Letter Of Transmittal

Type of Submittal:
___LUST _X_ERP ___VPLE ___ other (describe):

FROM: Name Bernd W. Rehm
Company RMT, Inc.
Address 744 Heartland Trail
Madison, WI 53717
Phone 608-831-4444
Date July 16, 1999

RECEIVED
JUL 20 1999
By [signature]

To: Program Assistant/BRR Program
Wisconsin Dept. of Natural Resources Box 12436
2300 N. Dr. Martin Luther King Jr. Dr.
Milwaukee, WI 53212

FOR: Site Name Tecumseh Products Company
Address 900 North Street
Grafton, WI 53024-1499

FID# 246009170
BRRTS# 02-46000751

Check type(s) of documents enclosed. Submittals are tracked & filed based on information you provide. Include FID & BRRTS numbers assigned to this site. Identify the intent of document(s) you are submitting in order to speed processing. Please attach required fees to this form.

Are you requesting Department Review? Y☒ N☐

√	TYPE OF DOCUMENT/REPORT	FEE	DNR CODE (office use only)
	Notification of Release	none	01
	Tank Closure/Site Assessment *where release(s) have been detected**	none	33
	Site Investigation Workplan	$500 if review is requested	35, 135~
	Site Investigation Report __ groundwater impacts above ES __ no groundwater impacts or gw impacts below ES *(if petroleum constituents only, case will be transferred to Department of Commerce)*	$750 if review is requested	37, 137~, 76, 96
	Request to Transfer Case to Department of Commerce	none	76
	Off-Site Determination Request	$500 mandatory	638~
X	Remedial Action Options Plan	$750 if review is requested	39, 143~
	NR 720.19 Site Specific Clean-Up Goal Proposal	$750 if review is requested	67, 68~
	NR 718 Landspreading Request	$500 mandatory	61~
	"Notification to Treat or Dispose" of Contaminated Soil/Water	none	99
	Injection/Infiltration Request	$500 mandatory	63~
	Quarterly Report or Update	$500 if review is requested	43, 43~
	O & M Form 4400-194	$300 if review is requested	92, 192~
	Remedial Action Options Report	$750 if review is requested	41, 41~
	Closure Review Request	$750 mandatory	79~
	NR700.11 Simple Site Closure Request	$250 mandatory	183~
	"Draft Deed Affidavit" or "Restriction required for close-out"	none	99
	"Well Abandonment Forms"	none	99
	Remedial Design Report	$750 if review is requested	147, 148~
	Construction Documentation Reports	$250 if review is requested	151, 152~
	Long Term Monitoring Plan	$300 if review is requested	24, 25~
	Voluntary Party Liability Exemption (VPLE) Application	$250 mandatory	662
	VPLE "Phase I/II Assessments" or "Additional Reports"	computed hourly	99
	Tax Cancellation Agreement	$500 mandatory	654
	Negotiated Agreement	$1000 mandatory	630
	Lender Assessment	$500 mandatory	686
	Negotiation and Cost Recovery (municipalities only)	fee for each service, mandatory	90~
	General Liability Clarification Request	$500 mandatory	684
	Lease Letter Request - Single Property	$500 mandatory	646
	Lease Letter Request -Multiple Properties	$1000 mandatory	646
	Request for Other Technical Assistance	$500 mandatory	90~
	Other (please describe)		

* Closure reports for sites where no releases have been detected should be sent directly to "Clean Closures" c/o DNR Remediation & Redevelopment Program, P.O. Box 7921, Madison WI 53707

letter of transmittal doc 2/24/99

Remarks:

RMT®
Integrated Environmental Solutions

744 Heartland Trail 53717-1934
P.O. Box 8923 53708-8923
Madison, WI
Telephone: 608-831-4444
Fax: 608-831-3334

July 16, 1999

Mr. John Feeney
Wisconsin Department of Natural Resources
4041 North Richards Street
P.O. Box 12436
Milwaukee, WI 53212

Subject: Remedial Action Options and Design Report - East Parking Lot Area
Tecumseh Products Company, Grafton Facility
WDNR FID #246009170, BRRTS #02-46000751

Dear Mr. Feeney:

The Remedial Action Options and Design (RAO/D) Report for soil in the East Parking Lot Area is attached for your review. The RAO/D Report presents the excavation alternative that was discussed during the meeting held in your offices with the WDNR, Tecumseh, and RMT on April 20, 1999. Your review of this document is requested, and a check for $750 is attached.

Please call either me (608-662-5108) or Kerry DeKeyser (920-898-5711) at Tecumseh Products if you have questions regarding this submittal.

Sincerely,

RMT, Inc.

Bernd W. Rehm, P.G.
Senior Consulting Hydrogeologist

Attachments:

xc: Daryl McDonald, Tecumseh
Dave Eberhart, Tecumseh
Bruce McCuaig, Tecumseh
Kerry DeKeyser, Tecumseh
Hank Handzel, DeWitt Ross & Stevens
Jennifer Baker, Decision Quest

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24600970
ERR-ERP

REMEDIAL ACTION OPTIONS AND DESIGN REPORT EAST PARKING LOT AREA

PREPARED FOR
TECUMSEH PRODUCTS COMPANY
GRAFTON, WISCONSIN

PREPARED BY
RMT, INC.
MADISON, WISCONSIN

July 1999

WISCONSIN JACK W. ANDERSON E-28206 Madison, WI PROFESSIONAL ENGINEER
7/15/99

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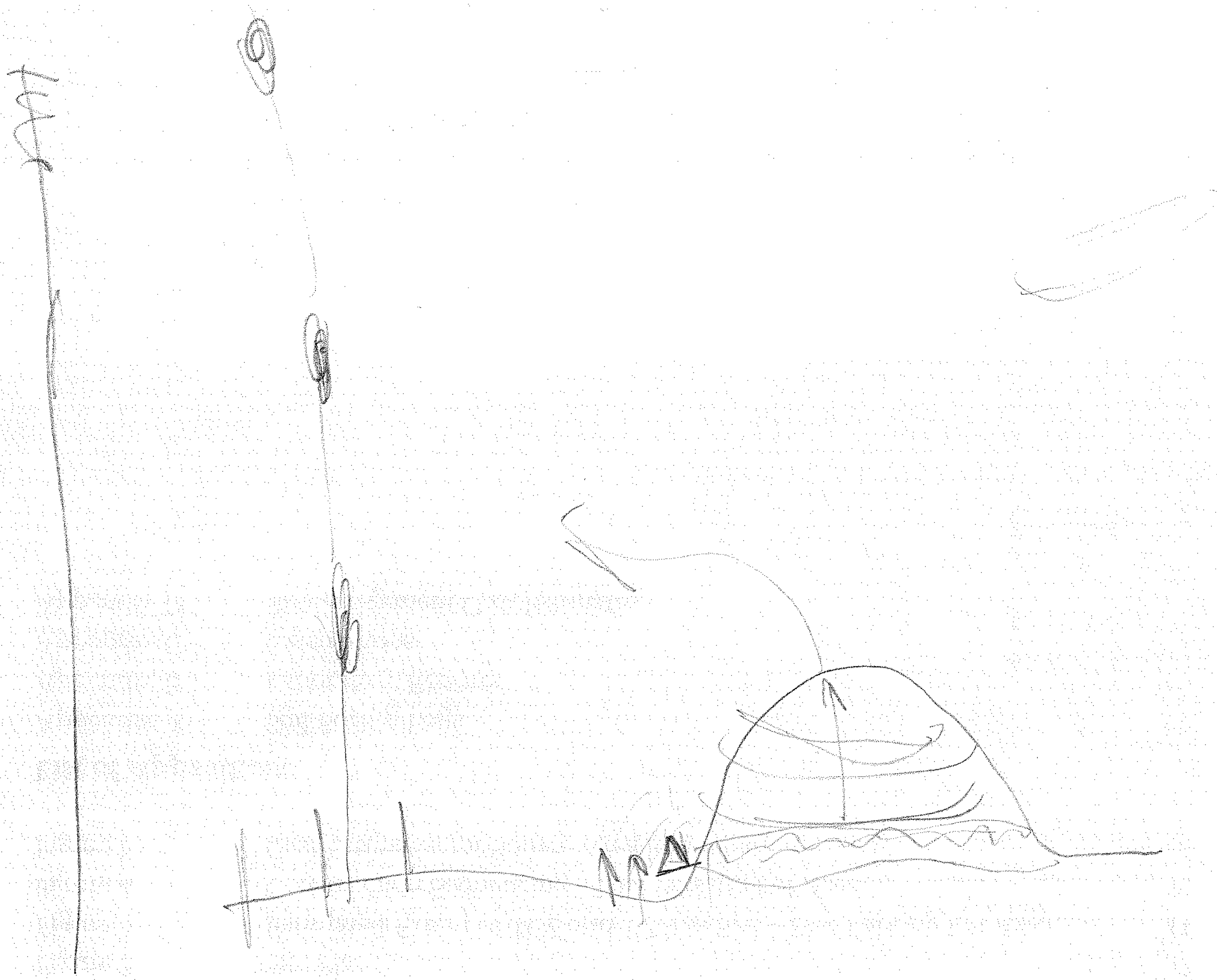

Executive Summary

Tecumseh Products Company (Tecumseh) owns and operates a manufacturing facility at 900 North Street in Grafton, Wisconsin. The Grafton facility has machined and assembled small gasoline engines since the mid-1950s. The engine assembly operations included vapor degreasing, painting, and engine testing. Degreasing solvents, paint solvents, gasoline, and motor oil were stored on-site and used in the manufacturing operations.

The facility in Grafton is a complex site, with volatile organic compounds present in unsaturated soil, soil aquifers, and bedrock aquifers. Many of the apparent source areas of the compounds are now beneath expansions of the manufacturing building and are not readily accessible. The mixture of compounds at the site is degrading through microbial action; however, not all compounds are degrading at the same rate and the degradation is not uniform throughout all of the source areas. At this time, it is proposed that a remedial action be undertaken in the near future to address a portion of the site that is readily accessible and amenable to remediation.

The purpose of this Remedial Action Options and Design Report is to evaluate remedial alternatives for a remedial action for one specific area, the East Parking Lot Area. No action, containment, *in situ* treatment, *ex situ* treatment, and removal and disposal were the soil technology categories evaluated in this report. Several technologies within each category were screened on the basis of implementability, effectiveness, and overall cost. The screening process focused on eliminating those technologies that have severe limitations based on the constituents of concern and the site-specific conditions at the Grafton facility. Two technologies, soil mixing with hot air treatment and conventional excavation and landfill disposal, passed the initial screening process, and were further evaluated based on technical feasibility and cost. The selected remedial action for the unsaturated soil in the East Parking Lot Area was excavation of soil hot spots (90 percent of the solvent mass) at the target cleanup concentrations of 1.0 mg/kg trichloroethene and 10 mg/kg 1,1,1-trichloroethane. Disposal of excavated nonhazardous soil will be as a special waste at a Subtitle D landfill. Excavated soil that is characteristically hazardous will be managed appropriately. This remedial action will remove a substantial fraction of the solvents that could provide long-term leaching to the groundwater. A brief discussion of the remedial design is also provided in this report. Plans and specifications will be provided to the WDNR in a later submittal.

Section 1
Introduction

1.1 Background

Tecumseh Products Company (Tecumseh) is evaluating remedial options at the Grafton, Wisconsin, facility to address impacted soil at three on-site areas, as part of a voluntary response action under Wisconsin Administrative Code (WAC) NR 700. The impacted areas were apparently affected by historical manufacturing activities conducted at the facility. The Grafton facility has machined and assembled small gasoline engines since the mid-1950s. The engine assembly operations included vapor degreasing, painting, and engine testing. Degreasing solvents, paint solvents, gasoline, and motor oil were stored on-site and used in the manufacturing operations. This report represents a remedial action for one specific area, the East Parking Lot Area.

The Tecumseh facility is located at 900 North Street, Grafton, Wisconsin, 53024. The primary contact person representing Tecumseh is Mr. Kerry DeKeyser; Tecumseh Products Company, 1604 Michigan Avenue, New Holstein, Wisconsin 53601 (920-898-5711). Mr. David Eberhardt, is the Plant Manager (414-377-2700). This report was prepared by RMT, Inc. (RMT), Madison, Wisconsin, on behalf of the Tecumseh Products Company. The RMT project manager is Mr. Bernd Rehm (608-831-4444).

1.2 Regulatory Status and Past Activities

Site investigations and the evaluation of appropriate response actions are being performed under the WAC, Chapters NR 700 series of regulations. Investigations of soil and groundwater impacts are described in detail in the Investigation Summary Report (RMT, 1997). A summary of the past activities performed at the Grafton facility, includes both pre-NR 700 and NR 716 site investigations, as follows:

- Eight underground storage tanks (USTs) that contained petroleum products were removed from the site from December 1988 through June 1992. Evidence of releases were noted for both soil and groundwater (Fox, 1993a and 1994a) (pre–NR 700 investigations).
- The Phase I subsurface investigation (NR 716) was conducted in August 1994 to define hydrogeologic conditions and the extent of chlorinated solvents previously detected in groundwater (RMT, 1994a and 1994b).
- The Phase 2 subsurface investigation (NR 716) was conducted in November and December 1994 to better define off-site groundwater impacts and the depth of the plume beneath the site (RMT, 1994c and 1995a).

- A preliminary remedial options analysis was performed in parallel with the subsurface investigations, to develop possible remedial approaches, identify data gaps, and assist with long-term project planning.

The Phase 3 subsurface investigation (NR 716) was conducted in the summer of 1995 to identify and characterize potential volatile organic compound (VOC) sources at the facility, and to continue to delineate the extent of VOCs detected in groundwater, downgradient of the facility (RMT, 1995b, 1996, 1997).

Semiannual groundwater monitoring of the VOC plume was initiated in 1997. The program is ongoing, with submittal to the WDNR following each sampling event.

Additional investigations focused on better delineating the extent of VOCs in soil beneath the parking lot on the east side of the plant were undertaken in the fall of 1998. The results of these investigations are presented in Section 2 of this report.

Additional investigations of the rate of *in situ* degradation beneath the East Recycling Docks Area was also initiated in the fall of 1998. A treatability study workplan for this activity was submitted to the WDNR (RMT, 1998). The results of the study will be submitted to the WDNR when the study is complete.

1.3 Purpose and Scope

The purpose of this report is to develop a remedial action approach for the unsaturated soil in the East Parking Lot Area. This document meets the requirements of preparing a Remedial Action Options Report (NR 722) and Design Report (NR 724). This portion of the remedial action will be incorporated into a site-wide remedial action approach in the future.

This report screens appropriate technologies in order to identify and evaluate practicable remedial options to address the chlorinated VOC source area in the East Parking Lot Area (i.e., zone of chlorinated VOC-impacted soil located above the water table that may be contributing constituents of concern to groundwater).

A remedial option was selected on the basis of implementability, effectiveness, and cost. A brief summary of the remedial design of the selected remedial action is also provided in this report.

The scope of this report includes the following:

- Development of remedial action objectives and soil cleanup standards in accordance with NR 720
- Summary of site conditions and the technical basis for developing remedial actions

- Screening of appropriate remedial technologies based on their implementability, effectiveness, and relative cost.
- Preparation of conceptual design approaches for the assembled remedial options
- Estimation of the capital, operation, and maintenance costs
- Evaluation of the assembled remedial options based on their technical and economic feasibility
- Selection of Remedial Action
- Description of remedial design

Section 2
Summary of Site Conditions

The Subsurface Investigation Report (RMT, 1997) submitted to the WDNR includes discussions of the site setting, manufacturing history, hydrogeologic conditions, and contaminant nature and extent. Since 1997, additional groundwater investigations have been completed on the south side of the facility (RMT, 1999a) and the results of that investigation have been submitted to the WDNR. Semiannual groundwater monitoring was begun in 1997 with semiannual reports being submitted to the WDNR (latest being Moraine, 1999). The findings of these previously submitted materials are summarized briefly in this section of the report.

Additional soil investigations were completed beneath the parking lot on the east side of the facility in the fall of 1998. The findings of the soil investigation were presented verbally to the WDNR during a meeting on April 20, 1999, and are included in detail in this document (see Subsection 2.5).

2.1 Site Setting

The Tecumseh facility is located at 900 North Street, Grafton, Wisconsin, 53024, in the SW ¼ of the SE ¼ of Section 13, Township 10N, Range 21E, in Ozaukee County (Figure 1). Residential land uses are found to the west and north, both residential and commercial uses are present to the east, and industrial uses are found to the south.

The site slopes gently to the east between elevations of about 770 to 757 feet relative to the USGS National Geodetic Vertical Datum (NGVD) of 1929. The Milwaukee river is located approximately 2,000 feet to the east of the facility (Figure 1) and Lake Michigan is about 3.5 miles to the east. Surface water (i.e., storm water) on the site is routed to an on-site 1 million gallon storm water pond, which also serves as a source of water for fire protection. Surface water flow is also routed to the north and northeast through ditches that eventually discharge to the Milwaukee River.

2.2 Facility Description and History

The Subsurface Investigation Report (RMT, 1997) submitted to the WDNR includes discussions of the facility's manufacturing history. A summary of this information is provided in the following paragraphs.

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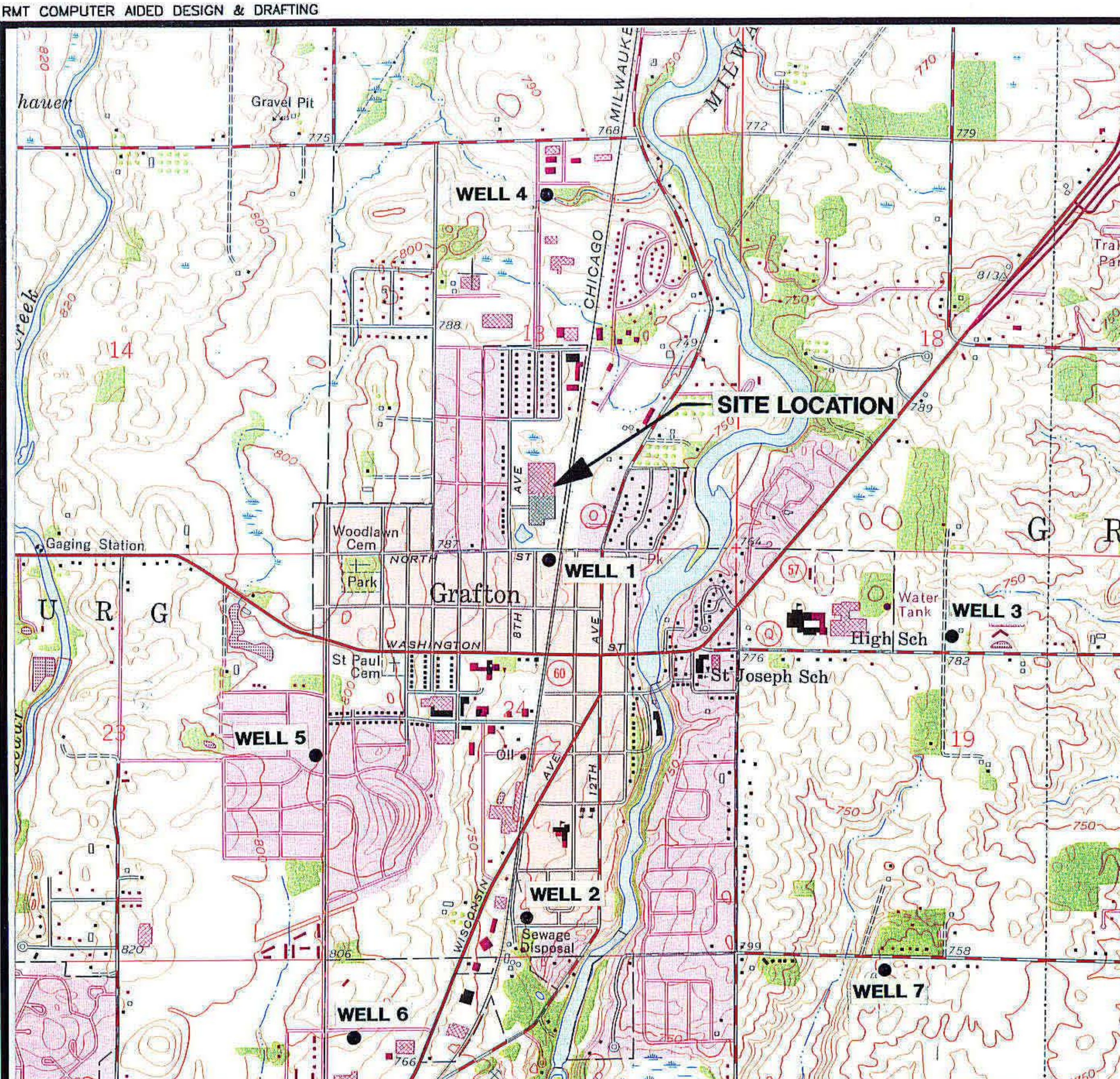


STATE LOCATION

0 2000 4000

SCALE: 1"=2000

SITE LOCATOR MAP

TECUMSEH PRODUCTS COMPANY GRAFTON, WISCONSIN

LEGEND

● WELL 5 — VILLAGE OF GRAFTON WATER-SUPPLY WELL

SOURCE: BASE MAP FROM CEDARBURG, WI. 7.5 MIN. USGS QUADRANGLE.

RMT INC.

DWN. BY:	BREWSTEK
APPROVED BY:	BWR
DATE:	JUNE 1999
PROJ. #	3084.25
FILE #	30842503.DWG

FIGURE 1

PLOT DATA
Drawing Name: J:\03084\25\30842503.dwg
Operator Name: BREWSTEK
Scale: 1"=1'
Dwg Size:
Attached Xref's: No xref's Attached.
42366 Bytes
Plot Time: 10:03.5363 AM
Plot Date: Wednesday, June 16, 1999

The initial building on the site was constructed by Power Products Company in 1952. Power Products Company operated the facility until 1955, when Tecumseh Products acquired the facility. The building expanded to the north, with major additions in 1961, 1967, 1968, 1970, 1972, 1973, and 1978. The original building included a basement, but the remainder of the facility is slab-on-grade construction. Prior to any construction, the site was a wooded lowland. Construction included the placement of fill soil to bring the site to its current grades. Pilings were also required to mitigate unstable soil conditions beneath the northernmost portion of the facility.

The facility has produced small gasoline engines since 1952. Parts degreasing has been a part of the manufacturing process since the beginning of operations. Trichloroethene (TCE) was used for degreasing until the mid-1960's, when it was replaced by 1,1,1-Trichloroethane (TCA). By 1989, TCA was replaced with an aqueous cleaner, except for small-scale use in the service department. By 1994, all use of TCA for parts cleaning was discontinued.

The first engine assembly degreaser was located at grade in the northwest corner of the original 1952 building (Figure 2). Solvent was managed in both drums and an aboveground tank. No spills from the degreaser were recorded. In 1979, the engine assembly degreaser moved to the southeast corner of the 1968 addition. This at-grade degreaser was serviced by an aboveground tank located inside the building. The tank was filled from a truck through an overhead piping system from the east parking lot.

Small-parts degreasing was also done in the southeast corner of the original building in small above grade degreasing units (Southeast Degreaser Area, Figure 2).

Once cleaned, engines were painted in the northwest corner of the original building. In 1968, painting operations move to the east side of the 1968 building addition, and were moved again to their current location on the east side of the facility in 1990. Water curtain spray booths were used to paint engines until 1990, when a dry painting system was installed. Solvents associated with the painting included xylene, toluene, and Stoddard solvent.

From 1952 until 1966, waste management activities were reported to have occurred primarily on a concrete dock in the northwest corner of the 1952 building (West Dock Area, Figure 2). Solvents awaiting off-site disposal were stored in 55-gallon drums. Some machine cleaning using steam, kerosene, and TCE was also apparently done in this area. Waste management activities were moved to the southeast corner of the facility due to the northward expansion of the manufacturing operations (Recycling Docks Area, Figure 2). Waste materials were generally stored in large containers until taken off-site for disposal. Machine cleaning was also reported as being done in this area. In 1975, the waste management area was moved south slightly to its current location. The current location includes a sump for the collection of storm water and is covered by a canopy.

2.3 Hydrogeology

The Subsurface Investigation Report (RMT, 1997) submitted to the WDNR includes discussions of hydrogeologic conditions in the area of the facility. The information is briefly summarized in the following paragraphs.

In general, the site is located on unconsolidated glacial Quaternary deposits that unconformably overlie Paleozoic sedimentary rocks. The Paleozoic rocks unconformably overlie Precambrian crystalline rocks at depths of more than 1,200 feet. Groundwater is generally found from 5 to 30 feet below ground surface, with flow toward Lake Michigan to the east. The migration of groundwater is strongly influenced by the presence of fractures in the bedrock aquifer that underlies the area (described below).

The glacial deposits consist of a heterogeneous mixture of gravel, sand, silt, and clay laid down as end moraines and outwash plains. The glacial sediments range in thickness from 0 feet to the east of the facility to over 50 feet to the west of the facility. The first material encountered beneath the facility is till from 10 to 20 feet thick. The till consists of silt and clay (85 to 100%) with 0 to 15% sand and gravel. The hydraulic conductivity of the till is expected to be no greater than 10^{-6} cm/s. The till is underlain by 3 to 30 feet of silty-fine to medium-grained sand that was deposited as an outwash plain. The sand is thickest beneath the east side of the facility and thins to the west. On the east the sand lies on the bedrock surface, while on the west the sand is underlain by more clayey till. The hydraulic conductivity of the outwash is on the order of 8×10^{-3} cm/s.

The Niagara dolomite is the shallowest bedrock unit below the site. The depth to rock below the ground surface has been observed to range from 0 to at least 100 feet. It is generally fractured, massive to thin-bedded, with a total thickness of about 550 feet in the area of the site. Aerial photograph interpretation and pumping test results from nearby Saukville show a strong northwest to southeast preferential hydraulic conductivity (anisotrotropy) in the dolomite aquifer. The permeability of the dolomite can be highly variable as a result of differences in the environment under which the sediments that formed the rock were deposited (reefs to deep-water muds) and as a result of variable fracturing. The hydraulic conductivity of the dolomite typically ranges from 6×10^{-5} to 3×10^{-2} cm/s, with a geometric mean of 2×10^{-3} cm/s. A possible reef was encountered about 4,000 feet to the east of the facility. The hydraulic conductivity of the reef materials range from 5×10^{-1} to 2×10^{0} cm/s. Groundwater flow rates within the dolomite and the reef were estimated to be on the order of 2,000 to 5,000 ft/yr, respectively.

The Niagara dolomite is used for water supplies in the area. The Village of Grafton has six operating potable-water supply wells completed totally or in part in the dolomite. Village wells No. 3 and No. 7 are located to the east and southeast (generally downgradient) of the facility, respectively. Three private water supply wells for residences within the Town of Grafton are also completed in the dolomite, and are located to the east of the facility.

2.4 Nature and Extent of Contamination

Investigations of soil contamination guided by the operational history of the facility and groundwater contamination investigations are described in detail in the Subsurface Investigation Report (RMT, 1997). Additional groundwater information has been submitted to the WDNR regarding the southern edge of the solvent plume found at the site (RMT, 1999) and on the historical trends in chemical concentrations since January 1997 (Moraine, 1999). The following subsections briefly present the findings of these investigations in Subsections 2.4.1, General Facility Soil, and 2.4.2, Groundwater.

The soil to the east of the facility plant was investigated in 1995 and 1996 and the findings were presented in the Subsurface Investigation Report (RMT, 1997). The findings of these investigations resulted in additional soil investigations in the fall of 1998. The findings of the 1998 soil investigation were presented verbally to the WDNR during a meeting on April 20, 1999, and are included in detail in Subsection 2.4.2 along with the results of the earlier investigations.

2.4.1 General Facility Soil

The shallow soil beneath the West Dock Area (till to a depth of about 17 feet) was found to contain as much as 110 mg/kg of TCE and as much as 1.8 mg/kg of cis-1,2-Dichloroethene (1,2-DCE). The presence of 1,2-DCE in the soil indicates that some degree of biodegradation is taking place in the soil beneath the West Dock Area. At least half of the horizontal extent of the chlorinated compounds is found beneath the current building footprint. At the west Dock TCA and volatile and semivolatile petroleum hydrocarbons were only found in shallow soil (2.5 to 4.5 feet below ground surface) immediately to the west and outside of the building wall. The highest TCA concentration observed was 8.9 mg/kg. These findings were consistent with the historical operations noted for this area.

The Southeast Degreaser Area was found to contain low concentrations of TCE and TCA (maximum concentrations of 0.16 mg/kg and 0.96 mg/kg, respectively) in the till from depths of 4 to 15 feet below the floor. The occurrence of the solvents was limited to the immediate vicinity of the degreaser. Residual machine oils were also found in this area at concentrations of 1.1 to 62.8 mg/kg (measured as diesel range organics). Free product oil has been found at the water table. By 1997, oil recovery from a well in the area was less than or equal to 0.2 gallons per month.

