ADVANCED ENVIRONMENTAL, INC.

ENVIRONMENTAL MANAGEMENT CONSULTANTS

352 South Saginaw Street • Suite 600 • Flint, Michigan 48502 • (800) 423-2043 • (810) 238-9190 • Fax (810) 238-9195
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Doc-37

SOIL AND GROUNDWATER FEASIBILITY REPORT
GENERAL MOTORS CORPORATION - TANK FARM 37
902 EAST HAMILTON STREET
FLINT, MICHIGAN

MERA Site ID No. 250075

Advanced Environmental, Inc., Project Number 4124CQ
December 20, 1994

ADVANCED ENVIRONMENTAL, INC.
ENVIRONMENTAL MANAGEMENT CONSULTANTS

December 20, 1994

Mr. Ben Hall
Shiawassee District Office
Michigan Department of Natural Resources
Underground Storage Tank Division
10650 Bennett Road
Morrice, Michigan 48857

RE: SOIL AND GROUNDWATER FEASIBILITY REPORT
General Motors Corporation - Tank Farm 37
902 East Hamilton Street - Flint, Michigan
Advanced Project No. 4124
MERA Site ID No. 250075

Dear Mr. Hall:

Pursuant to the Michigan Leaking Underground Storage Tank Act (LUST), Advanced Environmental, Inc., has prepared this Soil and Groundwater Feasibility Report to remediate the oil and BTEX constituents in the soil and groundwater at the former GM Tank Farm 37 site.

If you have any questions or need further information, please call (810) 238-9190.

Sincerely,

ADVANCED ENVIRONMENTAL, INC.

Constance M. Boris, Ph.D.
Senior Project Engineer

Mark W. Keyes, P.G.
Project Manager

CMB:j

Enclosures

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LEAKING UNDERGROUND STORAGE TANK
REPORT COVER SHEET

Required under the authority of 1988 PA 478, as amended

INSTRUCTIONS: Complete this form with all the applicable information and submit with each report listed below as required. The Certified Underground Storage Tank Professional (CUSTP) MUST sign below. Failure to submit a report within the stated time period may result in Administrative Penalties under Section 11a. **Return all completed forms to the appropriate ERD District Office listed on the back of this form.**

FACILITY NAME:	**General Motors Corporation CLCD Tank Farm 37**	*MUSTFA CLAIM #:*	
ADDRESS:	**902 East Hamilton Street Flint, MI**	*MERA SITE ID #:*	**250075**
O/O NAME:	**General Motors Corporation CLCD North**	*RELEASE DATE:*	**February 16, 1990**
O/O ADDRESS:	**902 East Hamilton Street Flint, MI 48439**	*PHONE NO:*	
CONTACT PERSON:	**Mr. Paul Barth**	*PHONE NO:*	**(810) 236-4220**

REPORT SUBMITTED:

___ Initial Abatement (20 day)
___ Initial Assessment (60 day)
___ Soil Corrective Action Plan (75 day)
___ Soil Feasibility Analysis (150 day)
___ Phase I Hydrogeological Study (150 day)
___ Soil Remediation Corrective Action Plan (210 day)
___ Phase II Hydrogeological Work Plan (210 day)
___ Phase II Hydrogeological Study
_X_ Soil & Groundwater Feasibility Analysis
___ Risk Assessment and Type C Corrective Action Plan
___ Request for Review of Closed Loop System
___ Free Product
___ Release Closure
___ Soil and Groundwater Remediation Corrective Action Plan

COMPLETE FOR ALL REPORTS

1. Free Product Present: Currently? **YES** If YES, total gallons recovered since last report: **5 gallons (estimated)**
   Previously? **YES** If YES, total gallons recovered to date: **Unknown**
2. Has the UST been emptied? **YES**
3. Site identified as a "lower priority" per Sec. 6e? **NO**
4. Distance from point of release to nearest municipal well supply: **N/A** No. of wells impacted: **None**
5. Distance from point of release to nearest private well: **N/A** No. of wells impacted: **None**
   Number of homes where drinking water is impacted: **N/A**
6. Distance from point of release to nearest surface water/wetlands: **1 Mile**
7. Have vapors been identified in any confined spaces (basement, sewers, etc.)? **NO**
8. Estimated cost of proposed investigation or remedy: **$235,000.00**
   (Feasibility Studies, Corrective Action Plans and Hydrogeological Workplans ONLY)
9. What type of technology is being proposed/used as a remedy? **Thermal Desorption**
10. Since last report: Total cu. yards soil remediated: **None** Total gallons groundwater remediated: **Unknown**
11. Projected amount of time required to complete investigation or remedy: **N/A**
12. Date(s) when on-site activities will be conducted: **Summer, 1995**

CERTIFICATION OF REPORT

I, **Mark W. Keyes**, hereby attest to the accuracy of the statements in this document and all
(print CUSTP name)

attachments. I certify that it was submitted to the MDNR on **December 20, 1994**
(date submitted)

[signature] 12/20/94 [signature]

Mark W. Keyes, Project Manager
Interim CUSTP Signature/Date - Required

Constance M. Boris, Ph.D., Sr. Project Engineer
Interim QUSTC Project Manager's Signature/Date

CONSULTANT: Advanced Environmental, Inc. PHONE NO: (810) 238-9190
ADDRESS: 352 South Saginaw Street, Suite 600, Flint, Michigan 48502

REGION I - HEADQUARTERS
Dan Schultz, Regional Supervisor

Marquette District Office
Clif Clark, Supervisor
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Marquette, MI 49855
Telephone: 906-228-6561
Fax: 906-228-5245

Chrystal Falls Field Office
1420 U.S. 2 West
Crystal Falls, MI 49920
Telephone: 906-875-6622
Fax: 906-875-3336

Newberry Field Office
RR#1, S. M-123 near M-28
Newberry, MI 49868
Telephone: 906-293-5131
Fax: 906-293-8728

REGION II - HEADQUARTERS
Dan Schultz, Regional Supervisor
8717 North Roscommon Road
Roscommon, MI 48653
Telephone: 517-275-5151
Fax: 517-275-5167

Cadillac District Office
Dan Darnell, Supervisor
Route #1, 8015 Mackinaw Trail
Cadillac, MI 49601
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John Alford, Supervisor
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Grayling District Office
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Route #3, 1955 North I-75BL
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Saginaw Bay District Office
Brenda Brouillet, Supervisor
503 North Euclid Avenue, Suite 9
Bay City, MI 48706
Telephone: 517-684-9141
Fax: 517-684-9799

REGION III - HEADQUARTERS
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General Office Building - Third Floor
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Grand Rapids District Office
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Jackson District Office
Gary Klepper, Supervisor
Jackson State Office Building
301 East Louis Glick Highway
Jackson, MI 49201
Telephone: 517-780-7900
Fax: 517-780-7855

Plainwell District Office
Linn Duling, Supervisor
1342 M-89, Suite B
Plainwell, MI 49080
Telephone: 616-692-2120
Fax: 616-692-3050

Shiawassee District Office
Rod Mosier, Supervisor
10650 South Bennett Drive
Morrice, MI 48857
Telephone: 517-625-4600
Fax: 517-625-5000

Southeast MI District Office
Dipo Oyinsan, Supervisor
38980 Seven Mile Road
Livonia, MI 48152
Telephone: 313-953-0241
Fax: 313-953-0243

DIVISION OFFICE
Knapps Office Centre
Post Office Box 30426
Lansing, MI 48909
Telephone: 517-373-9837
Fax: 517-373-2637 or
517-373-9657

FOR POLLUTION EMERGENCY
1-800-292-4706

TABLE OF CONTENTS

FIGURES

TABLES

1.0 GENERAL INFORMATION

Name of Site:	General Motors Corporation Tank Farm 37
Site Address:	902 East Hamilton Street Flint, Michigan 48439
Contact Person:	Mr. Paul Barth
Owner/Operator Address:	General Motors Corporation 902 East Hamilton Street Flint, Michigan 48439
MERA Site ID No:	250075
Geographical Location:	The site is located on the south side of Stewart Street and east of Leith Street, just west of the Grand Trunk Western Railroad rail siding. The location of the site is illustrated in Figure 1.

2.0 INTRODUCTION

The purpose of this report is to analyze alternatives for the remediation and/or MERA Type C closure of the former General Motors (GM) Tank Farm 37 (TF37) site.

On February 16, 1990, a confirmed release was reported to the Michigan Department of State Police, Fire Marshal Division (MSP/FMD) for the TF37 site. As a consequence, 17, 12,000-gallon steel underground storage tanks (USTs) containing gasoline, motor oil, hydraulic oil, lube oil, naphtha, and mineral seal were decommissioned (contents removed) in February, 1990, and the tanks were physically removed during the period of April through July, 1991 (Figure 2). Upon removal, two USTs were observed to have holes. Field notes taken during the UST excavation indicated stained soils on the north, west, and east sidewalls. Laboratory results of soil samples collected from the northeast corner of the tank farm indicated significant concentrations of benzene, toluene, ethylbenzene, and xylenes (BTEX) constituents.

3.0 SITE GEOLOGY AND HYDROGEOLOGY

Site geology consists of a surface fill layer varying in thickness from approximately four to 13 feet. The fill is underlain throughout most of the site by a sand unit which extends from the fill interface down to a distance of approximately eight to 12 feet. At soil boring TB-6, the sand unit does not exist and the fill is in contact with a deeper, gray silt layer. The silt layer is present on the site averaging three to five feet in thickness. A clay layer at least five feet thick lies at the TB-6 location beneath the silt layer at a depth of approximately 20 feet below grade.

Groundwater was encountered at variable depths during drilling of test borings and monitoring wells, which is likely due to the discontinuous nature of the soil units and differences in their hydraulic conductivities. The predominant water-bearing unit is the sand layer, which had a thickness ranging from one to 10 feet. Static water levels in the monitoring wells were recorded at an approximate depth of 10 to 11 feet below grade. Based on static water levels from the eight monitoring wells, the groundwater flow is toward the area between the existing and the former tank farms. It appears that this flow direction is controlled by the 30-inch product recovery well installed in 1990, to remove floating free product.

In-situ hydraulic conductivity tests for the silt underlying the uppermost water-bearing unit indicated a value of 0.65 ft/day at location MW-4D and 0.38 ft/day for location MW-10D. The vertical hydraulic conductivity of a Shelby tube sample collected from the lower silty clay layer at TB-10 was 8.5 x 10-5 ft/day.

The former UST area where the tanks were pulled is covered with limestone, thereby allowing this area to act as a recharge area. The surrounding area is covered with either concrete or asphalt. Precipitation, whether from rain or snowfall, surcharges the ground with water. If the product recovery well is being pumped, contaminated groundwater will be moving into the excavated backfill. If the well is not being pumped, it can migrate into the fill underlying the roadway.

4.0 PRELIMINARY ABATEMENT SYSTEM

Free product was found in monitoring wells along the west side of the former tank farm. These wells were removed during the excavation of the tanks. However, to capture free product and maintain hydraulic control, a 30-inch diameter product recovery well, as mentioned earlier, was installed near the southeast corner of the former tank farm, along with infiltration trenches near the east and south sidewalls of the excavation. Subsequent hydrogeological investigations indicated that groundwater flow is influenced by the 30-inch recovery well south of former Tank Farm 37. Based on three sets of static water level data collected from the existing monitoring wells, the groundwater flow is toward a bowl-shaped area between the recovery well and monitoring well Section 2/MW-3, or between the former and the new tank farm.

Eight additional monitoring wells were installed in mid-1992. Free product (oil) was found in monitoring well Section2/MW-3. On March 18, 1994, free product was found for the first time in monitoring well MW-8. These two monitoring wells are located just west of the former tank farm. Free product is regularly recovered from these two wells using SoakEase® oil absorbent tubes. Free product (gasoline) is actively recovered by pumping product from the 30-inch recovery well south of the former tank farm, while oil is pumped from the recovery well south of the new tank farm.

5.0 RESULTS OF HYDROGEOLOGICAL INVESTIGATION

Hydrogeological investigations of the former tank farm site took place in October, 1991; July, 1992; and June, 1994. Results of these investigations are tabulated in Tables 1 through 5, and illustrated in Figures 3 to 8. Field observations indicated that the soil is stained in the vicinity of the fluctuating groundwater table which is influenced by precipitation events and the operation of the 30-inch recovery well.

The 1994 investigation using the Geoprobe® indicated black-colored fill (ranging from one to eight feet below grade) in several borings (G-1 to G-8) installed on the west side of the former tank that exhibited low PID readings. Impacted soil observed in Geoprobe® borings G-9, G-12, G-13, G-15, G-20, G-21, G-23, and possibly G-24 as well as previous (1992) borings TB-5, TB-8, MW-5, MW-7, and MW-9 is most likely due to dissolved constituents in the groundwater adsorbing onto the soil particles. Assuming oil floating on groundwater impacted a two-foot layer of soil at the groundwater table on the western edge of former Tank Farm 37, the volume of soil requiring remediation totals approximately 400 cubic yards. However, approximately 2,000 cubic yards on the west side of the Tank Farm would need to be removed in order to gain access to the soil impacted by floating oil on the groundwater.

