	No headspace; HCl to pH <2; cool 4 °C	14 days
Formaldehyde	One 1-L glass bottle	Cool 4 °C	3 days (from collection to derivitization/extraction); 3 days (from derivitization/extraction to analysis)
Fluoride	One 500-mL Polyethylene	Cool 4 °C	28 days
Metals	Two 1-L polyethylene bottles (for filtered and unfiltered)	HNO_3 to pH <2; cool 4 °C	6 months (28 days for mercury)
Semivolatile organic compounds	Two 1-L amber glass bottles with Teflon®-lined cap	Cool 4 °C	7 days (until extraction); 40 days (from extraction to analysis)
PCBs	One 1-L amber glass bottle with Teflon®-lined cap	Cool 4°C	7 days (until extraction); 40 days (from extraction to analysis)
Cyanide	One 1-L polyethylene bottle	NaOH to pH >12; cool 4 °C	14 days[a]
Chromium speciation	One 1-L polyethylene bottle	Cool 4 °C	24 hours
Ammonia nitrogen	One 1-L polyethylene bottle	H_2SO_4 to pH <2; cool 4 °C	28 days
pH[b]	Plastic or glass container	None	None[c]
Specific conductance[b]	Plastic or glass container	None	None[c]
Temperature[b]	Plastic or glass container	None	None[c]
Eh[b]	Plastic or glass container	None	None[c]
Dissolved oxygen[b]	Plastic or glass container	None	None[c]
Turbidity	Plastic or glass container	None	None[c]
VOCs (field)	Three 40-mL vials with Teflon®-lined caps	No headspace; HCl to pH <2; cool 4 °C	14 days

[a] USEPA holding time provided. Referenced method suggests that analysis should be completed as soon as possible after collection
[b] Field measurement
[c] Immediately upon sample collection
- From Time of Sample Collection

▨ Change since last revision

8.1.2 Field Measurement

QC procedures for pH, temperature, specific conductance, water level, Eh, turbidity, D.O., VOCs, and soil headspace measurements are limited to checking the reproducibility of the measurement by obtaining duplicate readings on a single sample, by calibrating the instrument or by comparing it to a known standard, and by analyzing QC check samples. The types of QC checks, including frequency, criterion, and corrective action, are defined in Table 5. This information is also discussed in Sections 3.6 and 6.1.

TABLE 10. INTERNAL QC CHECKS

Parameter/ Method	QC Check	Frequencies	Control Limits	Laboratory Corrective Action
VOCs/8260B, C	Method blanks	One per 12 hour analytical shift of a similar matrix	No target analytes detected above EQL	Change the purge gas source and regenerate the molecular sieve purge gas; if considered a false positive, full explanation required
	Surrogate spikes	Every sample, blank, standard	Control limits listed in **Table 6A**	Explain the presence of matrix interference in case narrative
	LCS	One for each 20 field samples collected from similar matrices and analyzed at the laboratory each day	Control limits listed in **Table 6A**	Reanalyze and/or explain in case narrative
	MS/MSD samples	One for each 20 field samples collected from similar matrices and analyzed at the laboratory each day	Control limits listed in Table 6A	Explain in case narrative
	IS areas	Every sample, blank, standard	-50% to +100% of associated continuing calibration standards; retention time within 30 seconds of previous calibration	The chromatographic system and the mass spectrometer must be inspected for malfunctions and corrections must be made; reanalyze samples after corrections are made
	GCMS mass tuning	At beginning of each 12 hour analytical shift	Control criteria listed in method	Tuning criteria must be met prior to sample analysis
SVOCs/8270C	Method blanks	One for each 20 field samples collected from similar matrices and analyzed at the laboratory each day	No target analytes detected above EQL*	Determine the source of the interference and take corrective action to eliminate the problem
	LCS	One for each 20 field samples collected from similar matrices and analyzed at the laboratory each day	Control limits listed in **Table 6B**	Reanalyze and/or explain in the case narrative
	Surrogate spikes	Every sample, blank, standard	Control limits listed in **Table 6B**	Explain the presence of matrix interference in the case narrative
	MS/MSD samples	One pair per 20 field samples, of a similar matrix	Control limits listed in **Table 6B**	Explain in the case narrative
	IS areas	Every sample, blank, standard 12 hour shift	-50% to + 100% of associated continuing calibration standard	The chromatographic system and the mass spectrometer must be inspected for malfunctions and corrections must be made; reanalyze samples after corrections are made
	GCMS mass tuning	At beginning of each 12 hour analytical shift	Control criteria listed in method	Tuning criteria must be met prior to sample analysis
PCB/8082	Method blanks	One for each extraction batch (up to 20 samples) or when there is a change in reagents	No target analytes detected above EQL	Reanalyze and/or elevate the detection limit to the concentration in the method blank
	LCS	One for each extraction batch (up to 20 samples) or when there is a change in reagents	Control limits listed in **Table 6C**	Reanalyze and/or explain in case narrative
	Surrogate spikes	Every sample, blank, standard	CAS control limits listed in **Table 6C**	Explain the presence of matrix interference in the case narrative
	MS/MSD samples	One pair for each 20 field samples collected from similar matrices and analyzed at the laboratory each day	Control limits listed in method and **Table 6C**	Reanalyze and/or explain in case narrative

TABLE 10 (cont.) INTERNAL QC CHECKS

Parameter/ Method	QC Check	Frequencies	Control Limits	Laboratory Corrective Action
Metals/6010B	Reagent/ preparation blanks	One for each 20 field samples collected from similar matrices and analyzed at the laboratory each day	No analytes detected above EQL	Reanalyze and/or explain in case narrative
	LCS	One for each 20 field samples collected from similar matrices and analyzed at the laboratory each day	CAS control limits listed in **Table 6E**	Reanalyze and/or explain in case narrative
	MS samples	One for each 20 field samples collected from similar matrices and analyzed at the laboratory each day	CAS control limits listed in Table 6E	Explain in case narrative
	Duplicate samples	One for each 20 field samples collected from similar matrices and analyzed at the laboratory each day	CAS control limits in **Table 6E**	Explain in case narrative
	Instrument blanks	After each initial or continuing calibration	Control criteria listed in method	Correct the problem, recalibrate, and reanalyze the previous 10 samples
As, Pb, Hg, Se, Tl/7060A/7421	Reagent/ preparation blanks	One for each 20 field samples collected from similar matrices at the GM facility and analyzed at the laboratory each day	Analyte not detected above EQL	Reanalyze and/or explain in case narrative
	LCS	One for each 20 field samples collected from similar matrices and analyzed at the laboratory each day	CAS control limits in **Table 6E**	Reanalyze and/or explain in case narrative
	MS samples	One for each 20 field samples collected from similar matrices and analyzed at the laboratory each day	Control limits shown in **Table 6E**	Explain in case narrative
	Duplicate samples	One for each 20 field samples collected from similar matrices and analyzed at the laboratory each day	RPD control limits shown in **Table 6E**	Explain in case narrative
	Instrument blanks	After each initial or continuing calibration	Criteria listed in method	Explain in case narrative or reanalyze
Cyanide/ 9010A	Reagent/ preparation blanks	One for each 20 field samples collected from similar matrices and analyzed at the laboratory each day	Analyte not detected above EQL	Reanalyze and/or explain in case narrative
	LCS	One for each 20 field samples collected from similar matrices and analyzed at the laboratory each day	CAS control limits in **Table 6D**	Reanalyze and/or explain in case narrative
	MS samples	One for each 20 field samples collected from similar matrices and analyzed at the laboratory each day	CAS control limits in **Table 6D**	Explain in case narrative
	Duplicate samples	One for each 20 field samples collected from similar matrices and analyzed at the laboratory each day	RPD within **Table 6D** control limits	Explain in case narrative
Formaldehyde EPA 8315A	Method blank	One for each 20 field samples collected from similar matrices and analyzed at the laboratory each day	Analyte not detected above EQL	Reanalyze and/or explain in case narrative
	Laboratory control sample	One for each 20 field samples collected from similar matrices and analyzed at the laboratory each day	Control limits shown in **Table 6D**	Reanalyze and/or explain in case narrative
	Matrix spike	One for each 20 field samples collected from similar matrices and analyzed at the laboratory each day	Control limits shown in **Table 6D**	Reanalyze and/or explain in case narrative
	Matrix spike duplicate	One for each 20 field samples collected from similar matrices and analyzed at the laboratory each day	Control limits shown in **Table 6D**	Reanalyze and/or explain in case narrative

TABLE 10 (cont.) INTERNAL QC CHECKS

Parameter/ Method	QC Check	Frequencies	Control Limits	Corrective Action
[illegible] EPA [illegible]	[illegible]	[illegible] analyzed at the laboratory each day	[illegible] above EQL*	[illegible] narrative
	Laboratory control sample	One for each 20 field samples collected from similar matrices and analyzed at the laboratory each day	Control limits shown in Table 6D	[illegible] narrative
	[illegible]	[illegible]	[illegible]	[illegible]
	Laboratory Duplicate	One for each 20 field samples collected from similar matrices and analyzed at the laboratory each day	Control limits shown in Table 6D	Explain in case narrative
Ammonia Nitrogen EPA 351.4	Preparation blank	One for each 20 field samples collected from similar matrices and analyzed at the laboratory each day	Analyte not detected above EQL	Reanalyze and/or explain in case narrative
	LCS	One for each 20 field samples collected from similar matrices and analyzed at the laboratory each day	Control limits shown in **Table 6D**	Reanalyze and/or explain in case narrative
	Matrix spike	One for each 20 field samples collected from similar matrices and analyzed at the laboratory each day	Control limits shown in **Table 6D**	Explain in case narrative
	Laboratory duplicate	One for each 20 field samples collected from similar matrices and analyzed at the laboratory each day	Control limits shown in **Table 6D**	Explain in case narrative
TOC ASTM D412982M	Instrument blank	One for each 20 samples analyzed at the laboratory each day	Not established	Blank correction performed during calculation
	Laboratory control sample	One for each 20 samples collected and analyzed at the laboratory each day	Control limits in **Table 6D**	Reanalyze and/or explain in case narrative
Total Solids EPA 160.3	Laboratory duplicate	One for every 20 field samples collected from similar matrices and analyzed at the laboratory each day	Control limits shown in **Table 6D**	Reanalyze and/or explain in case narrative
Hexavalent Chromium [illegible] EPA SW-846 7195/6010B	Reagent/ preparation blanks	One for each 20 field samples collected from similar matrices and analyzed at the laboratory each day	No analytes detected above EQL	Reanalyze and/or explain in case narrative
	LCS	One for each 20 field samples collected from similar matrices and analyzed at the laboratory each day	CAS control limits listed in **Table 6D**	Reanalyze and/or explain in case narrative
	MS samples	One for each 20 field samples collected from similar matrices and analyzed at the laboratory each day	CAS control limits listed in **Table 6D**	Explain in case narrative
	Duplicate samples	One for each 20 field samples collected from similar matrices and analyzed at the laboratory each day	CAS control limits in **Table 6D**	Explain in case narrative
	Instrument blanks	After each initial or continuing calibration	Control criteria listed in method	Correct the problem, recalibrate, and reanalyze the previous 10 samples
[illegible] Chromium [illegible] EPA [illegible]	Preparation blank	One for each 20 field samples collected from similar matrices and analyzed at the laboratory each day	[illegible] above EQL*	[illegible] narrative
	LCS	One for each 20 field samples collected from similar matrices and analyzed at the laboratory each day	Control limits shown in Table 6D	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible] analyzed at the laboratory each day	[illegible] Table 6D	[illegible]

* 2 x EQL for common laboratory contaminants

QC = Quality Control
VOC = Volatile Organic Compounds
MS/MSD = Matrix Spike/Matrix Spike Duplicate
IS = Internal Standard
EQL = Estimated Quantitation Limit
PCB = Polychlorinated Biphenyls
LCS = Laboratory Control Standard
RPD = Relative Percent Difference
GCMS = Gas Chromatograph Mass Spectrometer

▨ Change since last revision

STANDARD OPERATING PROCEDURE

ION CHROMATOGRAPHY

GEN-300.0

Revision 3

June 29, 2000

Approved By: ______________________ 6/29/00
Supervisor Date

______________________ 6-29-00
QA Manager Date

______________________ 6/29/00
Laboratory Manager Date

COLUMBIA ANALYTICAL SERVICES, INC.
1317 South 13th Avenue
Kelso, Washington 98626

Annual review of this SOP has been performed and the SOP still reflects current practice.
Initials: ______ Date: __________
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Standard Operating Procedure

for

ION CHROMATOGRAPHY

1. SCOPE AND APPLICATION

1.1. This procedure has been applied to the determination of fluoride, chloride, nitrite, bromide, nitrate, sulfate, thiosulfate and acetate. EPA Method 300.0 is defined for bromate, bromide, chlorate, chloride, chlorite, nitrate-N, nitrite-N, o-phosphate-P, and sulfate.

1.2. This procedure can be applied to various matrices including drinking water, surface water, mixed domestic and industrial wastewater, groundwater, reagent waters, solids (after extraction procedure), and leachates (when no acetic acid is used).

1.3. The analytical range varies for all of the different anions. The normal range for bromide, nitrite, nitrate and acetate is the method detection limit to 5 ppm. The normal range for chloride, fluoride and sulfate is the method detection limit to 10 ppm. However very high concentrations of anions may be determined using appropriate dilutions.

2. METHOD SUMMARY

2.1. Ion chromatography is an analytical technique for the determination selected ions, depending on system configuration. It utilizes ion exchange mechanisms and conductivity detection for the separation and quantitation of anions or cations in a water matrix. This procedure is designed specifically for anions.

2.2. A small volume of sample (approximately 1 mL) is injected into the ion chromatograph (Dionex Series 2000I), where the anions of interest are separated and measured. The system consists of:

Automated sampler	(Dionex P/N 39534)
Analytical pump	(Dionex System 2000i)
Guard column	(Dionex AG4A P/N 37042 or AG4A-SC P/N 43175)
Separator column	(Dionex AG4A P/N 37041 or AG4A-SC P/N 43174)
Suppressor device	(Dionex P/N 037072)
Conductivity detector	(Dionex P/N 40157)

2.3. The goal in any separation process is to obtain resolution and to obtain symmetrical chromatographic peaks. The mobile phase is liquid eluent (Sodium Carbonate/Bicarbonate) and the stationary phase is a polystyrene/divinylbenzene resin. The eluent controls the rate of migration through the column by its type and concentration. Whereas the separation column separates anion components by their differential affinity for its stationary phase. Detection is accomplished by suppressed conductivity. Conductivity is a universal property of ionic species in a solution and shows a simple dependence on concentration. By using chemical suppression, the conductivity background can be reduced to increase sensitivity and selectivity. Suppression is accomplished using an ion exchange membrane.

2.4. The system is calibrated using a series of analyses including calibration standards and blanks. The standards are used to prepare a calibration curve of response vs concentration. Subsequent anion concentrations in samples are determined by using response and the calibration curve to determine the concentration. Adjustments may be made to account for any dilutions or any unique sample preparation steps. Results are reported using routine CAS analytical reports or project specific report procedures.

3. DEFINITIONS

3.1. Stock standard solution - a concentrated solution containing a single certified standard that is a method analyte. Stock solutions are used to prepare calibration standards.

3.2. Calibration standards - a solution of analytes prepared in the laboratory from stock standard solutions, diluted as needed, and used to calibrate the instrument response with respect to analytical concentration.

3.3. Laboratory Control Standards (LCS) - a solution of analytes prepared in the laboratory from stock standard solutions purchased or prepared independently from calibration standards.

3.4. Method Blank (MB) - a solution of the laboratory prepared deionized water that is carried through analysis like a sample, to serve as a measure of contamination associated with laboratory storage, preparation, or instrumentation.

3.5. Continuous calibration verification standard (CCV) - a solution of analytes prepared in the laboratory from stock standards to be at approximately the midpoint of calibration curves. CCV's are analyzed every 10 injections to verify that the instrument system performance has not changed during the course of the analytical run.

3.6. Continuing calibration blank (CCB) - a blank solution of deionized water. CCB's are analyzed every 10 injections to verify that the instrument system has not become contaminated during the course of the analytical run.

3.7. Rinse blank (RB) - a solution of the laboratory prepared deionized water that is carried through analysis like a sample, to serve as a measure of carry-over from the previous sampling and analytical run.

3.8. Sample Duplicate - two aliquots of the same sample that are treated exactly the same throughout laboratory analytical procedures. The purpose is to verify the precision associated with the laboratory procedures. The Relative Percent Difference (RPD) should not exceed 20%.

3.9. Matrix Spike - aliquots of sample to which known amounts of an analyte of interest has been added. These are treated exactly the same throughout laboratory analytical procedures. The purpose of a matrix spike is to determine whether the sample matrix contributes bias to the analytical results. In this method, spikes are very useful in determining proper retention times when a low concentration of an analyte is detected or expected to be adjacent to a large concentration of analyte. When a spike is used to verify retention times calculation of recovery is not necessary.

3.10. Analytical Run Sequence - Samples are analyzed in a set referred to as an analysis sequence. The sequence begins with the instrument calibration or calibration verification followed by samples interspersed with calibration standards. The sequence ends when the set of samples has been injected or when qualitative and/or quantitative QC criteria are exceeded.

4. INTERFERENCES

4.1. Interference's can be caused by substances with retention times that are similar to and overlap those of the anion of interest. Large amounts of an anion can interfere with the peak resolution of an adjacent anion. Sample dilution and/or spiking can be used to solve most interference problems. The most common examples of this are:

- High levels of chloride can interfere with the detection of nitrite and even nitrate.
- Sulfite will interfere with the sulfate peak.
- Thiosulfate can interfere if the run time of the entire chromatogram is too short.
- The water dip or negative peak that elutes near fluoride can interfere with the AI-450 programs ability to properly integrate the baseline for the

chromatographic run. Concentrated eluent can be added to remove this interference, but is not normally done.

4.2. Method interferences may be caused by contaminants in the reagent water, reagents, glassware, and other sample processing apparatus that lead to discrete artifacts or elevated baseline in ion chromatograms.

4.3. Samples that contain particles larger than 0.45 μ and reagent solutions that contain particles larger than 0.20 μ require filtration to prevent damage to instrument columns and flow systems.

