DRAFT FINAL

Privileged & Confidential
Prepared at Request of General Motors Counsel

Baseline Environmental Site Assessment Buildings 37 and 44, Delphi-Flint West Facility Flint, Michigan

General Motors Corporation
Worldwide Facilities Group -
Environmental Remediation and
International Environmental Support

Detroit, Michigan

February 1999

DRAFT FINAL

TECHNICAL REPORT

Privileged and Confidential
Prepared at Request General Motors Counsel

Baseline Environmental Site Assessment, Buildings 37 and 44, Delphi-Flint West Facility, Flint, Michigan

General Motors Corporation,
Worldwide Facilities Group - Environmental Remediation &
International Environmental Support,
Detroit, Michigan

February 1999

BBL
BLASLAND, BOUCK & LEE, INC.
engineers & scientists

185 N.W. Spanish River Boulevard
Boca Raton, Florida 33431-4230
(561) 750-3733

Table of Contents

LIST OF ACRONYMS

ACM	Asbestos-containing materials
AST	Above-ground storage tank
ASTM	American Society for Testing and Materials
BBL	Blasland, Bouck & Lee, Inc.
BDL	Below detection limit
BESA	Baseline Environmental Site Assessment
BLS	Below land surface
Brighton	Brighton Analytical laboratories, Inc.
CE	Consumer's Energy
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation and Liability Information System
CFC	Chlorofluorocarbons
CFR	Code of Federal Regulations
cm/sec	centimeters per second
COC	Chain of Custody
DCE	Dichloroethene
DCC	Direct Contact Criteria
EPA	Environmental Protection agency
ERD	Environmental Response Division
ERIIS	Environmental Risk Information and Imaging Services
ERNS	Emergency Response Notification System
ESA	Environmental Site Assessment
FOIA	Freedom of Information Act
gpd/ft	gallons per day per foot
gpd/ft^2	gallons per day per square foot
GCC	Groundwater Contact Criteria
GM	General Motors Corporation
gpm	gallons per minute
GSI	Groundwater/surface water interface
HWS	Michigan Environmental Contamination List (hazardous waste sites)
LRST	Michigan Leaking Underground Storage Tank List
LUST	Leaking underground storage tank
MDEQ	Michigan Department of Environmental Quality
MERA	Michigan Environmental response Act
NFRAP	No Further Remedial Action Planned
NPL	National Priorities List
NREPA	Natural Resources and Environmental Protection Act
OBG	O'Brien & Gere
PA	Public Act
PAOC	Potential Area of Concern
ppm	parts per million
PSIC	Particulate Soil Inhalation Criteria
RAATS	RCRA Administrative Action tracking System
RCRA	Resource Conservation and Recovery Act
RCRIS	Resource Conservation and Recovery Information System
RQ	Reportable Quantities
RST	Michigan Facility and Tank Data Report (Registered storage tank)
SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization Act 0f 1986

SME	Soil and Materials Engineers, Inc.
SVOC	Semi-Volatile Organic Compounds
SWD	Solid Waste Division
SWF	Solid waste facilities
SWP	Soil Water Partitioning
TCE	Trichloroethene
TVA	Toxic vapor Analyzer
UCL	Upper confidence limit
USCS	Unified Soil Classification System
USEPA	United States Environmental Protection Agency
USPCI	United States Pollution Control, Incorporated
UST	Underground Storage Tank
USTD	Underground Storage Tank Division
VOC	Volatile Organic Compounds
VSIC	Volatile Soil Inhalation Criteria
WMD	Waste Management Division
μg/kg	micrograms per kilogram
μg/L	micrograms per liter

PART A - INTRODUCTION

1. Introduction

1.1 Purpose

This Baseline Environmental Site Assessment Report summarizes the results of an environmental site assessment and investigation work conducted at Buildings 37 and 44 and in the immediate surrounding areas (the Property) at Delphi-Flint West, General Motors Corporation (GM), located in Section 12, Township 7 North, Range 6 East, Flint, Genessee County, Michigan (Figure A-1). This document is a compilation of recent environmental assessment and investigation work completed at the property in anticipation of the sale of the parcel. The intent of this document is to summarize current environmental conditions at this parcel and establish a baseline of environmental conditions at the time that the parcel is sold separate current and future environmental liability.

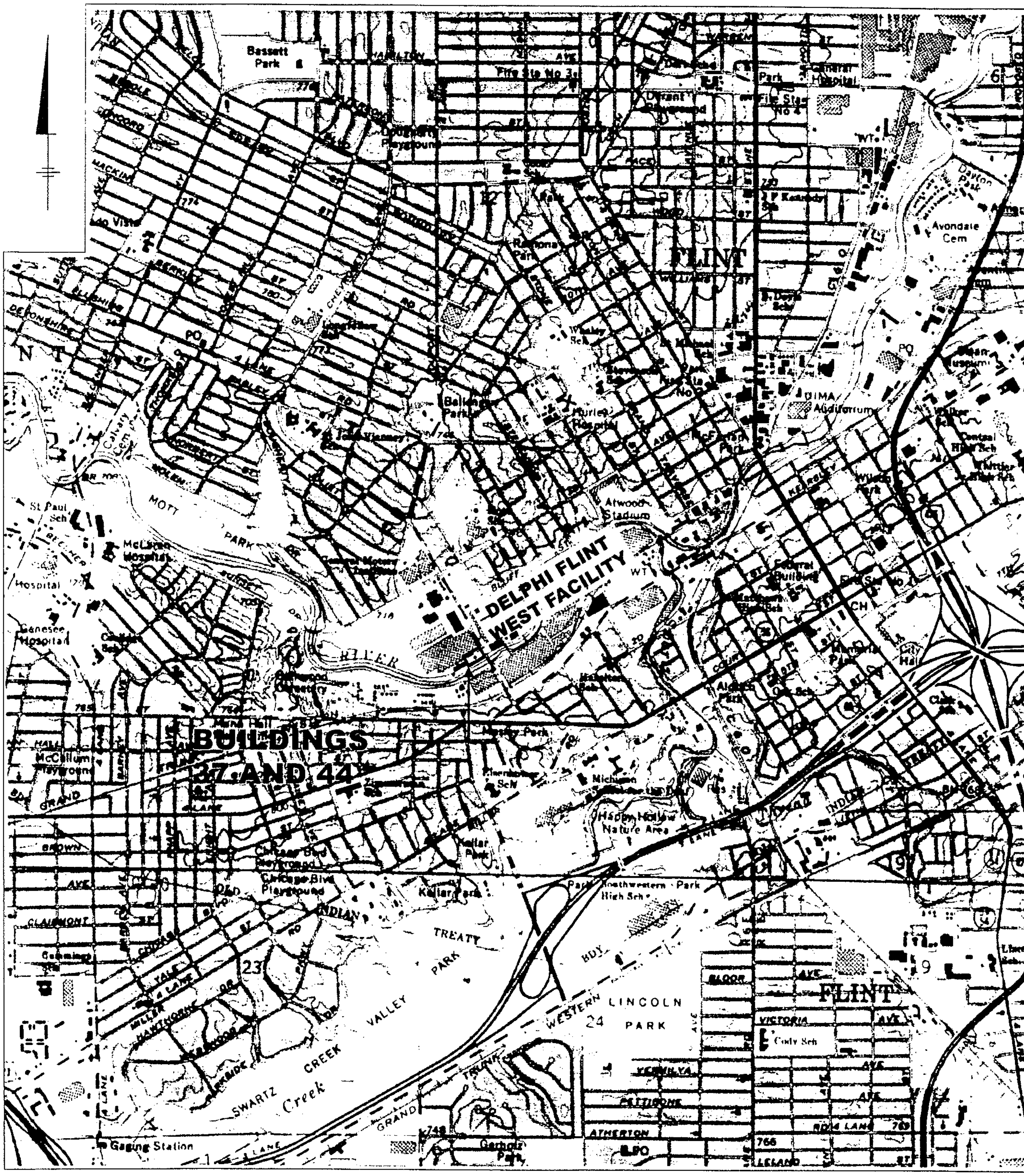
1.2 Report Organization

The remainder of this report is divided into three parts. Part B is a summary of the Phase I Environmental Site Assessments (ESAs) prepared by BBL (1997). Part C includes a summary of the Phase II ESA conducted by Soil and Materials Engineers, Inc. (SME) to confirm or deny the release of contaminants suspected based on both a Phase I ESA performed by SME and on current and expected future land use. Part C also includes an overall evaluation of the field data collected by SME. Figures and tables are included in the relevant parts of this document.

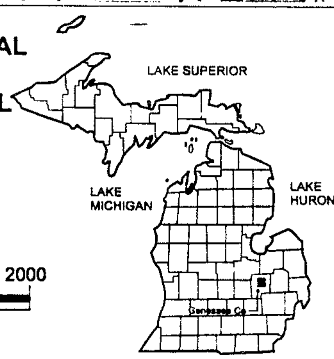
1.3 Baseline Environmental Site Assessment (BESA) Limitations

The conclusions reached herein are based on the limits of the investigation described in this report. BBL can offer no assurances and assumes no responsibility for Property conditions or activities that were outside of the scope of inquiry provided. In performing its investigation, BBL has used usual and customary practices, and has performed the scope of work by keeping within industry standards as defined in ASTM Standard Practice E 1527-97 and standard agency procedures, as appropriate. It is understood that BBL has relied on the accuracy of documents, oral information, and other material and information provided by sources documented in this report. BBL has analyzed the information obtained in this investigation, in keeping with existing environmental standards and enforcement practices, but cannot accurately predict what actions any given agency make take presently, or what standards and practices may apply to the subject Property in the future.

PART A - FIGURES



PRIVLEGED AND CONFIDENTIAL
PREPARED AT REQUEST
GENERAL MOTORS COUNSEL



MAP SOURCE:
UNITED STATES GEOLOGIC SURVEY TOPOGRAPHIC QUADRANGLE, 7.5 MIN. SERIES,FLINT NORTH & FLINT SOUTH, MICHIGAN, (1969).

2000 0 2000
APPROXIMATE SCALE IN FEET

9/29/98 BOC-54-APD
48076003\48067084.CDR

GENERAL MOTORS CORPORATION
BUILDINGS 37 AND 44
DELPHI FLINT WEST FACILITY. FLINT, MICHIGAN
BASELINE ENVIRONMENTAL SITE ASSESSMENT

PROPERTY LOCATION MAP

BBL BLASLAND, BOUCK & LEE, INC.
engineers & scientists

FIGURE
A-1

PART B - PHASE I ENVIRONMENTAL SITE ASSESSMENT SUMMARY

1. Site Description

1.1 Property Description

Building 37 was constructed in 1966 and is used as the primary switchhouse for distributing electrical power to the Flint West Facility. The Property consists of a parcel of approximately 22,175 square feet, and Building 37 has a total floor space of approximately 3,000 square feet. The yard on the east side of Building 37 (Building 37 Yard) comprises an area of approximately 6,800 square feet. An electrical substation located on the west side of Building 37 comprises 12,375 square feet. Building 37 is a one story structure on a concrete base consisting of brick walling up to approximately 3 ½ feet with metal insulated walls from there up to a flat roof.

Building 44 is a small building with a floor space of approximately 515 square feet and is currently used to store spill response equipment and office furniture. The Property formerly housed the pumps for supplying fuel oil to Building 11, (the power house). The power house is located east of Building 44 across Chevrolet Avenue. Building 44 consists of a one story structure on a concrete base consisting of brick walling approximately 3 ½ feet high with metal insulated walls and a flat roof.

The Property is located on the west side of Chevrolet Avenue, north of the Flint River. The Property is bordered by the concrete channelized Flint River to the south, the former Building 2A location to the north, and a four-lane paved road (Chevrolet Avenue) to the east. On the west side of the electrical substation and the south side of the former Building 2A is the location of the former coal stockpile for Building 2A. Attached to the north side of Building 44 is a chainlink enclosed compound which contains piping and metering equipment for the Consumers Power natural gas main.

1.2 Surrounding Land Use

Figure B-1 shows the surrounding land use in the vicinity of the Property. Buildings associated with Flint West are situated along a one mile stretch of the Flint River. Previously, the Flint West Facility consisted of approximately 40 buildings, several of which have undergone closure and demolition. Buildings at the Flint West Facility range from a few hundred-square feet to more than 700,000-square feet in size. The surrounding properties associated with the Facility were developed for the manufacture and assembly of automobiles and automobile parts as early as 1915.

On the east side of Chevrolet Avenue are Building 2 and Building 11. Building 2 is a 500,000-square-foot building formerly used for injection molding and painting of radiator grills, gas tank reservoirs, and headlamp bezels. Building 11 is a 64,000-square-foot power house that supplies steam and compressed air for the entire Facility. According to Facility records, Building 2 and Building 11 were constructed in 1916.

Building 30, Building 42, and the location of the former Building 5 are south of the Property, across the Flint River. These buildings and four holding tanks comprise the Facility's industrial wastewater treatment plant (WWTP). According to Facility records, Building 30 was constructed in 1949 and Building 42 was constructed in 1968. Prior to its demolition in August 1995, Building 5 shared a common wall with Building 30. Building 5, a 176,000-square-foot building constructed in 1926, was originally used to manufacture valves, camshafts, and cylinder cases. During the site inspection, the former Building 5 location consisted of a grassy area surrounded by a chainlink fence. BBL conducted Phase II site investigation activities at the former Building 5 area, and documented LNAPL and elevated lead concentrations were identified at the site (BBL, February 1997).

On the north side of the Property is the former Building 2A location. Manufacturing and assembly ceased at Building 2A in November 1994. Demolition activities of Building 2A began in October 1995 and were completed in February

1996. During the site inspection, the former Building 2A consisted of concrete areas and patches of gravel enclosed by a chainlink fence. BBL conducted Phase II site investigation activities at the former Building 2A area, and elevated dissolved hydrocarbons and zinc concentrations were identified at the site (BBL, June 1997).

Residential neighborhoods surround the entire Facility, but do not abut the parcel where the Property is located. The private homes closest to the Property are approximately three-quarters of a mile to the north and northwest (as shown in the Appendix A aerial photograph). A large residential neighborhood is located across the Flint River and south of the former Building 5 location across Glenwood Avenue.

Figure B-1 shows the surrounding land use in the vicinity of Buildings 37 and 44. Buildings associated with Flint West are situated along a one mile stretch of the Flint River and summarized in Table B-1. Previously, the Flint West Facility consisted of approximately 40 buildings, several of which have undergone closure and demolition. Buildings at the Flint West Facility range from a few hundred-square feet to more than 700,000-square feet in size. The surrounding properties associated with the Facility were developed for the manufacture and assembly of automobiles and automobile parts as early as 1915.

1.3 Topography

Property topography is affected by the proximity of the Property to the Flint River. The Property is bordered by the river on the south side and is approximately 756 feet above mean sea level (MSL). The Property was approximately 10 to 13 feet above the water level of the river at the time of BBL's site visit. The topography on the Property is generally flat, but the surrounding land is sloped towards the Flint River.

1.4 Geologic and Hydrogeologic Settings

Pleistocene glacial drift overlays Paleozoic sedimentary rocks in the Flint area (Wiitala *et al.*, 1963). Pre-Cambrian igneous and metamorphic rocks of the Canadian shield form the bedrock upon which several thousand feet of sandstone, limestone, shale, and evaporites of the Michigan Basin have been deposited. The Flint area is located in the southeast portion of the basin.

Glacial drift of generally low hydraulic conductivity mantles the bedrock in nearly all parts of Genesee County. These deposits consist of clay, silty sand, gravel, and boulders. Hydraulic conductivity is highly variable in both the horizontal and vertical planes. Glacial deposits, in general, are an important source of water in Michigan. However, outwash plains and buried stream valleys are the most productive facies. The lacustrine deposits that are predominant in the vicinity of Flint have low permeabilities due to the abundance of clay (Wiitala *et al.*, 1963). Thin lenses of permeable sand and gravel yield adequate water for domestic use, but the primary source of groundwater in communities surrounding the Flint area is the Pennsylvanian Saginaw aquifer (Wiitala *et al*,. 1963). The City of Flint itself purchases water from the City of Detroit, which obtains water from Lake Huron (City of Flint Water Services, personal communication). The glacial deposits are approximately 50 feet thick in the vicinity of Flint (Genessee County Department of Public Health, personal communication). The top of the Saginaw formation lies between 600 and 700 feet above mean sea level MSL. The Property is approximately 756 feet above MSL.

In the vicinity of Flint, sandstones of the Pennsylvanian Grand River and Saginaw formations form the uppermost bedrock aquifer. Fractures greatly enhance the permeability of the sandstone beds. The thickness of the Grand River-Saginaw aquifer varies from 200 feet to 400 feet (Mandle and Westjohn, 1989).

Shale, siltstone, and thin-bedded sandstone intercalated with shale of the lower Saginaw formation serve as a regional confining unit separating the Grand River-Saginaw aquifer from the Parma-Bayport aquifer (Wiitala *et al*,. 1963). The Late Mississippian Bayport Limestone and the Early Pennsylvanian Parma Sandstone Member of the Saginaw

formation make up the Parma-Bayport aquifer. The Bayport Parma aquifer is not used as a source of water in the vicinity of Flint (Westjohn and Weaver, 1996).

The Mississippian Michigan formation lies beneath the Saginaw formation. The upper portion is composed of shale, thin-bedded limestone, dolomite, gypsum, and anhydrite, and separates the Parma-Bayport aquifer from the Marshall aquifer (Mandle and Westjohn, 1989). Sandstones in the lower portion are hydraulically connected to the Early Mississippian Marshall Sandstone below and compose the Marshall aquifer. The thickness of the Michigan formation averages around 100 feet in the vicinity of Flint (Wiitala *et al.*, 1963).

The Marshall formation is present in most of Genesee County. It consists primarily of sandstone, with some beds of conglomerate, shale, and dolomite. Thickness varies from over 200 feet in the northern part of the county to 70 feet in the south. In some places, the Marshall, Michigan, and Saginaw formations form a single aquifer (Wiitala *et al.*, 1963).

The Early Mississippian Coldwater Shale forms the base of the aquifer system and ranges in thickness from 500 to 1,100 feet.

1.4.1 Site Specific Geology

Land surface surrounding Buildings 37 and 44 is asphalt paved. Based on soil borings performed as part of Phase II ESI activities conducted at the former Building 2A (BBL, June 1997) near-surface lithology consists of sand and gravel fill material in the uppermost five feet. A yellowish brown sand is present from 5 feet to 15 feet below land surface (BLS). A gray clay is present from 15 to 20 feet BLS. The depth of the clay increases towards the Flint River as the sand and gravel layer (and fill) thickens. The native clay and till in the Flint vicinity are not useable aquifers. The lithology is as follows:

Sample Interval	Description
0-1.0 feet BLS	Concrete
1-5 feet BLS	Reddish black sand, fine to coarse grained, trace of gravel, trace of clay
5-9 feet BLS	Light yellowish brown sand, fine to medium grained
9-15 feet BLS	Dark yellowish brown sand, fine to medium grained
15-20 feet BLS	Clay, grey, soft, cohesive

The till in the Flint vicinity is not a useable aquifer. According to the Genesee County Health Department (personal communication), there were no potable water wells drilled to tap the glacial drift since 1967, when records were first required. Local regulations require that an aquifer used for potable water be at least 25 feet thick. In addition, Michigan Department of Public Health regulations require all potable wells to be cased to 25 feet BLS (Rule 818). Personnel from the City of Flint Water Services stated that hookup to the municipal water supply is mandatory within City limits.

Based on groundwater elevation data collected on July 20, 1996 (after one week of little or no precipitation) and August 4, 1996 (within 24 hours after a 48 hour rain event) groundwater flows primarily towards the Flint River (O'Brien & Gere's Summary Report - Subsurface Assessment, Delphi Flint West Facility, Flint, Michigan, January 3, 1996). This data concurs with additional file reports on the surrounding area, that determined a groundwater flow direction towards the Flint River (BBL, 1997). The water table in the area lies approximately 4 to 16-feet BLS, depending on distance from the Flint River.

