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MEMORANDUM

Sent via email

TO:	Dave Favero/Grant Trigger/Bryan Rose	REF. NO.:	012610
FROM:	Michael Tomka/Alan Weston/Sophia Dore/ev/3	DATE:	December 22, 2011
RE:	**Interim Memo - Groundwater and Storm Water Treatment System Technology Assessment and Laboratory Treatability Study RACER Facility, Bay City, Michigan**		

INTRODUCTION

As a result of the General Motors Corporation (GMC) bankruptcy in 2009, the General Motors Power Train (GMPT) Bay City Plant property located in Bay City, Michigan is being/has been divided between Revitalizing Auto Communities Environmental Response (RACER), which is now responsible for the former Machine Storage Area (MSA) and former Crotty Street Channel (CSC) (Site), and General Motors LLC (GM LLC) is responsible for the remainder of the property. The existing remediation system is also being divided, which will require RACER to pursue independent groundwater treatment and possibly associated discharge permitting. Compounds exceeding criteria in the RACER groundwater stream include metals (arsenic, barium, mercury, and thallium), dioxins, ammonia, polychlorinated biphenyls (PCB), and low levels of volatile organic compounds (VOCs).

A treatability study is currently underway to determine how groundwater from the RACER property can best be treated for discharge to the Saginaw River or City of Bay City Publicly Owned Treatment Works (POTW). This memo contains a summary of results obtained to date from the treatability study.

TREATABILITY STUDY SUMMARY

Sample Acquisition

A sample of groundwater was used for this testing. The sample consisted of water from the CSC System and the MSA System. For the CSC System, 27.5 gallons of water were collected from EW-14. For the MSA System, 7 gallons were collected from each of EW-6, EW-10, and EW-12; 1.5 gallons were collected from each of EW-7 and EW-9; and 1.75 gallons were collected from each of EW-8 and EW-11. The water was shipped to Conestoga-Rovers & Associates' (CRA's) laboratory in Niagara Falls, New York by ground freight and received September 7 and 8, 2011.

Task 1: Initial Characterization

An initial analysis of the water sample was performed. The pH of the water was 7.2 pH units, which is close to neutral. The water contained total suspended solids (TSS) of 223 milligrams per liter (mg/L) and total dissolved solids (TDS) of 976 mg/L. Ammonia-nitrogen was present at 11.4 mg/L. Total and iron

bacterial microbial counts in the water were both greater than 10^4 colony forming units (CFU) per milliliters (mL), which is very high. The water contained low levels of VOC including cis-1,2-dichloroethylene and xylenes. The water also contained PCB Aroclor 1242 at 2.7 micrograms per liter (µg/L). Metals present at concentrations higher than the Rule 57 criteria included arsenic at 28 µg/L, cadmium at 10 µg/L, chromium at 254 µg/L, lead at 140 µg/L, mercury at 2.3 µg/L, and thallium at 31 µg/L. These data are shown in Table 1.

In the first stage of this study, aeration and settling testing, PACT® testing, and bubble accelerated filtration (BAF) testing were performed.

Task 2. Aeration and Settling Test

The effectiveness of aeration followed by settling for removing contaminants of concern was tested. Subsamples of water were aerated for 0.5 hour, 2 hours, and 4 hours using an air stone. Aeration produced a non-gelatinous solid that settled quickly and was easy to filter. After aeration, solids were allowed to settle for 30 minutes and the supernatants were analyzed.

The aeration and setting treatment resulted in the removal of 80-84 percent of the PCB (Aroclor 1242). Arsenic, cadmium, lead, mercury, and thallium were removed to non-detect levels. However, the detection limits were too high to show whether the treated water would meet Rule 57 criteria. Greater than 98 percent removal of chromium was also observed, which decreased the chromium concentration to below Rule 57 criteria. These data are shown in Table 2.

Task 3. PACT® Testing

PACT® was simulated in the lab. A jar containing powdered carbon and an active microbial population was set up. Once the microbial population was established, a sample of the water was added such that 25 grams (g) of powdered carbon per liter of water were present in the sample. Subsamples were withdrawn after 4, 8, and 24 hours. Solids were settled in the withdrawn subsamples, and the supernatant water was analyzed for ammonia, TDS, TSS, PCB, and metals.