The 1992 investigation indicated high concentrations of both polynuclear aromatic hydrocarbons (PNAHs) and BTEX constituents at the groundwater table at 11 feet to 13 feet below grade indicating overlapping plumes on the north side of the former TF37 at boring location TB-5. The boring log for TB-5 indicated a smear zone of hydrocarbons from seven and one-half feet to 13.5 feet just above a buried 1.5 foot thick layer of concrete. Assuming a smear zone of six feet due to fluctuating groundwater levels at the TB-5 boring location, in the excavated area of the former tank farm, and impacted soil from six to 14 feet outside the excavated area, yields a total of approximately 225 cubic yards. An equal amount of overlying soil would need to be removed to obtain access to the impacted soil in the smear zone. In addition, the two, 1.5-foot thick concrete pads would also need to be removed, and the soil and/or groundwater would need to be sampled for the presence of oil or gasoline constituents.

The larger BTEX-contaminated soil plume surrounds the northeast corner of the former tank farm as indicated from Geoprobe® boring G-23 to the northwest to G-21 (just south of TB-6) to the southeast. A source area appears to be located at the G-15 boring location beginning at six feet below grade (A hydrocarbon odor was also detected at the G-15 boring location.). Assuming a six-foot smear zone for the BTEX plume yields approximately 1,050 cubic yards of impacted soil overlain by about 1,700 cubic yards of soil. A smaller area of BTEX-impacted soil in the vicinity of TB-7 in the excavated area of the former tank farm totals approximately 85 cubic yards.

In summary, given the assumptions stated above, the soil impacted by petroleum constituents totals 1,025 cubic yards and soil impacted by BTEX constituents totals 1,135 cubic yards. However, approximately 4,070 cubic yards of overlying soil would also need to be excavated and segregated.

On September 23, 1994, Advanced submitted a report to the Michigan Department of Natural Resources (MDNR) entitled *Additional Soil and Groundwater Delineation* for the GM TF37 located in Flint, Michigan. This report presented soil and groundwater plume maps identifying the extent of the impacted soil and groundwater associated with the release from the former underground storage tank farm. Based on the findings of the investigation, Advanced has completed the following Soil and Groundwater Feasibility Report to aid in determining the preferred option to remediate the soil and groundwater at the site.

6.0 QUALIFICATIONS ON COST ESTIMATES OF REMEDIAL ALTERNATIVES

The former tank farm site is a complex site to remediate due to the presence of overlapping plumes (BTEX and oil). While soil vapor extraction combined with sparging has been shown to be quite effective in removing volatile organic compounds from soils and groundwater, it is not particularly effective in oil-saturated soils. Therefore, in examining remedial alternatives, hybrid alternatives need to be considered. Given the volume of soil that would need to be excavated on the site, in-situ alternatives appear to be preferable.

The remedial costs provided below are estimates only. This is because pilot tests would be needed to determine the radius of influence for a soil vapor extraction well given the variable hydraulic conductivity on the site. Biological sampling would need to be performed to assess whether indigenous bacteria will degrade the oil found in the soil. The pressure and temperature of on-site generated steam would need to be defined in order to design a system for steam injection to recover oil from the plumes on the site.

It should be noted that the northern edge of the soil BTEX plume has not been fully delineated. It was not known that piping in this area led to two tanks on the south side of the engine plant until recently.

The cost analysis presented below is based on the assumption that the overlying fill material meets the MERA Type B cleanup criteria.

The cost estimates do not include the cost of metering and supplying electricity, natural gas, steam, or surcharges to the City of Flint for the disposal of treated groundwater.

Preventive parts and labor for maintenance purposes have not been included in the cost estimates.

The cost estimates do not reflect delays or standby time due to bad weather or unsafe working conditions.

In addition, the time period estimated to clean up a site cannot be accurately predicted without pilot testing, nor can the extent of contamination be defined with certainty in fill areas.

7.0 REMEDIAL ALTERNATIVES - SOIL

The following options were considered for remediating the BTEX and oil constituents in the soil associated with the former tank farm. The summaries detail equipment, manpower, laboratory analysis, and completion time for each of the options:

- Option 1 - Excavation and Disposal;
- Option 2 - Thermal Desorption;
- Option 3 - Soil Vapor Extraction for BTEX-Containing Soils/Excavation for Oil-Containing Soils;
- Option 4 - In-Situ Biological Treatment;
- Option 5 - Steam Injection/Extraction Wells for Oil Recovery;
- Option 6 - Soil Washing with a Surfactant; and,
- Option 7 - MERA Type C Closure After Completion of Free Product Removal.

Solidification is not a viable option at this site due to the volatility of BTEX constituents. Therefore, this option was not considered in the analysis of remedial alternatives.

Table 6 summarizes the advantages and disadvantages of each of these options for soil remediation, while Table 7 summarizes the costs of each remedial alternative.

OPTION 1:

SOIL EXCAVATION & DISPOSAL

Excavation of 4,070 cubic yards including overburden, transport and disposal of 2,160 cubic yards of soil in the oil and BTEX plumes. Estimated time to complete the excavation of impacted soil is two weeks.

LABOR:	
Excavation and segregation of 4,070 cubic yards of overlying soil and excavation of 2,160 cubic yards of impacted soil at $3.65/cubic yard	$ 22,740.00
Transportation and disposal of contaminated soil $100.00/ton (2,160 cubic yards - 2 tons/cubic yard) or 4,320 tons =	$432,000.00
Grading cost of 6,230 cubic yards at $1.15/cubic yard	$ 7,165.00
Compacted sand backfill @ $10.35 cubic yard x 6,230 cubic yards	$ 64,480.00
On-Site Supervision @ $45.00/hour x 60 hours =	$ 2,700.00
Project Management @ $90.00/hour x 30 hours =	$ 2,700.00
Report	$ 1,200.00
EQUIPMENT:	
PID Rental @ $100.00/Day =	$ 600.00
Field Pack @ $50.00/Day =	$ 300.00
ANALYTICAL:	
Closure samples: BTEX, MTBE, PNAH and Lead; $180.00 x 40 =	$7,200.00
ESTIMATED COST:	**$541,085.00**

SCHEDULE:	
Contractor Arrangements	2 Weeks
Excavation & Disposal	2 Weeks
Sample Analysis	3 Weeks
Report Preparation	4 Weeks
Total:	11 Weeks

OPTION 2:

THERMAL DESORPTION:

Thermal desorption of the 2,160 cubic yards of contaminated soil includes excavation of 4,070 cubic yards of overlying fill material, thermal treatment and compacted backfill. Estimated remediation time would be approximately four weeks (This alternative should also be considered in the larger context of remediating the soil excavated in the former Tank Farm 94 area.).

LABOR:	
Excavation of overlying and impacted soil @ $3.65/cubic yard x 6,230 cubic yards =	$ 22,740.00
Excavation of 135 cubic yards of buried concrete $5.00/cubic yard (on-site disposal)	675.00
Compacted sand backfill for overlying soil @ $10.35/cubic yard x 4,070 cubic yards =	$ 42,125.00
Compacted backfill of treated soil @ $3.65/cubic yard x $2,160 cubic yards =	$ 7,884.00
Compacted sand backfill to cover 5% loss of treated soil or 108 cubic yards @ $10.35/cubic yard (Note that this is included as a contingency. There should be no loss of soil pore space due to thermal desorption.)	$ 1,118.00
Thermal Treatment @ $63.25/cubic yard x 2,160 cubic yards =	$136,620.00
On-Site Supervision @ $45.00/hour x 60 hours =	$ 2,700.00
Project Management @ $90.00/hour x 30 hours =	$ 2,700.00
Report Preparation	$ 1,200.00
EQUIPMENT:	
PID @ $100.00/Day =	$ 600.00
Field Pack $50.00/Day =	$ 300.00
ANALYTICAL:	
Closure sampling:	
Sample Analysis: BTEX, MTBE, PNAH and lead @ $180.00/sample x 40 =	$ 7,200.00
Sample analysis beneath concrete pads: BTEX, MTBE, PNAH, cadmium, chromium, and lead at $240/sample x 35	$ 8,400.00

ESTIMATED COST: **$234,262.00**

SCHEDULE:

Contractor Arrangements	2 Weeks
Thermal Desorption	2 Weeks
Sample Analysis	3 Weeks
Report Preparation	4 Weeks
Total:	11 Weeks

OPTION 3:

SOIL VAPOR EXTRACTION (BTEX) AND SOIL EXCAVATION (OIL):

SOIL VAPOR EXTRACTION (SVE)

SVE is a process of inducing air flow through unsaturated soils to remove volatile organic compounds. Volatilization and biodegradation are the removal processes. Variations on the SVE system include: spray aeration with soil vapor extraction (S.A.V.E.) and directional drilling to install horizontal pipe to capture soil vapors to minimize concrete saw cutting and the road disruption to truck traffic. The S.A.V.E. system addresses BTEX contamination in both soil and groundwater. Vapor extraction wells would be placed in the center of the plume. Sparge points would be placed east of the plume near the landscaped island. Installation of a SVE system with vapor phase carbon and re-injection of air flow back into the area with 1,135 cubic yards of soil contaminated with BTEX constituents. Approximately 1,025 cubic yards of soil contaminated with oil and 2,225 cubic yards of overlying fill would be excavated. Prior to the operation of a SVE system, plastic Visqueen® would be placed over the entire excavated area and tied into the concrete areas by trenching and folding the Visqueen® under the soil. Limestone would be removed prior to placement of the Visqueen® and then placed over the Visqueen® once in place.

EQUIPMENT:	
SVE Blower	$12,000.00
Piping/Trenching (vertical and horizontal)	$35,000.00
Carbon canister with virgin carbon	$12,000.00
Installation	$ 3,000.00
Pilot Test	$ 5,000.00
Visqueen® cap	$ 1,000.00
LABOR: Start-up	
On-Site Supervision @ $45.00/hour x 80 =	$ 3,600.00
Project Management @ $90.00/hr. x 30 =	$ 2,700.00
Report	$ 1,200.00
ESTIMATED COST	**$75,500.00**

OPERATION & MAINTENANCE:

6 MONTHS:

Site visit once a week for first six months = 24 visits x 3 hours per visit = 72 hours x $45.00 hour =	$ 3,240.00
Quarterly reports, 2 reports in 6 months @$250.00/report =	$ 500.00
Carbon replacement, 10 lbs. per day X 180 days = 1,800 lbs. of carbon @ $3.00/lb.	$ 5,400.00
Analytical cost, mobile laboratory with chemist (1 day) once a month at $1,000/visit X 6 visits =	$ 6,000.00
ESTIMATED COST	**$15,140.00**

3 YEARS:

2 visits a month for 30 months = 60 visits x 3 hours per visit = 180 hours. 180 hours x $45.00/hour =	$ 8,100.00
Carbon Replacement, 10 lbs. per day x 1095 days (3 years) = 10,950 lbs. of carbon x $3.00 per pound =	$32,850.00
Analytical Cost, Mobile Laboratory with chemist 1 day, once a month at $1,000/visit x 30 visits =	$30,000.00
Quarterly reports, 12 reports in 3 years. 12 x $250.00/report =	$ 3,000.00
ESTIMATED COST	**$73,950.00**
Present Value (Interest rate at 8%)	$58,701.00

5 YEARS:

2 visits a month for 54 months = 108 visits x 3 hours per visit = 324 hours. 324 hours x $45.00/hour =	$14,580.00
Carbon Replacement, 10 lbs. per day x 1825 days (5 years) = 18,250 lbs. of carbon x $3.00 per pound =	$54,750.00
Analytical Cost, Mobile Laboratory with chemist 1 day, once a month at $1,000.00/visit x 54 visits =	$ 54,000.00
Quarterly Reporting, 20 reports in 5 years. 20 reports x $250.00/report	$ 5,000.00
ESTIMATED COST	**$128,330.00**
Present Value (Interest rate at 8%)	$87,328.00

SOIL EXCAVATION

Excavation of 1,025 cubic yards of oil-impacted soil and 2,225 cubic yards of overlying fill material at $3.65/cubic yard	$ 11,863.00
Transport and disposal of oil-impacted soil $100.00/ton 1,025 cubic yards - 2 tons/cubic yard, or 2,050 tons =	$205,000.00
Compacted sand backfill @ $10.35 cubic yard x 3,250 cubic yards =	$ 33,638.00
Grading of 3,250 cubic yards at $1.10/cubic yard =	$ 3,575.00
On-site supervision @ $45.00/hr x 30 =	$ 1,350.00

EQUIPMENT:

PID Rental @ $100.00/Day =	$ 500.00
Field Pack @ $50.00/Day =	$ 250.00

CLOSURE:

Soil sample collection, 40 samples	$ 4,000.00
Soil sample analytical, 40 soil samples x $180.00/sample =	$ 7,200.00
Report preparation	$ 1,200.00

ESTIMATED COST: **$268,576.00**

SOIL VAPOR EXTRACTION

Present Value

6 months	$ 90,640.00
3 years	$134,201.00
5 years	$162,828.00

SOIL VAPOR EXTRACTION AND SOIL EXCAVATION

Present Value

6 Months	$359,216.00
3 Years	$402,777.00
5 Years	$431,404.00

SCHEDULE:

Contractor scheduling	2 Weeks
Installation	4 Weeks
Start up	4 Weeks
Duration 3 to 5 years	260 Weeks
Closure sample collection	1 Week
Closure sample analysis	3 Weeks
Report preparation	4 Weeks
Total	278 Weeks

OPTION 4:

IN-SITU BIOLOGICAL TREATMENT COMBINED WITH EXCAVATION AND DISPOSAL:

Contaminated soil is excavated, treated with an enhanced biological culture and placed back into the excavation in one-foot lifts. The organisms are given a steady oxygen supply from a venting system installed during excavation operations. This option is only viable for the 1,135 cubic yards of BTEX-impacted soil. Biological treatment is not particularly effective on soils contaminated with waste oil. The 1,025 cubic yards of oil-impacted soil can be remediated by excavation or thermal treatment.