The State of Michigan Act 451 Part 201 Administrative Rules (R299.5101(c)) and the Code of Federal Regulation (CFR, Part 40, Section 149.2) define an aquifer as *"... a geological formation, group of formations, or part (portion) of a formation that is capable of yielding a significant amount of ground water to wells or springs."* The thin surficial water bearing unit at the site has a very low transmissivity [10^{-4} to 10^{-5} centimeters per second (cm/sec)] and does not meet the definition of an aquifer for the following reasons:

1. The unit does not yield enough water for it to be considered an economically viable water source; and,

2. The natural water quality of the surficial water-bearing unit is highly mineralized and is such that extensive treatment would be required prior to use.

The practical definition of an aquifer is further clarified in the book *Groundwater and Wells* as "a saturated bed, formation, or group of formations which yields water in sufficient quantity to be economically useful (Driscoll, 1986)." From an economical standpoint, wells that yield less than approximately 2 gallons per minute (gpm) are not useful as water supply. Site-specific data collected from the Flint West facility was input into the Cooper-Jacob equation to estimate sustainable flow from the surficial water-bearing unit, as follows:

$$Q = \frac{s\ T}{264\ \log\ 0.3\ \frac{Tt}{r^2 S}}$$

Where Q = pumping rate, gpm
T = transmissivity, gallons per day per foot (gpd/ft) = K*b
K = conductivity, gpd/ft^2 = 4.2
(site data, BBL, June 1997)
s = drawdown, feet = 5
r = distance from pumping well, feet = 5
t = time since pumping started, days = 365
b = saturated thickness, feet = 5
S = storage coefficient, dimension less = 0.15

$$Q = \frac{5\ x\ 21}{264\ \log\ 0.3\ (\frac{21\ x\ 365}{5^2\ x\ 0.15})} = 0.14 gpm$$

This projection was verified by data from short-term pumping at monitoring wells installed for leaking underground storage tank (LUST) investigation at the nearby Building 2A (ES&E, January 8, 1992). Results of a step drawdown test indicated that 1 gpm was the maximum sustainable pumping rate for the pump test. This information further supports the determination that the surficial water-bearing unit cannot be considered an aquifer.

A review of well completion records from Genesee County indicated that potable wells in the area are open to the Saginaw sandstone below the glacial deposits.

In addition, and as added emphasis, there are several institutional reasons that this water unit could not be used as a potable aquifer, namely:

1. Other much more productive and economically viable aquifer sources are readily available in the area;

2. The surficial medium-to-fine grained sand unit is highly variable in thickness, and is not thick enough to support the amount of casing required by the State of Michigan Department of Health for public potable water supply wells (25 feet) throughout much of the Flint West property. State regulations (Michigan Drinking Water Regulations, R 325.10818) require that casings for potable water supply wells extend at least 25 feet BLS.;

3. The Genesee County Health Department will not issue permits for public potable water supply wells within the Flint City limits; and,

4. Potable water is readily available throughout the Flint area from the municipal utility and hookup is mandatory.

1.5 Hydrology

Storm water runoff is collected in a catch basin located between Buildings 37 and 44 and from roof drains associated with the site and transferred through a storm sewer line (tied into a storm water outfall) to the Flint River.

1.6 Surface Water

As previously noted, the Flint River lies to the south of the Property and is controlled and contained within a concrete channel. The channel was constructed in 1966 and 1967 by the United States Army Corps of Engineers for flood control. Schwartz Creek lies to the west and south of the Property and is a tributary to the Flint River.

1.7 Historical Land Use

Neither Building 37 nor Building 44 were visible on historical Sanborn maps dated 1928, 1950, and 1970. However, Facility records indicate that Building 37 was constructed in 1966 and operated as the primary switchhouse for at the Facility. Electrical power distribution equipment was present in Building 37 during the site inspection. Facility records indicate that Building 44 was constructed in 1971 and operated as a pump house for supplying fuel oil to the power house at the Flint West Facility. In 1989 the pumps were removed from Building 44. Building 44 currently contains spill response equipment and office furniture.

Facility personnel reported that underground storage tanks (USTs) were once located in the Building 37 Yard. Four 50,000-gallon USTs stored fuel oil for use at Building 11 (the power house). In addition, there was a 550-gallon UST that contained excess fuel oil released during pump house operations. According to the Phase I UST Compliance Report (Hunter/Keck, 1989), these USTs were removed in 1989. The locations of the former USTs are shown on Figure B-2 and are discussed in Section 2.2.1.

1.8 Historical Aerial Photograph Review

To obtain a historical perspective of the Property, a review of historical aerial photographs was conducted. Aerial photographs from the years 1966, 1977, 1982, 1987 and 1992 were obtained from the Genesee County Metropolitan Planning Commission, and reviewed. A description of each aerial photograph is presented below:

1966 Aerial Photograph (Scale: 1 inch = 400 feet)

Building 44 does not appear on this photograph. Building 37 appeared as a small rectangular building with an overhead utility trestle extending from the southern portion of the building across the Flint River to Building 5.

Railroad easements were visible on the north side of Building 37. To the west of Building 37 was an electrical substation and a coal stockpile which appeared as a solid black mass. Building 11 and the Building 2 assembly plant were east of Building 37 across Chevrolet Avenue. Building 2A was present to the north of Building 44. Across the Flint River to the south were Building 5, Building 30, and the Grand Trunk Western Railroad. Considerable construction activity was visible along the Flint River. This activity appeared to be associated with the concrete channelization of the Flint River by the Army Corps of Engineers.

1977 Aerial Photograph (Scale: 1 inch = 200 feet)

Building 44 appeared as a small rectangular building. Additions to the north and west sections of Building 5 have been completed. Four large treatment tanks and Building 42 have been added to the IWWPTP southwest of Building 5. The Flint River concrete channelization appeared complete in this aerial photograph.

1982 Aerial Photograph (Scale: 1 inch =200 feet)

Six above ground storage tanks (ASTs) west of Building 2A have been removed. Otherwise, the Property and surrounding areas appeared unchanged.

1987 Aerial Photograph (Scale: 1 inch = 200 feet)

The Property and surrounding areas appeared unchanged.

1992 Aerial Photograph (Scale: 1 inch = 200 feet)

The yard on the west side of the Property appeared to have been paved over with asphalt. The coal stockpile area on the west side of the electrical substation appeared as a light grey instead of a dark black. This suggests that the coal has been removed or used and that the stockpile had been deactivated. Otherwise, the Property and surrounding areas appeared unchanged.

No fill, solid waste disposal, or other activities that meet the criteria of a PAOC were observed during the review of available aerial photographs.

1.9 Site Features and Historical Facility Operations

During the site inspection of Building 37, various types of switching equipment and control consoles were observed at the active electrical switching station. A utility trestle extending across the Flint River was observed on the south side of Building 37. Rubber hoses were observed exiting the east side of Building 37 and continuing into piping contained within a concrete conduit. Electrical power is conveyed through the wires contained inside the hoses to other plants at the Flint West Facility. An electrical substation was observed on the west side of Building 37. During the site inspection of Building 44, spill response equipment and miscellaneous office furniture were observed in the building. Concrete blocks where the former fuel pumps were located and two fuel pipes capped with wooden plugs were observed. These fuel pipes are further discussed in Section 2.3.2. In addition the following observations were noted:

The Property was enclosed by a chainlink fence. Observations noted during the site inspection that are scheduled to be addressed by GM are as follows:

- A drum was observed along the fence adjacent to the Flint River at the Building 37 Property. Facility personnel indicated that the drum contained soil from the installation of MW-37-4. MW-37-4 as discussed in Section 2.6,

was associated with the investigation of USTs 3,4,5,6 and A formerly located in the Building 37 Yard. The drum is discussed further in Section 2.10.
- Soil stockpiled on a sheet of visqueen was observed in the Building 37 Yard adjacent to Building 44. The soil stockpile is discussed further in Section 2.12.

The following changes from the 1992 aerial photograph were observed during the Property inspection:

- Building 2A was no longer present (reportedly demolished in 1996).
- The three level parking garage located north of the former Building 2A was no longer present (reportedly demolished in 1993).
- Building 5 was no longer present (reportedly demolished in August 1995).

2. Environmental Conditions

The following discussion of environmental conditions was derived from observations made and information collected and reviewed while performing this Phase I ESA.

2.1 PCBs

Based on discussions with Facility personnel and a review of records, it was determined that GM maintains a formal polychlorinated biphenyls (PCB) Management program to detect and document PCB-containing materials at Flint West. The PCB Management program has been maintained since the early 1980's and consists of regular inspections, repair reports, and records of removal and disposal of PCB-containing materials at the Facility. PCBs may be present in transformers or capacitors at GM plants. Historically, PCBs have been used in hydraulic fluids. PCBs are not typically associated with other GM materials or processes.

2.1.1 Transformers

According to Facility records there was a spare transformer containing PCBs on the east side of Building 37. Facility records did not indicate any PCB releases from this spare transformer. The spare PCB containing transformer was removed and disposed of on October 18, 1988. The former location of the spare PCB containing transformer is shown in Figure B-2. Stains were not observed on the ground in this area during the site inspection. Transformers were not observed at Building 37 during the site inspection. There was no record of PCB-containing transformers associated with Building 44. No PCB-containing transformers were observed at Building 44 during the site inspection.

Because there is no known or documented release of PCBs and no PCB transformers remain at the Property, no PAOC has been identified.

2.1.2 Capacitors

According to Facility personnel and records, there were no PCB-containing capacitors at Buildings 37 or 44. During the site inspection, PCB-containing capacitors were not noted in Building 37 or Building 44.

2.1.3 Hydraulic Fluids

There was no record of PCB-containing hydraulic fluids being used at Building 37 or Building 44 or in the Building 37 Yard. During the site inspection, PCB-containing hydraulic fluids were not noted in Building 37 or Building 44.

2.2 Storage Tanks

2.2.1 Underground Storage Tanks

Facility personnel reported that five USTs were once located in the Building 37 Yard. Four 50,000-gallon USTs (UST Nos. 3, 4, 5, and 6) stored fuel oil for use at Building 11 (the power house) and a 550-gallon UST (UST A) stored excess fuel oil released to the concrete floor during pump house operations in Building 44. Environmental Science & Engineering, Inc. (ESE) conducted the UST removal activities in 1989.

Because there is no known or documented release of hazardous substances or petroleum products to the storm sewers at levels that would pose an unacceptable risk to human health and the environment, this area does not meet the definition of a PAOC.

2.3.1.2 Sanitary Sewers

There are no sanitary sewers located beneath the building to collect sanitary wastewater. According to Facility drawings, a sanitary sewer line ran from the former Building 2A, through the area on the east side of Building 37, to the City of Flint sanitary sewer system. Prior to demolition activities, sanitary sewer pipes associated with Building 2A were drained, disconnected, and capped. The sanitary sewer line is shown in Figure B-4.

Because there is no known or documented release of hazardous substances or petroleum products from the sanitary sewer piping at levels that would pose an unacceptable risk to human health and the environment, this area does not meet the definition of a PAOC.

2.3.2 Industrial Process Lines

According to Facility records, there were no industrial process lines associated with the Building 37. During the site inspection, industrial process lines were not observed at Building 37.

According to Facility records, there were two industrial process lines associated with Building 44. The two industrial process lines are the two pipes which were used to convey number 2 fuel oil from Building 44 underneath Chevrolet Avenue to Building 11. During the Site inspection, two 4" diameter underground metal pipes were noted in Building 44 that appear to be the pipes reportedly used to convey number 2 fuel oil to the power house. The power house is located approximately 125 feet east of Building 44. The pipes terminate aboveground in Building 44 and are capped with wooden plugs. The air in the pipes exhibited a strong hydrocarbon odor. A sample of liquid obtained from the pipes appeared to be a petroleum product. There is no known or documented release from these pipes of a hazardous substance or petroleum product to soils or groundwater that would constitute a PAOC; however, due to the age of the pipes (26 years) and the presence of a petroleum product in the pipes, the pipes represented a liability issue as a threat of release. The location of the two former fuel pipes is shown on Figure B-2.

On February 24, 1998, the contents of the fuel pipes were removed and drummed for disposal by AquaTech. After the pipes were emptied, the pipes were pressure washed and tested. The pipe testing (each pipe was tested separately) consisted of capping both ends of each pipe and pressurizing the water in the pipe to 10 pounds per square inch (psi). The pipe integrity was determined satisfactory after maintaining a pressure of 10 psi for 30 minutes.

Both fuel pipes maintained a pressure of 10 psi for 30 minutes. Following testing, the pipes were grouted shut on both ends. Because the contents of the fuel pipes were removed, the pipes cleaned, and the pipes' integrity was confirmed, the fuel pipes between Buildings 11 and 44 are no longer considered to represent a liability issue.

2.4 Floor Drains

No floor drains were observed in Building 37 or 44. Two floor drains were historically located in Building 44. The floor drains were used to convey accidental spillage from the fuel oil pumps to UST A. The location of the piping that connected the floor drains to UST A was not identified on facility drawings; however, the floor drains were abandoned in place with concrete in 1989 when UST A was removed. Portions of the floor drain piping remain below Building 44. The location of the floor drains and UST A are shown on Figure B-2.

Because there is no known or documented release from the floor drains and associated piping of hazardous substances or petroleum products at levels that would pose an unacceptable risk to human health and the environment, this area does not meet the definition of a PAOC.

2.5 Pits, Ponds, and Lagoons

According to Facility records, there were no pits, ponds, or lagoons associated with management of liquid or solid waste at the Property. During the site inspection, pits, ponds, and lagoons were not observed at Building 37 or Building 44.

2.6 Groundwater Wells

On May 2, 1990 a 2-inch diameter monitoring well, MW-37-4, was installed to a depth of 21 feet below land surface (Figure B-3). MW-37-4 was installed to monitor the groundwater quality in the vicinity of the former USTs located in the Building 37 Yard. According to ESE's closure report, the well was constructed with galvanized steel to a depth of 16 feet with a screened section of stainless steel #7 slot to 21 feet. As previously noted, MDEQ approved Type B residential closure under PA 307 for the former USTs located in the Building 37 Yard. Consequently, MW-37-4 was abandoned on September 1, 1995. No production wells or recovery wells were noted in the site records or observed on-site during the site inspection.

The documentation indicates that a release may have occurred in the vicinity of this well; however, analytical data indicate that impacts were not present in the groundwater. Therefore, since there were no impacts to groundwater of hazardous substances or petroleum products at levels that would pose an unacceptable risk to human health and the environment, this area does not meet the definition of a PAOC.

2.7 Asbestos

An asbestos survey has not been conducted at Building 37; however, the Traverse Group did visually inspect Building 37 and suspected that the electrical switching equipment may include a wall of transite (an asbestos containing material). No other asbestos containing materials were noted during the site inspection by BBL or the Traverse Group.

Based on the Traverse Group asbestos survey results, the following asbestos containing materials were identified at Building 44:

- Mudded pipe fittings
- Roof flashing material

Asbestos containing materials will be removed and disposed of during the deactivation activities at Building 44.

2.8 Pits, Sumps and Trenches

According to Facility records, there were no pits, sumps, or trenches at Building 37 or Building 44. During the site inspection, pits, sumps, and trenches were not observed at Building 37 or Building 44.

2.9 Hydraulic Equipment

According to Facility records, there were no hydraulic hoists or lifts at Building 37 or Building 44. During the site inspection, hydraulic equipment was not observed at Building 37 or Building 44.

2.10 Drums

According to Facility records, drums were not used at Building 37 or Building 44. During the site inspection, a drum was observed along the fence adjacent to the Flint River near Building 37. Facility personnel indicated that the drum contained soil from the installation of MW-37-4. As previously discussed in Section 2.6, MW-37-4 was associated with the investigation of USTs 3,4,5,6 and A. Analytical soil results from the investigation indicated that the concentrations of BTEX in soil were below Type B and Tier I Residential Direct Contact Values (DCVs). According to Facility personnel, this drum of non-hazardous soil was removed during the week of November 17, 1997 and disposed of by ECDC Laidlaw.

2.11 Hazardous Materials

According to Facility records, hazardous materials were not used or stored at Building 37 or Building 44. During the site inspection, hazardous materials were not observed at Building 37 or Building 44.

2.12 Solid Waste

According to Facility records, solid waste was not generated at Building 37 or Building 44. During the site inspection, solid waste was not observed at Building 44; however, soil stockpiled on a sheet of visqueen was observed in the Building 37 Yard adjacent to Building 44. The stockpiled soil resulted from soil borings performed in the Building 37 Yard, associated with the investigation of USTs 3,4,5,6 and A. Analytical soil results from the investigation indicated that the concentrations of BTEX in soil were below Type B and Tier I Residential DCVs. According to Facility personnel, this stockpile of non-hazardous soil was removed during the week of November 17, 1997 and disposed of by ECDC Laidlaw.

2.13 Stains

During the site inspection, surface stains were not noted on the floor of Building 37 or Building 44, or on the surrounding land surfaces.

2.14 Stressed Vegetation

During the site inspection, stressed vegetation was not noted at Building 37 or Building 44.

2.15 Process Equipment/Tanks

According to Facility records, process equipment and tanks were not used at Building 37. During the site inspection, process equipment and tanks were not observed at Building 37.

According to Facility records, the process equipment used at Building 44 consisted of the pumps used to convey fuel oil to Building 11. During site inspection, process equipment/tanks were not observed at Building 44.

2.16 Facility Records

Facility records were reviewed during the site inspection and include the following:

- Spill reports as discussed in Section 3.5.1.
- Previous investigations as discussed in Section 3.5.2.
- Plant Drawings as discussed in Section 3.5.3.
- Waste Management files as discussed in Section 3.5.4.

During the site inspection, BBL did not identify records pertaining to site deactivation or decommissioning activities, nor did BBL observe such activities.

3. Record Review

3.1 ERIIS Database Review

BBL retained ERIIS to perform an environmental records database search of federal, state, and county records in accordance with ASTM E 1527-94. ERIIS performed a Custom Corridor search which included Buildings 2, 7, 11, 13, 17, 29, 36, 37, and 44. With a Custom Corridor report some sites plotted within the radius of the Custom Corridor may not actually be within the ASTM radius of the Property. For the purpose of constructing the summary table below, the ASTM radius was used to determine the database profile for the Property. The resulting ERIIS report for the Custom Corridor was obtained in September of 1997. The review of federal and state records identified seven Properties within a one-mile radius of the subject Property that may have been impacted by hazardous materials or petroleum products, or that store, use, or manufacture such materials as follows (some Properties appear on multiple lists):

		Properties Within Radius			
Database (miles)	**Radius of Search (miles)**	**0 to 1/4 Mile**	**1/4 to ½ Mile**	**½ to 1 Mile**	**Total Listings**
National Priorities List (NPL)	1	0	0	0	0
RCRA Information System (RCRIS-TS) Facilities	1	0	0	0	0
No Further Remedial Action Planned Properties (NFRAP)	0.5	1	0	NA	1
CERCLA Information System (CERCLIS)	0.5	0	0	NA	0
RCRIS Large Quantity Generators (RCRIS-LG)	0.25	2	NA	NA	2
RCRIS Small Quantity Generators (RCRIS-SG)	0.25	0	NA	NA	0
Emergency Response Notification System (ERNS)	0.5	0	NA	NA	0
Michigan Environmental Contamination List (HWS)	1	1	0	0	1
Michigan Leaking Underground Storage Tank List (LRST)	0.5	3	3	NA	6
Michigan Solid Waste Facilities (SWF)	0.5	0	0	NA	0
Michigan Facility and Tank Data Report (RST)	0.25	2	NA	NA	2
NA = not within search radius				Total Listings	12[1]

[1] - These twelve listings represent only seven distinct properties.

The Building 37/44 Property was identified in the Michigan Facility and Tank Data Report (Registered Storage Tank) database. The following sub-sections are a brief summary of the information provided in the above table. Further details about the subject Property, its status, and the surrounding properties within the search radius are contained in the ERIIS report included as Appendix B. Based on a review of the ERIIS report and available Federal, State, and Facility records, none of the properties identified above have conditions that would constitute a PAOC at the Property.