The PACT® treatment resulted in the removal of 91-93 percent of the Aroclor 1242 and up to 92 percent of the ammonia. Arsenic, cadmium, chromium, lead, and thallium were all removed to low or non-detect levels. However, the detection limits were too high to show whether the treated water would meet Rule 57 criteria. Removal of mercury was not observed. These data are shown in Table 3.

Task 4: BAF Testing

BAF treatment was simulated in the lab by first sparging a subsample of water at a high sparge rate to float particles to the top of the sample attached to bubbles. BAF treatment was not successful in the initial tests because the formation of foam did not occur. The BAF test was repeated using smaller bubbles; however, the formation of floating foam was not observed. The formation of foam is required for BAF treatment to be successful since the particles adhere to the foam and are floated out of the water. The tests showed that BAF treatment is not suitable for treatment of the water.

Additional Evaluation

The aeration and settling treatment and the PACT treatment produced good results. However, the decision on whether they were effective enough to be considered for full-scale implementation was dependent on the discharge criteria, either for discharge to a Publicly Owned Treatment Works (POTW) or for direct discharge to a surface water body. The POTW and National Pollutant Discharge Elimination System (NPDES) limits require PCB be at non-detect levels in the discharge. The method detection limit for United States Environmental Protection Agency (USEPA) Method 8082A is 0.065 part per billion (ppb); therefore, neither the PACT treatment or aeration and settling met the discharge criteria. Therefore, additional testing was proposed which included testing of a 20-micron filter and the use of Granular Activated Carbon (GAC).

Task 5. Filtration Test

The next phase of the treatability study was performed considering aeration of the water for 24 hours followed by filtration through a 20-micron filter. PCB results indicated that Aroclor 1242 concentrations of less than 0.02 ppb, which are below the USEPA Method 8082A detection limit of 0.065 ppb and, therefore, met the POTW and NPDES discharge requirements. In addition, filtration removed 60 percent of the arsenic. The residual arsenic concentrations were slightly above Rule 57 levels. Ninety-seven percent of the chromium was removed and, therefore, chromium met the Rule 57 criteria. Cadmium, lead, mercury, and thallium were removed to non-detect levels. However, their detection limits were too high to determine whether the treated water met Rule 57 criteria. These data are shown in Table 4.

Task 6. Carbon Column Tests

Testing of GAC was performed using a glass column packed with GAC. The water was aerated and the solids settled prior to running through the column. Preliminary results are shown in Table 6 and indicated that effluent from the GAC column contained Aroclor 1242 concentrations of less than 0.02 µg/L, which were below the USEPA Method 8082A detection limit of 0.065 ppb and met discharge requirements. These data are shown in Table 5. Metals analysis on this water sample is pending.

SUMMARY TO DATE

The results of the testing to date show that:

- Aeration and settling resulted in the removal of 80-84 percent of the PCB (Aroclor 1242). PCB removal was not sufficient to achieve the target concentration of less than 0.065 µg/L
- PACT® treatment resulted in the removal of up to 93 percent of the Aroclor 1242, which was not sufficient to achieve the target concentration of less than 0.065 µg/L
- BAF treatment was not appropriate for the groundwater because formation of a foam did not occur
- Aeration followed by filtration through a 20-micron filter resulted in Aroclor 1242 concentrations of less than 0.02 µg/L
- Aeration followed by treatment with GAC resulted in Aroclor 1242 concentrations of less than 0.02 µg/L

- For aeration and settling, PACT® treatment, filtration, and GAC treatment, metals removal was observed; however, the detection limits used were too high to show whether the treated water met Rule 57 criteria

WORK IN PROGRESS

Task 6: Carbon Column Test without Filtration

Metals analysis on this water sample is in progress.

Task 7: Longevity Testing

The longevity testing as described in the work plan is in progress. The longevity test will determine whether clogging or fouling of the filter and/or GAC by iron bacteria will occur. The testing in progress will determine the longevity of:

- A 20-micron bag filter treating aerated water
- A GAC vessel treating aerated water
- A GAC vessel treating water aerated and pre-filtered through a 20-micron bag filter

A low levels metals analysis will be performed on effluent from the most successful treatment so that final metals concentrations with respect to Rule 57 criteria can be determined.

Once the treatment process steps are confirmed, optimization testing may be required to determine parameters such as the amount and quality of the solids produced and optimal aeration times. This optimization will be performed as the next phase of this study.

