STS CONSULTANTS, LTD.

Additional Investigation Work Plan
Holtz – Krause Landfill

Foley & Lardner
777 E. Wisconsin Ave.
Milwaukee, WI 53002

STS Project No. 4-21954XB

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THE INFRASTRUCTURE IMPERATIVE

STS CONSULTANTS

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January 27, 2005

Mr. Bill Evans
Wisconsin Department of Natural Resources
West Central Region Office
1300 West Clairemont Avenue
Eau Claire, WI 54702-4001

RE: Holtz-Krause Landfill, STS Project No. 4-21954XB

Dear Mr. Evans:

This Work Plan has been prepared to address investigative activities outlined in the January 27, 2005 STS Response Letter to the Wisconsin Department of Natural Resources (WDNR) letter dated May 13, 2003 to Mr. David Erickson. Specifically, the document provides a work plan for the following two tasks: (1) sampling and analytical testing of leachate within the landfill waste, and (2) installation of a new monitoring well nest near the intersection of Kent Street and Grand Avenue. If you have any questions concerning the information contained herein, please feel free to contact us.

Respectfully,

STS CONSULTANTS, LTD.

Mark M. Mejac, P.G., C.G.W.P.
Senior Project Scientist - Hydrogeologist

Jeanne M. Tarvin, P.G., C.P.G.
Senior Principal Scientist – Hydrogeologist

cc: Barbara J. Hennings

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Wisconsin Department of Natural Resources
STS Project No. 4-21954XB
January 27, 2005

1.0 INTRODUCTION

1.1 Site Description

The Holtz-Krause Landfill Site (Holtz-Krause) is located in the City of Wausau in Marathon County, Wisconsin. The site is located in Section 6, Township 28 North, Range 8 East, and Section 1, Township 28 North, Range 7 East, in Marathon County. The landfill exists within the Wausau city limit area, with a variety of surrounding land uses. The adjacent land uses include: residential and railroad property to the east; wooded wetlands and the Eau Claire River to the south; residential, commercial, and cemetery properties to the west; and cemetery, railroad and industrial property to the north. The site location is shown on Figure 1.

Holtz-Krause Landfill comprises approximately 57 acres and reportedly contains 1.4 million cubic yards of municipal, residential, and industrial refuse. The operational history of the site for solid waste disposal dates from approximately 1957 to December, 1980, at which time the site was closed. An initial cap was placed on the landfill between closure and 1982. The cap did not meet WDNR design standards and groundwater monitoring analysis indicated contamination above the NR 140 of the Wisconsin Administrative Code (WAC) Enforcement Standard (ES). Final closure of the site, excluding the phased groundwater/leachate extraction remedy, was completed in 1994 and 1995 in accordance with the July 22, 1992 Record of Decision (ROD) and the Consent Decree between the Wisconsin Department of Natural Resources (WDNR) and settling parties represented by the Holtz-Krause Steering Committee, which was entered in Federal Court on August 26, 1994.

The current condition of the site reflects construction and installation of the cap and gas extraction system in 1994 and 1995. All of the components of the ROD were complied with except the three components of the remedy associated with the phased groundwater/leachate extraction remedy. The WDNR accepted work on the following tasks on October 5, 1995:

1. Construction of a low-permeable landfill cap consistent with Chapter NR 504, (WAC);
2. An active gas extraction system containing thirty-five gas extraction wells, a blower house and a candlestick flare and a condensate collection system;
3. Installation of groundwater monitoring wells to complete the long-term groundwater monitoring network;

4. Operation and maintenance of all systems;
5. Long-term groundwater monitoring;
6. Abandonment of monitoring wells which did not conform to NR 141 WAC or were not necessary for long-term monitoring;
7. Disposal of investigative wastes generated during the Remedial Investigation (RI) and Remedial Action (RA) phases of the project; and
8. Institutional controls, deed restrictions and site controls.

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The three remaining phased groundwater/leachate extraction components of the selected remedy as outlined in the ROD include the following:

1. Phased groundwater/leachate extraction dependent on groundwater exceedances of NR 140 WAC standards;
2. Wastewater discharge to local surface waters if the groundwater extraction phase is triggered; and
3. On-site wastewater treatment required to the degree necessary to meet WPDES permit requirements (other than gas condensate to the local POTW).

According to the ROD, the groundwater/leachate extraction remedy at the site will be approached in a phased manner and the need for those components of the remedy will be dependent on the results of long-term groundwater monitoring initiated immediately after the completion of the cap and active gas extraction system. The 1992 ROD states the following as the criteria for implementation of the phased groundwater/leachate extraction component of the remedy: "If groundwater monitoring outside of the design management zone, one year after completion of the cap indicates the groundwater quality exceeds NR 140 WAC, a groundwater extraction system will be implemented".

Long-term groundwater monitoring was initiated in April 1996. The results of groundwater monitoring conducted since 1996 are summarized in the following reports:

- March 7, 1997 STS report entitled "1996 Groundwater Monitoring Summary"
- April 1998 STS report entitled "1997 Groundwater Analysis Report"
- March 8, 1999 STS report entitled "1998 Annual Performance Evaluation Report"

- March 22, 2000 report entitled "1999 Annual Performance Evaluation Report" (Fifth Year Supplemental Report)
- March 16, 2001 report entitled "2000 Annual Monitoring Report"
- March 29, 2002 report entitled "2001 Annual Monitoring Report"

Since the ROD was issued in 1992, WDNR promulgated the NR 700 WAC series which was developed "to establish consistent, uniform standards and procedures that allow for site-specific flexibility, pertaining to the identification, investigation and remediation of sites and facilities which are subject to regulation under s.291.11, 292.15, 292.31 or 292.4, stats". Recognizing the applicability of the NR 700 WAC series (in particular the applicability of remediation by natural attenuation for the groundwater component of the remedy), as well as the WDNR's authority under the Consent Decree and ROD, WDNR has provided one-year extensions of the groundwater extraction system evaluations since 1997.