TCA is the predominant chlorinated compound found in the till beneath the Recycling Dock Area, with concentrations as high as 670 mg/kg. TCE was observed at concentrations up to 2.7 mg/kg. Degradation products of TCE and TCA also found included 1,2-DCEs (up to 41 mg/kg) and 1,1-Dichloroethane (1,1-DCA) (up to 0.45 mg/kg). The highest concentrations were generally found at the water table near the contact between the till and underlying sand. Volatile petroleum constituents (up to 550 mg/kg) and semivolatile petroleum compounds (up to 45 mg/kg) were also found in this area. Concentrations of the solvents and petroleum compounds decrease by factors of at least 100 in the sand below the water table. Free product has not been observed in the Recycling Dock Area.

2.4.2 East Parking Lot Area

This area was originally named the TCA Filling Area to reflect what was assumed to be the potential source of the solvents as described in Subsection 2.2. The investigations of the area found that TCE was the predominant chlorinated compound and found that the highest concentrations of both TCE and TCA were not focused at the degreaser storage tank fill-pipe. The origin(s) of the chlorinated compounds in the area between the plant building and the east property line has not been identified. The area was therefore renamed the East Parking Lot Area.

The East Parking Lot Area has been a gravel-covered area since the initial facility construction in 1952. The area is subject to continual truck traffic for the delivery of raw materials and parts, for the shipment of completed products, and for the off-site shipment of recycle materials and wastes. No other manufacturing operations take place in the area. A number of subsurface utilities (gas, water, sanitary sewer, and storm sewer) are found beneath the gravel lot, and overhead electrical service to the plant crosses the lot (Figure 3). The storm sewers route precipitation from roof drains under the parking lot to a ditch along the east facility property line. The East Parking Lot Area does not have its own storm water sewers. Precipitation falling on the gravel lot either evaporates, runs off the surface to the east, or infiltrates to the underlying soil and groundwater.

LEGEND

ESTIMATED EXTENT OF TCE, ISOCONCENTRATION IN SOIL (ug/kg)

ESTIMATED EXTENT OF TCA, ISOCONCENTRATION IN SOIL (ug/kg)

PROJECT: TECUMSEH PRODUCTS COMPANY
GRAFTON FACILITY NR 700
GRAFTON, WISCONSIN

SHEET TITLE: CONSTRUCTION SEQUENCING-
EAST PARKING LOT AREA

DRAWN BY: STORMERL	SCALE:	PROJ. NO. 3084.25
CHECKED BY: SAK	1"=30'	FILE NO. 30842504.DWG
APPROVED BY: BWR	DATE PRINTED: JUL 15 1999	FIGURE 4
DATE: JUNE 1999		

RMT INC.
744 Heartland Trail
Madison, WI 53717-1934
P.O. Box 8923
Madison, WI 53708-8923
Phone: 608/831-4444

RMT COMPUTER AIDED DESIGN & DRAFTING

The location of soil borings and the estimated extent of TCE and TCA in the area are illustrated in Figure 3. The logs for the borings installed during the fall of 1998 are provided in Appendix A, and the laboratory reports for the soil analyses are provided in Appendix B. A summary of the detected volatile organic compounds (VOCs) for the area is provided in Table 1.

A total of 44 borings have been advanced in the area to depths of up to about 30 feet below ground (the top of the bedrock surface). The near surface soil consists of clay till to depths of 9 to 12 feet (typically about 10 feet). Concentrations of either TCE of TCA in excess of 0.025 mg/kg are found throughout the area of the parking lot. Given the widespread occurrence of VOCs in the soil samples, it is possible that the entire area could have concentrations on the order of 0.01 mg/kg or greater for a volume of about 42,700 yd^3. However, as shown on Figure 3, only about 30 percent of the area has concentrations of solvents typically in excess of 0.1 mg/kg, and only about 10 percent has concentrations typically in excess of 1 mg/kg. The volume of soil having concentrations greater than 0.1 mg/kg is estimated to be approximately 10,400 yd^3, while concentrations greater than 1,000 occupy about 3,500 yd^3.

The soil contamination found beneath the Recycling Docks does not extend eastward into the East Parking Lot Area. The borings closest to the fill pipe for the degreaser do not show a pattern consistent with surface spills of TCA at the point at which a delivery hose would have been connected to the pipe (immediately adjacent to the plant wall). Rather, the highest TCA concentrations are found some 6 to 8 feet deep and 40 feet to the east of the fill point (Cross-section B-B', Figure 3). TCE concentrations in the area of high TCA occurrence are low, ranging from less than 0.001 to 0.11 mg/kg.

The major occurrence of TCE is found in the northern portion of the East Parking Lot Area, where concentrations between 10 and 150 mg/kg are found in the till between the 1 to 10 feet below ground surface. The northern area of TCE occurrence appears to extend from a point about 50 ft east of the plant building to the eastern edge of the East Parking Lot Area, a distance of about 120 ft. The area of concentrations above 1 mg/kg is from 40 to 80 feet wide. Little TCA is associated with the northern TCE area, except where there is overlap with the TCA area to the west and at a depth of 8 feet in boring SB-17TCA on the east edge of the TCE area (cross-section B-B', Figure 3).

A second, southern area of TCE occurrence is defined by a single boring (SB-18TCA) where concentrations range from 4.2 to 12 mg/kg. The TCE Area overlaps with an occurrence of TCA between depths of 4 to 10 feet to the south of boring SB-18TCA.

Table 1
Summary of VOCs Detected in Soil (μg/kg) - East Parking Lot Area
Tecumseh Products Company

Boring I.D.	Sample Depth	1,1,1 - TCA	TCE	1,1 - DCA	1,2 - DCA	1,1 - DCE	cis - 1,2 - DCE	PCE	Toluene	1,1,2 - TCA
SB1TCA	7.5 - 9.5	**3.3**	< 1.2	**38**	< 1.2	**9.2**	< 1.2	< 2.3	< 1.2	< 1.2
	10 - 12	**16**	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2	< 2.3	< 1.2	< 1.2
SB2TCA	5 - 7	**630** H,D	**1.4** H	< 1.2	< 1.2	< 1.2	< 1.2	< 2.4	< 1.2	< 1.2
	7.5 - 9.5	**2,300** H,D	**6.0** H	**16** H	**23** H	**100** H	< 5.7	< 11	< 5.7	< 5.7
SB3TCA	2.5 - 4.5	**120** H,D	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1	< 2.3	< 1.1	< 1.1
	5 - 7	**16,000** H,D	**5.4** H	< 1.1	< 1.1	< 1.1	< 1.1	< 2.3	< 1.1	< 1.1
SB4TCA	5 - 7	**2.2**	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1	< 2.3	< 1.1	< 1.1
	10 - 11.5	< 6.0	**110**	**8.0**	< 6.0	< 6.0	< 6.0	< 12	< 6.0	< 6.0
SB5TCA	5 - 7	**5.1**	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2	<2.4	< 1.2	< 1.2
	10 - 11.5	**46**	**81**	**120**	< 6.1	< 6.1	< 6.1	< 12	< 6.1	< 6.1
SB6TCA	5 - 7	**5.7**	< 1.1	< 1.1	< 1.1	< 1.1	< 1.1	< 2.2	< 1.1	< 1.1
	10 - 11	**110**	**49**	< 5.7	< 5.7	< 5.7	< 5.7	< 11	< 5.7	< 5.7
SB7TCA	7.5 - 9.5	**6,700** D	< 60	< 60	< 60	< 60	< 60	< 120	< 60	< 60
	10 - 11	**1,900**	**110**	< 58	< 58	< 58	< 58	< 120	< 58	< 58
SB8TCA	7.5 - 9.5	< 57	**180**	< 57	< 57	< 57	< 57	< 110	< 57	< 57
	10 - 11	**100**	**730**	< 60	< 60	< 60	< 60	< 120	< 60	< 60
SB9TCA	2.5 - 4.5	**13**	**19**	< 1.2	< 1.2	< 1.2	< 1.2	< 2.3	< 1.2	< 1.2
	7.5 - 9.5	**1.6**	**5.8**	< 1.1	< 1.1	< 1.1	< 1.1	< 2.2	< 1.1	< 1.1
SB10TCA	7.5 - 9.5	**1,900** D	**23,000** D	**9.6**	< 1.2	**7.7**	**13**	< 2.4	< 1.2	< 1.2
	10 - 12	**1,200** D	**8,000** D	**13**	< 1.2	< 1.2	**56** E	< 2.4	< 1.2	< 1.2
SB11bTCA	7.5 - 9.5	**5.2**	**17**	< 1.2	< 1.2	< 1.2	< 1.2	< 2.3	< 1.2	< 1.2
	10 - 11	**28**	**47**	**1.7**	< 1.1	< 1.1	< 1.1	< 2.2	**1.1**	< 1.1
SB12TCA	2.5 - 4.5	**9.1**	**4,900** D	< 1.1	< 1.1	< 1.1	**14**	< 2.2	< 1.1	**2.8**
	7.5 - 9.5	**14**	**10,000** D	< 1.1	< 1.1	< 1.1	**19**	< 2.2	< 1.1	**2.6**
SB13TCA	7.5 - 9.5	**31**	**6.4**	< 1.1	< 1.1	< 1.1	< 1.1	< 2.3	< 1.1	< 1.1
	10 - 11	**150**	**75**	< 6.1	< 6.1	**11**	< 6.1	< 12	< 6.1	< 6.1
SB14TCA	2.5 - 4.5	< 2,800	**44,000** D	< 2,800	< 2,800	< 2,800	< 2,800	< 5,700	< 2,800	< 2,800
	7.5 - 9.5	< 1,200	**19,000** D	< 1,200	< 1,200	< 1,200	< 1,200	<2,400	< 1,200	< 1,200
SB15TCA	5 - 7	**4.4**	**88**	< 1.1	< 1.1	< 1.1	< 1.1	< 2.2	< 1.1	< 1.1
	7.5 - 9.5	**3.0**	**54**	**1.4**	< 1.2	< 1.2	**1.3**	< 2.4	< 1.2	< 1.2
SB16TCA	5 - 7	< 5.7	**62**	< 5.7	< 5.7	< 5.7	< 5.7	< 11	< 5.7	< 5.7
	7.5 - 9.5	**6.7**	**80**	< 5.9	< 5.9	< 5.9	**38**	< 12	< 5.9	< 5.9
SB17TCA	5 - 7	**81** D	**280** D	< 1.2	< 1.2	< 1.2	**1.5**	< 2.4	< 1.2	< 1.2
	7.5 - 9.5	**1,400** D	**8,800** D	< 1.2	< 1.2	< 1.2	**2.7**	**7.5**	< 1.2	< 1.2
SB18TCA	1 - 2	**40**	**4,200**	--	--	--	--	--	--	--
	4 - 6	**120**	**12,000**	--	--	--	--	--	--	--
	8 - 10	**85**	**5,200**	--	--	--	--	--	--	--
SB19TCA	1 - 2	< 25	< 25	--	--	--	--	--	--	--
	4 - 6	< 25	**47**	--	--	--	--	--	--	--
	8 - 10	**90**	**350**	--	--	--	--	--	--	--
SB20TCA	1 - 2	< 25	**120**	--	--	--	--	--	--	--
	4 - 6	< 25	< 25	--	--	--	--	--	--	--
	8 - 10	**48**	**270**	--	--	--	--	--	--	--
SB21TCA	1 - 2	< 25	< 25	--	--	--	--	--	--	--
	4 - 6	< 25	**92**	--	--	--	--	--	--	--
	8 - 10	**30**	< 25	--	--	--	--	--	--	--
SB22TCA	1 - 2	< 25	< 25	--	--	--	--	--	--	--
	4 - 6	< 25	< 25	--	--	--	--	--	--	--
	8 - 10	< 25	**29**	--	--	--	--	--	--	--

Table 1 (Continued)
Summary of VOCs Detected in Soil (µg/kg) - East Parking Lot Area
Tecumseh Products Company

Boring I.D.	Sample Depth	1,1,1 - TCA	TCE	1,1 - DCA	1,2 - DCA	1,1 - DCE	cis - 1,2 - DCE	PCE	Toluene	1,1,2 - TCA
SB23TCA	1 - 2	< 25	< 25	--	--	--	--	--	--	--
	4 - 6	**180**	**29**	--	--	--	--	--	--	--
	8 - 10	**360**	**170**	--	--	--	--	--	--	--
SB24TCA	1 - 2	< 25	< 25	--	--	--	--	--	--	--
	4 - 6	< 25	**31**	--	--	--	--	--	--	--
	8 - 10	**31**	**77**	--	--	--	--	--	--	--
SB25TCA	1 - 2	**< 25**	**< 25**	--	--	--	--	--	--	--
	4 - 6	**220**	**< 25**	--	--	--	--	--	--	--
	8 - 10	**480**	**130**	--	--	--	--	--	--	--
SB26TCA	1 - 2	< 25	< 25	--	--	--	--	--	--	--
	4 - 6	**92**	< 25	--	--	--	--	--	--	--
	8 - 10	< 25	< 25	--	--	--	--	--	--	--
SB27TCA	1 - 2	< 25	< 25	--	--	--	--	--	--	--
	4 - 6	< 25	< 25	--	--	--	--	--	--	--
	8 - 10	< 25	< 25	--	--	--	--	--	--	--
SB28TCA	1 - 2	< 25	< 25	--	--	--	--	--	--	--
	4 - 6	**160**	< 25	--	--	--	--	--	--	--
	8 - 10	**230**	< 25	--	--	--	--	--	--	--
SB29TCA	1 - 2	< 25	< 25	--	--	--	--	--	--	--
	4 - 6	< 25	< 25	--	--	--	--	--	--	--
	8 - 10	**32**	**120**	--	--	--	--	--	--	--
SB30TCA	1 - 2	**340**	< 25	--	--	--	--	--	--	--
SB31TCA	1 - 2	< 25	< 25	--	--	--	--	--	--	--
SB32TCA	1 - 2	**35**	**5,700**	--	--	--	--	--	--	--
SB33TCA	1 - 2	**190**	**9,200**	--	--	--	--	--	--	--
SB34TCA	1 - 2	< 25	< 25	--	--	--	--	--	--	--
SB35TCA	1 - 2	**140**	**130,000**	--	--	--	--	--	--	--
SB36TCA	1 - 2	**60**	**< 25**	--	--	--	--	--	--	--
SB37TCA	1 - 2	< 25	< 25	--	--	--	--	--	--	--
SB38TCA	1 - 2	< 25	< 25	--	--	--	--	--	--	--

Notes:

All results are listed in µg/kg.

This table includes only those compounds that were detected in a least one sample.

-- = compound not analyzed.

Bold = Indicates constituents that were detected above the Method Detection Limit.

D = Value from a diluted analysis.

E = Concentration exceeds calibration range.

H = Analysis was performed 1 to 2 days past the 14-day hold time for VOC analysis.

Soil borings SB1TCA through SB17TCA were installed between July 1995 and June 1996.

Soil borings SB18TCA through SB38TCA were installed between August 21 and September 1, 1998.

DCA = Dichloroethane

DCE = Dichloroethene

PCE = Tetrachloroethene

TCE = Trichloroethene

TCA = Trichloroethane

Degradation products of TCE and TCA are present at low concentration (less than about 0.120 mg/kg) in the East Parking Lot Area. These concentrations are several orders of magnitude lower than the parent compounds, suggesting that only a very limited degree, if any, biodegradation of the chlorinated compounds is taking place.

2.4.3 Groundwater

Shallow On-site Groundwater. Groundwater in the West Dock Area is found in the sand below the till. Concentrations of TCE in the groundwater are on the order of 1,600 μg/L or less while 1,2-DCE concentrations range from about 200 to 2,000 μg/L. The high proportion of degradation products indicates that biodegradation is taking place in the groundwater below the West Dock Area. As with the soil investigations, TCA was not observed in the groundwater.

Groundwater immediately beneath the Southeast Degreaser Area is found at the top of the sand and below the till. The shallow groundwater contained only low concentrations of TCE (less than or equal to 25 μg/L). Groundwater in the sand to the east (downgradient) from water table monitoring wells yield samples with on the order of 200 to 800 μg/L of chlorinated solvents, including TCE and TCA degradation products. Petroleum compounds were also observed in the shallow groundwater.

The Recycling Docks Area also has the water table at the top of the outwash sand. The shallow groundwater contains TCA and its degradation products as the predominant chlorinated solvents (concentrations between 1,000 and 2,000 μg/L). TCE and its degradation products have been observed from 20 to 700 μg/L in this area. When compared to the overlying soil concentration, the chlorinated ethenes below the Recycling Docks Area appear in large part to have originated at the upgradient Southeast Degreaser Area. Petroleum constituents are also present at tens to hundreds of μg/L.

Groundwater beneath the East Parking Lot Area is first encountered at the top of the outwash sand, below the clay till (Cross-sections A-A′ and B-B′, Figure 3). TCE and TCA are found throughout the thickness of the sand below the northern area of TCE and TCA occurrence, with concentrations ranging from less than 1 to about 14,000 μg/L. The chlorinated compounds seen in the shallow groundwater at the downgradient edge of the south end of the East Parking Lot Area (e.g., MW-3) apparently originate from the Southeast Degreaser and the Recycling Docks Area. The chlorinated compounds seen in the shallow groundwater at the downgradient edge of the north end of the East Parking Lot Area (e.g., MW-12) apparently originate from the soil contamination found below the East Parking Lot Area. The chlorinated compounds seen in the shallow

? from under building

groundwater at the downgradient edge in the center of the East Parking Lot Area (e.g., MW-9 and MW-9D) apparently originate from the West Dock Area. The concentrations of chlorinated compounds found in the unsaturated soil upgradient of these wells are much too low to account for the concentrations found in the wells.

Deep On-Site Groundwater. Monitoring wells have been installed to depth of about 160 feet along the east (downgradient) facility property line. Chlorinated ethenes and ethanes at concentrations of 100's to 1,100 μg/L have been observed in the dolomite aquifer to elevations of 600 feet NGVD (depths of 160 ft) to date. Degradation products and groundwater geochemical indicators indicate that some degree of biodegradation of the chlorinated compounds is occurring (RMT, 1997). Groundwater data collected since the completion of the Subsurface Investigation Report (RMT, 1997) show no clear trends in concentrations over time at the central and northern monitoring wells, but may suggest a slight decline in TCE and TCA in the monitoring wells downgradient of the Recycling Docks Area (Moraine, 1999).

Deep Off-site Groundwater. The water table to the east of the Milwaukee River is found within the dolomite aquifer and the glacial sediments are unsaturated. The anisotropy imposed on the groundwater flow system by the fractures result in southeastward flow (and contaminant migration) even though the hydraulic gradient is to the east (RMT, 1997). Investigation borings became deeper with distance downgradient of the facility to ensure that any VOC plume leaving the facility would not be missed as recharge to the aquifer pushed the plume downward. At a distance of about 1,600 feet downflow from the facility (MW-19 BR1 and BR2), TCE in the groundwater ranged from 150 to 380 μg/L at an elevation of 690 feet NGVD. TCE concentrations at an elevation of 540 feet NGVD have decreased to a few 10's of μg/L. 1,2-DCEs concentrations are about 10 to 20 percent of the TCE concentration at the higher elevation, and from 10 to 60 percent at the lower elevation. TCA concentrations at this location are less than about 20 μg/L, while the TCA degradation products are on the order of 150 μg/L at an elevation of 690 feet and on the order of 10 μg/L at the lower elevation. This information, combined with the geochemical data presented in the Subsurface Investigation Report (RMT, 1997) indicates that the chlorinated compounds are biologically degrading with distance from the facility. By the time the next monitoring well location is reached about 4,600 feet downflow of the facility (MW-21 BR1 and BR2), there are no VOCs detected to date.

Section 3
Basis for Remedial Action

The Tecumseh facility in Grafton is a complex site, with VOCs present in unsaturated soil, soil aquifers, and bedrock aquifers. Organic compounds associated with degreasing solvents, paint solvents, and petroleum hydrocarbons are found in some or all of soil, glacial sediment aquifers, and bedrock aquifers. Many of the source areas of the compounds are now beneath expansions of the manufacturing building and not readily accessible. The mixture of compounds is degrading through microbial action; however, not all compounds are degrading at the same rate and the degradation is not uniform throughout the site. Rather than trying to approach the entire site at one time, it is proposed that a remedial action be undertaken in the near future to address a portion of the site that is readily accessible and amenable to remediation.

The remedial action is intended to address the residual chlorinated solvents present in the unsaturated soil beneath the East Parking Lot Area. This clay soil retains some of the highest concentrations of chlorinated compound observed beneath the facility. Unlike areas of VOC contamination under the facility buildings, only limited degradation is evident in the soil, and infiltration of precipitation through the gravel parking lot can leach the chlorinated compounds to the underlying aquifer in the outwash sand and deeper bedrock aquifers. Mitigating this area of high concentrations of VOCs and continued leaching to groundwater will not address all of the issues at the site, but will provide a significant benefit to the environment. The remedial action will be incorporated into the remediation process under NR 700 as this facility moves to closure. The remainder of the report focuses on the remediation of the soil beneath the East Parking Lot Area.

The evaluation of remedial technologies and development of the selected remedial action are predicated on the definition of the extent of VOCs presented in Section 2 of this report and definition of soil cleanup targets in Section 4 of this report. If the extent of VOCs in excess of the cleanup targets is substantially greater than presented to date, the remedial action may be suspended and remedial options re-evaluated at that time.

Section 4
Remedial Action Objectives

4.1 Exposure Pathways

The chlorinated compounds present in the soil are not expected to present immediate risks to workers in the industrial setting of the facility. Surface soil samples (0 to 0.5 ft in depth) were not collected during the investigations to date. However, the lack of any evidence of releases, coupled with rapid volatilization of the solvents in the top feet of gravel and soil, suggests that the potential for exposure by direct contact is likely to be insignificant, if present at all. Ambient air monitoring was conducted during the drilling of soil borings in the area. There was no evidence of the presence of organic vapors in the breathing zone of the investigators while they were on site. Any volatilization of the solvents from the underlying soil through the gravel surface of the parking lot would appear to attenuated through dilution in the air immediately above the parking lot surface.

Excavation into the portions of the area may expose construction workers to concentrations on the order of several 100's of mg/kg of TCE and 10's of mg/kg of TCA. Development and implementation of appropriate work health and safety protocols can control potential worker exposures through dermal contact with the soil, incidental ingestion of soil, or inhalation of vapors from the soil in or near the excavation.

While groundwater is not a direct part of the proposed remedial action, it should be noted that the chemicals from the unsaturated soil in the East Parking Lot Area migrate to groundwater but are only a fraction of the total chlorinated compound loading to the groundwater beneath the facility. Other source areas beneath the facility plant and chlorinated compounds held in the underlying sand and bedrock aquifers by sorption or residual saturation also provide ongoing contributions to the dissolved chemical concentrations in the groundwater. Groundwater beneath the facility is not used for potable or industrial purposes, and therefore does not present a potential pathway of exposure. However, the chlorinated compounds in the underlying aquifers will migrate to the east and beyond the facility property line. The Village of Grafton potable water-supply wells have not been adversely impacted by the off-site migration of the chemicals from the Tecumseh facility (RMT, 1997). The data collected to date suggests that the chlorinated compounds are attenuated within the bedrock aquifer (RMT, 1997) and monitoring wells placed in front of the plume as 'sentinels' are monitored semiannually (Moraine, 1999) to verify that the attenuation is continuing. Three private potable water-supply wells in a small portion of the Town of Grafton to the east of the facility produce water with very low concentrations of chlorinated chemicals. These concentrations were deemed acceptable for human consumption by the State of Wisconsin (RMT, 1997).

4.2 Remedial Action Objectives

There are two objectives for this remedial action:

- To mitigate potential exposures to workers that may perform excavation activities in the areas of residual chlorinated compounds in the soil
- To mitigate, to the extent practicable, the long-term continued leaching of chlorinated compounds from the soil to the underlying aquifer in order to improve the quality of the water from the private water-supply wells and result in a more rapid attenuation of the groundwater plume to the east of the facility.

The remedial objective for the proposed remedial action is not intended to stand alone as a remedy for the site under Wisconsin Administrative Code (WAC) NR 700. The remedial action will be incorporated into a site-wide remedial action in the future. The proposed action is not designed to bring the entire site to closure under NR 726.

4.3 Soil Cleanup Targets

Soil clean up targets for the remedial action are presented to provide a basis for the evaluation of the remedial technologies and to guide the actual implementation of the selected technology. The selection of the target concentrations for this remedial action is designed to address the high concentrations found in the soil; i.e., solvent "hotspots" remediation.

The hotspots are defined on the basis of the highly left-skewed concentration distributions in the East Parking Lot Area (i.e., small volumes of soil contain large masses of solvents). For the distribution of solvent occurrence described in Subsection 2.4.2 of this report, the skew is summarized as follows:

SOLVENT CONCENTRATION RANGE (mg/kg)	CUMULATIVE SOIL VOLUME (m^3)	CUMULATIVE SOLVENT MASS (kg)	PERCENT OF TOTAL SOLVENT MASS
10 - 100	510	32.1	59
1 - 10	2,670	45.7	87
0.1 - 1	7,950	49.0	94
0.025 - 0.1	32,100	52.4	100

(See Appendix C for computations.)

For the East Parking Lot Area, approximately 90 percent of the solvent mass is found within a 2,670 m^3 area (about 3,500 yd^3). A reasonable definition of a "hotspot" for purposes of this remedial action is therefore 1.0 mg/kg of solvent.

The mitigation of potential future exposures was the first of the remedial objectives. To meet this objective requires that the 1.0 mg/kg target be protective of human health and the environment. The United States Environmental Protection Agency (USEPA, 1999) has generated risk-based screening concentrations for industrial direct contact scenarios at concentrations of 520 mg/kg of TCE and 41,000 mg/kg for TCA. A 1.0 mg/kg target for TCE would clearly be protective in this scenario. The target for TCA could be raised to 10 mg/kg for TCA and still be well below the USEPA's risk-based screening concentration. With respect to potential inhalation exposures, the Michigan Department of Environmental Quality (MDEQ) has developed screening and cleanup criteria for industrial scenarios (MDEQ, 1998). The lowest soil screening concentrations for inhalation of ambient air are 500 mg/kg and 460 mg/kg for TCE and TCA, respectively. Again, target concentrations of 1.0 and 10 mg/kg of TCE and TCA would clearly be protective of this potential exposure pathway. The scenario in which a construction worker in an excavation could be potentially exposed by the inhalation pathway has not been quantitatively assessed due to the wide range of potential site conditions (e.g. excavation depth and shape, meteorological conditions, work sequencing, etc.). Rather than try to define acceptable risks and target a cleanup concentration, the issue of this potential exposure is best addressed through deed notification, monitoring during construction, worker protection, and engineering controls.

WAC NR 720 establishes an approach to developing acceptable Residual Contaminant Levels (RCLs) for the protection of groundwater from the leaching of contaminants from soil. To calculate RCLs, site-specific data was used for the following parameters:

- Soil fraction organic matter content at 0.037 (Appendix C)
- Bulk density at 2.10 g/cm^3(Appendix C)
- Total porosity at 0.21 given the measured bulk density and an assume particle density of 2.65 g/cm^3(Appendix C)
- Hydraulic conductivity of the underlying aquifer at 8x10^{-3} cm/s (RMT, 1997)
- Hydraulic gradient in the underlying aquifer at 0.008 (RMT, 1997)
- Length of waste parallel to flow at 4,880 cm (RMT, 1997).

Literature values were used for partition coefficients, and NR 720 default values were used for the remaining parameters as shown in Appendix C. The RCL computed in Appendix C is 0.008 mg/kg. This is below the VOC method quantitation limit of 0.025 mg/kg for soil using the required in-field methanol preservation technique specified by the WDNR. The computed

RCL would increase to greater than 0.014 mg/kg if paving of the area were to reduce the infiltration by at least 50 percent. Again, this is below the quantitation limit of 0.025 mg/kg for soil using in-field methanol preservation.

The computed RCL concentration identifies the entire mass of soil beneath the East Parking Lot Area as requiring remedial action, even though 90 percent of the solvent mass is in only 10 percent of the soil volume. It is not practicable to excavate the entire East Parking Lot Area to concentrations below quantitation limits. The remedial objective for the proposed remedial action is not intended to stand alone as a remedy for the site under NR 700. The action therefore does not necessarily have to achieve complete groundwater protection on its own. By addressing 90 percent of the solvent mass at the target cleanup concentrations of 1.0 mg/kg TCE and 10 mg/kg TCA, the remedial action will have removed a substantial fraction of the solvents that could provide long-term leaching to the groundwater.

Section 5
Screening of Remedial Technologies

This section identifies and screens an array of remedial technologies that could potentially be utilized to manage impacted soil at the East Parking Lot Area. The treatment of this area is a remedial action to address the VOC-impacted soil in the unsaturated zone. These technologies were identified to address the remedial action objectives based on RMT's experience with similar projects and on recent technical literature. Individual technologies will be combined in Section 6 to form remedial action options. For example, an *in situ* treatment technology may be combined with a containment technology (e.g., asphalt pavement) to form a complete option.