3.1.1 Summary of United States Environmental Protection Agency Databases

National Priorities List

The National Priorities List (NPL) is a listing of facilities and/or locations where environmental contamination has been confirmed. The NPL was devised as a method for the EPA to prioritize these properties for the purpose of taking remedial action as funded by the Hazardous Waste Substances Superfund program, that was initially established under the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA),

and reinstated under the Superfund Amendments and Reauthorization Act of 1986 (SARA).

No NPL properties were listed within a one-mile radius of the Property, nor is the Property listed.

Resource Conservation and Recovery Information System Treatment, Storage, and Disposal Facilities

The Resource Conservation and Recovery Information System Treatment Storage, and Disposal (RCRIS-TS) list identifies those facilities or locations that have notified the EPA of their activities relative to the handling of hazardous waste, as well as treatment, storage, and disposal facilities. The appearance of a property on this list does not necessarily indicate environmental problems on the property, but rather that the property is (or was) engaged in hazardous waste handling activities and, therefore, may have the potential to cause environmental degradation if hazardous wastes have been mishandled or otherwise released in an uncontrolled manner. Information pertaining to the status of facilities tracked by the RCRA Administrative Action Tracking System (RAATS, March 3, 1995) is included in the RCRIS-TS report.

No RCRIS-TS properties were listed within a one-mile radius of the Property, nor is the Property listed.

No Further Remedial Action Planned Properties

The No Further Remedial Action Planned (NFRAP) Report contains information pertaining to properties which have been removed from the Federal EPA's CERCLIS Database. NFRAP properties may be properties where, following an initial investigation, no contamination was found, contamination was removed quickly without need for the property to be placed on the NPL, or the contamination was not serious enough to require federal superfund action or NPL consideration.

Flint West was listed on the NFRAP database. According to the database review, a preliminary site assessment was conducted on April 12, 1991. This listing indicates that the United States Environmental Protection Agency did not identify any PAOCs at the Property.

No other NFRAP Properties were listed in the database review within a one-half-mile radius of the Property.

Comprehensive Environmental Response, Compensation and Liability Information System List

The Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS) list contains facilities and/or locations that the United States Environmental Protection Agency (USEPA) or state environmental agency is investigating to determine if an existing or threatened release of hazardous substances is present. These properties may also occur on the NPL list as slated for EPA-funded response action, or they may be under state or federal enforcement action for cleanup by the responsible parties.

No CERCLIS properties were listed within a one-half-mile radius of the Property, nor is the Property listed.

Resource Conservation and Recovery Information System - Large Quantity Generators

The Resources Conservation and Recovery Information System - Large Quantity Generators (RCRIS-LG) report contains information pertaining to facilities that generate more than 1,000 kilograms (kg) of hazardous waste per month or meet other applicable requirements of the RCRA. Information pertaining to the status of facilities tracked by the RAATS (March 3, 1995) is included in the RCRIS-LG report.

Flint West (the Facility) and Maples Collision and Frame Service were reported as RCRIS-LG facilities within a one-quarter-mile radius of the Property.

Flint West continues to operate as a hazardous waste generator. It should be noted that the RCRA Part A application included all manufacturing buildings, processes, and substances from the Facility. The application does not identify any hazardous waste management units (HWMU) at the Property. Appearance of the Facility on this list does not constitute a PAOC for the Property.

Maples Collision and Frame Service on 1919 Corunna Road is located approximately one-quarter mile southwest of the Property. Information provided by ERIIS indicates that this site generates F003 type wastes, which include non-halogenated solvents as listed in the *EPA Hazardous Waste Reference Guide*. This facility is not reported in RAATS. Because this site is located on the other side of the Flint River, it is hydraulically separated from the Building 37/Building 44 property. Consequently, soil or groundwater contamination at the Maples Collision and Frame Service site, if any, would not constitute a PAOC with respect to the Building 37/44 Property.

Resource Conservation and Recovery Information System - Small Quantity Generators

The Resource Conservation and Recovery Information System - Small Quantity Generators (RCRIS-SG) report contains information pertaining to facilities that either generate between 100 kg and 1,000 kg of hazardous waste per month or meet other applicable requirements of the RCRA. Information pertaining to the status of facilities tracked by the RAATS (March, 3, 1995) is included in the RCRIS-SG report.

No RCRIS-SG properties were reported within a one-quarter-mile radius of the Property, nor is the Property listed.

Emergency Response Notification System

The Emergency Response Notification System (ERNS) is a national computer database that is used to store information concerning the sudden and/or accidental release of hazardous substances, including petroleum, into the environment. The ERNS reporting system contains preliminary information on specific releases, including the spill location, the substance released, and the responsible party. The information in the ERNS pertains only to those releases that occurred between January 1, 1997, and June 11, 1997.

No ERNS locations were identified within a half-mile radius of the Property, nor is the Property listed.

3.1.2 Summary of Michigan Department of Environmental Quality Databases

Michigan Environmental Contamination List (HWS)

The Michigan Environmental Contamination List (HWS) contains summary information pertaining to properties deemed hazardous by the MDEQ. Established under Michigan Environmental Response Act 307, the environmental contamination list is equivalent to the state hazardous waste properties list referenced in ASTM E 1527-97.

Flint West was listed on the HWS list. The ERIIS report stated that BTEX constituents were released from petroleum bulk storage areas located at surrounding properties. These areas are discussed in the following section as the five leaking USTs identified in the Michigan Leaking Underground Storage Tank List section. These surrounding properties do not constitute a PAOC at the Building 37/44 Property, because groundwater flow from these areas would not be expected to reach the Property.

No other HWS properties were reported within a one-mile radius of the Property.

Michigan Leaking Underground Storage Tank List

The Michigan Leaking Underground Storage Tank (LRST) Report is a comprehensive list of all reported leaking aboveground and underground storage tanks located within the State of Michigan. ERIIS' LRST report consists of

the listings maintained by the MDEQ LUST Section and the Michigan Department of State Police (Fire Marshal Division).

Five LRST locations were reported within a one-half-mile radius of the Building 37/44 Property. The properties listed are: Total Petroleum #2606 located at 1330 W. Court Street, approximately 0.5 miles southeast of the Property; Jim's Automatic Transmission Service located at 2202 Corunna Road, approximately 0.4 miles southwest of the Property; an unnamed site located at 1625 W. Third Avenue, approximately 0.4 miles northwest of the Property; and G.M.I. Engineering & MGR Institute located at 1700 W. third Avenue, approximately 0.3 miles northwest of the Property. Based on their distance from the Property, and the hydrogeologic nature of the subsurface, these sites do not constitute PAOCs at the Property. The Flint West Facility was reported as a LRST location and is discussed in the Michigan Facility and Tank Data Report section below.

No other LRST properties were listed within a one-half-mile radius of the Property.

Michigan Solid Waste Facilities List

The Michigan Solid Waste Facilities (SWF) List is a comprehensive listing of all active and inactive solid waste landfills and processing facilities within the State of Michigan.

No SWF properties were identified within a one-half-mile radius of the Property, nor at the property.

Michigan Facility and Tank Data Report

The Michigan Facility and Tank Data Report (RST) is a comprehensive listing of all registered underground storage tanks within the State of Michigan.

Twenty-one USTs were listed at Flint West Facility in the RST. Eighteen of the twenty-one USTs are reported as removed. Five of the tanks reported as removed were located in the Building 37 Yard. In July of 1995 MDEQ approved Residential Cleanup Closure for these five USTs. The three USTs reported as active include two 12,000-gallon gasoline USTs (Nos. 23 & 24) located on the west side of Building 7 and one 15,000-gallon quench oil tank (No. 25) near Building 4 that has been closed. Based on the MDEQ-approved Type B Residential Closure for the USTs formerly located in the Building 37 Yard and the location of the existing USTs, these USTs do not constitute a PAOC at the Building 37/44 Property.

One other UST site was identified within a one-quarter-mile radius of the Property. Central Quality Services on 1701 Glenwood Avenue, located approximately one-eighth mile to the southeast of the Facility, has registered one 6,000-gallon gasoline UST. Information reported from ERIIS indicated that this tank is closed. This UST was not reported in the LUST database; therefore it does not represent a PAOC with respect to the Property.

3.1.3 Unplottable Sites

In addition to the above listed properties, the ERIIS database search also identified 112 "unplottable sites". Due to the limitations of the ERIIS database search, the locations of these properties could not be accurately determined by ERIIS. BBL personnel reviewed the street addresses and determined that none of these "unplottable sites" are located within the ASTM search radii of the Property. Therefore, it is unlikely that these sites have conditions that would constitute a PAOC at the Property.

3.2 Sanborn Fire Insurance Maps

The ERIIS collection of historical Sanborn Fire Insurance Maps was researched. Sanborn Fire Insurance Maps for the Property were reviewed for the following years: 1928, 1950, and 1970.

The Sanborn maps for 1928 and 1950 indicate an undeveloped area, between the Flint River and the railroad easements to the north, for the present location of Building 37 and Building 44. The 1970 Sanborn map does not show Building 37, even though site records indicate that Building 37 was constructed in 1966. Building 44 was constructed in 1971.

Based on review of the Sanborn maps for the Property, there does not appear to be evidence of activity associated with the Property that would constitute a PAOC.

3.3 Freedom of Information Act Review

3.3.1 MDEQ Files

BBL personnel visited the MDEQ to review files available under the Michigan Freedom of Information Act, Public Act 442 of 1976.

3.3.1.1 Underground Storage Tank Division

The files reviewed at the USTD, pertaining to the Building 37 Yard, included correspondence and reports related to USTs 3, 4, 5, 6, and A formerly located in the Building 37 Yard. USTs 3, 4, 5, 6, and A were previously discussed in Section 2.2.1. This file review did not reveal any PAOCs at the Property.

3.3.1.2 Environmental Response Division

There were no files at the ERD pertaining to the Building 37/44 Property.

3.3.1.3 Waste Management Division

There were no files at the WMD pertaining to the Building 37/44 Property.

3.3.1.4 Surface Water Division

There were no files at the SWD pertaining to the Building 37/44 Property.

3.3.2 Fire Marshall UST Files

The only document noted in the Fire Marshall UST files pertaining to Building 37 was a release notification form for USTs 3, 4, 5, 6 formerly located in the Building 37 Yard. This review did not reveal any PAOCs at the Property.

3.4 Title Search

Because of the quantity of historical files and information available concerning previous operations at the Property and Facility, a title search was not performed for this Phase I ESA.

3.5 Property Environmental Files

GM Property environmental files were reviewed to identify information that would indicate a release of hazardous substances or petroleum products to soils or groundwater at levels that would pose an unacceptable risk to human health or the environment. The file review was conducted during the site visit to the Property on September 24 and 25, 1997.

3.5.1 Spill Reports

The only document noted in the spill reports file that pertained to Building 37 or Building 44 was a copy of the release notification form for USTs 3, 4, 5, and 6 that was submitted to the state fire marshall. This file review did not reveal any PAOCs at the Property.

3.5.2 Previous Investigations and Remedial Action

The files documenting previous investigations and remedial action were reviewed. Reports of tank closures at Building 37 were noted during a review of Facility files. The UST closure information for the Building 37 Yard was previously discussed in Section 2.2.1. In addition, reports of tank closures and related investigations from Plant 2A, which is north and adjacent to the Building 37 property, were noted during a review of Facility files. The UST closure at Building 2A was on the west end of Building 2A, approximately two-tenths of a mile northwest of Building 37. BBL conducted a Phase I ESA and Phase II ESI at the former location of Building 2A. The data collected during these investigations do not identify any PAOCs with respect to Building 37. Consequently, the information in the files did not reveal any PAOCs at the Property.

3.5.3 Plant Drawings Files

The plant drawings files were reviewed. Although these files did not contain information concerning releases, they did provide information on the location of utilities and areas of interest (i.e., USTs, former PCB transformer location, etc.). No PAOCs were identified based on the plant drawings files.

3.5.4 Waste Management Files

3.5.4.1 Hazardous Waste Manifests

Hazardous waste manifests files were not available for Building 37 or Building 44 because hazardous wastes were not generated or stored at the Property. Historical records did not reveal any indication of past generation or storage of hazardous waste at the Building 37/44 Property.

3.5.4.2 Non-hazardous Solid Waste

Based on the review of Facility records, non-hazardous solid wastes were not generated or stored at the Building 37/44 Property.

4. Conclusions and Recommendations Based on Environmental Site Assessment

4.1 Record Review

BBL reviewed available documents within the guidance presented in ASTM E 1527-97 and identified no PAOCs at the Site. Several potential off-site sources of environmental contamination were identified, including investigations at the former Building 2A, but none of the off-site issues qualifies as a PAOC with respect to the Site.

4.2 Site Reconnaissance

During the inspection of the Property, BBL noted no evidence of PAOCs at the Property. A potential liability issue to a potential buyer was noted, as described below.

4.3 Conclusions

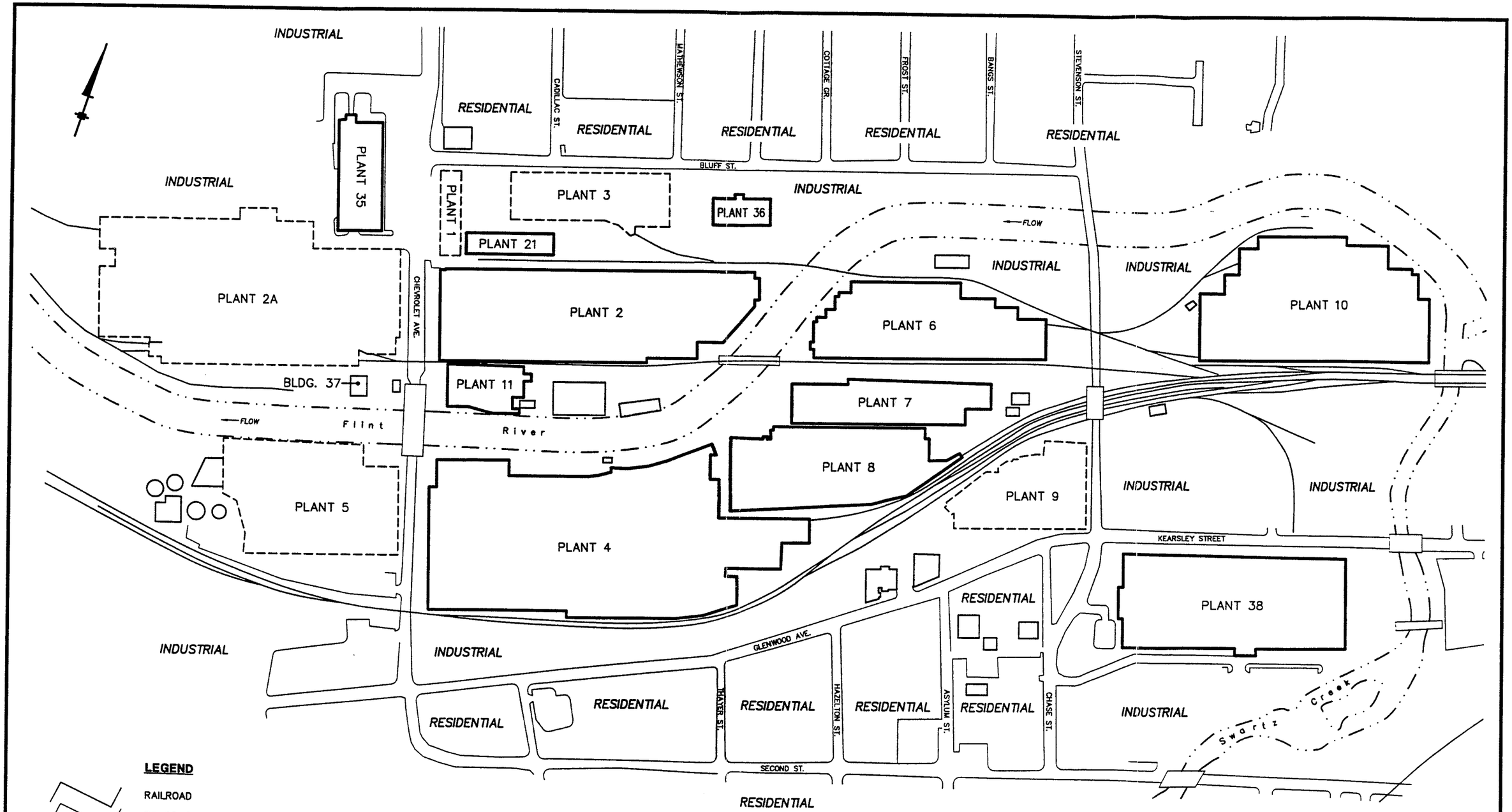
The information evaluated as part of the Phase I ESA and discussed in this report indicates that there are no PAOCs at the site. BBL performed a Phase I Environmental Site Assessment in conformance with the scope and limitations of ASTM Practice E 1527-97 for the Building 37/44 property. Any exceptions to, or deletions from, this practice are described in Part A Section 1.3 of this report. This assessment has revealed no evidence of PAOCs; however, conditions that represent a potential environmental liability as a threat of release of petroleum products were discovered.

Two 4" diameter underground metal pipes were noted in Building 44. These underground pipes reportedly conveyed fuel oil from Building 44 to boilers at Building 11. The pipes terminated aboveground in Building 44 and were capped with wooden plugs. The air in the pipes at Building 44 exhibited a strong hydrocarbon odor. A sample of liquid in the pipes appeared to be a petroleum product. There was no known or documented release from these pipes of a hazardous substance or petroleum product to soils or groundwater that could pose an unacceptable risk to human health or the environment. The pipes were also reportedly contained within a secondary containment pipe. Due to the presence of product in the pipes, the pipes represented a liability issue as a threat of release of petroleum product. BBL recommended removing the fuel from the pipes to eliminate a potential source of release and testing the integrity of the fuel pipes during the follow-up work at Flint West.

On February 24, 1998, the contents of the fuel pipes were removed and drummed for disposal by AquaTech. After the pipes were emptied, the pipes were pressure washed and tested. The pipe testing (each pipe was tested separately) consisted of capping both ends of each pipe and pressurizing the water in the pipe to 10 pounds per square inch (psi). The pipe integrity was determined satisfactory after maintaining a pressure of 10 psi for 30 minutes.

Both fuel pipes maintained a pressure of 10 psi for 30 minutes. Following testing, the pipes were grouted shut on both ends. Because the contents of the fuel pipes were removed, the pipes cleaned, and the pipes' integrity was confirmed, the fuel pipes between Buildings 11 and 44 are no longer considered to represent a liability issue.

PART B - FIGURES



BASE MAP DIGITIZED FROM "GROUNDWATER ELEVATION MAP" FROM O'BRIEN & GERE, ENGINEERS, INC. (9/95) FILE NUMBER 5858-014-003, FIGURE 3. SOURCE SCALE IS 1"=200'.

ALL LOCATIONS AND FEATURES ARE APPROXIAMTE ONLY.

PRIVILEGED AND CONFIDENTIAL
PREPARED AT REQUEST OF
GENERAL MOTORS COUNSEL

GENERAL MOTORS CORPORATION
BUILDINGS 37 AND 44
DELPHI FLINT WEST FACILTY, FLINT, MICHIGAN
BASELINE ENVIRONMENTAL SITE ASSESSMENT

FACILITY LAYOUT AND SURROUNDING LAND USE MAP

BBL BLASLAND, BOUCK & LEE, INC. *engineers & scientists*

FIGURE **B-1**

9/29/98 BOC-54-APD
48076003\48076061.DWG

FORMER BUILDING 2A LOCATION

BUILDING 37
(PRIMARY SWITCH HOUSE)

ELECTRICAL SUBSTATION

FORMER LOCATION OF
SPARE PCB TRANSFORMER

PROPERTY CONTINUES
APPROXIMATELY 130 FT
TO WEST, TO INCLUDE THE
ELECTRICAL SUBSTATION

FORMER TANK LOCATIONS

EXCAVATION AREA

TANK 3

TANK 4

TANK 5

TANK 6

BUILDING
44
(OIL PUMP
HOUSE)

FUEL/
OIL PIPES
TO BLDG 11

GUARD RAIL

VENT
LINE

FORMER
FLOOR
DRAINS

FORMER TANK A

UG PWR, 46KV

CONCRETE RIVER EMBANKMENT

Flint River

BRIDGE

CHEVROLET AVE.