EQUIPMENT:	
Biological organisms cost $295.00/magnum, 15 magnums treat 1,025 cubic yards of soil 15 x $295.00 =	$ 4,425.00
Air venting pipe and blower system with installation =	$ 9,000.00
PID @ $100.00/day x 2 =	$ 200.00
Field Pack @ $50.00/day x 2 =	$ 100.00
LABOR:	
Excavation & compacted backfill	$ 6,500.00
On-Site Supervision @ $45.00/hour x 24 hours =	$ 1,080.00
Project Management @ $90.00/hour x 20 hours =	$ 1,800.00
Report	$ 1,200.00
OPERATION & MAINTENANCE:	
Bi-weekly site visits for 6 months = 12 visits.	
Labor, 3 hours per visit x 12 visits = 36 hours at $45.00 hour =	$ 1,620.00
Analytical cost, Mobile laboratory with chemist 1 day, once a month at $1,000/visit x 6 visits =	$ 6,000.00
ESTIMATED COST OF IN-SITU BIOLOGICAL TREATMENT:	$31,925.00

EXCAVATION & DISPOSAL

LABOR:	
Excavation of 2,225 cubic yards of overlying soil at $3.65/cubic yard	$ 8,121.00
Excavation of 1,025 cubic yards of oil-impacted soil at $3.65/cubic yard	$ 3,741.00

Transport and disposal of 1,025 cubic yards, or 2,050 tons, of oil-impacted soil at $100.00/ton =	$205,000.00
Grading of 3,250 cubic yards of soil at $1.10/cubic yard =	$ 3,575.00
Compacted sand backfill @ $10.35/cubic yard x 3,250 cubic yards =	$ 33,638.00
On-Site supervision @ $45.00/hour x 30 =	$ 1,350.00
Project Management @ $90.00/hour x 15 =	$ 1,350:00
EQUIPMENT:	
PID Rental @ $100.00/Day =	$ 300.00
Field Pack @ $50.00/Day =	$ 150.00
ESTIMATED COST:	**$257,225.00**
CLOSURE:	
Soil sample collection, 40 samples	$4,000.00
Soil sample analytical, 40 soil samples x $180.00/sample =	$7,200.00
Report preparation	$1,200.00
ESTIMATED COST:	**$ 12,400.00**

TOTAL COST:

Excavation, transport and disposal	$257,225.00
In-Situ biological treatment	$ 31,925.00
Closure	$ 12,400.00
Total:	**$301,550.00**

SCHEDULE:

Contractor scheduling	2 Weeks
Installation	7 Weeks
Start up	1 Week
Duration	30 Weeks
Closure sample collection	1 Week
Closure sample analysis	3 Weeks
Report Preparation	4 Weeks
Total	48 weeks

OPTION 5:

STEAM INJECTION AND EXTRACTION WELLS FOR THE RECOVERY OF OIL FROM SATURATED SOIL

This alternative is based on the observation that GM has a readily available supply of steam and the capacity to pre-treat oily groundwater through its process waste plant. To the best knowledge of Advanced, this approach, while used for secondary recovery in oil production wells, has not been used as a remediation technique. It is innovative and untested in the field for remediation, implying a risk of failure. In addition, because of the thermodynamics of this approach including the temperature and pressure of the steam, a preliminary design and pilot test would be needed to assess if it would be effective on the site. Potential subsidence in the asphalt parking lot remains a slight possibility during winter operation of the system. More likely, the asphalt would exhibit deterioration in the steam injection area. Subsidence in the parking lot may result from dewatering the aquifer in this area. Dewatering may also affect the walls of the new tank farm, depending on its design.

Install eight steam injection wells at the boundary of the oil plume or install three horizontal stainless steel shallow-set screens at approximately 14 feet below grade throughout the oil plume area . Install two product recovery wells and dewater the area prior to start-up. Hydraulic conductivity and pump tests would need to be done to determine if the aquifer in this area could be dewatered prior to start-up. Assume a five-year operation period.

EQUIPMENT:	
2 Extraction Wells (6-inch diameter) @ $4,500/well	$ 9,000.00
3 Lines of Horizontal Pipe (4-inch diameter)/OR 10 Steam Injection Wells on Plume Boundary	
Trenching and Equipment (Blower/Air Compressor/ Pumps/ Biofilter/Meters/Gauges/Explosion-Proof Building)	$125,000.00
Preliminary Design	$ 5,000.00
Pilot Test	$ 25,000.00
LABOR:	
On-Site Supervision @ $45.00/hr x 80 hours	$ 3,600.00
Project Management @ $90/hr x 40 hrs.	$ 3,600.00
OPERATION AND MAINTENANCE:	
Quarterly site visits = 20 visits x 3 hrs./visit 60 hrs. x $45.00/hr.	$ 2,700.00
Analytical costs for PHAHs and lead @ $120.00/sample x 2 monitoring wells (MW-8,Sec2/MW-3) x 20 quarters	$ 4,800.00
Quarterly Reporting, 20 reports @ $250/report	$ 5,000.00
	$ 12,500.00
Present Value (interest rate at 8%)	$ 8,506.00
ESTIMATED COST - 5 YEARS OPERATION (PRESENT VALUE)	**$179,706.00**

OPTION 6:

SOIL WASHING WITH A SURFACTANT

Preliminary results from laboratory studies on the use of surfactants in washing oils from soils have shown that this method has good potential. In 1991, Ang and Abdul S. Abdul of the GM NAO R & D Center in Warren, showed that a nonionic alcohol-ethoxylate surfactant had the potential to wash over 80% of the oil from sandy soils. A pilot test in the field indicated that over 85% of the oil could be washed from the soils after 105 pore volume washings. (See *In-Situ Surfactant Washing of Polychlorinated Biphenyls and Oils from a Contaminated Field Site: Phase II Pilot Study,* Abdul S. Abdul and Carolina Ang, Groundwater, September-October, 1994, pg. 727.)

Using an inexpensive surfactant, such as a soap solution, to wash the oil from the soil may make this approach feasible. The drawback would be the significant volume of water needed to flush the soil.

Pilot tests would be needed to assess the economics of this approach.

OPTION 7:

MERA TYPE C CLOSURE REQUEST

The sidewalls and floor of the excavation of the former TF37 remain impacted by either BTEX or oil constituents. The backfill of the excavation is also impacted by the cone of influence from the 30-inch recovery well when it is pumped and by infiltration and recharge caused by precipitation events.

Free product on the site is actively being recovered from a recovery well located north of the new tank farm and a recovery well located south of the new tank farm. Free product (oil) found on the groundwater in monitoring wells Section 2/MW-3 and MW-8 is being recovered using Soakease® absorbent tubes. However, additional recovery wells (one near the G-2 boring location) with the recovered flow piped into a nearby process waste line should be installed to hasten free product recovery on the site.

A MERA Type C closure request could be initiated once there was no occurrence of free product on the groundwater over four consecutive quarters.

Comparing the laboratory analytical results of the soil samples collected from the 1994 investigation, it becomes apparent that Geoprobe® boring location G-15 is a source area for BTEX from six to at least ten feet below grade. The source area extends from the northeast corner of the tank farm to the G-21 boring location. While the concentrations in the soil are high with respect to MERA Type B cleanup criteria, they are still below the MERA Industrial Type C cleanup criteria. Applying a MERA Industrial Type C cleanup criteria would allow the overlying fill material (approximately one to eight feet below grade) to remain in place.
The source area can be treated in place using the SAVE® soil vapor extraction system or by venting the area using a blower, drawing the vapors through a catalytic converter, and re-injecting them back into the system. Bioremediation is also an option. The most effective of these approaches can be determined by performing pilot tests and/or collecting samples of indigenous microorganisms.

It should be noted that a MERA Type C closure has a number of requirements including a public hearing, a description of proposed human exposure controls, a restrictive covenant on the deed, an operation and maintenance plan, a monitoring plan, and financial assurance on the part of the site owner. For example, with regard to human exposure controls, access to below-grade depths would be restricted. Employees digging six feet below grade would be prohibited without the use of personal protective clothing. The deed to this parcel of property would be restricted. Hydraulic control over the groundwater would need to be maintained to assure that there would be no off-site migration and therefore, no exposure potential for off-site receptors. To further enhance groundwater control, the source area between the northeast corner of the tank farm and boring locations G-15 and G-21 should be excavated and either treated or disposed.

In addition, a cap should be placed over the area to reduce precipitation infiltration. The main disadvantage of a MERA Type C closure is that operation and maintenance costs can be quite costly over a long time period, say twenty years.

Visqueen® Cap	
Visqueen® will be laid over approximately 7,000 square feet comprising the former tank farm area	$ 1,000.00
<u>5 Years</u>	
Monitoring	
4 visits/year for 60 months = 240 visits x 3 hours per visit = 720 hours. 720 hours x $60.00/hour =	$43,200.00
Quarterly Reporting, 20 reports in 5 years.	
20 reports x $250.00/report	$ 5,000.00
Free Product Removal (5 years)	<u>$35,520.00</u>
ESTIMATED COST	**$84,720.00**
Present Value - 5 years	$56,930.00

It is difficult to predict the time period at which the free product will be completely recovered. Monitoring of the groundwater and quarterly reporting could be required for 20 to 30 years or more.

8.0 REMEDIAL ALTERNATIVES - GROUNDWATER

Floating free product (oil) was found first in Section 2/MW-3 and then in MW-8 in March, 1994. The floating free oil is recovered via a recovery well and infiltration trenches. Oil in the monitoring well is recovered using Soakease® absorbent socks on a regular basis.

Concentrations of BTEX constituents in the groundwater found at the G-15 boring location exceeded even the MERA Industrial Type C cleanup criteria for benzene, ethylbenzene and xylenes. The source of the BTEX is most likely piping formerly located in this area.

As discussed in the Introduction section of this report, free product is being pumped to a 30-inch recovery well. Fluids are sloped toward the recovery well via an infiltration trench installed on the east side of the excavation of the former tank farm and an infiltration trench on the south side of the excavation. Assuming a porosity of 0.2, approximately 45,000 gallons of water may be impacted by oil on the west side of the former tank farm.

Conventional pump and treat systems are used on approximately three-fourths of all contaminated sites. Such systems pump relatively large volumes of water with relatively low contaminant concentrations. Because of the slow rates of contaminant desorption and dissolution, these systems must displace many volumes of aquifer water to lower contaminant concentrations, implying that such systems are inherently inefficient. Therefore, some of the alternatives, such as air sparging and flushing the soil with surfactants, should also be considered along with the conventional pump and treat technology.

The common methods of separating BTEX from groundwater are air stripping and carbon filtration. Carbon filtration is usually expensive for groundwater with significant BTEX concentrations due to the high cost of carbon and its disposal. An air stripper can be used but carbon and the cost of replacing fouled packing in the stripper are major expenses. Another method is to use an internal combustion engine with a spray aeration system and a vacuum chamber, i.e., the S.A.V.E. system. The vacuum increases the flow of both free product and water to the extraction wells..

Oil in the groundwater is more difficult to remove than BTEX for a variety of reasons such as viscosity, reduced volatility, and the possible presence of other constituents in the oil. The free product, however, must be removed. In addition to the trench/recovery well system, two additional recovery wells should be placed in the plume area, on either side of the pipe chase. Table 8 summarizes the advantages and disadvantages of the remedial alternatives for groundwater and Table 9 summarizes the cost of each remedial alternative.

OPTION 1:

PUMP AND TREAT GROUNDWATER AND FREE PRODUCT

Pumping the 30-inch recovery well should continue. Data needs to be collected on the total gallonage pumped and the total time the well is being pumped.

Two additional six-inch recovery wells for a pump and treat operation will be installed in the oil plume on the west side of the former tank farm. Recovered groundwater and free product will be pumped to the GM on-site wastewater treatment plant. The cost estimate does not include surcharges to the City of Flint.