4.4. The acetate ion elutes early during the chromatographic run. The retention times of the anions also seem to differ when large amounts of acetate are present. Therefore, this method is not recommended for leachates of solid samples when acetic acid is used for pH adjustments.

5. SAFETY

5.1. Normal accepted laboratory safety practices should be followed during reagent preparation and instrument operation. No known carcinogenic materials are used in this method. However, each chemical reagent should be treated as a potential health hazard. Exposure to these reagents should be reduced to the lowest possible level. A reference file of material safety data sheets is available to all personnel involved in these analyses. CAS also maintains a file of OSHA regulations regarding the safe handling of the chemicals specified in this method.

5.2. All samples should be considered hazardous and appropriate gloves should be worn whenever handling samples.

6. SAMPLE COLLECTION, CONTAINERS, PRESERVATION AND STORAGE

6.1. Samples should be collected in scrupulously clean glass or polyethylene bottles.

6.2. The analyst must check current LIMS worklist(s) to determine if samples require analysis to avoid holding time violations. Sample management will directly notify the laboratory of samples received that are short holding time.

6.3. Sample preservation and holding times for the anions are:

Analyte	Preservation	Holding Time
Bromate	None required	28 days
Bromide	None required	28 days
Chlorate	None required	28 days
Chloride	None required	28 days
Chlorite	Cool to 4°C	immediately
Nitrate-N	Cool to 4°C	48 hours
Nitrite-N	Cool to 4°C	48 hours
O-Phosphate-P	Cool to 4°C	48 hours
Sulfate	Cool to 4°C	28 days

7. APPARATUS & EQUIPMENT

7.1. Balance-Analytical, capable of accurately weighing to the nearest 0.0001 g.

7.2. Ion chromatograph - Analytical system complete with ion chromatograph and all required accessories including syringes, analytical columns, compressed gases and detectors.

7.3. Anion guard column: A protector of the separator column. If omitted from the system the retention times will be shorter.

7.4. Anion separator column: This column produces the separation of the anions.

7.5. Anion analytical column. Dionex Sarasep.

7.6. Anion suppressor device: Dionex anion micro membrane suppressor (P/N 37106).

7.7. Detector-Conductivity Cell: approximately 1.25 μL internal volume.

7.8. Autosampler: Dionex or any compatible with system configuration.

7.9. The Dionex AI-450 Data Chromatography Software or equivalent.

8. REAGENTS, STANDARDS, AND CONSUMABLE MATERIALS

8.1. Sample bottles - Glass or polyethylene of sufficient volume to allow replicate analyses of anions of interest.

8.2. Reagent water - Distilled or deionized water, free of the anions of interest. Water should contain particles no larger than 0.20 μ.

8.3. Stock Eluent solution - Sodium bicarbonate 1.7 mM, sodium carbonate 1.8 mM. Dissolve 57.12 g sodium bicarbonate (NaHCO3) and 76.32 g of sodium carbonate (Na2CO3) in reagent water and dilute to 1 L. This reagent is stable for 1 year.

8.4. Working eluent solution - Dilute 10 mLs of stock eluent solution to 4L with reagent grade water. The working eluent can be diluted to increase retention times when more complete resolution is needed. This solution is stable for one week from date of preparation.

8.5. Regeneration solution (micro membrane suppressor) - Sulfuric acid 0.025N. Dilute 2.8 mL of conc. sulfuric acid (H2SO4) to 4L with reagent grade water. This solution is stable for one week from date of preparation.

8.6. Stock standard solutions, 1000 mg/L (1 mg/mL): Stock standards are purchased commercially or prepared from ACS reagent grade materials (dried at 105°C for 30 mins) as listed below. Stock solutions expire 6 months from the date of preparation.

8.6.1. Bromide (Br-) 1000 mg/L: Dissolve 1.2875 g sodium bromide (Na Br) in reagent water and dilute to 1 L

8.6.2. Bromate (BrO3-) 1000 mg/L: Dissolve 1.1798 g of sodium bromate (NaBrO3) in reagent water and dilute to 1 L.

8.6.3. Chlorate (ClO3-) 1000 mg/L: Dissolve 1.2753 g of sodium chlorate (NaClO3) in reagent water and dilute to 1 L.

8.6.4. Chloride (Cl-) 1000 mg/L: Dissolve 1.6485 g sodium chloride NaCl) in reagent water and dilute to 1 L.

8.6.5. Chlorite (ClO2-) 1000 mg/L: Dissolve 1.3410 g of sodium chlorite (NaClO2) in reagent water and dilute to 1 L.

8.6.6. Fluoride (F-) 1000 mg/L: Dissolve 2.2100 g sodium fluoride (NaF) in reagent water and dilute to 1 L.

8.6.7. Nitrate NO-3-N) 1000 mg/L: Dissolve 6.0679 g sodium nitrate (NaNO3) in reagent water and dilute to 1 L.

8.6.8. Nitrite (NO-2-N) 1000 mg/L: Dissolve 4.9257 g sodium nitrite (NaNO2) in reagent water and dilute to 1 L.

8.6.9. Phosphate (PO=4-P) 1000 mg/L: Dissolve 4.3937 g potassium phosphate (KH2PO4) in reagent water and dilute to 1 L.

8.6.10. Sulfate (SO4=) 1000 mg/L: Dissolve 1.8141 g potassium sulfate (K2SO4) in reagent water and dilute to 1 L.

8.6.11. Acetate

8.6.11.1. CH3COOK 1000 mg/L: Dissolve 0.1661g potassium acetate in reagent water and dilute to 100 mls.

8.6.11.2. CH3COONa 1000 mg/L: Dissolve 0.1389g sodium acetate in reagent water and dilute to 100 mls.

8.7. Working standards

Working solutions of 100 mg/L are prepared by diluting 10 mLs of the 1000 mg/L stock standards to 100 mLs with reagent grade water. The working standards should be prepared weekly, except those that contain nitrite and/or phosphate, which are prepared fresh daily.

8.8. The continuing calibration (CCV) is prepared from the working standards as shown below. The CCV standard should be prepared weekly, except those that contain nitrite and/or phosphate, which are prepared fresh daily.

Anion	Initial Vol.	Initial Conc.	Final Vol.	Final Conc.
Fluoride	5.0 mls	100 mg/L	100 ml	5.0 mg/L
Chloride	5.0 mls	100 mg/L	100 ml	5.0 mg/L
Nitrite	2.0 mls	100 mg/L	100 ml	2.0 mg/L
Bromide	2.0 mls	100 mg/L	100 ml	2.0 mg/L
Nitrate	2.0 mls	100 mg/L	100 ml	2.0 mg/L
Sulfate	5.0 mls	100 mg/L	100 ml	5.0 mg/L

8.9. Laboratory Control Sample (LCS) - The LCS's for each individual anion is prepared from a purchased standard unless a commercially prepared standard in unavailable. Standards from outside sources expire in accordance with the expiration from the manufacturer. Follow the instructions that are provided with each standard for LCS preparation.

8.9.1. Cl, SO4 LCS: This LCS is prepared in accordance with the manufacturers instructions, usually 10 mls APG to 1.0 L of DIW. This concentration of Cl, and SO4 is too high to analyze straight so a working solution is prepared by diluting 25 mls of the stock Cl, SO4 LCS to 500 mls in reagent water. The working standards should be prepared weekly. When this LCS is analyzed a "20" needs to be added to the dilution column on the schedule for that sample.

8.9.2. NO3, NO2 LCS: The NO3 portion of the LCS is generally prepared by making a dilution of the APG to fit the NO3 value within the range of calibration. So that if the NO3 true value is 12.0 mg/L when 10 mls of APG is diluted to one liter, the analyst would use 2.5 mls and dilute it to one liter thereby creating a solution that is 3.0 mg/L in concentration. This working standard should be prepared weekly. The NO2 portion is prepared by diluting 2.5 mls of the 1000 mg/L stock standard to one liter so the final solution concentration is 2.5 mg/L NO2. There is not currently a nitrite standard available commercially. The NO2 working solution is prepared daily.

8.9.3. F LCS: The F LCS is prepared by making a dilution on the APG source similar to the preparation of the NO3 LCS. Determine the true value of the fluoride when prepared in accordance with the manufacturers instructions, then determine an appropriate dilution to get the fluoride value within the calibration range. The working standards should be prepared weekly.

8.9.4. Br LCS: The bromide LCS is prepared from the 1000 mg/L stock solution. Dilute 2.5 mls of 1000 mg/l Br to 1000 mls. There is not currently a bromide standard available commercially. The working standards should be prepared weekly.

8.9.5. The acetate LCS is prepared in the lab by the analyst from dry chemical. The LCS must be a different source than the CCV. If CH3COOK is used for the CCV use CH3COONa for the LCS or vice versa. The LCS is normally prepared to be at a level of 4.0 mg/L. Dilute 4.0 mls of 100 mg/L acetate solution to 100 mls with reagent water. The working standards should be prepared weekly.

8.10. Matrix Spike Solutions: The matrix spike solution is prepared from 1000 mg/L solutions of F, Cl, NO2, NO3, Br, and SO4. Aliquot exactly 2.5 mls of 1000 mg/L Cl & SO4 solution, 2.5 mls of 1000 mg/L NO2, Br, NO3 solution and 2.5 mls of 1000 mg/L F solution into a 25 ml volumetric flask. Dilute to the mark with reagent grade water. This solution yields 100 mg/L of the above mentioned anions. The matrix spike solution should be prepared weekly, except those that contain nitrite and/or phosphate, which are prepared fresh daily.

8.11. Consumable materials.

- ml vials with filter caps. (Dionex P/N 038141)
- 10cc disposable filter syringes with lure-lok fittings.
- syringe filters.
- 25ml centrifuge tubes.
- Varying sizes of pipettors and associated tips.

9. PROCEDURE

9.1. Instrument preparation.

9.1.1. Check eluent and regenerant levels in containers and fill to appropriate levels as necessary.

9.1.2. Ensure nitrogen gas is on and operating at 80 psi by the regulator on the tank.

9.1.3. Load corresponding schedules on IC instruments and allow the systems to warm up briefly. When the ready light on the pump module comes on, the system is ready for operation, this normally only takes a few minutes. Continue with section 9.2 or 9.3 below, depending on whether a new multi-point calibration is necessary or not.

9.2. Calibration

9.2.1. The instruments must be calibrated every 6 months or when a new column is installed. However, if system configuration changes are made or a significant change in response is observed, a new calibration must be performed.

9.2.2. Analyze a minimum of 5 standards for each ion of interest and a blank. The concentration of standards should bracket the working range of the system. Use these analyses to establish a linear regression calibration curve. The blank, or "zero" point is used but the curve is not forced through (0,0). The resulting correlation coefficient must be 0.995 or better.

9.2.3. Document the calibration of the instrument on the raw data by printing the calibration curves. The data system file path is used to identify the calibration.

9.3. Sample analysis

9.3.1. A typical analysis run sequence is shown below. Prepare samples and load the autosampler cassettes in conjunction with the data system acquisition sequence for the set of analyses.

A TYPICAL IC RUN

Inj # 1	CCV
Inj # 2	CCB
Inj # 3	LCS
Inj # 4	MB
Inj # 5	LCS
Inj # 6	LCS
Inj # 7	Sample #1
Inj # 8	Sample #1 DUP
Inj # 9	Sample #1 SPK
Inj # 10	Sample #2
Inj # 11	Sample #3
Inj # 12	Sample #4
Inj #13	Sample #5
Inj #14	Sample #6
Inj #15	Sample #7
Inj #16	Sample #8
Inj #17	CCV
Inj #18	CCB

9.3.2. Load one cassette with one vial for each LCS corresponding to each anion, one MB, one CCV and one LCS. This will normally fill one cassette depending on the number of different anions the analyst is looking for. The Cl, SO4 LCS is in one vial, the NO2 and NO3 LCS is in one vial and the Br and F LCS's have separate vials so that a normal run initiation (QC)cassette would be as follows:

Inj #1	CCV	
Inj #2	CCB	
Inj #3	NO2	LCS
Inj #4	MB	
Inj #5	NO3	LCS
Inj #6	CL,SO4	LCS

9.3.3. Once the QC cassette is loaded in the auto sampler, press run on the autosampler then run on the interface unit. This will commence system run.

9.3.4. Water samples are prepared in one of two ways:

9.3.4.1. If the water sample has no solids floating in it, is not turbid and is otherwise clean and clear looking the sample may be placed directly in the sample vial. When in doubt filter the sample. The sample vials hold approximately 5 mls of sample with the vial cap properly installed. Sample should never be poured into the sample vial. Always pipette sample into vial. This will minimize contamination from materials used in the cap liners of sample bottles.

9.3.4.2. If the sample appears to be or is known to be dirty or turbid the sample needs to be filtered by one of two means.

9.3.5. For most samples a 0.45μ micron filter on the end of a 10 cc syringe will filter the sample adequately.

9.3.6. If the sample will not easily filter through a 0.45μ filter then it needs to be prefiltered through filter with larger openings. Place a centrifuge tube in the bottom of a vacuum flask. Place the filter holding apparatus on the filter flask such that the bottom of the filter device is down in the centrifuge tube. Set up the rest of the filter apparatus and filter the sample into the tube. Then the sample can be filtered further if necessary.

Note: If the sample is prefiltered using a syringe filter, flag or append the sample identification with an "F" on the raw data.

9.3.7. To prepare soil/solid sample for analysis, refer to the SOP for Anions In Soils Extraction For Ion Chromatography (GEN-300.0S).

9.3.8. Transfer the appropriate amount of sample to a sample vial. Place a filter cap in the vial and press the cap down until the cap is flush with the top of the vial.

9.3.9. When the cassette is full place it in the auto sampler.

9.4. Dilutions

9.4.1. If the measured concentration of the anion is outside the working range of the instrument then a dilution should be performed. The working range is defined as the MDL to high value on the curve for the anion being tested.

9.4.2. Dilutions up to and including 50x can be prepared in the vial. Use 5 mls as the final volume of the vial.

NOTE: Do not use the mark on the vial as it is just over 5 mls

9.4.3. Dilutions greater than 50x must be prepared in a volumetric flask.

10. DATA REDUCTION AND REPORTING

10.1. Sample Analyses

Preliminary results are reviewed to determine if dilutions are required. Sample results to be reported are highlighted and reported directly from chromatograms associated with individual samples processed. Concentration, dilution factor and sample identification number are highlighted for reporting purposes.

10.2. QC Analyses

It is the operators responsibility to review analytical data to ensure that all quality control requirements have been met for each analytical run. Results for QC analyses are calculated and recorded as specified in section 11 of SOP. Average, RPD, spike level and spike recovery are manually written on pertinent chromatograms. All chromatograms (see append. A) will be initialed, dated and attached to required data quality worksheet (see append. B).

10.3. The data packet for the sequence is submitted for review by supervisor or designee. The results are transferred to the appropriate report form located in the CAS network directory R:\WET\WIP. These forms are made from templates located in R:\WET\FORMS. Once the results are transferred, the report is reviewed.

10.4. Refer to the SOP for Laboratory Data Review Process for general instructions for data review.

11. QA/QC REQUIREMENTS

11.1. Laboratory Control Samples (LCS)

11.1.1. LCS's must be run daily for all anions being tested for and once every 20 samples for the anion being tested.

11.1.2. LCS's must be within 10% of the true value.

11.1.3. If the LCS is outside the acceptance criteria stop the run, correct the problem and reanalyze the LCS.

11.2. Method Detection Limits (MDL) and Method Reporting Limits

11.2.1. MDL's must be performed every 6 months, when a new operator begins work or whenever there is a significant change in the background or instrument response.

11.2.2. The detection limits capable of being obtained by the present system, using a pump rate of 2 mL/min. and a 200 µL sample loop are:

Analyte	MDL (mg/L)
Fluoride	0.09
Chloride	0.05
Nitrite-N	0.04
Bromide	0.08
Nitrate-N	0.02
O-Phosphate	0.009
Sulfate	0.07

11.2.3. The method reporting limits for the current systems are:

Analyte	MRL (mg/L)
Fluoride	0.2
Chloride	0.2
Nitrite-N	0.1
Bromide	0.1
Nitrate-N	0.1
O-Phosphate	0.05
Sulfate	0.2

11.3. Continuing Calibration Verification (CCV)

11.3.1. A CCV is analyzed every 10 injections including rinse blanks and eluent blanks.

11.3.2. All CCV's for the anions being tested for must be within 10% of the true value.

NOTE: If the analyst is not looking for all 6 of the normal anions then only the values of the anions in question need be within range.

11.4. Continuing Calibration Blanks (CCB)

11.4.1. A CCB must be analyzed every 10 injections following the same criteria as the CCV.

11.4.2. All CCB's must be less than the MRL for the anion being tested.

11.5. Method Blank (MB)

11.5.1. A method blank must be analyzed daily prior to the run and once every 20 samples.

11.5.2. All MB's must be less than the MRL for each anion being tested.

11.6. Matrix Spikes (MS)

11.6.1. A matrix spike must be analyzed for each anion being tested. A matrix spike must be analyzed a minimum of 10% of the field samples. This is accomplished by running a spike and spike duplicate every 20 samples being tested.

11.6.2. The matrix spike must be within 20% of the true value of the spike level.

11.7. Duplicates (DUP)

11.7.1. A DUP must be analyzed every 20 samples per anion being tested.

11.7.2. The acceptance criteria for a DUP is less than 20% RPD. The RPD is calculated as follows:

$$\frac{Hi - Lo}{Avg.} x\ 100$$

12. CONTENGENCIES FOR HANDLING OUT-OF-CONTROL OR UNACCEPTABLE DATA

Corrective action measures applicable to specific analysis steps are discussed in the applicable section of this (and other applicable) SOP(s). Also, refer to the SOP for *Nonconformity and Corrective Action* for correct procedures for identifying and documenting such data. Procedures for applying data qualifiers are described in the SOP for *Report Generation* or in project-specific requirements.

13. METHOD PERFORMANCE

This method was validated through single laboratory studies of accuracy and precision. Refer to the reference method for additional method performance data available.

The method detection limit (MDL) is established using the procedure described in the SOP for *The Determination of Method Detection Limits* (ADM-MDL). Method Reporting Limits are established for this method based on MDL studies and as specified in the CAS Quality Assurance Manual.