Further, to meet the requirements of NR 716 WAC, the WDNR in their September 4, 1998 Comment Letter on the 1997 Groundwater Analysis Report requested that the Steering Committee install two bedrock wells (MW-11D and MW-25D) to identify the degree and extent of contamination in the bedrock. The letter indicated that the extent must be defined to determine the effectiveness of the landfill cap and gas extraction system to consider natural attenuation as a groundwater restoration remedy under NR 726.05 WAC. In December 1998, STS, under the direction of the Steering Committee, installed and sampled the two bedrock wells. The absence of contaminants of concern in these two downgradient bedrock wells support the conclusion that the contamination has been defined both vertically and laterally.

1.2 Purpose

This Work Plan was prepared to address investigative activities outlined in the January 27, 2005 STS Response Letter to the Wisconsin Department of Natural Resources (WDNR) letter dated May 13, 2003 to Mr. David Erickson. Specifically, the document provides a work plan for the following two tasks: (1) sampling and analytical testing of leachate within the landfill waste, and (2) installation of a new monitoring well nest near the intersection of Kent Street and Grand Avenue. This document is organized into six sections of text, and includes tables and figures. Sections 1.0 through 4.0 provide site background information, and Section 5.0 provides a proposed scope of work to address the additional work. Standard operating procedures are attached.

2.0 PROJECT BACKGROUND

2.1 Site History

The history of the Holtz and Krause Landfill as presented herein was obtained from review of the Remedial Investigation Report (Geraghty & Miller, 1991). The Rib Mountain Construction Company purchased a 57 acre parcel of land (the Holtz and Krause Landfill site) east of the City of Wausau in 1957 for use as a sand and gravel pit. At approximately the same time, the owners of the company, Otto Holtz and William Krause, signed contracts with a number of municipalities to use the site as a sanitary landfill for solid waste disposal. During the course of its operation, the site reportedly accepted over 1.4 million cubic yards of municipal, residential and industrial waste, until it was ordered closed in 1980.

Citizen complaints regarding operation of the Holtz and Krause Landfill have ranged from airborne dust and waste paper to contamination of potable water obtained from the adjacent and underlying shallow sand and gravel aquifers. Apparent groundwater contamination prompted officials from the WDNR to visit the site to observe landfill management methods and assess potential groundwater contamination. Photographs taken by WDNR personnel in 1966 document that the landfill was operated as an open dump and that solid waste was dumped into areas where sand and gravel were excavated and the water table was exposed. The WDNR pursued legal action against Holtz and Krause, Inc. for willful operation violations. Operation of the landfill continued until December 1980, when the landfill stopped accepting waste. Becher-Hoppe, Engineers, Inc. of Schofield, Wisconsin was hired by the owners to oversee groundwater monitoring, site design and closure of the site.

2.2 Technical Summary of Previous Work

2.2.1 Early Investigation

Several investigations/evaluations were conducted prior to initiation of the RI/FS. The following list summarizes the documents/activities that exist to characterize site conditions at the Holtz-Krause Landfill:

- June 1969: Division of Environmental Protection; water samples collected.
- May to November 1969: Wisconsin District 4 Sanitation; water samples collected for bacteriological studies.

- August 1969: Wisconsin District 4 Sanitation; surface water samples collected near Holtz-Krause landfill.
- November 1972: G. Fred Lee; Water Quality Report.
- July 1972: Bashew and Martin; surface and groundwater quality report.
- February 1973: Ronald G. Hennings; Water Quality and Hydrogeologic Assessment.
- September 1974: Lon C. Ruedisili and Donald Olson; Hydrogeologic Investigation of the Holtz and Krause Landfill.
- December 1974: James B. McDonald; Report of Investigations of WDNR, Wausau Dump.
- December 1975: Becher-Hoppe Engineers, Inc.; Holtz and Krause Sanitary Landfill Report.
- February 1979: Becher-Hoppe Engineers, Inc.; Holtz and Krause Landfill Abandonment Plan.
- February 1980: Becher-Hoppe Engineers, Inc.; Holtz and Krause Landfill Final Abandonment Plan (revised). This document was summarized in Technical Memorandum Number One (Geraghty & Miller, 1989).
- September 1981: Marathon County Planning Commission; closing, monitoring, and long-term care requirements of the Holtz and Krause Landfill.
- April 1984: Becher-Hoppe Engineers, Inc.; soil boring report of cap integrity.
- December 1985: USEPA; potential hazardous waste site assessment.
- July 1986: USEPA; potential hazardous waste site assessment.
- August 1986: Foth and Van Dyke; Work Plan submitted for hydrogeologic investigation and closure plan at Holtz and Krause Landfill site.

Periodic sampling of the monitoring wells installed on the site in 1974 was also conducted by the WDNR. The analytical results of samples collected indicated the following VOCs were detected in the groundwater: alkalated benzenes, chlorofluoromethane, dichlorofluoromethane, hydrocarbons, toluene, trichloroethene, vinyl chloride, xylene and ethylbenzene.

A fish survey was also conducted by the WDNR in the mid-70s to mid-80s. Fish, turtle, snail and clam tissue were analyzed for metals and pesticides, however no elevated metals or pesticides were detected in any of the samples. Furthermore, a Wisconsin publication reported that the Eau

Claire and Wisconsin Rivers near Wausau had not been impacted by the Holtz and Krause Landfill (WDNR, 1986).