LEGEND

- RAILROAD
- ROADS, PAVEMENT
- CONCRETE CHANNELIZED FLINT RIVER
- BUILDING, PLANT
- FORMER BUILDING LOCATION
- FENCE
- UNDERGROUND UTILITY
- APPROXIMATE PROPERTY BOUNDARY
- FORMER FLOOR DRAINS (CONNECTED TO TANK A VIA VENT LINE)

0 20' 40'

APPROXIMATE SCALE IN FEET

BASE MAP DIGITIZED FROM "SOIL BORING AND MONITORING WELL LOCATIONS" FROM ENVIRONMENTAL SCIENCE & ENGINEERING, INC. (REV. 2/92) FILE NUMBER 590-0872-A-3837. SOURCE SCALE IS 1"=20'. ALSO REFERENCE DRAWING "P.E.C.-9000" BY CHEVROLET-FLINT MANUFACTURING, PLANT ENGINEERING DEPARTMENT (DATE/SCALE UNKNOWN).

SOME ADDITIONAL INFORMATION TAKEN FROM "EXTREMELY HAZARDOUS WASTE LOCATIONS" FIGURE A-1 JOB NUMBER 89114 (4/89) FROM HUBBELL, ROTH & CLARK, INC. SOURCE SCALE 1"=120'.

ALL LOCATIONS AND FEATURES ARE APPROXIMATE ONLY.

**PRIVILEGED AND CONFIDENTIAL
PREPARED AT REQUEST OF
GENERAL MOTORS COUNSEL**

GENERAL MOTORS CORPORATION
BUILDINGS 37 AND 44
DELPHI FLINT WEST FACILITY, FLINT, MICHIGAN
BASELINE ENVIRONMENTAL SITE ASSESSMENT

SITE PLAN

BBL BLASLAND, BOUCK & LEE, INC. *engineers & scientists*

FIGURE **B-2**

9/29/98 BOC-54-APD
48076003\48076082.DWG

FORMER BUILDING 2A LOCATION

BUILDING 37
(PRIMARY SWITCH HOUSE)

ELECTRICAL SUBSTATION

FORMER LOCATION OF
SPARE PCB TRANSFORMER

PROPERTY CONTINUES
APPROXIMATELY 130 FT
TO WEST, TO INCLUDE THE
ELECTRICAL SUBSTATION

FORMER TANK LOCATIONS

EXCAVATION AREA

TANK 3

TANK 4

TANK 5

TANK 6

BUILDING
44
(OIL PUMP
HOUSE)

SB37-5

FUEL/
OIL PIPES
TO BLDG 11

GUARD RAIL

VENT
LINE

FORMER
FLOOR
DRAINS
(FORMERLY CONNECTED
TO TANK A)

FORMER TANK A

UG PWR, 46KV

SB37-1

SB37-2

SB37-3

CONCRETE RIVER EMBANKMENT

Flint River

CHEVROLET AVE.

BRIDGE

LEGEND

- RAILROAD
- ROADS, PAVEMENT
- CONCRETE CHANNELIZED FLINT RIVER
- BUILDING, PLANT
- FORMER BUILDING LOCATION
- FENCE
- UNDERGROUND UTILITY
- APPROXIMATE PROPERTY BOUNDARY
- FORMER FLOOR DRAINS (CONNECTED TO TANK A VIA VENT LINE)

0 20' 40'

APPROXIMATE SCALE IN FEET

BASE MAP DIGITIZED FROM "SOIL BORING AND MONITORING WELL LOCATIONS" FROM ENVIRONMENTAL SCIENCE & ENGINEERING, INC. (REV. 2/92) FILE NUMBER 590-0872-ACF337. SOURCE SCALE IS 1"=20'. ALSO REFERENCE DRAWING "P.E.C.-9000" BY CHEVROLET-FLINT MANUFACTURING, PLANT ENGINEERING DEPARTMENT (DATE/SCALE UNKNOWN).

SOME ADDITIONAL INFORMATION TAKEN FROM "EXTREMELY HAZARDOUS WASTE LOCATIONS" FIGURE A-3, JOB NUMBER 89114 (4/89) FROM HUBBELL, ROTH & CLARK, INC. SOURCE SCALE 1"=120'.

ALL LOCATIONS AND FEATURES ARE APPROXIMATE ONLY.

**PRIVILEGED AND CONFIDENTIAL
PREPARED AT REQUEST OF
GENERAL MOTORS COUNSEL**

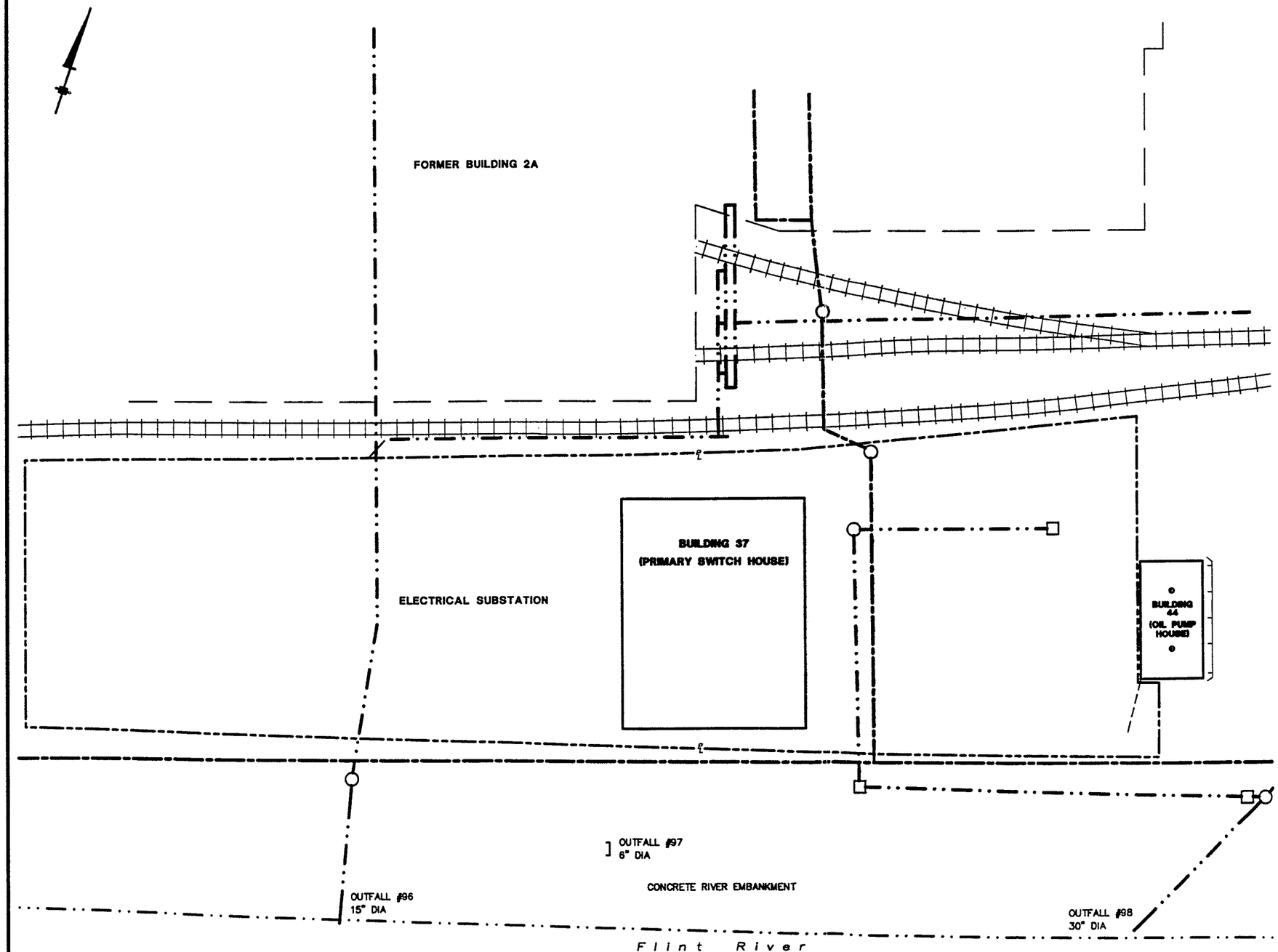
GENERAL MOTORS CORPORATION
BUILDINGS 37 AND 44
DELPHI FLINT WEST FACILITY, FLINT, MICHIGAN
BASELINE ENVIRONMENTAL SITE ASSESSMENT

FORMER UST CLOSURE WITH SOIL BORING AND MONITORING WELL LOCATIONS

BBL BLASLAND, BOUCK & LEE, INC. engineers & scientists

FIGURE B-3

9/29/98 BOC-54-APD
48076003\48076083.DWG



LEGEND

- RAILROAD
- ROADS, PAVEMENT
- CONCRETE CHANNELIZED FLINT RIVER
- BUILDING - PLANT
- FORMER BUILDING LOCATION
- FENCE
- APPROXIMATE PROPERTY BOUNDARY
- STORM DRAIN LINE
- SANITARY SEWER LINE
- APPROXIMATE LOCATION OF MANHOLE
- APPROXIMATE LOCATION OF CATCH BASIN

0 30' 60'

APPROXIMATE SCALE IN FEET

BASE MAP DIGITIZED FROM "SOIL BORING AND MONITORING WELL LOCATIONS" FROM ENVIRONMENTAL SCIENCE & ENGINEERING, INC. (REV. 2/92) FILE NUMBER 59C-0872-ACP337. SOURCE SCALE IS 1"=20'. ALSO REFERENCE DRAWING "P.E.C.-9000" BY CHEVROLET-FLINT MANUFACTURING, PLANT ENGINEERING DEPARTMENT (DATE/SCALE UNKNOWN).

SOME ADDITIONAL INFORMATION TAKEN FROM "EXTREMELY HAZARDOUS WASTE LOCATIONS" FIGURE A-3, JOB NUMBER 89114 (4/89) FROM HUBBELL, ROTH & CLARK, INC. SOURCE SCALE 1"=120'.

ALL LOCATIONS AND FEATURES ARE APPROXIMATE ONLY.

PRIVILEGED AND CONFIDENTIAL
PREPARED AT REQUEST OF
GENERAL MOTORS COUNSEL

GENERAL MOTORS CORPORATION
BUILDINGS 37 AND 44, PRIMARY SWITCH HOUSE
DELPHI FLINT WEST FACILITY, FLINT, MICHIGAN
BASELINE ENVIRONMENTAL SITE ASSESSMENT

LOCATION OF SANITARY SEWER LINES AND STORM DRAIN LINES

BBL BLASLAND, BOUCK & LEE, INC. engineers & scientists

FIGURE B-4

x: 48076004
12/01/97 BOC-54-MAJ APD
48076050\37-P1ESA\48076006.DWG

PART B - TABLES

TABLE B-1
SURROUNDING BUILDING INFORMATION

BASELINE ENVIRONMENTAL SITE ASSESSMENT - BUILDINGS 37 AND 44
DELPHI-FLINT WEST FACILITY
FLINT, MICHIGAN

BUILDING #	BUILT	ORIGINAL HISTORICAL USE	SQ. FT.	PRESENT PRODUCTION OR USE	PROCESSES
1	1927	Main Office	59,390	No production, building has been demolished	Purchasing, finance, and administration
2	1916	Assembly Plant	500,000	Crankshafts, radiator grilles, instrument panels, gas tank reservoirs, headlamp bezels	Grinding, balancing, and drilling, plastic injection molding, vacuum metalizing, and painting
2A	1922	Fisher Body	485,000	Exhaust systems, radiator supports (deactivated October 1995 and demolished)	Metal stamping, tube mills, vector benders
4	1915	Mason motors	700,000	Engines	Complete engine assembly
5	1926	Valves, camshafts, cylinder cases	176,000	Cylinder cases, radiator caps(Demolished August 1995)	Complete machining of rough castings
11	1916	Powerhouse	64,000	No production	Steam/Compressed air for all plants and GMI
30	1949	IWWPTP	8,000	No production	Waste water treatment
37	1966	Primary electrical switch	3,000	No production, building to be demolished	Switch gear
42	1968	IWWPTP	3,700	No production	Waste water treatment
44	1971	Fuel oil pump	512	No production (Spill response equipment storage), scheduled to be demolished	None

Notes:
IWWPTP - Industrial Wastewater Pre-Treatment Plant
Information for this table provided by Facility personnel.

TABLE B-2
RELATION BETWEEN STRATIGRAPHIC AND HYDROGEOLOGIC UNITS IN THE MICHIGAN BASIN

BASELINE ENVIRONMENTAL SITE ASSESSMENT - BUILDINGS 37 AND 44
DELPHI-FLINT WEST FACILITY
FLINT, MICHIGAN

ERA	PERIOD	EPOCH	GLACIATION	STRATIGRAPHIC UNIT			HYDROGEOLOGIC UNIT
Cenozoic	Quaternary	Holocene					Glacial drift aquifer[1]
		Pleistocene	Wisconsin Illinoisan Pre-Illinoisan				
Paleozoic	Pennsylvanian	Middle		Grand River Formation			Grand River-Saginaw aquifer
		Early		Saginaw Formation			Saginaw confining unit
	Mississippian	Late		Grand Rapids Group	Bayport Limestone	Parma Sandstone Member	Parma-Bayport aquifer
					Michigan Formation		Michigan confining unit
						Stray Sandstone Member	Marshall aquifer
		Early		Marshall Sandstone		Napoleon Sandstone Member	
				Coldwater Shale			Coldwater confining unit

Notes:

Dotted lines indicate unconformities
Table modified from Mandle and Westjohn 1989.

[1] Glacial drift deposits; Semi-confining in the Flint vicinity

Table B-3
Comparison of Residential Closure Soil Results to Current Residential Criteria
Type B Closure of Underground Storage Tanks 3, 4, 5, and 6 (Approved July 1995)

Baseline Environmental Site Assessment - Buildings 37 and 44
Delphi-Flint West Facility
Flint, Michigan

Sample ID	Constituent			
	Benzene	Toluene	Ethylbenzene	Xylenes
SB-37-1 (10-12FT)	ND	ND	ND	ND
SB-37-2 (8.5-10.5FT)	ND	ND	ND	ND
SB-37-3 (17-19FT)	ND	ND	ND	ND
MW-37-4 (9-11FT)	ND	ND	37	72
MW-37-4 (17.5-18FT)	ND	ND	30	56
SB-37-5 (12-14FT)	ND	12	26	164
Type B - DCV	13,000	1.7E+07	7.5E+06	1.4E+06
Tier I Residential DCV	88,000	2.4E+07	1.1E+07	2.0E+08

Notes:

Concentrations are in micrograms per kilogram (ug/Kg)

DCV - Direct Contact Value

ND - Not detected

The detection limit for the listed compounds is 10 mg/Kg.

Analytical results tabulated above are from the Type B Closure Report - Building 37 by Environmental Science & Engineering, Inc., A

Type B Criteria are from the Michigan Department of Environmental Quality Operational Memorandum No. 8 Revision #2, February 1

Tier 1 Criteria are from the Michigan Department of Environmental Quality Operational Memorandum No.4 Revision #1, November 1

Table B-4
Comparison of Residential Closure Groundwater Results to Current Residential Criteria
Type B Closure of Underground Storage Tanks 3, 4, 5, and 6 (Approved July 1995)

Baseline Environmental Site Assessment - Buildings 37 and 44
Delphi-Flint West Facility
Flint, Michigan

	MW-37-4				Type B Health	Type B	Tier 1 Health	Tier 1	Tier 1
Constituent	06/08/90	02/18/91	07/24/91	09/10/91	Based DWV	GSI	Based DWV	GSI	GWDC
Benzene	2.4	ND	ND	ND	1.2	60	5	53	9,300
Toluene	ND	ND	ND	ND	1,500	110	790	110	>5.26E5
Ethylbenzene	ND	ND	ND	ND	680	31	74	31	>1.69E5
Xylenes	ND	ND	ND	ND	13,000	29	280	59	>1.86E5

Notes:
Concentrations are in micrograms per kilogram (ug/Kg)
DWV - Drinking Water Value
GSI - Groundwater Surface Water Interface Criteria
GWDC - Groundwater Direct Contact Criteria
ND - Not detected
The detection limit for the listed compounds is 1 ug/Kg.
Analytical results tabulated above are from the Type B Closure Report - Building 37 by Environmental Science, & Engineering, Inc., April 1992.
Type B Criteria are from the Michigan Department of Environmental Quality Operational Memorandum No. 8 Revision #2, February 1994.
Tier 1 Criteria are from the Michigan Department of Environmental Quality Operational Memorandum No.4 Revision #1, November 1996.

PART C - SUMMARY OF PHASE II INVESTIGATION CONDUCTED BY SME

1. SME Data Collection

Soil and Materials Engineers, inc. (SME) performed a Phase II Environmental Site assessment (ESA) at the former Building 37/Building 44 Property for the future operation of the Asylum Substation - Consumers Energy. The report was submitted to GM in September 1998. Soil and groundwater samples were collected by SME for analysis of benzene, toluene, ethylbenzene, and xylenes (BTEX), polynuclear aromatic hydrocarbons (PAH), volatile organic halocarbons, polychlorinated biphenyls (PCBs), and the ten Michigan metal as follows:

- One soil probe (SP5) and one boring (B1) were advanced to evaluate potential migration of contaminants from former Plant 2A. One soil sample from SP-5 and two soil samples from B1 were collected and submitted for laboratory analysis. B1 was later completed as monitoring well MW-1. Groundwater samples were collected from MW-1 and SP5.

- One boring (B2) was advanced to evaluate potential contamination from the pipes that transferred fuel oil from Building 44 to the powerhouse across Chevrolet Avenue. Two soil samples were collected from B2 and submitted for laboratory analysis. B2 was later completed as monitoring well MW-2. A groundwater sample was collected from MW-2.

- One boring (B3) was advanced to evaluate the presence of contaminants at the inferred down gradient location of the former USTs and coal piles. Two soil samples were collected from B3 and submitted for laboratory analysis. B3 was later completed as monitoring well MW-3. A groundwater sample was collected from MW-3.

- Four soil probes (SP1 through SP4) were advanced in the former UST area. Three soil samples from SP1 and two soil samples from SP2 through SP4 were collected and submitted for laboratory analysis. Groundwater samples were collected from SP1 through SP4.

A total of 16 soil samples and 8 groundwater samples were collected by SME. Analytical data for metals and organic constituents in soil and groundwater are summarized in Tables C-1 and C-2.

2. Summary of SME Results

2.1 Overview

This section summarizes the results of field screening and laboratory analyses.

2.2 Criteria Used by SME to Evaluate Data

Current and future land use at Flint West fits the generic criteria established for the industrial and commercial subcategory II, III, and IV exposure scenarios. In their Phase II report, SME compared the soil and groundwater analytical data to both residential and industrial criteria. The residential criteria were used to determine if the site is a "facility" as defined in Section 20101(1)(o) of PA 451. Analytical data for metals and organic constituents in groundwater samples were compared to the Health-based Drinking Water Values (HB DWVs) provided in OM#8. It was noted that the following incorrect data comparisons by SME for a generic residential scenario existed in the tables:

- Section 20120a.(2) states that the MDEQ shall utilize only reasonable and relevant exposure pathways in determining the adequacy of site specific criteria. SME did not use reasonable and relevant pathways at this parcel.

- Review of material supplied to GM by Consumers Energy (CE) indicates that metal constituents in individual soil samples were compared to the MDEQ Default Criteria taken from OM # 15: Type A Cleanup Criteria dated September 30, 1993; however, Type A Default Values were established by MDEQ to facilitate cleanup at sites where naturally occurring metals are of concern. The residential DCC outlined in OM #18 are the appropriate comparison criteria for metals in soil for a residential exposure scenario. In cases where the Statewide Default Background Level is greater than the DCC, the Statewide Default Background Level becomes the applicable criteria.

- SME compared soil concentrations to GSI protection criteria. Because groundwater concentrations were directly evaluated at the sampling locations, GSI protection criteria of soils are not relevant.