14. POLLUTION PREVENTION

It is the laboratory's practice to minimize the amount of solvents and reagents used to perform this method wherever technically sound, feasibly possible, and within method requirements. Standards are prepared in volumes consistent with laboratory use in order to minimize the volume of expired standards to be disposed of. The threat to the environment from solvents and/or reagents used in this method may be minimized when recycled or disposed of properly.

15. WASTE MANAGEMENT

The laboratory will comply with all Federal, State, and local regulations governing waste management, particularly the hazardous waste identification rules and land disposal restrictions as specified in the laboratory Safety Manual, Sections 6 and 7.

16. REFERENCES

Determination of Inorganic Anions by Ion Chromatography, U.S. Environmental Protection Agency Method 300.0, Revision 2.1, August 1993.

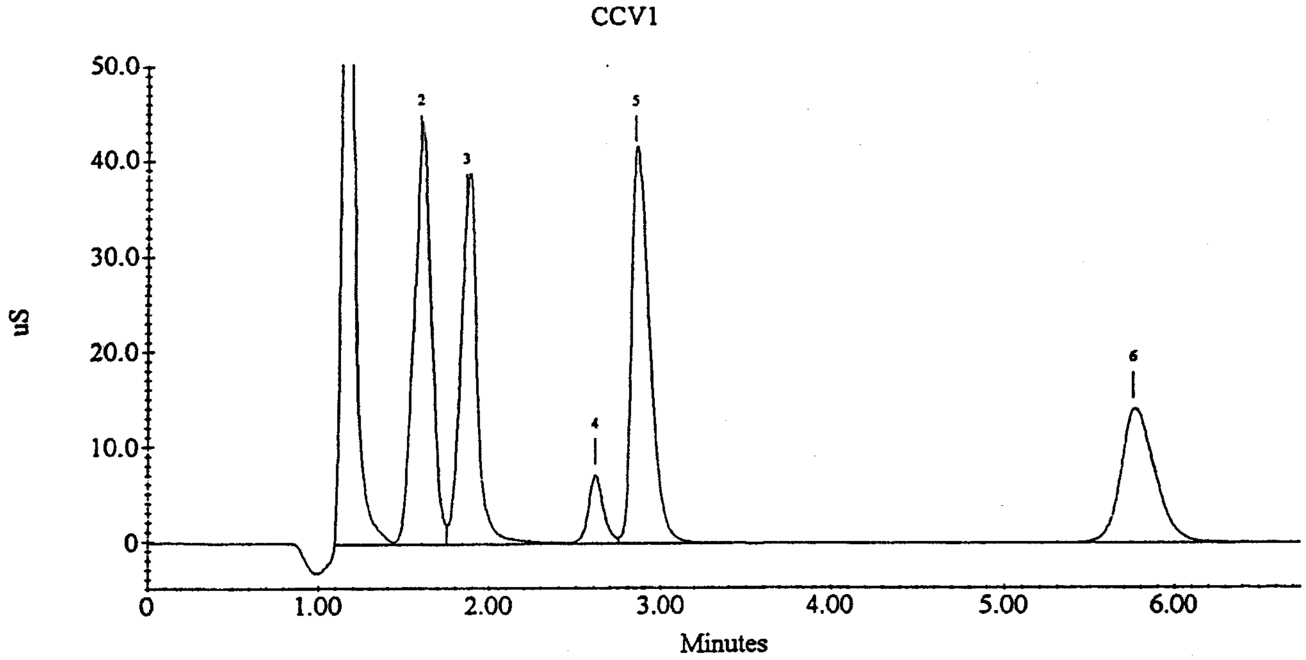
APPENDIX A

Columbia Analytical Services, Inc.

Ion Chromatography :	EPA Method 300.0 : ...\Sc2-0214.met
Sample Name : CCV1 Date Time Collected : 5/20/00 10:07:35 AM	Method File Name : ...\Sc2-0214.met Schedule File Name : ...\An20520.sch
Injection Number : 1 Dilution Factor : 1.00 Batch ID Number : AS4A-SC 02/18/98 KA0011911	Column ID : AS4A-SC 02/18/98 KA0011911 Data File Name : ...\DATA_001.DXD Injection Volume : 1.00

Peak Information : All Components

Peak Number	Peak Retention Time	Anion	Concentration (ppm)	Peak Height	Peak Area
1	1.15	fluoride	5.128	71478	423281
2	1.60	chloride	4.795	41053	313953
3	1.87	nitrite	2.176	34838	261503
4	2.61	bromide	1.997	7157	45169
5	2.85	nitrate	1.998	40883	308630
6	5.76	sulfate	4.981	13965	197662



APPENDIX B

Ion Chromatography Data Quality Report
Inorganics

1. Holding times met for all samples analyzed?	yes/no/NA
2. Are all chromatograms signed and dated?	yes/no/NA
3. Are dilutions within upper limits of the curve?	yes/no/NA
4. Are analysis/extraction stickers included on report?	yes/no/NA
5. Are detection limits reported correctly?	yes/no/NA
6. Are all quality control criteria met?	yes/no/NA
a. Method Blanks, CCV's, CCB's, LCS's, Dups, and Spikes analyzed at the proper frequency?	yes/no/NA
b. Are CCV's and CCB's all within acceptance limits?	yes/no/NA
c. Are results for Method Blanks all ND?	yes/no/NA
d. Are all QC samples within acceptance criteria? (LCS% rec, MS% rec, Duplicate RPD's, etc.)	yes/no/NA
e. Are all exceptions explained?	yes/no/NA
8. Are all samples labelled correctly?	yes/no/NA

CAS Standard Identification Codes and Abbreviated Footnotes for Chromatograms

G1	Sample was analyzed past the end of recommended holding time. See Nonconformity sheet.
G2	Sample was reanalyzed past holding time. Initial analysis was performed within recommended holding time.
G4	Sample was received past the end of recommended holding time.
R1	High RPD is because the duplicate sample results are less than three times the method reporting limit.
D	MRL is elevated because of matrix interferences and the sample required diluting.
F	Sample filtered primary to analysis.

LCS

Fluoride	True Value = 6.8 ppm	CAS ID # = AN1-16-V	Expires08/15/00
Chloride	True Value =5.0ppm	CAS ID # = ERA#092	Expires 06/30/00
Nitrite	True Value = 100 ppm	CAS ID # = ______________	Expires:____________
Bromide	True Value = 4.0 ppm	CAS ID # = AN1-16-U	Expires 08/15/00
Nitrate	True Value = 9.3 ppm	CAS ID # = AN1-16-T	Expires7/12/00
Sulfate	True Value = 5.0 ppm	CAS ID # = ERA#092	Expires 06/30/00

CCV CAS ID # =__________________ Expires____________

Fluoride	True Value = 5.0 ppm
Chloride	True Value = 5.0 ppm
Nitrite	True Value = 2.0 ppm
Bromide	True Value = 2.0 ppm
Nitrate	True Value = 2.0 ppm
Sulfate	True Value = 5.0 ppm

Spike

2.0ppm X dilution factor CAS ID# = ____________________ Expires_____________

Analyst:____Date:____________

First Review:____Date:____________

Final Review:____Date:____________

STANDARD OPERATING PROCEDURE

for
METALS DIGESTION

SOP No.: MET-7195

Revision: 1

July 7, 2000

Approved by: ______________________ Supervisor — 7/7/00 Date

______________________ QA Manager — 7-7-00 Date

______________________ Laboratory Manager — 7/10/00 Date

1317 South 13th Avenue
Kelso, Washington 98626

Annual review of this SOP has been performed and the SOP still reflects current practice.
Initials: ______ Date: __________
Initials: ______ Date: __________
Initials: ______ Date: __________

NON-CONTROLLED COPY
Will Not Be Updated

Hexavalent Chromium: EPA 7195

1 SCOPE AND APPLICATION

This procedure is used to determine the concentration of dissolved hexavalent chromium [Cr(VI)] in ground waters and certain domestic and industrial wastes using EPA method 7195.

2 METHOD SUMMARY

Method 7195 is based on the separation of Cr(VI) from solution by coprecipitation of lead chromate with lead sulfate in a solution of acetic acid. After the separation, the supernate is drawn off and the precipitate is washed to remove occluded Cr(III). The Cr(VI) is then reduced and resolubilized in nitric acid and quantified as Cr(III) by ICP-OES.

3 DEFINITIONS

3.1 **Matrix Spike** (MS) - In the matrix spike analysis, predetermined quantities of standard solutions of certain analytes are added to a sample matrix prior to sample digestion and analysis. The purpose of the matrix spike is to evaluate the effects of the sample matrix on the methods used for the analyses. Percent recoveries are calculated for each of the analytes detected.

3.2 **Matrix Spike Duplicate** (MSD) - In the matrix spike duplicate analysis, predetermined quantities of standard solutions of certain analytes are added to a sample matrix prior to sample digestion and analysis. The purpose of the matrix spike duplicate is to evaluate the effects of the sample matrix on the methods used for the analyses. Percent recoveries are calculated for each of the analytes detected. The relative percent difference between the matrix spikes is calculated and used to assess analytical precision.

3.3 **Duplicate Sample** (DUP) - A laboratory duplicate. The duplicate sample is a separate field sample aliquot that is processed in an identical manner as the sample proper. The relative percent difference between the samples is calculated and used to assess analytical precision.

3.4 **Method Blank** - The method blank is an artificial sample designed to monitor introduction of artifacts into the process. The method blank is carried through the entire analytical procedure.

4 SAFETY

Follow normal CAS precautions as per the CAS Safety Manual. Sufficient care must be taken in handling all reagents. Protective equipment should be used at all times. Protective equipment includes safety glasses, gloves and a lab coat. Consult the Material Safety Data Sheets (MSDS) or the Safety Officer for more information.

5 SAMPLE PRESERVATION AND STORAGE

Aqueous samples must be refrigerated at 4°C from receipt until analysis. Analysis must occur within 24 hours of sampling.

6 APPARATUS AND EQUIPMENT

6.1 50 mL Centrifuge Tubes

6.2 Pipettes

6.3 Centrifuge

6.4 Vacuum source

7 STANDARDS AND REAGENTS

7.1 ASTM Type II water

7.2 Concentrated nitric acid

7.3 Glacial acetic acid

7.4 Lead nitrate solution (33.1% w/v)

7.5 Ammonium sulfate solution (2.7% w/v)

8 RESPONSIBILITIES

It is the responsibility of the analyst to perform the analysis according to this SOP and to complete all documentation required for data review. Analysis and interpretation of the results are performed by personnel in the laboratory who have demonstrated the ability to generate acceptable results utilizing this SOP. This demonstration is in accordance with the training program of the laboratory. Final review and sign-off of the data is performed by the department supervisor/manager or designee.

It is the responsibility or the department supervisor/manager to document analyst training. Documenting method proficiency is also the responsibility of the department supervisor/manager.

9 PROCEDURE

9.1 Transfer a 30 mL portion and a 3.0 mL portion to labeled 50 mL centrifuge tubes. Dilute the 3.0 mL sample to 30 ml with reagent water. Adjust the pH of the samples to 3.5 ± 0.3 by adding glacial acetic acid dropwise. Proceed immediately to step 7.2.

9.2 Add 0.500 mL of lead nitrate solution to the centrifuge tubes, cap and shake. Allow the samples to stand for 3 min.

9.3 After the formation of lead chromate add 1.5 mL of glacial acetic acid, cap and mix.

9.4 Add 0.500 mL of ammonium sulfate solution, cap and mix.

9.5 Centrifuge the samples for 5 min.

9.6 Aspirate the supernate to within approximately 1 mL above the precipitate. Rinse the precipitate and the sides of the centrifuge tube with 25 mL of reagent water and centrifuge. Again, aspirate the supernate.

9.7 Add 1.5 mL of concentrated nitric acid and 3.0 mL of 1:1 HCl to the centrifuge tube and shake. Dilute to 30 mL and analyze the samples by ICP-OES.

10 QA/QC REQUIREMENTS

Prepare one method blank, one laboratory control sample, one duplicate sample, and one spike sample for every twenty samples for both the undiluted samples and the 3.0 mL - 30 mL diluted samples. Analyze and report the undiluted samples. If however the matirx spike for the undiluted samples is out of control analyze and report the diluted sample.

11 CONTENGENCIES FOR HANDLING OUT-OF-CONTROL OR UNACCEPTABLE DATA

Corrective action measures applicable to specific analysis steps are discussed in the applicable section of this (and other applicable) SOP(s). Also, refer to the SOP for *Nonconformity and Corrective Action* for correct procedures for identifying and documenting such data. Procedures for applying data qualifiers are described in the SOP for *Report Generation* or in project-specific requirements.

12 REPORTING

12.1 Preparation data sheets including volumes used are completed and a batch lot number is assigned and attached to the data sheet. The Manufacturer's lot number for the reagents used are added to the digestion data sheet.

12.2 Spiking sheets are completed including all spike data and volumes of spiking solutions used.

13 METHOD PERFORMANCE

This method was validated through single laboratory studies of accuracy and precision. Refer to the reference method for additional available method performance data.

The method detection limit (MDL) is established using the procedure described in the SOP for *The Determination of Method Detection Limits* (ADM-MDL). Method Reporting Limits are established for this method based on MDL studies and as specified in the CAS Quality Assurance Manual.

14 POLLUTION PREVENTION

It is the laboratory's practice to minimize the amount of solvents and reagents used to perform this method wherever technically sound, feasibly possible and within method requirements. Standards are prepared in volumes consistant with the laboratory use in order to minimize the volume of expired standards to be disposed of. The threat to the environment from solvents and/or reagents used in this method may be minimized when recycled or disposed of properly.

15 WASTE MANAGEMENT

The laboratory will comply with all Federal, State and local regulations governing waste management, particularly the hazardous waste identification rules and disposal restrictions as specified in the laboratory Safety Manual, Sections 6 and 7.

16 REFERENCES

Test Methods For Evaluating Solid Waste, Physical/Chemical Methods. EPA SW-846, 3rd Edition, Final Update 1

ATTACHMENT II

Revised Figure 5-12

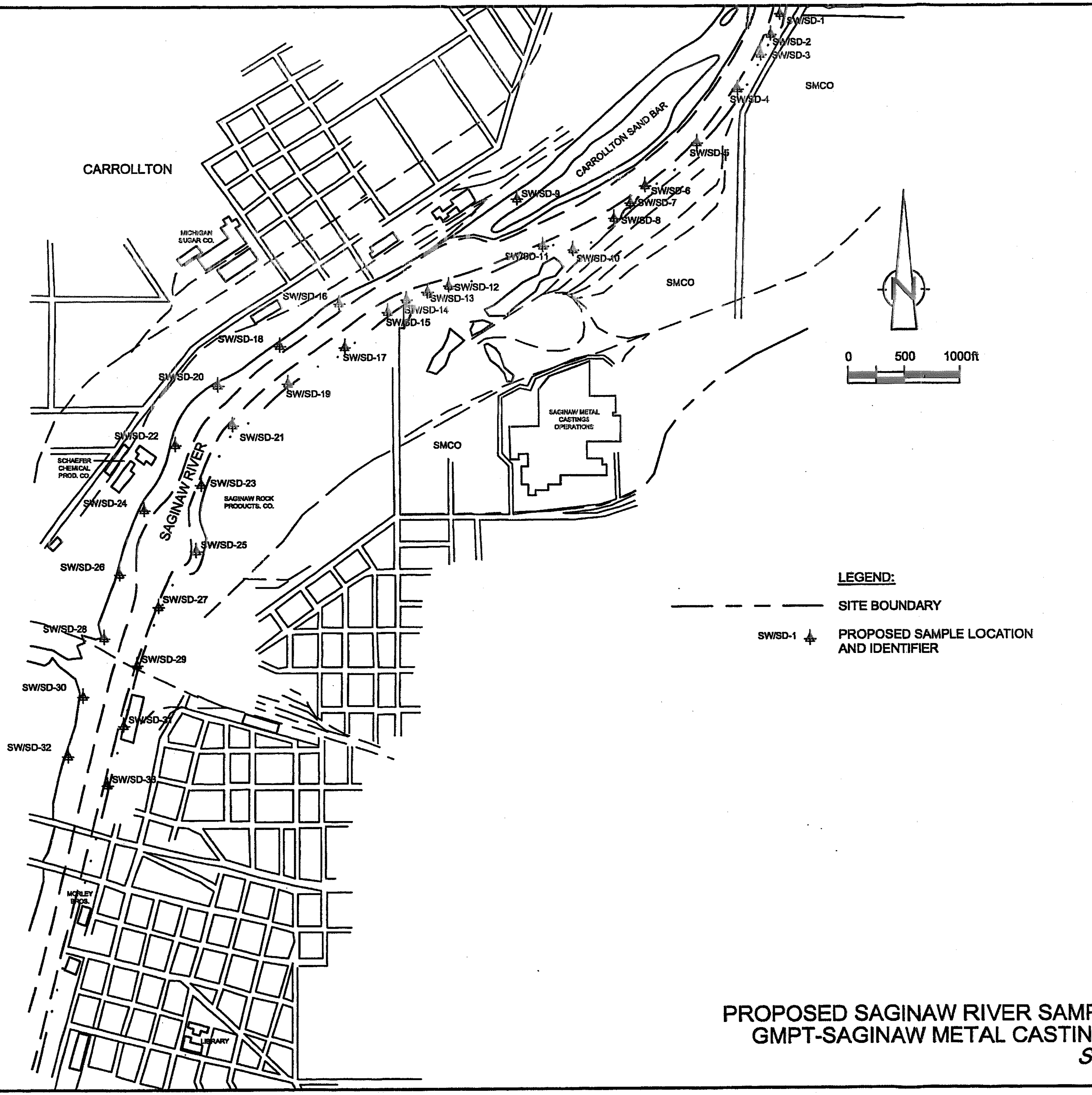
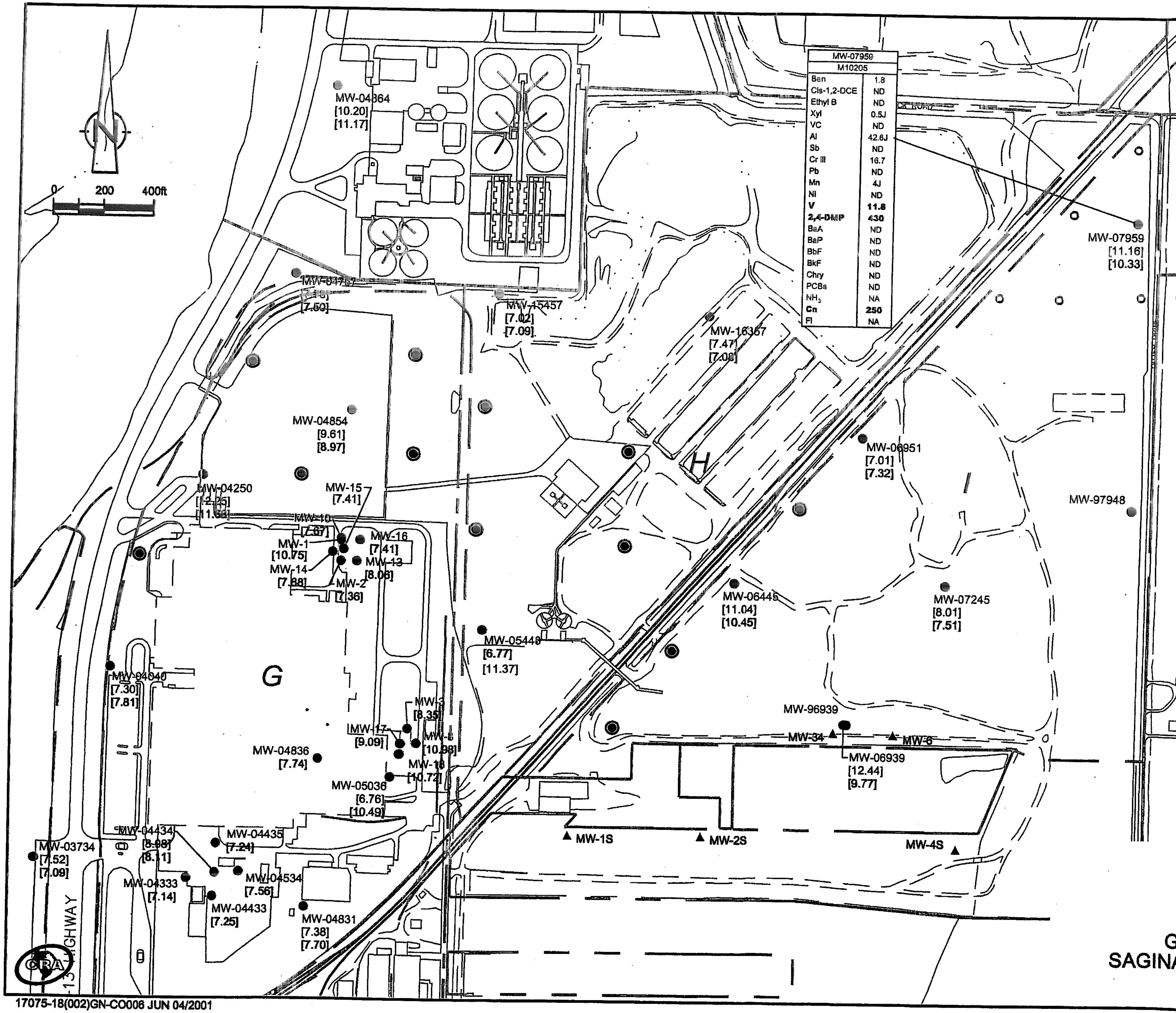