During the screening process, the technologies that may prove infeasible to implement, that are unlikely to be effective, or that do not achieve the remedial action objectives in a cost-effective manner are eliminated from further consideration. This screening process focuses on eliminating those technologies that have severe limitations based on the constituents of concern and the site-specific conditions.

5.1 Identification of Remedial Technologies

5.1.1 No Action

This option has been included to provide a baseline against which other alternatives can be compared. In the "No Action" option, remediation of the impacted soil at the East Parking Lot Area would be left to naturally occurring biological and physical site processes. No monitoring would be conducted at the site.

5.1.2 Containment Technologies

Technologies in this category are intended to contain the impacted soil or vapors in-place. As a containment technology, the objective of a cover system would be to provide a physical barrier over the impacted soil to prevent direct contact (i.e., dermal or inhalation) and to reduce the transfer of contaminants from the unsaturated soil to groundwater by limiting the infiltration of precipitation. These approaches would, in general, be effective as long as the cover system was maintained. Specific technologies are described below.

Soil Cover

A soil cover may be constructed using general fill or low-permeability clay. A simple soil cover, consisting of up to several feet of clean material, would render direct contact less likely by providing increased separation between the surface and the underlying impacted soil. A low-permeability clay cover is typically used where there is an additional objective of reducing infiltration, and hence leaching, to the underlying groundwater. The East Parking Lot Area is an active truck traffic area; therefore, a soil cover option is not suitable.

Asphalt Pavement

An asphalt pavement system may be installed consisting of sufficient base course and asphalt to support the anticipated vehicle loads. The asphalt pavement would prevent direct contact and would significantly reduce infiltration. Periodic inspection and maintenance of the asphalt pavement would be required. Asphalt pavement will be considered further.

5.1.3 *In Situ* Treatment Technologies

Technologies in this category are used to treat the impacted soil in-place. The objective would be to reduce the mass of chlorinated VOCs in the unsaturated zone so that continued transport to groundwater is minimized.

The effectiveness of *in situ* treatment will vary with the technology, soil conditions, contaminants of concern, and duration of treatment. Specific technologies are described below.

Soil Vapor Extraction

Soil vapor extraction (SVE) involves the removal of VOC vapors from the unsaturated zone through the use of induced air currents. Volatile organic compounds are removed by drawing uncontaminated air through the soil matrix. The contaminated soil vapors are partitioned into the uncontaminated air in a mass transfer process. In addition, the decreased concentrations and pressure in the soil matrix cause free-phase and dissolved-phase VOCs to volatilize at a greater rate than would occur naturally. Negative pressure in the subsurface is typically achieved using a system of vapor extraction wells manifolded to an air blower at the surface. The vapors flow through piping to the blower and are either exhausted to the atmosphere or to an off-gas treatment unit, using technologies such as granular activated carbon or thermal oxidation.

SVE is considered a conventional technology and is well-accepted by the WDNR. A potential regulatory issue with SVE is the facility's location within an air quality nonattainment area. This creates additional restrictions on the discharge of VOCs to the atmosphere. The SVE emissions will need to be reviewed in light of the requirements of WAC Chapters NR 419 and NR 445.

SVE is most effective in permeable, coarse-grained soil. Since the clay soil observed in the upper 10 to 12 feet at the East Parking Lot Area is fine-grained and has low permeability, the option of SVE will not be considered as a potential remedial action.

Soil Vapor Extraction with Steam Injection

Steam could be injected in the subsurface in combination with the SVE system to raise the soil temperature, which would enhance volatilization and removal of the VOCs for subsequent extraction by the SVE system. Depending on the amount of steam capacity available at the facility, and on the proximity of the steam source (e.g., the boiler room) to the area requiring remediation, steam injection may be a cost-effective enhancement to *in situ* soil remediation at this site. Steam from the boiler would be injected into the unsaturated soil, adjacent to the SVE wells. Moisture in the extracted air would be managed appropriately in the SVE system. By raising the soil temperature, the subsurface conditions for bioremediation would be temporarily or permanently enhanced. Implementation of a sequential remediation approach involving bioremediation should consider the temperature effects of steam injection in the subsurface. SVE with steam injection has the same limitations as conventional SVE with regard to permeability of the soil. Therefore, it will not be considered as an option in the East Parking Lot Area, due to the presence of low permeability, fine-grained clay soil in the upper 10 to 12 feet of the site.

Intrinsic Bioremediation and Monitoring

Microorganisms are ubiquitous in most subsurface environments. In some settings, the subsurface environment combined with the anthropogenic chemicals is conducive to (or at least not inhibitory of) the microbial activity. In such cases, microbiological activity may be reducing the concentrations of contaminants in soil and groundwater without any further human intervention. This inherent ability of the soil and groundwater to degrade contaminants is defined as intrinsic bioremediation, and is a key component to the natural attenuation of anthropogenic chemicals (Hinchee et al., 1995; USEPA, 1996).

In situ treatment by microorganisms relies on either an organism's direct use of an anthropogenic organic compound to sustain its growth, or takes advantage of fortuitous chemical reactions associated with microbial growth (co-metabolism). Microorganisms can use aromatic hydrocarbons as the primary growth substrates in aerobic environments. Chlorinated aliphatic compounds (e.g., trichloroethene) can be used as the electron acceptors in metabolic processes in anaerobic environments. Microbial activity can also produce enzymes that break down some or "selected" chlorinated aliphatic compounds in aerobic environments (USEPA, 1996; Wiedemeir et al., 1995; Norris et al., 1994; and NRC, 1993).

Intrinsic bioremediation is generally most applicable to petroleum hydrocarbons; however, the co-release of chlorinated solvents with aromatic hydrocarbons may result in the intrinsic bioremediation of the chlorinated compounds, since the chlorinated compounds are used as electron acceptors or are co-metabolized. The bioremediation of some chlorinated compounds may result in the production of intermediate products that are more toxic than the original chemical (e.g., production of vinyl chloride from trichloroethene during reductive dehalogenation in anaerobic settings). In some settings, however, the vinyl chloride may be degraded as the environment becomes aerobic (Vogel, 1994), or it may be degraded by iron-reducing organisms in anaerobic environments (Bradley and Chapelle, 1996).

An on-site bioremediation assessment was performed at the East Parking Lot Area. The soil samples show little presence of TCE or TCA degradation products in the area. Petroleum hydrocarbons were not detected in the initial sampling of the area (RMT, 1997) and no visual indications of petroleum residues were noted in the fall of 1998 sampling. The bioremediation capabilities of the clay soil are therefore considered to be low, and intrinsic bioremediation will not be considered as a potential remedial option.

Enhanced Bioremediation

Enhanced bioremediation is defined as the engineered manipulation of subsurface environments to initiate or increase the rate of bioremediation of anthropogenic compounds (Norris et al., 1994; Cookson, 1994). Similar to intrinsic bioremediation, enhanced bioremediation will reduce VOCs in the soil and below the water table. The engineered manipulation may include the introduction of a primary substrate (carbon source) to sustain microbial growth, the introduction of electron donors and/or electron acceptors, or the introduction of other nutrients (e.g., nitrogen or phosphorus). The approach assumes that an indigenous microbial population relevant to the degradation of the anthropogenic chemicals is present in the subsurface. Enhanced bioremediation to reduce chlorinated VOCs in the subsurface is considered an innovative technology. Treatability testing is required to assess what changes to the subsurface environment are needed to achieve enhanced bioremediation. The design process then determines what chemicals are introduced, and where and how the introduction is made in the subsurface to achieve optimum microbial degradation.

Enhanced bioremediation is typically more easily engineered in the permeable and saturated zones due to more straightforward delivery methods and higher levels of biological activity. The soils being considered for remediation in the East Parking Lot Area are in the low permeability unsaturated zone and the bioremediation assessment shows little evidence of current VOC degradation in the area. Enhanced bioremediation will therefore not be considered as a viable option.

Soil Flushing

Soil flushing is an *in situ* process in which a solvent and/or surfactant solution is injected into the soil to enhance the solubility of the contaminants or enhance the mobility of NAPL residuals in the soil. An extraction and re-injection system is required to remove the solubilized chemicals from the subsurface. This technology, like several others, has limited success in fine-grained soil, such as the clay encountered at the Grafton facility. The introduction of surfactants in the sand underlying the clay may not be advisable because the VOCs could be mobilized as a DNAPL, which would easily be transported to the shallow bedrock aquifer. In Wisconsin, an administrative barrier exists for the injection of certain chemicals, such as solvents or surfactants, into the subsurface. Therefore, this technology will not be considered further.

Soil Mixing With Hot Air Injection

Soil mixing with hot air injection is an in situ technology used to remove organics via low temperature thermal desorption from subsurface soil under comparatively low temperatures (400°F to 800°F). The impacted soil is mechanically mixed in-place with the hot air injected as the soil is mixed. During the injection process, organics are destroyed or are transferred from the solid matrix to a gaseous matrix, to allow vapor extraction. Depending on the process option, the off-gas organic vapors may be recovered and treated.

This innovative technology is offered commercially in the form of modified trenching machines called mobile injection treatment units (MITU®), or large-diameter augers. The MITU® technology has the capability of treating VOCs, including chlorinated compounds, *in situ* to depths ranging from 0 to 30 feet. However, the smaller, more accessible units typically treat soil to an approximate 12-foot depth. The method that uses large-diameter augers can go to greater depths in soil. Since only shallow soil is being considered for remediation, only the smaller-scale MITU® technology will be considered in the evaluation.

The major component of the MITU® unit is a modified rock trenching unit with a custom fabricated ventilation vacuum hood. The trenching unit is fitted with injection systems and a full vapor recovery system. Hot air is forced into the soil while the trenching unit cuts and rotates the material. The treated soil is returned to its original location, but at a lower compaction than the original soil condition. Depending on the size of the treatment unit and the soil characteristics, temporary structural supports (e.g., steel plates) may be required to allow the unit to travel over the treated areas. This process will be considered further for the East Parking Lot Area.

Oxidation Process

This is an *in situ* remediation technology that applies a well-known chemical process known as Fenton's reagent, widely used in the wastewater industry, to treat chlorinated organics. The process consists of chemically converting organic contaminants to carbon dioxide, water, and oxygen. The oxidant in this process may be a mixture of hydrogen peroxide and trace amounts of metallic salts in solution. Alternative oxidants may consist of sodium percarbonate (sodium carbonate peroxohydrate), which is a stable microcrystalline powder. Chemicals that are capable of being oxidized include aliphatic and aromatic organic contaminants, including petroleum hydrocarbons and chlorinated solvents (e.g., TCE). These constituents may be treated both in the soil or groundwater. The environmental application of this chemistry was developed to remediate impacted soil and groundwater in locations that were difficult or not cost-effective to access for excavation-based remediation (i.e., beneath buildings and other structures).

Geo-Cleanse® and others (CleanOx®, ISOTEC®) provide patented technologies for the introduction of oxidants that is representative of this innovative remedial approach. These commercially available processes inject the hydrogen peroxide mixture as a slurry into the subsurface through probes that are installed with a conventional drilling rig. The chemical oxidation process can result in high heat (400°F) and gas pressure within the soil, which requires special health and safety considerations, and a gas extraction system if performed under a building or near utilities.

The effectiveness of the slurry injection delivery system depends on the soil type. The clay observed at the Grafton facility would require close spacing of the injection points, and multiple injections of the treatment chemical slurry, to achieve a meaningful reduction in VOC concentration and mass.

The presence of other constituents (e.g., petroleum) will affect the treatment dosage required. The pH of the soil will likely need to be altered to achieve the optimum pH range needed for the chemical oxidation process. Typically, the soil pH will return to its natural state.

Fenton's reagent technology has been relatively widely applied for the remediation of readily oxidized compounds such as petroleum hydrocarbons. Laboratory testing has shown the feasibility of *in situ* TCE oxidation in contaminated clay using hydrogen peroxide (Gates and Siegrist, 1995). Fenton's reagent has been used at the field scale by vendors since late in 1996 to effectively treat TCE-containing soil *in situ*. However, GeoCleanse® informed RMT that their oxidation process would not be able to destroy the TCA found in the unsaturated soil beneath the Grafton facility. They encountered problems at a site in Pennsylvania and subsequently performed bench-scale work to try to develop alternate methods for destroying the TCA. The results of the bench-scale work were unsatisfactory. Some of the other vendors openly acknowledge this limitation of Fenton's reagent in the recent technical literature. Alternative oxidants such as sodium percarbonate may be applicable for TCA treatment, but treatability studies would need to be performed and the solution would be unproven at field scale. Due to the potential ineffectiveness of Fenton's reagent in the treatment of TCA, chemical oxidation will not be considered as a remedial option.

5.1.4 *Ex Situ* Treatment Technologies

Technologies in this category consist of *ex situ* treatment of the impacted soil. The soil would be removed from the source area prior to treatment. The objective of *ex situ* treatment would be to achieve levels necessary for off-site disposal or possibly to allow on-site regrading or beneficial reuse of the material.

The effectiveness of *ex situ* treatment will depend on the treatment process, soil type, and contaminants of concern. Specific technologies are described below.

Thermal Desorption or Incineration

Thermal desorption is a contaminant removal process wherein the excavated soil is heated to temperatures ranging from 200 to 1,000°F to volatilize and desorb the organics from the soil. The organic gases and water vapor are then concentrated, removed, and treated. The clean soil can be reused as backfill. Incineration differs from thermal desorption in its desired result, which is decomposition of organic contaminants. Incineration would require the use of a rotary kiln, infrared furnace, or similar device to raise the soil temperature to a range of 1,600 to 2,200°F. This temperature would act to volatilize and combust the organics. Incineration is typically more expensive than thermal desorption, and its higher temperatures are not necessary to treat the contaminants at this site. In either case, a thermal treatment unit for chlorinated compounds, such as TCE and TCA, would have to be permitted by the state. Because a fixed thermal desorption facility is not located within a reasonable distance from the Grafton site, this technology will not be considered further.

Bioremediation: Biopile

Biopiles are forms of *ex situ*, typically aerobic, bioremediation in which the contaminated soil is excavated from the site and amended physically and/or chemically and then stockpiled or windrowed to enhance bioremediation of contaminants.

The soil might be mixed with bulking agents, such as straw, compost, or wood chips, and with nutrient sources, such as liquid fertilizer and/or manure, as well as with a co-metabolite (toluene, methane, phenol), if necessary. The mixed soil is then piled on an impermeable liner. An air supply system and exhaust piping may be installed within the pile. The piping can be left open to the atmosphere for passive ventilation with oxygen, or it can be connected to a blower that either pulls or pushes an oxygen source from the atmosphere through the pile. Monitoring devices for measuring oxygen content, temperature, and moisture may also be installed. Depending on the effectiveness of the biopile treatment, the residual soil may be regraded on-site or disposed at an off-site landfill.

The technology is commonly applied to the remediation of petroleum-contaminated soil. Application to chlorinated VOCs is conceptually possible, but there are no documented applications. For this reason, biopiles will not be considered as an option for TCE and TCA remediation for the East Parking Lot Area.

Bioremediation: Slurry Phase

Slurry phase bioremediation involves mixing excavated soil with a solution (usually water) in a batch process to create a soil slurry to which nutrients and oxygen can be added. This aerobic process is done to enhance the activity of microorganisms to degrade the organic contaminants. Once the slurry has biologically reduced the organic contaminant(s) to the acceptable level, the soil is dewatered and can be returned to its original location or disposed of elsewhere. This process is typically used for very large quantities of soil and is typically applied to petroleum hydrocarbons. Therefore, it will not be considered further.

Chemical Dechlorination

Excavated soil is mixed with a glycolate reagent (APEG - Alkaline Metal Hydroxide/ Polyethylene Glycol) and heated to dechlorinate and detoxify the chlorinated contaminants, usually in a batch process. Base-catalyzed decomposition (BCD) is a comparable technology that does not require a glycolate reagent. Following treatment, the soil can be placed in its original location or elsewhere on-site. This process is typically used for very large volumes of soil containing recalcitrant contaminants, such as PCBs, and will therefore not be considered at this site.

5.1.5 Removal and Disposal Technologies

Technologies in this category apply to the removal of impacted soil from the source area. Removal of the soil, followed by backfilling with clean soil, would achieve the remedial action objectives by eliminating the potential for future leaching to groundwater or direct contact with impacted soil. The use of backhoes and standard earthmoving equipment would be considered conventional excavation. This technology is reliable and is implementable at the East Parking Lot Area. The removed soil would be disposed of appropriately based on the waste characteristics. Disposal options are discussed below.

Subtitle D Management

The source(s) of the VOCs found in the soil are unknown (see Section 2 for discussion). The soil is therefore not considered to be a listed hazardous waste (WDNR, 1993). Soil classified as a nonhazardous solid waste would be managed and disposed at a Subtitle D licensed facility.

Subtitle C Management

The excavated soil could be potentially hazardous on the basis of ignitability, corrosivity, reactivity, or leachability. However, the soil is not expected to be ignitable or reactive based on generator knowledge of the material. If the soil is classified as a characteristic hazardous waste by the Toxicity Characteristic Leaching Procedure (TCLP), the material would be managed accordingly. Depending on its solvent concentration, the soil may be subject to land disposal restrictions, which require minimum treatment prior to land disposal.

Beneficial Reuse

If *ex situ* treatment of the soil by one of the technologies described in Subsection 5.1.4 is effective, on-site regrading or beneficial reuse of the material may be possible. Potential uses on-site might include parking lot regrading, backfill, berms, landscaping, or soil cover. Regulatory approval of the beneficial reuse of the material would be required by the WDNR.

5.2 Screening of Remedial Technologies

The screening of remedial technologies is summarized in Table 2. Site conditions, contaminant and waste characteristics, and technology limitations were used to evaluate the implementability and effectiveness of the remedial technologies, as follows:

- *Site conditions* - The available site data was reviewed to identify conditions that may limit or promote the use of certain technologies (e.g., soil type, physical constraints, ongoing facility operations). Technologies that are clearly precluded by existing site conditions were eliminated from further consideration.

Table 2
Screening of Remedial Technologies for Soil
Based on Implementability, Effectiveness, and Relative Cost
Tecumseh Grafton Facility
East Parking Lot Area

TECHNOLOGY CATEGORY	REMEDIAL TECHNOLOGY	SCREENING BASIS			ACCEPTABLE FOR FURTHER CONSIDERATION[1]
		IMPLEMENTABILITY	EFFECTIVENESS	RELATIVE COST	
No action	No action	Implementable	Not applicable to expedite observed natural attenuation	Low	No
Containment technologies	Soil cover	Not implementable; low-permeability (clay) soil is not compatible with current use as parking lot	Moderate; would limit direct contact and infiltration	Low	No
	Asphalt pavement	Implementable and compatible with intended future use	High; would limit direct contact and infiltration	Low	Yes
In situ treatment technologies	Soil vapor extraction	Implementable	Moderate; fine-grained soil may reduce effectiveness	Low-medium	No
	SVE with steam injection	Moderately implementable; would require modification of the boiler room and conventional SVE system	Moderate-high; fine-grained soil may reduce effectiveness	Medium	No
	Intrinsic bioremediation and monitoring	Not implementable; limited natural biodegradation	Low-moderate	Low	No
	Enhanced bioremediation	Moderately implementable; would require additional treatability studies and admixtures to develop enhance biodegradation	Moderate; innovative technology, limited capability to deliver materials to soil matrix	Low-medium	No
	Soil flushing	Not implementable due to fine-grained soil and administrative restrictions of solvent/surfactant subsurface injection	Low-moderate	Medium	No

Table 2
Screening of Remedial Technologies for Soil
Based on Implementability, Effectiveness, and Relative Cost
Tecumseh Grafton Facility
East Parking Lot Area

TECHNOLOGY CATEGORY	REMEDIAL TECHNOLOGY	SCREENING BASIS			ACCEPTABLE FOR FURTHER CONSIDERATION[1]
		IMPLEMENTABILITY	EFFECTIVENESS	RELATIVE COST	
In situ treatment technologies (continued)	Soil mixing with hot air injection (MITU®)	Implementable; may require support system to allow equipment access over treated soil area	Moderate-high for TCE and TCA removal; innovative technology; debris may limit effectiveness of soil mixing machinery	Medium	Yes
	In situ chemical oxidation process	Implementable for TCE-containing soil; hydrogen peroxide oxidants would not address TCA-containing soil	Demonstrated as moderate-high for TCE, but hydrogen peroxide oxidants are reportedly not effective for TCA based on wastewater literature and vendor information; innovative technology; fine-grained soil may limit effectiveness of the liquid delivery system; debris may limit effectiveness of injector probe installation	Medium	No
Ex situ treatment technologies	Thermal desorption or incineration	Implementable for areas that can be removed by conventional excavation, facility not located nearby	High	High	No
	Bioremediation: biopile	Implementable for areas that can be removed by conventional excavation	Moderate	Medium	No
	Bioremediation slurry phase	Implementable for areas that can be removed by conventional excavation	Moderate-high	High	No
	Chemical dechlorination	Implementable for areas that can be removed by conventional excavation	High	High	No

Table 2
Screening of Remedial Technologies for Soil
Based on Implementability, Effectiveness, and Relative Cost
Tecumseh Grafton Facility
East Parking Lot Area

TECHNOLOGY CATEGORY	REMEDIAL TECHNOLOGY	SCREENING BASIS			ACCEPTABLE FOR FURTHER CONSIDERATION(1)
		IMPLEMENTABILITY	EFFECTIVENESS	RELATIVE COST	
Removal and disposal	Subtitle D landfill disposal	May not be implementable based on waste characteristics	High	Low-Medium	Yes
	Subtitle C landfill disposal	Moderately implementable; material may require further treatment to meet land ban restrictions	High	High	Yes
	Beneficial reuse (on-site)	Moderately implementable, depending on *ex situ* treatment effectiveness and WDNR approval requirements	High	Low	No

Note:
1. Remedial technologies were eliminated from further consideration based on a balance of the anticipated implementability, effectiveness, and relative cost.

- *Technology limitations* - During the screening process, the level of technology development, the performance record, and the inherent construction, operation, and maintenance requirements associated with each technology were reviewed. Technologies that were unreliable and that performed poorly were eliminated in the screening process. Innovative technologies were identified as such, but were not eliminated if additional information was needed to assess their effectiveness.

General screening ratings for the purposes of evaluating implementability, effectiveness, and relative cost in Table 2 are as follows:

- *Implementability:*
  - Implementable - Technology has been readily implemented at other sites with similar site conditions and contaminant and waste characteristics.
  - Moderately implementable - Site conditions, or contaminant and waste characteristics, will require major modifications to the traditional technology to allow implementation.
  - Not implementable - Site conditions, or contaminant and waste characteristics, preclude this technology from being implemented.

  State and federal regulations that may limit or preclude the implementation of a specific technology (i.e., administrative barriers) were considered under implementability in Table 2.
- *Effectiveness:*
  - Low - Technology limitations preclude this technology from reliably achieving the remedial action objectives.
  - Moderate - Technology may achieve the remedial action objectives, given the site conditions, and contaminant and waste characteristics. However, modifications to the traditional technology would be necessary.
  - High - Technology has consistently achieved the remedial action objectives at other sites with similar site conditions, and contaminant and waste characteristics. Technology should achieve the remedial action objectives.
- *Relative Cost:*
  - Low - Technology has been implemented at other similar sites for a capital and operation and maintenance cost of less than $500,000.
  - Medium - The capital and operation and maintenance cost may be several factors greater then the "low" relative cost.
  - High - The capital and operation and maintenance cost may range from several factors to an order-of-magnitude greater than the "low" relative cost.

The technologies in Table 2 were screened to determine which ones were appropriate for further consideration. The justification for the screening and selection is as follows:

- Among the containment technologies, the use of asphalt pavement would be appropriate to limit direct contact with surface soil and to reduce surface water infiltration at the East Parking Lot Area. However, the asphalt pavement does not result in a significant reduction of chlorinated VOC concentration or mass when compared to the current condition. Therefore, this containment technology would likely be combined with another treatment technology to form a remedial option. The option of using a clay soil cover as a containment technology was eliminated because it is not compatible with the area's current use as a parking lot.

- Among the *in situ* treatment technologies, soil mixing with hot air injection provides the highest degree of implementability and effectiveness at a reasonable relative cost. Soil vapor extraction (SVE) methods were not considered further because they are more applicable to coarse-grained soils. Soil flushing was eliminated because of the administrative barrier for the subsurface injection of chemicals and the uncertainties of DNAPL mobilization, as well as soil permeability limitations. Bioremediation options were excluded due to the observed lack of degradation products in the soil.

  The chemical oxidation process would likely address the TCE-impacted soil. However, in addition to limitations related to soil permeability, chemical oxidation with hydrogen peroxide is reportedly not effective for TCA reduction, based on available wastewater literature and information from GeoCleanse® and other vendors. Chemical oxidation is therefore being excluded as a remedial option.

- Among the *ex situ* treatment technologies, biopiling either on- or off-site is implementable but has not yet been shown effective in reducing chlorinated VOC levels. The remaining *ex situ* treatment technologies were considered cost-prohibitive for the anticipated volume of excavated soil.

- Among the removal and disposal technologies, conventional excavation and off-site disposal is implementable and reliable for the East Parking Lot Area. Special provisions may be required to allow excavation adjacent to the utility corridors. Excavated soil and treatment residuals may be disposed of at an off-site Subtitle D facility or managed appropriately, depending on the waste classification of the material. The on-site placement or beneficial reuse of soil treated *ex situ* has not been retained. The ability to gain WDNR approval of on-site placement or beneficial reuse is not assured; therefore, it was not assumed for remedial option development or cost-estimating purposes.

The retained technologies can be combined to form integrated remedial options to address the source area. Two combinations are possible, as discussed below.

5.3 Assembly of Remedial Options

In this subsection, the retained technologies have been assembled into remedial options to address the East Parking Lot Area. Table 3 summarizes the assembled options and the rationale for the development of the options. Two unique remedial options have been assembled. These options represent the practicable response actions that appear best suited to achieve the remedial action objectives for the Tecumseh facility in Grafton, Wisconsin.

The remedial options include *in situ* soil mixing with hot air treatment using the MITU®, and conventional excavation and off-site disposal in a landfill facility. Consistent with the planned land use of the area, both options include asphalt paving as a post-treatment containment technology.

The options vary in their level of proven effectiveness, anticipated level of soil contaminant reduction, and cost. The practicability of implementing the remedial options was also considered.

Table 3
Assembly of Remedial Options Based on Technology Screening
Tecumseh Grafton Facility
East Parking Lot Area

ASSEMBLED REMEDIAL OPTIONS	RATIONALE
In situ soil mixing with hot air treatment using mobile injection treatment unit (MITU®)[(1)]	■ Waste characteristics and anticipated volume conducive to *in situ* approach ■ Effective reduction of TCE and TCA
Conventional excavation of impacted soil in unsaturated zone and disposal in a Subtitle D or managed accordingly, depending on solvent concentration[(1)]	■ Effective reduction of TCE and TCA ■ Excavation sequencing will allow for continued use as a shipping and receiving area during construction

Notes:

(1) Although it is not being considered an integral or necessary component of either remedial option, asphalt paving will be implemented, in addition to the chosen remedial option. It is consistent with planned land use as a parking lot, but will also limit infiltration of precipitation and reduce future potential for exposure.

Section 6
Evaluation of Remedial Options

This section contains descriptions of both remedial options for the impacted soil in the East Parking Lot Area, as well as evaluations of the technical and economic feasibility of implementation for each option.

6.1 Description of Options for Remediation

Two approaches to remediation of this area are considered applicable—conventional excavation and landfill disposal, or soil mixing with hot air treatment using a mobile injection treatment unit (MITU®).

As described in Subsection 4.2, the target cleanup concentrations for the remedial action are 1.0 mg/kg TCE and 10 mg/kg TCA. The East Parking Lot Area impacts are divided into two separate areas for discussion purposes, the northern area and the southern area (Figure 4). In the northern area, there are two hot spots targeted for remediation: a TCA hot spot, with dimensions of approximately 25 feet by 30 feet, where TCA concentrations exceed 10 mg/kg; and a TCE hot spot, with approximate dimensions varying from 40 to 80 feet wide by 120 feet long, where TCE concentrations exceed 1.0 mg/kg. These hot spots require treatment to 10 feet below ground surface (bgs). In the southern area there is one TCE hot spot, with approximate dimensions of 35 feet by 45 feet, where TCE concentrations exceed 1.0 mg/kg. This hot spot requires treatment to 12 feet bgs. Adding the soil volumes from the northern and southern areas, the total estimated soil treatment volume for the East Parking Lot Area is 4,400 cubic yards. This volume is based on a cleanup standard of 1 mg/kg for TCE and 10 mg/kg for TCA, and includes a 20 percent contingency factor.

6.1.1 Soil Mixing With Hot Air Treatment

This remedial option consists of performing *in situ* combined thermal injection and vapor extraction utilizing a mobile injection treatment unit (MITU®). In this process, VOCs would be desorbed from the soil at relatively low temperatures (400° F to 800° F), and the vapors would be extracted under vacuum and treated using vapor-phase granular activated carbon. The MITU® 12 has a vertical reach of 12 feet, which would be an adequate depth for the entire impacted zone. The MITU® is a self-contained unit mounted on a rock trencher. A vapor collection hood is mounted on the arm of the trencher. The exhaust from the trencher's diesel engine provides the heated air under the collection hood. Electrically heated rods can also be installed beneath the collection hood to boost the temperature, if required.