EQUIPMENT:		
	Pneumatic pumps, $2,500 x 2 =	$ 5,000.00
	Air Compressor	$ 6,000.00
	Piping/Metering	$ 2,500.00
LABOR:		
	Installation of two 6" recovery wells to 15' below grade	$ 8,000.00
	On-Site Supervision @ $45.00/hr. x 24 hours	$ 1,080.00
	Project Management @ $90/hr. x 10 hours	$ 900.00
ESTIMATED COST		**$23,481.00**

OPERATION AND MAINTENANCE:

1 YEAR	
Quarterly site visits = 4 visits x 3 hrs./visit 12 hrs. x $45.00/hr. =	$ 540.00
Analytical costs for BTEX, MTBE, PHAHs, and lead @ $180.00/sample x 4 monitoring wells (MW-8, Sec2/MW-3, MW-7, and MW-9) x 4 quarters	$ 2,880.00
Quarterly Reporting, 4 reports/year @ $250/report	$ 1,000.00
	$ 4,420.00

3 YEARS

Quarterly site visits = 12 visits x 3 hrs./visit 36 hrs. x $45.00/hr.	$ 1,620.00
Analytical costs for BTEX, MTBE, PHAHs, and lead @ $180.00/sample x 4 monitoring wells (MW-8, Sec2/MW-3, MW-7, and MW-9) x 12 quarters	$ 8,640.00
Quarterly Reporting, 12 reports @ $250/report	$ 3,000.00
	$13,260.00
Present Value (interest rate at 8%)	$10,526.00

5 YEARS

Quarterly site visits = 20 visits x 3 hrs./visit 60 hrs. x $45.00/hr.	$ 2,700.00
Analytical costs for BTEX, MTBE, PHAHs, and lead @ $180.00/sample x 4 monitoring wells (MW-8, Sec2/MW-3, MW-7, and MW-9) x 20 quarters	$14,400.00
Quarterly Reporting, 20 reports @ $250/report	$ 5,000.00
	$22,100.00
Present Value (interest rate at 8%)	15,040.00

ESTIMATED COST (PRESENT VALUE)

One Year	**$27,901.00**
Three Years	**$34,007.00**
Five Years	**$38,521.00**

OPTION 2:

FREE PRODUCT (OIL) RECOVERY WITH ADDITIONAL PRODUCT RECOVERY WELLS/SPRAY AERATION VAPOR EXTRACTION FOR BTEX

Free product (oil) would be pumped and treated using two extraction wells. A soil vapor extraction system with spray aeration will be installed in the BTEX plume area.

Either sparging the groundwater or using the S.A.V.E. system would introduce air into the subsurface enhancing natural attenuation using the indigenous bacteria.

The S.A.V.E. system can be used on free product and contaminated groundwater as well as contaminated soil. It is approximately $10,000 lower in cost over the traditional soil vapor extraction system costed in Option 3 for the remedial alternatives for soil.

ESTIMATED COST - PRESENT VALUE

6 Months	$196,866.00
3 Years	$241,177.00
5 Years	269,804.00

TOTAL COST OF HYBRID ALTERNATIVE (Present Value): FREE PRODUCT RECOVERY AND THE S.A.V.E. SYSTEM

1 Year	**$221,767.00**
3 Years	**$272,184.00**
5 Years	**$305,325.00**

OPTION 3:

BIOREMEDIATION

The use of biofilters and indigenous bacteria are in-situ methods that can be used in addition to the conventional treatment of pump and treat. However, in order to assess if the bioremediation approach would even be feasible, several samples of soil and water should be collected and reduction in the concentrations of the TPH and/or oil and grease could be monitored using the native bacteria. Sample collection and analysis of the microbial populations costs $350.00 per sample.

9.0 CONCLUSION

A MERA Type B cleanup criteria will be the cleanup goal for the former Tank Farm 37 site. If this stated goal cannot be reached within a reasonable time period, a mixed Type B/C cleanup criteria may then become the default goal.

The complex nature of the plumes in the former Tank Farm 37 site required the development of hybrid alternatives to address the oil and BTEX plumes within each of the affected media. Tables 6 through 9 present the technical and cost comparisons for the remedial alternatives for soil and groundwater.

With respect to groundwater on the site, free product is being actively recovered from two recovery wells, one located north of the new tank farm and the other located south of the new tank farm. Free product is also being recovered from Section 2/MW-3 and MW-8 monitoring wells using Soakease® absorbent tubes on a regular basis. To hasten the recovery of free product, consideration should be given to the installation of two additional recovery wells on the west side of the former tank farm.

Groundwater in the oil and BTEX plumes would continue to be addressed by the current abatement system (infiltration trenches and recovery wells). Even though BTEX constituents in the groundwater would be effectively addressed by the S.A.V.E. system or a soil vapor extraction system combined with air sparging, the actual time needed to achieve the MERA Type B cleanup criteria is unknown. Therefore, due to this uncertainty, as well as the sunk costs of installing the two recovery wells, piping, and infiltration trenches, the current pump and treat groundwater system will be retained. To increase the recovery of free product, two additional recovery wells should be installed on the west side of the former tank farm.

With regard to alternatives for remediating the soil on the site, thermal desorption is the preferred alternative for the following reasons. Technically, this option can treat both the oil and the BTEX constituents in the soil, making it a preferred option over the hybrid alternatives. There is no long-term monitoring or O & M costs associated with this approach. This option is cost effective relative to the other remedial alternatives. Unit costs could be decreased if the soil from another nearby tank farm is also treated using thermal desorption. While a site-specific air permit will be needed, the time needed to process the application is approximately 30 days. Soil samples will be needed to be run through the system to assure that a MERA Type B cleanup criteria can be met prior to final selection. Soil sampling costs may be higher than estimated due to the presence of fill, the presence of buried concrete pads in the former Tank Farm area, buried foundations from pre-war buildings, and permanent structures such as the Stewart Street Bridge and the concrete-encased pipe chase.

While the steam injection/recovery well option is interesting, it is innovative and untested for site remediation. A detailed thermodynamic analysis would need to done followed by pilot field tests. Dewatering of the site may cause problems with the structural integrity of the new tank farm and there may be possible ground subsidence. Soil washing using a soap/water solution would generate large volumes of water that may make it too expensive. Bioremediation has too many uncertainties to determine feasibility without collecting and analyzing microbial populations on the site. This option may not be particularly effective on the oil constituents in the soil. Soil vapor extraction would only be effective on the BTEX constituents and would need to be combined with another alternative to treat the oil constituents in the soil. Given these comparisons, the preferred option to attempt to meet the MERA Type B cleanup criteria is thermal desorption for treating the soil at the former Tank Farm 37 site and continuing the groundwater pump and treat system. If the MERA Type B cleanup criteria cannot be reached within a reasonable time period, a MERA Type C closure request will be prepared for MDNR approval.

10.0 SIGNATURE BLOCK

The information contained in this report is based on existing site conditions disclosed or discovered during the current site investigation activities.

Prepared by: ______________________

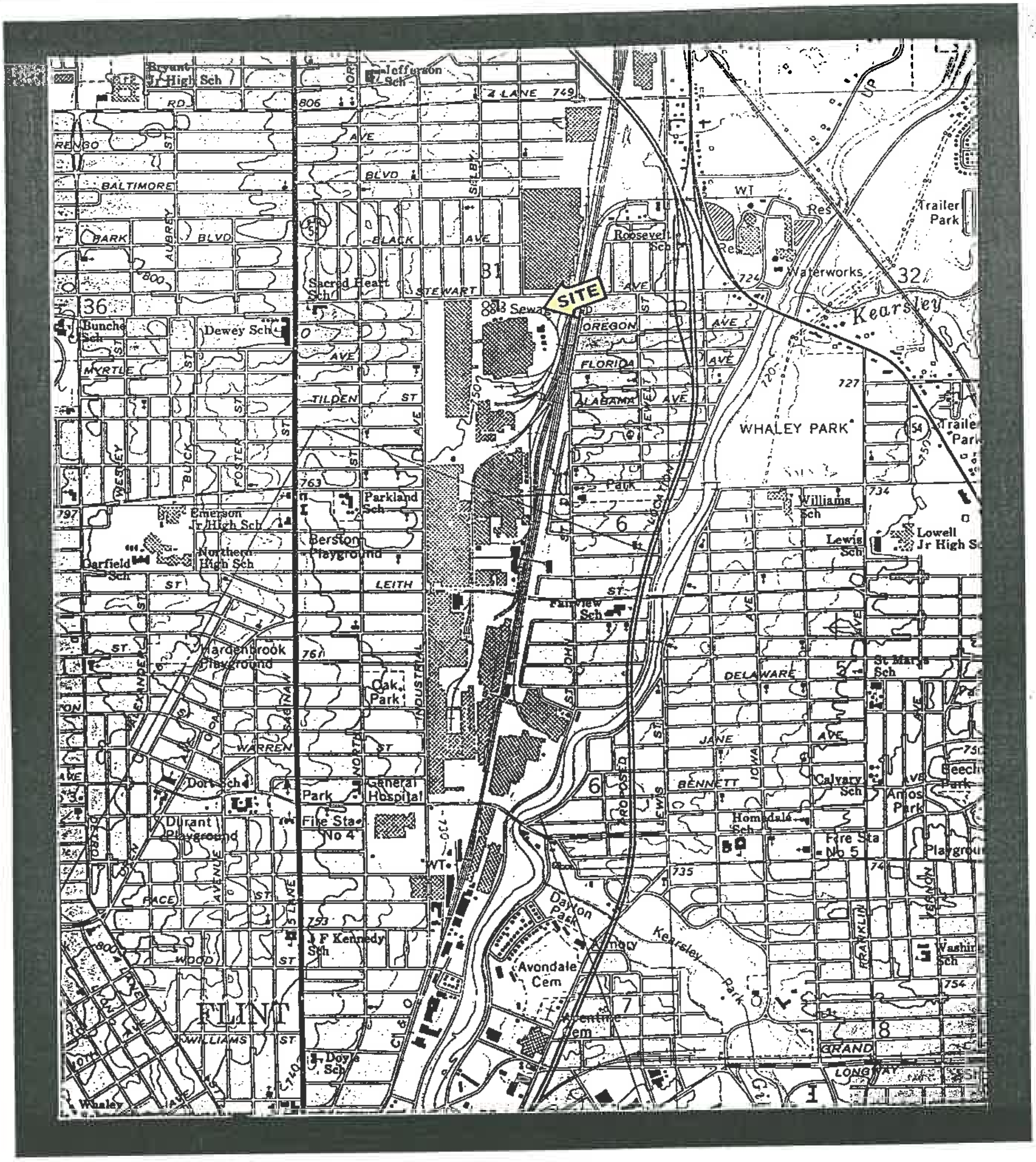
Constance M. Boris, Ph.D., Sr. Project Engineer

Reviewed by: ______________________

Mark Keyes, P.G., Project Manager

Date: December 20, 1994

FIGURES

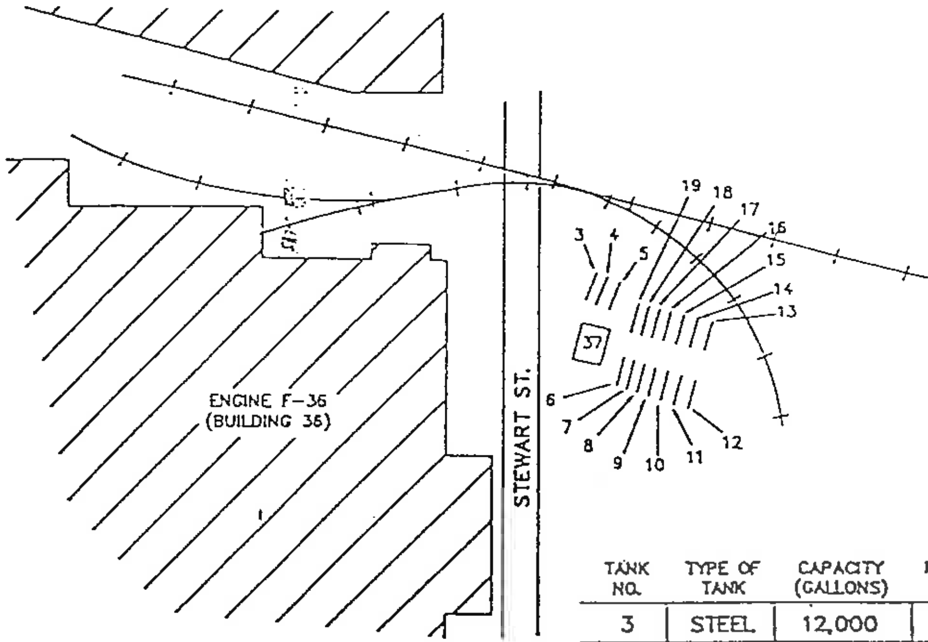


ADVANCED ENVIRONMENTAL, INC.

ENVIRONMENTAL MANAGEMENT CONSULTANTS

TITLE: U.S. GEOLOGICAL SURVEY/TOPOGRAPHIC MAP
FORMER TANK FARM NUMBER 37
BOC FLINT AUTOMOTIVE DIVISION – FLINT, MI.