figure 5-12

PROPOSED SAGINAW RIVER SAMPLE LOCATIONS
GMPT-SAGINAW METAL CASTING OPERATIONS
Saginaw, Michigan

ATTACHMENT III

Figure 5-9c



MW-07959	
M10205	
Ben	1.8
Cis-1,2-DCE	ND
Ethyl B	ND
Xyl	0.5J
VC	ND
Al	42.6J
Sb	ND
Cr III	16.7
Pb	ND
Mn	4J
Ni	ND
V	**11.8**
2,4-DMP	**430**
BaA	ND
BaP	ND
BbF	ND
BkF	ND
Chry	ND
PCBs	ND
NH_3	NA
Cn	**250**
Fl	NA

LEGEND:

— — —	INVESTIGATIVE UNIT BOUNDARY AND IDENTIFIER
○	PROPOSED RFI TEMPORARY MONITORING WELL LOCATION
◉	PROPOSED GROUNDWATER GRAB SAMPLE LOCATION
MW-03734 ●	RFI MONITORING WELL LOCATION AND IDENTIFIER
MW-1S ▲	EXISTING WELL LOCATION AND IDENTIFIER
[7.00]	PHASE 1A pH MEASUREMENT (std. units)
[7.00]	PHASE 1B pH MEASUREMENT (std. units)

NOTES:

1. ALL RESULTS ARE REPORTED IN mg/kg OR mg/L
2. SOIL ANALYTICAL RESULTS ARE INDICATED WITH B____. GROUNDWATER RESULTS ARE INDICATED WITH SAMPLE NUMBERS BEGINNING WITH M____ OR H____.
3. BOLDED VALUES ARE THOSE PARAMETER CONCENTRATIONS THAT EXCEED THE PHASE 1B SCREENING LEVELS
4. J = ESTIMATED
5. ADDITIONAL PHASE 1B ANALYTICAL RESULTS ARE PROVIDED IN THE JANUARY AND FEBRUARY 2001 MONTHLY PROGRESS REPORTS AND ATTACHMENT X TO THIS ADDENDUM

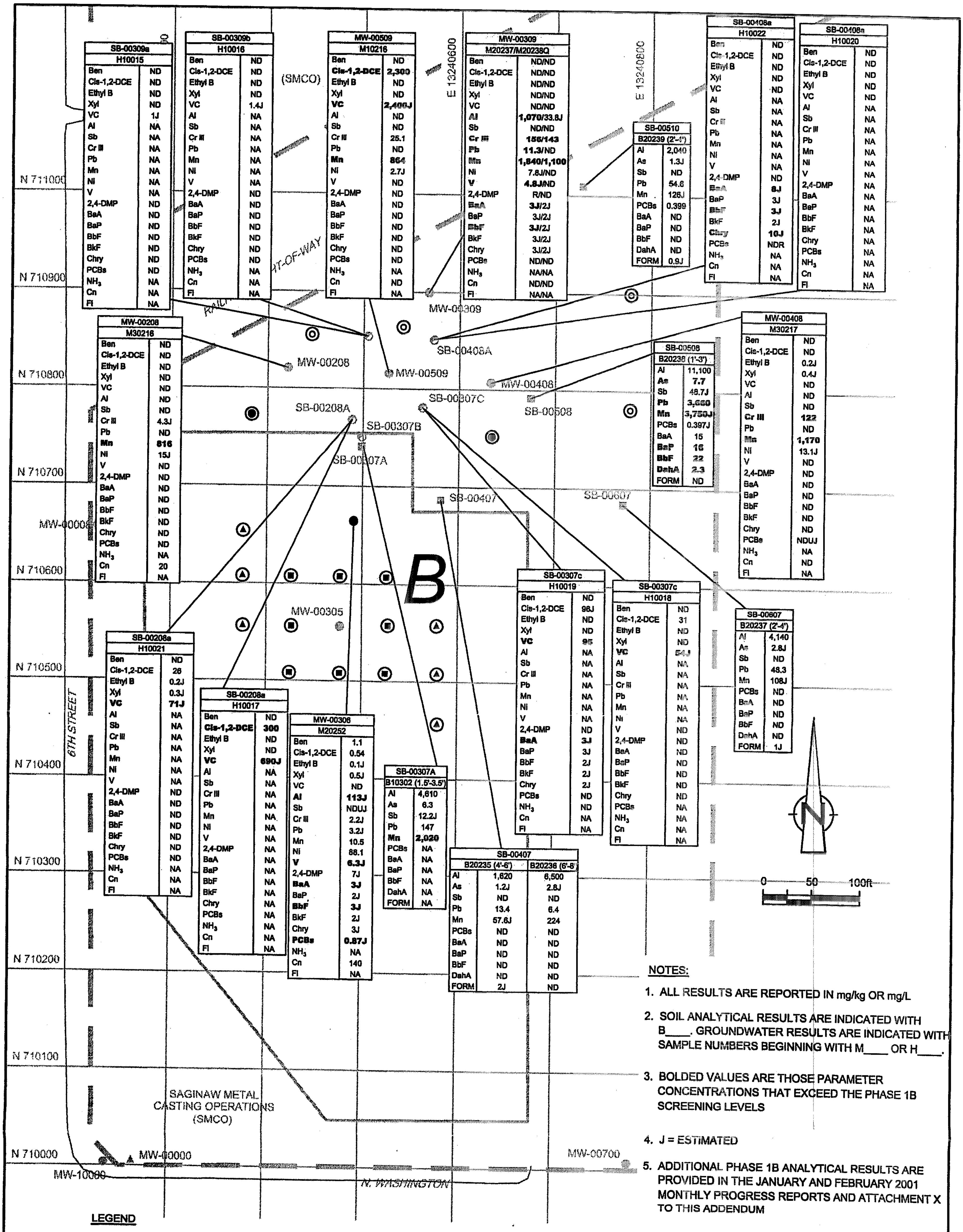
figure 5-9c

PROPOSED SAMPLE LOCATIONS
GENERAL MOTORS CORPORATION
SAGINAW METAL CASTING OPERATIONS
Saginaw, Michigan

17075-18(002)GN-CO006 JUN 04/2001

ATTACHMENT IV

Figure 5-2c



SB-00309a	
H10015	
Ben	ND
Cis-1,2-DCE	ND
Ethyl B	ND
Xyl	ND
VC	1J
Al	NA
Sb	NA
Cr III	NA
Pb	NA
Mn	NA
Ni	NA
V	NA
2,4-DMP	ND
BaA	ND
BaP	ND
BbF	ND
BkF	ND
Chry	ND
PCBs	ND
NH_3	NA
Cn	NA
Fl	NA

SB-00309b	
H10016	
Ben	ND
Cis-1,2-DCE	ND
Ethyl B	ND
Xyl	ND
VC	1.4J
Al	NA
Sb	NA
Cr III	NA
Pb	NA
Mn	NA
Ni	NA
V	NA
2,4-DMP	ND
BaA	ND
BaP	ND
BbF	ND
BkF	ND
Chry	ND
PCBs	ND
NH_3	NA
Cn	NA
Fl	NA

MW-00509	
M10216	
Ben	ND
Cis-1,2-DCE	**2,300**
Ethyl B	ND
Xyl	ND
VC	**2,400J**
Al	ND
Sb	ND
Cr III	25.1
Pb	ND
Mn	**864**
Ni	2.7J
V	ND
2,4-DMP	ND
BaA	ND
BaP	ND
BbF	ND
BkF	ND
Chry	ND
PCBs	ND
NH_3	NA
Cn	ND
Fl	NA

MW-00309	
M20237/M20238Q	
Ben	ND/ND
Cis-1,2-DCE	ND/ND
Ethyl B	ND/ND
Xyl	ND/ND
VC	ND/ND
Al	**1,070/33.8J**
Sb	ND/ND
Cr III	**156/143**
Pb	**11.3/ND**
Mn	**1,840/1,100**
Ni	7.8J/ND
V	**4.8J/ND**
2,4-DMP	R/ND
BaA	**3J/2J**
BaP	3J/2J
BbF	**3J/2J**
BkF	3J/2J
Chry	3J/2J
PCBs	ND/ND
NH_3	NA/NA
Cn	ND/ND
Fl	NA/NA

SB-00510	
B20239 (2'-4')	
Al	2,040
As	1.3J
Sb	ND
Pb	54.6
Mn	126J
PCBs	0.399
BaA	ND
BaP	ND
BbF	ND
DahA	ND
FORM	0.9J

SB-00408a	
H10022	
Ben	ND
Cis-1,2-DCE	ND
Ethyl B	ND
Xyl	ND
VC	ND
Al	NA
Sb	NA
Cr III	NA
Pb	NA
Mn	NA
Ni	NA
V	NA
2,4-DMP	ND
BaA	**8J**
BaP	3J
BbF	**3J**
BkF	2J
Chry	**10J**
PCBs	NDR
NH_3	NA
Cn	NA
Fl	NA

SB-00408a	
H10020	
Ben	ND
Cis-1,2-DCE	ND
Ethyl B	ND
Xyl	ND
VC	ND
Al	NA
Sb	NA
Cr III	NA
Pb	NA
Mn	NA
Ni	NA
V	NA
2,4-DMP	NA
BaA	NA
BaP	NA
BbF	NA
BkF	NA
Chry	NA
PCBs	NA
NH_3	NA
Cn	NA
Fl	NA

MW-00208	
M30216	
Ben	ND
Cis-1,2-DCE	ND
Ethyl B	ND
Xyl	ND
VC	ND
Al	ND
Sb	ND
Cr III	4.3J
Pb	ND
Mn	**816**
Ni	15J
V	ND
2,4-DMP	ND
BaA	ND
BaP	ND
BbF	ND
BkF	ND
Chry	ND
PCBs	ND
NH_3	NA
Cn	20
Fl	NA

SB-00508	
B20238 (1'-3')	
Al	11,100
As	**7.7**
Sb	48.7J
Pb	**3,660**
Mn	**3,750J**
PCBs	0.397J
BaA	15
BaP	**16**
BbF	**22**
DahA	**2.3**
FORM	ND

MW-00408	
M30217	
Ben	ND
Cis-1,2-DCE	ND
Ethyl B	0.2J
Xyl	0.4J
VC	ND
Al	ND
Sb	ND
Cr III	**122**
Pb	ND
Mn	**1,170**
Ni	13.1J
V	ND
2,4-DMP	ND
BaA	ND
BaP	ND
BbF	ND
BkF	ND
Chry	ND
PCBs	NDUJ
NH_3	NA
Cn	ND
Fl	NA

SB-00307c	
H10019	
Ben	ND
Cis-1,2-DCE	96J
Ethyl B	ND
Xyl	ND
VC	**95**
Al	NA
Sb	NA
Cr III	NA
Pb	NA
Mn	NA
Ni	NA
V	NA
2,4-DMP	ND
BaA	**3J**
BaP	3J
BbF	2J
BkF	2J
Chry	2J
PCBs	ND
NH_3	ND
Cn	NA
Fl	NA

SB-00307c	
H10018	
Ben	ND
Cis-1,2-DCE	31
Ethyl B	ND
Xyl	ND
VC	**54J**
Al	NA
Sb	NA
Cr III	NA
Pb	NA
Mn	NA
Ni	NA
V	ND
2,4-DMP	ND
BaA	ND
BaP	ND
BbF	ND
BkF	ND
Chry	ND
PCBs	NA
NH_3	NA
Cn	NA
Fl	NA

SB-00607	
B20237 (2'-4')	
Al	4,140
As	2.8J
Sb	ND
Pb	48.3
Mn	108J
PCBs	ND
BaA	ND
BaP	ND
BbF	ND
DahA	ND
FORM	1J

SB-00208a	
H10021	
Ben	ND
Cis-1,2-DCE	26
Ethyl B	0.2J
Xyl	0.3J
VC	**71J**
Al	NA
Sb	NA
Cr III	NA
Pb	NA
Mn	NA
Ni	NA
V	NA
2,4-DMP	ND
BaA	ND
BaP	ND
BbF	ND
BkF	ND
Chry	ND
PCBs	ND
NH_3	NA
Cn	NA
Fl	NA

SB-00208a	
H10017	
Ben	ND
Cis-1,2-DCE	**300**
Ethyl B	ND
Xyl	ND
VC	**690J**
Al	NA
Sb	NA
Cr III	NA
Pb	NA
Mn	NA
Ni	NA
V	NA
2,4-DMP	NA
BaA	NA
BaP	NA
BbF	NA
BkF	NA
Chry	NA
PCBs	NA
NH_3	NA
Cn	NA
Fl	NA

MW-00306	
M20252	
Ben	1.1
Cis-1,2-DCE	0.54
Ethyl B	0.1J
Xyl	0.5J
VC	ND
Al	**113J**
Sb	NDUJ
Cr III	2.2J
Pb	3.2J
Mn	10.5
Ni	88.1
V	**6.3J**
2,4-DMP	7J
BaA	**3J**
BaP	2J
BbF	**3J**
BkF	2J
Chry	3J
PCBs	**0.87J**
NH_3	NA
Cn	140
Fl	NA

SB-00307A	
B10302 (1.5'-3.5')	
Al	4,610
As	6.3
Sb	12.2J
Pb	147
Mn	**2,020**
PCBs	NA
BaA	NA
BaP	NA
BbF	NA
DahA	NA
FORM	NA

SB-00407		
	B20235 (4'-6')	B20236 (6'-8')
Al	1,620	6,500
As	1.2J	2.8J
Sb	ND	ND
Pb	13.4	6.4
Mn	57.6J	224
PCBs	ND	ND
BaA	ND	ND
BaP	ND	ND
BbF	ND	ND
DahA	ND	ND
FORM	2J	ND

NOTES:

1. ALL RESULTS ARE REPORTED IN mg/kg OR mg/L
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3. BOLDED VALUES ARE THOSE PARAMETER CONCENTRATIONS THAT EXCEED THE PHASE 1B SCREENING LEVELS
4. J = ESTIMATED
5. ADDITIONAL PHASE 1B ANALYTICAL RESULTS ARE PROVIDED IN THE JANUARY AND FEBRUARY 2001 MONTHLY PROGRESS REPORTS AND ATTACHMENT X TO THIS ADDENDUM

LEGEND

▬ ▬ ▬	INVESTIGATIVE UNIT BOUNDARY
▭	APPROXIMATE LOCATION OF FORMER PARTS PLANT
▣	PROPOSED PRODUCT DELINEATION SOIL BORING LOCATION
▲	PROPOSED PRODUCT DELINEATION BORING LOCATION CONTINGENT UPON RESULTS OF INITIAL BORINGS
●	PROPOSED GROUNDWATER GRAB SAMPLE LOCATION
◎	PROPOSED RFI SOIL BORING LOCATION
MW-00306 ●	RFI MONITORING WELL PROPOSED RESAMPLE
MW-10000 ●	RFI MONITORING WELL LOCATION AND IDENTIFIER
SB-00307A ◎	RFI TEMPORARY MONITORING WELL LOCATION AND IDENTIFIER
SB-00407 ▪	RFI SOIL BORING LOCATION AND IDENTIFIER

figure 5-2c

INVESTIGATIVE UNIT B
PROPOSED SAMPLING LOCATIONS
GENERAL MOTORS CORPORATION
SAGINAW METAL CASTING OPERATIONS
Saginaw, Michigan