2.2.2 Remedial Investigation

Geraghty & Miller, Inc. conducted the RI under contract with the WDNR and the Holtz-Krause Steering Committee through Holtz and Krause Contractors, Inc. beginning in September of 1989 and ending in 1991. Data collection objectives were to characterize the site, define the migration pathways and describe methods used to evaluate the extent and magnitude of contamination migration within those pathways, assess risk and provide data for the Feasibility Study (FS). The data collection scope of work consisted of the following activities: completion of shallow auger borings in the existing landfill cover material and geotechnical and laboratory analysis of the soil samples; collection and laboratory analysis of soil and waste samples from borings completed through and near the landfill; collection and analysis of geologic, geotechnical and hydrogeologic information from borings, water-table monitoring wells and piezometers; collection and laboratory analysis of two rounds of groundwater samples obtained from these monitoring wells; completion of air monitoring surveys around the perimeter of the landfill; collection and laboratory analysis of two rounds of surface water samples; collection and chemical analysis of sediment samples and resident aquatic biota; and, collection and chemical analysis of a leachate sample.

Consistent with the requirements of the National Contingency Plan (NCP), a Quantitative Baseline Risk Assessment (BRA) was performed on the RI data to evaluate the potential present and future risks to human health. The BRA, included in the RI, evaluated two hypothetical future groundwater exposures: 1) potable use by a resident at the site, and 2) contact while showering. Both hypothetical groundwater exposure scenarios were within or below USEPA guidelines for acceptable risks based on the RI data. Because these risks are based on potential, not actual exposures, they are conservative and the actual risks are considered much lower.

The major findings of the RI are contained in the June 1991 RI Report and are summarized briefly below:

- Four geologic units were encountered at the site. The uppermost unit is a sand to silt topsoil unit, which includes the landfill cover material. The native unit underlying the topsoil is a fine to coarse, poorly sorted sand containing traces of gravel. Underlying the sand is a silty fine sand which grades to stiff clay. This unit is apparently discontinuous across the site. Below this unit is the granitic bedrock.

- Two major hydrostratigraphic units are reported in the unconsolidated material at the site. The upper of which is the sand unit and the lower unit is the silty sand to clay that overlies the bedrock. Groundwater was encountered at depths of 4 to 46 feet below ground surface, at approximate elevations of 1165 to 1230 feet mean sea level (msl). Groundwater flow was generally east to west, with a southern component of flow near the southern portion of the site.

- Soil samples collected from the landfill cover contained detectable concentrations of trichloroethene (7 and 13 micrograms per kilogram [μg/kg]), toluene (2 μg/kg), PAHs (81 to 4,400 μg/kg), pesticides (9.1 to 360 μg/kg) and PCBs (140 to 360 μg/kg) and elevated concentrations of cobalt, copper, mercury and zinc. The distribution of samples containing detectable or elevated organic and inorganic constituents does not appear to follow any spatial pattern across the landfill.

- Subsurface soil samples are reported to contain detectable levels of VOCs (1 to 100 μg/kg), semi-volatiles (110 to 21,000 μg/kg) and the pesticide methoxychlor. Several of the semi-volatiles and methoxychlor were also detected in background samples.

- The waste samples generally contained a greater number of chemical constituents at higher concentrations than other media collected during the investigation. VOCs were detected in all but one waste sample in concentrations ranging from 0.002 to 41 milligrams per kilogram (mg/kg). Detected semi-volatiles were reported in concentrations ranging from 0.110 to 240 mg/kg. Dieldrin was detected in one waste sample at 0.031 mg/kg. PCBs were detected in 6 waste samples from 0.420 to 26.2 mg/kg. Elevated concentrations of cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickel, selenium, silver, zinc and cyanide were also reported in the waste.

- Based on two rounds of groundwater analyses conducted in 1989 and 1990, VOCs, semi-volatiles, organochlorine pesticides, chlorinated herbicides and triazine pesticides were detected in the groundwater samples. The most frequently detected VOCs were aromatic hydrocarbons. The concentrations of total aromatic hydrocarbons (benzene, toluene, ethylbenzene, and xylenes) ranged from below the laboratory detection limit to 208 micrograms per liter (μg/L) across the site. Concentrations of semi-VOCs ranged from 2 to 11 μg/L. Pesticides and herbicides ranged in concentration from 0.4 to 1.1 μg/L. Statistically elevated concentrations of inorganic compounds consisted of barium, iron and manganese. The highest concentrations of organic and inorganic compounds were detected in wells installed into the waste fill at the landfill.

- Surface water samples contained only one detection of organics (toluene at 1 μg/L, during one sample round). Iron was detected in several surface water samples at concentrations greater than 1 milligram per liter (mg/L).
- The only leachate sample that was collected contained no detectable organic compounds; however, the iron concentration exceeded 1 mg/L.
- Sediment samples collected from the surface water bodies adjacent to the landfill contained detectable concentrations of VOCs and PAHs. Elevated concentrations of inorganic compounds were not detected in the sediment samples.

2.2.3 Feasibility Study

Geraghty & Miller, Inc. was retained by the WDNR and the Holtz-Krause Steering Committee through Holtz and Krause Contractors, Inc. to complete a Feasibility Study (FS). The objective of the FS was to identify and evaluate alternatives for the remediation of the landfill.

The FS resulted in compilation of seven alternative measures for the Holtz and Krause Site. The potential range of actions including no action, source control (waste containment), and groundwater remediation were considered and evaluated using the nine criteria from the National Contingency Plan (NCP). When considering all factors, Geraghty & Miller recommended Alternative 5. The FS identified Alternative 5 as follows: Soil Cap, Groundwater Interception and Discharge to the Eau Claire River.