- SME compared groundwater concentrations to HB DWVs, but because the water bearing unit present at the site is not an aquifer as discussed in Section 2.3.2, HB DWVs as well as soil protective of groundwater criteria are not applicable.

- Statistical analysis of sample data is allowed under Part 201 and should be conducted to determine if positive detections are indeed statistically significant and exceed respective relevant criteria.

Relevant exposure pathways and applicable criteria are discussed in detail in the sections below.

2.3 Applicable Regulatory Standards Evaluated by BBL

Current and expected land use at Flint West fits the criteria established for the industrial and commercial subcategory II exposure scenario contained in OM#18; therefore, industrial criteria should be used to evaluate analytical data from samples collected at the property in order to determine if unacceptable risk to human health and the environment exists at the site. As a standard practice, relevant exposure pathways were evaluated in order to determine relevant industrial criteria.

If site constituent concentrations are below relevant industrial/commercial subcategory II criteria, then no further investigation or response activities are warranted in the area where the sample was collected. If concentrations are above relevant generic criteria, then further investigation is required to determine the extent of contaminants above relevant generic industrial/commercial subcategory II criteria.

2.3.1 Potential Exposure Pathways for Soil Evaluated by BBL

Exposure pathways to be considered for soil include direct contact (dermal and ingestion), inhalation of fugitive dust, inhalation of volatile emissions, surface runoff and erosion, inhalation of particulates from soil in the upper six-inches of the soil column, and migration to groundwater.

Exposure of Site workers to soil impacts by dermal contact is a potentially complete pathway. Soil concentrations at the Property were compared to direct contact criteria (DCC).

Although the site is covered with concrete and asphalt and inhalation of fugitive dust may not be a complete exposure pathway, soil data have been compared to volatile soil inhalation criteria (VSIC) and particulate soil inhalation criteria (PSIC).

Mobilization to potable groundwater is also a potential ingestion pathway for soil contamination, but because groundwater quality was directly evaluated by analysis of groundwater samples collected in each area where soils were sampled, comparison of soil data to groundwater protection criteria was not necessary. Further, as discussed in the following text, groundwater in the surficial unit is not an "aquifer" as defined in the administrative rules of Part 201.

2.3.2 Potential Exposure Pathways for Groundwater Evaluated by BBL

The State of Michigan Act 451 Part 201 Administrative Rules (R299.5101(c)) and the Code of Federal Regulation (CFR, Part 40, Section 149.2) define an aquifer as *"... a geological formation, group of formations, or part (portion) of a formation that is capable of yielding a significant amount of ground water to wells or springs."* The thin surficial water bearing unit at the site has a very low transmissivity (10^{-4} to 10^{-5} cm/sec) and does not meet the definition of an aquifer for the following reasons:

1. The unit does not yield enough water for it to be considered an economically viable water source; and,

2. The natural water quality of the surficial water-bearing unit is highly mineralized and is such that extensive treatment would be required prior to use.

The practical definition of an aquifer is further clarified in the book *Groundwater and Wells* as "a saturated bed, formation, or group of formations which yields water in sufficient quantity to be economically useful (Driscoll, 1986)." From an economical standpoint, wells that yield less than approximately 2 gpm are not useful as water supply. Site-specific data collected from the Flint West facility was input into the Cooper-Jacob equation to estimate sustainable flow from the surficial water-bearing unit, as follows:

$$Q = \frac{s\ T}{264\ \log\ 0.3\ \frac{Tt}{r^2 S}}$$

Where Q = pumping rate, gpm
T = transmissivity, gpd/ft) = K*b

K = conductivity, gpd/ft^2 = 4.2
(site data, BBL, June 1997)
s = drawdown, feet = 5
r = distance from pumping well, feet = 5
t = time since pumping started, days = 365
b = saturated thickness, feet = 5
S = storage coefficient, dimension less = 0.15

$$Q = \frac{5 \times 21}{264 \log 0.3 \left(\frac{21 \times 365}{5^2 \times 0.15}\right)} = 0.14 gpm$$

This projection was verified by data from short-term pumping at monitoring wells installed for LUST investigation at the nearby Building 2A (ES&E, January 8, 1992). Results of a step drawdown test indicated that 1 gpm was the maximum sustainable pumping rate for the pump test. This information further supports the determination that the surficial water-bearing unit cannot be considered an aquifer.

A review of well completion records from Genesee County indicated that potable wells in the area are open to the Saginaw sandstone below the glacial deposits.

In addition, and as added emphasis, there are several institutional reasons that this water unit could not be used as a potable aquifer, namely:

1. Other much more productive and economically viable aquifer sources are readily available in the area;

2. The surficial medium-to-fine grained sand unit is highly variable in thickness, and is not thick enough to support the amount of casing required by the State of Michigan Department of Health for public potable water supply wells (25 feet) throughout much of the Flint West property. State regulations (Michigan Drinking Water Regulations, R 325.10818) require that casings for potable water supply wells extend at least 25 feet bls.;

3. The Genesee County Health Department will not issue permits for public potable water supply wells within the Flint City limits; and,

4. Potable water is readily available throughout the Flint area from the municipal utility and hookup is mandatory.

Representatives of the Genesee County Health Department (personal communication) stated there were no public potable water supply wells drilled to tap the glacial drift since 1967, when records were first required. Personnel from the City of Flint Water Services stated that hookup to the municipal water supply is mandatory within City limits (Flint City Code, Section 46-25).

Accordingly, the surficial unit is not an aquifer, the ingestion pathway is not complete and health-based and aesthetic drinking water criteria are not applicable to Site groundwater. Exposure pathways to be considered for groundwater include direct contact (dermal and ingestion) and discharge to surface water.

Dermal contact with groundwater by utility workers has been considered; therefore, groundwater results were compared to the utility worker groundwater contact criteria (GCC) published by Michigan Department of Environmental Quality (MDEQ).

Groundwater venting to surface water is a viable pathway to consider for groundwater. Groundwater concentrations were compared to groundwater/surface water interface (GSI) criteria.

2.4 Statistical Approach

The purpose of the statistical evaluation was to determine a concentration that would be representative of the actual concentration that someone would be expected to encounter at the property. In order to determine if the site is a "facility", BBL calculated a 95% Lower Confidence Limit (LCL) for the mean of all compounds for which at least a single data point exceeded the relevant generic criteria for a residential exposure scenario. Statistical methods commonly used to determine a 95% LCL of the mean require a normally distributed data set. The site data was tested for normality to determine the appropriate statistical approach. The Shapiro-Wilk test of Normality was used to test each data set as outlined in the EPA document titled "Statistical Training Course For Ground-water Monitoring Data Analysis".

2.4.1 Statistical Evaluation

The first step in performing the statistical evaluation of the laboratory data is to determine if it is normally distributed, that is the data, when placed in numerical order, should show a high correlation. The Shapiro-Wilk Test (Shapiro and Wilk, 1965) is performed to determine if the data set is normally distributed. The first step of the Shapiro-Wilk Test involves plotting the from the smallest value to the largest in a column in a table. In a second column, plot the sorted data in reverse order. The third column represents the difference between the numbers in first and second columns. The next step in the process is to determine the number of samples in the sample group and look up a predetermine set of coefficients for the number of samples. These coefficients are placed in a fourth column in the table. The differences in the data are then multiplied by the coefficients in the fourth column and the subsequent values are then placed in a fifth column and totaled. Only positive values in the third column are used in this part of the evaluation. Once this is done, the standard deviation of the data is calculated and is used in the following equation along with the total value from column five in the data evaluation table.

$$W = \left[\frac{b}{SD\sqrt{n-1}}\right]^2$$

Where:
W = The Shapiro-Wilk Test statistic
b = The sum of the data in the fifth column of the data table
SD = Standard deviation
n = number of samples in the data set

The subsequent value of W is then compared to a tabulated value for W for the given number of samples. If the value in the tabulated value for W is less than the calculated value of W then the data is normally distributed. If the tabulated value of W is greater than the calculated value of W then the data is not normally distributed.

When this test was performed for the laboratory analytical data for arsenic in soil, the results showed that the data was not normally distributed. Because the data was not normally distributed, the natural logarithm of the data was determined and the Shapiro-Wilk Test was redone following the steps outlined above. After the natural logarithm of the data was calculated, the results of the Shapiro-Wilk Test showed that the data had a lognormal distribution.

After the distribution of the data in the data set has been determined, the 95% LCL for the data set is determined as follows:

- Calculate the mean of the data set
- Calculate the standard deviation of the data set
- Determine the LCL using the equation presented below:

$$LCL = e^{[(x)-(t)(s)]}$$

Where: LCL = Lower Confidence Limit
e = Constant (based on the natural logarithm)
x = mean of the data set
t = t-ratio for 95% confidence limit
s = Standard deviation of the data set

2.5 Discussion of SME Laboratory Analytical Data

Data collected by SME were compared by BBL to the relevant criteria for a residential exposure scenario to determine if the Site is considered a "facility" under Part 201. SME data were also compared to industrial criteria. Under a residential exposure scenario the analytical results for constituents in soil and groundwater were compared to applicable regulatory criteria, as follows:

- Analytical results for constituents in groundwater were compared to GSI criteria and GCC from Operational Memorandum #18: Part 201 Generic Cleanup Criteria Tables issued by the MDEQ in August of 1998.

- Analytical results for constituents in soil were compared to Generic Residential DCC, VSIC, and PSIC from Operational Memorandum #18: Part 201 Generic Cleanup Criteria Tables issued by the MDEQ in August of 1998.

As a first screen, BBL compared the data from each sampling location to the above-listed applicable regulatory criteria for a residential exposure scenario. The soil concentrations of the analyzed constituents were below relevant criteria with the exception of arsenic. Arsenic concentrations in ten soil samples exceeded the residential DCC. A statistical analysis was then conducted to determine whether the 95% Lower Confidence Limit (LCL) of the median concentration of arsenic exceeded the relevant generic criteria. The 95% LCL of the soil arsenic concentrations was 5,139 μg/kg, below the residential DCC of 6,600 μg/kg. The calculation of the 95% LCL for arsenic in soil is presented in Appendix B.

The groundwater concentrations of the analyzed constituents were below relevant criteria. It should be noted that although total copper (in three samples) in groundwater exceeded the calculated GSI criteria, the calculated GSI is applicable to the dissolved metal concentration only. It is expected that filtered samples collected for dissolved copper analysis would be below GSI criteria.

Further, barium concentrations in seven of the eight groundwater samples were below detection limit (BDL) of 200 μg/L . The detected concentration, 210 micrograms per liter (μg/L), was only slightly above the criterion of 200 μg/L. Based on a statistical evaluation provided by Dr. Gibbons (Appendix C), the 95% LCL calculated for barium was 100 μg/L and therefore below the criterion. Furthermore, groundwater samples from monitoring well MW-3, downgradient of SP3 (where barium was detected), was below the GSI criteria. Thus, barium can be eliminated as a concern.

Consequently, the site should not be considered a "facility" as defined in Part 201 of PA 451.

3. Conclusions and Recommendations

Based on some detections of arsenic in soil samples, a statistical analysis was conducted to determine the 95% Lower Confidence Limit (LCL) of the mean concentration of arsenic at the site. The 95% LCL of the soil arsenic concentrations was 5,139 μg/kg, below the residential DCC of 6,600 μg/kg. Concentrations of other analyzed constituents in soil did not exceed residential criteria for relevant pathways.

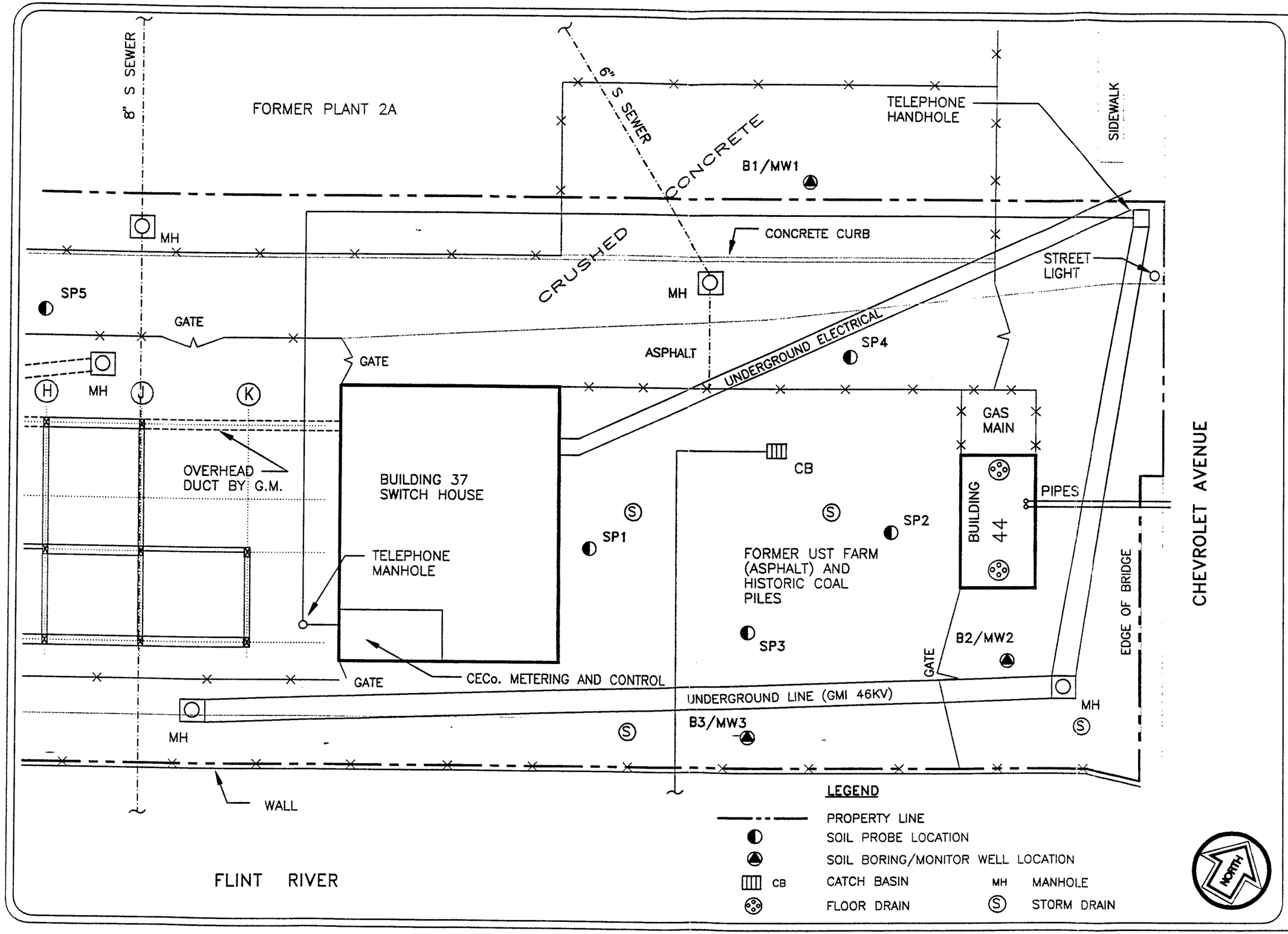
Although concentration of total copper (in three samples) in groundwater exceeded the calculated GSI criteria, the calculated GSI criteria is applicable to the dissolved metal concentration only. It is expected that filtered samples collected for dissolved copper analysis would be below GSI criteria.

Further, barium concentrations in seven of the eight groundwater samples were below detection limit (BDL) of 200 μg/L. The detected concentration, 210 μg/L, was only slightly above the criterion of 200 μg/L. Based on a statistical evaluation provided by Dr. Gibbons (Appendix C), the 95% LCL calculated for barium was 100 μg/L and therefore below the criterion. Furthermore, groundwater samples from monitoring well MW-3, downgradient of SP3 (where barium was detected), was below the GSI criteria. Thus, barium can be eliminated as a concern.

In addition, pursuant to Section 20107a and because the parcel is not a 'facility', there are no known conditions at the parcel that will require the exercise of due care by undertaking a response activity to mitigate unacceptable exposure to levels of hazardous substances present in soils and groundwater. In the case that contamination is discovered that determines the parcel or portions of the parcel are considered a facility that there was no evidence of during the previously appropriate inquiries, the due care responsibilities must be complied with as defined in Section 20107a.

Current and future land use is and will remain as industrial at Flint West.

PART C - FIGURES



SOIL BORING, SOIL PROBE, AND MONITOR WELL LOCATION DIAGRAM
CONSUMERS ENERGY COMPANY
CHEVROLET INDUSTRIAL SUBSTATION
FLINT, MICHIGAN

DATE: 7-15-98
SCALE: 1" = 20'
DRAFTER: ARR/MBA
JOB: PE 29742

FILE NAME H:29000\29742-01.DWG

Figure No. 2

PART C - TABLES

TABLE C-1
SUMMARY OF LABORATORY ANALYTICAL DATA FOR SOIL
BASELINE ENVIRONMENTAL SITE ASSESSMENT

BUILDINGS 37/44
DELPHI-FLINT WEST FACILITY
FLINT, MICHIGAN

Parameter Detected	EPA Method	Detection Level	Sample Identification				Residential Infinite Source VSIC	Residential PSIC	Residential DCC	Industrial Infinite Source VSIC	Industrial PSIC	Industrial DCC
			SP-1 (0-2')	SP-1 (10-12')	SP-1 (14-16')	SP-2 (4-6')						
PAH Constituents												
Fluoranthene	8270	330	<330	<330	<330	<330	7.4E+08	9.3E+09	5.1E+07	8.8+08	4.1E+09	5.4E+08
Pyrene	8270	330	<330	<330	<330	<330	6.5E+08	6.7E+09	3.2E+07	7.7E+08	2.9E+09	3.4E+08
Metals												
Arsenic	7061	100	**13,000**	**8,000**	**7,800**	6,300	NLV	7.2E+05	6,600	NLV	9.1E+05	1.0E+05
Barium	7081	1,000	100,000	39,000	57,000	15,000	NLV	3.3E+08	3.0E+07	NLV	1.5E+08	3.2E+08
Cadmium	7131	50	350	110	650	91	NLV	1.7E+06	2.1E+05	NLV	2.2E+06	2.3E+06
Chromium	7191	2,500	23,000	8,600	5,300	51,000	NLV	2.6E+05	2.0E+06	NLV	3.3E+05	2.2E+07
Copper	7211	1,000	26,000	5,900	5,300	6,600	NLV	1.3E+08	1.6E+07	NLV	5.9E+07	1.7E+08
Lead	7421	1,000	180,000	11,000	8,600	8,200	NLV	1.0E+08	4.0E+05	NLV	4.4E+07	9.0E+05
Mercury	7470	100	<100	<100	3,400	<100	NLV	ID	1.3E+05	NLV	ID	1.4E+06
Silver	7761	500	<500	<500	<500	<500	NLV	6.7E+06	2.6E+06	NLV	2.9E+06	2.1E+07
Zinc	7950	1,000	220,000	27,000	27,000	44,000	NLV	ID	1.4E+08	NLV	ID	1.0E+09

ALL CONCENTRATIONS IN MICROGRAMS PER KILOGRAM (ug/kg)
Notes:
ID - Inadequate data to develop a criterion
NA - Not available
DCC - Direct Contact Criteria
PSIC - Particulate Soil Inhalation Criteria
IP - In process
NLV - Not likely to volatalize
VSIC - Volatile Soil Inhalation Criteria
Samples collected in August 1998 by Soil and Materials Engineers, Inc.
Only constituents detected above the detection level are presented in this table; constituents not listed for each EPA Method were BDL.
All relevant generic criteria presented above are from the MDEQ Operational Memorandum #18: Part 201 Cleanup Criteria Tables issued in August 1998.
Bold values exceed Residential DCC.