This is a one-time treatment option requiring no ongoing operation and maintenance. Soil samples would be collected to determine the effectiveness of the treatment approach. Following treatment, the area would be paved with asphalt.

6.1.2 Conventional Excavation and Landfill Disposal

Conventional excavation would address both the TCE- and TCA-containing soils at the source area. Excavation would involve the use of backhoes or tracked excavators or other standard earthmoving equipment to physically remove the impacted soil from areas having TCE concentrations greater than 1.0 mg/kg or TCA concentrations greater than 10 mg/kg. The entire clay layer in the impacted areas will be excavated to the depth of the water table (approximately 10 to 12 feet bgs), which is coincident with the top of the underlying sand layer. Representative soil sampling will be performed and samples will be analyzed using a mobile laboratory throughout the excavation process to ensure that the appropriate volume of material is removed in order to meet the cleanup goals. The estimated total excavation volume in the northern and southern areas of the East Parking Lot is 4,400 cubic yards.

Testing performed on the excavated material will be used to characterize the soil for disposal. Preliminary testing indicates that VOC concentrations are low enough for the excavated soil to be classified as a special waste. In this case the material will be handled as a Subtitle D waste and will be disposed of in a local licensed landfill facility. Should a portion of the waste contain sufficient VOC levels to be classified as a characteristically hazardous waste, that portion will be managed as such. Following excavation, the areas will be backfilled and compacted. The East Parking Lot Area will then be paved with asphalt.

6.2 Technical Feasibility

6.2.1 Soil Mixing With Hot Air Treatment

The use of soil mixing with hot air treatment to address VOC impacts in the unsaturated soil in this area will meet the remedial action objectives. Hot air treatment by thermal injection is a relatively new, innovative treatment technology capable of rapidly removing VOCs from soil. This action is also technically feasible, given the site characteristics, and utilizes readily available technologies. The technology has been demonstrated as effective in treating TCE-impacted soil, for example, at a Superfund site in Pennsylvania. The MITU® technology reduced TCE contaminants from a high of 13 mg/kg to 0.3 mg/kg (98 percent reduction).

The concerns associated with the implementation of this option are with utility lines that intersect the treatment areas and the potential for subsurface debris. Subsurface debris can slow the production rate of, and potentially damage the MITU®. It is recommended that the exact location and depth to each utility line be determined to ensure that damage to equipment and utilities does not occur. Locating debris may also be necessary prior to implementing this action. Ground-penetrating radar can achieve the needed subsurface survey.

6.2.2 Conventional Excavation and Landfill Disposal

Conventional soil excavation will meet the remedial action objectives for the unsaturated soil. This remediation technology is a proven solution, and offers complete removal of VOCs in the excavated areas (i.e., 100 percent reduction). The excavation will be performed by a qualified, licensed contractor with standard earthmoving equipment, which is readily available.

Technical issues include excavation around existing utilities. The subsurface utilities that will interfere with excavation include a sanitary sewer to the east of the parking lot, and a fire protection water line to the west. A 10-foot clearance will be maintained from the sanitary sewer line. Similarly, in the area of the water line, the contractor will excavate as close as possible to the line without disturbing the structural stability of the soil around the line.

Another issue is traffic flow, since the area is used as a major shipping and receiving area for the Tecumseh Facility, it is imperative that area remain operational during construction. An excavation sequencing plan which will allow for continuous traffic flow has been designed to address this technical issue. Excavated material will be managed appropriately.

6.2.3 Summary of Technical Feasibility Considerations

A summary of the technical feasibility considerations for each of the remedial options discussed previously is shown in Table 4. In general, both of the remedial options selected for the site locations are technically feasible. However, there are certain considerations related to each option that need to be addressed prior to implementation.

Table 4
Summary of Technical Feasibility Considerations
Tecumseh Grafton Facility
East Parking Lot Area

REMEDIAL OPTIONS	TECHNICAL FEASIBILITY
In situ soil mixing with hot air treatment using mobile injection treatment unit (MITU)	■ This option appears to be technically feasible using readily available technologies. ■ This option is an innovative treatment technology. ■ Utility lines and buried debris could affect implementability.
Conventional excavation and landfill disposal	■ This option appears to be technically feasible using readily available equipment. ■ This is a proven treatment method. ■ Utilities must be worked around. ■ Sequencing plan has been designed for continued traffic flow. ■ Availability of landfill facility is assumed.

The considerations that affect the feasibility for each remedial option are summarized below.

In Situ Hot Air Treatment

– *In situ* hot air treatment is an innovative treatment technology using conventional equipment. The process is technically feasible in this area if certain considerations are addressed. Utility lines and subsurface debris are the main considerations that could affect implementability, and these should be located prior to implementation. The process is effective for both TCA and TCE reduction, and would provide a 90 percent reduction in the maximum and median concentrations of TCE and TCA in the remediation areas.

Convention Excavation and Landfill Disposal

– Excavation is a proven treatment method using conventional equipment, and the option is technically feasible in the East Parking Lot Area. An excavation sequencing plan will allow for continued traffic flow through the area. Similar consideration for subsurface utilities must be taken for this technology, and the availability of an appropriate landfill for disposal is assumed. This method is effective for both TCA and TCE reduction, and would provide removal of approximately 90 percent of the VOC mass in the East Parking Lot Area.

6.3 Economic Feasibility

General assumptions used to estimate costs for remedial action in the East Parking Lot Area at the Tecumseh Grafton Facility are as follows:

- Direct capital costs include mobilization, site preparation, construction/site work, purchased equipment, and off-site disposal.
- Mobilization costs are assumed to be 5 percent of direct capital costs, except where specified by the vendor.
- A 30 percent contingency was added to the direct capital cost.
- Indirect capital costs include engineering design, construction assistance, and waste characterization laboratory analysis.
- Indirect capital costs do not include regulatory report preparation, regulatory approvals, legal fees, or public relations assistance.
- A discount rate of 3 percent was used for determining the present worth of monitoring costs. This value is the balance of assuming an 8 percent interest rate and a 5 percent inflation rate, based on USEPA approaches for remedial cost estimating.
- The total cost includes direct capital, indirect capital, and groundwater monitoring costs.

- Paving costs have not been included, since paving is not an integral part of either remedial option. However, the paving costs would be the same for both options.

6.3.1 Specific Assumptions

The following specific assumptions were used to estimate costs for remedial action in the East Parking Lot Area:

In Situ Hot Air Treatment

- The treatment area includes the approximate 60- by 120-foot and 25- by 30-foot areas in the northern portion, to a depth of 10 feet bgs, and the 35-by 45-foot area in the southern portion, to a depth of 12 feet bgs (as defined in Section 2 of this report).
- The soil around the water line and the sanitary sewer will not be treated.
- The total treatment volume is 4,400 cubic yards, with a soil density of 1.75 tons/cubic yard.
- A 20 percent contingency was added to obtain the anticipated soil volume.
- A contingency is included in the direct capital cost estimate to account for potential subsurface debris.

Conventional Excavation and Disposal

- The treatment area includes the approximate 60- by 120-foot and 25- by 30-foot areas in the northern portion, to a depth of 10 feet bgs, and the 35- by 45-foot area in the southern portion, to a depth of 12 feet bgs (as defined in Section 2 of this report).
- The soil around the water line and the sanitary sewer will not be excavated.
- The total excavation volume is 4,400 cubic yards, with a soil density of 1.75 tons/cubic yards.
- A 20 percent contingency was added to obtain the anticipated soil volume.
- The cost estimate is based on disposal of all excavated soil in a local Subtitle D landfill.

6.3.2 Summary of Estimated Costs and Levels of Uncertainty

A summary of the estimated costs and uncertainties is presented in Table 5 and shown on Figure 5. A best judgment cost estimate has been prepared for each of the remedial options. This estimate includes direct and indirect capital costs associated with implementation and monitoring costs. The supporting tables for the best judgment cost estimates are located in Appendix D.

For each remedial option, a low range estimate and high range estimate are also shown in Table 5 and on Figure 4. The high and low estimates are based on either specific uncertainties associated with the technologies involved or on a percentage of the best judgment cost. The most significant uncertainties that affect the costs for each option are listed below.

In Situ Hot Air Treatment

- The presence of utilities and subsurface debris may affect the performance of this process and should be verified.
- Off gas treatment by carbon absorption will be necessary. Total amount used will vary depending on VOC levels in the soil.

Conventional Excavation and Disposal

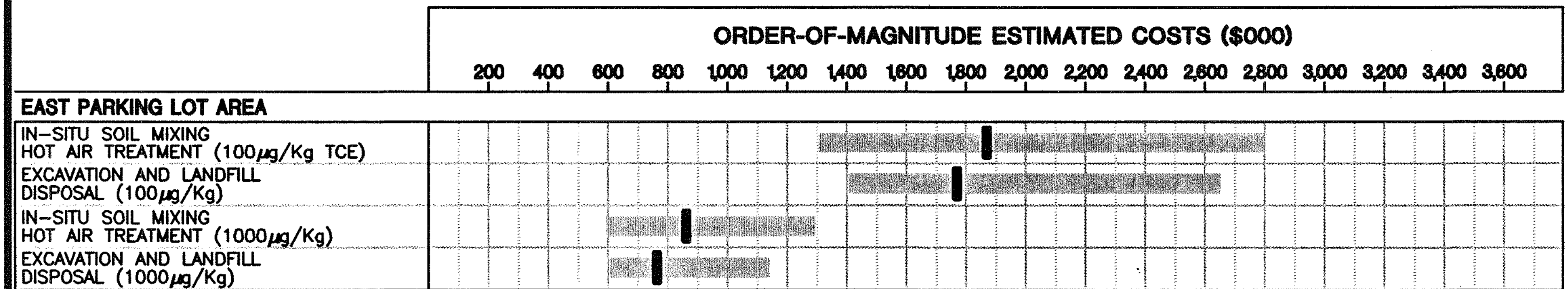
- The presence of subsurface utilities will affect this treatment option and their exact location should be verified.
- Based on the results of limited preliminary testing, it is assumed the excavated material will be classified as a nonhazardous material. If post-excavation testing shows that a portion of the material must be classified as characteristically hazardous, hauling and disposal costs will increase significantly.

Table 5
Summary of Estimated Costs and Uncertainties
Tecumseh Grafton Facility
East Parking Lot Area

REMEDIAL OPTION	COST ESTIMATES			UNCERTAINTIES
	LOW	BEST JUDGMENT	HIGH	
In situ soil mixing with hot air treatment using MITU	$600K	$860K	$1,290K	■ Post-treatment soil compaction ■ Presence of utilities and subsurface debris
Excavation and off-site landfill disposal as nonhazardous (special waste)	$605K	$760K	$1,130K[2]	■ Soil disposal requirements (hazardous/nonhazardous) ■ Presence of utilities

Notes:
1. Appendix A provides cost assumptions and details.
2. High cost estimate is based on nonhazardous (special waste) unit rate for hauling and disposal. If a portion of the soil is characteristically hazardous, the estimated cost will increase significantly.

RMT COMPUTER AIDED DESIGN & DRAFTING



LEGEND

RANGE OF ESTIMATED COSTS

BEST JUDGEMENT ESTIMATE

1. ESTIMATED COSTS INCLUDE TESTING, DESIGN, CONSTRUCTION AND OPERATION AND MAINTENANCE COSTS.

COST ESTIMATES FOR SOURCE AREA REMEDIATION TECUMSEH GRAFTON FACILITY

RMT INC.

DWN. BY:	STORMERL
APPROVED BY:	BWR
DATE:	JUNE 1999
PROJ. #	3084.25
FILE #	30842505.DWG

FIGURE 5

Section 7
Selection of a Remedial Action

This section will recommend a remedial action for the East Parking Lot Area. A rationale will be provided, with additional detail concerning the implementation of the selected remedy.

7.1 Rationale for Selection

The selected remedial action at Tecumseh Products Company in Grafton, Wisconsin, is conventional excavation and off-site disposal of approximately 4,400 cubic yards of TCE and TCA impacted soil from the East Parking Lot Area. The excavated soil will be classified as a special waste, and the material will be managed and disposed as such at a Subtitle D licensed facility. Should a portion of the waste contain TCE concentrations high enough to be classified as a characteristically hazardous waste, that portion of the waste will be managed appropriately.

This solution provides a very high level of effectiveness at a reasonable cost for the vast majority (about 90 percent) of the solvent residuals in the East Parking Lot Area. Excavation of the impacted soil is preferred over *in situ* soil mixing with hot air treatment, because it is more economical and because post-treatment soil compaction problems can be more effectively addressed. The East Parking Lot Area is a critical shipping and receiving area at Tecumseh Products, so the ability to achieve adequate soil compaction for heavy traffic in a short period of time is a major consideration. With the exception of two identified underground utility lines, there is no significant obstruction to excavation at the location. An excavation sequencing plan has been designed so that sections of the shipping and receiving area will remain operational throughout construction.

7.2 Implementation Schedule

The proposed schedule for implementing this remedial action is as follows:

■ Submit Remedial Action Options and Design Report to the WDNR	June 1999
■ Preparation of Final Construction Plans and Specifications	3 weeks after report is submitted to the WDNR
■ Bidding Period and Initiation of Activities	1 month after completion of plans and specifications

- Completion of Remedial Action (excavation, disposal, and backfilling) | 1 month after start of construction activities

7.3 Cost

The cost estimate for this alternative, including direct and indirect capital costs associated with excavation and disposal of the material in a Subtitle D facility, and monitoring costs, is $780,000.

7.4 Time Frame for Compliance with Applicable Standards

The applicable standards for this remediation will be the target cleanup concentrations developed in Section 4. These levels will be achieved at the time excavation is complete. According to the schedule described above, this will be accomplished by October 1, 1999. The parking lot will be paved after the remedial action is complete.

7.5 Performance Measurement

As described above, the performance of the selected remedy will be measured by the attainment of the cleanup concentrations. As the soils are excavated, samples will be screened in the field with a gas chromatograph mounted in a mobile laboratory to determine the extent of affected soil and hence the limits of excavation. The analytical methodologies used in the mobile laboratory will be consistent with those specified in EPA Method 8260. Samples will be collected along the excavated sidewalls at depths of about 4 and 8 feet below ground surface, and along a horizontal spacing of every 25 feet.

The goal of this excavation project is to remove the TCA and TCE hot spots from the northern and southern portions of the East Parking Lot Area. There is no specific regulation that defines the boundaries of the necessary excavation area. Instead, the goal concentrations of 10 mg/kg for TCA and 1 mg/kg for TCE were defined using an optimization curve for the volume of soil excavated versus the mass of contaminants removed, based on an analysis of risk. The goal concentrations are therefore approximate by nature. For this reason, soil sampling results obtained by the mobile laboratory will be sufficient to define the limits of excavation. The goal is to obtain the applicable concentration of TCE or TCA averaged in soil samples collected along an excavation sidewall, within a 95 percent confidence interval. As shown during the Subsurface Investigation (RMT, 1997), a graphical comparison of the laboratory and field gas chromatography results for TCE and TCA in soil indicated a good linear correlation between the two methods ($r^2 = 0.77$ and 0.83, respectively) (Appendix C, Figures 8 and 9). The mobile laboratory chosen for this work will also be required to develop a correlation of their field instrument to verify these results.

Section 8
Remedial Design

This section will discuss the design of the selected remedial action to be implemented for the East Parking Lot Area at Tecumseh Products Company in Grafton, WI.

8.1 Description of Remedial Action

The remedial action will consist of the excavation and off-site disposal of approximately 4,400 cubic yards of VOC-contaminated soil in the unsaturated zone at the East Parking Lot Area, and the subsequent backfilling of the excavated areas with clean soil.

8.1.1 Excavation

As mentioned in Subsection 7.1, excavation of the impacted material is the preferred method of remediation because it is the most cost-effective and implementable alternative given the conditions at the site. Another factor in the selection of this alternative was the ability to quickly and thoroughly compact the backfill to allow continuous use of the area as a shipping and receiving area for the plant.

Lateral or horizontal excavation limits will be based on goal concentrations of 1 mg/kg TCE and 10 mg/kg TCA. As described previously, the East Parking Lot Area has been divided into two areas, the northern and the southern. In the northern area, there are two hot spots targeted for remediation: a TCA hot spot, with dimensions of approximately 25 feet by 30 feet, where TCA concentrations exceed 10 mg/kg; and a TCE hot spot, with approximate dimensions of 60 feet by 120 feet, where TCE concentrations exceed 1 mg/kg. In the southern area, there is one TCE hot spot with approximate dimensions of 35 feet by 45 feet, where TCE concentrations exceed 1 mg/kg. In both the northern and southern areas, the entire clay layer will be excavated to the depth of the underlying sand layer or to the water table, whichever is shallower. The top of this sand layer is approximately coincident with the top of the water table in these areas. In the northern area, the depth of excavation will be approximately 10-foot bgs, while the depth of excavation in the southern area will be approximately 12-foot bgs. Based on preliminary sampling, the total estimated volume of soil excavation is 4,400 cubic yards.

The subsurface utilities that will interfere with excavation include a sanitary sewer to the east of the parking lot, and a fire protection water line to the west. A 10-foot clearance will be maintained from the sanitary sewer line. Similarly, in the area of the water line, the contractor will excavate as close as possible to the line without disturbing the structural stability of the soil around the line.

Excavation will be performed using standard earthmoving equipment, such as tracked excavators or backhoes. The excavation activities will be sequenced to allow continuous operation of the shipping and receiving area. Figure 4 provides a layout of the excavation sequencing plan. The four areas will be excavated sequentially to provide continued access of the parking lot for loading and unloading purposes. Each area is sized to provide access to the bottom of the excavation for backfilling purposes. The limits of construction are approximate; the actual limits will be clearly marked with traffic barricades and flagging, or surrounded with orange construction fence during construction.

8.1.2 Backfill

General fill material will be used to backfill and restore the excavated areas to the top of the pre-excavation clay layer grades. Compaction of the backfill will be performed in 1-foot maximum lifts, to ensure adequate stability for the heavy traffic flow of the East Parking Lot Area. Base coarse material, similar to the gravel layer presently in place, will be added on top of the general fill to restore the excavated area to pre-excavation grades and to allow driving on the area until asphalt paving is completed.

8.2 Construction Procedures

Construction is to progress under the principals and practices described below.

8.2.1 Site Preparation and Approvals

The work locations will be prepared by bringing in necessary equipment and temporary job trailers. The location is already a restricted-use area, so further limits to public access will not be necessary. Local permits and approvals will be obtained by the contractor before commencing work, as necessary. Utilities will be properly located prior to commencing construction activities.

8.2.2 Excavation

Standard excavation equipment and practices will be used for the removal of the contaminated soil at the East Parking Lot Area. The base of the excavation will be to the water table or the base of the clay layer, whichever is shallower (approximately 10 to 12 feet below existing grade). The base will be maintained at a minimum grade of 0.5 percent to promote positive drainage of incidental infiltration water. Excavation will be completed in a sequence of four (4) areas, to allow for continued traffic through the area. While under construction, each area, including the limits of construction, will be fenced with temporary structures at all times for safety purposes. Contaminated soil will be transported to a permitted landfill facility via licensed haulers.

8.2.3 Confirmation Sampling

As the excavation proceeds, soil samples will be collected for chemical analysis to confirm that the cleanup concentrations have been met. Samples will be collected at 25-foot intervals along the sidewalls at depths of about 4 and 8 feet below ground surface. Soil samples will be analyzed for TCE and TCA using a mobile laboratory equipped with a gas chromatograph. As described previously, because the remedial action is meant to remove hot spots only, there is no specific regulation that defines the boundary. Therefore, the mobile laboratory data will be used as final data. Sample results along each sidewall will be averaged and compared to the cleanup concentrations for TCE (1 mg/kg) or TCA (10 mg/kg).

8.2.4 Backfill

The excavated area will be backfilled to within 6 inches of the pre-construction conditions through the use of a general fill material at the East Parking Lot. Soil will be placed and compacted in 1-foot lifts to minimize settlement. A 6- to 8-inch layer of base coarse material will then be placed over the disturbed area.

8.2.5 Construction Documentation

The construction at the East Parking Lot Area will be performed by qualified, licensed contractors with experience in remedial projects of this type. This work will be observed by staff under the direction of a professional engineer. Daily documentation reports will be maintained at the jobsite. Quantities will be documented via hand measurements and load tickets.

At the completion of the remedial action, a construction documentation report will be submitted to the WDNR. The report will contain descriptive and photographic documentation. Drawings will be used to illustrate the final horizontal and vertical extent of removal. The report will be submitted within 60 days after the completion of construction.

Section 9
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APPENDIX A

Appendix A
Soil Boring Logs

RMT Field Soil Boring Log Information

RMT Project No: 3084.23

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Project Name: Tecumseh	Start Date: 8/31/98	End Date: 8/31/98	Boring Number: SB-18-TCA
Boring Drilled By: GMS, Dan Bendorf	Drilling Method: Geoprobe, 48" Macro-Sampler		

Drill Rig: Geoprobe	Common Well Name:	Initial Water Level:	Surface Elevation:	Borehole Diameter: 2 Inches

Boring Location: State Plane, Easting, Northing

SW 1/4 of SE 1/4 of Section 13 T 10 N,R 21E

Local Grid Location (If applicable): ☐ N ☐ S Feet; ☐ E ☐ W Feet

County: Ozaukee	State: WI	DNR County Code:	Civil Town/City/ or Village: Grafton	

	Number	Length (In) Recovered	Blow Counts	Depth In Feet	Group Name, Percent & Range of Particle Sizes, Plasticity, Color, Odor, Moisture, Density/Consistency, Additional Comments, Geologic Origin (Stratigraphic Unit)	Sample Type	PID/FID	Standard Penetration	Well Diagram	RQD/ Comments
VOCs, TOC, BD 1-2 11:10 a	1	40		2	0-1' Sand & Gravel Fill 1-4' Lean clay w/ gravel, reddish brown 10YR moist, plastic	CL				
VOCs 4-6 11:15 a	2	36		4 6	As above 6-8' Elastic Silt, yellow brown 10YR, sl plastic, moist	CL				
VOCs 8-10 11:20 a	3			8 10 12	Silt grades to lean clay (CL), tr. gravel, gray 10YR 5/1, no odor dry Silt @ 11.5', trace sand, moist, gray 10YR 5/1, no odor	CL				

Logged By: Rob Hafemeister (JAB)

Checked By: J Berg

F-204B (R 12-94)

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RMT Field Soil Boring Log Information

RMT Project No: 3084.23

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Project Name	Start Date	End Date	Boring Number
Tecumseh	8/31/98	8/31/98	SB-19-TCA

Boring Drilled By	Drilling Method
GMS, Dan Bendorf	Geoprobe

Drill Rig	Common Well Name	Initial Water Level	Surface Elevation	Borehole Diameter
Geoprobe				2 Inches

Boring Location
State Plane Easting Northing

SW 1/4 of SE 1/4 of Section 13 T 10 N,R 21 E

Local Grid Location (If applicable)
☐ N ☐ E
Feet ☐ S Feet ☐ W

County	State	DNR County Code	Civil Town/City/ or Village
Ozaukee	WI		Grafton

	Number	Length (In) Recovered	Blow Counts	Depth In Feet	Group Name, Percent & Range of Particle Sizes, Plasticity, Color, Odor, Moisture, Density/Consistency, Additional Comments, Geologic Origin (Stratigraphic Unit)	Sample Type	PID/FID	Standard Penetration	Well Diagram	RQD/ Comments
1-2' @ VOCs 10:30	1	29		2	0-1' Sand + Gravel, Fill 1'-4' Lean Clay (CL) tr. gravel, plastic, red brown no odor	CL				
4-6' @ VOCs 10:35	2	47		4, 6, 7	As above					
				8	poorly graded Sand, fine grained, moist	SP				
8-10' @ VOCs 10:40	3	42		9, 10	Lean Clay, gray 10YR 5/1, dry, no odor	CL				
				12	EOB @ 12'					

Logged By: Rob Hofmeister

Checked By: James O. Buss

F-204B (R 12-94)

RMT Field Soil Boring Log Information

RMT Project No: 3084.23

Project Name	Start Date	End Date	Boring Number
Tecumseh	8/31/98	8/31/98	SB20TCA

Boring Drilled By	Drilling Method
GMS, Dan Bendorf	Geoprobe, 48" Sampler

Drill Rig	Common Well Name	Initial Water Level	Surface Elevation	Borehole Diameter
Geoprobe				2 Inches

Boring Location: State Plane — Easting — Northing

SW 1/4 of SE 1/4 of Section 13 T 10 N, R 21E

Local Grid Location (If applicable): ☐ N ☐ S Feet; ☐ E ☐ W Feet

County	State	DNR County Code	Civil Town/City/or Village
Ozaukee	WI		Grafton

Number	Length (In) Recovered	Blow Counts	Depth In Feet	Group Name, Percent & Range of Particle Sizes, Plasticity, Color, Odor, Moisture, Density/Consistency, Additional Comments, Geologic Origin (Stratigraphic Unit)	Sample Type	PID/FID	Standard Penetration	Well Diagram	RQD/Comments
VOCS TOC/TIC BD @ 12:30 1			2	0-1' Sand & gravel, (Fill) Lean Clay, yellow brown 10YR, Plastic, dry no odor	CL				
VOC's 12:35 @ 4-6 2			4, 6	Organic Soil (clay) sl. plastic, grass roots, black 10YR2/1, no odor dry	CL/OL				
VOCS TOC/TIC 12:40 BD 8-12 3A @			8, 10, 12						
				EOB @ 12'					

Logged By: Rob Hafmeister

Checked By: James A. Buss

F-204B (R 12-94)

RMT Field Soil Boring Log Information

RMT Project No: 3084.23

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Project Name	Start Date	End Date	Boring Number
Tecumseh	8/31/98	8/31/98	SB21TCA

Boring Drilled By	Drilling Method
GMS	Geoprobe

Drill Rig	Common Well Name	Initial Water Level	Surface Elevation	Borehole Diameter
Geoprobe				2 Inches

Boring Location
State Plane Easting Northing
SW 1/4 of SE 1/4 of Section ~~8~~ T 10 N,R 21E

Local Grid Location (If applicable)
☐ N ☐ E
Feet ☐ S Feet ☐ W

County	State	DNR County Code	Civil Town/City/ or Village
Ozaukee	WI		Grafton

Number	Length (In) Recovered	Blow Counts	Depth In Feet	Group Name, Percent & Range of Particle Sizes, Plasticity, Color, Odor, Moisture, Density/Consistency, Additional Comments, Geologic Origin (Stratigraphic Unit)	Sample Type	PID/FID	Standard Penetration	Well Diagram	RQD/ Comments
VOCs 1-2 1:45 pm 1	48		2 4	0-1' Sand & Gravel Fill 1-4' Lean Clay, with sand olive gray 10YR no odor, moist. color to marbled gray & reddish brown 4" Sand Seam @ 3.5'	CL				
VOCs 4-6 1:50 pm 2	48		6 8	Lean Clay, yellow brown & reddish brown as above. 2" Sand Seam @ 5'	CL				
VOCs 8-10 1:55 pm 3	48		10 12	poorly graded sand w/ gravel, yellow brown 10YR no odor, wet. 11-12 Lean Clay, red-brown, plastic, no odor wet.	SP CL				
				EOB @ 12'					

Logged By: Hafemeister

Checked By: James A. Buso

F-204B (R 12-94)

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RMT Field Soil Boring Log Information

RMT Project No: 3084.23

Project Name	Start Date	End Date	Boring Number
Tecumseh	9/1/98	9/1/98	SB22TCA

Boring Drilled By	Drilling Method
GMS: Dan Bendorf	48" Macro-Core

Drill Rig	Common Well Name	Initial Water Level	Surface Elevation	Borehole Diameter
Geoprobe				2 Inches

Boring Location
State Plane Easting Northing
SW 1/4 of SE 1/4 of Section 13 T 10 N,R 21E

Local Grid Location (If applicable)
☐ N ☐ E
Feet ☐ S Feet ☐ W

County	State	DNR County Code	Civil Town/City/ or Village
Ozaukee	WI		Grafton

	Number	Length (In) Recovered	Blow Counts	Depth In Feet	Group Name, Percent & Range of Particle Sizes, Plasticity, Color, Odor, Moisture, Density/Consistency, Additional Comments, Geologic Origin (Stratigraphic Unit)	Sample Type	PID/FID	Standard Penetration	Well Diagram	RQD/ Comments
VOCs 1-2 8:30am	1	40		2	0'-1' Sand + Gravel 1'-2' Silty Sand, gray, no odor 2'-4' Lean clay w/ sand (CL), red/brown, no odor, dry	CL				
VOCs 4-6 8:35am	2	46		4 6	As above, tr. sand & gravel, dry, no odor	CL				
VOCs 8-10 8:40am	3	48		8 10 12	Lean Clay (CL) as above, no odor 3" sand seam @ end of Sampler	CL				
					EOB @ 12'					