Please contact Alan or me if you have any questions about this summary.

TABLE 1

INITIAL GROUNDWATER CHARACTERIZATION
LABORATORY TREATABILITY STUDY
RACER: BAY CITY
BAY COUNTY, MICHIGAN

Parameters	*Units*	*Rule 57 Value*	*Representative Groundwater Sample (Influent)*	*River 100'*	*River 200'*	*Representative Stormwater Sample*
General Chemistry						
pH	S.U.		7.15	8.44 J/8.42 J	8.44 J	7.39
Total Suspended Solids	mg/L		223	20/18	11	ND(4.0)
Total Dissolved Solids	mg/L		976	510/510	490	260
Ammonia-Nitrogen	mg/L		11.4	ND(0.21)/ND(0.22)	ND(0.21)	0.069 J
Total Aerobic Microbial Counts	CFUs		34400	-	-	-
Iron Specific Microbial Counts	CFUs		54400	-	-	-
Biochemical Oxygen Demand (BOD)	mg/L		56	ND(2.0)/ND(2.0)	ND(2.0)	ND(2.0)
Chemical Oxygen Demand (COD)	mg/L		200	37/40	61	20
Volatile Organic Compounds						
cis-1,2-Dichloroethene	mg/L	880	2.58	ND (1)/ND(1)	ND (1)	ND (1)
trans-1,2-Dichloroethene	mg/L	470	ND (2)	ND (1)/ND(1)	ND (1)	ND (1)
Ethylbenzene	mg/L	110	1.33 J	ND (1)/ND(1)	ND (1)	ND (1)
Toluene	mg/L	270	ND (2)	0.13 J/0.2 J	ND (1)	ND (1)
Vinyl Chloride	mg/L	13	2.58 J	ND (1)/ND(1)	ND (1)	ND (1)
m/p-Xylenes	mg/L	370	3.52	ND/ND	ND	ND
o-Xylene	mg/L		2.08	ND/ND	ND	ND
Polychlorinated biphenyls (PCB)						
Aroclor 1242	mg/L		2.72	0.16 J/ND(0.19)	ND (0.19)	ND (0.19)
Metals						
Aluminum	mg/L		331	220 J/570 J	310	ND(50)
Antimony	mg/L	1.7	ND (40)	0.55 J/0.38 J	0.52 J	0.20 J
Arsenic	mg/L	10	27.9 J	3.4 J/3.3 J	3.3 J	ND(5.0)
Barium	mg/L	1900	809.7	50 J/51 J	51 J	22 J
Beryllium	mg/L	160	0.687 J	ND (1)/ND(1)	ND (1)	ND (1)
Cadmium	mg/L	2.5	9.98 J	ND (1)/ND(1)	ND (1)	ND (1)
Calcium	mg/L		196000	63000/62000	63000	70000
Chromium	mg/L	120	254	ND (10)/0.77 J	ND (10)	ND(10)
Cobalt	mg/L	100	22.1	0.38 J/0.42 J	0.35 J	0.12 J
Copper	mg/L	470	26.9	2.6 J/2.3 J	2.0 J	2.5 J
Iron	mg/L		79200	360/570	370	1000
Lead	mg/L	14	140	0.50 J/0.57 J	0.43 J	ND(3.0)
Lithium	mg/L	720	14.9 J			
Magnesium	mg/L		36800	21000/21000	21000	11000
Manganese	mg/L	1300	820	43 J/43 J	40 J	ND(50)
Mercury	mg/L	0.0018	2.27 J	0.0013 J/0.0011 J	0.00088 J	0.00084
Molybdenum	mg/L	120	7.69			
Nickel	mg/L	2600	143	1.8 J/2.1 J	1.8 J	0.43 J
Potassium	mg/L		15700			
Selenium	mg/L	120	ND (50)	ND(5)/ND(5)	ND(5)	2.5 J
Silver	mg/L	130	2.22 J	ND(0.2)/ND(0.2)	ND(0.2)	ND(0.2)