CRA

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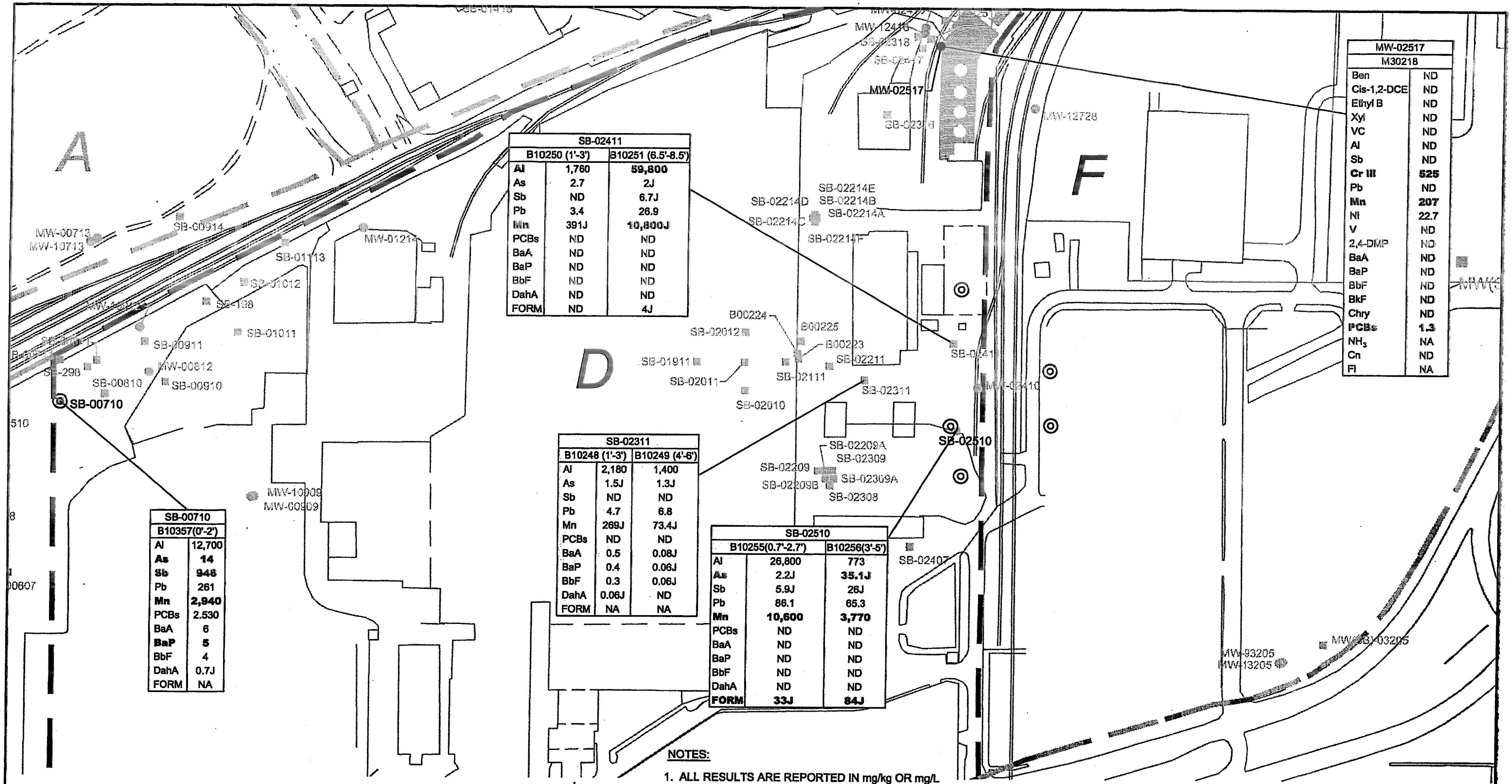
ATTACHMENT V

Revised Figure 5-4e



SB-00710	
	B10357(0'-2')
Al	12,700
As	**14**
Sb	**946**
Pb	261
Mn	**2,940**
PCBs	2.530
BaA	6
BaP	**5**
BbF	4
DahA	0.7J
FORM	NA

SB-02411		
	B10250 (1'-3')	B10251 (6.5'-8.5')
Al	1,760	**59,800**
As	2.7	2J
Sb	ND	6.7J
Pb	3.4	26.9
Mn	391J	**10,800J**
PCBs	ND	ND
BaA	ND	ND
BaP	ND	ND
BbF	ND	ND
DahA	ND	ND
FORM	ND	4J

SB-02311		
	B10248 (1'-3')	B10249 (4'-6')
Al	2,180	1,400
As	1.5J	1.3J
Sb	ND	ND
Pb	4.7	6.8
Mn	269J	73.4J
PCBs	ND	ND
BaA	0.5	0.08J
BaP	0.4	0.06J
BbF	0.3	0.06J
DahA	0.06J	ND
FORM	NA	NA

SB-02510		
	B10255(0.7'-2.7')	B10256(3'-5')
Al	26,800	773
As	2.2J	**35.1J**
Sb	5.9J	26J
Pb	86.1	65.3
Mn	**10,600**	**3,770**
PCBs	ND	ND
BaA	ND	ND
BaP	ND	ND
BbF	ND	ND
DahA	ND	ND
FORM	**33J**	**84J**

MW-02517	
	M30218
Ben	ND
Cis-1,2-DCE	ND
Ethyl B	ND
Xyl	ND
VC	ND
Al	ND
Sb	ND
Cr III	**525**
Pb	ND
Mn	**207**
Ni	22.7
V	ND
2,4-DMP	ND
BaA	ND
BaP	ND
BbF	ND
BkF	ND
Chry	ND
PCBs	**1.3**
NH_3	NA
Cn	ND
Fl	NA

LEGEND

▬ ▬ ▬	INVESTIGATIVE UNIT BOUNDARY AND IDENTIFIER
◎	PROPOSED RFI SOIL BORING LOCATION
MW-02517 ●	RFI MONITORING WELL PROPOSED RESAMPLE
MW-12728 ●	RFI MONITORING WELL LOCATION AND IDENTIFIER
SB-02111 ▨	RFI SOIL BORING LOCATION AND IDENTIFIER

N

0 100 200ft

NOTES:

1. ALL RESULTS ARE REPORTED IN mg/kg OR mg/L
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figure 5-4e

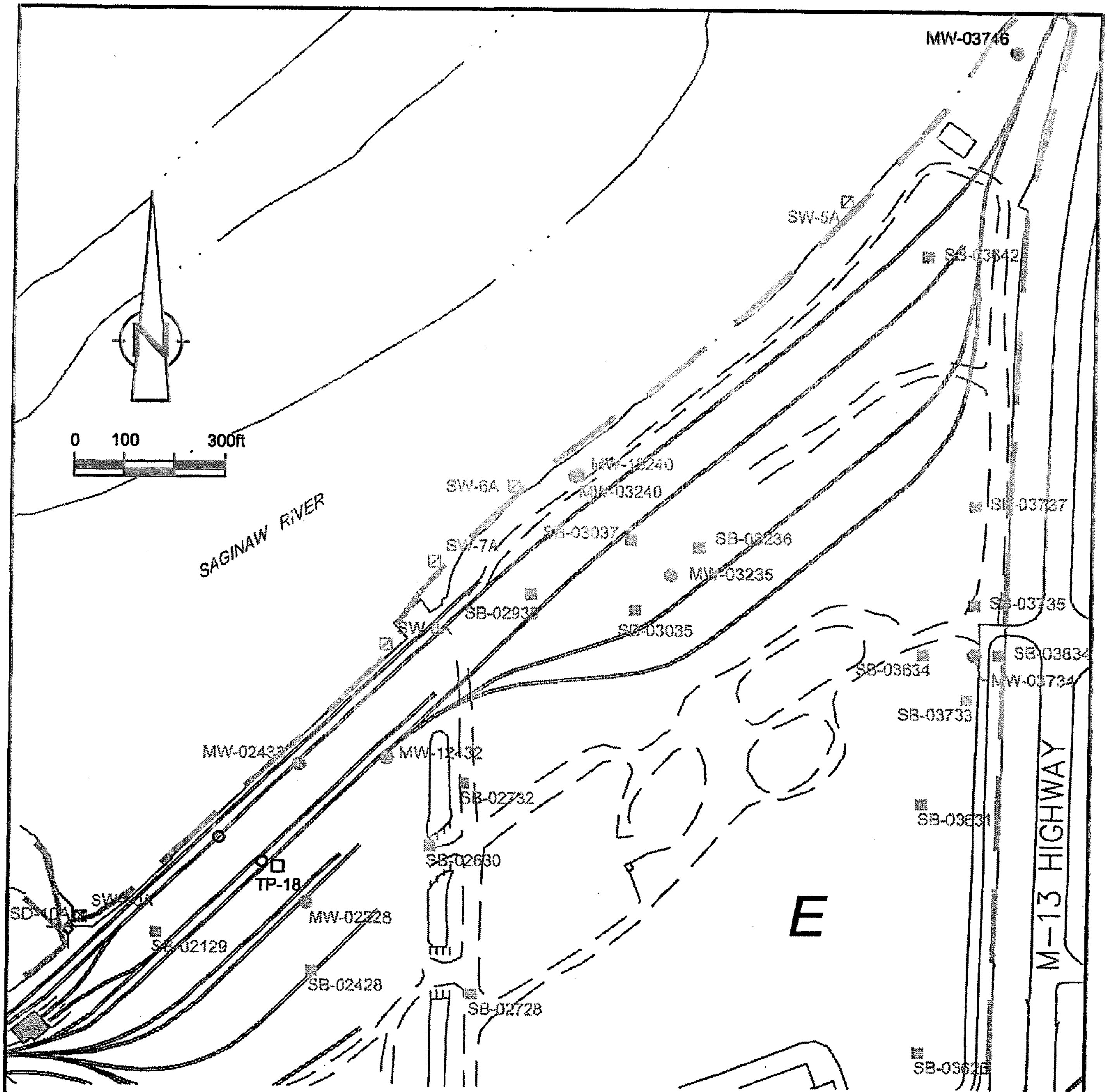
INVESTIGATIVE UNITS D AND F
PROPOSED SAMPLING LOCATIONS
GENERAL MOTORS CORPORATION
SAGINAW METAL CASTING OPERATIONS
Saginaw, Michigan

CRA

17075-18(002)GN-CO001 JUN 04/2001

ATTACHMENT VI

Revised Figure 5-5c



LEGEND

▬ ▬ ▬ INVESTIGATIVE UNIT BOUNDARY AND IDENTIFIER

TP-18 ☐ TEST PIT LOCATION

○ PROPOSED RFI TEMPORARY MONITORING WELL LOCATION

MW-03746 ● RFI MONITORING WELL PROPOSED FLUORIDE SAMPLE

MW-02228 ● RFI MONITORING WELL LOCATION AND IDENTIFIER

SB-02728 ▪ RFI SOIL BORING LOCATION AND IDENTIFIER

figure 5-5c

INVESTIGATIVE UNIT E
PROPOSED SAMPLING LOCATIONS
GENERAL MOTORS CORPORATION
SAGINAW METAL CASTING OPERATIONS
Saginaw, Michigan

17075-18(002)GN-CO007 JUN 04/2001

ATTACHMENT VII

Figure 5-7d, 5-7e and RMT's 1987 Report on Basement Wall Leaks

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AIR AND WATER CHARACTERIZATION OF BASEMENT WALL LEAKS AT GENERAL MOTORS CORPORATION CENTRAL FOUNDRY DIVISION SAGINAW NODULAR IRON PLANT SAGINAW, MICHIGAN

SEPTEMBER 1987

THE AMERICAN BOARD OF INDUSTRIAL HYGIENE
INCORPORATED
CERT NO. 2274
PENNSYLVANIA 1960
JITENDRA T. RADIA

Martin Stromberger
Martin J. Stromberger, P.E.
Project Engineer

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Thomas J. Jancek
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Jitendra T. Radia, P.E., CIH
Manager, Industrial Hygiene and
Air Pollution Engineering

STATE OF MICHIGAN
THOMAS P. KUNES
ENGINEER
No. 28811
LICENSED PROFESSIONAL ENGINEER

9-8-87

Thomas P. Kunes
Thomas P. Kunes, P.E.
President, Northern Region

1125:10 101:RTD:sagi0903

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1. INTRODUCTION

1.1 Background

RMT, Inc., was retained by the General Motors Corporation - Central Foundry Division (GMC-CFD) Saginaw Nodular Iron plant to investigate the water and air characteristics of water leaks in the basement of the Saginaw, Michigan facility.

Site visits were conducted on August 13, 1987, and August 19, 1987, by RMT personnel to obtain water and air samples.

This report summarizes the results of the analyses of these samples.

1.2 Purpose

The purpose of this project was to investigate the characteristics of the water coming from the leaks and the air in the vicinity of the leaks through the collection and analysis of various samples.

1.3 Scope

The scope of the project included the following:

- The collection and analysis of one water sample for volatile organic constituents from the primary leak site.
- The collection and analysis of two water samples for ammonia and amine content from the primary leak site.
- The measurement of the concentration of various constituents in the air near the leaks through the use of a Draeger pump and tubes for the following compounds:
    - arsine
    - phosphine
    - carbon monoxide

- hydrogen sulfide
- ammonia
- nitrogen oxides
- hydrocarbons

- The collection and analysis of organic constituents in the air near two of the leak sites through the use of charcoal tubes.

2. FINDINGS AND CONCLUSIONS

1. Analyses of water samples from the primary leak site in the plant basement detected the following constituents:

	Level Detected	Ground Water Standard
Ammonia	965 - 1200 mg/l	none
Amines	approx. 1-5	none
Acetone	8000 ug/l	none
Methyl ethyl ketone	940 ug/l	none
Toluene	210 ug/l	2000 ug/l[1]
Benzene	28 ug/l	5 ug/l[2]
1,1-dichloroethane	1.9 ug/l	none

[1] Proposed recommended maximum contaminant level
[2] Proposed maximum contaminant level

As the above table indicates, the proposed standard for benzene has been exceeded. While the benzene standard of 5 ug/l is proposed, many state and federal agencies have used the 5 ug/l concentration as a cleanup level. In some instances, the agencies have used the maximum contaminant level goal of 0 ug/l for a cleanup level.

2. Measured atmospheric ammonia concentrations in the vicinity of the leak sites varied from 0 to 70 ppm. The measured concentrations exceeded the TLV-TWA[1] (25 ppm) and TLV-STEL[1] (35 ppm) only near the primary leak site. Outside of the primary leak area yellow tape boundary, measured ammonia concentrations were generally less than one-third of the TLV-TWA.

3. Draeger tube measurements conducted at the leak sites showed nondetectable or very low levels in the atmosphere of other constituents as listed below. No levels above the ACGIH TLV-TWA for these other compounds were detected.

    Nitrogen Oxide
    Hydrocarbons
    Hydrogen Sulfide
    Arsine
    Phosphine
    Carbon Monoxide

---

[1] Threshold Limit Value - Time-Weighted Average (TLV-TWA) and Threshold Limit Value - Short-Term Exposure Limit (TLV-STEL) as specified by the American Conference of Governmental Industrial Hygienists.

4. Long-term air samples taken using charcoal tubes showed low levels of the organic compounds listed below present at both the primary leak site and leak site #2. No levels above the ACGIH TLV-TWA for these compounds were detected.

Hexane Equivalents
Methylene Chloride
Methyl Isobutyl Ketone
Toluene

3. RECOMMENDATIONS

1. Because of the relatively high concentrations of ammonia measured in the air near the primary leak site, any workers intending to spend a substantial period of time (greater than 5-10 minutes) within the yellow tape boundary should be equipped with air-purifying respirators fitted with ammonia and organic vapor cartridges to protect against potential overexposures. Organic vapor cartridges should be used in conjunction with the ammonia cartridges due to the detection of acetone and other volatile organics in the water analysis results. Workers should receive the proper medical clearance, training, and fit-testing before donning a respirator and a written respirator program should be established and implemented according to MIOSHA standards.

2. Since the proposed MCL for benzene was exceeded in the ground water sample, and elevated levels of other volatile organic compounds were detected, it is recommended that a hydrogeologic investigation be performed to evaluate the source and extent of contamination.

4. SITE DESCRIPTION

The leaks were located in the basement of the GMC-CFD Saginaw Nodular Iron Plant in Saginaw, Michigan. Four separate leak sites were investigated. The leaks originate in the lower portion of the basement walls. Three of the leaks were from interior walls associated with an unexcavated portion of the basement. The other leak was from an outside basement wall. A sketch of the basement area is presented in Figure 6-1.

This primary leak site was cordoned off from the rest of the basement through the use of yellow tape. The tape encompasses an area whose boundaries were approximately 30 feet east, 25 feet north, and 30 feet west of the leak site.

Liquid from the primary leak was on portions of the floor of the basement both within and outside this yellow tape area. Very little liquid was on the basement floor near the other leak sites.

An ammonia-like odor was present in the vicinity of the primary leak site but not in the vicinity of the other leak sites.

5. WATER CHARACTERIZATION

5.1 Discussion of Analysis Results

Water sample laboratory analysis results are presented in Table 5-1. Two samples showed a relatively high level of ammonia in the water. In addition, only a few parts per million of amines were measured in the August 19, 1987, sample.

The volatile organic analyses detected acetone, methyl ethyl ketone (MEK), toluene, benzene, and 1,1-dichloroethane. Currently, there are no ground water quality standards or criteria for any of the compounds detected. There are, however, proposed standards and criteria for Benzene and Toluene. Benzene has a proposed maximum contaminant level (MCL) of 5 ug/l (ppb) and toluene has a proposed recommended maximum contaminant level (RMCL) of 2000 ug/l (ppb). The proposed MCL for benzene was exceeded in the ground water sample. The proposed RMCL for toluene was not exceeded.

Maximum contaminant levels are enforceable standards, and recommended maximum contaminant levels are unenforceable criteria. While the ground water standard for benzene is proposed, many state and federal agencies have used the proposed MCL as a cleanup level. In some instances, agencies have used the maximum contaminant level goal of 0 ug/l for a cleanup level.

We recommend that a hydrogeologic investigation be performed to evaluate the source and extent of benzene. While the other compounds detected do not have standards or have not been detected at levels above the proposed ground water quality criteria. Their source of extent should also be evaluated.