Logged By: Hafemeister

Checked By: James A. Buss

F-204B (R 12-94)

RMT Field Soil Boring Log Information

RMT Project No: 3084.23

Page 1 of 1

Project Name	Start Date	End Date	Boring Number
Tecumseh	8/31/98		SB-23-TCA

Boring Drilled By	Drilling Method
GMS Dan Bendorf	Geoprobe - Macro-core

Drill Rig	Common Well Name	Initial Water Level	Surface Elevation	Borehole Diameter
Geoprobe				2 Inches

Boring Location
State Plane Easting Northing
SW 1/4 of SE 1/4 of Section 13 T 10 N,R 21E

Local Grid Location (If applicable)
☐ N ☐ E
Feet ☐ S Feet ☐ W

County	State	DNR County Code	Civil Town/City/ or Village
Ozaukee	WI		

Number	Length (In) Recovered	Blow Counts	Depth In Feet	Group Name, Percent & Range of Particle Sizes, Plasticity, Color, Odor, Moisture, Density/Consistency, Additional Comments, Geologic Origin (Stratigraphic Unit)	Sample Type	PID/FID	Standard Penetration	Well Diagram	RQD/ Comments
1-2' @ 9:10 VOCs 1	16"	—	2	well graded ~~gravelly sand, GW~~ sand with gravel, ~~no~~ pale yellow no odor, dry.	GP				
4-6' @ VOCs @ 9:15 2			4, 6, 8	4.0 Lean clay (CL), plastic, red/brown 10YR no odor, dry 1" gravel seam @ 7'	~~GP~~ CL				
8-10' @ 9:20 3			8, 10, 12	10.5' poorly graded sand, tr. gravel (SP), ~~pale~~ red/brown 10YR, dry, no odor	GP				

EOB @ 12

Logged By: Hafemeister

Checked By: James A. Buss

F-204B (R 12-94)

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RMT Field Soil Boring Log Information

RMT Project No: 3084.23

Project Name	Start Date	End Date	Boring Number
Tecumseh	8/31/98	8/31/98	SB24TCA

Boring Drilled By: GMS, Dan Bendorf

Drilling Method: Geoprobe - 48" Macrocore

Drill Rig	Common Well Name	Initial Water Level	Surface Elevation	Borehole Diameter
Geoprobe				2 Inches

Boring Location State Plane Easting Northing

SW 1/4 of SE 1/4 of Section 13 T 10 N,R 21E

Local Grid Location (If applicable) ☐ N Feet ☐ S ☐ E Feet ☐ W

County	State	DNR County Code	Civil Town/City/or Village
Ozaukee	WI		Grafton

Number	Length (In) Recovered	Blow Counts	Depth In Feet	Group Name, Percent & Range of Particle Sizes, Plasticity, Color, Odor, Moisture, Density/Consistency, Additional Comments, Geologic Origin (Stratigraphic Unit)	Sample Type	PID/FID	Standard Penetration	Well Diagram	RQD/ Comments
VOCs 1-2 2:25 1	46"		2	0-1' Sand & Gravel fill 1-4' poorly graded sand (SP) trace gravel, fine grained, red/brown, moist no odor	SP				
VOCs 4-6 2:30 2	24"		4 6	Sand as above	SP				
VOCs 8-10 2:35 3			8 10	As above but with silt, trace clay, trace gravel, wet, no odor	SM				
			12 14						

Logged By: Hafemeister

Checked By: James A. Rosso

F-2048 (R 12-94)

RMT Field Soil Boring Log Information

RMT Project No: 3084.23

Page 1 of 1

Project Name	Start Date	End Date	Boring Number
Tecumseh	8/31/98	8/31/98	SB25TCA

Boring Drilled By	Drilling Method
GMS, Dan Bendorf	Geoprobe 48" Macro Sampler

Drill Rig	Common Well Name	Initial Water Level	Surface Elevation	Borehole Diameter
Geoprobe				2 Inches

Boring Location — State Plane: Easting ___ Northing ___

SW 1/4 of SE 1/4 of Section 13 T 10 N,R 21E

Local Grid Location (If applicable): Feet ☐ N ☐ S; Feet ☐ E ☐ W

County	State	DNR County Code	Civil Town/City/ or Village
Ozaukee	WI		Grafton

	Number	Length (In) Recovered	Blow Counts	Depth In Feet	Group Name, Percent & Range of Particle Sizes, Plasticity, Color, Odor, Moisture, Density/Consistency, Additional Comments, Geologic Origin (Stratigraphic Unit)	Sample Type	PID/FID	Standard Penetration	Well Diagram	RQD/ Comments
VOC's 1-2 3pm	1			2	0'-1' Sand & Gravel Fill Lean Clay, tr. sand, Plastic, Black 10YR moist	CL				
VOC's 4-6 3:05 pm	2			4 6	Lean clay as above, color to red-brown, moist. no odor	CL				
VOC's 8-10 3:10 pm	3			8 10	As above, with silt. 3" sand seam @ 10'	CL				
				12						

Logged By: R. Hafemeister

Checked By: James A. Buss

F-2048 (R 12-94)

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RMT Field Soil Boring Log Information

RMT Project No: 3084.23

Project Name	Start Date	End Date	Boring Number
Tecumseh	8/31/98	8/31/98	SB26TCA

Boring Drilled By	Drilling Method
~~Geoprobe~~ GMS, Dan Bendorf	Geoprobe 48" Macro Sampler

Drill Rig	Common Well Name	Initial Water Level	Surface Elevation	Borehole Diameter
Geoprobe				2 Inches

Boring Location: State Plane — Easting / Northing

SW 1/4 of SE 1/4 of Section 13 T 10 N,R 21E

Local Grid Location (If applicable): ☐ N ☐ S Feet; ☐ E ☐ W Feet

County	State	DNR County Code	Civil Town/City/ or Village
Ozaukee	WI		Grafton

	Number	Length (In) Recovered	Blow Counts	Depth In Feet	Group Name, Percent & Range of Particle Sizes, Plasticity, Color, Odor, Moisture, Density/Consistency, Additional Comments, Geologic Origin (Stratigraphic Unit)	Sample Type	PID/FID	Standard Penetration	Well Diagram	RQD/ Comments
VOC's 1-2 4:35	1	46		2	0-1' Sand & Gravel (Fill) Lean Clay, black, no odor 4" Sand @ 3' Clay, gray, no odor	CL				
VOC's 4-6 4:40 pm	2	46		4, 6	Lean clay, red/brown, moist, no odor	CL				
VOC's 8-10 4:45 pm	3			8, 10	As above, color to gray, no odor	CL				
				12, 14	EOB @ 12'.					

Logged By: R. Hafemeister

Checked By: James A. Buso

F-204B (R 12-94)

RMT Field Soil Boring Log Information

RMT Project No: 3084.23

Project Name	Start Date	End Date	Boring Number
Tecumseh	9/1/98	9/1/98	SB27TCA

Boring Drilled By	Drilling Method
GMS : Dan Bendorf	48" Macro Core

Drill Rig	Common Well Name	Initial Water Level	Surface Elevation	Borehole Diameter
Geoprobe				2 Inches

Boring Location: State Plane — Easting, Northing
SW 1/4 of SE 1/4 of Section 13 T 10 N,R 21 E

Local Grid Location (If applicable): ☐ N ☐ S Feet; ☐ E ☐ W Feet

County	State	DNR County Code	Civil Town/City/or Village
Ozaukee	WI		Grafton

	Number	Length (In) Recovered	Blow Counts	Depth In Feet	Group Name, Percent & Range of Particle Sizes, Plasticity, Color, Odor, Moisture, Density/Consistency, Additional Comments, Geologic Origin (Stratigraphic Unit)	Sample Type	PID/FID	Standard Penetration	Well Diagram	RQD/ Comments
VOCs 1-2' 7:55a	1	46		2	0-1' Sand+Gravel (Fill); 1-2' Silty Sand, no odor, gry 10YR5/1; 2-4' Lean Clay (CL), plastic, tr. gravel, tr. sand, red/brown, no odor	SM, CL				
VOCs 8:00a 4-6	2	36		4, 6	As above, no odor; 1" wet Sand Seam @ ≈5'	CL				
VOCs 8:05a 8-10	3			8, 10, 12	As above, but color to gray @ 10'	CL				

Logged By: R. Hafemeister

Checked By: James A. Buss

F-204B (R 12-94)

RMT Field Soil Boring Log Information

RMT Project No: 3084.23

Page 1 of 1

Project Name	Start Date	End Date	Boring Number
Tecumseh	8/31/98	8/31/98	SB287CA

Boring Drilled By	Drilling Method
GMS, Dan Bendorf	48" Macro Sampler

Drill Rig	Common Well Name	Initial Water Level	Surface Elevation	Borehole Diameter
Geoprobe				2 Inches

Boring Location
State Plane Easting Northing
SW 1/4 of SE 1/4 of Section 13 T 10 N,R 21 E

Local Grid Location (If applicable)
Feet ☐ N ☐ S Feet ☐ E ☐ W

County	State	DNR County Code	Civil Town/City/ or Village
Ozaukee	WI		Grafton

	Number	Length (In) Recovered	Blow Counts	Depth In Feet	Group Name, Percent & Range of Particle Sizes, Plasticity, Color, Odor, Moisture, Density/Consistency, Additional Comments, Geologic Origin (Stratigraphic Unit)	Sample Type	PID/FID	Standard Penetration	Well Diagram	RQD/ Comments
VOC's 1-2' 3:50 pm	1			2	0-1' Sand & Gravel (Fill) Lean clay, black to red/brown at 3'.	CL				
VOC's 4-6 3:55 pm	2			4 6	Lean clay as above, no odor	CL				
4pm	3			8 10	Lean clay as above color to gray	CL				
				12	EOB @ 12'					

Logged By: R. Hafemeister

Checked By: James A. Buse

F-2048 (R 12-94)

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RMT Field Soil Boring Log Information

RMT Project No: 3084.29 — Page 1 of 1

Project Name	Start Date	End Date	Boring Number
Tecumseh	8/31/98	8/31/98	SB26TCA

Boring Drilled By	Drilling Method
GMS Dan Bendorf	48" Macro Sampler

Drill Rig	Common Well Name	Initial Water Level	Surface Elevation	Borehole Diameter
Geoprobe				2 Inches

Boring Location — State Plane: Easting / Northing

SW 1/4 of SE 1/4 of Section 13 T 10 N,R 21E

Local Grid Location (If applicable): ☐ N ☐ S Feet; ☐ E ☐ W Feet

County	State	DNR County Code	Civil Town/City/or Village
Ozaukee	WI		Grafton

Number	Length (In) Recovered	Blow Counts	Depth In Feet	Group Name, Percent & Range of Particle Sizes, Plasticity, Color, Odor, Moisture, Density/Consistency, Additional Comments, Geologic Origin (Stratigraphic Unit)	Sample Type	PID/FID	Standard Penetration	Well Diagram	RQD/ Comments
VOCs 1-2 @ 5:00 pm 1			0–2	0-1' Sand & Gravel (Fill) Lean clay tr. gravel, black, no odor	CL				
VOCs 4-6 5:05pm 2			4–6	Clay as above but color to red/brown, no odor	CL				
VOCs @ 5:10 8-10 3			8–12	As above 3" sand seam, wet @ 11.8-12'	CL				
			12	EOB @ 12'					

Logged By: R. Hafemeister

Checked By: James A. Buss

F-204B (R 12-94)

RMT Field Soil Boring Log Information

RMT Project No: 3084.23

Page 1 of 1

Project Name	Start Date	End Date	Boring Number
Tecumseh	9/1/98	9/1/98	SB30TCA

Boring Drilled By	Drilling Method
GMS: Dan Bendorf	48" Macro-Core

Drill Rig	Common Well Name	Initial Water Level	Surface Elevation	Borehole Diameter
Geoprobe				2 Inches

Boring Location
State Plane Easting Northing
SW 1/4 of SE 1/4 of Section 13 T 10 N,R 21E

Local Grid Location (If applicable)
☐ N ☐ E
Feet ☐ S Feet ☐ W

County	State	DNR County Code	Civil Town/City/ or Village
Ozaukee	WI.		Grafton

Number	Length (In) Recovered	Blow Counts	Depth In Feet	Group Name, Percent & Range of Particle Sizes, Plasticity, Color, Odor, Moisture, Density/Consistency, Additional Comments, Geologic Origin (Stratigraphic Unit)	Sample Type	PID/FID	Standard Penetration	Well Diagram	RQD/ Comments
~~VOCs~~ ~~TOC/MC~~ ~~BD~~ 12:50 pm 1	48		2	0'-1' Sand & Gravel (Fill) no odor Lean Clay, (CL) red/brown, no odor	CL				
Composite 1:00 pm 2	48"		4 6	Lean Clay, as above, no odor.	CL				
~~TOC/MC~~ ~~BD~~ 1:00 3 pm 3	48"		8 10 12	Clay as above, color to gray, no odor	CL				

Logged By:	Checked By:
Hafemeister	James A. Burr

F-204B (R 12-94)

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RMT Field Soil Boring Log Information

RMT Project No: 3084.23

Project Name	Start Date	End Date	Boring Number
Tecumseh	9/1/98	9/1/98	SB31TCA

Boring Drilled By	Drilling Method
GMS: Dan Bendorf	48" Macro-Core

Drill Rig	Common Well Name	Initial Water Level	Surface Elevation	Borehole Diameter
Geoprobe				2 Inches

Boring Location State Plane Easting Northing
SW 1/4 of SE 1/4 of Section 13 T 10 N,R 21 E

Local Grid Location (If applicable) ☐ N ☐ E Feet ☐ S Feet ☐ W

County	State	DNR County Code	Civil Town/City/ or Village
Ozaukee	WI.		Grafton

Number	Length (In) Recovered	Blow Counts	Depth In Feet	Group Name, Percent & Range of Particle Sizes, Plasticity, Color, Odor, Moisture, Density/Consistency, Additional Comments, Geologic Origin (Stratigraphic Unit)	Sample Type	PID/FID	Standard Penetration	Well Diagram	RQD/ Comments
1	46"		2, 4	0'-2', sand & Gravel (Fill), 1' sand @ 2', no odor, Lean Clay, 3'-4', no odor	SP, CL				
2	46"		6, 8	Clay as above, red/brown, no odor, plastic	CL				
			10	EOB @ 8'					
~~3~~			12	~~EOB @ 12'~~					

VOC's 1:50 pm composite

Logged By: R. Hafemeister

Checked By: James A. Buss

F-204B (R 12-94)

RMT Field Soil Boring Log Information

RMT Project No: 3084.23 Page 1 of 1

Project Name	Start Date	End Date	Boring Number
Tecumseh	9/1/98	9/1/98	SB32TCA

Boring Drilled By	Drilling Method
GMS: Dan Bendorf	48" Macro-Core

Drill Rig	Common Well Name	Initial Water Level	Surface Elevation	Borehole Diameter
Geoprobe				2 Inches

Boring Location
State Plane Easting Northing
SW 1/4 of SE 1/4 of Section 13 T 10 N,R 21E

Local Grid Location (If applicable) ☐ N ☐ E Feet ☐ S Feet ☐ W

County	State	DNR County Code	Civil Town/City/ or Village
Ozaukee	WI.		Grafton

Number	Length (In) Recovered	Blow Counts	Depth In Feet	Group Name, Percent & Range of Particle Sizes, Plasticity, Color, Odor, Moisture, Density/Consistency, Additional Comments, Geologic Origin (Stratigraphic Unit)	Sample Type	PID/FID	Standard Penetration	Well Diagram	RQD/ Comments
~~VOCs TCL/HAC BD~~ 1 2:15pm			2	0'-1' Sand & Gravel (Fill Lean Clay (CL), red/brown, plastic, dry, no odor [redacted] tr. gravel, tr. sand	CL				
~~Composite~~ 2:30 2			4 6	As above, no odor, dry, sweet odor	CL				
~~TCL/HAC BD~~ 2:35 3pm 3			8 10		CL				
			12	EOB @ 12'.					

Logged By: R. Hafemeister

Checked By: James A. [illegible]

F-204B (R 12-94)

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RMT Field Soil Boring Log Information

RMT Project No: 3084,27

Project Name	Start Date	End Date	Boring Number
Tecumseh	9/1/98	9/1/98	SB33TCA

Boring Drilled By	Drilling Method
GMS: Dan Bendorf	48" Macro Core-Sampler

Drill Rig	Common Well Name	Initial Water Level	Surface Elevation	Borehole Diameter
Geoprobe				2 Inches

Boring Location: State Plane — Easting — Northing
SW 1/4 of SE 1/4 of Section 13 T 10 N,R 21E

Local Grid Location (If applicable): ☐ N ☐ S Feet; ☐ E ☐ W Feet

County	State	DNR County Code	Civil Town/City/ or Village
Ozaukee	WI		Grafton

	Number	Length (In) Recovered	Blow Counts	Depth In Feet	Group Name, Percent & Range of Particle Sizes, Plasticity, Color, Odor, Moisture, Density/Consistency, Additional Comments, Geologic Origin (Stratigraphic Unit)	Sample Type	PID/FID	Standard Penetration	Well Diagram	RQD/ Comments
VOCs 3:05 pm	1	46		2	0-1' Sand & Gravel (fill), Lean Clay (CL) black to red/brown plastic, dry, no odor	CL				
Discrete & composite 3:10 pm	2	46		4, 6	As above, no odor	CL				
				8	EOB @ 8'					

Logged By: R. Hafemeister

Checked By: James A. Buss

F-2048 (R 12-94)

RMT Field Soil Boring Log Information

RMT Project No: 3084.23

Project Name	Start Date	End Date	Boring Number
Tecumseh	9/1/98	9/1/98	SB34TCA

Boring Drilled By	Drilling Method
GMS: Dan Bendorf	48" Macro-Core

Drill Rig	Common Well Name	Initial Water Level	Surface Elevation	Borehole Diameter
Geoprobe				2 Inches

Boring Location
State Plane Easting Northing
SW 1/4 of SE 1/4 of Section 13 T 10 N,R 21E

Local Grid Location (If applicable) ☐ N ☐ S Feet ☐ E ☐ W Feet

County	State	DNR County Code	Civil Town/City/or Village
Ozaukee	WI		Grafton

Number	Length (In) Recovered	Blow Counts	Depth In Feet	Group Name, Percent & Range of Particle Sizes, Plasticity, Color, Odor, Moisture, Density/Consistency, Additional Comments, Geologic Origin (Stratigraphic Unit)	Sample Type	PID/FID	Standard Penetration	Well Diagram	RQD/ Comments
VOCs 1-2 11:15 am 1	48		2	0'-1' Sand & Gravel (Fill) slight (sweet) solvent-like odor Lean Clay, solvent-like odor, black to red/brown, dry tr. sand, tr. gravel (Sweet odor)	CL				
			4	EOB @ 4'					

Logged By: R. Hafemeister

Checked By: James A. Buss

F-204B (R 12-94)

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RMT Field Soil Boring Log Information

RMT Project No: 3084.23

Project Name	Start Date	End Date	Boring Number
Tecumseh	9/1/98	9/1/98	SB35TCA

Boring Drilled By	Drilling Method
GMS: Dan Bendorf	48" Macro-Core Sampler

Drill Rig	Common Well Name	Initial Water Level	Surface Elevation	Borehole Diameter
Geoprobe				2 Inches

Boring Location
State Plane Easting Northing
SW 1/4 of SE 1/4 of Section 13 T 10 N,R 21E

Local Grid Location (If applicable)
☐ N ☐ E
Feet ☐ S Feet ☐ W

County	State	DNR County Code	Civil Town/City/or Village
Ozaukee	WI		Grafton

Number	Length (In) Recovered	Blow Counts	Depth In Feet	Group Name, Percent & Range of Particle Sizes, Plasticity, Color, Odor, Moisture, Density/Consistency, Additional Comments, Geologic Origin (Stratigraphic Unit)	Sample Type	PID/FID	Standard Penetration	Well Diagram	RQD/ Comments
VOC's 11:35 am 1			2	0'-1' Sand+Gravel Fill (Sweet Odor) 1'-4' Lean clay, tr. gravel, tr. sand, gray to red/brown sweet-odor	CL				
			4						
			6	EOB @ 4'					
			8						
			10						
			12						

Logged By: R. Hafemeister

Checked By: James A. Buss

F-204B (R 12-94)

RMT Field Soil Boring Log Information

RMT Project No: 3084.23

Page 1 of 1

Project Name	Start Date	End Date	Boring Number
Tecumseh	9/1/98	9/1/98	SB36TCA

Boring Drilled By	Drilling Method
GMS; Dan Bendorf	48" Macro-Core

Drill Rig	Common Well Name	Initial Water Level	Surface Elevation	Borehole Diameter
Geoprobe				2 Inches

Boring Location
State Plane — Easting — Northing
SW 1/4 of SE 1/4 of Section 13 T 10 N,R 21E

Local Grid Location (If applicable)
☐ N ☐ S Feet — ☐ E ☐ W Feet

County	State	DNR County Code	Civil Town/City/ or Village
Ozaukee	WI.		Grafton

	Number	Length (In) Recovered	Blow Counts	Depth In Feet	Group Name, Percent & Range of Particle Sizes, Plasticity, Color, Odor, Moisture, Density/Consistency, Additional Comments, Geologic Origin (Stratigraphic Unit)	Sample Type	PID/FID	Standard Penetration	Well Diagram	RQD/ Comments
VOC's 1-2 10:20	1	46		0–4	0'-1' Sand + Gravel (Fill), no odor 1'-4' Lean clay w/sand, tr. gravel, plastic, red/brown no odor, dry	CL				
VOC's 4-6 TOC/MC BD 10:25	2	45		4–8	Lean clay as above	CL				
VOC's TOC/MC BD 10:30	3	48		8–12	Lean clay as above, color to gray	CL				
				12	EOB @ 12'.					

Logged By: R. Hafimeister

Checked By: James A. Buss

F-204B (R 12-94)

RMT Field Soil Boring Log Information

RMT Project No: 3084.23

Project Name	Start Date	End Date	Boring Number
Tecumseh	9/1/98	9/1/98	SB37TCA

Boring Drilled By	Drilling Method
GMS: Dan Bendorf	48" Macro-Core

Drill Rig	Common Well Name	Initial Water Level	Surface Elevation	Borehole Diameter
Geoprobe				2 Inches

Boring Location
State Plane Easting Northing
SW 1/4 of SE 1/4 of Section 13 T 10 N,R 21E

Local Grid Location (If applicable)
☐ N ☐ E
Feet ☐ S Feet ☐ W

County	State	DNR County Code	Civil Town/City/ or Village
Ozaukee	WI		Grafton

Number	Length (In) Recovered	Blow Counts	Depth In Feet	Group Name, Percent & Range of Particle Sizes, Plasticity, Color, Odor, Moisture, Density/Consistency, Additional Comments, Geologic Origin (Stratigraphic Unit)	Sample Type	PID/FID	Standard Penetration	Well Diagram	RQD/ Comments
VOCs 9:30 am 1-2 1	46		2	0'-2' Sand & Gravel (Fill)					
				2'-4' Lean Clay (CL), plastic, red/brown no odor dry	CL				
VOCs 9:35 am 4-6 2	44		4 6	As above, no odor, tr. gravel, tr. sand	CL				
VOCs 9:40 am 8-10 3	40		8 10	As above, no odor	CL				
			11 12	Poorly graded sand (SP), gray, wet, no odor					
				EOB@ 12'					

Logged By: R. Hafemeister

Checked By: James A. Buss

F-2048 (R 12-94)

~~RMT~~ Field Soil Boring Log Information

RMT Project No: 3084.23

Page 1 of 1

Project Name	Start Date	End Date	Boring Number
Tecumseh	8/31/98	8/31/98	~~SB-17TCA~~ SB-38TCA

Boring Drilled By	Drilling Method
GMS, Dan Bendorf	48" Macrocore

Drill Rig	Common Well Name	Initial Water Level	Surface Elevation	Borehole Diameter
Geoprobe				2 Inches

Boring Location: State Plane Easting Northing

SW 1/4 of SE 1/4 of Section 13 T 10 N, R 21 E

Local Grid Location (If applicable): ☐ N ☐ S Feet; ☐ E ☐ W Feet

County	State	DNR County Code	Civil Town/City/ or Village
Ozaukee	WI		Grafton

	Number	Length (In) Recovered	Blow Counts	Depth In Feet	Group Name, Percent & Range of Particle Sizes, Plasticity, Color, Odor, Moisture, Density/Consistency, Additional Comments, Geologic Origin (Stratigraphic Unit)	Sample Type	PID/FID	Standard Penetration	Well Diagram	RQD/ Comments
1-2 @ 9:45 VOCs	1			2	well graded sand w/ gravel (Fill) 0-2' 2-4' Lean clay (CL), tr. gravel, Plastic, red brown dry, no odor	CL				
4-6 VOCs @ 9:50	2			4 6	Lean clay, as above, no odor 1" gravel @ 4.5' 6-8 GeoClense Sample	CL				
8-10' ~~6-8~~ @ 9:55 VOCs	3			8 10	As above color to gray e 10'	CL				
				11 12	poorly graded sand, dry (SP), no odor	SP				

EOB @ 12'

Logged By: R. Hafemeister

Checked By: James A. Buss

F-2048 (R 12-94)

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APPENDIX B

CARDINAL
ENVIRONMENTAL

3303 Paine Avenue, Sheboygan, WI 53081
(920)459-2500 Fax: (920)459-2503
www.cardinalenvironmental.com

Kerry De Keyser
Tecumseh Products Company
1604 Michigan Avenue
New Holstein , WI 53061-0000

Batch Number: 981850
Report Date: 9/22/98
Date Received: 9/21/98
Project Mgr: PVE

Parameter	Result	Units	LOD	LOQ	Method	Analyst	Date Analyzed
Cardinal Sample Number: 39537 Date Collected: 8/31/98 Grab; Sample Description: Tecumseh Soil - SB~~17~~38TCA 8'-10'							
1,1,1-Trichloroethane	<25	ug/Kg	6.7	22	SW 8021		9/14/98
Trichloroethene	57	ug/Kg	4.5	15	SW 8021		9/14/98
Cardinal Sample Number: 39538 Date Collected: 8/31/98 Grab; Sample Description: Tecumseh Soil - SB19TCA 1'-2'							
1,1,1-Trichloroethane	<25	ug/Kg	6.7	22	SW 8021		9/14/98
Trichloroethene	<25	ug/Kg	4.5	15	SW 8021		9/14/98
Cardinal Sample Number: 39539 Date Collected: 8/31/98 Grab; Sample Description: Tecumseh Soil - SB19TCA 4'-6'							
1,1,1-Trichloroethane	<25	ug/Kg	6.7	22	SW 8021		9/14/98
Trichloroethene	47	ug/Kg	4.5	15	SW 8021		9/14/98
Cardinal Sample Number: 39540 Date Collected: 8/31/98 Grab; Sample Description: Tecumseh Soil - SB19TCA 8'-10'							
1,1,1-Trichloroethane	90	ug/Kg	6.7	22	SW 8021		9/14/98
Trichloroethene	350	ug/Kg	4.5	15	SW 8021		9/14/98
Cardinal Sample Number: 39541 Date Collected: 8/31/98 Grab; Sample Description: Tecumseh Soil - SB18TCA 1'-2'							
1,1,1-Trichloroethane	40	ug/Kg	6.7	22	SW 8021		9/14/98
Trichloroethene	4,200	ug/Kg	4.5	15	SW 8021		9/14/98

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Appendix B
Laboratory Reports

CARDINAL

ENVIRONMENTAL

3303 Paine Avenue, Sheboygan, WI 53081
(920)459-2500 Fax: (920)459-2503
www.cardinalenvironmental.com

Kerry De Keyser
Tecumseh Products Company
1604 Michigan Avenue
New Holstein , WI 53061-0000

Batch Number: 981850
Report Date: 9/22/98
Date Received: 9/21/98
Project Mgr: PVE

Parameter	Result	Units	LOD	LOQ	Method	Analyst	Date Analyzed
Cardinal Sample Number: 39532 Date Collected: 8/31/98 Grab; Sample Description: Tecumseh Soil - SB23TCA 1'-2'							
1,1,1-Trichloroethane	**<25**	ug/Kg	6.7	22	SW 8021		9/14/98
Trichloroethene	**<25**	ug/Kg	4.5	15	SW 8021		9/14/98
Cardinal Sample Number: 39533 Date Collected: 8/31/98 Grab; Sample Description: Tecumseh Soil - SB23TCA 4'-6'							
1,1,1-Trichloroethane	**180**	ug/Kg	6.7	22	SW 8021		9/14/98
Trichloroethene	**29**	ug/Kg	4.5	15	SW 8021		9/14/98
Cardinal Sample Number: 39534 Date Collected: 8/31/98 Grab; Sample Description: Tecumseh Soil - SB23TCA 8'-10'							
1,1,1-Trichloroethane	**360**	ug/Kg	6.7	22	SW 8021		9/14/98
Trichloroethene	**170**	ug/Kg	4.5	15	SW 8021		9/14/98
Cardinal Sample Number: 39535 Date Collected: 8/31/98 Grab; Sample Description: Tecumseh Soil - SB~~17~~38TCA 1'-2'							
1,1,1-Trichloroethane	**<25**	ug/Kg	6.7	22	SW 8021		9/14/98
Trichloroethene	**<25**	ug/Kg	4.5	15	SW 8021		9/14/98
Cardinal Sample Number: 39536 Date Collected: 8/31/98 Grab; Sample Description: Tecumseh Soil - SB~~17~~38TCA 4'-6'							
1,1,1-Trichloroethane	**<25**	ug/Kg	6.7	22	SW 8021		9/14/98
Trichloroethene	**<25**	ug/Kg	4.5	15	SW 8021		9/14/98