TABLE 1

INITIAL GROUNDWATER CHARACTERIZATION
LABORATORY TREATABILITY STUDY
RACER: BAY CITY
BAY COUNTY, MICHIGAN

Parameters	*Units*	*Rule 57 Value*	*Representative Groundwater Sample (Influent)*	*River 100'*	*River 200'*	*Representative Stormwater Sample*
Metals - Continued						
Sodium	mg/L		48200	68000/68000	68000	1400
Strontium	mg/L	21,000	1070			
Thallium	mg/L	1.2	30.9	2/ND(2)	1.5 J	0.24 J
Vanadium	mg/L	53	7.13 J	1.4 J/2.5 J	1.7 J	0.46 J
Zinc	mg/L	3300	311	ND(50)/ND(50)	ND(50)	2.5 J
Dissolved Metals						
Dissolved Aluminum	mg/L		79.8			
Dissolved Antimony	mg/L	1.7	ND (40)			
Dissolved Arsenic	mg/L	10	10.2			
Dissolved Barium	mg/L	1900	429			
Dissolved Beryllium	mg/L	160	0.693 J			
Dissolved Cadmium	mg/L	2.5	3.34 J			
Dissolved Calcium	mg/L		193000			
Dissolved Chromium	mg/L	120	0.127 J			
Dissolved Cobalt	mg/L	100	4.69			
Dissolved Copper	mg/L	470	2.79			
Dissolved Iron	mg/L		2820	ND(100)/ND(100)	150	
Dissolved Lead	mg/L	14	ND (125)			
Dissolved Lithium	mg/L	720	10.3			
Dissolved Magnesium	mg/L		37500			
Dissolved Manganese	mg/L	1300	655			
Dissolved Mercury	mg/L	0.0018	26.2			
Dissolved Molybdenum	mg/L	120	2.22			
Dissolved Nickel	mg/L	2600	ND (10)			
Dissolved Potassium	mg/L		15800			
Dissolved Selenium	mg/L	120	27.2			
Dissolved Silver	mg/L	130	1.00 J			
Dissolved Sodium	mg/L		57200			
Dissolved Strontium	mg/L	21,000	982			
Dissolved Thallium	mg/L	1.2	26.5			
Dissolved Vanadium	mg/L	53	1.73 J			
Dissolved Zinc	mg/L	3300	16.5 J			

Notes:

J - Estimated results
- Exceeds Rule 57 criteria
- > USEPA Method 8082A detection limit for PCBs (0.065 ppb)

TABLE 2

TREATMENT OF GROUNDWATER BY AERATION AND SETTLING
LABORATORY TREATABILITY STUDY
RACER: BAY CITY
BAY COUNTY, MICHIGAN

Parameters	*Units*	*Rule 57 Value*	*Untreated*	*0.5hr Aeration*	*2hr Aeration*	*4hr Aeration*
Polychlorinated biphenyls (PCB)						
Aroclor 1242	mg/L		2.72	0.470	0.540	0.440
General Chemistry						
Total Suspended Solids (TSS)	mg/L		223	33.0	72.0	75.0
Metals						
Aluminum	mg/L		331	151 J	89.3 J	24.9 J
Antimony	mg/L	1.7	ND (40)	ND (40)	ND (40)	ND (40)
Arsenic	mg/L	10	27.9 J	ND (50)	ND (50)	ND (50)
Barium	mg/L	1900	809.7	395	399	346
Beryllium	mg/L	160	0.687 J	0.813 J	0.829 J	0.821 J
Cadmium	mg/L	2.5	9.98 J	ND (37.5)	ND (37.5)	ND (37.5)
Calcium	mg/L		196000	168000	126000	80600
Chromium	mg/L	120	254	0.697 J	3.92 J	0.525 J
Cobalt	mg/L	100	22.1	1.38 J	1.49 J	2.42 J
Copper	mg/L	470	26.9	ND (20)	1.56 J	0.013 J
Iron	mg/L		79200	10100	17500	20600
Lead	mg/L	14	140	ND (125)	ND (125)	ND (125)
Lithium	mg/L	720	14.9 J	ND (50)	ND (50)	ND (50)
Magnesium	mg/L		36800	36900	38800	38100
Manganese	mg/L	1300	820	388	277	124
Mercury	mg/L	0.0018	2.27 J	1.39 J	1.06 J	ND (30)
Molybdenum	mg/L	120	7.69	3.92 J	1.54 J	0.819 J
Nickel	mg/L	2600	143	ND (10)	ND (10)	ND (10)
Potassium	mg/L		15700	14400	15400	17900
Selenium	mg/L	120	ND (50)	ND (50)	ND (50)	ND (50)
Silver	mg/L	130	2.22 J	15.6 J	7.18 J	13.7 J
Sodium	mg/L		48200	101000	106000	109000
Strontium	mg/L	21,000	1070	991	923	768
Thallium	mg/L	1.2	30.9	ND (40)	ND (40)	ND (40)
Vanadium	mg/L	53	7.13 J	1.39 J	3.56 J	2.14 J
Zinc	mg/L	3300	311	57.7	83.1	96.1
Dissolved Metals						
Dissolved Aluminum	mg/L		79.8	81.9	54.1	37.9 J
Dissolved Antimony	mg/L	1.7	ND (40)	5.55 J	7.98 J	12.8 J
Dissolved Arsenic	mg/L	10	10.2	6.06 J	13.2 J	16.9 J
Dissolved Barium	mg/L	1900	429	343	234	171
Dissolved Beryllium	mg/L	160	0.693 J	0.586 J	0.606 J	0.599 J
Dissolved Cadmium	mg/L	2.5	3.34 J	1.66 J	1.80 J	2.58 J
Dissolved Calcium	mg/L		193000	175000	118000	66400
Dissolved Chromium	mg/L	120	0.127 J	ND (10)	1.18 J	ND (10)
Dissolved Cobalt	mg/L	100	4.69	ND (20)	0.861 J	ND (20)