FIGURE: 1	PROJECT MGR: CMB
SCALE: 1:24 000	PROJECT NO: **4124CQ**



TANK NO.	TYPE OF TANK	CAPACITY (GALLONS)	MSDS NO.	PRODUCT STORED
3	STEEL	12,000		THINNER
4	STEEL	12,000	1	REG. GAS
5	STEEL	12,000	1	REG. GAS
6	STEEL	12,000	14	HYDRAULIC OIL
7	STEEL	12,000	14	HYDRAULIC OIL
8	STEEL	12,000	12	MOTOR OIL
9	STEEL	12,000	12	MOTOR OIL
10	STEEL	12,000	12	MOTOR OIL
11	STEEL	12,000	12	MOTOR OIL
12	STEEL	12,000	12	MOTOR OIL
13	STEEL	12,000	8	MINERAL SEAL
14	STEEL	12,000	8	MINERAL SEAL
15	STEEL	12,000	10	P47 WAY OIL
16	STEEL	12,000	15	SOLUBLE
17	STEEL	12,000	15	SOL (ELRAY)
18	STEEL	12,000	12	MOTOR OIL
19	STEEL	12,000	11	A-50 LUBE

BLDG 37
TANK LOCATION PLAN

NOT TO SCALE

WW Engineering & Science

39209 West Six Mile Road • Livonia, Michigan 48152 • (313)591-0522

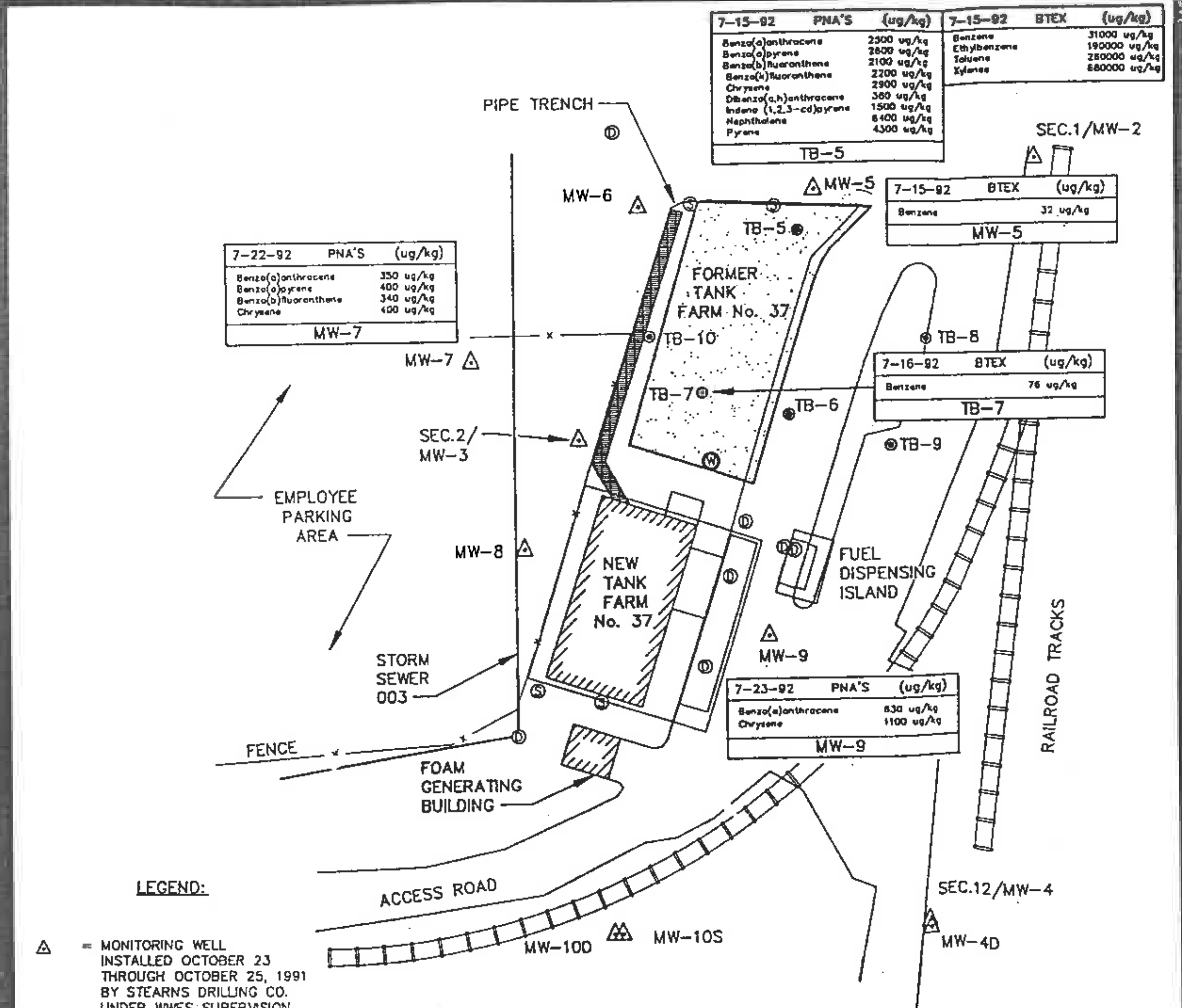
N

ADVANCED ENVIRONMENTAL, INC.
ENVIRONMENTAL MANAGEMENT CONSULTANTS

TITLE: TANK LOCATION PLAN – BUILDING 37
ADAPTED FROM WW ENGINEERING & SCIENCE
INITIAL ABATEMENT MEASURES REPORT

DATE: FERUARY 16, 1990 PROJECT MGR: C.M.B.

FIGURE: **2** PROJECT NO: **4124CQ**



LEGEND:

- △ = MONITORING WELL INSTALLED OCTOBER 23 THROUGH OCTOBER 25, 1991 BY STEARNS DRILLING CO. UNDER WWES SUPERVISION
- △ = MONITORING WELL INSTALLED JULY 15 THROUGH JULY 24, 1992 BY STEARNS DRILLING COMPANY UNDER WWES SUPERVISION
- ● = TEST BORING DRILLED JULY 15 THROUGH JULY 24, 1992 BY STEARNS DRILLING COMPANY UNDER WWES SUPERVISION
- Ⓦ = RECOVERY WELL LOCATION
- Ⓓ = STORM SEWER/CATCH BASIN LOCATION
- Ⓢ = SANITARY SEWER MANHOLE LOCATION
- —— = APPROXIMATE LOCATION OF STORM SEWER 003
- ⬚ = APPROXIMATE LIMITS OF FORMER UST EXCAVATION

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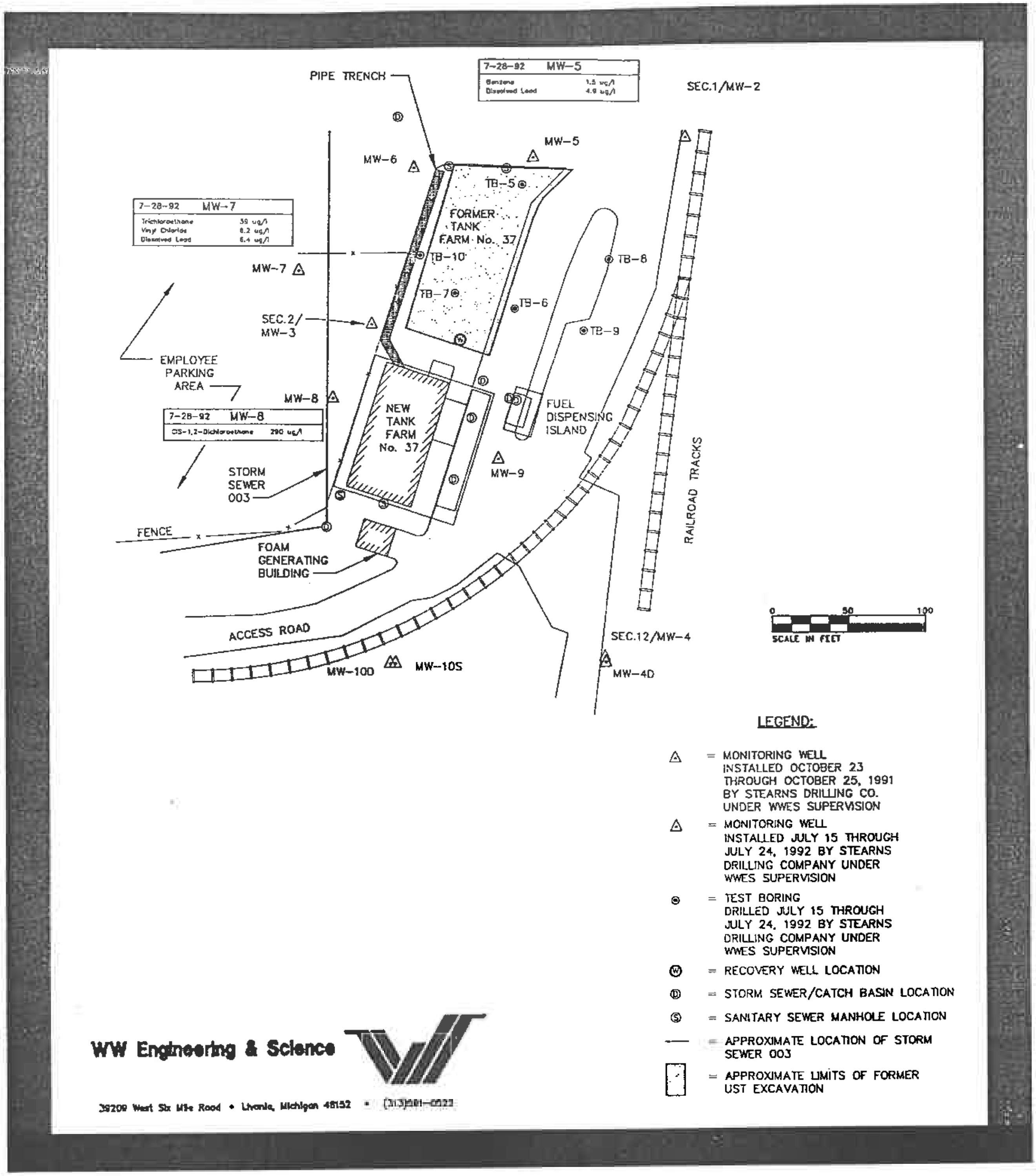
ADVANCED ENVIRONMENTAL, INC.

ENVIRONMENTAL MANAGEMENT CONSULTANTS

TITLE: COMPOUNDS DETECTED IN SOILS ABOVE TYBE B ADAPTED FROM WW ENGINEERING & SCIENCE REMEDIAL SUBSURFACE INVESTIGATION REPORT