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Kerry De Keyser
Tecumseh Products Company
1604 Michigan Avenue
New Holstein , WI 53061-0000

Batch Number: 981850
Report Date: 9/22/98
Date Received: 9/21/98
Project Mgr: PVE

Parameter	Result	Units	LOD	LOQ	Method	Analyst	Date Analyzed
Cardinal Sample Number: 39542 Date Collected: 8/31/98 Grab; Sample Description: Tecumseh Soil - SB18TCA 4'-6'							
1,1,1-Trichloroethane	**120**	ug/Kg	6.7	22	SW 8021		9/14/98
Trichloroethene	**12,000**	ug/Kg	450	150	SW 8021		9/14/98
Cardinal Sample Number: 39543 Date Collected: 8/31/98 Grab; Sample Description: Tecumseh Soil - SB18TCA 8'-10'							
1,1,1-Trichloroethane	**85**	ug/Kg	6.7	22	SW 8021		9/14/98
Trichloroethene	**5,200**	ug/Kg	4.5	15	SW 8021		9/14/98
Cardinal Sample Number: 39544 Date Collected: 8/31/98 Grab; Sample Description: Tecumseh Soil - SB20TCA 1'-2'							
1,1,1-Trichloroethane	**<25**	ug/Kg	6.7	22	SW 8021		9/14/98
Trichloroethene	**120**	ug/Kg	4.5	15	SW 8021		9/14/98
Cardinal Sample Number: 39545 Date Collected: 8/31/98 Grab; Sample Description: Tecumseh Soil - SB20TCA 4'-6'							
1,1,1-Trichloroethane	**<25**	ug/Kg	6.7	22	SW 8021		9/14/98
Trichloroethene	**<25**	ug/Kg	4.5	15	SW 8021		9/14/98
Cardinal Sample Number: 39546 Date Collected: 8/31/98 Grab; Sample Description: Tecumseh Soil - SB20TCA 8'-10'							
1,1,1-Trichloroethane	**48**	ug/Kg	6.7	22	SW 8021		9/14/98
Trichloroethene	**270**	ug/Kg	4.5	15	SW 8021		9/14/98

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Kerry De Keyser
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1604 Michigan Avenue
New Holstein , WI 53061-0000

Batch Number: 981850
Report Date: 9/22/98
Date Received: 9/21/98
Project Mgr: PVE

Parameter	Result	Units	LOD	LOQ	Method	Analyst	Date Analyzed
Cardinal Sample Number: 39547 Date Collected: 8/31/98 Grab							
Sample Description: Tecumseh Soil - SB21TCA 1'-2'							
1,1,1-Trichloroethane	<25	ug/Kg	6.7	22	SW 8021		9/14/98
Trichloroethene	<25	ug/Kg	4.5	15	SW 8021		9/14/98
Cardinal Sample Number: 39548 Date Collected: 8/31/98 Grab							
Sample Description: Tecumseh Soil - SB21TCA 4'-6'							
1,1,1-Trichloroethane	<25	ug/Kg	6.7	22	SW 8021		9/14/98
Trichloroethene	92	ug/Kg	4.5	15	SW 8021		9/14/98
Cardinal Sample Number: 39549 Date Collected: 8/31/98 Grab							
Sample Description: Tecumseh Soil - SB21TCA 8'-10'							
1,1,1-Trichloroethane	30	ug/Kg	6.7	22	SW 8260		9/14/98
Trichloroethene	<25	ug/Kg	4.5	15	SW 8260		9/14/98
Cardinal Sample Number: 39550 Date Collected: 8/31/98 Grab							
Sample Description: Tecumseh Soil - SB24TCA 1'-2'							
1,1,1-Trichloroethane	<25	ug/Kg	6.7	22	SW 8260		9/14/98
Trichloroethene	<25	ug/Kg	4.5	15	SW 8260		9/14/98
Cardinal Sample Number: 39551 Date Collected: 8/31/98 Grab							
Sample Description: Tecumseh Soil - SB24TCA 4'-6'							
1,1,1-Trichloroethane	<25	ug/Kg	6.7	22	SW 8260		9/14/98
Trichloroethene	31	ug/Kg	4.5	15	SW 8260		9/14/98

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Tecumseh Products Company
1604 Michigan Avenue
New Holstein , WI 53061-0000

Batch Number: 981850
Report Date: 9/22/98
Date Received: 9/21/98
Project Mgr: PVE

Parameter	Result	Units	LOD	LOQ	Method	Analyst	Date Analyzed
Cardinal Sample Number: 39552 Date Collected: 8/31/98 Grab; Sample Description: Tecumseh Soil - SB24TCA 8'-10'							
1,1,1-Trichloroethane	**31**	ug/Kg	6.7	22	SW 8260		9/14/98
Trichloroethene	**77**	ug/Kg	4.5	15	SW 8260		9/14/98
Cardinal Sample Number: 39553 Date Collected: 8/31/98 Grab; Sample Description: Tecumseh Soil - SB25TCA 1'-2'							
1,1,1-Trichloroethane	**<25**	ug/Kg	6.7	22	SW 8260		9/14/98
Trichloroethene	**<25**	ug/Kg	4.5	15	SW 8260		9/14/98
Cardinal Sample Number: 39554 Date Collected: 8/31/98 Grab; Sample Description: Tecumseh Soil - SB25TCA 4'-6'							
1,1,1-Trichloroethane	**220**	ug/Kg	6.7	22	SW 8260		9/14/98
Trichloroethene	**<25**	ug/Kg	4.5	15	SW 8260		9/14/98
Cardinal Sample Number: 39555 Date Collected: 8/31/98 Grab; Sample Description: Tecumseh Soil - SB25TCA 8'-10'							
1,1,1-Trichloroethane	**480**	ug/Kg	6.7	22	SW 8260		9/14/98
Trichloroethene	**130**	ug/Kg	4.5	15	SW 8260		9/14/98
Cardinal Sample Number: 39556 Date Collected: 8/31/98 Grab; Sample Description: Tecumseh Soil - SB28TCA 1'-2'							
1,1,1-Trichloroethane	**<25**	ug/Kg	6.7	22	SW 8260		9/14/98
Trichloroethene	**<25**	ug/Kg	4.5	15	SW 8260		9/14/98

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Tecumseh Products Company
1604 Michigan Avenue
New Holstein , WI 53061-0000

Batch Number: 981850
Report Date: 9/22/98
Date Received: 9/21/98
Project Mgr: PVE

Parameter	Result	Units	LOD	LOQ	Method	Analyst	Date Analyzed
Cardinal Sample Number: 39557 Date Collected: 8/31/98 Grab Sample Description: Tecumseh Soil - SB28TCA 4'-6'							
1,1,1-Trichloroethane	**160**	ug/Kg	6.7	22	SW 8260		9/14/98
Trichloroethene	**<25**	ug/Kg	4.5	15	SW 8260		9/14/98
Cardinal Sample Number: 39558 Date Collected: 8/31/98 Grab Sample Description: Tecumseh Soil - SB28TCA 8'-10'							
1,1,1-Trichloroethane	**230**	ug/Kg	6.7	22	SW 8260		9/14/98
Trichloroethene	**<25**	ug/Kg	4.5	15	SW 8260		9/14/98
Cardinal Sample Number: 39559 Date Collected: 8/31/98 Grab Sample Description: Tecumseh Soil - SB26TCA 1'-2'							
1,1,1-Trichloroethane	**<25**	ug/Kg	6.7	22	SW 8260		9/14/98
Trichloroethene	**<25**	ug/Kg	4.5	15	SW 8260		9/14/98
Cardinal Sample Number: 39560 Date Collected: 8/31/98 Grab Sample Description: Tecumseh Soil - SB26TCA 4'-6'							
1,1,1-Trichloroethane	**92**	ug/Kg	6.7	22	SW 8260		9/14/98
Trichloroethene	**<25**	ug/Kg	4.5	15	SW 8260		9/14/98
Cardinal Sample Number: 39561 Date Collected: 8/31/98 Grab Sample Description: Tecumseh Soil - SB26TCA 8'-10'							
1,1,1-Trichloroethane	**<25**	ug/Kg	6.7	22	SW 8260		9/14/98
Trichloroethene	**<25**	ug/Kg	4.5	15	SW 8260		9/14/98

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Tecumseh Products Company
1604 Michigan Avenue
New Holstein , WI 53061-0000

Batch Number: 981850
Report Date: 9/22/98
Date Received: 9/21/98
Project Mgr: PVE

Parameter	Result	Units	LOD	LOQ	Method	Analyst	Date Analyzed
Cardinal Sample Number: 39562 Date Collected: 8/31/98 Grab							
Sample Description: Tecumseh Soil - SB29TCA 1'-2'							
1,1,1-Trichloroethane	<25	ug/Kg	6.7	22	SW 8260		9/14/98
Trichloroethene	<25	ug/Kg	4.5	15	SW 8260		9/14/98
Cardinal Sample Number: 39563 Date Collected: 8/31/98 Grab							
Sample Description: Tecumseh Soil - SB29TCA 4'-6'							
1,1,1-Trichloroethane	<25	ug/Kg	6.7	22	SW 8260		9/14/98
Trichloroethene	<25	ug/Kg	4.5	15	SW 8260		9/14/98
Cardinal Sample Number: 39564 Date Collected: 8/31/98 Grab							
Sample Description: Tecumseh Soil - SB29TCA 8'-10'							
1,1,1-Trichloroethane	**32**	ug/Kg	6.7	22	SW 8260		9/14/98
Trichloroethene	**120**	ug/Kg	4.5	15	SW 8260		9/14/98

LOD Limit of Detection + *Result estimated below the LOQ.*
LOQ Limit of Quantitation * *Result falls between LOD and LOQ*

Comments: Analyzed by U.S. Oil Co., Inc., WI Lab Cert. #445027660.

Approved By: [signature] **Date:** 9/25/98

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CARDINAL ENVIRONMENTAL

3303 Paine Avenue, Sheboygan, WI 53081

(920) 459-2500 * (800) 413-7225 * FAX: (920) 459-2503

5022673

CHAIN OF CUSTODY RECORD

Batch # ____________

Client: Cardinal Environmental
Client Address: 3303 Paine Avenue
Sheboygan, WI 53081
Contact: Phil Van Ess

Sampler Signature: RMT
Client Phone / FAX: (608) 831-4444
Project Number: Tecumseh Soil
PM: PVE
Sample Delivered By: USA Courier

Laboratory Analysis

5022673

	Sample Identification	Grab/ Comp	Date	Time	Laboratory Number	No. of Container	Type of Container	Temp. Rec'd	Preservative	8260 TCLP Volatiles	% Moisture
A	SB23TCA 1'-2'	g	8/31/98	9:10 am		2	VOC VIAL Special	ON ice	MeOH	X	X
B	SB23TCA 4'-6'	g	8/31/98	9:15 am		2	↓	↓		X	X
C	SB23TCA 8'-10'	g	8/31/98	9:20 am		2	↓	↓		X	X
D	SB17TCA 1'-2' (38 ssm 10/6/98)	g	8/31/98	9:45 am		2	↓	↓		X	X
E	SB17TCA 4'-6' (38 ssm 10/6/98)	g	8/31/98	9:50 am		2	↓	↓		X	X
F	SB17TCA 8'-10 (38 ssm 10/6/98)	g	8/31/98	9:55 am		2	↓	↓		X	X
G	SB19TCA 1'-2'	g	8/31/98	10:30 am		2	↓	↓		X	X
H	SB19TCA 4'-6'	g	8/31/98	10:35 am		2	↓	↓		X	X
I	SB19TCA 8'-10'	g	8/31/98	10:40 am		2	↓	↓		X	X
J	SB18TCA 1'-2'	g	8/31/98	11:10 am		2	↓	↓		X	X

Samples are to be run 8260 (w/o comp) Normal list - Not TCLP - per PVE - [illegible] 9/[illegible]

Relinquished by:	Date	Time	Received by:	Date	Time
Rob Hafmeister/RMT	9/1/98	9:50 am	Dave Otto US Oil	9/1/98	9:55
Dave Otto US Oil	9/1/98	3:10	Linda Smith US Oil	9/1/98	3:10

SOIL MATRIX

Turn Around Time: Normal

Condition: ∞

Remarks: SUB: US Analytical Services
% Moisture to be completed to calculated dry weight concentration
MeOH preservation will be completed after laboratory receipt. Rec. on ice good cond.
Send all reports + invoices to Cardinal Env.

CARDINAL ENVIRONMENTAL

3303 Paine Avenue, Sheboygan, WI 53081

(920) 459-2500 * (800) 413-7225 * FAX: (920) 459-2503

5022673

CHAIN OF CUSTODY RECORD

Batch # ______________

LGS

Client: Cardinal Environmental

Client Address: 3303 Paine Avenue, Sheboygan, WI 53081

Contact: Phil Van Ess

Sampler Signature: RMT

Client Phone / FAX: (608) 831-4444

Project Number: Tecumseh Soil

PM: PVE

Sample Delivered By: USA Courier

Laboratory Analysis

	Sample Identification	Grab/Comp	Date	Time	Laboratory Number	No. of Container	Type of Container	Temp. Rec'd	Preservative	8260 TCLP Volatiles	% Moisture
5022673											
K	SB18TCA 4'-6'	g	8/31/98	11:15 am		2	VOC VIAL Special	on ice	MeOH	X	X
L	SB18TCA 8'-10'	g	8/31/98	11:20 am		2	↓	↓		X	X
M	SB20TCA 1'-2'	g	8/31/98	12:30 pm		2	↓	↓		X	X
N	SB20TCA 4'-6'	g	8/31/98	12:35 pm		2	↓	↓		X	X
O	SB20TCA 8'-10'	g	8/31/98	12:40 pm		2	↓	↓		X	X
P	SB21TCA 1'-2'	g	8/31/98	1:45 pm		2	↓	↓		X	X
Q	SB21TCA 4'-6'	g	8/31/98	1:50 pm		2	↓	↓		X	X
R	SB21TCA 8'-10'	g	8/31/98	1:55 pm		2	↓	↓		X	X
S	SB24TCA 1'-2'	g	8/31/98	2:25 pm		2	↓	↓		X	X
T	SB24TCA 4'-6'	g	8/31/98	2:30 pm		2	↓	↓		X	X

Relinquished by:	Date	Time	Received by:	Date	Time
Rob Hofemeister / RMT	9/1/98	9:50 am	Dave Otto US Oil	9-1-98	9:55
Dave Otto US Oil	9/1/98	3:10	Linda Dmito US OIL	9-1-98	3:10

Turn Around Time: Normal

Condition: 9

Remarks: SUB: US Analytical Services — SOIL MATRIX
% Moisture to be completed to calculate dry weight concentration
MeOH preservation will be completed after laboratory receipt. - Rec on ice good condition
Send all reports + invoices to Cardinal Env.

CARDINAL ENVIRONMENTAL

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(920) 459-2500 * (800) 413-7225 * FAX: (920) 459-2503

5022673/5022674

CHAIN OF CUSTODY RECORD

Batch # ____________ (6)

Client: Cardinal Environmental

Client Address: 3303 Paine Avenue, Sheboygan, WI 53083

Contact: Phil Van Ess

Sampler Signature: RMT

Client Phone / FAX: (608) 831-4444

Project Number: Tecumseh Soil

PM: PVE

Sample Delivered By: USA Courier

Laboratory Analysis: 8260 Trip Volatiles; % Moisture

	Sample Identification	Grab/ Comp	Date	Time	Laboratory Number	No. of Container	Type of Container	Temp. Rec'd	Preserva-tive	8260 Trip Volatiles	% Moisture
5022673											
U	SB24TCA 8'-10'	g	8/31/98	2:35 pm		2	VOC VIAL Special	on ice	MeOH	X	X
V	SB25TCA 1'-2'	g	8/31/98	3 pm		2	↓	↓		X	X
W	SB25TCA 4'-6'	g	8/31/98	3:05 pm		2				X	X
X	SB25TCA 8'-10'	g	8/31/98	3:10 pm		2				X	X
Y	SB28TCA 1'-2'	g	8/31/98	3:50 pm		2				X	X
Z	SB28TCA 4'-6'	g	8/31/98	3:55 pm		2				X	X
5022674 A	SB28TCA 8'-10'	g	8/31/98	4 pm		2				X	X
B	SB26TCA 1'-2'	g	8/31/98	4:35 pm		2				X	X
C	SB26TCA 4'-6'	g	8/31/98	4:40 pm		2				X	X
D	SB26TCA 8'-10'	g	8/31/98	4:45 pm		2	↓	↓		X	X

Relinquished by:	Date	Time	Received by:	Date	Time
Rob Hafemeister / RMT	9/1/98	9:50 am	Dave Otto US Oil	9-1-98	9:55
Dave Otto US Oil	9/1/98	3:10	Linda Smith US Oil	9-1-98	3:10

Turn Around Time: Normal

Condition: 5

Remarks: SUB: U.S. Analytical Services — SOIL MATRIX
% Moisture to be completed to calculate dry weight concentration
MeOH preservation will be completed after laboratory receipt. rec. on ice, good cond.

Send all reports + invoices to Cardinal Env.

CARDINAL ENVIRONMENTAL

3303 Paine Avenue, Sneboygan, WI 53081

(920) 459-2500 * (800) 413-7225 * FAX: (920) 459-2503

5022674

CHAIN OF CUSTODY RECORD

Batch # ____________

(6)

Client: Cardenal Environmental	Sampler Signature: RMT
Client Address: 3303 Paine Avenue, Sheboygan, WI 53081	Client Phone / FAX: (608) 831-4444
	Project Number: Tecumseh Soil — PM: PVE
Contact: Phil Van Ess	Sample Delivered By: USA Courier

Laboratory Analysis

	Sample Identification	Grab/Comp	Date	Time	Laboratory Number	No. of Container	Type of Container	Temp. Rec'd	Preservative	8260 TCLP Volatiles	% Moisture							
5022674																		
E	SB29TCA 1'-2'	g	8/31/98	5:00 pm		2	VOC VIAL Special	on ice	MeOH	X	X							
F	SB29TCA 4'-6'	g	8/31/98	5:05 pm		2	↓	↓		X	X							
G	SB29TCA 8'-10'	g	8/31/98	5:10 pm		2	↓	↓		X	X							
		g				2	↓	↓		X	X							
		g				2	↓	↓		X	X							
		g				2	↓	↓		X	X							
		g				2	↓	↓		X	X							
		g				2	↓	↓		X	X							
		g				2	↓	↓		X	X							
		g				2	↓	↓		X	X							

Relinquished by:	Date	Time	Received by:	Date	Time
Rob Hofemeister/RMT	9/1/98	9:50 am	Dave Otto US Oil	9-1-98	9:55
Dave Otto US Oil	9/1/98	3:10	Linda Smith US Oil	9-1-98	3:10

SOIL MATRIX

Turn Around Time: Normal

Condition: I

Remarks: SUB: U.S. Analytical Services
% Moisture to be completed to calculate dry weight concentration
MeOH preservation will be completed after laboratory receipt. Rec on ice good condition
Send all reports & invoices to Cardinal Env.

CARDINAL
ENVIRONMENTAL

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(920)459-2500 Fax: (920)459-2503
www.cardinalenvironmental.com

Kerry De Keyser
Tecumseh Products Company
900 North Avenue
Grafton , WI 53024-0000

Batch Number: 981893
Report Date: 9/28/98
Date Received: 9/25/98
Project Mgr: PVE

Parameter	Result	Units	LOD	LOQ	Method	Analyst	Date Analyzed
Cardinal Sample Number: 39680 Date Collected: 9/1/98 Grab							
Sample Description: Tecumseh Soil SB27TCA 1'-2'							
1,1,1-Trichloroethane	<25	ug/Kg	6.7	22	SW 8021		9/16/98
Trichloroethene	<25	ug/Kg	4.5	15	SW 8021		9/16/98
Cardinal Sample Number: 39681 Date Collected: 9/1/98 Grab							
Sample Description: Tecumseh Soil SB27TCA 4'-6'							
1,1,1-Trichloroethane	<25	ug/Kg	6.7	22	SW 8021		9/16/98
Trichloroethene	<25	ug/Kg	4.5	15	SW 8021		9/16/98
Cardinal Sample Number: 39682 Date Collected: 9/1/98 Grab							
Sample Description: Tecumseh Soil SB27TCA 8'-10'							
1,1,1-Trichloroethane	<25	ug/Kg	6.7	22	SW 8021		9/16/98
Trichloroethene	<25	ug/Kg	4.5	15	SW 8021		9/16/98
Cardinal Sample Number: 39683 Date Collected: 9/1/98 Grab							
Sample Description: Tecumseh Soil SB22TCA 1'-2'							
1,1,1-Trichloroethane	<25	ug/Kg	6.7	22	SW 8021		9/16/98
Trichloroethene	<25	ug/Kg	4.5	15	SW 8021		9/16/98
Cardinal Sample Number: 39684 Date Collected: 9/1/98 Grab							
Sample Description: Tecumseh Soil SB22TCA 4'-6'							
1,1,1-Trichloroethane	<25	ug/Kg	6.7	22	SW 8021		9/16/98
Trichloroethene	<25	ug/Kg	4.5	15	SW 8021		9/16/98

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CARDINAL ENVIRONMENTAL

3303 Paine Avenue, Sheboygan, WI 53081
(920)459-2500 Fax: (920)459-2503
www.cardinalenvironmental.com

Kerry De Keyser
Tecumseh Products Company
900 North Avenue
Grafton , WI 53024-0000

Batch Number: 981893
Report Date: 9/28/98
Date Received: 9/25/98
Project Mgr: PVE

Parameter	Result	Units	LOD	LOQ	Method	Analyst	Date Analyzed
Cardinal Sample Number: 39685 Date Collected: 9/1/98 Grab Sample Description: Tecumseh Soil SB22TCA 8'-10'							
1,1,1-Trichloroethane	**<25**	ug/Kg	6.7	22	SW 8021		9/16/98
Trichloroethene	**29**	ug/Kg	4.5	15	SW 8021		9/16/98
Cardinal Sample Number: 39686 Date Collected: 9/1/98 Grab Sample Description: Tecumseh Soil SB37TCA 1'-2'							
1,1,1-Trichloroethane	**<25**	ug/Kg	6.7	22	SW 8021		9/16/98
Trichloroethene	**<25**	ug/Kg	4.5	15	SW 8021		9/16/98
Cardinal Sample Number: 39687 Date Collected: 9/1/98 Grab Sample Description: Tecumseh Soil SB37TCA 4'-6'							
1,1,1-Trichloroethane	**<25**	ug/Kg	6.7	22	SW 8021		9/16/98
Trichloroethene	**33**	ug/Kg	4.5	15	SW 8021		9/16/98
Cardinal Sample Number: 39688 Date Collected: 9/1/98 Grab Sample Description: Tecumseh Soil SB37TCA 8'-10'							
1,1,1-Trichloroethane	**<25**	ug/Kg	6.7	22	SW 8021		9/16/98
Trichloroethene	**<25**	ug/Kg	4.5	15	SW 8021		9/16/98
Cardinal Sample Number: 39689 Date Collected: 9/1/98 Grab Sample Description: Tecumseh Soil SB36TCA 1'-2'							
1,1,1-Trichloroethane	**60**	ug/Kg	6.7	22	SW 8021		9/16/98
Trichloroethene	**<25**	ug/Kg	4.5	15	SW 8021		9/16/98

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Kerry De Keyser
Tecumseh Products Company
900 North Avenue
Grafton , WI 53024-0000

Batch Number: 981893
Report Date: 9/28/98
Date Received: 9/25/98
Project Mgr: PVE

Parameter	Result	Units	LOD	LOQ	Method	Analyst	Date Analyzed
Cardinal Sample Number: 39690 Date Collected: 9/1/98 Grab							
Sample Description: Tecumseh Soil SB36TCA 4'-6'							
1,1,1-Trichloroethane	**100**	ug/Kg	6.7	22	SW 8021		9/16/98
Trichloroethene	**26**	ug/Kg	4.5	15	SW 8021		9/16/98
Cardinal Sample Number: 39691 Date Collected: 9/1/98 Grab							
Sample Description: Tecumseh Soil SB36TCA 8'-10'							
1,1,1-Trichloroethane	**<25**	ug/Kg	6.7	22	SW 8021		9/16/98
Trichloroethene	**<25**	ug/Kg	4.5	15	SW 8021		9/16/98
Cardinal Sample Number: 39692 Date Collected: 9/1/98 Grab							
Sample Description: Tecumseh Soil SB34TCA 1'-2'							
1,1,1-Trichloroethane	**<25**	ug/Kg	6.7	22	SW 8021		9/16/98
Trichloroethene	**<25**	ug/Kg	4.5	15	SW 8021		9/16/98
Cardinal Sample Number: 39693 Date Collected: 9/1/98 Grab							
Sample Description: Tecumseh Soil SB35TCA 1'-2'							
1,1,1-Trichloroethane	**140**	ug/Kg	6.7	22	SW 8021		9/16/98
Trichloroethene	**130,000**	ug/Kg	4500	15000	SW 8021		9/16/98
Cardinal Sample Number: 39694 Date Collected: 9/1/98 Grab							
Sample Description: Tecumseh Soil SB30TCA 1'-2'							
1,1,1-Trichloroethane	**340**	ug/Kg	6.7	22	SW 8021		9/16/98
Trichloroethene	**<25**	ug/Kg	4.5	15	SW 8021		9/16/98

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Kerry De Keyser
Tecumseh Products Company
900 North Avenue
Grafton , WI 53024-0000

Batch Number: 981893
Report Date: 9/28/98
Date Received: 9/25/98
Project Mgr: PVE

Parameter	Result	Units	LOD	LOQ	Method	Analyst	Date Analyzed
Cardinal Sample Number: 39695 Date Collected: 9/1/98 Grab							
Sample Description: Tecumseh Soil SB31TCA 1'-2'							
1,1,1-Trichloroethane	<25	ug/Kg	6.7	22	SW 8021		9/16/98
Trichloroethene	<25	ug/Kg	4.5	15	SW 8021		9/16/98
Cardinal Sample Number: 39696 Date Collected: 9/1/98 Grab							
Sample Description: Tecumseh Soil SB32TCA 1'-2'							
1,1,1-Trichloroethane	35	ug/Kg	6.7	22	SW 8021		9/16/98
Trichloroethene	5,700	ug/Kg	4.5	15	SW 8021		9/16/98
Cardinal Sample Number: 39697 Date Collected: 9/1/98 Grab							
Sample Description: Tecumseh Soil SB33TCA 1'-2'							
1,1,1-Trichloroethane	190	ug/Kg	6.7	22	SW 8021		9/16/98
Trichloroethene	9,200	ug/Kg	4.5	15	SW 8021		9/16/98

LOD Limit of Detection + *Result estimated below the LOQ.*
LOQ Limit of Quantitation * *Result falls between LOD and LOQ*

Comments: Analyzed by US Oil Co., Inc., WI DNR Certified Lab #445027660.