2.3 Remedial Action Overview

Based on the RI/FS, the BRA, the comments received during the public comment period, and the Summary of Remedial Alternative Selection prepared by WDNR, the WDNR selected Modified Alternative 4 as the remedial action for Holtz and Krause. Modified Alternative 4 is outlined as the selected remedy in the July 22, 1992 ROD. The specific components of the selected remedy are outlined in Section 1.1 of this report. As stated in Section 1.1, 8 of the 11 components of the selected remedy were started and/or completed in 1994 and 1995. The remaining three components of the remedy pertain to the phased groundwater/leachate extraction remedy. The need for implementation of the phased groundwater/leachate extraction remedy is to be based on: 1) the results of the groundwater monitoring quality data collected since completion of the other 8 remedy components; 2) associated risks to human health and the environment; and, 3) considerations of State soil and groundwater standards. Final determination of the need to implement a phased groundwater/leachate system will be made by WDNR after review of the long term groundwater monitoring data. In the event that a phased groundwater/leachate collection system was deemed to be necessary in the future, such a system was to be designed to minimize declines in the water table at the locations of local wetlands.

Since issuance of the ROD, WDNR promulgated the NR 700, WAC series. The purpose of the NR 700, WAC series is to establish consistent, uniform standards and procedures that allow for site specific flexibility pertaining to the identification investigation and remediation of sites and facilities subject to regulation under s.292.11, 292.15, 292.31 or 292.41, stats. In addition, chapters NR 720, NR 722 and NR 726 are applicable to solid waste facilities where remedial action is required by the WDNR pursuant to NR 508.20(11). With the promulgation of the NR700 series, WDNR accepted natural attenuation of groundwater as a final remedy for groundwater. When the 1992 ROD was issued for the Holtz and Krause site, natural attenuation was not an acceptable remedy for groundwater under the existing NR 100 and NR 500 series. The long term groundwater quality data collected since 1996 supports the conclusion that natural attenuation of groundwater is occurring and is an acceptable final remedy for groundwater. As such, a groundwater/leachate collection system is not necessary.

3.0 REGIONAL AND SITE – SPECIFIC HYDROGEOLOGIC SETTING

3.1 Topography

The Holtz-Krause Site is located in the Great Lakes section of the Central Lowland Physiographic Province of Wisconsin, which is characterized by a gently rolling appearance with poorly developed drainage patterns. The present physiography of the area is controlled by the top of the bedrock surface and has been modified by glacial erosion and deposition. The land surface is commonly between elevation 1,100 and 1,300 feet msl within the study area. Topography at the site was modified through the operation of a sand and gravel pit and later by the landfill.

Prior to construction of the new landfill cover, the surface of the Holtz-Krause Landfill generally sloped to the southwest. The elevation of the study area ranged from approximately 1,228 feet above msl northeast of the intersection of Swanee Avenue and Northwestern Avenue, to approximately 1,160 ft. msl at Pils Slough. The land surface in the site area generally slopes to the southwest from Northwestern Avenue toward Horseshoe, Pils and Cemetery Sloughs. Prior to re-covering, the landfill cover sloped to the southwest. A ridge, approximately 50 feet high is located west of Cemetery Slough.

The landfill cap completed in 1995 has a 2 percent slope from north to south with the exception of approximately 259 feet in the middle of the landfill where the slope was modified to 1 percent to minimize contact with waste. The reworking and improvement of the landfill cover did not significantly change overall site grades, although the top of the cover generally slopes to the south, rather than the southwest. Some site grading was also completed to create a handicap access path, the on-site roads and to improve and re-direct surface water drainageways, but this has not changed the gross site profile.

3.2 Surface Hydrogeology

The Holtz-Krause Site is located within the northern part of the Central Wisconsin River Drainage Basin. The Wisconsin River, which is located west of the landfill, drains approximately 12,280 square miles. Average discharge at Merrill, Wisconsin, approximately 20 miles upstream, is 2,687 cubic feet per second (cfs). High and low extremes in discharge at Merrill were 99,400 cfs on August 31, 1941 and 90 cfs on September 26, 1908. The Wisconsin River has several tributaries near Wausau. Among them is the Eau Claire River (south of the study area) which flows east to west.

The Holtz-Krause Landfill is bounded on three sides by wetlands and other surface-water bodies. The wetlands consist of oxbow lakes and sloughs associated with the Eau Claire River. A small intermittent stream bounds the landfill on the east. A review of historical aerial photos indicates that prior to landfilling activities, oxbows and sloughs existed on the area now occupied by the landfill. In addition, the intermittent stream, now bounding the site on the east, previously trended through the area now occupied by the landfill. The topographically low areas bounding the landfill to the west and south are within the 500-year floodplain (FEMA, 1981).

Currently, surface water drainage is generally to the south/southwest across the site. The intermittent stream which trends along the east side of the landfill drains into Horseshoe Slough. Drainage from the landfill cover is toward Pils Slough and Horseshoe Slough.

The principal components affecting surface water hydrology are precipitation in the area and the slope of the landfill cap. Surface soils, topography, and the upland and wetland vegetation also affect the surface water hydrology to a lesser extent. Precipitation causes the surface water drainage rate to be variable and dependent on seasonal and long-term climatic changes. The average yearly precipitation in the Central Wisconsin River Basin was approximately 30 inches for the years 1931 to 1960, with evapotranspiration averaging about 20 inches per year (Devaul and Green, 1971). During 1998, the Wausau Airport recorded 30.57 inches of precipitation. Precipitation observations are discussed further in Section 7.3.

3.3 Glacial and Bedrock Geology

Unconsolidated deposits of early Wisconsin or pre-Wisconsin age cover almost the entire Marathon County with the exception of the east-central and southeastern areas of the county. The unconsolidated deposits consist of ground moraine deposits, residual bedrock soils (saprolite), and undifferentiated alluvial and glaciofluvial deposits. The ground moraine deposits consist of clayey and stoney till and contain fragments of nearby bedrock. The ground moraine deposits are generally less than 50 feet thick in Marathon County, with exception of where they overlie channels in the bedrock.