TABLE C-1
SUMMARY OF LABORATORY ANALYTICAL DATA FOR SOIL
BASELINE ENVIRONMENTAL SITE ASSESSMENT

BUILDINGS 37/44
DELPHI-FLINT WEST FACILITY
FLINT, MICHIGAN

Parameter Detected	EPA Method	Detection Level	Sample Identification				Residential Infinite Source VSIC	Residential PSIC	Residential DCC	Industrial Infinite Source VSIC	Industrial PSIC	Industrial DCC
			SP-2 (14-16')	SP-3 (2-4')	SP-3 (14-16')	SP-4 (2-4')						
PAH Constituents												
Fluoranthene	8270	330	<660	<330	<330	<330	7.4E+08	9.3E+09	5.1E+07	8.8+08	4.1E+09	5.4E+08
Pyrene	8270	330	<660	<330	<330	<330	6.5E+08	6.7E+09	3.2E+07	7.7E+08	2.9E+09	3.4E+08
Metals												
Arsenic	7061	100	5,600	5,500	6,300	**53,000**	NLV	7.2E+05	6,600	NLV	9.1E+05	1.0E+05
Barium	7081	1,000	16,000	16,000	11,000	13,000	NLV	3.3E+08	3.0E+07	NLV	1.5E+08	3.2E+08
Cadmium	7131	50	94	87	120	130	NLV	1.7E+06	2.1E+05	NLV	2.2E+06	2.3E+06
Chromium	7191	2,500	5,700	5,400	11,000	6,900	NLV	2.6E+05	2.0E+06	NLV	3.3E+05	2.2E+07
Copper	7211	1,000	5,200	4,900	4,700	5,200	NLV	1.3E+08	1.6E+07	NLV	5.9E+07	1.7E+08
Lead	7421	1,000	6,400	5,900	12,000	9,500	NLV	1.0E+08	4.0E+05	NLV	4.4E+07	9.0E+05
Mercury	7470	100	<100	<100	<100	<100	NLV	ID	1.3E+05	NLV	ID	1.4E+06
Silver			<500	<500	<500	<500	NLV	6.7E+06	2.6E+06	NLV	2.9E+06	2.1E+07
Zinc	7950	1,000	25,000	22,000	23,000	24,000	NLV	ID	1.4E+08	NLV	ID	1.0E+09

ALL CONCENTRATIONS IN MICROGRAMS PER KILOGRAM (ug/kg)
Notes:
ID - Inadequate data to develop a criterion
NA - Not available
DCC - Direct Contact Criteria
PSIC - Particulate Soil Inhalation Criteria
IP - In process
NLV - Not likely to volatalize
VSIC - Volatile Soil Inhalation Criteria
Samples collected in August 1998 by Soil and Materials Engineers, Inc.
Only constituents detected above the detection level are presented in this table; constituents not listed for each EPA Method were BDL.
All relevant generic criteria presented above are from the MDEQ Operational Memorandum #18: Part 201 Cleanup Criteria Tables issued in August 1998.
Bold values exceed Residential DCC.

TABLE C-1
SUMMARY OF LABORATORY ANALYTICAL DATA FOR SOIL
BASELINE ENVIRONMENTAL SITE ASSESSMENT

BUILDINGS 37/44
DELPHI-FLINT WEST FACILITY
FLINT, MICHIGAN

Parameter Detected	EPA Method	Detection Level	Sample Identification				Residential Infinite Source VSIC	Residential PSIC	Residential DCC	Industrial Infinite Source VSIC	Industrial PSIC	Industrial DCC
			SP-4 (13-15)	SP-5 (10-12')	B-1 (5-7')	B-1 (13-15)						
PAH Constituents												
Fluoranthene	8270	330	<330	<330	<330	<330	7.4E+08	9.3E+09	5.1E+07	8.8+08	4.1E+09	5.4E+08
Pyrene	8270	330	<330	<330	<330	<330	6.5E+08	6.7E+09	3.2E+07	7.7E+08	2.9E+09	3.4E+08
Metals												
Arsenic	7061	100	4,900	**12,000**	6,300	**23,000**	NLV	7.2E+05	6,600	NLV	9.1E+05	1.0E+05
Barium	7081	1,000	11,000	38,000	65,000	68,000	NLV	3.3E+08	3.0E+07	NLV	1.5E+08	3.2E+08
Cadmium	7131	50	73	578	120	120	NLV	1.7E+06	2.1E+05	NLV	2.2E+06	2.3E+06
Chromium	7191	2,500	4,400	7,800	15,000	16,000	NLV	2.6E+05	2.0E+06	NLV	3.3E+05	2.2E+07
Copper	7211	1,000	4,600	12,000	250,000	10,000	NLV	1.3E+08	1.6E+07	NLV	5.9E+07	1.7E+08
Lead	7421	1,000	7,900	12,000	57,000	15,000	NLV	1.0E+08	4.0E+05	NLV	4.4E+07	9.0E+05
Mercury	7470	100	<100	<100	<100	<100	NLV	ID	1.3E+05	NLV	ID	1.4E+06
Silver			<500	<500	<500	<500	NLV	6.7E+06	2.6E+06	NLV	2.9E+06	2.1E+07
Zinc	7950	1,000	19,000	20,000	34,000	32,000	NLV	ID	1.4E+08	NLV	ID	1.0E+09

ALL CONCENTRATIONS IN MICROGRAMS PER KILOGRAM (ug/kg)
Notes:
ID - Inadequate data to develop a criterion
NA - Not available
DCC - Direct Contact Criteria
PSIC - Particulate Soil Inhalation Criteria
IP - In process
NLV - Not likely to volatalize
VSIC - Volatile Soil Inhalation Criteria
Samples collected in August 1998 by Soil and Materials Engineers, Inc.
Only constituents detected above the detection level are presented in this table; constituents not listed for each EPA Method were BDL.
All relevant generic criteria presented above are from the MDEQ Operational Memorandum #18: Part 201 Cleanup Criteria Tables issued in August 1998.
Bold values exceed Residential DCC.

TABLE C-1
SUMMARY OF LABORATORY ANALYTICAL DATA FOR SOIL
BASELINE ENVIRONMENTAL SITE ASSESSMENT

BUILDINGS 37/44
DELPHI-FLINT WEST FACILITY
FLINT, MICHIGAN

Parameter Detected	EPA Method	Detection Level	Sample Identification				Residential Infinite Source VSIC	Residential PSIC	Residential DCC	Industrial Infinite Source VSIC	Industrial PSIC	Industrial DCC
			B-2 (1-3')	B-2 (9-11')	B-3 (9-11')	B-3 (13-15)						
PAH Constituents												
Fluoranthene	8270	330	<330	410	<330	<330	7.4E+08	9.3E+09	5.1E+07	8.8+08	4.1E+09	5.4E+08
Pyrene	8270	330	<330	390	<330	<330	6.5E+08	6.7E+09	3.2E+07	7.7E+08	2.9E+09	3.4E+08
Metals												
Arsenic	7061	100	**72,000**	**14,000**	**17,000**	**8,200**	NLV	7.2E+05	6,600	NLV	9.1E+05	1.0E+05
Barium	7081	1,000	66,000	110,000	11,000	120,000	NLV	3.3E+08	3.0E+07	NLV	1.5E+08	3.2E+08
Cadmium	7131	50	170	390	590	790	NLV	1.7E+06	2.1E+05	NLV	2.2E+06	2.3E+06
Chromium	7191	2,500	11,000	170,000	23,000	35,000	NLV	2.6E+05	2.0E+06	NLV	3.3E+05	2.2E+07
Copper	7211	1,000	12,000	31,000	43,000	1.8E+05	NLV	1.3E+08	1.6E+07	NLV	5.9E+07	1.7E+08
Lead	7421	1,000	130,000	180,000	2.1E+05	1.6E+05	NLV	1.0E+08	4.0E+05	NLV	4.4E+07	9.0E+05
Mercury	7470	100	<100	<100	<100	<100	NLV	ID	1.3E+05	NLV	ID	1.4E+06
Silver			<500	910	<500	<500	NLV	6.7E+06	2.6E+06	NLV	2.9E+06	2.1E+07
Zinc	7950	1,000	46,000	100,000	1.1E+05	1.5E+05	NLV	ID	1.4E+08	NLV	ID	1.0E+09

ALL CONCENTRATIONS IN MICROGRAMS PER KILOGRAM (ug/kg)
Notes:
ID - Inadequate data to develop a criterion
NA - Not available
DCC - Direct Contact Criteria
PSIC - Particulate Soil Inhalation Criteria
IP - In process
NLV - Not likely to volatalize
VSIC - Volatile Soil Inhalation Criteria
Samples collected in August 1998 by Soil and Materials Engineers, Inc.
Only constituents detected above the detection level are presented in this table; constituents not listed for each EPA Method were BDL.
All relevant generic criteria presented above are from the MDEQ Operational Memorandum #18: Part 201 Cleanup Criteria Tables issued in August 1998.
Bold values exceed Residential DCC.

TABLE C-2
SUMMARY OF LABORATORY ANALYTICAL DATA FOR GROUNDWATER
BASELINE ENVIRONMENTAL SITE ASSESSMENT

BUILDINGS 37/44
DELPHI-FLINT WEST FACILITY
FLINT, MICHIGAN

Parameter Detected (Total)	EPA Method	Detection Level (ug/L)	Sample Identification								Health Based DWC	GSI Values	GCC
			SP1	SP2	SP3	SP4	SP5	MW-1	MW-2	MW-3			
Arsenic	7061	5	31	<5	13	<5	<5	20	7	16	50	150	4700
Barium	7081	200	<200	<200	**210**	<200	<200	<200	<200	<200	2,000	200	1.5E+07
Copper	7131	25	<25	<25	<25	<25	<25	**41**	**57**	**44**	1,000	21*	8.1E+06
Lead	7421	3	7	<3	*9*	<3	<3	<3	<3	<3	4	29*	ID

ALL CONCENTRATIONS IN MICROGRAMS PER LITER (ug/L)
Notes:
ID - Inadequate data to develop a criterion
DWC - Drinking water criteria
GSI - groundwater Surface Water Interface Value
GCC - Groundwater Contact Criteria
Only constituents detected above the detection level are presented in this table; constituents not listed for each EPA Method were below detection limits.
All relevant generic criteria presented above are from the MDEQ Operational Memorandum #18: Part 201 Cleanup Criteria Tables issued in August 1998.
Bold values exceed GSI criterion; however, the GSI criteria for barium and copper are for dissolved concentrations.
Italic values exceed health-based DWC
* - Indicates that the value is expressed as dissolved concentration.

References

American Society for Testing and Materials (ASTM). 1997. *E 1527-97 Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process* (Philadelphia, PA)

Blasland, Bouck, & Lee, Inc. (BBL). 1995. Phase I Environmental Site Assessment, Building 2A, Delphi-Flint West Facility Boca Raton, Florida: December.

Blasland, Bouck, & Lee, Inc. (BBL). 1997. Phase II Environmental Site Investigation, Former Building 2A, Delphi-Flint West Facility Boca Raton, Florida: June.

Blasland, Bouck, & Lee, Inc. (BBL). 1997. Phase II Environmental Site Investigation, Building 5, Delphi-Flint West Facility Boca Raton, Florida: February.

Blasland, Bouck, & Lee, Inc. (BBL). 1997. Phase I Environmental Site Assessment, Building 37, Delphi-Flint West Facility Boca Raton, Florida: December.

Blasland, Bouck, & Lee, Inc. (BBL). 1997. Phase I Environmental Site Assessment, Building 44, Delphi-Flint West Facility Boca Raton, Florida: December.

Blasland, Bouck, & Lee, Inc. (BBL). 1998. Letter report to Mark napolitan documenting cleaning of pipes at Building 44, Boca Raton, Florida: April 3.

ERIIS. 1997. ERIIS Report: Pertaining to: General Motors Delphi-Flint West Custom Corridor Buildings 2,7,11,13,17,29,36,37 and 44 Herndon, Virginia: September 25.

Environmental Science & Engineering, Inc. (ESE). 1992. Type B Closure Report, Building 37, Underground Storage Tank No. 3, 4, 5, 6, and A, AC Rochester Flint West Williamston, Michigan: April 8.

Gibbons, Robert D., 1994, Statistical Methods for Groundwater Monitoring, John Wiley & Sons, New York

Hunter/Keck, Inc. 1989. Report of Phase I, Underground Storage Tanks, Compliance Program, AC Rochester, Flint West, Flint, Michigan Williamston, Michigan: August 31.

Mandle, R.J., and Westjohn, D.B. 1989. Geohydrologic Framework and Ground-Water Flow in the Michigan Basin: American Water Resources Monograph Series No. 13, p.83-109.

Michigan Department of Environmental Quality (MDEQ). 1998. Operational Memorandum #18: Part 201 Generic Cleanup Criteria Tables: August 31.

MDEQ. 1998. Update to Operational Memorandum #18: Part 201 Generic Cleanup Criteria Tables: October 2.

Mosier, Rodney, of the Michigan Department of Environmental Quality, Environmental Response Division, to William Schroeck of Delphi Energy and Management Systems (formerly AC Rochester, Flint West). 1996. "Residential Cleanup Closure, Underground storage tanks 3, 4, 5, 6, and A" Flint, Michigan: July 18.

United States Environmental Protection Agency (USEPA), 1992, Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Draft Addendum to Interim Final Guidance, Washington

United States Geological Survey Circular 1099. 1994. Regional Aquifer System Analysis Program of the United States Geological Survey 1978 - 1992.

References

Westjohn, D.B., and Weaver, T.L. 1996. Hydrogeologic Framework of Pennsylvanian and Late Mississippian Rocks in the Central Lower Peninsula of Michigan: U.S. Geological Survey Water-Resources Investigations Report 94-4107 Lansing, Michigan: 1996.

Wiitala, S.W., Vanlier, K.E., and Krieger, R.A. 1963. The Water Resources of the Flint Area, Michigan, Geological Survey Water Supply Paper 1499-E.

Appendix A
Data Validation Summary

MEMORANDUM

BBL
BLASLAND, BOUCK & LEE, INC.
engineers & scientists

Privileged and Confidential
Prepared at Request General Motors Counsel

To: L. A. Yusko, Boca **Date:** 1/20/99

From: D.G. Castro, Tampa **cc:**

Re: Field Sampling Event
GM--Flint West Site 37/44 BESA

Attached are the Consumers Power Company, Laboratory Commercial Services, of Jackson, MI (CPC LCS) laboratory data reports prepared for the June 25 & 30 and July 6, 1998 soil and ground-water sampling episode at the Flint West site. The samples were collected by SME personnel and the following reports were prepared by CPC LCS:

1. CPC LCS No. CHEM-98-1150;
2. CPC LCS No. CHEM-98-1201; and
2. CPC LCS No. CHEM-98-1230.

The above-referenced analytical data packages were received for review on January 18, 1999. A limited data validation and quality assurance review was conducted and completed on January 20, 1999 utilizing standard validation procedures (USEPA, 1994). My comments are presented in two main sections, based upon a review of the field notes and the lab data, as follows.

Field Documentation

The chain-of-custody appeared to be fully completed.

Laboratory Data Package

Besides the surrogate-spike data, no additional quality control (QC) data accompanied the data reports. The PCB surrogate spiking result in GP-4 (GW) did not reach its respective QC limit and the corresponding PCB data are unacceptable, especially without additional QC data to review. While the remaining data cannot be disqualified, it should be used with caution because many of the concentrations are reported as Not Detected (ND), yet there is insufficient QC data to indicate that the laboratory systems were operating within prescribed control limits. If available, the remaining QC data should be reviewed to very the validity of the data.

Except as noted, the analytical results appear to be valid and may be used for quantitative purposes.

DGC/dgc

References:

1. EPA 540/R-94/012, February 1994, USEPA CLP National Functional Guidelines for Organic Data Review; and

2. EPA 540/R-94/013, February 1994, USEPA CLP National Functional Guidelines for Inorganic Data Review

Appendix B
Statistical Calculations for Arsenic in Soil

CALCULATION OF 95% UPPER CONFIDENCE LIMIT ON THE MEAN
ARSENIC CONCENTRATIONS IN SOIL

n	x(i)	ln(x(i))	ln(x(n-1+1))	x(n-1+1)-x(i)	a(n-1+1)	b(i)
1	4,900	8.4970	11.1844	2.6874	0.5056	1.3588
2	5,500	8.6125	10.8780	2.2655	0.3290	0.7454
3	5,600	8.6305	10.0432	1.4127	0.2521	0.3561
4	6,300	8.7483	9.7410	0.9927	0.1939	0.1925
5	6,300	8.7483	9.5468	0.7985	0.1447	0.1155
6	6,300	8.7483	9.4727	0.7244	0.1005	0.0728

CALCULATION OF 95% UPPER CONFIDENCE LIMIT ON THE MEAN
ARSENIC CONCENTRATIONS IN SOIL

n	x(i)	ln(x(i))	ln(x(n-1+1))	x(n-1+1)-x(i)	a(n-1+1)	b(i)
1	4,900	8.4970	11.1844	2.6874	0.5056	1.3588
2	5,500	8.6125	10.8780	2.2655	0.3290	0.7454
3	5,600	8.6305	10.0432	1.4127	0.2521	0.3561
4	6,300	8.7483	9.7410	0.9927	0.1939	0.1925
5	6,300	8.7483	9.5468	0.7985	0.1447	0.1155
6	6,300	8.7483	9.4727	0.7244	0.1005	0.0728
7	7,800	8.9619	9.3927	0.4308	0.0593	0.0255
8	8,000	8.9872	9.0119	0.0247	0.0196	0.0005
9	8,200	9.0119	8.9872	-0.0247		2.8671
10	12,000	9.3927	8.9619	-0.4308		
11	13,000	9.4727	8.7483	-0.7244		
12	14,000	9.5468	8.7483	-0.7985		
13	17,000	9.7410	8.7483	-0.9927		
14	23,000	10.0432	8.6305	-1.4127		
15	53,000	10.8780	8.6125	-2.2655		
16	72,000	11.1844	8.4970	-2.6874		

W	0.9085	Geom Mean	9.325298
W(0.05,16)	0.887	SD	0.776659

W>Wcrit, therefore log-transformed data are normally distributed.

H 2.3892

LCL=exp(X-(0.5*S^2+S*H/SQRT(n-1 5,139

Appendix C
Statistical Evaluation by Dr. Gibbons

Privileged and Confidential
Prepared at Request General Motors Counsel

Statistical Evaluation of General Motors Assessment Sampling Data for Buildings 37/44 Delphi-Flint West Facility

Prepared

by

Robert D. Gibbons Ph.D.

January, 1999

Dr. R.D. Gibbons
Professor of Biostatistics
University of Illinois at Chicago
912 S. Wood Street
Chicago, IL 60612
312-413-7755

Executive Summary

Results of comparisons of onsite 95% lower confidence limits (LCLs) to drinking water criteria (DWC), ground-water surface water interface values (GSI) and ground-water contact criteria (GCC) revealed that in all cases, the confidence interval for the true onsite mean concentration contained the regulatory standard. In light of this we do not have statistically significant evidence of an exceedance of any of the three sets of standards. The LCLs were a mixture of normal and nonparametric limits based on results of distributional testing and all provided a minimum of 95% confidence per constituent.

Table of Contents

1.0 Introduction

Statistical methods for detection monitoring have been well studied in recent years (see Gibbons, 1994a, 1996, USEPA 1992 and ASTM Standard PS 64-96 authored by Gibbons, Brown and Cameron, 1996). Although equally important, statistical methods for assessment sampling, Phase II and III investigations, on-going monitoring and corrective action sampling and monitoring have received less attention. One may ask why statistical analysis is necessary in assessment monitoring. Why not simply compare each measurement to the corresponding criterion? There are several reasons why statistical methods are essential in assessment and corrective action sampling programs. First, a single measurement tells us very little about the true concentration in the sampling location of interest, and with only one sample we have no idea if the measured concentration is a typical or an extreme value. Our objective is to compare the true concentration (or some interval that contains it) to the relevant criterion or standard. Second, in many cases the constituents of interest are naturally occurring (*e.g.*, metals) and the naturally existing concentrations may exceed the relevant criteria. In this case, the relevant comparison is to background (*e.g.*, off-site soil or upgradient groundwater) and not to a fixed criterion. As such, background data must be statistically characterized to obtain a statistical estimate of an upper bound for the naturally occurring concentrations so that it can be confidently determined if onsite concentrations are above background levels. Third, we are often confronted with the problem of comparing numerous potential constituents of concern to criteria or background, at numerous sampling locations. By chance alone there will be exceedances as the number of comparisons becomes large. The statistical approach to this problem can insure that both false positive and false negative results are minimized.