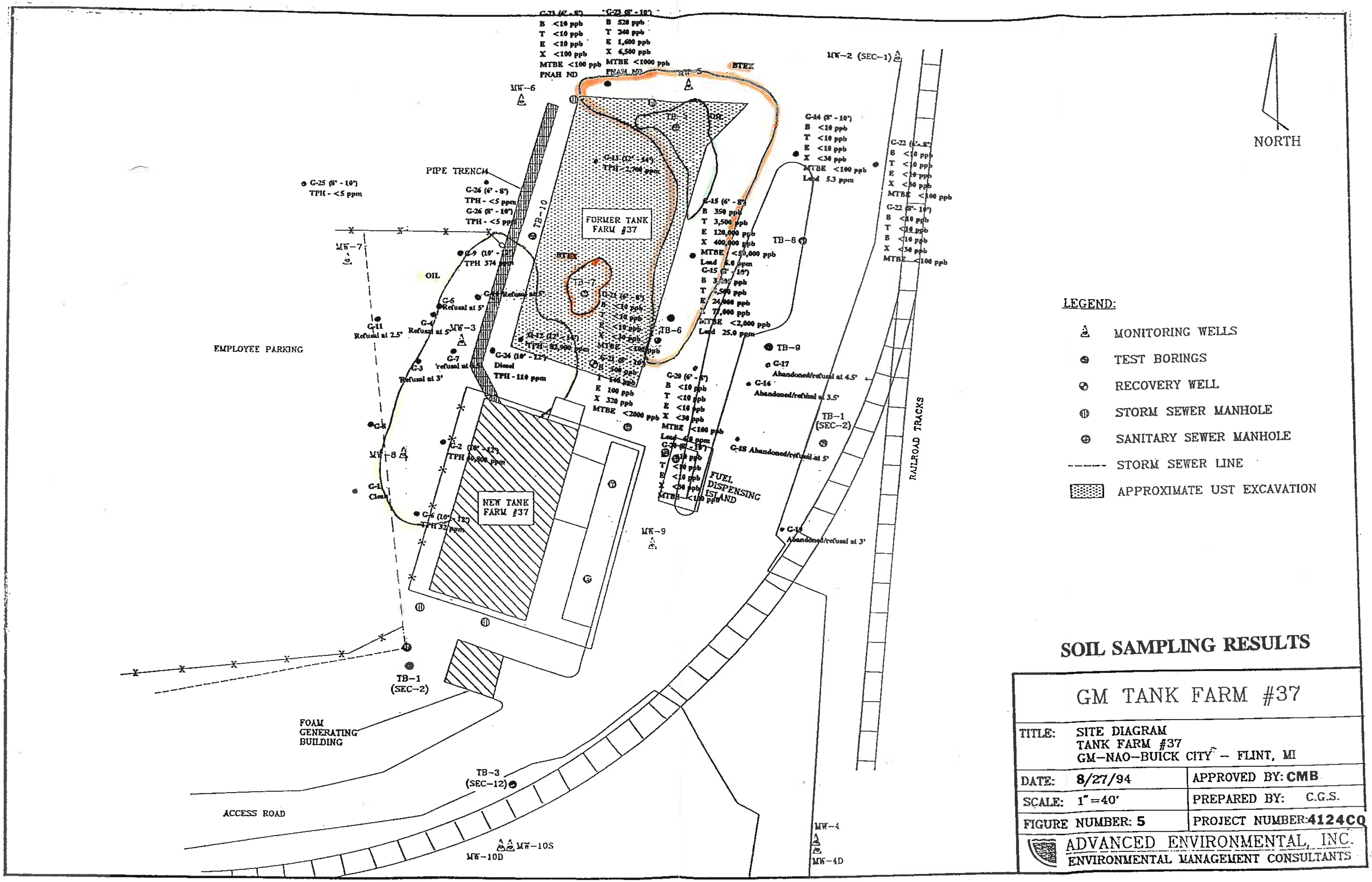
DATE: OCTOBER 15, 1992	PROJECT MGR: C.M.B.
FIGURE: 3	PROJECT NO: 4124CQ



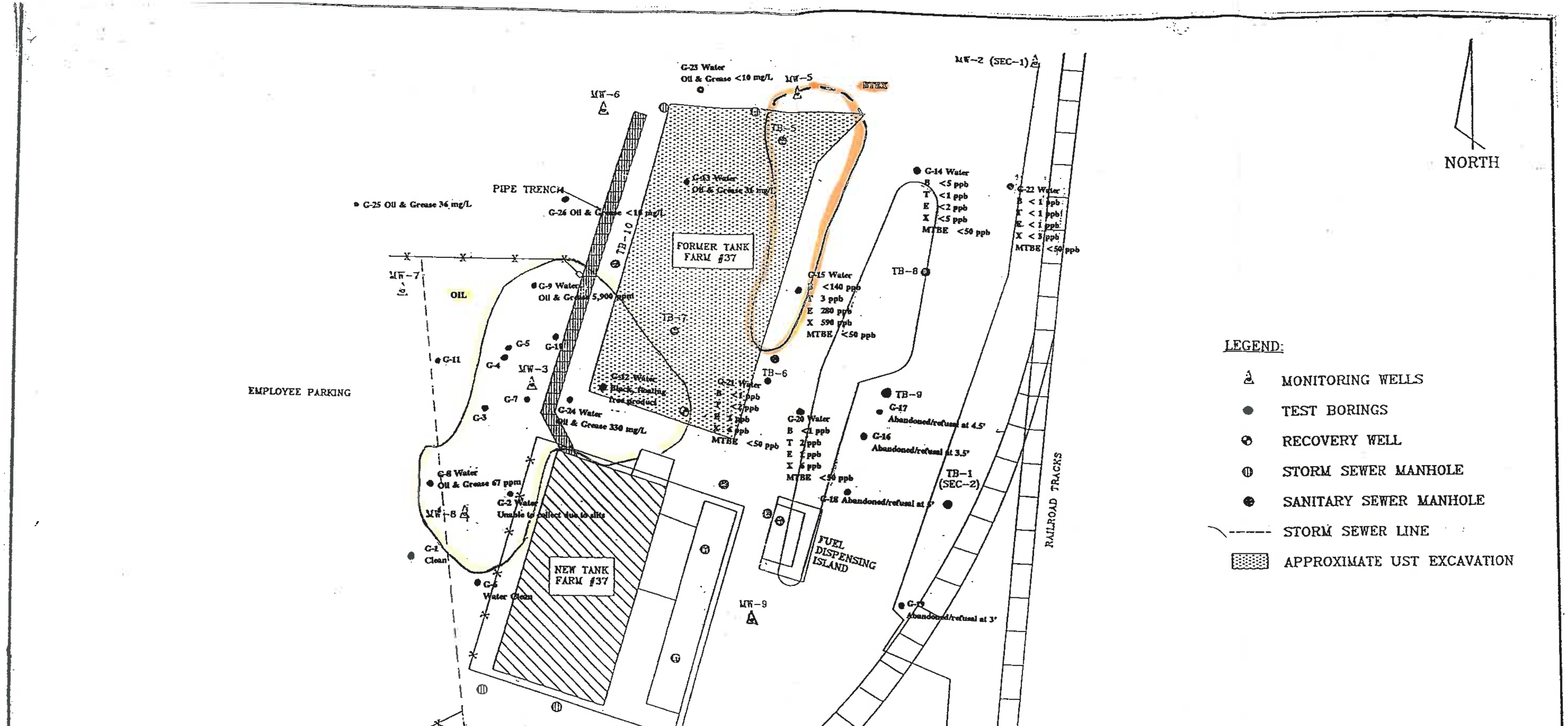
ADVANCED ENVIRONMENTAL, INC.

ENVIRONMENTAL MANAGEMENT CONSULTANTS

TITLE:	COMPOUNDS DETECTED IN G.WATER ABOVE TYBE B ADAPTED FROM WW ENGINEERING & SCIENCE REMEDIAL SUBSURFACE INVESTIGATION REPORT
DATE: OCTOBER 15, 1992	PROJECT MGR: C.M.B.
FIGURE: 4	PROJECT NO: 4124CQ

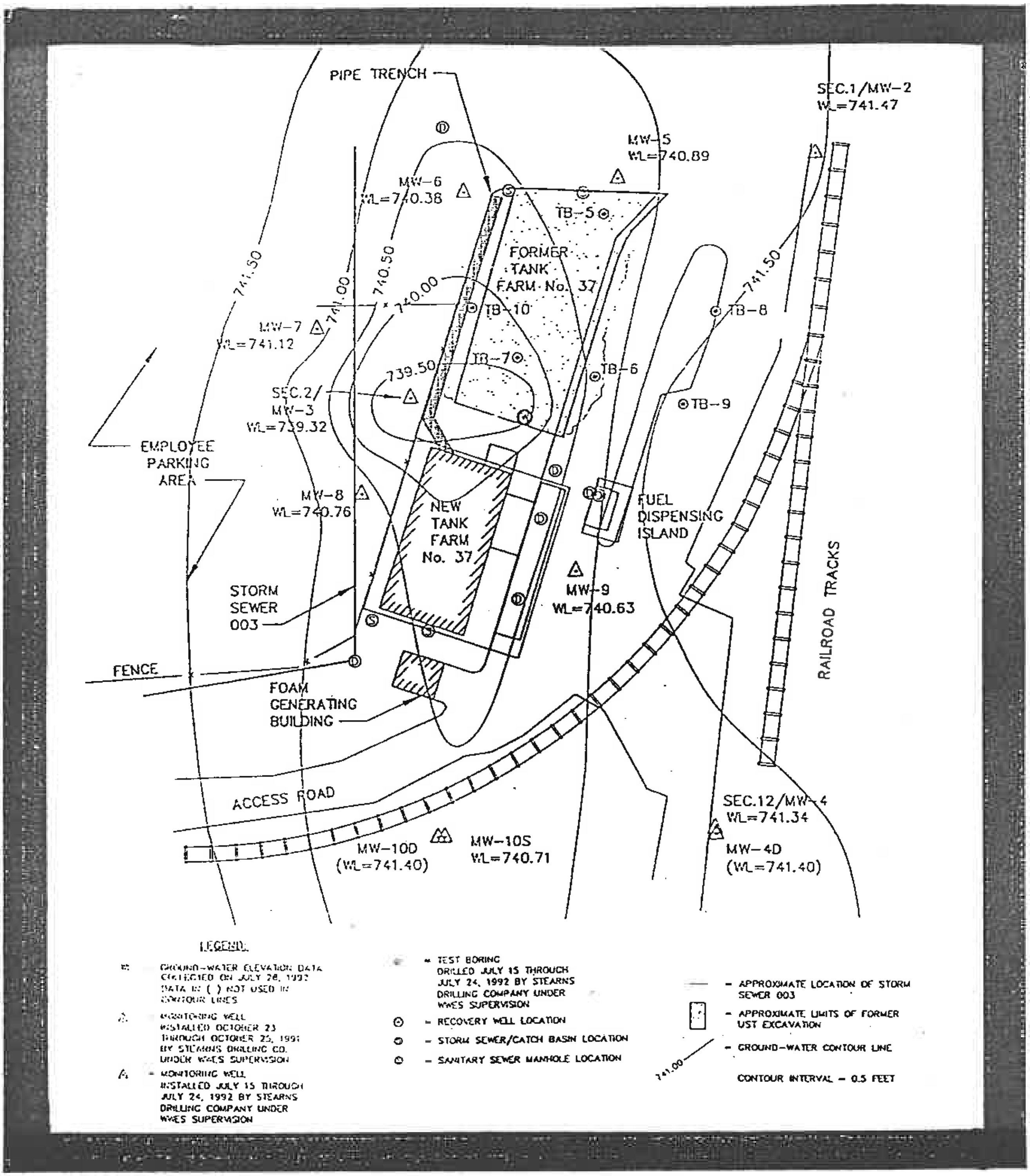


NORTH
LEGEND:
MONITORING WELLS
TEST BORINGS
RECOVERY WELL
STORM SEWER MANHOLE
SANITARY SEWER MANHOLE
STORM SEWER LINE
APPROXIMATE UST EXCAVATION
FORMER TANK FARM #37
NEW TANK FARM #37
PIPE TRENCH
EMPLOYEE PARKING
FUEL DISPENSING ISLAND
RAILROAD TRACKS
FOAM GENERATING BUILDING
ACCESS ROAD
TB-1 (SEC-2)
TB-3 (SEC-12)
MW-10D
MW-10S
MW-4
MW-4D
MW-9
MW-2 (SEC-1)
SOIL SAMPLING RESULTS
GM TANK FARM #37
TITLE: SITE DIAGRAM
TANK FARM #37
GM-NAO-BUICK CITY – FLINT, MI
DATE: 8/27/94
APPROVED BY: CMB
SCALE: 1"=40'
PREPARED BY: C.G.S.
FIGURE NUMBER: 5
PROJECT NUMBER: 4124CO
ADVANCED ENVIRONMENTAL, INC.
ENVIRONMENTAL MANAGEMENT CONSULTANTS



GROUNDWATER SAMPLING RESULTS

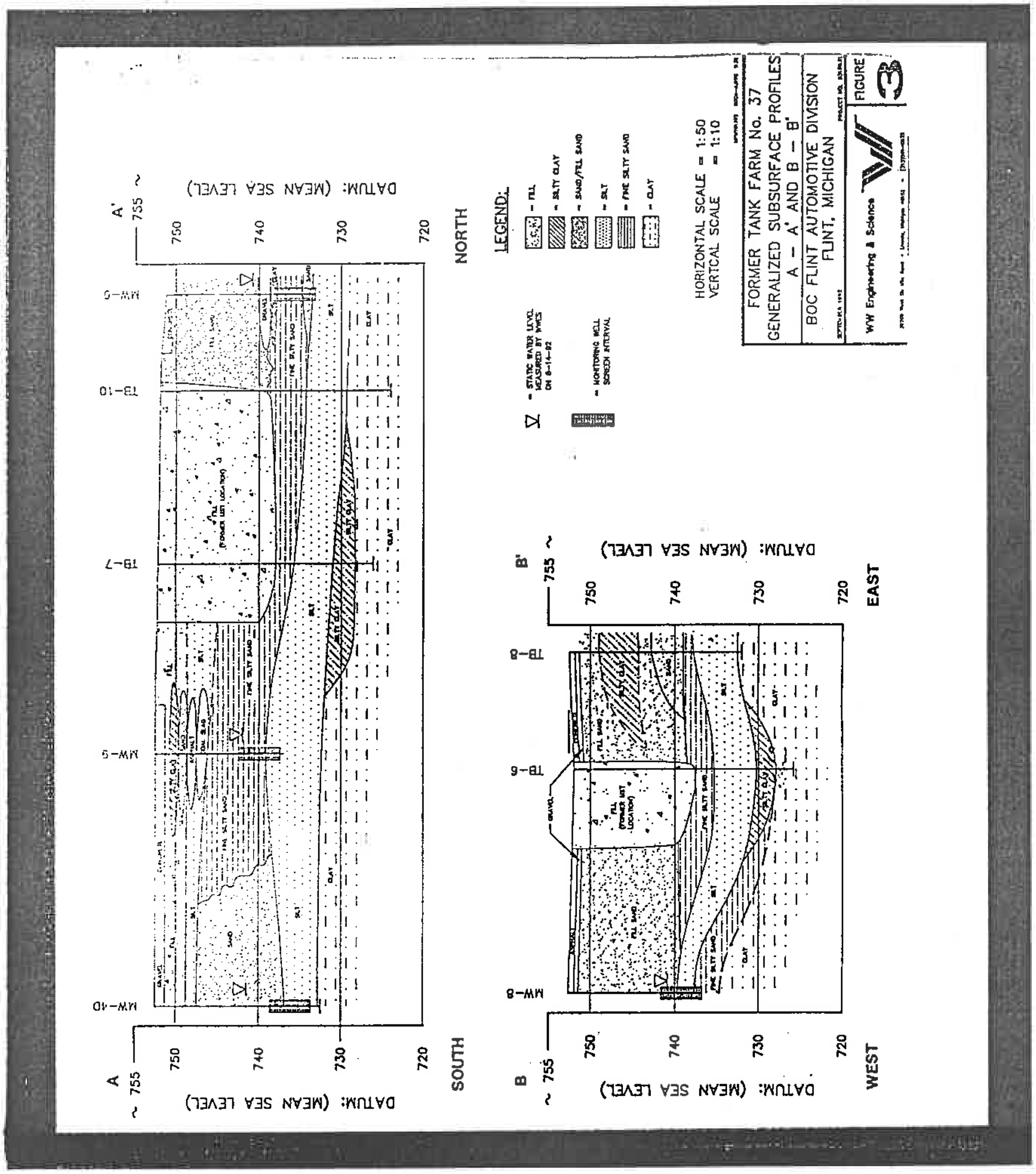
GM TANK FARM #37	
TITLE: SITE DIAGRAM TANK FARM #37 GM-NAO-BUICK CITY - FLINT, MI	
DATE: 8/27/94	APPROVED BY: CMB
SCALE: 1"=40'	PREPARED BY: C.G.S.
FIGURE NUMBER: 6	PROJECT NUMBER: 4124CQ
ADVANCED ENVIRONMENTAL, INC. ENVIRONMENTAL MANAGEMENT CONSULTANTS	



ADVANCED ENVIRONMENTAL, INC.