TABLE 2

TREATMENT OF GROUNDWATER BY AERATION AND SETTLING
LABORATORY TREATABILITY STUDY
RACER: BAY CITY
BAY COUNTY, MICHIGAN

Parameters	*Units*	*Rule 57 Value*	*Untreated*	*0.5hr Aeration*	*2hr Aeration*	*4hr Aeration*
Dissolved Metals (cont'd)						
Dissolved Copper	mg/L	470	2.79	ND (20)	ND (20)	ND (20)
Dissolved Iron	mg/L		2820	31.0 J	25.7 J	27.3 J
Dissolved Lead	mg/L	14	ND (125)	ND (125)	ND (125)	ND (125)
Dissolved Lithium	mg/L	720	10.3	39.7	28.5	39.6
Dissolved Magnesium	mg/L		37500	40800	38100	38500
Dissolved Manganese	mg/L	1300	655	368	104	29.3
Dissolved Mercury	mg/L	0.0018	26.2	ND (30)	ND (30)	2.51 J
Dissolved Molybdenum	mg/L	120	2.22	2.63 J	1.08 J	3.58 J
Dissolved Nickel	mg/L	2600	ND (10)	ND (10)	ND (10)	ND (10)
Dissolved Potassium	mg/L		15800	17300	17400	14300
Dissolved Selenium	mg/L	120	27.2	2.17 J	ND (50)	4.37 J
Dissolved Silver	mg/L	130	1.00 J	0.521 J	1.43 J	0.935 J
Dissolved Sodium	mg/L		57200	67800	108000	55500
Dissolved Strontium	mg/L	21,000	982	1050	903	692
Dissolved Thallium	mg/L	1.2	26.5	21.8 J	20.9 J	25.8 J
Dissolved Vanadium	mg/L	53	1.73 J	ND (20)	ND (20)	0.199 J
Dissolved Zinc	mg/L	3300	16.5 J	2.74 J	2.19 J	1.68 J

Notes:

J - Estimated results
- Exceeds Rule 57 criteria
- > USEPA Method 8082A detection limit for PCBs (0.065 ppb)