In the general area around the site, the tills have been mapped as till of the Wausau Member of the Marathon Formation (Mickelson, et al., 1984). The Marathon Formation till is light grey, pale yellow or pale brown, depending on the degree of oxidation. The Wausau member till contains an average 43 percent sand, 34 percent silt and 23 percent clay. Sand and gravel units are also present within the formation. The Wausau Member is frequently thin and found directly overlying bedrock, grussified bedrock, or saprolitic bedrock. Till of the Wausau Member was deposited by southeastward flowing of the Chippewa Sub lobe, a pre-Wisconsinan age of the Pleistocene.

Large deposits of alluvial and glaciofluvial sands and gravels are found in the central part of Marathon County along the Wisconsin River. Smaller deposits have also been mapped along the Eau Claire River and a few of its tributaries. The undifferentiated alluvial and glaciofluvial deposits are described as noncalcareous silty sand, sand, and gravelly sand, which may contain and/or overlie, glacial outwash deposits (Attig and Muldoon, 1989).

The bedrock in Marathon County is composed of Precambrian igneous and metamorphic rock, which is part of the southern margin of the exposed Precambrian Shield. Scattered outliers of Paleozoic-age sandstones that unconformably overlie the Precambrian-age rocks are also found in Marathon County (Laberge and Myers, 1983). Metamorphic green schist facies intruded by numerous granitic plutons underlie much of Marathon County. Radiometric dating indicates that these formations are from the early Proterozoic time (1.5 to 1.6 billion years ago).

The Holtz-Krause Landfill is situated on the fluvial sediments and Pleistocene-age outwash overlying the Precambrian-age bedrock. Bedrock adjacent to the landfill consists of felsic meta volcanic rocks (i.e., rhyolites to dacites). Soil surrounding the Holtz-Krause Landfill consists of well-drained loamy sands to sandy loams characterized by high permeability's and slopes of zero to 12 percent. Soil and sediment associated with the sloughs are mucky loamy sands with slopes of zero to one percent (Fiala, et. al., 1989).

Based on the RI (Geraghty & Miller, 1991), five geologic units were encountered at the site. The uppermost unit is topsoil or landfill cover material. The topsoil is generally 0.5 to 2 feet thick across the site and consists of black to tan silt and fine sand. Prior to placement of the new landfill cover, the landfill cover material was characterized as brown to tan, fine to medium sand with trace silt. The native unit underlying the topsoil is a gray to brown, fine to coarse, poorly sorted sand with trace gravel. This unit is the predominant unconsolidated unit encountered at the site. The sands generally contained greater than 85 percent quartz, with trace silt and angular granite fragments. Underlying the sand unit is a gray to tan silty fine sand. The silty sand grades to a discontinuous red to brown very stiff mottled clay containing trace silt and angular granite fragments. Underlying the silty sand and silty clay unit is granite bedrock (weathered at the surface). The unconsolidated sand at the site is Pleistocene-age outwash deposits and the bedrock is Pre-Cambrian in age. The silty sand to discontinuous silty clay unit overlying the bedrock is common in the Wausau area and is probably an erosional feature of the granite (Kendy and Bradbury, 1988).

The sand unit increases in thickness from approximately 7 feet east of Northwestern Avenue to over an estimated 125 feet thick west of Cemetery Slough, near monitoring wells MW-11A and B. The silty sand and discontinuous silty clay unit which underlies the sand is generally 7 to 10 feet thick (where present). However, the silty clay unit is at least 20 feet thick at well MW-17C. The silty clay unit was not encountered above the bedrock at monitoring wells MW-11C and MW-24C, but was encountered at MW-25D (17 feet thick) and MW-11D (2 feet thick). (See Figure 3 for a map of well locations.)

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The surface of the bedrock slopes to the southwest across the site. The highest bedrock elevation measured at the site is 1,217 feet msl near Northwestern Avenue. The bedrock elevations at the two new bedrock wells are 1,063 feet msl in MW-11D and 1,049 feet msl in MW-25D, which is consistent with the overall slope of the bedrock surface to the southwest.

3.4 Hydrogeology

The unconsolidated deposits overlying crystalline bedrock constitute the most important source of water in Marathon County. Wells completed in the unconsolidated deposits of the Wisconsin River Valley yield up to 1000 gallons per minute. Relatively small amounts of water are produced from wells completed within the fractured crystalline bedrock. The amounts of water produced in the crystalline bedrock vary with the degree of fracturing.

In Marathon County, groundwater flow is generally toward the Wisconsin River. Locally, groundwater discharges into springs, streams, lakes and wetlands. Typically, lakes and marshes interrupt the natural gradient of the water table where lakes and marshes lack surface inflow and outflow. In the Central Wisconsin River Basin, groundwater movement is typically from the sides of the basin toward the streams and from north to south. Local groundwater flow patterns in the area typically mimic surface water drainage patterns, discharging to local streams and tributaries of the Eau Claire River. Horizontal hydraulic gradients are typically about 30 to 70 feet per mile in the county, although gradients are steeper near the river valleys (Kendy, 1986).

The geologic information gathered during the RI indicates that two major hydrostratigraphic units exist in the unconsolidated material. The upper hydrostratigraphic unit consists of the fine to coarse sand to silty sand with gravel (sand). The lower unit is the silty clay to clay (silty clay) which directly overlies the igneous bedrock. Depth to ground water in the 38 wells installed during the investigation ranges from 46 feet below ground surface (bgs) in MW-3A to approximately 4 feet bgs in MW-21A, as measured during the RI. The groundwater table configuration generally follows the surface topography of the site and thus groundwater flow direction in the RI was reported from northeast to southwest.

The RI reports horizontal hydraulic gradients of 0.04 to 0.08 ft/ft across the eastern portion of the site and 0.01 to 0.001 ft/ft in the western and southern portions of the site. Vertical hydraulic gradients were reported as generally downward in the upper portion of the sand hydrostratigraphic unit, ranging from 0.001 ft/ft at MW-12A/B to 0.8 ft/ft at MW-3A/B. Vertical gradients were not observed at a few of the well locations during the November 1989 and June 1990 RI monitoring events. Vertical gradients were reported as upward between the silty clay hydrostratigraphic unit and the sand hydrostratigraphic unit at the two well nests monitored (MW-17B/C and MW-19B/A).