5.2 Sampling Methodology

All samples were collected at the primary leak site from the liquid stream trickling down the basement wall. The August 13, 1987, ammonia sample was collected in a 500-milliliter amber glass bottle. The volatile organic analysis (VOA) sample was collected in a 50-milliliter VOA vial. Both samples were transported to the RMT, Inc., laboratory in Madison, Wisconsin, in a chilled cooler under chain-of-custody.

The August 19, 1987, ammonia sample was collected in a 250-milliliter nalgene bottle and transported in a chilled cooler under chain-of-custody to the Wisconsin Occupation Health Laboratory for analysis.

TABLE 5-1
WATER ANALYSIS RESULTS

Sample Date	Parameter (1)	Result	Ground Water Quality Criteria
August 13, 1987	Ammonia, Nitrogen	965 mg/l as N	
	Acetone	8000 ug/l	
	Methyl ethyl ketone	940 ug/l	
	Toluene	210 ug/l	2000 ug/l[1]
	Benzene	28 ug/l	5 ug/l[2]
	1, 1-dichloroethane	1.9 ug/l	
August 19, 1987	Ammonia	1220 mg/l	
	Amines	approx. 1-5 ppm	

[1] Proposed recommended maximum contaminant level (RMCL)
[2] Proposed maximum contaminant level (MCL)

---

(1) No other constituents present above detection level. Specific detection levels presented in Appendix A.

6. AIR CHARACTERIZATION

6.1 Discussion of Sampling Results

A summary of the air sampling results is presented in Tables 6-1 and 6-2 and in Figure 6-1. These results show that the primary compound measured at the site was ammonia. Ammonia concentrations in the air near the site were measured using a Draeger pump and tubes for ammonia. These ammonia tubes also detect the presence of amines. However, the water analyses showed only approximately 1-5 parts per million of amine compounds present in the water. Therefore, it is unlikely that a substantial amount of amines are present in the plant air near the leak.

Measured ammonia concentrations are compared in Tables 6-1 and 6-2 to the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value - Time-Weighted Average (TLV-TWA), an eight-hour average limit, and to the TLV-Short-Term Exposure Limit (TLV-STEL), a 15-minute average limit. The measured concentrations of ammonia were greater than the TLV-TWA and TLV-STEL only near the primary leak area. Additionally, the ammonia concentrations were much greater near the surface of the liquid (1-2 feet above the surface) near the leak site than in the normal breathing zone (4-5 feet above the surface). Outside of the primary leak area yellow tape boundary, measured ammonia concentrations were generally less than one-third of the TLV-TWA.

The high ammonia concentration (9 ppm) measured at leak site #3 was taken at a level approximately 1 inch above the leak. Measurements taken at approximately 4 feet above the leak showed an ammonia concentration of 0 ppm.

TABLE 6-1
DRAEGER TUBE
AIR SAMPLING RESULTS

Primary Leak Site

Sample Number	Location and Parameter	Concentration ppm
	Ammonia (TLV-TWA = 25 ppm, TLV-STEL = 35 ppm)	
1	4 feet west, 2 inches high	31
2	10 feet west, 4 feet high	5
3	20 feet west, 10 feet north, 4 feet high	4
4	3 feet north, 1 foot high	28
5	6 feet north, 4 feet high	3
6	20 feet east, 20 feet north, 4 feet high (OB)	0
7	25 feet north, 4 feet high (OB)	6
8	15 feet west, 25 feet north, 4 feet high (OB)	4
9	30 feet west, 10 feet north, 4 feet high (OB)	3
10	1 foot west, 1 foot high	70
11	10 feet west, 50 feet north, 1 foot high (OB)	3
12	5 feet west, 25 feet north, 1 foot high (OB)	4
13	40 feet east, 10 feet north, 1 foot high (OB)	4
	Nitrogen Oxides (TLV-TWA = 3ppm)	
14	10 feet west, 50 feet north, 4 feet high	0
15	10 feet west, 30 feet north, 4 feet high	0
16	3 feet north, 1 foot high	0
	Hydrocarbons	
17	10 feet west, 30 feet north, 4 feet high	0
18	3 feet north, 1 foot high	0

(OB) – Outside Yellow Tape Boundary

TABLE 6-1 (Cont'd)
DRAEGER TUBE
AIR SAMPLING RESULTS

Primary Leak Site

Sample Number	Location and Parameter	Concentration ppm
	Hydrogen Sulfide (TLV-TWA = 10 ppm)	
19	3 feet west, 2 feet high	0
	Arsine (TLV-TWA = 0.05 ppm)	
20	3 feet west, 2 feet high	0
	Phosphine (TLV-TWA = 0.3 ppm)	
21	3 feet west, 2 feet high	0
	Carbon Monoxide (TLV-TWA = 50 ppm)	
22	10 feet west, 10 feet north, 4 feet high	2
	Leak Site #2	
	Ammonia (TLV-TWA = 25 ppm, TLV-STEL = 35 ppm)	
23	6 inches high	Trace
	Nitrogen Oxide (TLV-TWA = 3 ppm)	
24	1 foot high	Trace
	Leak Site #3	
	Ammonia (TLV-TWA = 25 ppm, TLV-STEL = 35)	
25	2 inches high	9
26	4 feet high	0

TABLE 6-1 (Cont'd)
DRAEGER TUBE
AIR SAMPLING RESULTS

Sample Number	Location and Parameter	Concentration ppm
	Leak Site #4	
	Ammonia (TLV-TWA = 25 ppm, TLV-STEL = 35 ppm)	
27	1 foot high	0
	Nitrogen Oxide (TLV-TWA = 3 ppm)	
28	1 foot high	Trace

collection using an SKC Model 224-PCXR7 pump calibrated at approximately a one-liter-per-minute flow rate. The charcoal tubes were analyzed by the Wisconsin Occupation Health Laboratory in Madison, Wisconsin, by gas chromatography.

APPENDIX A

LABORATORY ANALYSIS RESULTS

Marty Stromberger

RMT INC.

Great Lakes Office
325 S. Clinton Street
P.O. Box 447
Grand Ledge, MI 48837-0447
Phone: 517-627-4044

August 27, 1987

Mr. Bill Hudson
Central Foundry Division – GMC
Saginaw Nodular Iron
2100 Veterans Memorial Parkway
Saginaw, MI 48605-5073

Dear Bill:

Please find attached the first set of water analyses of the liquid coming from the basement wall near column S-24 at the Saginaw Nodular Iron plant. This sample was collected by RMT on August 13, 1987 and confirms the analytical results verbally given to you on August 17, 1987.

These laboratory water analyses along with Drager Tube analyses, charcoal tube analyses and another water analysis will be incorporated into one report and submitted to GM Saginaw Nodular Iron shortly.

If you have any comments, please contact us.

Sincerely,

Tom

Thomas J. Jancek
Process Consultant

TJJ/kab

cc: Betsy Berg
Marty Stromberger

RMT, INC.
LABORATORY REPORT

CLIENT: GM Saginaw Nodular Iron
PROJECT #: 1125.10
RMT SAMPLE #: 25574
SAMPLE DESCRIPTION: Leak from Wall

REPORT DATE: 8/24/87
P.O. #: 081487-0112510
SAMPLE DATE: 8/13/87

PRIORITY POLLUTANT VOLATILE ORGANIC ANALYSIS*

Priority Pollutant #	CAS #	Name	Levels Detected, ug/l
(1)	107-02-8	acrolein	< 200
(2)	107-13-1	acrylonitrile	< 200
(4)	71-43-2	benzene	28
(6)	56-23-5	carbon tetrachloride	< 1.0
(7)	108-90-7	chlorobenzene	< 1.0
(10)	107-06-2	1,2-dichloroethane	< 1.0
(11)	71-55-6	1,1,1-trichloroethane	< 4.2
(13)	75-34-3	1,1-dichloroethane	1.9
(14)	79-005	1,1,2-trichloroethane	< 1.0
(15)	79-34-5	1,1,2,2-tetrachloroethane	< 2.0
(16)	75-00-3	chloroethane	< 1.0
(19)	110-75-8	2-chloroethylvinyl ether	< 4.0
(23)	67-66-3	chloroform	< 1.0
(25)	95-50-1	1,2-dichlorobenzene	< 2.0
(26)	541-73-1	1,3-dichlorobenzene	< 2.0
(27)	106-46-7	1,4-dichlorobenzene	< 2.0
(29)	75-35-4	1,1-dichloroethylene	< 1.6
(30)	156-60-5	trans-1,2-dichloroethylene	< 2.6
(32)	78-87-5	1,2-dichloropropane	< 2.0
(33)	10061-02-6	trans-1,3-dichloropropylene	< 2.0
	10061-01-05	cis-1,3-dichloropropylene	< 2.0
(38)	100-41-4	ethylbenzene	< 2.0
(44)	75-09-2	methylene chloride	< 2.0
(45)	74-87-3	chloromethane	< 1.0
(46)	74-83-9	bromomethane	< 1.0
(47)	75-25-2	bromoform	< 2.0
(48)	75-27-4	bromodichloromethane	< 1.0
(49)	75-69-4	fluorotrichloromethane	< 4.6
(51)	124-48-1	chlorodibromomethane	< 2.0
(85)	127-18-4	tetrachloroethylene	< 6.8
(86)	108-88-3	toluene	210
(87)	79-01-6	trichloroethylene	< 4.6
(88)	75-01-4	vinyl chloride	< 1.0
--	---	acetone	8,000
--	---	methylethylketone	940

*Sample submitted had air bubbles in vial.

Paul E. Duranceau

Paul E. Duranceau, Laboratory Director

96.01:LAB:gmsag

RMT Inc.
LABORATORY REPORT

CLIENT: GM Saginaw
PROJECT #: 1125.10
RMT SAMPLE #: 25574
DESCRIPTION: Leak from Wall

SAMPLE DATE: 8/13/87
REPORT DATE: 8/18/87
TOTAL # PAGES: 1
P.O. #: 081487-0112510
FILE NAME: SAG001WA

WATER ANALYSIS

PARAMETERS	RESULT	UNITS
Ammonia, Nitrogen	965	mg/l as N

Paul E. Duranceau

Paul E. Duranceau, Laboratory Director

STATE LABORATORY OF HYGIENE
UNIVERSITY OF WISCONSIN
CENTER FOR HEALTH SCIENCES

In Reply Please Refer to:
Wisconsin Occupational Health Laboratory
979 Jonathon Drive
Madison, WI 53713
(608) 263-6550

RECEIVED RMT, INC
AUG 28 1987
FILE:

August 27, 1987

Tom Kannal
RMT
1406 E. Washington Avenue
Madison, WI 53703

RE: 1073.10

Dear Tom:

Below are results for samples we received from you on August 21, 1987 for analysis:

Sample #	Lab #	Results
3342	128774	Ammonia = 1,220 μg/ml Sample also contains a few ppm of a light amine similar to dimethylethylamine.
3307	128775	Hexane equivalents <1 ppm Methylene chloride <1 ppm Methyl Isobutyl Ketone <1 ppm. Toluene <1 ppm
3316	128776	Hexane equivalents <1 ppm Methylene chloride <1 ppm Methyl Isobutyl Ketone <1 ppm Toluene <1 ppm

If you have any questions regarding these results, please feel free to contact me.

Sincerely,

Terry Burk

Terry Burk, Chemist Supervisor III

TB/ms

CB RMT

AMMONIA SAMPLE RESULTS
Received on AUG. 21. 1987

AN ALIQUOT OF THE SAMPLE WAS TAKEN TO RUN AMMONIA. THIS WAS DETERMINED BY USING AN ORION AMMONIA ELECTRODE MODEL 95-110. THE ALIQUOT HAD 10 MOLAR SODIUM HYDROXIDE ADDED AND THE MILLIVOLT READING OBTAINED WAS COMPARED TO A GRAPH OF STANDARD AMMONIA CONCENTRATIONS.

Analysts - JOHN BRAY

Date reported AUG. 27. 1987

WISCONSIN OCCUPATIONAL HEALTH LABORATORY
STATE LABORATORY OF HYGIENE

APPENDIX B

FIELD DATA SHEETS AND CALCULATIONS

AIR SAMPLING DATA FORM

Project Name: Nodular ~~Gray~~ Iron

Date: 8/19/87

Project No.: 1073.10

Sample Collector's Name: Marty & Tom

Project Site:

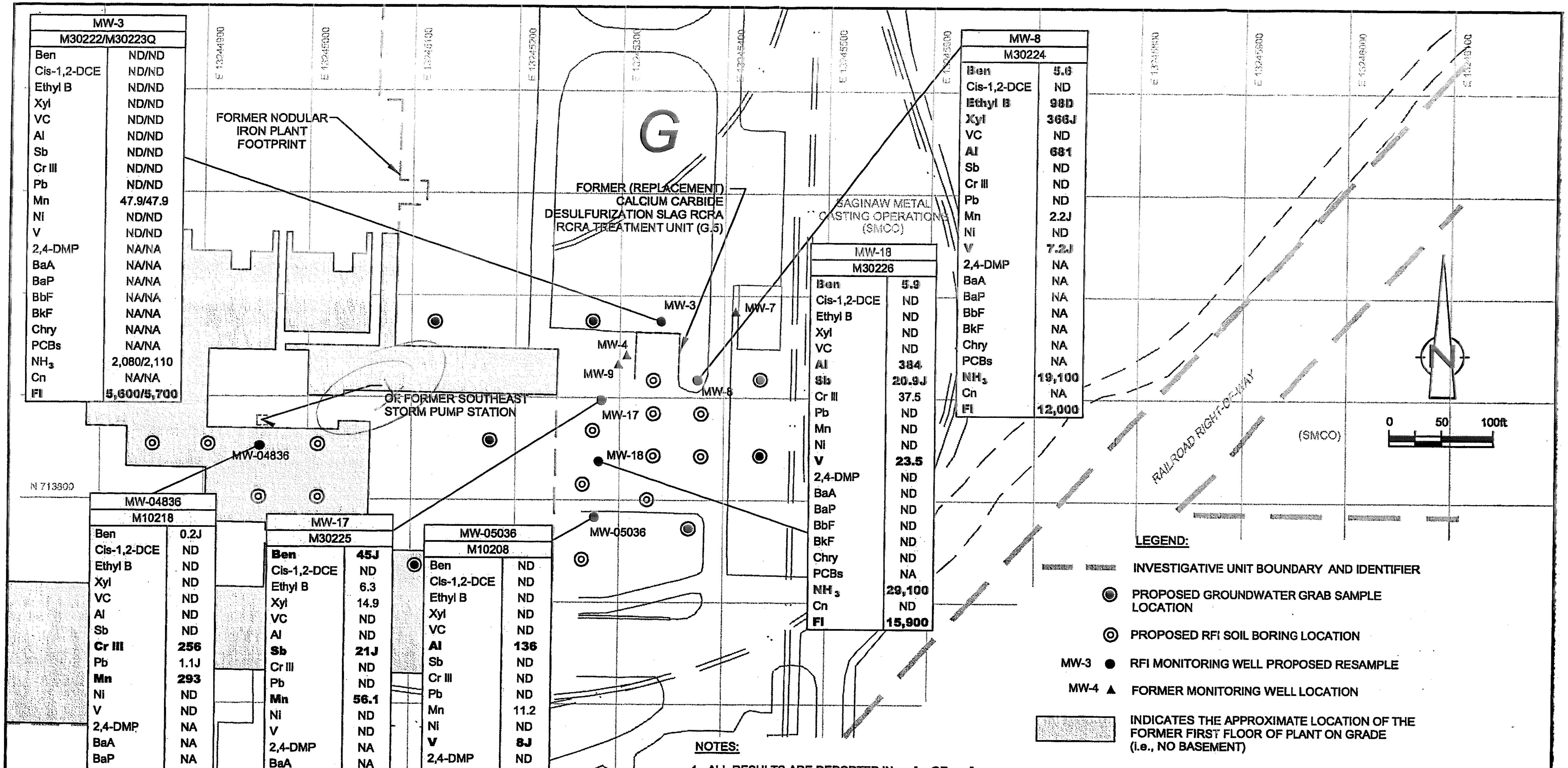
Signature: Thomas G.