Approved By: [signature] **Date:** 9/28/98

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CARDINAL ENVIRONMENTAL

3303 Paine Avenue, Sheboygan, WI 53081

(920) 459-2500 * (800) 413-7225 * FAX: (920) 459-2503

5022684

CHAIN OF CUSTODY RECORD

Batch # ____________

Client: Cardinal Environmental	Sampler Signature: RMT / Rob Hafemeister
Client Address: 3303 Paine Avenue, Sheboygan, WI 53081	Client Phone / FAX: ~~[illegible]~~
	Project Number: Tecumseh Soil — PM: PVE
Contact: Phil Van Ess	Sample Delivered By: USA Courier

Laboratory Analysis: LGS

	Sample Identification 5022684	Grab/Comp	Date	Time	Laboratory Number	No. of Container	Type of Container	Temp. Rec'd	Preservative	8260 TCLP Volatiles	% Moisture
A	SB27TCA 1'-2'	g	9/1/98	7:55 am		2	VOC VIAL Special	ON ice	MeOH	X	X
B	SB27TCA 4'-6'	g	9/1/98	8:00 am		2	↓	↓		X	X
C	SB27TCA 8'-10'	g	9/1/98	8:05 am		2				X	X
D	SB22TCA 1'-2'	g	9/1/98	8:30 am		2				X	X
E	SB22TCA 4'-6'	g	9/1/98	8:35 am		2				X	X
F	SB22TCA 8'-10'	g	9/1/98	8:40 am		2				X	X
G	SB37TCA 1'-2'	g	9/1/98	9:30 am		2				X	X
H	SB37TCA 4'-6'	g	9/1/98	9:35 am		2				X	X
I	SB37TCA 8'-10'	g	9/1/98	9:40 am		2				X	X
J	SB36TCA 1'-2'	g	9/1/98	10:20 am		2	↓	↓		X	X

Relinquished by	Date	Time	Received by	Date	Time
Rob Hafemeister / RMT	9/2/98	7:30 a	Linda Dmitts	9/2/98	2:00

Turn Around Time: Normal

Condition: 6

Remarks: SUB: U.S. Analytical Services

SOIL MATRIX

% Moisture to be completed to calculate dry weight concentration

MeOH preservation will be completed after laboratory receipt. Rec on ice good condition

Send all reports & invoices to Cardinal Environmental

CARDINAL ENVIRONMENTAL

3303 Paine Avenue, Sheboygan, WI 53081

(920) 459-2500 * (800) 413-7225 * FAX: (920) 459-2503

5022684

CHAIN OF CUSTODY RECORD

Batch # ______________

Client: Cardinal Environmental	Sampler Signature: RMT/Rob Hofmeister
Client Address: 3303 Paine Avenue, Sheboygan, WI 53081	Client Phone / FAX:
	Project Number: Tecumseh Soil — PM: PVE
Contact: Phil Van Ess	Sample Delivered By: USA Courier

Laboratory Analysis: LGS

	Sample Identification (5022684)	Grab/Comp	Date	Time	Laboratory Number	No. of Container	Type of Container	Temp. Rec'd	Preservative	8260 TCLP Volatiles	% Moisture
K	SB36TCA 4'-6'	g	9/1/98	10:20 am		2	VOC VIAL Special	ON ice	MeOH	X	X
L	SB36TCA 8'-10	g	9/1/98	10:30 am		2	↓	↓		X	X
M	SB34TCA 1'-2'	g	9/1/98	11:15 am		2				X	X
N	SB35TCA 1'-2'	g	9/1/98	11:35 am		2				X	X
O	SB30TCA 1'-2'	g	9/1/98	12:50 pm		2				X	X
P	SB31TCA 1'-2'	g	9/1/98	1:50 pm		2				X	X
Q	SB32TCA 1'-2'	g	9/1/98	2:25 pm		2				X	X
R	SB33TCA 1'-2'	g	9/1/98	3:05 pm		2				X	X
		g				2				X	X
		g				2				X	X

Relinquished by:	Date	Time	Received by:	Date	Time
Rob Hofmeister	9/2/98	7:30 am	Linda Smits	9/2/98	2:30
Relinquished by:	Date	Time	Received by:	Date	Time

Turn Around Time: Normal

Condition:

Remarks: SUB: U.S. Analytical Services — SOIL MATRIX
% Moisture to be completed to calculate dry weight concentration
MeOH preservation will be completed after laboratory receipt. Rec on ice good condition
Send all reports + invoices to Cardinal Environmental

CARDINAL ENVIRONMENTAL

3303 Paine Avenue, Sheboygan, WI 53081

(920) 459-2500 * (800) 413-7225 * FAX: (920) 459-2503

Pg. 1 of 2

CHAIN OF COUSTODY RECORD

Batch # 981893

Client Information: TECUMSEH PRODUCTS CO. 900 NORTH AVE. GRAFTON, WI 53024

Contact:

Sampler Signature:

Client Phone / FAX:

Project Number:

PM: FVE

Sample Delivered By:

Laboratory Analysis: 1,1,1-TRICHLOROETHANE (8021); TRICHLOROETHANE

Sample Identification TECUMSEH SOIL	Grab/ Comp	Date	Time	Laboratory Number	No. of Container	Type of Container	Temp. Rec'd	Preserva-tive	1,1,1-TRICHLOROETHANE (8021)	TRICHLOROETHANE
SB27TCA 1'-2'	G	9/1		39680						
4'-6'	↓	↓		39681						
8'-10'	↓	↓		39682						
SB22TCA 1'-2'	↓	↓		39683						
4'-6'	↓	↓		39684						
8'-10'	↓	↓		39685						
SB37TCA 1'-2'	↓	↓		39686						
4'-6'	↓	↓		39687						
8'-10'	↓	↓		39688						
SB36TCA 1'-2'	↓	↓		39689						

Relinquished by:	Date	Time	Received by:	Date	Time
			A. Pfeil	9/25/98	4:30

Turn Around Time:

Condition: 2

Remarks: US OIL

CARDINAL ENVIRONMENTAL

3303 Paine Avenue, Sheboygan, WI 53081

(920) 459-2500 * (800) 413-7225 * FAX: (920) 459-2503

Pg. 2 of 2

CHAIN OF CUSTODY RECORD

Batch # 981893

Client Information: TECUMSEH

Contact:

Sampler Signature:

Client Phone / FAX:

Project Number:

PM: AVE

Sample Delivered By:

Laboratory Analysis: 1,1,1-Trichloroethane (1,1,1-TCA); Trichloroethene (TCE)

Sample Identification	Grab/Comp	Date	Time	Laboratory Number	No. of Container	Type of Container	Temp. Rec'd	Preserva-tive
SB36TCA 4'-6'	G	9/1		39690				
8'-10'	↓	↓		39691				
SB34TCA 1'-2'	↓	↓		39692				
35 4'-2'	↓	↓		39693				
30 8'-2'	↓	↓		39694				
31 1'-2'	↓	↓		39695				
32 1'-2'	↓	↓		39696				
33 1'-2'	↓	↓		39697				

Relinquished by:	Date	Time	Received by:	Date	Time
			A. Hull	9/5/98	4:30

Turn Around Time:

Condition: I

Remarks: US Oil

CARDINAL
ENVIRONMENTAL
(920) 459-2500 fax (920) 459-2503
3303 Paine Avenue Sheboygan, WI 53081

Kerry De Keyser
Tecumseh Products Company
900 North Avenue
Grafton, WI 53024

Sample #: 39146
Collect Date: 9/1/98
Receive Date: 9/1/98
Report Date: 9/22/98

Sample Description: Composite Waste Characterization

Test	Result	Units	Reporting Limit	Quan Limit	Method	Date Analyzed
pH	9.80	units			9045	9/4/98
Aroclor 1016	ND	mg/Kg	0.0383	0.0333	8082	9/9/98
Aroclor 1221	ND	mg/Kg	0.0766	0.0666	8082	9/9/98
Aroclor 1232	ND	mg/Kg	0.0383	0.0333	8082	9/9/98
Aroclor 1242	ND	mg/Kg	0.0383	0.0333	8082	9/9/98
Aroclor 1248	ND	mg/Kg	0.0383	0.0333	8082	9/9/98
Aroclor 1254	ND	mg/Kg	0.0383	0.0333	8082	9/9/98
Aroclor 1260	ND	mg/Kg	0.0383	0.0333	8082	9/9/98
% Dry Weight	87%				CLP	9/8/98
Reactive Sulfide	ND	mg/Kg	20	20	SW-846	9/10/98
Free Cyanide	ND	mg/Kg	2.00	2.00	SM-4500	9/10/98
Specific Gravity	1.76				D1475	9/14/98
Paint Filter Test	no free liquids				9095	9/14/98
Chlorine (bomb calorimeter)	ND	%	1.00	0.010	D808	9/10/98
Flash Point	no flash up to 200F				1010	9/14/98

TCLP Results:

Test	Result	Units	Reg Limit	Matrix Spike Recovery(%)	Method	Date Analyzed
Arsenic	<0.10	mg/L	5.0	98	6010B	9/9/98
Barium	<1.00	mg/L	100	89	6010B	9/9/98
Cadmium	<0.10	mg/L	1.0	90	6010B	9/9/98
Chromium	<0.50	mg/L	5.0	86	6010B	9/9/98
Copper	<0.50	mg/L	N/A	86	6010B	9/9/98
Lead	<0.50	mg/L	5.0	89	6010B	9/9/98
Mercury	<0.010	mg/L	0.20	99	7470A	9/10/98

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Nickel	<0.50	mg/L	N/A	85	6010B	9/9/98
Selenium	<0.10	mg/L	1.0	101	6010B	9/9/98
Silver	<0.10	mg/L	5.0	87	6010B	9/9/98
Zinc	<0.50	mg/L	N/A	84	6010B	9/9/98
Benzene	<0.10	mg/L	0.5	114	8260	9/9/98
Carbon Tetrachloride	<0.1	mg/L	0.5	110	8260	9/9/98
Chlorobenzene	<0.10	mg/L	100	112	8260	9/9/98
Chloroform	<0.100	mg/L	6.0	118	8260	9/9/98
1,2-Dichloroethane	<0.10	mg/L	0.5	118	8260	9/9/98
1,1-Dichloroethene	<0.1	mg/L	0.7	112	8260	9/9/98
Methyl Ethyl Ketone	<1.0	mg/L	200	110	8260	9/9/98
Tetrachloroethene	<0.1	mg/L	0.7	116	8260	9/9/98
Trichloroethene	0.79	mg/L	0.5	112	8260	9/9/98
Vinyl Chloride	<0.1	mg/L	0.2	104	8260	9/9/98
Cresols	<0.1	mg/L	200	50	8270	9/10/98
Phenol	<0.01	mg/L	N/A	N/A	8270	9/10/98
1,4-Dichlorobenzene	<0.1	mg/L	7.5	44	8270	9/10/98
2,4-Dinitrotoluene	<0.10	mg/L	0.13	70	8270	9/10/98
Hexachlorobenzene	<0.10	mg/L	0.13	24	8270	9/10/98
Hexchlor-1,3-butadiene	<0.1	mg/L	0.5	40	8270	9/10/98
Hexachloroethane	<0.1	mg/L	3.0	42	8270	9/10/98
Nitrobenzene	<0.1	mg/L	2.0	50	8270	9/10/98
Pentachlorophenol	<0.1	mg/L	100	84	8270	9/10/98
Pyridine	<0.1	mg/L	5.0	14	8270	9/10/98
2,4,5-Trichlorophenol	<0.1	mg/L	400	56	8270	9/10/98
2,4,6-Trichlorophenol	<0.1	mg/L	2.0	56	8270	9/10/98

Analyzed by Specialized Assays, WI Lab Certification #998020430.

ND = Not detected at the report limit.

Authorized by ____________________ **Date** 9/24/98

CARDINAL ENVIRONMENTAL
(920) 459-2500 fax (920) 459-2503
3303 Paine Avenue Sheboygan, WI 53081

Kerry De Keyser
Tecumseh Products Company
900 North Avenue
Grafton, WI 53024

Sample #: 39147
Collect Date: 9/1/98
Receive Date: 9/1/98
Report Date: 9/22/98

Sample Description: Discrete Waste Characterization - SB33TCA 4'-8'

Test	Result	Units	Reporting Limit	Quan Limit	Method	Date Analyzed
pH	9.30	units			9045	9/4/98
Aroclor 1016	ND	mg/Kg	0.0383	0.0333	8082	9/9/98
Aroclor 1221	ND	mg/Kg	0.0766	0.0666	8082	9/9/98
Aroclor 1232	ND	mg/Kg	0.0383	0.0333	8082	9/9/98
Aroclor 1242	ND	mg/Kg	0.0383	0.0333	8082	9/9/98
Aroclor 1248	ND	mg/Kg	0.0383	0.0333	8082	9/9/98
Aroclor 1254	ND	mg/Kg	0.0383	0.0333	8082	9/9/98
Aroclor 1260	ND	mg/Kg	0.0383	0.0333	8082	9/9/98
% Dry Weight	90%				CLP	9/8/98
Reactive Sulfide	ND	mg/Kg	20	20	SW-846	9/10/98
Free Cyanide	ND	mg/Kg	2.00	2.00	SM-4500	9/10/98
Specific Gravity	1.91				D1475	9/14/98
Paint Filter Test	no free liquids				9095	9/14/98
Chlorine (bomb calorimeter)	ND	%	1.00	0.010	D808	9/10/98
Flash Point	no flash up to 200F				1010	9/14/98

TCLP Results:

Test	Result	Units	Reg Limit	Matrix Spike Recovery(%)	Method	Date Analyzed
Arsenic	<0.10	mg/L	5.0	98	6010B	9/9/98
Barium	<1.00	mg/L	100	89	6010B	9/9/98
Cadmium	<0.10	mg/L	1.0	90	6010B	9/9/98
Chromium	<0.50	mg/L	5.0	86	6010B	9/9/98
Copper	<0.50	mg/L	N/A	86	6010B	9/9/98
Lead	<0.50	mg/L	5.0	89	6010B	9/9/98
Mercury	<0.010	mg/L	0.20	99	7470A	9/10/98

Nickel	<0.50	mg/L	N/A	85	6010B	9/9/98
Selenium	<0.10	mg/L	1.0	101	6010B	9/9/98
Silver	<0.10	mg/L	5.0	87	6010B	9/9/98
Zinc	<0.50	mg/L	N/A	84	6010B	9/9/98
Benzene	<0.10	mg/L	0.5	112	8260	9/9/98
Carbon Tetrachloride	<0.1	mg/L	0.5	112	8260	9/9/98
Chlorobenzene	<0.10	mg/L	100	102	8260	9/9/98
Chloroform	<0.100	mg/L	6.0	112	8260	9/9/98
1,2-Dichloroethane	<0.10	mg/L	0.5	118	8260	9/9/98
1,1-Dichloroethene	<0.1	mg/L	0.7	116	8260	9/9/98
Methyl Ethyl Ketone	<1.0	mg/L	200	106	8260	9/9/98
Tetrachloroethene	<0.1	mg/L	0.7	118	8260	9/9/98
Trichloroethene	0.23	mg/L	0.5	110	8260	9/9/98
Vinyl Chloride	<0.1	mg/L	0.2	104	8260	9/9/98
Cresols	<0.1	mg/L	200	50	8270	9/10/98
Phenol	<0.1	mg/L	N/A	N/A	8270	9/10/98
1,4-Dichlorobenzene	<0.1	mg/L	7.5	42	8270	9/10/98
2,4-Dinitrotoluene	<0.10	mg/L	0.13	66	8270	9/10/98
Hexachlorobenzene	<0.10	mg/L	0.13	22	8270	9/10/98
Hexchlor-1,3-butadiene	<0.1	mg/L	0.5	38	8270	9/10/98
Hexachloroethane	<0.1	mg/L	3.0	40	8270	9/10/98
Nitrobenzene	<0.1	mg/L	2.0	46	8270	9/10/98
Pentachlorophenol	<0.1	mg/L	100	84	8270	9/10/98
Pyridine	<0.1	mg/L	5.0	22	8270	9/10/98
2,4,5-Trichlorophenol	<0.1	mg/L	400	54	8270	9/10/98
2,4,6-Trichlorophenol	<0.1	mg/L	2.0	54	8270	9/10/98

Analyzed by Specialized Assays, WI Lab Certification #998020430.

ND = Not detected at the report limit.

Authorized by [signature] **Date** 9/24/98

112418

Cardinal Environmental, Inc. 7732
3303 Paine Avenue
Sheboygan, WI 53081
(920)459-2500 FAX (920)459-2503

TO: Specialized Assays
2960 Foster Creighton Dr.
Nashville TN 37204

Results Requested By: Phil Van Ess
Turn Around Time: Normal

Quote:
Project:

ANALYTICAL WORK REQUEST

98-A106160

Lab Number	Sample Description	Date Sampled	Analysis Requested	No. of Bottles
39146	Composite waste Characterization	9/1/98	Waste Management Protocol B	2
39147	SB33TCA 4-8' Discrete waste characterization	↓	" " " "	2
			98-A106161	

COMMENTS: See Peter Jacobs w/any questions concerning Protocol B analysis

SEND RESULTS TO: Angie Rothwell

*Please return coolers to above address.
*Please reference Cardinal lab number on all invoices.

Cooler #

CHAIN OF CUSTODY#:	Samples Shipped By:	
Relinquished by: [signature]	Date/Time 9-3-98 3:30	Received by:
Relinquished by:	Date/Time	Received by:

25

SPECIALIZED ASSAYS, INC.

2960 Foster Creighton Dr.
P.O. Box 40566
Nashville, TN 37204-0566
Phone 1-615-726-0177

PROJECT QUALITY CONTROL DATA

Matrix Spike Recovery

Analyte	units	Orig. Val.	MS Val	Spike Conc	Recovery	Target Range	Q.C. Batch
Aroclor 1260	mg/kg	< 0.0333	0.1772	0.1667	106.30	29. - 152.	5898

Matrix Spike Duplicate

Analyte	units	Orig. Val.	Duplicate	RPD	Limit	Q.C. Batch
Free Cyanide	mg/kg	9.85	9.85	0.00	20.	6233
Aroclor 1260	mg/kg	0.1772	0.1102	46.62*	42.	5898

Laboratory Control Data

Analyte	units	Known Val.	Analyzed Val	% Recovery	Target Range	Q.C. Batch
Aroclor 1016	mg/kg	0.1667	0.1968	118.	60 - 140	5994
Aroclor 1260	mg/kg	0.1667	0.1682	101.	60 - 140	5898

Duplicates

Analyte	units	Orig. Val.	Duplicate	RPD	Limit	Q.C. Batch
Specific Gravity		1.13	1.12	0.89	15	7905

Blank Data

Analyte	Blank Value	Units	Q.C. Batch
Arsenic	< 0.10	mg/l	4533
Barium	< 1.00	mg/l	4533
Cadmium	< 0.100	mg/l	4533
Chromium	< 0.50	mg/l	4533
Lead	< 0.50	mg/l	4533
Mercury	< 0.010	mg/l	5631
Selenium	< 0.100	mg/l	4533
Silver	< 0.10	mg/l	4533
Benzene	< 0.10	mg/l	4584
Carbon tetrachloride	< 0.1	mg/l	4584
Chlorobenzene	< 0.10	mg/l	4584
Chloroform	< 0.100	mg/l	4584
1,2-Dichloroethane	< 0.10	mg/l	4584
1,1-Dichloroethene	< 0.10	mg/l	4584
Methylethylketone	< 1.0	mg/l	4584
Tetrachloroethene	< 0.1	mg/l	4584
Trichloroethene	< 0.10	mg/l	4584
Vinyl Chloride	< 0.1	mg/l	4584
Cresols	< 0.1	mg/l	4647
Phenol	0.000	mg/l	4647
1,4-D[illegible]zene	< 0.1	mg/l	4647

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Phone 1-615-726-0177

PROJECT QUALITY CONTROL DATA

Blank Data

Analyte	Blank Value	Units	Q.C. Batch
2,4-Dinitrotoluene	< 0.10	mg/l	4647
Hexachlorobenzene	< 0.10	mg/l	4647
Hexchlor-1,3-butadien	< 0.1	mg/l	4647
Hexachloroethane	< 0.1	mg/l	4647
Nitrobenzene	< 0.1	mg/l	4647
Pentachlorophenol	< 0.1	mg/l	4647
Pyridine	< 0.1	mg/l	4647
2,4,5-Trichlorophenol	< 0.1	mg/l	4647
2,4,6-Trichlorophenol	< 0.1	mg/l	4647
Aroclor 1016	< 0.0333	mg/kg	5898
Aroclor 1221	< 0.0666	mg/kg	5898
Aroclor 1232	< 0.0333	mg/kg	5898
Aroclor 1242	< 0.0333	mg/kg	5898
Aroclor 1248	< 0.0333	mg/kg	5898
Aroclor 1254	< 0.0333	mg/kg	5898
Aroclor 1260	< 0.0333	mg/kg	5898

COPY 2

SPECIALIZED ASSAYS, INC.

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PROJECT QUALITY CONTROL DATA

Matrix Spike Recovery

Analyte	units	Orig. Val.	MS Val	Spike Conc	Recovery	Target Range	Q.C. Batch
Aroclor 1260	mg/kg	< 0.0333	0.1772	0.1667	106.30	29. - 152.	5898

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Analyte	units	Orig. Val.	Duplicate	RPD	Limit	Q.C. Batch
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Aroclor 1260	mg/kg	0.1772	0.1102	46.62#	42.	5898

Laboratory Control Data

Analyte	units	Known Val.	Analyzed Val	% Recovery	Target Range	Q.C. Batch
Aroclor 1016	mg/kg	0.1667	0.1968	118.	60 - 140	5898
Aroclor 1260	mg/kg	0.1667	0.1682	101.	60 - 140	5898

Duplicates

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Specific Gravity		1.13	1.12	0.89	15	7905

Blank Data

Analyte	Blank Value	Units	Q.C. Batch
Arsenic	< 0.10	mg/l	4533
Barium	< 1.00	mg/l	4533
Cadmium	< 0.100	mg/l	4533
Chromium	< 0.50	mg/l	4533
Lead	< 0.50	mg/l	4533
Mercury	< 0.010	mg/l	5631
Selenium	< 0.100	mg/l	4533
Silver	< 0.10	mg/l	4533
Benzene	< 0.10	mg/l	4584
Carbon tetrachloride	< 0.1	mg/l	4584
Chlorobenzene	< 0.10	mg/l	4584
Chloroform	< 0.100	mg/l	4584
1,2-Dichloroethane	< 0.10	mg/l	4584
1,1-Dichloroethene	< 0.10	mg/l	4584
Methylethylketone	< 1.0	mg/l	4584
Tetrachloroethene	< 0.1	mg/l	4584
Trichloroethene	< 0.10	mg/l	4584
Vinyl Chloride	< 0.1	mg/l	4584
Cresols	< 0.1	mg/l	4647
Phenol	0.000	mg/l	4647
1,4-Di[illegible]zene	< 0.1	mg/l	4647

28

COPY 2

SPECIALIZED ASSAYS, INC.

2960 Foster Creighton Dr.
P.O. Box 40566
Nashville, TN 37204-0566
Phone 1-615-726-0177

PROJECT QUALITY CONTROL DATA

Blank Data

Analyte	Blank Value	Units	Q.C. Batch
2,4-Dinitrotoluene	< 0.10	mg/l	4647
Hexachlorobenzene	< 0.10	mg/l	4647
Hexchlor-1,3-butadien	< 0.1	mg/l	4647
Hexachloroethane	< 0.1	mg/l	4647
Nitrobenzene	< 0.1	mg/l	4647
Pentachlorophenol	< 0.1	mg/l	4647
Pyridine	< 0.1	mg/l	4647
2,4,5-Trichlorophenol	< 0.1	mg/l	4647
2,4,6-Trichlorophenol	< 0.1	mg/l	4647
Aroclor 1016	< 0.0333	mg/kg	5898
Aroclor 1221	< 0.0666	mg/kg	5898
Aroclor 1232	< 0.0333	mg/kg	5898
Aroclor 1242	< 0.0333	mg/kg	5898
Aroclor 1248	< 0.0333	mg/kg	5898
Aroclor 1254	< 0.0333	mg/kg	5898
Aroclor 1260	< 0.0333	mg/kg	5898

APPENDIX C

Appendix C
Calculations

Technical Memorandum

Date: 9 June 1999

To: 3084.25 Technical File

xc: Bernd Rehm, 3084.23 Tech. File

From: Jim Buss

Project No: **3084.25**

Subject: Residual Contaminant Level (RCL) Calculations

The attached spreadsheet presents the RCL analysis for the Tecumseh Products Company facility in Grafton, Wisconsin. RCLs have been calculated using the traditional soil-water partitioning coupled with dilution as presented in NR 720. Site specific data for the soils at the site have shown substantial total organic carbon (TOC) with an average of 37,000 mg/kg (see Table 1). Bulk density for the site was also determined, at a mean value of 2.1 g/cm^3 (Table 1). Laboratory results for these determinations are attached.

Trichloroethene (TCE) is the driver with a baseline (existing conditions) RCL of 8 µg/kg. If recharge through the site is reduced, the RCL can be increased. The WDNR assumes a default recharge value of 10 inches per year over vegetated surfaces. Although there are no default values for recharge through paving, it is reasonable to assume that well-maintained paving could cut recharge at least in half. This would result in a TCE RCL of 14 µg/kg.

The discussion below presents the approach to development of RCLs for this site. A spreadsheet where the RCLs are calculated is attached to this memorandum (see Table 2).

RCLs were calculated for the fine-grained soils in the east parking lot using a partitioning analysis coupled with dilution in the underlying aquifer. The partitioning analysis generates an uncorrected RCL concentration for a compound in a soil sample assuming the soil moisture concentration is equal to the PAL for that compound. The uncorrected RCL is then multiplied by a dilution factor to reflect the dilution of the impacted soil moisture as it recharges the aquifer.

As described above, the RCLs were developed to be protective of the NR 140 PAL. There may be flexibility in the WDNR to allow development of RCLs that are protective of enforcement

1/15

standards (ESs). If this were the case, the RCLs could be multiplied by a factor of 10 (for TCE) or 5 (for TCA).

There are 2 steps to the RCL calculation process which are described in detail as follows:

1. RCLs are expressed as a contaminant concentration detected in soil. In the first step of this analysis, the soil concentration is determined using partitioning analysis and assumes that the soil moisture has a concentration equal to the PAL. The soil moisture is assumed to eventually reach the underlying aquifer as contaminated recharge. This analysis assumes that there is no volatilization, which would otherwise lower the concentration in the soil moisture and result in a higher RCL. The calculation for this partitioning analysis is:

   $C_{soil} = C_{soil\ moisture}(K_{oc}foc + 0_w/rho)$ where,

   C_{soil} = concentration in the soil sample (μg/kg)

   $C_{soil\ moisture}$ = concentration in soil moisture, this is equal to the PAL (μg/L)

   K_{oc} = partition coefficient for the compound of interest (L/kg)

   foc = decimal fraction of organic carbon in the sample (unitless)

   0_w = percentage soil moisture (unitless)

   rho = soil density (g/cm^3)

2. The result of the partitioning analysis is multiplied by a dilution factor (DF). The DF incorporates the site-specific rate of groundwater flow through the water table aquifer immediately beneath the contaminated soil. The DF is presented in NR 720 and is described as :

   DF = 1+(Kid)/(RL) where,

   K = hydraulic conductivity (in/yr)

   i = horizontal hydraulic gradient (unitless)

   d = depth of groundwater mixing zone

   L = the length of the of the source are parallel to the direction of groundwater flow (in)

R = groundwater recharge rate (in/yr)

Values for each of the parameters in this analysis as well as the results of the analysis are presented in Table 2. Three separate scenarios have been evaluated:

1. A background scenario where the surface conditions are unchanged. In this case, the recharge through the impacted area is equivalent to the WDNR default of 10 inches annually.

2. A paving scenario where the site is paved as a parking lot. In this case, the recharge is assumed to be 5 inches per year.

3. A low permeability scenario where recharge is reduced to 0.2 inches per year.

Table 1
TOC, Moisture, and Density
Tecumseh Products Company
Grafton, Wisconsin

Sample Designation and depth	Total Organic Carbon mg/kg	Moisture Content percent	Soil Density g/cm^3
SB18TCA 1-2 feet	45,000	3	2.03
SB18TCA 4-6 feet	42,000	18	NA
SB19TCA 5-6 feet	NA	NA	1.94
SB20TCA 0-2 feet	NA	NA	2.17
SB20TCA 1-2 feet	36,000	11	NA
SB20TCA 8-10 feet	43,000	17	NA
SB21TCA 6-8 feet	NA	NA	2.05
SB30TCA 1-2 feet	37,000	13	2.08
SB30TCA 8-10 feet	22,000	16	2.11
SB32TCA 1-2 feet	38,000	10	2.12
SB32TCA 8-9 feet	NA	NA	2.19
SB32TCA 8-10 feet	34,000	15	NA
SB36TCA 4-5 feet	NA	NA	2.21
SB36TCA 4-6 feet	36,000	10	NA
SB36TCA 8-9 feet	NA	NA	2.14
SB36TCA 8-10 feet	37,000	13	NA
Average	37,000	12.6	2.1
Notes	1. TOC analyzed by USEPA Method 9060		
	2. NA indicates not analyzed		

Table 2
RCL and SSL Calculations
Tecumseh Products Company
Grafton, Wisconsin

Substance	Groundwater Standards (1) ES (ug/l)	PAL (ug/L)	Koc(2) ml/g	RCL$_{gw}$ (ug/kg) with partitioning and NR 720 dilution (10 inches recharge) (3) Till	RCL$_{gw}$ (ug/kg) with partitioning and NR 720 dilution (5 inches recharge)	RCL$_{gw}$ (ug/kg) with partitioning and NR 720 dilution (0.2 inches recharge)
trichloroethene	5	0.5	126	8.3 E+00	1.4 E+01	3.0 E+02
1,1,1-trichloroethane	200	40	152	8.0 E+02	1.4 E+03	2.9 E+04

Wis. RCL$_{GW}$ Dilution Factor (unitless) (4)		
10" recharge	5" recharge	0.2" recharge
3.5 E+00	6.0 E+00	1.3 E+02

Soil Data used for RCL and SSL Calculations

Parameter	foc	Ow	n	d	L	R	R	R	rho	k	i
	fraction of organic carbon	average volumetric soil moisture content	total porosity	depth of groundwater mixing zone	source length parallel to groundwater flow	annual groundwater recharge	annual groundwater recharge with pavement	annual groundwater recharge with composie liner pavement	dry bulk density	Hydraulic Conductivity	hydraulic gradient
Units	fraction	fraction	fraction	inches	inches	inches	inches	inches	g/cc	in/yr	unitless
Source of Value	site data	site data	default	default	site data	default	-	-	site data	site data	site data
Till	0.037	0.126	0.43	60	1920	10	5	0.2	2.10	100000	0.008

Footnotes and Notes

(1) Groundwater standards include:
NR 140 ESs for SSL calculations and PALs for RCL calculations

(2) Koc (soil organic carbon/water partition coefficients) are from:
Dense Chlorinated Solvents by Pankow and Cherry, Waterloo Press, 1996

(3) RCLs calculated by partitioning and NR 720 dilution are calculated as RCL = DF x PAL x (Koc x foc + 0w/rho)

(4) Dilution factor is calculated based on method outlined in NR 720 as DF =1+ (K x I x d / RxL)

NA means not available.