Hydraulic conductivity, as calculated from slug tests performed during the RI, ranged from 1.0×10^{-4} to 1.0×10^{-3} cm/sec in the sand hydrostratigraphic unit and 3.9×10^{-4} to 7.4×10^{-5} cm/sec in the silty clay unit. The average estimated linear horizontal groundwater flow velocity in the sand unit ranges from approximately 4,300 ft/yr in the eastern portion of the site to approximately 220 ft/yr in the southern and western portions of the site. The increased velocity estimated for the eastern portion of the site reflects the steeper hydraulic gradients observed there. The average horizontal flow velocity in the silty clay is estimated in the RI to range from 106 ft/yr in the eastern portion of the site to 5 ft/yr in the southern and western portions of the site. This assumed that the horizontal hydraulic gradients at depth are the same as at the water table and that the silty clay has an effective porosity of 10 percent and an average hydraulic conductivity of 1.7×10^{-4} cm/sec.

Water table elevation data were collected from monitoring wells maintained by the Steering Committee and several monitoring wells maintained by Union Pacific Railroad (UP-MW prefix). While we understand that analytical testing has been conducted by Union Pacific Railroad and Koch Refining on upgradient contaminated sites and that testing supports a conclusion that the petroleum related constituents (i.e., benzene and naphthalene) detected on-site may be the result in whole or in part to the upgradient sources, the results of that testing are not included in this report.

Consistent with previous data, the groundwater flow direction is generally from the east and northeast of the site toward the west and southwest. Some seasonal fluctuation in groundwater flow direction was observed; however, since 1996, the groundwater elevation data and flow direction have been relatively consistent. The horizontal hydraulic gradient across the site varies from 0.35 to 0.05 beneath the landfill to less than or equal to 0.001 in the topographically lower, downgradient area west and southwest of the landfill.

While vertical gradients measured at the site exhibit slight temporal variations, the gradients are of a magnitude that places them within the error of the underlying measurements (e.g., elevation survey data and groundwater level measurements). Accordingly, groundwater is interpreted to flow horizontally through the monitored portion of the study area without measurable upward or downward flow components.

Observed horizontal hydraulic gradients along with the mean hydraulic conductivity for the sand aquifer obtained from the Remedial Investigation Report (geometric mean = 1.8×10^{-2} cm/s) were used to estimate the average linear velocity in the sand aquifer above the bedrock. Beneath the landfill, the average linear velocity estimates ranges from 2,100 to 3,100 feet per year (ft/yr) while the velocity downgradient of the landfill ranges from 25 to 62 ft/yr. These estimates are comparable to those presented in the Remedial Investigation Report and in the post-1996 Groundwater Monitoring Summary Reports. The downgradient velocity of less than or equal to 62 ft/yr is representative of the groundwater exiting the site.

3.5 Upgradient Sources

At least two immediately upgradient sources of petroleum related impacts to soil and groundwater have been identified. The two immediately adjacent sites include the Koch Refining Company

(Koch) site located on the Holtz-Krause Real Estate Development property (also known as the former Gustafson Oil site), and the Union Pacific Railroad Company's (Union Pacific) Wausau Rail yard site located at 1235 East Junction Street. The Koch site was used as a distribution center for road oils by Gustafson Oil from the 1950s through the 1970s. During that period of time, road oils were blended and naphthalene added as an emulsifying agent. There were several above ground storage tanks used for storage and product was moved using an underground distribution system. Both of these sites have petroleum related contamination and may have contributed, in part or in whole, to impacts observed on the Holtz-Krause landfill site.

A full-scale SVE/bioventing system was installed in September 1996 on the Union Pacific site to remediate petroleum constituents in groundwater. The system is still in-place and being monitored on a bi-monthly basis. Groundwater monitoring is currently being conducted on an annual basis.

Free product was originally identified on the Koch site in Monitoring Well MW-3R. Free product has been periodically bailed from MW-3R since August of 1996. Three extraction wells were installed in September 1997 for the purpose of extracting free product. Since that time, free product has been removed from two of the three extraction wells and MW-3R. In November, 1998, Koch requested case closure for their site. In February 1999, the WDNR granted case closure despite the continued presence of free product on the Koch site.

4.0 RECEPTOR IDENTIFICATION AND ASSESSMENT

There are no on-site users of groundwater or surface water; therefore, there is not completed groundwater pathway on-site. The Baseline Risk Assessment (BRA), included as part of the June 1991 Geraghty & Miller Remedial Investigation (RI) Report, evaluated two hypothetical future groundwater exposures, including potable use by a resident at the site and contact while showering. Both hypothetical groundwater exposure scenarios were within or below USEPA guidelines for acceptable risks based on the RI data. It should be noted that concentrations of compounds of concern have decreased or remained steady since the RI; therefore, the BRA conclusion that there is no current pathway of potential exposure for groundwater at or in the near vicinity of the site continues to be supported.

Potential downgradient receptors include users of groundwater and surface water downgradient of the site. One inactive municipal water supply well (Wausau Well No. 8, WUWN BG330) is located approximately one mile southwest and downgradient of the site. According to Mr. Dave Erickson, City of Wausau, Well No. 8 is used only on an emergency basis due to naturally occurring, but elevated, iron and manganese concentrations observed in the well. A telephone conversation with Mr. Glen Falkowski, WDNR, on February 5, 1997, indicated that Well No. 8 was taken off-line in 1992 and is not connected to the Wausau municipal water distribution system. Several sampling events would be required before the WDNR would allow the well to return to service. No other public or private potable water supply wells are known to be located downgradient of the site. Therefore, the potential for human contact with the residual dissolved parameters through the public use of downgradient groundwater is limited.