Calibration: Circle one

[✓ Mini-buck]

Rotometer # — date of last Cal. / /

Pump Number	SKC 1		SKC 2	
Filter Number	3307		3316	
Filter Type	lg char tube		lg char tube	
Sample Location	In basement near leak in wall main leak (Location 1)		2nd leak (location 2)	
Rotometer Reading	Start	Stop	Start	Stop
	—	—	—	—
Time	Start	Stop	Start	Stop
	9:19 am	11:15 am	9:59 am	11:20 am
Total (Min)	116 min.		81 min.	
Flow Rate (lpm)	Start	Stop	Start	Stop
	1.0 l	1.0 l	1.0 l	1.0 l
Average	1 l		1 l	
Volume Sampled (L)	116 l		81 l	
Analysis Requested				
Remarks				



MW-3	
M30222/M30223Q	
Ben	ND/ND
Cis-1,2-DCE	ND/ND
Ethyl B	ND/ND
Xyl	ND/ND
VC	ND/ND
Al	ND/ND
Sb	ND/ND
Cr III	ND/ND
Pb	ND/ND
Mn	47.9/47.9
Ni	ND/ND
V	ND/ND
2,4-DMP	NA/NA
BaA	NA/NA
BaP	NA/NA
BbF	NA/NA
BkF	NA/NA
Chry	NA/NA
PCBs	NA/NA
NH_3	2,080/2,110
Cn	NA/NA
FI	**5,600/5,700**

MW-8	
M30224	
Ben	**5.6**
Cis-1,2-DCE	ND
Ethyl B	**98D**
Xyl	**366J**
VC	ND
Al	**681**
Sb	ND
Cr III	ND
Pb	ND
Mn	2.2J
Ni	ND
V	**7.2J**
2,4-DMP	NA
BaA	NA
BaP	NA
BbF	NA
BkF	NA
Chry	NA
PCBs	NA
NH_3	**19,100**
Cn	NA
FI	**12,000**

MW-18	
M30226	
Ben	**5.9**
Cis-1,2-DCE	ND
Ethyl B	ND
Xyl	ND
VC	ND
Al	**384**
Sb	**20.9J**
Cr III	37.5
Pb	ND
Mn	ND
Ni	ND
V	**23.5**
2,4-DMP	ND
BaA	ND
BaP	ND
BbF	ND
BkF	ND
Chry	ND
PCBs	NA
NH_3	**29,100**
Cn	ND
FI	**15,900**

MW-04836	
M10218	
Ben	0.2J
Cis-1,2-DCE	ND
Ethyl B	ND
Xyl	ND
VC	ND
Al	ND
Sb	ND
Cr III	**256**
Pb	1.1J
Mn	**293**
Ni	ND
V	ND
2,4-DMP	NA
BaA	NA
BaP	NA
BbF	NA
BkF	NA
Chry	NA
PCBs	NA
NH_3	2030
Cn	NA
FI	**2,800**

MW-17	
M30225	
Ben	**45J**
Cis-1,2-DCE	ND
Ethyl B	6.3
Xyl	14.9
VC	ND
Al	ND
Sb	**21J**
Cr III	ND
Pb	ND
Mn	**56.1**
Ni	ND
V	ND
2,4-DMP	NA
BaA	NA
BaP	NA
BbF	NA
BkF	NA
Chry	NA
PCBs	NA
NH_3	**25,500**
Cn	NA
FI	**17,000**

MW-05036	
M10208	
Ben	ND
Cis-1,2-DCE	ND
Ethyl B	ND
Xyl	ND
VC	ND
Al	**136**
Sb	ND
Cr III	ND
Pb	ND
Mn	11.2
Ni	ND
V	**8J**
2,4-DMP	ND
BaA	ND
BaP	ND
BbF	ND
BkF	ND
Chry	ND
PCBs	ND
NH_3	NA
Cn	5J
FI	**9,100**

LEGEND:

▬ ▬	INVESTIGATIVE UNIT BOUNDARY AND IDENTIFIER
◉	PROPOSED GROUNDWATER GRAB SAMPLE LOCATION
◎	PROPOSED RFI SOIL BORING LOCATION
MW-3 ●	RFI MONITORING WELL PROPOSED RESAMPLE
MW-4 ▲	FORMER MONITORING WELL LOCATION
▨	INDICATES THE APPROXIMATE LOCATION OF THE FORMER FIRST FLOOR OF PLANT ON GRADE (i.e., NO BASEMENT)

NOTE: PHYSICAL FEATURES DEPICTED ON THIS FIGURE MAY NOT REPRESENT CURRENT CONDITIONS

NOTES:

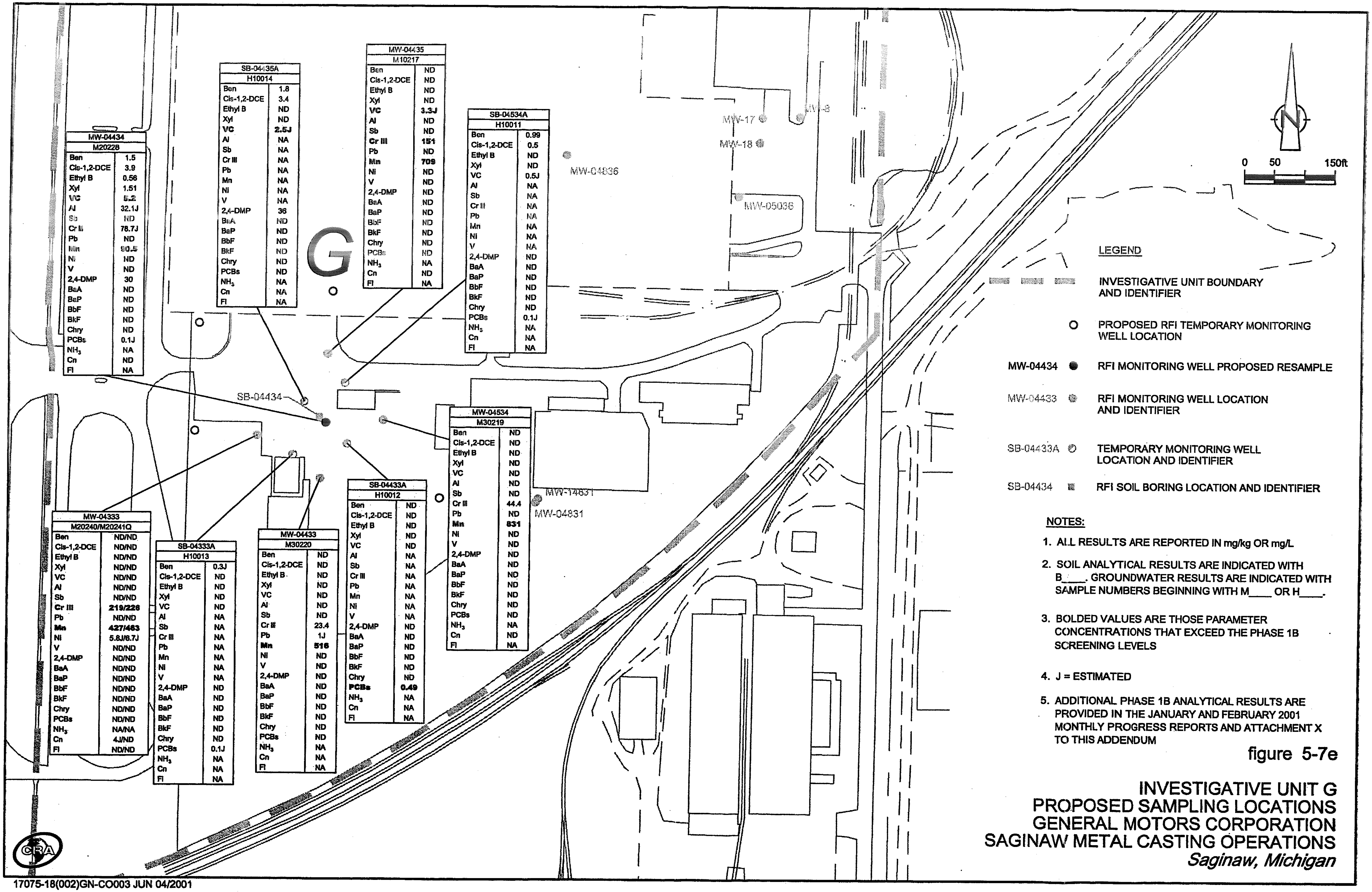
1. ALL RESULTS ARE REPORTED IN mg/kg OR mg/L
2. SOIL ANALYTICAL RESULTS ARE INDICATED WITH B____. GROUNDWATER RESULTS ARE INDICATED WITH SAMPLE NUMBERS BEGINNING WITH M____ OR H____.
3. BOLDED VALUES ARE THOSE PARAMETER CONCENTRATIONS THAT EXCEED THE PHASE 1B SCREENING LEVELS
4. J = ESTIMATED
5. ADDITIONAL PHASE 1B ANALYTICAL RESULTS ARE PROVIDED IN THE JANUARY AND FEBRUARY 2001 MONTHLY PROGRESS REPORTS AND ATTACHMENT X TO THIS ADDENDUM

figure 5-7d

INVESTIGATIVE UNIT G
PROPOSED SAMPLING LOCATIONS
GENERAL MOTORS CORPORATION
SAGINAW METAL CASTING OPERATIONS
Saginaw, Michigan

CRA

17075-18(002)GN-CO004 JUN 04/2001



MW-04434	
M20228	
Ben	1.5
Cis-1,2-DCE	3.9
Ethyl B	0.56
Xyl	1.51
VC	**5.2**
Al	32.1J
Sb	ND
Cr III	78.7J
Pb	ND
Mn	**80.5**
Ni	ND
V	ND
2,4-DMP	30
BaA	ND
BaP	ND
BbF	ND
BkF	ND
Chry	ND
PCBs	0.1J
NH_3	NA
Cn	ND
Fl	NA

SB-04435A	
H10014	
Ben	1.8
Cis-1,2-DCE	3.4
Ethyl B	ND
Xyl	ND
VC	**2.5J**
Al	NA
Sb	NA
Cr III	NA
Pb	NA
Mn	NA
Ni	NA
V	NA
2,4-DMP	36
BaA	ND
BaP	ND
BbF	ND
BkF	ND
Chry	ND
PCBs	ND
NH_3	NA
Cn	NA
Fl	NA

MW-04435	
M10217	
Ben	ND
Cis-1,2-DCE	ND
Ethyl B	ND
Xyl	ND
VC	**3.3J**
Al	ND
Sb	ND
Cr III	**151**
Pb	ND
Mn	**709**
Ni	ND
V	ND
2,4-DMP	ND
BaA	ND
BaP	ND
BbF	ND
BkF	ND
Chry	ND
PCBs	ND
NH_3	NA
Cn	ND
Fl	NA

SB-04534A	
H10011	
Ben	0.99
Cis-1,2-DCE	0.5
Ethyl B	ND
Xyl	ND
VC	0.5J
Al	NA
Sb	NA
Cr III	NA
Pb	NA
Mn	NA
Ni	NA
V	NA
2,4-DMP	ND
BaA	ND
BaP	ND
BbF	ND
BkF	ND
Chry	ND
PCBs	0.1J
NH_3	NA
Cn	NA
Fl	NA

MW-04534	
M30219	
Ben	ND
Cis-1,2-DCE	ND
Ethyl B	ND
Xyl	ND
VC	ND
Al	ND
Sb	ND
Cr III	44.4
Pb	ND
Mn	**831**
Ni	ND
V	ND
2,4-DMP	ND
BaA	ND
BaP	ND
BbF	ND
BkF	ND
Chry	ND
PCBs	ND
NH_3	NA
Cn	ND
Fl	NA

SB-04433A	
H10012	
Ben	ND
Cis-1,2-DCE	ND
Ethyl B	ND
Xyl	ND
VC	ND
Al	NA
Sb	NA
Cr III	NA
Pb	NA
Mn	NA
Ni	NA
V	NA
2,4-DMP	ND
BaA	ND
BaP	ND
BbF	ND
BkF	ND
Chry	ND
PCBs	**0.49**
NH_3	NA
Cn	NA
Fl	NA

MW-04333	
M20240/M20241Q	
Ben	ND/ND
Cis-1,2-DCE	ND/ND
Ethyl B	ND/ND
Xyl	ND/ND
VC	ND/ND
Al	ND/ND
Sb	ND/ND
Cr III	**219/226**
Pb	ND/ND
Mn	**427/463**
Ni	5.8J/6.7J
V	ND/ND
2,4-DMP	ND/ND
BaA	ND/ND
BaP	ND/ND
BbF	ND/ND
BkF	ND/ND
Chry	ND/ND
PCBs	ND/ND
NH_3	NA/NA
Cn	4J/ND
Fl	ND/ND

SB-04333A	
H10013	
Ben	0.3J
Cis-1,2-DCE	ND
Ethyl B	ND
Xyl	ND
VC	ND
Al	NA
Sb	NA
Cr III	NA
Pb	NA
Mn	NA
Ni	NA
V	NA
2,4-DMP	ND
BaA	ND
BaP	ND
BbF	ND
BkF	ND
Chry	ND
PCBs	0.1J
NH_3	NA
Cn	NA
Fl	NA

MW-04433	
M30220	
Ben	ND
Cis-1,2-DCE	ND
Ethyl B	ND
Xyl	ND
VC	ND
Al	ND
Sb	ND
Cr III	23.4
Pb	1J
Mn	**516**
Ni	ND
V	ND
2,4-DMP	ND
BaA	ND
BaP	ND
BbF	ND
BkF	ND
Chry	ND
PCBs	ND
NH_3	NA
Cn	NA
Fl	NA

LEGEND

▨ ▨ ▨	INVESTIGATIVE UNIT BOUNDARY AND IDENTIFIER
○	PROPOSED RFI TEMPORARY MONITORING WELL LOCATION
MW-04434 ●	RFI MONITORING WELL PROPOSED RESAMPLE
MW-04433 ●	RFI MONITORING WELL LOCATION AND IDENTIFIER
SB-04433A ●	TEMPORARY MONITORING WELL LOCATION AND IDENTIFIER
SB-04434 ■	RFI SOIL BORING LOCATION AND IDENTIFIER

NOTES:

1. ALL RESULTS ARE REPORTED IN mg/kg OR mg/L
2. SOIL ANALYTICAL RESULTS ARE INDICATED WITH B____. GROUNDWATER RESULTS ARE INDICATED WITH SAMPLE NUMBERS BEGINNING WITH M____ OR H____.
3. BOLDED VALUES ARE THOSE PARAMETER CONCENTRATIONS THAT EXCEED THE PHASE 1B SCREENING LEVELS
4. J = ESTIMATED
5. ADDITIONAL PHASE 1B ANALYTICAL RESULTS ARE PROVIDED IN THE JANUARY AND FEBRUARY 2001 MONTHLY PROGRESS REPORTS AND ATTACHMENT X TO THIS ADDENDUM

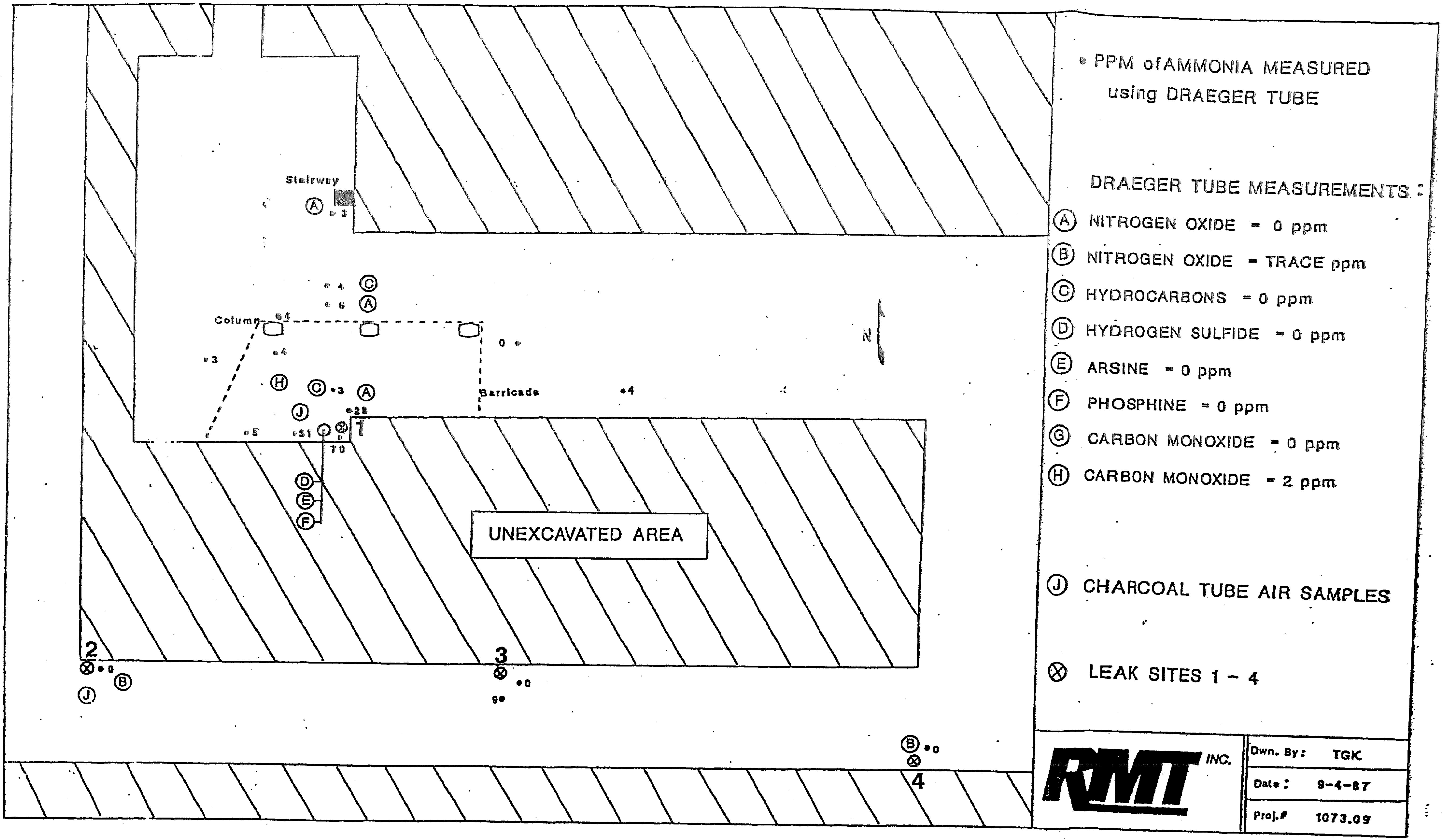
figure 5-7e

INVESTIGATIVE UNIT G
PROPOSED SAMPLING LOCATIONS
GENERAL MOTORS CORPORATION
SAGINAW METAL CASTING OPERATIONS
Saginaw, Michigan