Un

QC: JDH
QA: JDH

RMT, Inc.
Bulk Density Determination

Project Name: TECUMSEH | **Project #:** 3084.23

Sample Location	Sample Diameter (in)	Sample Height (in)	Sample Volume (cc)	Tare Wt. (g)	Wet Wt. + Tare (g)	Bulk Density (pcf)	g/cm³
SB-18-TCA, 1-2'	1.51	2.43	71.31	84.63	229.54	126.9	2.03
SB-19-TCA, 5-6'	1.53	2.94	88.58	83.44	255.56	121.3	1.94
SB-20-TCA, 0-2'	1.64	2.46	85.16	84.46	269.45	135.6	2.17
SB-21-TCA, 6-8'	1.65	2.74	96.01	85.12	282.24	128.2	2.05
SB-30-TCA, 1-2'	1.55	3.41	105.44	83.14	302.85	130.1	2.08
SB-30-TCA, 8-10'	1.66	3.90	138.32	83.58	375.59	131.8	2.11
SB-32-TCA, 1-2'	1.52	3.51	104.37	83.91	305.92	132.8	2.12
SB-32-TCA, 8-9'	1.67	3.27	117.37	84.19	341.67	136.9	2.19
SB-36-TCA, 4-5'	1.67	2.67	95.84	83.41	295.45	138.1	2.21
SB-36-TCA, 8-9'	1.67	3.50	125.63	83.26	352.46	133.8	2.14

average = 2.1 g/cm³

CARDINAL ENVIRONMENTAL

3303 Paine Avenue, Sheboygan, WI 53081
(920)459-2500 Fax: (920)459-2503
www.cardinalenvironmental.com

Revised Report

Kerry De Keyser
Tecumseh Products Company
900 North Avenue
Grafton , WI 53024-0000

Batch Number: 981700
Report Date: 11/4/98
Date Received: 9/3/98
Project Mgr: PVE

Parameter	Result	Units		LOD	LOQ	Method	Analyst	Date Analyzed
Cardinal Sample Number: 39117 Date Collected: 8/31/98 Grab; Sample Description: SB18TCA 1-2 Tecumseh Soil								
% Moisture	**3.0**	%	MVT	0.1	0.1	SW 5030		9/8/98
Total Organic Carbon	**45,000**	mg/Kg	EnC	120	380	SW 9060		10/30/98
Cardinal Sample Number: 39118 Date Collected: 8/31/98 Grab; Sample Description: SB20TCA 1-2 Tecumseh Soil								
% Moisture	**11.0**	%	MVT	0.1	0.1	SW 5030		9/8/98
Total Organic Carbon	**36,000**	mg/Kg	EnC	120	380	SW 9060		10/30/98
Cardinal Sample Number: 39119 Date Collected: 8/31/98 Grab; Sample Description: SB20TCA 8-10 Tecumseh Soil								
% Moisture	**17.0**	%	MVT	0.1	0.1	SW 5030		9/8/98
Total Organic Carbon	**43,000**	mg/Kg	EnC	120	380	SW 9060		10/30/98
Cardinal Sample Number: 39120 Date Collected: 9/1/98 Grab; Sample Description: SB36TCA 4-6 Tecumseh Soil								
% Moisture	**10.0**	%	MVT	0.1	0.1	SW 5030		9/8/98
Total Organic Carbon	**36,000**	mg/Kg	EnC	120	380	SW 9060		10/30/98
Cardinal Sample Number: 39121 Date Collected: 9/1/98 Grab; Sample Description: SB36TCA 8-10 Tecumseh Soil								
% Moisture	**13.0**	%	MVT	0.1	0.1	SW 5030		9/8/98
Total Organic Carbon	**37,000**	mg/Kg	EnC	120	380	SW 9060		10/30/98

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CARDINAL

ENVIRONMENTAL

3303 Paine Avenue, Sheboygan, WI 53081
(920)459-2500 Fax: (920)459-2503
www.cardinalenvironmental.com

Revised Report

Kerry De Keyser
Tecumseh Products Company
900 North Avenue
Grafton , WI 53024-0000

Batch Number: 981700
Report Date: 11/4/98
Date Received: 9/3/98
Project Mgr: PVE

Parameter	Result	Units		LOD	LOQ	Method	Analyst	Date Analyzed
Cardinal Sample Number: 39122 Date Collected: 9/1/98 Grab								
Sample Description: SB30TCA 1-2 Tecumseh Soil								
% Moisture	**13.0**	%	MVT	0.1	0.1	SW 5030		9/8/98
Total Organic Carbon	**37,000**	mg/Kg	EnC	120	380	SW 9060		10/30/98
Cardinal Sample Number: 39123 Date Collected: 9/1/98 Grab								
Sample Description: SB30TCA 8-10 Tecumseh Soil								
% Moisture	**16.0**	%	MVT	0.1	0.1	SW 5030		9/8/98
Total Organic Carbon	**22,000**	mg/Kg	EnC	120	380	SW 9060		10/30/98
Cardinal Sample Number: 39124 Date Collected: 9/1/98 Grab								
Sample Description: SB32TCA 1-2 Tecumseh Soil								
% Moisture	**10.0**	%	MVT	0.1	0.1	SW 5030		9/8/98
Total Organic Carbon	**38,000**	mg/Kg	EnC	120	380	SW 9060		10/30/98
Cardinal Sample Number: 39125 Date Collected: 9/1/98 Grab								
Sample Description: SB32TCA 8-10 Tecumseh Soil								
% Moisture	**15.0**	%	MVT	0.1	0.1	SW 5030		9/8/98
Total Organic Carbon	**34,000**	mg/Kg	EnC	120	380	SW 9060		10/30/98
Cardinal Sample Number: 39126 Date Collected: 8/31/98 Grab								
Sample Description: SB18TCA 4-6 Tecumseh Soil								
% Moisture	**18.0**	%	MVT	0.1	0.1	SM 2540 G		9/8/98
Total Organic Carbon	**42,000**	mg/Kg	EnC	120	380	EPA 415.1		10/30/98

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(920)459-2500 Fax: (920)459-2503
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Revised Report

Kerry De Keyser	Batch Number: 981700
Tecumseh Products Company	Report Date: 11/4/98
900 North Avenue	Date Received: 9/3/98
Grafton , WI 53024-0000	Project Mgr: PVE

Parameter	Result	Units	LOD	LOQ	Method	Analyst	Date Analyzed

Comments:

LOD Limit of Detection + Result estimated below the LOQ.

*LOQ Limit of Quantitation * Result falls between LOD and LOQ*

ENC Analyzed by En Chem, WI Lab Certification #405132750.

MVT Analyzed by MVTL Laboratories, WI Lab Certification #241283020.

Approved By: [signature] **Date:** 11/4/98

9

COMPUTATION SHEET

RMT

SHEET 1 OF 2

744 Heartland Trail P.O. Box 8923 Madison, WI 53708-8923 (608) 831-4444 FAX: (608) 831-3334 VOICE: (608) 831-1989

PROJECT / PROPOSAL NAME	PREPARED		CHECKED		PROJECT / PROPOSAL NO.
Tecumseh-Grafton NR 700	By: BWR	Date: 09.06.99	By:	Date:	3084.25

Solvent Concentration Range (ug/kg)	Geometric Mean Concentra. (ug/kg)	Incremental Area (m^2)	Incremental Volume ② (m^3)	Cummulative Volume (m^3)	Incremental Solvent Mass ③ (kg)	Cummulative Solvent Mass (kg)	Percent of Total Solvent Mass
10000 - 100000	30000	170	510	510	32.1	32.1	59
1000 - 10000	3000	720	2160	2670	13.6	45.7	87
100 - 1000	300	1590	5280	7950	3.33	49.0	94
26 - 100 ①	50	8050	24150	32100	3.37	52.4	100

① Lowest concentration assumes quantitation limit of 25 ug/kg with methanol preservation of soil samples.

② Volume assume 3 m (10 ft) depth of remediation. See Figure 3 for areal distribution of solvent concentrations

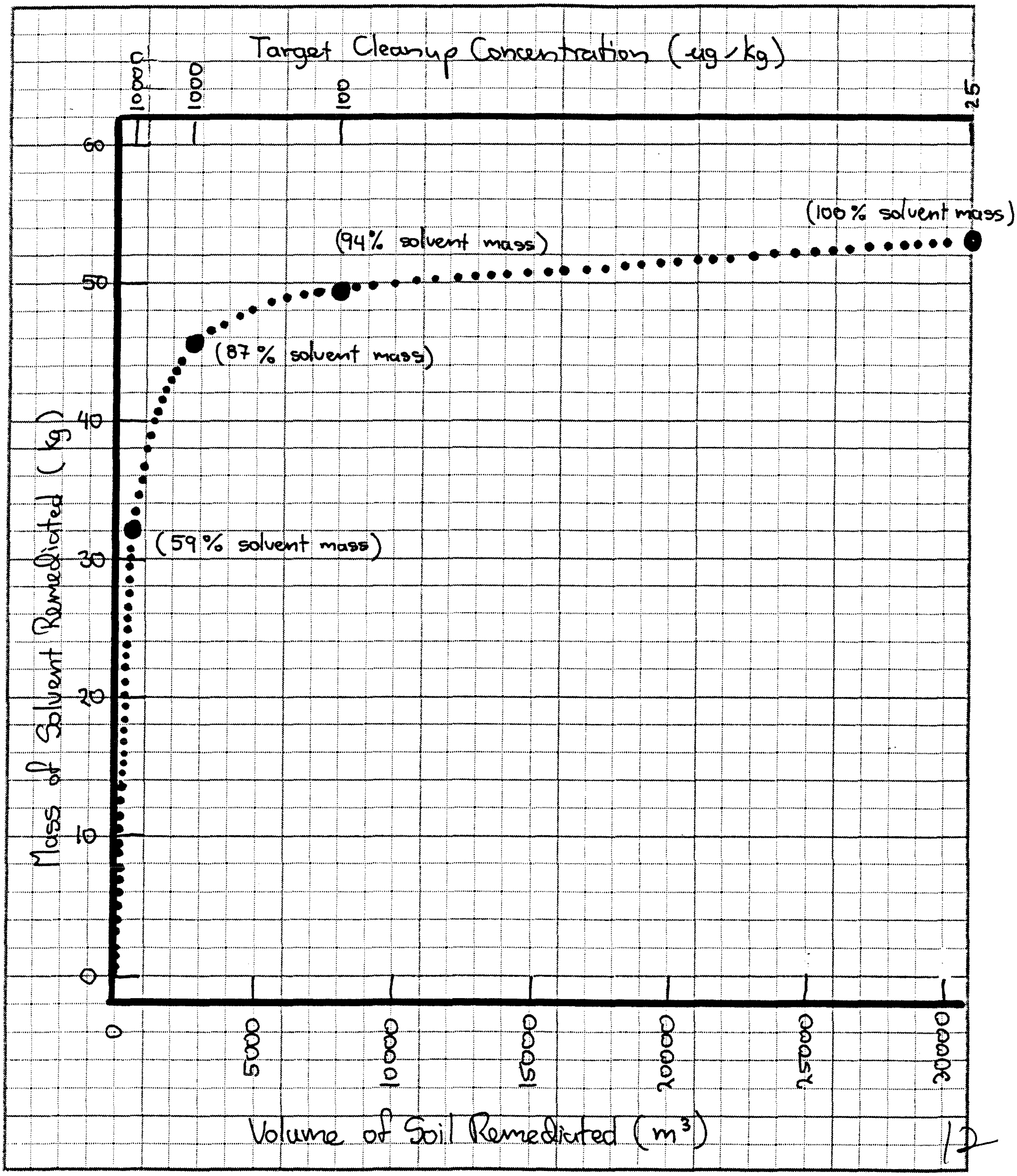
③ Assumes bulk density of 2100 kg/m^3 based on site-specific measurement of in-place soil.

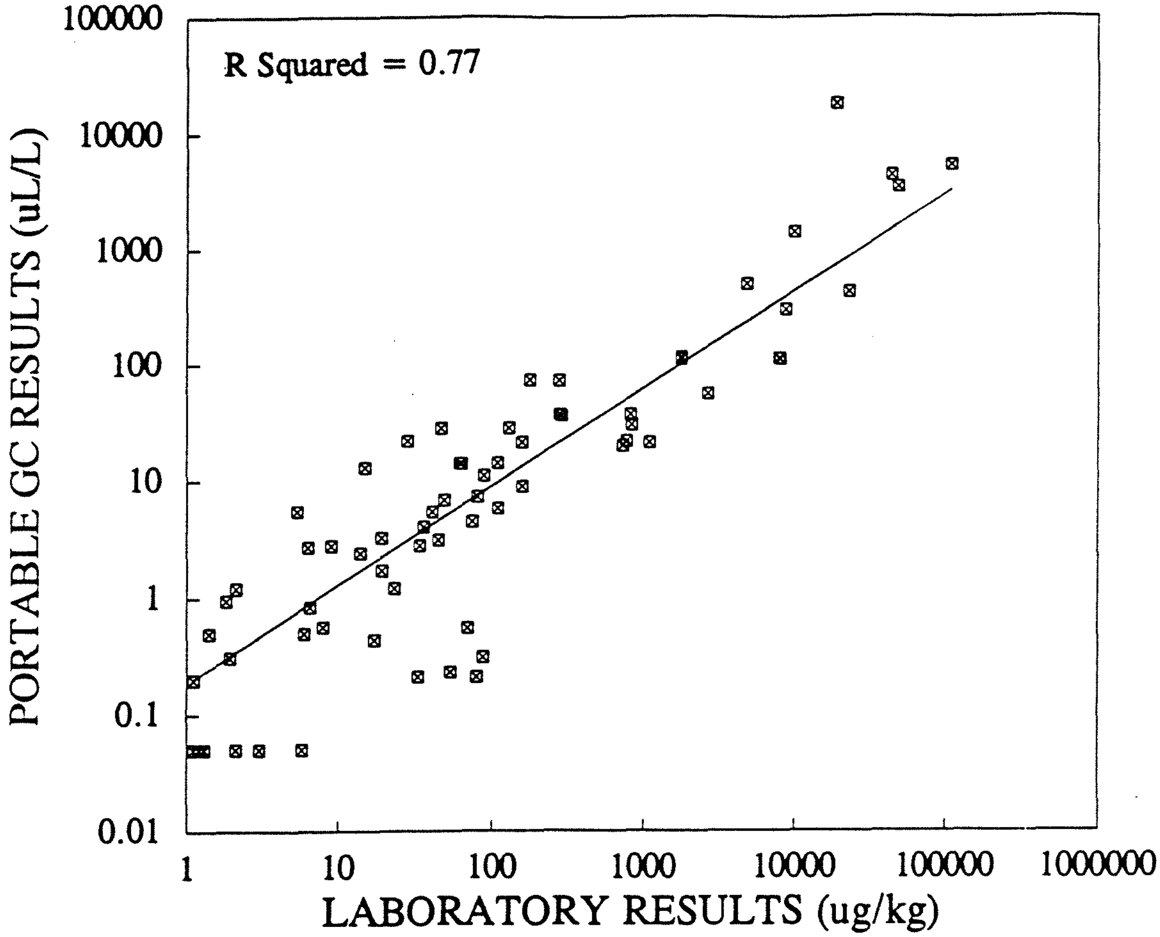
Solvent Mass (kg) = (Concentration, ug/kg)(Volume, m^3)(Density, kg/m^3)(10^{-9} kg/ug)

COMPUTATION SHEET

RMT
744 Heartland Trail P.O. Box 8923 Madison, WI 53708-8923 (608) 831-4444 FAX: (608) 831-3334 VOICE: (608) 831-1989

PROJECT / PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT / PROPOSAL NO.
Tecumseh Grafton NR700	BMR	9-06-99			3084.25





RMT COMPUTER AIDED DESIGN & DRAFTING

PLOT DATA

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Operator Name: RBN
Scale: 1"=1'

Dwg Size: 16439 Bytes
Plot Date: Thursday, March 20, 1997
Plot Time: 09:44.3509 AM
Attached Xref's: No xref's Attached.

LABORATORY VS. PORTABLE GC RESULTS FOR TCE IN SOIL

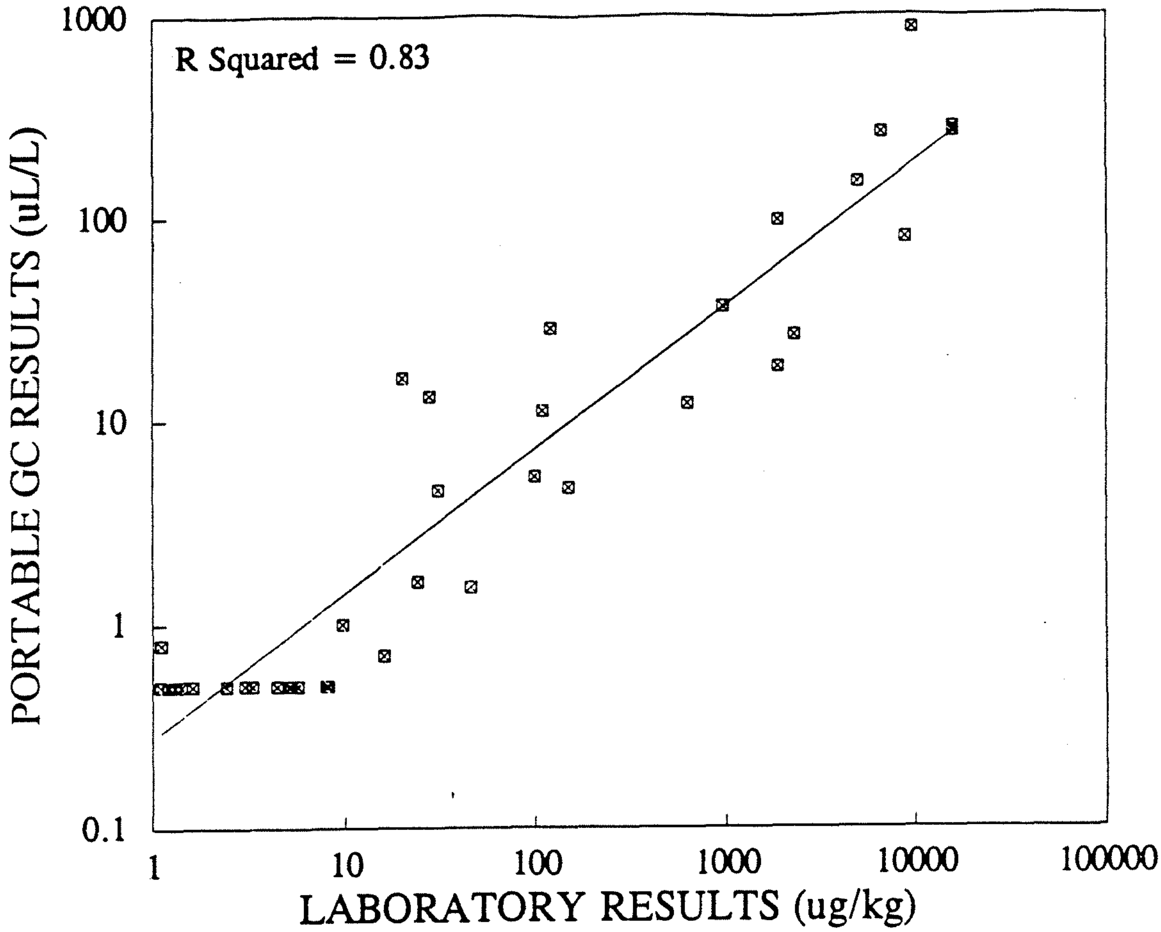
TECUMSEH PRODUCTS COMPANY GRAFTON, WISCONSIN

RMT INC.

DWN. BY:	RBN
APPROVED BY:	BWR
DATE:	APRIL 1997
PROJ. #	3084.18
FILE #	30841807.DWG

FIGURE 8

14



LABORATORY VS. PORTABLE GC
RESULTS FOR TCA IN SOIL
TECUMSEH PRODUCTS COMPANY
GRAFTON, WISCONSIN

RMT INC.

DWN. BY:	RBN
APPROVED BY:	BWR
DATE:	APRIL 1997
PROJ. #	3084.18
FILE #	30841808.DWG

FIGURE 9

15/15

PLOT DATA
Drawing Name: J:\03084\18\30841808.DWG
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Dwg Size: 13512 Bytes
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Plot Time: 09:45.3166 AM
Attached Xref's: No xref's Attached.

Appendix D
Best Judgement Cost Estimates

TABLE A1

CONCEPTUAL COST ESTIMATE FOR SUBSURFACE REMEDIAL OPTIONS ANALYSIS REPORT

TECUMSEH - GRAFTON FACILITY
Project # 3084.23

REMEDIAL OPTION 1 EAST PARKING LOT AREA - SOIL REMOVAL TO 1000 PPB

LINE ITEM	UNIT	UNIT COST	QUANTITY	TOTAL
DIRECT CAPITAL				
MOBILIZATION	%	5%	320,000	16,000
SITE PREPARATION				
Protect utilities	LS	15,000.00	1	15,000
Temporarily relocate gas lines	LS	5,000.00	1	5,000
Develop staging area	LS	5,000.00	0	0
Ground penetrating radar survey	LS	5,000.00	0	0
CONSTRUCTION/SITE WORK				
Base course (9" thick crushed traffic bond)	SY	8.15	1,230	11,000
Excavation	CY	8.00	4,400	36,000
General Fill	CY	16.00	5,200	84,000
Silt Fencing	LF	2.50	120	1,000
OFF-SITE DISPOSAL				
Hauling	TON	6.00	8,400	50,000
Disposal, special waste, subtitle D facility	TON	14.00	8,400	118,000
Contingency (direct capital)	%	30%	336,000	101,000
SUBTOTAL, DIRECT CAPITAL COSTS				437,000
INDIRECT CAPITAL COSTS				
Design	LS	20,000.00	1	20,000
Construction assistance	LS	20,000.00	1	20,000
Construction documentation	LS	10,000.00	1	10,000
Startup/shakedown	LS	5,000.00	0	0
Laboratory Analysis				
Soil characterization for disposal	EA	2,000.00	2	4,000
Confirmation sampling	EA	150.00	30	5,000
Waste profile acceptance assistance	LS	5,000.00	1	5,000
Air permit assistance	LS	5,000.00	0	0
SUBTOTAL, INDIRECT CAPITAL COSTS				64,000
TOTAL CAPITAL COSTS				500,000
ANNUAL OPERATION & MAINTENANCE COSTS				
Groundwater monitoring (per 1996 estimate)	YR	23,000.00	1	23,000
Contingency	%	30%	23,000	7,000
SUBTOTAL, ANNUAL O&M COSTS				30,000
PRESENT WORTH OF ANNUAL O&M COSTS n = 10 years, interest rate = 3%, P/A = 8.53		8.53	30,000	256,000
TOTAL (total capital + present worth of annual O&M costs)				756,000

GRAND TOTAL		**756,000**
	-20	605,000
	50	1,134,000

ASSUMPTIONS:

GENERAL

1. Costs rounded up to the nearest thousand dollars.
2. Perimeters, areas, and volumes of areas determined from Figure 1 of the updated investigation letter report, 1/29/99.
3. Costs determined from vendor quotes, Means Construction Cost data, and estimates from other similar projects.
4. Mobilization costs are assumed to be 5% of direct capital costs.
5. Contingency is assumed to be 30% of direct capital and 30% of annual O&M.
6. Indirect costs do not include regulatory report preparation, obtaining regulatory approvals, legal fees, or public relations assistance.
7. Interest rate 3%; the balance of an 8% interest rate less a 5% inflation rate, based on EPA approach for remedial cost estimating.
8. All costs are based on preliminary concepts. They are intended for comparison among options and not for final budgeting.

SPECIFIC

9. East Parking Lot Area for excavation includes north area (8,140 sf, 10 ft depth) and south area (1,450 sf, 12 ft depth).
10. Excavation volume is 4,400 cubic yards (includes 20% contingency), with a soil density of 1.75 ton/cubic yard.
11. Excavated soil will be direct landfilled as a special waste at a Subtitle D facility. Assumes soil is not characteristically hazardous for TCE. Should the tested soil be characteristically hazardous, soil hauling and disposal costs would increase significantly.
12. Contractor will work around water and sewer lines.

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TABLE A2

CONCEPTUAL COST ESTIMATE FOR SUBSURFACE REMEDIAL OPTIONS ANALYSIS REPORT

TECUMSEH - GRAFTON FACILITY
Project # 3084.23

REMEDIAL OPTION 2 EAST PARKING LOT AREA - IN-SITU HOT AIR TREATMENT - 1000 PPB

LINE ITEM	UNIT	UNIT COST	QUANTITY	TOTAL
DIRECT CAPITAL				
MOBILIZATION/INSURANCE	LS	50,000.00	1	50,000
SITE PREPARATION				
Protect utilities	LS	10,000.00	1	10,000
Fence removal for access	LF	3.00	0	0
Develop staging area	LS	5,000.00	1	5,000
Ground penetrating radar survey	LS	5,000.00	1	5,000
CONSTRUCTION/SITE WORK				
Base course (9" thick crushed traffic bond)	SY	8.15	1,230	11,000
MITU thermal injection service	TON	33.00	7,700	255,000
Carbon units	EA	690.00	3	3,000
Carbon disposal	LB	5.00	1,500	8,000
Compaction	LS	30,000.00	1	30,000
LEASED EQUIPMENT				
Plywood for stability while operating MITU	LS	1,000.00	1	1,000
OFF-SITE DISPOSAL				
Hauling	TON	6.00	720	5,000
Disposal, direct landfill, subtitle D facility	TON	14.00	720	11,000
Contingency (direct capital)	%	30%	394,000	119,000
SUBTOTAL, DIRECT CAPITAL COSTS				513,000
INDIRECT CAPITAL COSTS				
Design	LS	20,000.00	1	20,000
Construction assistance	LS	40,000.00	1	40,000
Construction documentation	LS	10,000.00	1	10,000
Laboratory Analysis				
Soil characterization for disposal	EA	2,000.00	0	0
Confirmation sampling	LS	15,000.00	1	15,000
Waste profile acceptance assistance	LS	5,000.00	0	0
Air permit assistance	LS	5,000.00	1	5,000
SUBTOTAL, INDIRECT CAPITAL COSTS				90,000
TOTAL CAPITAL COSTS				603,000
ANNUAL OPERATION & MAINTENANCE COSTS				
Groundwater monitoring (per 1996 estimate)	YR	23,000.00	1	23,000
Contingency	%	30%	23,000	7,000
SUBTOTAL, ANNUAL O&M COSTS				30,000
PRESENT WORTH OF ANNUAL O&M COSTS n = 10 years, interest rate = 3%, P/A = 8.53		8.53	30,000	256,000
TOTAL (total capital + present worth of annual O&M costs)				859,000

GRAND TOTAL		**859,000**
	-30	601,000
	50	1,289,000

ASSUMPTIONS:

GENERAL

1. Costs rounded up to the nearest thousand dollars.
2. Perimeters, areas, and volumes of areas determined from Figure 1 of the updated investigation letter report, 1/29/99.
3. Costs determined from vendor quotes, Means Construction Cost data, and estimates from other similar projects.
4. Contingency is assumed to be 30% of direct capital and 30% of annual O&M.
5. Indirect costs do not include regulatory report preparation, obtaining regulatory approvals, legal fees, or public relations assistance.
6. Interest rate 3%; the balance of an 8% interest rate less a 5% inflation rate, based on EPA approach for remedial cost estimating.
7. All costs are based on preliminary concepts. They are intended for comparison among options and not for final budgeting.

SPECIFIC

8. East Parking Lot Area for thermal treatment includes north area (8,140 sf, 10 ft depth) and south area (1,450 sf, 12 ft depth).
9. Treatment volume is 4,400 cubic yards (includes 20% contingency), with a soil density of 1.75 ton/cubic yard.
10. Plywood is included to account for soil instability during implementation.
11. Construction assistance assumes project will take 5 weeks, at a MITU rate of 350 ton/day.
12. Contractor will work around water and sewer lines.

APPENDIX D