Surface water samples were collected during the RI in October 1989 and June 1990. The results were discussed in the subsequent Geraghty & Miller Feasibility Study (FS). In general, analytes identified in the FS were interpreted as being either below the method detection limit or artifacts of laboratory testing. The distribution of the benzene, chloromethane, and vinyl chloride concentrations and the interpreted groundwater flow paths suggest that residual dissolved organic compounds are not migrating into Cemetery Slough, Pils Slough, and Horseshoe Slough. Therefore, based on the information provided above, there is currently no completed groundwater pathway and the potential for human exposure to residual parameters of concern in groundwater associated with the Holtz Krause Landfill is low.

5.0 SCOPE OF WORK

Detailed procedures that STS typically follows for the investigative tasks identified herein are provided as Appendix A.

5.1 Sampling of Leachate within the Landfill Waste

STS proposes collection of one round of leachate samples from gas extraction wells EW-15 and EW-16 as part of the June 2005 groundwater monitoring event. Gas extraction wells EW-15 and EW-16 were selected for sampling as they are the only two leachate head wells that have been found to contain greater than 3 feet of standing water, based on leachate head measurements obtained by STS on March 18, 2004. The samples from the gas extraction wells EW-15 and EW-16 will be submitted for laboratory analysis of the parameters listed in Appendix 1, Tables 3 and 4 of WAC NR 507. The resulting laboratory data will be provided as part of the 2005 Annual Report for the Holtz-Krause Landfill.

5.2 Installation of New Monitoring Well Nest

STS proposes to install two new monitoring wells. The additional monitoring wells will be located downgradient of existing monitoring well nests MW-11 and MW-24. These two new monitoring wells will be screened to terminate just above the silty sand unit identified in the May 13, 2003 WDNR letter. One of the two new monitoring wells will be nested with existing monitoring well MW-25D and identified on Figure 2 as MW-25C. Monitoring well MW-25C, which will be located downgradient of the MW-24 well nest, will be screened from 115 to 120 feet below ground surface to terminate just above the silty sand unit. Split-spoon soil samples will be collected through hollow-stem augers for soil classification purposes during installation of monitoring well MW-25C from the screen interval of the well (115 to 120 feet below ground surface); the remaining portion of the well will be "blind-drilled", as it will be located adjacent to deeper monitoring well MW-25D, from which split-spoon soil samples were obtained as part of its installation.

10 screen

The second new monitoring well is identified as MW-26C on Figure 2. Monitoring well MW-26C, which will be located downgradient of the MW-11 well nest, will also be screened from 115 to 120 feet below ground surface to terminate just above the silty sand unit. Split-spoon soil samples will be collected for soil classification purposes at 5-foot intervals during installation of monitoring well MW-26C.

Based on the new monitoring wells' distance from the Landfill, soil cuttings generated during installation of monitoring wells MW-25C and MW-26C are not anticipated to be impacted. As such, soil samples are not anticipated to be submitted for laboratory analysis from either MW-25C or MW-26C. The soil cuttings will be screened during drilling with a photoionization detector (PID) and based on the assumption that no elevated readings will be monitored, the cuttings will be disposed as general fill. In the event that elevated PID readings are detected, the soil cuttings will be containerized pending laboratory analysis prior to proper disposal. OK

The monitoring wells will be installed in accordance with WAC Chapter NR 141 (Appendix A). Once the wells are installed, they will be developed in accordance with WAC NR 141. Well development will generate water that will be contained in 55-gallon drums until laboratory results from water sampling are obtained. The two new monitoring wells will be added to the ongoing semi-annual groundwater monitoring program, such that groundwater samples collected from the two new wells will be submitted for laboratory analysis of VOCs in June and December 2005. The laboratory results of these two sampling events will be evaluated to determine if modifications to the monitoring program are appropriate.

The new wells will be surveyed upon completion. The location and elevation of the ground surface and top of PVC will be determined.