CRA

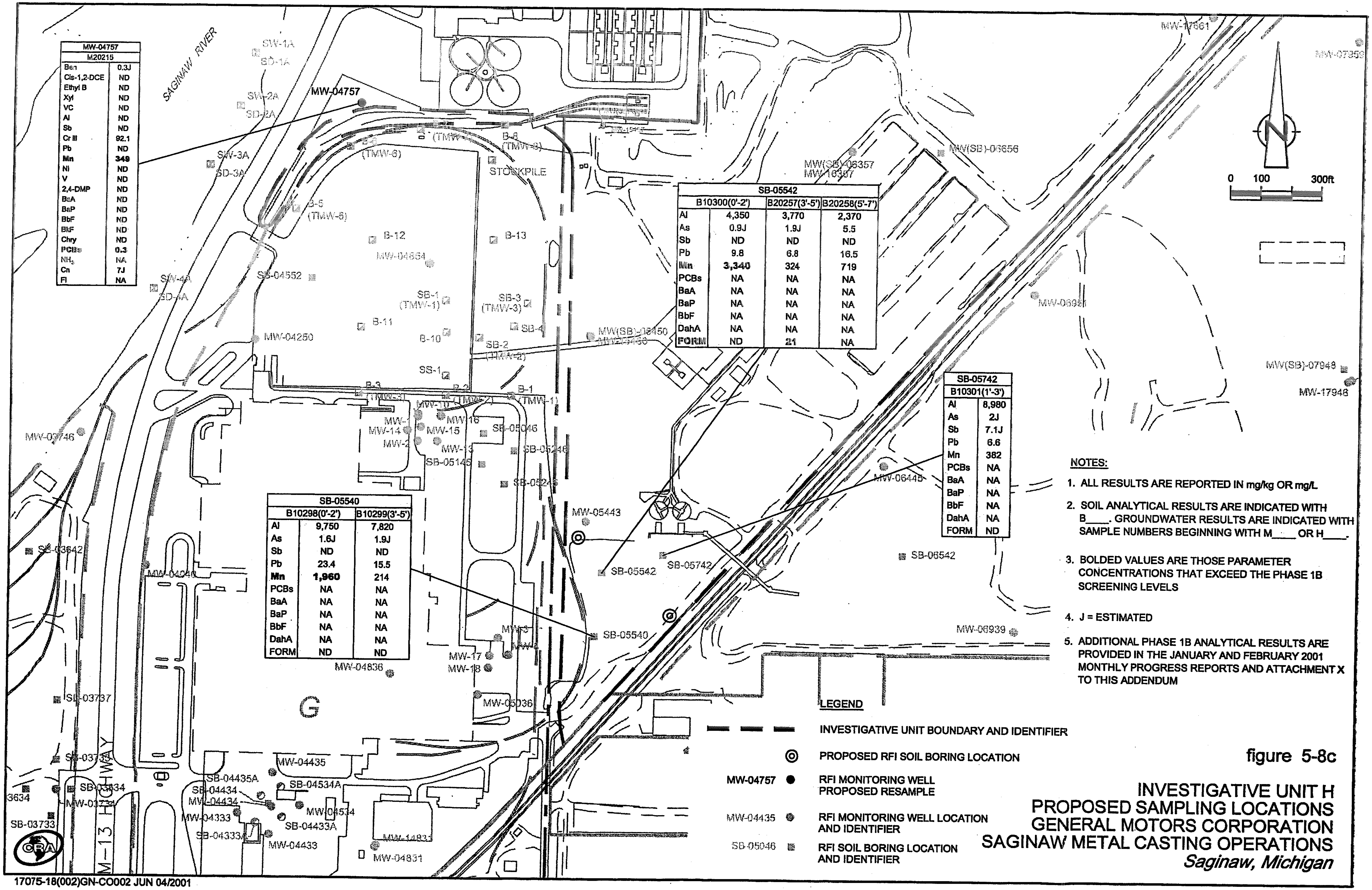
17075-18(002)GN-CO003 JUN 04/2001

FIGURE 6-1


Stairway
Ⓐ • 3
• 4 Ⓒ
• 6 Ⓐ
Column
• 4
• 4
• 3
0 •
Ⓗ
Ⓒ • 3
Ⓐ
Ⓙ
• 28
• 5
• 31
70
1
Barricade
• 4
N
Ⓓ
Ⓔ
Ⓕ
UNEXCAVATED AREA
2
⊗ • 0
Ⓑ
Ⓙ
3
⊗
• 0
9 •
Ⓑ • 0
⊗
4
• PPM of AMMONIA MEASURED using DRAEGER TUBE
DRAEGER TUBE MEASUREMENTS :
Ⓐ NITROGEN OXIDE = 0 ppm
Ⓑ NITROGEN OXIDE = TRACE ppm
Ⓒ HYDROCARBONS = 0 ppm
Ⓓ HYDROGEN SULFIDE = 0 ppm
Ⓔ ARSINE = 0 ppm
Ⓕ PHOSPHINE = 0 ppm
Ⓖ CARBON MONOXIDE = 0 ppm
Ⓗ CARBON MONOXIDE = 2 ppm
Ⓙ CHARCOAL TUBE AIR SAMPLES
⊗ LEAK SITES 1 - 4
RMT INC.
Dwn. By: TGK
Date: 9-4-87
Proj.# 1073.09

ATTACHMENT VIII

Figure 5-8c



MW-04757	
M20215	
Ben	0.3J
Cis-1,2-DCE	ND
Ethyl B	ND
Xyl	ND
VC	ND
Al	ND
Sb	ND
Cr III	92.1
Pb	ND
Mn	**349**
Ni	ND
V	ND
2,4-DMP	ND
BaA	ND
BaP	ND
BbF	ND
BkF	ND
Chry	ND
PCBs	**0.3**
NH_3	NA
Cn	7J
Fl	NA

SB-05542			
	B10300(0'-2')	B20257(3'-5')	B20258(5'-7')
Al	4,350	3,770	2,370
As	0.9J	1.9J	5.5
Sb	ND	ND	ND
Pb	9.8	6.8	16.5
Mn	**3,340**	324	719
PCBs	NA	NA	NA
BaA	NA	NA	NA
BaP	NA	NA	NA
BbF	NA	NA	NA
DahA	NA	NA	NA
FORM	ND	**21**	NA

SB-05742	
	B10301(1'-3')
Al	8,980
As	2J
Sb	7.1J
Pb	6.6
Mn	382
PCBs	NA
BaA	NA
BaP	NA
BbF	NA
DahA	NA
FORM	ND

SB-05540		
	B10298(0'-2')	B10299(3'-5')
Al	9,750	7,820
As	1.6J	1.9J
Sb	ND	ND
Pb	23.4	15.5
Mn	**1,960**	214
PCBs	NA	NA
BaA	NA	NA
BaP	NA	NA
BbF	NA	NA
DahA	NA	NA
FORM	ND	ND

NOTES:

1. ALL RESULTS ARE REPORTED IN mg/kg OR mg/L
2. SOIL ANALYTICAL RESULTS ARE INDICATED WITH B____. GROUNDWATER RESULTS ARE INDICATED WITH SAMPLE NUMBERS BEGINNING WITH M____ OR H____.
3. BOLDED VALUES ARE THOSE PARAMETER CONCENTRATIONS THAT EXCEED THE PHASE 1B SCREENING LEVELS
4. J = ESTIMATED
5. ADDITIONAL PHASE 1B ANALYTICAL RESULTS ARE PROVIDED IN THE JANUARY AND FEBRUARY 2001 MONTHLY PROGRESS REPORTS AND ATTACHMENT X TO THIS ADDENDUM

LEGEND

— — —	INVESTIGATIVE UNIT BOUNDARY AND IDENTIFIER
◎	PROPOSED RFI SOIL BORING LOCATION
MW-04757 ●	RFI MONITORING WELL PROPOSED RESAMPLE
MW-04435 ●	RFI MONITORING WELL LOCATION AND IDENTIFIER
SB-05046 ▨	RFI SOIL BORING LOCATION AND IDENTIFIER

figure 5-8c

INVESTIGATIVE UNIT H
PROPOSED SAMPLING LOCATIONS
GENERAL MOTORS CORPORATION
SAGINAW METAL CASTING OPERATIONS
Saginaw, Michigan

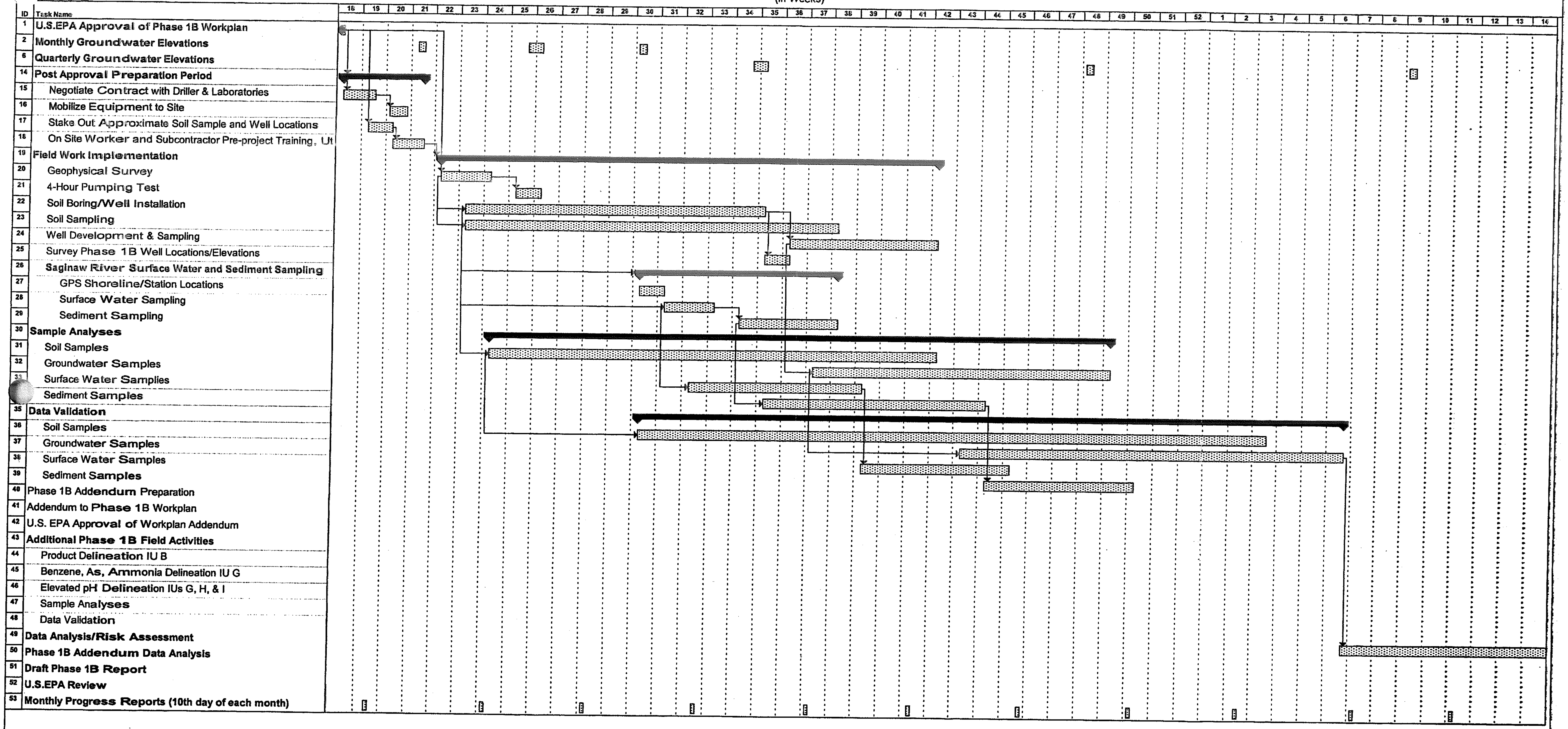
CRA

17075-18(002)GN-CO002 JUN 04/2001

ATTACHMENT IX

Revised Figure 5-14

GM Saginaw Metal Castings Operation
Phase 1B Workplan Implementation
(in Weeks)



ID	Task Name
1	U.S.EPA Approval of Phase 1B Workplan
2	Monthly Groundwater Elevations
6	Quarterly Groundwater Elevations
14	Post Approval Preparation Period
15	Negotiate Contract with Driller & Laboratories
16	Mobilize Equipment to Site
17	Stake Out Approximate Soil Sample and Well Locations
18	On Site Worker and Subcontractor Pre-project Training, Ut
19	Field Work Implementation
20	Geophysical Survey
21	4-Hour Pumping Test
22	Soil Boring/Well Installation
23	Soil Sampling
24	Well Development & Sampling
25	Survey Phase 1B Well Locations/Elevations
26	Saginaw River Surface Water and Sediment Sampling
27	GPS Shoreline/Station Locations
28	Surface Water Sampling
29	Sediment Sampling
30	Sample Analyses
31	Soil Samples
32	Groundwater Samples
33	Surface Water Samples
34	Sediment Samples
35	Data Validation
36	Soil Samples
37	Groundwater Samples
38	Surface Water Samples
39	Sediment Samples
40	Phase 1B Addendum Preparation
41	Addendum to Phase 1B Workplan
42	U.S. EPA Approval of Workplan Addendum
43	Additional Phase 1B Field Activities
44	Product Delineation IU B
45	Benzene, As, Ammonia Delineation IU G
46	Elevated pH Delineation IUs G, H, & I
47	Sample Analyses
48	Data Validation
49	Data Analysis/Risk Assessment
50	Phase 1B Addendum Data Analysis
51	Draft Phase 1B Report
52	U.S.EPA Review
53	Monthly Progress Reports (10th day of each month)

Project: 84068-063.009
Date: Mon 6/4/01

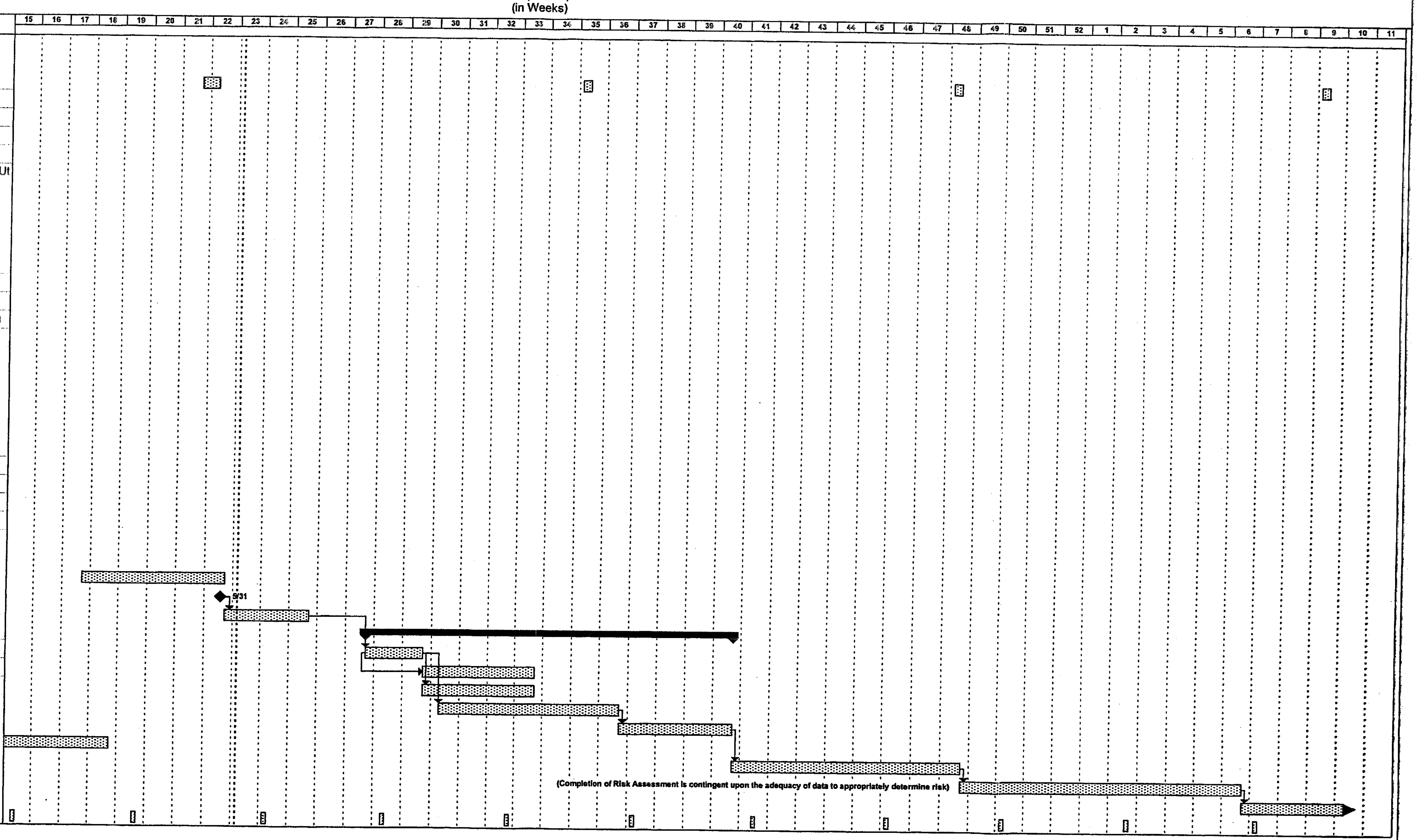
Task	▨	Milestone	◆	Rolled Up Task	▨	Rolled Up Progress	■	Project Summary	▬
Progress	■	Summary	▬	Rolled Up Milestone	◇	External Tasks	▨	Split	....
								Rolled Up Split	....

Figure 5_14 Rev3.MPP
Mon 6/4/01

FIGURE 5-14

GM Saginaw Metal Castings Operation
Phase 1B Workplan Implementation
(in Weeks)

ID	Task Name
1	**U.S.EPA Approval of Phase 1B Workplan**
2	**Monthly Groundwater Elevations**
6	**Quarterly Groundwater Elevations**
14	**Post Approval Preparation Period**
15	Negotiate Contract with Driller & Laboratories
16	Mobilize Equipment to Site
17	Stake Out Approximate Soil Sample and Well Locations
18	On Site Worker and Subcontractor Pre-project Training, Ut
19	**Field Work Implementation**
20	Geophysical Survey
21	4-Hour Pumping Test
22	Soil Boring/Well Installation
23	Soil Sampling
24	Well Development & Sampling
25	Survey Phase 1B Well Locations/Elevations
26	**Saginaw River Surface Water and Sediment Sampling**
27	GPS Shoreline/Station Locations
28	Surface Water Sampling
29	Sediment Sampling
30	**Sample Analyses**
31	Soil Samples
32	Groundwater Samples
33	Surface Water Samples
	Sediment Samples
35	**Data Validation**
36	Soil Samples
37	Groundwater Samples
38	Surface Water Samples
39	Sediment Samples
40	Phase 1B Addendum Preparation
41	Addendum to Phase 1B Workplan
42	U.S. EPA Approval of Workplan Addendum
43	**Additional Phase 1B Field Activities**
44	Product Delineation IU B
45	Benzene, As, Ammonia Delineation IU G
46	Elevated pH Delineation IUs G, H, & I
47	Sample Analyses
48	Data Validation
49	**Data Analysis/Risk Assessment**
50	**Phase 1B Addendum Data Analysis**
51	**Draft Phase 1B Report**
52	**U.S.EPA Review**
53	**Monthly Progress Reports (10th day of each month)**



Project: 84068-063.009
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Task	▨	Milestone	◆	Rolled Up Task	▨	Rolled Up Progress	▬	Project Summary	▬	Rolled Up Split	....
Progress	▬	Summary	▬	Rolled Up Milestone	◇	External Tasks	▨	Split	....		

Figure 5_14 Rev3.MPP
Mon 6/4/01

FIGURE 5-14

ATTACHMENT X

Soil and Groundwater Phase 1B Screening Results