TABLE 3

TREATMENT OF GROUNDWATER BY PACT TESTING
LABORATORY TREATABILITY STUDY
RACER: BAY CITY
BAY COUNTY, MICHIGAN

Parameters	*Units*	*Rule 57 Value*	*Untreated*	*4hr*	*8hr*	*24hr*
Polychlorinated biphenyls (PCB)						
Aroclor 1242	mg/L		2.72	0.230	0.240	0.200
General Chemistry						
Total Suspended Solids (TSS)	mg/L		223	22.0	3.00	10.0
Total Dissolved Solids (TDS)	mg/L		976	856	843	766
Ammonia-Nitrogen	mg/L		11.4	0.840	2.18	0.840
Total Metals						
Aluminum	mg/L		331	115	112	80.9
Antimony	mg/L	1.7	ND (40)	ND (40)	ND (40)	ND (40)
Arsenic	mg/L	10	27.9 J	ND (50)	2.22 J	12.6 J
Barium	mg/L	1900	809.7	289	308	257
Beryllium	mg/L	160	0.687 J	ND (12.5)	ND (12.5)	ND (12.5)
Cadmium	mg/L	2.5	9.98 J	ND (37.5)	ND (37.5)	ND (37.5)
Calcium	mg/L		196000	138000	145000	118000
Chromium	mg/L	120	254	ND (10)	ND (10)	0.721 J
Cobalt	mg/L	100	22.1	ND (20)	ND (20)	0.234 J
Copper	mg/L	470	26.9	1.49 J	2.33 J	ND (20)
Iron	mg/L		79200	367	194	142
Lead	mg/L	14	140	ND (125)	ND (125)	ND (125)
Lithium	mg/L	720	14.9 J	25.8 J	31.4	32.6
Magnesium	mg/L		36800	33100	36200	35100
Manganese	mg/L	1300	820	284	297	147
Mercury	mg/L	0.0018	2.27 J	4.30	6.04	4.23 J
Molybdenum	mg/L	120	7.69	1.88 J	2.73 J	3.03 J
Nickel	mg/L	2600	143	ND (10)	ND (10)	ND (10)
Potassium	mg/L		15700	13900	16500	14500
Selenium	mg/L	120	ND (50)	ND (50)	ND (50)	ND (50)
Silver	mg/L	130	2.22 J	ND (10)	ND (10)	0.379 J
Sodium	mg/L		48200	77900	82100	80100
Strontium	mg/L	21,000	1070	866	952	863
Thallium	mg/L	1.2	30.9	ND (40)	ND (40)	ND (40)
Vanadium	mg/L	53	7.13 J	ND (20)	ND (20)	ND (20)
Zinc	mg/L	3300	311	32.9	37.4	29.5
Dissolved Metals						
Dissolved Aluminum	mg/L		79.8	76.9	76.1	62.2
Dissolved Antimony	mg/L	1.7	ND (40)	ND (40)	ND (40)	ND (40)
Dissolved Arsenic	mg/L	10	10.2	5.64 J	2.84 J	6.64
Dissolved Barium	mg/L	1900	429	294	289	254
Dissolved Beryllium	mg/L	160	0.693 J	ND (12.5)	ND (12.5)	ND (12.5)
Dissolved Cadmium	mg/L	2.5	3.34 J	ND (37.5)	ND (37.5)	0.451 J
Dissolved Calcium	mg/L		193000	149000	152000	116000
Dissolved Chromium	mg/L	120	0.127 J	ND (10)	ND (10)	ND (10)
Dissolved Cobalt	mg/L	100	4.69	ND (20)	0.348 J	0.918 J
Dissolved Copper	mg/L	470	2.79	ND (20)	ND (20)	ND (20)
Dissolved Iron	mg/L		2820	6.24 J	2.24 J	2.42 J

TABLE 3

TREATMENT OF GROUNDWATER BY PACT TESTING
LABORATORY TREATABILITY STUDY
RACER: BAY CITY
BAY COUNTY, MICHIGAN

Parameters	*Units*	*Rule 57 Value*	*Untreated*	*4hr*	*8hr*	*24hr*
Dissolved Metals (cont'd)						
Dissolved Lead	mg/L	14	ND (125)	ND (125)	ND (125)	ND (125)
Dissolved Lithium	mg/L	720	10.3	25.3 J	31.8	26.6 J
Dissolved Magnesium	mg/L		37500	35600	24700	35400
Dissolved Manganese	mg/L	1300	655	307	287	143
Dissolved Mercury	mg/L	0.0018	26.2	ND (30)	ND (30)	4.74
Dissolved Molybdenum	mg/L	120	2.22	3.04 J	4.56 J	4.91 J
Dissolved Nickel	mg/L	2600	ND (10)	ND (10)	ND (10)	ND (10)
Dissolved Potassium	mg/L		15800	15100	14400	15700
Dissolved Selenium	mg/L	120	27.2	ND (50)	7.71 J	ND (50)
Dissolved Silver	mg/L	130	1.00 J	0.983 J	1.27 J	0.0772 J
Dissolved Sodium	mg/L		57200	85800	83900	82400
Dissolved Strontium	mg/L	21,000	982	931	938	868
Dissolved Thallium	mg/L	1.2	26.5	ND (40)	ND (40)	ND (40)
Dissolved Vanadium	mg/L	53	1.73 J	ND (20)	ND (20)	ND (20)
Dissolved Zinc	mg/L	3300	16.5 J	1.48 J	0.150 J	2.12 J