ENVIRONMENTAL MANAGEMENT CONSULTANTS

TITLE: GROUNDWATER CONTOUR MAP GM BOC FLINT AUTO DIVISION – TANK FARM NO. 37 ADAPTED FROM: WW ENGINEERING & SCIENCE	
DATE: SEPTEMBER 1992	FIGURE NO: 7
SCALE: NOT TO SCALE	PROJECT NO: **4124CQ**



ADVANCED ENVIRONMENTAL, INC.

ENVIRONMENTAL MANAGEMENT CONSULTANTS

TITLE: GENERALIZED SUBSURFACE PROFILES A – A' AND B – B' GM BOC FLINT AUTO DIVISION – TANK FARM NO. 37 ADAPTED FROM: WW ENGINEERING & SCIENCE	
DATE: SEPTEMBER 1992	FIGURE NO: 8
SCALE: NOT TO SCALE	PROJECT NO: 4124CQ

TABLES

TABLE 1

SOIL AND GROUNDWATER QUALITY

FORMER TANK FARM No. 37
BOC - Flint Automotive Division
Flint, Michigan

	Soil Sample Location and Depth (in feet)						Groundwater Samples		
Contaminant	Type B Cleanup Criteria	Sec 1/TB-1 SS-3 (7.5 ft.)	Sec 1/TB-1 SS-4 (10.0 ft.)	Sec 2/MW-3 SS-4 (10.0 ft.)	Sec 2/TB-1 SS-9 (22.5 ft.)	Sec 12/TB-3 SS-5 (12.5 ft.)	Type B Cleanup Criteria	Sec 1/MW-2	Sec 12/MW-4
Benzene (ppb)	20	<10	<10	<10	N/A	<10	1	<1.0	<1.0
Toluene (ppb)	20,000	10	12	60	N/A	11	800	<1.0	<1.0
Ethylbenzene (ppb)	1,000	<10	<10	13	N/A	<10	70	<1.0	<1.0
Xylenes (total) (ppb)	6,000	<10	<10	55	N/A	<10	300	<1.0	<1.0
Lead (ppm)		N/A	N/A	1.8	17	N/A		N/A	N/A

Notes:

* Type B cleanup criteria based on the MDNR documented dated 8/23/91
Based on local background...see report text.

E 2

SUMMARY OF SOIL SAMPLE LABORATORY ANALYTICAL RESULTS
FORMER TANK FARM No. 37
BOC - Flint Automotive Division

Sample ID Sample Designation Sample Date Sample Depth (in feet)		Type A Criteria	Type B Criteria 20 X GW	MW-5 SS-1 7/17/92 14-16	TB-5 SS-5 7/15/92 11-13	TB-5 SS-10 7/15/92 23.5 - 25.5	MW-6 SS-4 7/23/92 8.5 - 10.5	TB-6 SS-1 7/16/92 14 - 16	TB-6 SS-5 7/16/92 24 - 26	MW-7 SS-4 7/22/92 8.5 - 10.5
Polynuclear Aromatics (PNAHs)	Units									
Acenaphthene	µg/kg	330	8,000	ND	840	ND	ND	ND	ND	ND
Acenaphthylene	µg/kg	330	ID	ND	380	ND	ND	ND	ND	ND
Anthracene	µg/kg	330	40,000	ND	1,300	ND	ND	ND	ND	ND
Benzo(a)anthracene	µg/kg	330	@200	ND	2,500	ND	ND	ND	ND	350
Benzo(a)pyrene	µg/kg	330	@200	ND	2,600	ND	ND	ND	ND	400
Benzo(b)fluoranthene	µg/kg	330	@200	ND	2,100	ND	ND	ND	ND	340
Benzo(ghi)perylene	µg/kg	330	ID	ND	1,700	ND	ND	ND	ND	330
Benzo(k)fluoranthene	µg/kg	300	@200	ND	2,200	ND	ND	ND	ND	ND
Chrysene	µg/kg	330	@200	ND	2,900	ND	ND	ND	ND	400
Dibenzo(a,h)anthracene	µg/kg	330	@200	ND	380	ND	ND	ND	ND	ND
Fluoranthene	µg/kg	330	6,000	ND	4,700	ND	ND	ND	ND	600
Fluorene	µg/kg	330	6,000	ND	1,100	ND	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene	µg/kg	330	@200	ND	1,500	ND	ND	ND	ND	ND
Naphthalene	µg/kg	330	600	ND	6,400	ND	ND	ND	ND	ND
Phenanthrene	µg/kg	330	ID	ND	4,500	ND	ND	ND	ND	340
Pyrene	µg/kg	330	4,000	ND	4,300	ND	ND	ND	ND	660
Polychlorinated Biphenyls (PCBs)	Units									
PCB Aroclors	µg/kg	33	@1,000	ND	ND	ND	ND	ND	ND	ND
Volatile Organic Compounds Detected (BTEX)	Units									
Benzene	µg/kg	10	20	32	31,000	ND	ND	ND	ND	ND
Ethylbenzene	µg/kg	10	1,400	62	190,000	ND	ND	ND	ND	ND
Toluene	µg/kg	10	16,000	56	260,000	ND	ND	ND	ND	ND
Xylenes (o,m, and p)	µg/kg	30	6,000	2,600	680,000	ND	ND	ND	ND	ND
Total Lead	mg/kg	1	0.08	11	41	18	4.7	8.0	19	15

Notes:

- µg/kg = microgram per kilogram
- @ = Direct contact value
- mg/kg = milligram per kilogram
- Shaded numbers are organic compounds detected above Type B criteria
- ND = not detected
- ID = Insufficient data for MDNR to establish Type B Criteria

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SUMMARY OF SOIL SAMPLE LABORATORY ANALYTICAL RESULTS
FORMER TANK FARM No. 37
BOC - Flint Automotive Division

Sample ID Sample Designation Sample Date Sample Depth (in feet)		Type A Criteria	Type B Criteria 20 X GW	TB-7 SS-1 7/16/92 14-16	TB-7 SS-5 7/16/92 24-26	MW-8 SS-4 7/20/92 8.5 - 10.5	TB-8 SS-4 7/16/92 8.5 - 10.5	MW-9 SS-4 7/23/92 8.5 - 10.5	MW-9 SS-4 Dup 8.5 - 10.5	TB-9 SS-4 7/21/92 8.5 - 10.5
Polynuclear Aromatics (PNAHs)	Units									
Acenaphthene	μg/kg	330	8,000	ND	ND	ND	ND	ND	ND	ND
Acenaphthylene	μg/kg	330	ID	ND	ND	ND	ND	ND	ND	ND
Anthracene	μg/kg	330	40,000	ND	ND	ND	ND	ND	ND	ND
Benzo(a)anthracene	μg/kg	330	@200	ND	ND	ND	ND	ND	630	ND
Benzo(a)pyrene	μg/kg	330	@200	ND	ND	ND	ND	ND	ND	ND
Benzo(b)fluoranthene	μg/kg	330	@200	ND	ND	ND	ND	ND	ND	ND
Benzo(ghi)perylene	μg/kg	330	ID	ND	ND	ND	ND	ND	ND	ND
Benzo(k)fluoranthene	μg/kg	300	@200	ND	ND	ND	ND	ND	ND	ND
Chrysene	μg/kg	330	@200	ND	ND	ND	ND	ND	1,100	ND
Dibenzo(a,h)anthracene	μg/kg	330	@200	ND	ND	ND	ND	ND	ND	ND
Fluoranthene	μg/kg	330	6,000	ND	ND	ND	ND	ND	450	ND
Fluorene	μg/kg	330	6,000	ND	ND	ND	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene	μg/kg	330	@200	ND	ND	ND	ND	ND	ND	ND
Naphthalene	μg/kg	330	600	ND	ND	ND	ND	ND	ND	ND
Phenanthrene	μg/kg	330	ID	ND	ND	ND	ND	ND	600	ND
Pyrene	μg/kg	330	4,000	ND	ND	ND	ND	ND	1,200	ND
Polychlorinated Biphenyls (PCBs)	Units									
PCB Aroclors	μg/kg	33	@1,000	ND	ND	ND	ND	ND	ND	ND
Volatile Organic Compounds Detected (BTEX)	Units									
Benzene	μg/kg	10	20	76	ND	ND • •	ND	ND	ND	ND
Ethylbenzene	μg/kg	10	1,400	440	ND	ND • •	ND	ND	ND	ND
Toluene	μg/kg	10	16,000	56	ND	ND • •	ND	ND	ND	ND
Xylenes (o,m, and p)	μg/kg	30	6,000	1,400	ND	ND • •	ND	ND	ND	ND
Total Lead	mg/kg	1	0.08	10	7.3	6.9	6.6	3.7	4.6	3.8

Notes:

- μg/kg = microgram per kilogram
- @ = Direct contact value
- mg/kg = milligram per kilogram
- Shaded numbers are organic compounds detected above Type B criteria
- ND = not detected
- ID = Insufficient data for MDNR to establish Type B Criteria
- • • = Based on total lead

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SUMMARY OF SOIL SAMPLE LABORATORY ANALYTICAL RESULTS
FORMER TANK FARM No. 37
BOC - Flint Automotive Division

Sample ID Sample Designation Sample Date Sample Depth (in feet)		Type A Criteria	Type B Criteria 20 X GW	MW-10D SS-4 7/23/92 8.5 - 10.5	TB-10 SS-1 7/21/92 14-16	TB-10 SS-5 7/21/92 24 - 26
Polynuclear Aromatics (PNAHs)	Units					
Acenaphthene	µg/kg	330	8,000	ND	ND	ND
Acenaphthylene	µg/kg	330	ID	ND	ND	ND
Anthracene	µg/kg	330	40,000	ND	ND	ND
Benzo(a)anthracene	µg/kg	330	@200	ND	ND	ND
Benzo(a)pyrene	µg/kg	330	@200	ND	ND	ND
Benzo(b)fluoranthene	µg/kg	330	@200	ND	ND	ND
Benzo(ghi)perylene	µg/kg	330	ID	ND	ND	ND
Benzo(k)fluoranthene	µg/kg	300	@200	ND	ND	ND
Chrysene	µg/kg	330	@200	ND	ND	ND
Dibenzo(a,h)anthracene	µg/kg	330	@200	ND	ND	ND
Fluoranthene	µg/kg	330	6,000	ND	ND	ND
Fluorene	µg/kg	330	6,000	ND	ND	ND
Indeno(1,2,3-cd)pyrene	µg/kg	330	@200	ND	ND	ND
Naphthalene	µg/kg	330	600	ND	ND	ND
Phenanthrene	µg/kg	330	ID	ND	ND	ND
Pyrene	µg/kg	330	4,000	ND	ND	ND
Polychlorinated Biphenyls (PCBs)	Units					
PCB Aroclors	µg/kg	33	@1,000	ND	ND	ND
Volatile Organic Compounds Detected (BTEX)	Units					
Benzene	µg/kg	10	20	ND	ND • •	ND
Ethylbenzene	µg/kg	10	1,400	ND	ND • •	ND
Toluene	µg/kg	10	16,000	ND	ND • •	ND
Xylenes (o,m, and p)	µg/kg	30	6,000	ND	ND • •	ND
Total Lead	mg/kg	1	0.08	3.2	3.9	9.4

Notes:

- µg/kg = microgram per kilogram
- @ = Direct contact value
- mg/kg = milligram per kilogram
- Shaded numbers are organic compounds detected above Type B criteria
- ND = not detected
- ID = Insufficient data for MDNR to establish Type B Criteria

TABLE 3
SUMMARY OF GROUNDWATER SAMPLE LABORATORY ANALYTICAL RESULTS
DETECTED COMPOUNDS ONLY
FORMER TANK FARM No. 37
BOC - Flint Automotive Division