Of course, there is considerable USEPA support for statistical methods applied to detection, assessment and corrective action sampling and monitoring program data. For example, the 90% upper confidence limit (UCL) is used in SW846 (Chapter 9) for determining if a waste is hazardous. If the UCL is less than the criterion for a particular hazardous waste code, then the waste stream is considered to be nonhazardous even if certain individual measurements exceed the criterion. Similarly, in the USEPA *Statistical Anal-*

ysis of Groundwater Monitoring Data at RCRA Facilities Addendum to the Interim Final Guidance (1992), confidence intervals for the mean and various upper percentiles of the distribution are advocated for assessment and corrective action sampling. Interestingly, both the 1989 and 1992 USEPA guidance documents suggests use of the lower 95% confidence limit (LCL) as a tool for determining whether a criterion has been exceeded in assessment sampling. The latest USEPA guidance in this area (*i.e.*, the draft USEPA Unified Statistical Guidance) calls for use of the LCL in assessment monitoring and the UCL in corrective action. In this way, corrective action is only triggered if we have a high degree of confidence that the true concentration has exceeded the criterion or standard, whereas corrective action continues until we have a high degree of confidence that the true concentration is below the criterion or standard. This is the general approach adopted here as well.

The statistical methodology is first described in the following sections and then applied to the site-specific data.

1.1 Definitions

- *Assessment Monitoring* – Under Phase III Extent of Contamination (EOC efforts), investigative monitoring that is initiated after the presence of a contaminant has been detected in groundwater above a relevant criterion at one or more locations. The objective of the program is to determine if there is a statistically significant exceedance of a standard or criteria at a Potential Area of Concern (PAOC) or at the groundwater venting to surface water interface, and/or to quantify the rate and extent of migration of constituents detected in groundwater above residential criteria.

- *Compliance Monitoring* – As specified under 40 CFR 264.99, Compliance Monitoring is instituted when hazardous constituents have been detected above a relevant criterion at the compliance point during RCRA Detection Monitoring. Groundwater samples are collected at the compliance point, facility property boundary, and upgradient monitoring wells for analysis of hazardous constituents to determine if they are leaving the regulated unit at statistically significant concentrations.

- *Corrective Action Monitoring* – Under RCRA, Corrective Action Monitoring is instituted when hazardous constituents from a RCRA regulated unit have been detected at statistically significant concentrations between the compliance point and the downgradient facility property boundary, as specified under 40 CFR 264.100. Corrective Action Monitoring is conducted throughout the corrective action program that is implemented to address groundwater contamination. At non-RCRA sites, Corrective Action Monitoring is conducted throughout the active period of corrective action to determine the progress of remediation and to identify statistically significant trends in groundwater contaminant concentrations.

- *Detection limit - DL* – The true concentration at which there is a specified level of confidence (*e.g.*, 99% confidence) that the analyte is present in the sample.

- *Detection Monitoring* – Under Phase II Environmental Site Investigation (ESI) efforts, a program of monitoring for the express purpose of determining whether or not there has been a release of a contaminant to groundwater. Under RCRA, Detection Monitoring involves collection of groundwater samples from compliance point and upgradient monitoring wells on a semi-annual basis for analysis of hazardous constituents of concern, as specified under 40 CFR 264.98. Results are evaluated to determine if there is a statistically significant exceedance of the groundwater protection criterion and/or background. At non-RCRA sites, monitoring is conducted in a similar manner and results are compared to criteria to determine if there is a statistically significant exceedance.

- *Direct Push Sampling* – Groundwater sampling conducted with a device that is temporarily pushed into the ground with a hydraulic system or with a hammer. After groundwater sample collection, the device is removed from the ground. Examples include Geoprobe$^{(R)}$, Hydropunch$^{(R)}$, direct push, and environmental soil probe.

- *False negative rate* – The rate at which the statistical procedure does not indicate possible contamination when contamination is present.

- *False positive rate* – The rate at which the statistical procedure indicates possible contamination when none is present.

- *Lognormal distribution* – A frequency distribution whose logarithm follows a normal distribution.

- *Lower Confidence Limit - LCL* – A statistical estimate of the lower bound for the true mean concentration (or a percentile of the concentration distribution) with specified level of confidence (*e.g.*, 95%) based on m samples.

- *Lower Prediction Limit - LPL* – A statistical estimate of the minimum concentration that will provide a lower bound for the next series of k measurements from that distribution, or the mean of m new measurements for each of k sets of samples, with specified level of confidence (*e.g.*, 95%) based on a sample of n background measurements.

- *Nonparametric* – A term referring to a statistical technique in which the distribution of the constituent in the population is unknown and is not restricted to be of a specified form.

- *Nonparametric prediction limit* – The largest (or second largest) of n background samples. The confidence level associated with the nonparametric prediction limit is a function of n, m and k

- *Normal distribution* – A frequency distribution whose plot is a continuous, infinite, bell-shaped curve that is symmetrical about its arithmetic mean, mode and median (which are numerically equivalent).

- *Outlier* – A measurement that is statistically inconsistent with the distribution of other measurements from which it was drawn.

- *Parametric* – A term referring to a statistical technique in which the distribution of the constituent in the population is assumed to be known.

- *Quantification limit - QL* – The concentration at which quantitative determinations of an analyte's concentration in the sample can be reliably made during routine laboratory operating conditions.

- *Potential Area of Concern - PAOC* – Areas with a documented release or likely presence of a hazardous substance that could pose an unacceptable risk to human health or the environment.

- Phase I Environmental Site Assessment - ESA – Non-intrusive investigation that identifies PAOCs which may require further investigation in subsequent phases of work.

- Phase II Environmental Site Assessment - ESI – Intrusive survey to confirm or deny existence of a release into the environment at a PAOC at levels which may adversely impact public health or the environment.

- *Upper Confidence Limit - UCL* – A statistical estimate of the upper bound for the true mean concentration (or a percentile of the concentration distribution) with specified level of confidence (*e.g.*, 95%) based on m samples.

- *Upper Prediction Limit - UPL* – A statistical estimate of the maximum concentration that will not be exceeded by the next series of k measurements from that distribution, or the mean of m new measurements for each of k sets of samples, with specified level of confidence (*e.g.*, 95%) based on a sample of n background measurements.

- *Symbols*:
  - μ –the true population mean of a constituent.
  - $\bar{x}$ –the sample based mean or average concentration of a constituent computed from n background measurements.
  - σ^2 –the true population variance of a constituent.
  - s^2 –the sample based variance of a constituent computed from n background measurements.
  - s –the sample based standard deviation of a constituent computed from n background measurements.
  - $\bar{y}$ – the mean of the natural log transformed data.
  - s_y – the standard deviation of the natural log transformed data.
  - n –the number of background (offsite or upgradient) measurements.
  - k –the number of future comparisons for a single monitoring event (*e.g.*, the number of downgradient monitoring wells multiplied by the number of constituents to be monitored) for which statistics are to be computed.
  - α –the false positive rate for an individual comparison (*i.e.*, one sampling location and constituent).
  - m – the number of onsite or downgradient measurements used in computing the onsite mean concentration.
  - α^* –the site-wide false positive rate covering all sampling locations and constituents.
  - t – the $100(1-\alpha)$ percentage point of Student's t-distribution on $n-1$ degrees of freedom.
  - H_L – the factor developed by Land (1971) to obtain the lower $100(\alpha)\%$ confidence limit for the mean of a lognormal distribution.
  - H_U – the factor developed by Land (1971) to obtain the upper $100(\alpha)\%$ confidence limit for the mean of a lognormal distribution.

2.0 Approach

In the following, the general conceptual and statistical foundations of the sampling program are described.

- Identify relevant constituents for the specific type of facility, media (*e.g.*, soil, groundwater etc.) and area of interest. A facility is generally comprised of a series of subunits or "source areas" that may have a distinct set of sampling locations and relevant constituents of concern (referred to as a PAOC). The subunit may consist of a single sampling point or collection of sampling points. In some cases, the entire site may comprise the area of interest and all sampling locations are considered jointly. In all cases, the owner/operator should select the smallest possible list of constituents that adequately characterize the source area in terms of historical use.

- For each constituent obtain the appropriate regulatory criterion or standard (*e.g.*, maximum contaminant level - MCL) if one is available. The appropriate criterion or standard should be selected based on relevant pathways (*e.g.*, direct contact, ingestion, inhalation) and appropriate land use criteria (*e.g.*, commercial, industrial, residential).

- For each constituent which may have a background concentration higher than the relevant health based criterion, set "background" to the upper 95% confidence prediction limit (UPL) as described in the Technical Details section. The prediction limits are computed from all available data collected from background, or outside source areas that are unlikely to be contaminated, upstream, upwind or upgradient locations only. Henceforth, we will refer to background as constituting any of these types of offsite sources. The background data are first screened for outliers and then tested for normality and lognormality (see Technical Details section).

  - If the test of normality cannot be rejected (*e.g.*, at the 95% confidence level), background is equal to the 95% confidence normal

prediction limit.

- If the test of normality is rejected but the test of lognormality cannot be rejected, background is equal to the 95% confidence lognormal prediction limit.
- If the data are neither normal or lognormal or the detection frequency is less than 50%, background is the nonparametric prediction limit which is computed as the maximum of the background measurements. Note that if the detection frequency is zero, background is set equal to the appropriate Quantification Limit (QL) for that constituent which is the lowest concentration that can be reliably determined within specified limits of precision and accuracy by the indicated methods under routine laboratory operating conditions.

- If the background is greater than the relevant criterion or standard or if there is no criterion or standard, then comparisons are made to the background prediction limit. If the criterion is greater than background, then compare the appropriate confidence limit to the criterion. Note that if nothing is detected in background, then the background is the QL. If the criterion is lower than the QL, then the criterion is the QL.

- The number of samples taken, depends on whether we are comparing to background or a criterion and whether we are making comparisons at individual locations or by pooling samples within a source area. If comparison is to background, collect a minimum of one sample from each source area or sampling location. If comparison is to a criterion (*i.e.*, the criterion is greater than background), and we are concerned with a single location, a minimum of four independent samples from each sampling location will be required. If the comparison is to a criterion for an entire source area a minimum of one sample from each of four sampling locations within the source area are required. If there are fewer than four sampling locations within a given source area, then the total number of measurements from the source area must be four or more (*e.g.*, two sampling locations each with two independent samples).

- If comparison is to a criterion or standard there are two general approaches. In assessment sampling where interest is in determining if

a criterion has been exceeded, compare the 95% lower confidence limit (LCL) for the mean of at least four samples from a single location, source area or the entire site to the relevant criterion. In corrective action sampling and monitoring where interest is in demonstrating that the onsite concentration is lower than the criterion, compare the 95% upper confidence limit (UCL) for the mean of at least four samples from a single location, source area or the entire site to the relevant criterion.

- If the background prediction limit is larger than the relevant criterion, then do one of the following: (1) for a single measurement obtained from an individual location, compare this individual measurement to the background prediction limit for the next single measurement from each of k locations, (2) for multiple measurements obtained from a given source area or the entire site, compare the mean of the measurements to the background prediction limit for the mean of m measurements based on the best fitting statistical distribution or nonparametric alternative.

- Note that if the background UPL and the regulatory criterion are quite similar, it may be possible for the downgradient mean to exceed the background UPL but the LCL for the downgradient mean may still be less than the regulatory criterion. In this case, an exceedance is not determined.

3.0. Technical Details

The purpose of this section is to provide a description of the specific statistical methods to be used in assessment and corrective action sampling programs.

3.1 Comparison to a Regulatory Criterion or Standard

3.1.1 Confidence Limits for the Mean or Median Concentration

- The 95% normal LCL (assessment sampling and monitoring) or 95% normal UCL (corrective action) for the mean of at least four measurements is computed and compared to the Regulatory Criterion or Standard.

- The 95% normal LCL (assessment sampling and monitoring) for the mean of m measurements is computed as

$$\bar{x} - t_{[m-1,.05]}\frac{s}{\sqrt{m}} \cdot$$

- The 95% normal UCL (corrective action) for the mean of m measurements is computed as

$$\bar{x} + t_{[m-1,.05]}\frac{s}{\sqrt{m}} \cdot$$

- If $m < 8$, nondetects are replaced by one-half of the QL since with fewer than eight measurements, more sophisticated statistical adjustments are not appropriate. Similarly, we use a normal UCL because seven or fewer samples are insufficient to confidently determine distributional form of the data. Use of a lognormal limit with small samples can result in extreme limit estimates, therefore default to normality for $m < 8$.
- If $m \geq 8$, use Aitchison's (1955) method to adjust for nondetects and test for normality and lognormality of the data using the single group or multiple group version of the Shapiro-Wilk test (see following section for details). The multiple group version of the Shapiro-Wilk test is used when there are multiple measurements from multiple onsite locations (use 95% confidence level). Note that alternatives such as Cohen's (1961) method can be used, however the reporting limit must be constant for each constituents which is rarely the case.
- If $m \geq 8$, and the data are neither normally or lognormally distributed, compute the 95% nonparametric LCL or UCL for the median of m samples (see Hahn and Meeker (1991) section 5.2) Alternatively, if the data are lognormally distributed, compute a lognormal LCL or UCL for the mean (see Land, 1971). The $(1-\alpha)100\%$ lognormal UCL for the mean is

$$exp\left(\bar{y} + .5s_y + \frac{H_{1-\alpha}s_y}{\sqrt{m-1}}\right) .$$

The $(1-\alpha)100\%$ lognormal LCL for the mean is

$$exp\left(\bar{y} + .5s_y + \frac{H_{\alpha}s_y}{\sqrt{m-1}}\right) .$$

The factors H are given by Land (1975) and $\bar{y}$ and s_y and the mean and standard deviation of the natural log transformed data (*i.e.*, $y_. = log_e(x)$). The lognormal LCL or UCL for the median is simply the exponentiated result of computing the normal LCL or UCL on natural log transformed data (see Hahn and Meeker, 1991).

- Use Sen's nonparametric trend test to evaluate trends (both increasing and decreasing) to demonstrate the effectiveness of corrective action. The specific algorithm for computing Sen's test is given by Gibbons, 1994 (pages 175-178).

Confidence Limits for Other Percentiles of the Distribution

For some applications, we may wish to determine a LCL or UCL for a specific percentile of the distribution (*e.g.*, 90th, 95th or 99th percentiles of the concentration distribution). For a normal distribution, which is symmetric, the mean, median and 50th percentile are identical, however, this is not the case for the lognormal distribution where the mean is larger than the median or 50th percentile. Of course, in the nonparametric case, we can only derive confidence limits of percentiles, such as the 50th percentile of the distribution (*i.e.*, the concept of confidence limits for the mean does not exist without a specific parametric form of the distribution).

For those constituents with short term exposure risks or in those cases in which one may wish to show added environmental protection, confidence limits for upper percentiles of the distribution may be used (*e.g.*, 90th, 95th or 99th percentiles). The interpretation here is that we can have say 95% confidence that 95% of the distribution is beneath the estimated confidence limit. Both LCLs and UCLs for upper percentiles can be computed and normal, lognormal and nonparametric approaches have been described in general by Hahn and Meeker (1991) and are closely related to the statistical tolerance limits.

3.2 Generation of the Background Prediction Limit

When the background prediction limit exceeds the Regulatory Criterion or Standard, then onsite measurements are compared to the 95% con-

fidence upper prediction limit based on all available background data for that constituent. In the following section, the method by which the prediction limit is computed is presented.

3.2.1 Case 1: Compounds Quantified in All Background Samples

- For groundwater, obtain a minimum of four measurements from at least two background sampling locations. For soils, obtain measurements from a minimum of eight different background sampling locations.
- For groundwater, in which measurements are taken repeatedly from the same sampling location (*i.e.*, an upgradient sampling well), test normality of distribution using the multiple group version of the Shapiro-Wilk test (Wilk and Shapiro, 1968) applied to n upgradient or background measurements. The n background measurements refer to all available background measurements obtained at multiple background sampling locations (spatial) and all available sampling events (temporal). The multiple group version of the original Shapiro-Wilk test (Shapiro and Wilk, 1965) takes into consideration that upgradient measurements are nested within different upgradient sampling wells, hence the original Shapiro-Wilk test does not apply. This computation is described by Gibbons, 1994 (pages 228-231). For soils, the n background samples can be tested for normality using the original Shapiro-Wilk test (see Gibbons, 1994, pages 219-222) since each measurement is obtained from a unique background sampling location.
- If normality is not rejected (*i.e.*, at the 95% confidence level), compute the 95% (*i.e.*, site-wide) prediction limit as:

$$\bar{x} + t_{[n-1,\alpha]} s \sqrt{\frac{1}{m} + \frac{1}{n}} ,$$

where

$$\bar{x} = \sum_{i=1}^{n} \frac{x_i}{n} ,$$

$$s = \sqrt{\sum_{i=1}^{n} \frac{(x_i - \bar{x})^2}{n-1}} ,$$

α is the false positive rate for each individual test,

$t_{[n-1,\alpha]}$ is the one-sided $(1-\alpha)100\%$ point of Student's t distribution on $n-1$ degrees of freedom,

n is the number of background measurements.

and m is the number of measurements from which the onsite source area mean is computed. Note that if individual onsite measurements are to be compared to background (*e.g.*, the most recent measurement from each location), $m = 1$ and the prediction limit becomes:

$$\bar{x} + t_{[n-1,\alpha]} s \sqrt{1 + \frac{1}{n}} .$$

- Select $\alpha = .05/k$, where k is the number of comparisons (*i.e.*, sampling locations or source areas times the number of constituents).
- If normality is rejected, take natural logarithms of the n background measurements and recompute the multiple group Shapiro-Wilk test.
- If the transformation results in a nonsignificant G statistic (*i.e.*, the values $log_e(x)$ are normally distributed), we can compute the lognormal prediction limit as:

$$exp\left(\bar{y} + t_{[n-1,\alpha]} s_y \sqrt{\frac{1}{m} + \frac{1}{n}}\right) ,$$

where

$$\bar{y} = \sum_{i=1}^{n} \frac{log_e(x_i)}{n} ,$$

and

$$s_y = \sqrt{\sum_{i=1}^{n} \frac{(log_e(x_i) - \bar{y})^2}{n-1}} .$$

For $m > 1$ this lognormal prediction limit is for the onsite geometric mean or median concentration. To compute a lognormal

prediction limit for the onsite arithmetic mean concentration ($m > 1$) we can use Land's method and compute

$$exp\left(\bar{y} + .5s_y + H_{1-\alpha}s_y\sqrt{\frac{1}{m} + \frac{1}{n}}\right) .$$

- If log transformation does not bring about normality (*i.e.*, the probability of G is less than 0.01), compute the nonparametric prediction limit which is an order statistic (*i.e.*, an ordered measurement such the maximum) of the background concentration measurements. For the case of $m = 1$ tables are provided by Gibbons (1994a, chapter 2) for confidence levels based on using the largest ($x_{(n)}$) or second largest ($x_{(n-1)}$) measurement as the prediction limit as a function of n, k with and without verification resampling. For $m > 1$, one-sided nonparametric prediction limits for the median of m onsite measurements are given by Hahn and Meeker (1991, section 5.5.2).

In the context of groundwater sampling, this general decision tree is described in the new ASTM guidance document PS64-96.

3.2.2 Case 2: Compounds Quantified in at Least 50% of All Background Samples

- Apply the multiple group Shapiro-Wilk test to the n_1 quantified measurements only.

- If the data are normally distributed compute the mean of the n background samples as:

$$\bar{x} = \left(1 - \frac{n_0}{n}\right)\bar{x}' ,$$

where n_0 is the number of samples in which the compound was not detected, n is the total number of measurements and $\bar{x}'$ is the average of the $n - n_0$ detected values. The standard deviation is:

$$s = \sqrt{\left(1 - \frac{n_0}{n}\right)s^{2'} + \frac{n_0}{n}\left(1 - \frac{n_0 - 1}{n - 1}\right)\bar{x}^{2'}} ,$$

where s' is the standard deviation of the $n - n_0$ detected measurements. The normal prediction limit can then be com-

puted as previously described. This method is due to Aitchison (1955).