Notes:

J - Estimated results
- Exceeds Rule 57 criteria
- > USEPA Method 8082A detection limit for PCBs (0.065 ppb)

TABLE 4

TREATMENT OF GROUNDWATER BY AERATION AND FILTRATION
LABORATORY TREATABILITY STUDY
RACER: BAY CITY
BAY COUNTY, MICHIGAN

Parameters	*Units*	*Rule 57 Value*	*Untreated*	*24-hr Aeration and 20µm Filter Paper*
Polychlorinated biphenyls (PCB)				
Aroclor 1242	mg/L		2.72	ND(0.02)
Metals				
Aluminum	mg/L		331	592
Antimony	mg/L	1.7	ND (40)	8.31 J
Arsenic	mg/L	10	27.9 J	11.3 J
Barium	mg/L	1900	809.7	329
Beryllium	mg/L	160	0.687 J	0.259 J
Cadmium	mg/L	2.5	9.98 J	ND (37.5)
Calcium	mg/L		196000	108000
Chromium	mg/L	120	254	7.17
Cobalt	mg/L	100	22.1	1.09 J
Copper	mg/L	470	26.9	12.3
Iron	mg/L		79200	6180
Lead	mg/L	14	140	ND (125)
Lithium	mg/L	720	14.9 J	9.82 J
Magnesium	mg/L		36800	35800
Manganese	mg/L	1300	820	177
Mercury	mg/L	0.0018	2.27 J	ND (30)
Molybdenum	mg/L	120	7.69	2.92 J
Nickel	mg/L	2600	143	ND (10)
Potassium	mg/L		15700	12500
Selenium	mg/L	120	ND (50)	8.02 J
Silver	mg/L	130	2.22 J	ND (10)
Sodium	mg/L		48200	112000
Strontium	mg/L	21,000	1070	867
Thallium	mg/L	1.2	30.9	ND (40)
Vanadium	mg/L	53	7.13 J	6.42 J
Zinc	mg/L	3300	311	71.8

TABLE 4

TREATMENT OF GROUNDWATER BY AERATION AND FILTRATION
LABORATORY TREATABILITY STUDY
RACER: BAY CITY
BAY COUNTY, MICHIGAN

Parameters	*Units*	*Rule 57 Value*	*Untreated*	*24-hr Aeration and 20µm Filter Paper*
Dissolved Metals				
Dissolved Aluminum	mg/L		79.8	115
Dissolved Antimony	mg/L	1.7	ND (40)	29.9
Dissolved Arsenic	mg/L	10	10.2	21.1 J
Dissolved Barium	mg/L	1900	429	310
Dissolved Beryllium	mg/L	160	0.693 J	0.241 J
Dissolved Cadmium	mg/L	2.5	3.34 J	ND (37.5)
Dissolved Calcium	mg/L		193000	109000
Dissolved Chromium	mg/L	120	0.127 J	0.824 J
Dissolved Cobalt	mg/L	100	4.69	4.64 J
Dissolved Copper	mg/L	470	2.79	ND (20)
Dissolved Iron	mg/L		2820	45.4 J
Dissolved Lead	mg/L	14	ND (125)	ND (125)
Dissolved Lithium	mg/L	720	10.3	25.1 J
Dissolved Magnesium	mg/L		37500	35800
Dissolved Manganese	mg/L	1300	655	106
Dissolved Mercury	mg/L	0.0018	26.2	ND (30)
Dissolved Molybdenum	mg/L	120	2.22	2.87 J
Dissolved Nickel	mg/L	2600	ND (10)	ND (10)
Dissolved Potassium	mg/L		15800	14200
Dissolved Selenium	mg/L	120	27.2	ND (50)
Dissolved Silver	mg/L	130	1.00 J	1.04 J
Dissolved Sodium	mg/L		57200	119000
Dissolved Strontium	mg/L	21,000	982	870
Dissolved Thallium	mg/L	1.2	26.5	ND (40)
Dissolved Vanadium	mg/L	53	1.73 J	2.86 J
Dissolved Zinc	mg/L	3300	16.5 J	6.54 J