Sample ID Sample Date Screen Interval (in feet)		Type A Criteria	Type B Criteria	SEC.1 MW-2 7/28/92 7.7 - 12.7	SEC. 12 MW-4 7/28/92 10.5 - 15.5	MW-4D 7/28/92 14.3 - 19.3	MW-5 7/28/92 13.1 - 18.1	MW-6 7/28/92 12.9 - 17.9	MW-7 7/28/92 9.5 - 14.5
Polynuclear Aromatics (PNAHs)	Units								
Phenanthrene	μg/L	5	ID	ND	ND	ND	ND	ND	ND
Polychlorinated Biphenyls (PCBs)	Units								
PCB Aroclors	μg/L	0.1	0.02	ND	ND	ND	ND	ND	ND
Volatile Organic Compounds (BTEX)	Units								
Benzene	μg/L	1	1	ND	ND	ND	1.5	ND	ND
Ethylbenzene	μg/L	1	70	ND	ND	ND	16	ND	ND
Toluene	μg/L	1	800	ND	ND	ND	2.9	ND	ND
Xylenes (o,m, and p)	μg/L	3	300	ND	ND	ND	56	1.9	ND
Trichloroethene	μg/L	1	3	ND	ND	ND	ND	ND	39
1,1,1-Trichloroethane	μg/L	1	200	ND	ND	ND	ND	ND	28.0
1,1-Dichloroethane	μg/L	1	700	ND	ND	ND	ND	ND	6
1,1-Dichloroethene	μg/L	1	7	ND	ND	ND	ND	ND	2.4
cis-1,2-Dichloroethene	μg/L	1	70	ND	ND	ND	ND	ND	42
Vinyl Chloride	μg/L	1	0.02	ND	ND	ND	ND	ND	6.2
Dissolved Lead	μg/L	3	4 • • •	ND	ND	ND	4.9	3.7	6.4

Notes:

μg/L = microgram per liter
• • • = based on total lead

ND = not detected
ID = Insufficient data for MDNR to establish Type B Criteria
Shaded numbers are detected above Type B criteria

TABLE 3 (Page Two)
SUMMARY OF GROUNDWATER SAMPLE LABORATORY ANALYTICAL RESULTS
DETECTED COMPOUNDS ONLY
FORMER TANK FARM No. 37
BOC - Flint Automotive Division

Sample ID Sample Date Screen Interval (in feet)		Type A Criteria	Type B Criteria	MW-8 7/28/92 10.9 - 15.9	MW-8 Dup 7/28/92 10.9 - 15.9	MW-9 7/28/92 9.9 - 14.9	MW-10S 7/28/92 9.9 - 14.2	MW-10D 7/28/92 14.8 - 19.8
Polynuclear Aromatics (PNAHs)	Units							
Phenanthrene	µg/L	5	ID	6	5	ND	ND	ND
Polychlorinated Biphenyls (PCBs)	Units							
PCB Aroclors	µg/L	0.1	0.02	ND	ND	ND	ND	ND
Volatile Organic Compounds (BTEX)	Units							
Benzene	µg/L	1	1	ND	ND	ND	ND	ND
Ethylbenzene	µg/L	1	70	ND	ND	ND	ND	ND
Toluene	µg/L	1	800	ND	ND	ND	ND	ND
Xylenes (o,m, and p)	µg/L	3	300	ND	ND	ND	ND	ND
Trichloroethene	µg/L	1	3	ND	ND	ND	ND	ND
1,1,1-Trichloroethane	µg/L	1	200	47	62	ND	ND	ND
1,1-Dichloroethane	µg/L	1	700	20	24	ND	ND	ND
1,1-Dichloroethene	µg/L	1	7	ND	ND	ND	ND	ND
cis-1,2-Dichloroethene	µg/L	1	70	200	290	ND	ND	ND
Vinyl Chloride	µg/L	1	0.02	ND	ND	ND	ND	ND
Dissolved Lead	µg/L	3	4 • • •	3.0	ND	ND	ND	ND

Notes:

- µg/L = microgram per liter
- • • • = based on total lead
- ND = not detected
- ID = Insufficient data for MDNR to establish Type B Criteria
- Shaded numbers are detected above Type B criteria

TABLE 4

GENERAL MOTORS TANK FARM 37

ADDITIONAL DELINEATION

SOIL SAMPLE RESULTS

Advanced Project No. 4124BQ

Parameters	Sample ID																						Type B Cleanup Criteria	Industrial Type C Cleanup Criteria
	G-1 10-12'	G-2 10-12'	G-6 10-12'	G-9 10-12'	G-12 12-14'	G-13 12-14'	G-14 8-10	G-15 6-8'	G-15 8-10'	G-20 6-8'	G-20 8-10'	G-21 6-8'	G-21 8-10'	G-22 6-8'	G-22 8-10'	G-23 6-8'	G-23* 8-10'	G-24 10-12'	G-25 6-8'	G-25 8-10'	G-26 6-8'	G-26 8-10'		
Benzene (µg/kg)	NA	NA	NA	NA	NA	NA	<10	3,500	3,400	<10	<10	<10	500	<10	<10	<10	520	NA	NA	NA	NA	NA	24	85,000
Toluene (µg/kg)	NA	NA	NA	NA	NA	NA	<10	3,500	4,500	<10	<10	<10	140	<10	<10	<10	240	NA	NA	NA	NA	NA	2,200	33,000,000
Ethylbenzene (µg/kg)	NA	NA	NA	NA	NA	NA	<10	120,000	24,000	<10	<10	<10	100	<10	<10	<10	1,600	NA	NA	NA	NA	NA	620	14,000,000
Xylenes (µg/kg)	NA	NA	NA	NA	NA	NA	<30	400,000	77,000	<30	<30	<30	320	<30	<30	<10	6,500	NA	NA	NA	NA	NA	1,200	270,000,000
MTBE (µg/kg)	NA	NA	NA	NA	NA	NA	<100	<50,000	<2,000	<100	<100	<100	<2,000	<100	<100	<100	<1,000	NA	NA	NA	NA	NA	4,600	4,600,000
Lead (mg/kg)	NA	NA	NA	NA	NA	NA	5.3	6.0	25.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	80	400
TPH (mg/kg)	<1	40,800	32	374	82,900	2,700	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	--	--
Diesel Range Organics (mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<5	<5	110	<5	<5	<5	<5	--	--
Gasoline Range Organics (mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<1	14.1	NA	NA	NA	NA	NA	--	--

Notes:

- MDL for soil samples 10 µg/kg
- MTBE = methyl tertiary butyl ether
- NA = Not Analyzed
- Soil samples collected over the period of June 8, 9, 10, and 16, 1994.
- Type B criteria from *MERA Operational Memorandum #8, Revision #3*, dated February 4, 1994.
- Type C criteria from *MERA Operational Memorandum #14, Revision #1*, dated June 21, 1994.
- Concentrations of PNAHs for the soil sample collected from the G-23 location at the 8-10 foot depth below grade were <330 ppb.

TABLE 5

GENERAL MOTORS TANK FARM 37

ADDITIONAL DELINEATION

WATER SAMPLE RESULTS

Advanced Project No. 4123BQ

Parameters	Sample ID															Type B Cleanup Criteria	Industrial Type C Cleanup Criteria
	G-1	G-6	G-8	G-9	G-13	G-14	G-15	G-20	G-21	G-22	G-23	G-24	G-25	G-26	MW2		
Oil & Grease (mg/L)	<10	<10	67	5,900	31	NA	NA	NA	NA	NA	<10	330	36	<10	NA	--	--
Benzene (μg/L)	NA	NA	NA	NA	NA	5	140	<1	<1	<1	NA	NA	NA	NA	<1	1.2	5
Toluene (μg/L)	NA	NA	NA	NA	NA	<1	3.0	2.0	<1	<1	NA	NA	NA	NA	<1	790	790
Ethylbenzene (μg/L)	NA	NA	NA	NA	NA	2	280	1	<1	<1	NA	NA	NA	NA	<1	74	74
Xylenes (μg/L)	NA	NA	NA	NA	NA	5	590	6	<3	<3	NA	NA	NA	NA	<3	280	280
MTBE (μg/L)	NA	NA	NA	NA	NA	<50	<50	<50	<50	<50	NA	NA	NA	NA	<50	230	690

Notes:

- Water samples collected over the period of June 8, 9, 10, and 16, 1994.
- MTBE = methyl tertiary butyl ether
- Equipment Blank for Oil and Grease is <10 mg/L.
- NA = Not Analyzed
- Type B criteria from *MERA Operational Memorandum #8, Revision #3*, dated February 4, 1994.
- Type C criteria from *MERA Operational Memorandum #14, Revision #1*, dated June 21, 1994.

TABLE 6

GM TANK FARM 37
SOIL REMEDIATION ALTERNATIVE EVALUATION SUMMARY

Remedial Method		Advantages	Disadvantages
1.	Soil Excavation and Replacement	Can be implemented quickly; area disruption short term.	Excavation limited due to presence of bridge, new tank farm, and pipe chase; possible disruption of truck traffic to engine plant; liability for accidental spillage of soils during transit; costs incurred immediately; contamination relocated.
2.	On-site Thermal Desorption	In-situ treatment method; destroys BTEX contaminants; can fill excavation with treated soil; can be implemented quickly; no O&M costs.	Will require nearby fuel source and electrical drop; air permit required; permitting may invoke extensive monitoring requirements; permits may delay implementation of remedial action; costs incurred immediately.
3.	Soil-Vapor Extraction	In-situ treatment method; limited disruption of area; lower range of initial capital investment costs.	Uncertain operational period; capital costs incurred immediately; O&M costs.
4.	On-site Bioremediation	In-situ treatment; lower range of initial capital investment; limited disruption to area; contaminants converted to non-hazardous compounds.	May not attain desired clean closure levels; may have "dead spots" in area to be remediated if bacteria die or are not evenly distributed in soil; longer-term remedial action is likely; possibly affected by cold temperatures and temperature fluctuations; long-term O&M costs.
5.	Steam Injection/Excavation Wells for Oil Recovery	In-situ treatment method; steam readily available; water generated from dewatering and oil recovered from steam injection can be readily treated.	Innovative approach, not a tested method, implying a risk of failure; thermodynamic approach must be analyzed as well as structural integrity of tank farm; possible subsidence from dewatering and soil temperature change; uncertain if aquifer could be dewatered sufficiently for steam injection.
6.	Soil Washing With Surfactant	In-situ treatment method; limited disruption to area.	Significant volumes of water would be needed to flush the system; uncertain time period for meeting cleanup criteria; surcharge for groundwater discharge to POTW.
7.	MERA Type C Closure After Free Product Removal	Low capital cost; closure can be requested after removal of free product on the groundwater.	Public hearing; financial responsibility; deed restriction; long-term O&M costs; removal of source area and capping of former tank farm would still need to be completed.

TABLE 7

COST SUMMARY
SOIL REMEDIATION ALTERNATIVES
GM TANK FARM 37

Remedial Method	Capital Cost	O&M Costs	O&M Cost (Present Value)	Total Cost (Present Value)
Soil Excavation and Disposal	$541,085.00	-0-	-0-	$541,085.00
Thermal Desorption	$234,262.00	-0-	-0-	$234,262.00
Soil Vapor Extraction (BTEX)	$75,500.00	6 months: $ 15,140.00 3 years: $ 73,950.00 5 years: $128,330.00	$15,140.00 $58,701.00 $87,328.00	$ 90,640.00 134,201.00 162,828.00
Soil Excavation (Oil)	$268,576.00	-0-	-0-	$268,576.00 (5 years) $431,404.00
Bioremediation	(6 months) $ 31,925.00			
Excavation & Disposal	(with closure) $269,625.00			(6 months) $301,550.00
Steam Injection Extraction Wells	$171,200.00	(5 years) $12,500.00	$8,506.00	$179,706.00
Soil Washing	Pilot Tests Needed			
MERA Type C Controls With Free Product Recovery	$39,520.00	(5 years) $48,200.00		
Type C Request Preparation	$20,000.00			

Notes:

- Present values assumes 8% interest rate.
- The economics of each approach would need to be verified by pilot studies in the field.

TABLE 8

GM TANK FARM 37
GROUNDWATER REMEDIATION ALTERNATIVE EVALUATION SUMMARY

Remedial Method	Advantages	Disadvantages
1. Pump and Treat	Demonstrates active recovery of free product to the MDNR; large initial recovery of groundwater contaminants.	Inefficient method; slow rate of contaminant recovery after initial recovery; MERA Type A/B cleanup criteria may not be reached; long period of operation; large volumes of water generated which will have a surcharge for disposal at the POTW; O&M costs.
2. Free Product Recovery for Oil Spray Aeration Vapor Extraction for BTEX.	Increased contaminant recovery when combined with soil treatment; in-situ treatment method; demonstrates active recovery of free product to the MDNR.	Uncertain operational period; O&M costs.
3. Bioremediation	In-situ treatment method; lower capital costs.	Uncertain operational period; O&M costs.

TABLE 9

COST SUMMARY
GROUNDWATER REMEDIATION ALTERNATIVES
GM TANK FARM 37

Remedial Method	Capital Cost	O&M Costs	O&M Cost (Present Value)	Total Cost (Present Value)
Pump and Treat	$ 23,481.00	1 year: $ 4,420.00 3 years: 13,260.00 5 years: 22,100.00	4,420.00 10,526.00 15,040.00	$27,901.00 34,007.00 38,521.00
Free Product Recovery/Spray Aeration Vapor Extraction (S.A.V.E.)				6 months: $221,767.00 3 years: 272,184.00 5 years 305,325.00
Bioremediation	Pilot Testing Required			

Notes:

- Present values assumes an 8% interest rate.
- The economics of each approach would need to be verified by pilot studies in the field.