- If the multiple group Shapiro-Wilk test reveals that the data are lognormally distributed, replace $\bar{x}'$ with $\bar{y}'$ and s' with s'_y in the equations for $\bar{x}$ and s.
- The lognormal prediction limit for the onsite mean or median concentration may then be computed as previously described.
- Note that this adjustment only applies to positive random variables. The natural logarithm of concentrations less than 1 are negative and therefore the adjustment does not apply. For this reason we add 1 to each value (*i.e.*, $log_e(x_i + 1) \geq 0$).
- If the data are neither normally or lognormally distributed, compute a nonparametric prediction limit.

3.2.3 Case 3: Compounds Quantified in less than 50% of All Background Samples

- For individual comparisons of the most recent measurement in each sampling location to background (*i.e.*, $m = 1$), the nonparametric prediction limit for the next single measurement in each of k sampling locations is the largest concentration found in n background measurements.
- Gibbons (1990, 1991, 1994) has shown that the confidence associated with this decision rule, is a function of the multivariate extension of the hypergeometric distribution.
- Complete tabulation of confidence levels for $n = 4, \ldots, 100$, $k = 1, \ldots, 100$ comparisons (*i.e.*, sampling locations), is presented in Gibbons, 1994 (Table 2.5).
- To compare the source area median to background (*i.e.*, $m > 1$), compute a nonparametric prediction limit for the 50th percentile of the distribution of m onsite samples based on n background samples using the method described by Hahn and Meeker (1991, section 5.5).

In the context of groundwater sampling with $m = 1$, this general decision tree is described in the new ASTM guidance document PS64-96.

3.2.4 Detection of Outliers

From time to time anomalous results may be found among background samples due to a laboratory, sampling or clerical error. The net result is that the background prediction limit will be dramatically larger than it should be, leading to a less environmentally conservative sampling program. To eliminate these problems, background data are screened for outliers using Dixon's test at the 99% confidence level (see Gibbons, 1994, pages 254-257).

4.0. Application to Site Data

Results of all analyses (*i.e.*, the raw data, graphs, tables and worksheets) are all displayed in the Appendix. The assessment at buildings 37/44 of the Delphi-Flint West Facility involved the comparison of onsite arsenic, barium, copper, and lead ground-water samples to drinking water criteria (DWC), ground-water surface water interface values (GSI) and ground-water contact criteria (GCC) as described in Table C-2 of the Appendix. In this study, there were no available background ground-water monitoring data (given that this is a heavily industrialized area) therefore the only comparisons made were to the regulatory standards. Since this is an assessment monitoring program, we compare the 95% lower confidence limit (LCL) for the onsite mean concentration to the various regulatory standards. The LCL's were based on eight measurements for each constituent (see Table C-2 in the Appendix) and the specific form of the LCL (*i.e.*, normal, lognormal or nonparametric) was based on the results of distributional testing as previously described (see Table 2 of the Appendix). Where required, nondetects were set at one-half of the detection level. Complete computational details are presented in the four worksheets at the end of the Appendix.

Results of the analysis are displayed in Table 1 and the associated graphs in the Appendix for the comparison of the LCL to the drinking water standards. The results are summarized in the following Table.

Comparison of 95% LCLs to Regulatory Standards
Data in μg/L

Constituent	95% LCL	DWC	GSI	GCC
Arsenic	3.2	50	150	4700
Barium	100.0	2000	200	15000000
Copper	12.5	1000	21	8100000
Lead	1.5	4	29	NA

As described in the Appendix, the limit for arsenic was based on the normal distribution, whereas LCLs for the other three constituents were nonparametric. With eight measurements per constituent, the nonparametric LCL is the second ordered value (*i.e.*, second smallest) which provides a per constituent

confidence level of 96.1%. Inspection of the Table above reveals that there were no LCLs that exceeded any regulatory standard.

4.0. Summary

Results of comparisons to DWC, GSI and GCC standards to 95% LCLs derived from onsite ground-water monitoring data revealed that the true onsite mean concentration did not exceed any regulatory standard. The LCLs were a mixture of normal and nonparametric limits based on results of distributional testing and all provided a minimum of 95% confidence per constituent.

5.0. References

1. Aitchison, J. (1955). On the distribution of a positive random variable having a discrete probability mass at the origin. *Journal of the American Statistical Association,* **50**, 901-908.

2. Gibbons, R. D. (1987). Statistical models for the analysis of volatile organic compounds in waste disposal facilities. *Ground Water,* **25,** 572-580. Vol. **2,** 292-319.

3. Gibbons, R. D. (1990). A general statistical procedure for Groundwater Detection Monitoring at waste disposal facilities. *Ground Water,* **28**, 235-243.

4. Gibbons, R. D. (1991). Some additional nonparametric prediction limits for groundwater monitoring at waste disposal facilities. *Ground Water*, **29**, 729-736.

5. Gibbons, R. D. *Statistical Methods for Groundwater Monitoring*, Wiley, New York, 1994a.

6. Gibbons, R. D. *DUMPStat: an artificially intelligent computer program for groundwater monitoring applications* Discerning Systems, Vancouver, 1994b.

7. Gibbons, R.D. (1996). Some conceptual and statistical issues in analysis of groundwater monitoring data. *Environmetrics*, **7**, 185-199.

8. Gibbons, R.D., Brown J. & Cameron K. Provisional standard guide for developing appropriate statistical approaches for groundwater detection monitoring programs. *ASTM* **PS 64-96**, West Conshohocken, PA, 1996.

9. Hahn, G.J. & Meeker, W.Q. *Statistical Intervals: A Guide for Practitioners*, Wiley, New York, 1991.

10. Land, C.E. (1971) Confidence intervals for linear functions of the normal mean and variance. *Annals of Mathematical Statistics*, **42**, 1187-1205.

11. Land, C.E. (1975) Tables of confidence limits for linear functions of the normal mean and variance. In, *Selected Tables in Mathematical Statistics*, Vol. III, American Mathematical Society, Providence R.I., pp 385-419.

12. Sen, P. K. (1968). Estimates of the regression coefficient based on Kendall's tau. *Journal of the American Statistical Association*, **63**, 1379-1389.

13. Shapiro, S.S., and Wilk, M.B. (1965). An analysis of variance test for normality (complete samples). *Biometrika*, **52**, 591-611.

14. USEPA, Interim Final Guidance Document *Statistical analysis of groundwater monitoring data at RCRA facilities* (April, 1989).

15. USEPA, Addendum to Interim Final Guidance Document *Statistical analysis of groundwater monitoring data at RCRA facilities* (July, 1992).

16. Wilk, M.B., and Shapiro, S.S. (1968). The joint assessment of normality of several independent samples. *Technometrics*, **10, no 4.** 825-839.

APPENDIX

Site-Specific Results

Privileged and Confidential
Prepared at Request General Motors Counsel

TABLE C-2
SUMMARY OF LABORATORY ANALYTICAL DATA FOR GROUNDWATER
BASELINE ENVIRONMENTAL SITE ASSESSMENT

BUILDINGS 37/44
DELPHI-FLINT WEST FACILITY
FLINT, MICHIGAN

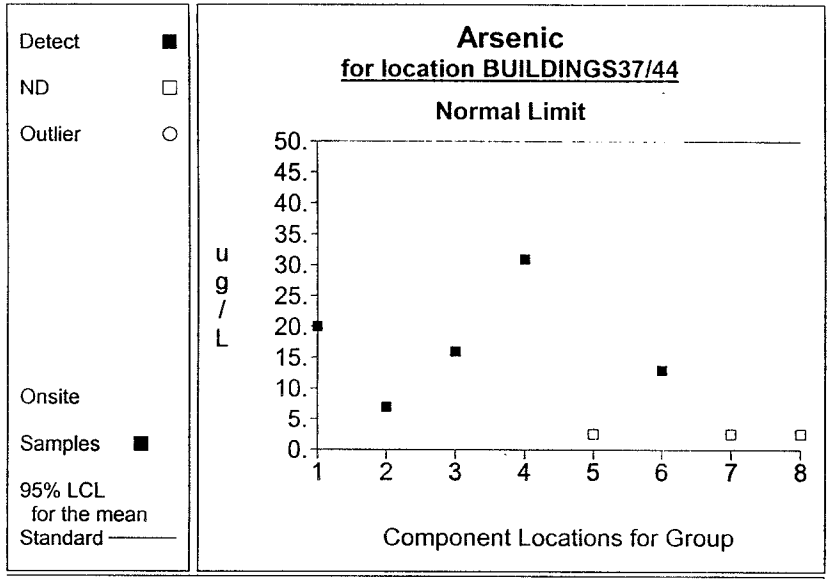
Parameter Detected (Total)	EPA Method	Detection Level (ug/L)	Sample Identification								Health Based DWC	GSI Values	GCC
			SP1	SP2	SP3	SP4	SP5	MW-1	MW-2	MW-3			
Arsenic	7061	5	31	<5	13	<5	<5	20	7	16	50	150	4700
Barium	7081	200	<200	<200	**210**	<200	<200	<200	<200	<200	2,000	200	15000000
Copper	7131	25	<25	<25	<25	<25	<25	**41**	**57**	**44**	1,000	21*	8.1E+06
Lead	7421	3	7	<3	*9*	<3	<3	<3	<3	<3	4	29*	ID

ALL CONCENTRATIONS IN MICROGRAMS PER LITER (ug/L)
Notes:
ID - Inadequate data to develop a criterion
DWC - Drinking water criteria
GSI - groundwater Surface Water Interface Value
GCC - Groundwater Contact Criteria
Only constituents detected above the detection level are presented in this table; constituents not listed for each EPA Method were below detection limits.
All relevant generic criteria presented above are from the MDEQ Operational Memorandum #18: Part 201 Cleanup Criteria Tables issued in August 1998.
Bold values exceed GSI criterion; however, the GSI criteria for barium and copper are for dissolved concentrations.
Italic values exceed health-based DWC
* - Indicates that the value is expressed as dissolved concentration.

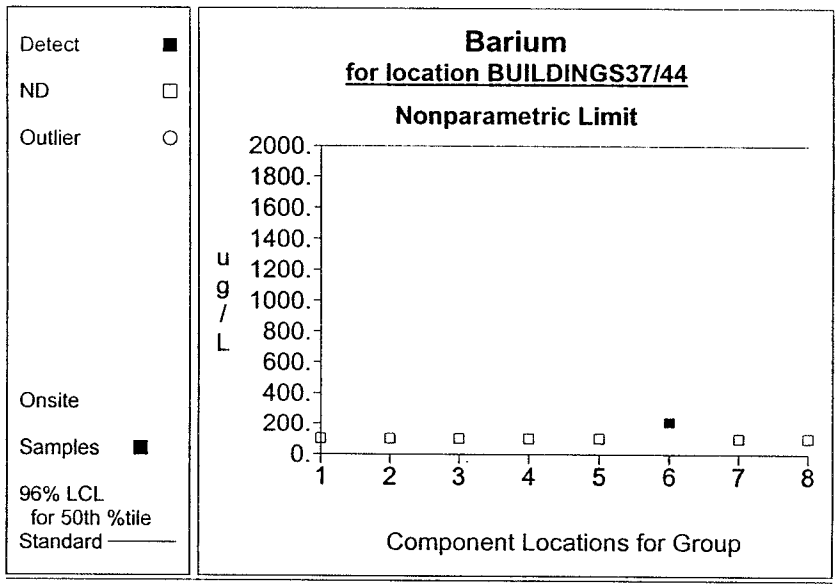
Test Site

Comparison to Standard

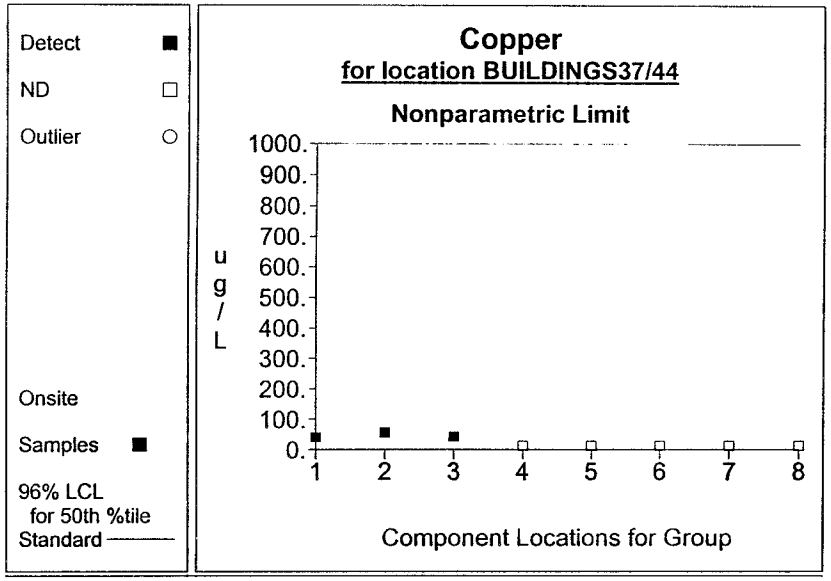
Analysis prepared on: 1/23/99



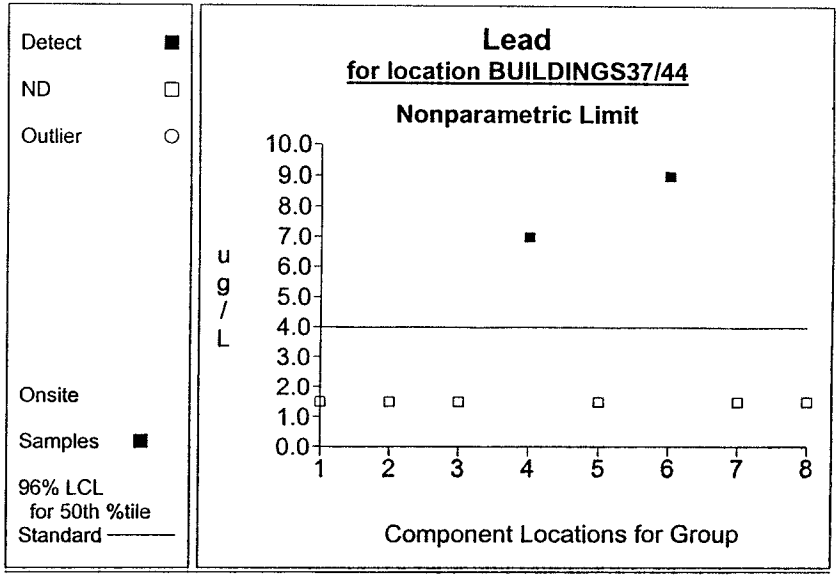
Graph 1



Graph 2



Graph 3



Graph 4

Prepared by: Robert D. Gibbons Ltd.

Privileged and Confidential
Prepared at Request General Motors Counsel

Test Site

Analysis prepared on: 1/23/99

Table 1

Lower 95% Confidence Limit for Comparing the Mean of the Selected Onsite Data to a Regulatory Standard

Constituent	Units	Location	Distribution	N	Mean	SD	Factor	95% LCL	Standard	Confidence
Arsenic	ug/L	BUILDINGS37/44	normal	8	10.875	11.458	0.670	3.200	50.000	0.950
Barium	ug/L	BUILDINGS37/44	nonpar	8				100.000	2000.000	0.961
Copper	ug/L	BUILDINGS37/44	nonpar	8				12.500	1000.000	0.961
Lead	ug/L	BUILDINGS37/44	nonpar	8				1.500	4.000	0.961

* - Insufficient Data
** - Significant Exceedance
LCL = Lower Confidence Limit
Nonparametric limits are for the median
Lognormal limits computed using Land's method (see Worksheet)
For lognormal dist, mean and sd are in natural log units

Privileged and Confidential
Prepared at Request General Motors Counsel

Prepared by: Robert D. Gibbons Ltd.

Test Site

Analysis prepared on: 1/23/99

Table 2

Shapiro Wilk Test of Normality and Lognormality

Constituent	Location	N (Detects)	Detect Freq	W raw	W log	Critical Value	Limit Type
Arsenic	BUILDINGS37/44	5	0.625	0.969	0.991	0.762	normal
Barium	BUILDINGS37/44	1	0.125				nonpar
Copper	BUILDINGS37/44	3	0.375				nonpar
Lead	BUILDINGS37/44	2	0.250				nonpar

Fit to distribution is confirmed if W < critical value.

Prepared by: Robert D. Gibbons Ltd.

Test Site

Analysis prepared on: 1/23/99

Worksheet 2 - Comparison to Standard

Arsenic at BUILDINGS37/44

Normal Confidence Limit

Privileged and Confidential
Prepared at Request General Motors Coun

Step	Equation	Description
1	Percentile = **mean** of the onsite / downgradient distribution.	
2	$\bar{X}_1$ = **sum[X_1] / M_1** **= 87.0 / 5** **= 17.4**	Compute the mean of the detected measurements.
3	S_1 = **((sum[X_1^2] - sum[X_1]^2/M_1) / (M_1-1))$^{1/2}$** **= ((1835.0 - 7569.0/5) / (5-1))$^{1/2}$** **= 8.961**	Compute sd of the detected measurements.
4	$\bar{X}$ = **(1 - M_0/M) $\bar{X}_1$** **= (1 - 3/8) 17.4** **= 10.875**	Compute adjusted mean.
5	S = [(1 - M_0/M) * S_1^2 + (M_0/M) (1 - (M_0-1)/(M-1)) $\bar{X}_1^2$]$^{1/2}$ = [(1 - 3/8) * 8.961^2 + (3/8) (1 - (3-1)/(8-1)) 17.4^2]$^{1/2}$ **= 11.458**	Compute adjusted sd.
6	LCL = $\bar{X}$ - tS/M$^{1/2}$ **= 10.875 - 1.895*11.458/8$^{1/2}$** **= 3.2**	Compute lower confidence limit for the mean of the M onsite / downgradient measurements.
7	Confidence = **0.95**	Confidence level for this location and constituent.

Prepared by: Robert D. Gibbons Ltd.

Test Site

Analysis prepared on: 1/23/99

Worksheet 2 - Comparison to Standard

Barium at BUILDINGS37/44

Nonparametric Confidence Limit

Privileged and Confidential
Prepared at Request General Motors Counsel

Step	Equation	Description
1	Percentile = **50th**	percentile of the onsite / downgradient distribution.
2	LCL = X(q)	Compute nonparametric lower confidence limit for a percentile
	= 100.0	of the distribution based on M onsite / downgradient samples.
3	M = **8**	Number of onsite / downgradient samples.
4	q = **2nd**	largest value from the M onsite / downgradient samples.
5	Confidence = **0.961**	Confidence level for this location and constituent.

Prepared by: Robert D. Gibbons Ltd.

Test Site

Analysis prepared on: 1/23/99

Worksheet 2 - Comparison to Standard

Copper at BUILDINGS37/44

Nonparametric Confidence Limit

Privileged and Confidential
Prepared at Request General Motors Counsel

Step	Equation	Description
1	Percentile = **50th**	percentile of the onsite / downgradient distribution.
2	LCL = X(q)	Compute nonparametric lower confidence limit for a percentile
	= **12.5**	of the distribution based on M onsite / downgradient samples.
3	M = **8**	Number of onsite / downgradient samples.
4	q = **2nd**	largest value from the M onsite / downgradient samples.
5	Confidence = **0.961**	Confidence level for this location and constituent.

Prepared by: Robert D. Gibbons Ltd.

Test Site

Analysis prepared on: 1/23/99

Worksheet 2 - Comparison to Standard

Lead at BUILDINGS37/44

Nonparametric Confidence Limit

Privileged and Confidential
Prepared at Request General Motors Counsel

Step	Equation	Description
1	Percentile = **50th**	percentile of the onsite / downgradient distribution.
2	LCL = X(q)	Compute nonparametric lower confidence limit for a percentile
	= **1.5**	of the distribution based on M onsite / downgradient samples.
3	M = **8**	Number of onsite / downgradient samples.
4	q = **2nd**	largest value from the M onsite / downgradient samples.
5	Confidence = **0.961**	Confidence level for this location and constituent.

Prepared by: Robert D. Gibbons Ltd.