Notes:

J - Estimated results

- Exceeds Rule 57 criteria

- > USEPA Method 8082A detection limit for PCBs (0.065 ppb)

TABLE 5

TREATMENT OF GROUNDWATER BY AERATION CARBON COLUMN TEST
LABORATORY TREATABILITY STUDY
RACER: BAY CITY
BAY COUNTY, MICHIGAN

Parameters	*Units*	*Rule 57 Value*	*Untreated*	*Aeration, Filtration, and GAC*
Polychlorinated biphenyls (PCB)				
Aroclor 1242	mg/L		2.72	ND(0.02)
Metals				
Aluminum	mg/L		331	(1)
Antimony	mg/L	1.7	ND (40)	(1)
Arsenic	mg/L	10	27.9 J	(1)
Barium	mg/L	1900	809.7	(1)
Beryllium	mg/L	160	0.687 J	(1)
Cadmium	mg/L	2.5	9.98 J	(1)
Calcium	mg/L		196000	(1)
Chromium	mg/L	120	254	(1)
Cobalt	mg/L	100	22.1	(1)
Copper	mg/L	470	26.9	(1)
Iron	mg/L		79200	(1)
Lead	mg/L	14	140	(1)
Lithium	mg/L	720	14.9 J	(1)
Magnesium	mg/L		36800	(1)
Manganese	mg/L	1300	820	(1)
Mercury	mg/L	0.0018	2.27 J	(1)
Molybdenum	mg/L	120	7.69	(1)
Nickel	mg/L	2600	143	(1)
Potassium	mg/L		15700	(1)
Selenium	mg/L	120	ND (50)	(1)
Silver	mg/L	130	2.22 J	(1)
Sodium	mg/L		48200	(1)
Strontium	mg/L	21,000	1070	(1)
Thallium	mg/L	1.2	30.9	(1)
Vanadium	mg/L	53	7.13 J	(1)
Zinc	mg/L	3300	311	(1)
Dissolved Metals				(1)
Dissolved Aluminum	mg/L		79.8	(1)
Dissolved Antimony	mg/L	1.7	ND (40)	(1)
Dissolved Arsenic	mg/L	10	10.2	(1)
Dissolved Barium	mg/L	1900	429	(1)
Dissolved Beryllium	mg/L	160	0.693 J	(1)
Dissolved Cadmium	mg/L	2.5	3.34 J	(1)
Dissolved Calcium	mg/L		193000	(1)

TABLE 5

TREATMENT OF GROUNDWATER BY AERATION CARBON COLUMN TEST
LABORATORY TREATABILITY STUDY
RACER: BAY CITY
BAY COUNTY, MICHIGAN

Parameters	*Units*	*Rule 57 Value*	*Untreated*	*Aeration, Filtration, and GAC*
Dissolved Metals (cont'd)				(1)
Dissolved Chromium	mg/L	120	0.127 J	(1)
Dissolved Cobalt	mg/L	100	4.69	(1)
Dissolved Copper	mg/L	470	2.79	(1)
Dissolved Iron	mg/L		2820	(1)
Dissolved Lead	mg/L	14	ND (125)	(1)
Dissolved Lithium	mg/L	720	10.3	(1)
Dissolved Magnesium	mg/L		37500	(1)
Dissolved Manganese	mg/L	1300	655	(1)
Dissolved Mercury	mg/L	0.0018	26.2	(1)
Dissolved Molybdenum	mg/L	120	2.22	(1)
Dissolved Nickel	mg/L	2600	ND (10)	(1)
Dissolved Potassium	mg/L		15800	(1)
Dissolved Selenium	mg/L	120	27.2	(1)
Dissolved Silver	mg/L	130	1.00 J	(1)
Dissolved Sodium	mg/L		57200	(1)
Dissolved Strontium	mg/L	21,000	982	(1)
Dissolved Thallium	mg/L	1.2	26.5	(1)
Dissolved Vanadium	mg/L	53	1.73 J	(1)
Dissolved Zinc	mg/L	3300	16.5 J	(1)

Notes:

J - Estimated results
- Exceeds Rule 57 criteria
- > USEPA Method 8082A detection limit for PCBs (0.065 ppb)
(1) Analysis pending