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Attachments

ATTACHMENTS

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Tables

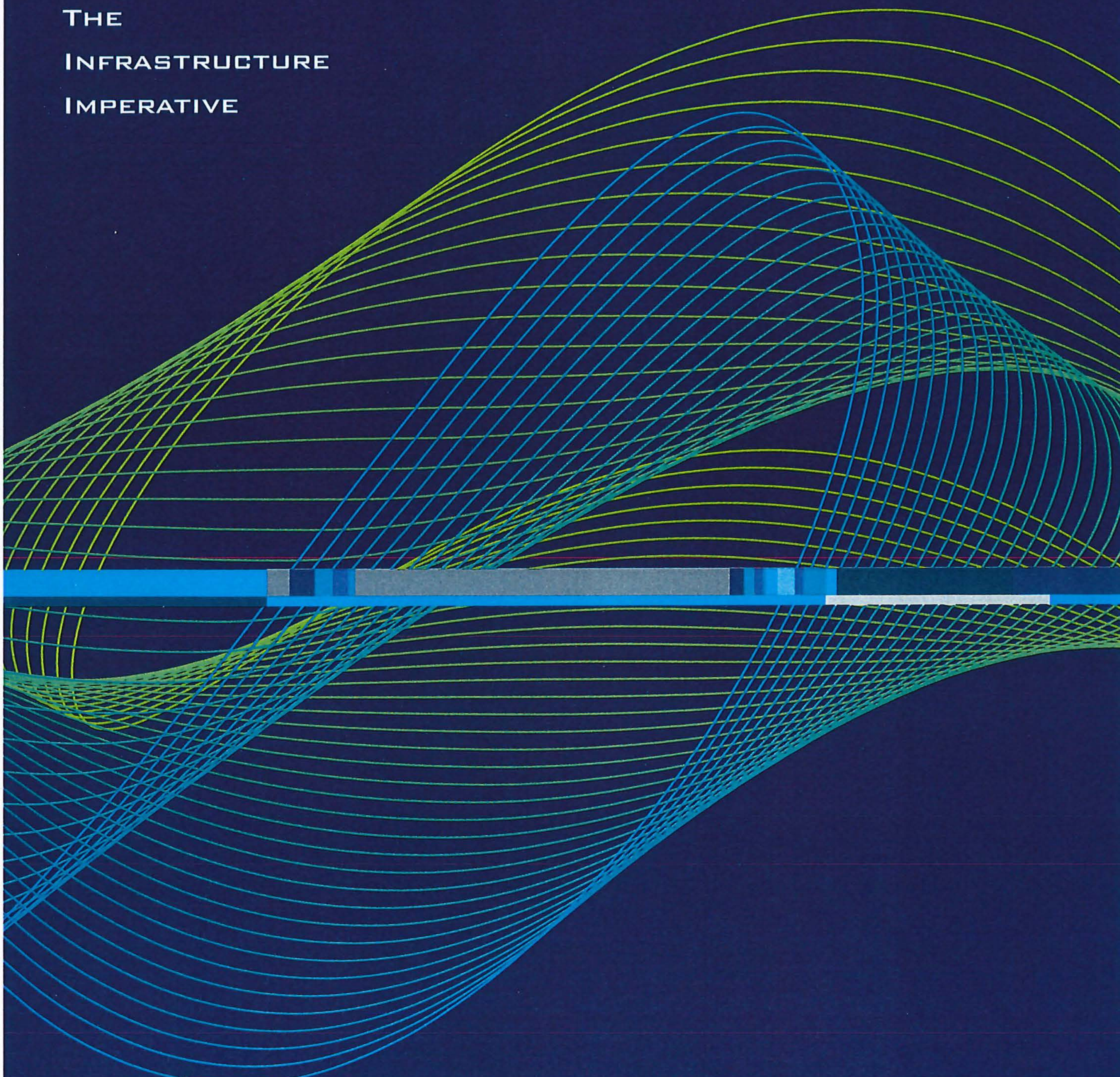
TABLES

Table 1
Leachate Head Elevation Summary
Holtz Krause Landfill

Gas Extraction Well	Top of Casing Elevation	Depth to Well Invert	Invert Well Elevation	Depth to Leachate	Leachate Head Elevation	Height of Standing Leachate	Corrected Height of Standing Leachate (see note below)	Corrected Leachate Elevation (see note below)
EW-1	1198.29	32.3	1165.99	32.10	1166.19	0.2	0	<1166.19
EW-2	1202.04	37.4	1164.64	37.03	1165.01	0.37	0.04	1165.01
EW-3	1204.19	35.7	1168.49	Dry	<1168.49	0	0	<1168.49
EW-4	1204.61	34.5	1170.11	34.38	1170.23	0.12	0	<1170.23
EW-5	1208.27	36.2	1172.07	36.05	1172.22	0.15	0	<1172.22
EW-6	1211.50	42.2	1169.3	Dry	<1169.3	0	0	<1169.3
EW-7	1208.82	41.9	1166.92	Dry	<1166.92	0	0	<1166.92
EW-8	1208.75	41.15	1167.6	Dry	<1167.6	0	0	<1167.6
EW-9	1210.60	43.9	1166.7	Dry	<1166.7	0	0	<1166.7
EW-10	1214.51	41.95	1172.56	41.24	1173.27	0.71	0.38	1173.27
EW-11	1218.79	17.55	1201.24	17.32	1201.47	0.23	0	<1201.47
EW-12	1215.99	40.7	1175.29	40.61	1175.38	0.09	0	<1175.38
EW-13	1216.32	22	1194.32	21.68	1194.64	0.32	0	<1194.64
EW-14	1213.85	30.55	1183.3	30.34	1183.51	0.21	0	<1183.51
EW-15	1209.90	35.85	1174.05	31.31	1178.59	4.54	4.21	1178.59
EW-16	1206.94	39.5	1167.44	28.51	1178.43	10.99	10.66	1178.43
EW-17	1203.99	26.45	1177.54	26.30	1177.69	0.15	0	<1177.69
EW-18	1201.71	33.8	1167.91	32.06	1169.65	1.74	1.41	1169.65
EW-19	1199.98	28.2	1171.78	26.73	1173.25	1.47	1.14	1173.25
EW-20	1198.86	34.7	1164.16	33.69	1165.17	1.01	0.68	1165.17
EW-21	1198.28	28.15	1170.13	Dry	<1170.13	0	0	<1170.13
EW-22	1194.69	27.95	1166.74	27.73	1166.96	0.22	0	<1166.96
EW-23	1190.58	25.1	1165.48	25.05	1165.53	0.05	0	<1165.53
EW-24	1186.93	19.6	1167.33	Dry	<1167.33	0	0	<1167.33
EW-25	1187.90	17.65	1170.25	17.35	1170.55	0.3	0	<1170.55
EW-26	1187.29	21.75	1165.54	19.71	1167.58	2.04	1.71	1167.58
EW-27	1193.25	25.4	1167.85	Dry	<1167.85	0	0	<1167.85
EW-28	1188.43	19.5	1168.93	19.23	1169.20	0.27	0	<1169.20
EW-29	1188.37	22.65	1165.72	21.85	1166.52	0.8	0.47	1166.52
EW-30	1193.17	25.85	1167.32	24.77	1168.40	1.08	0.75	1168.4
EW-31	1197.07	27.2	1169.87	Dry	<1169.87	0	0	<1169.87
EW-32	1188.48	21.7	1166.78	21.48	1167.00	0.22	0	<1167.00
EW-33	1192.17	22.1	1170.07	21.90	1170.27	0.2	0	<1170.27
EW-34	1192.26	19.8	1172.46	Dry	<1172.46	0	0	<1172.46
EW-35	1197.06	16.45	1180.61	16.16	1180.90	0.29	0	<1180.90

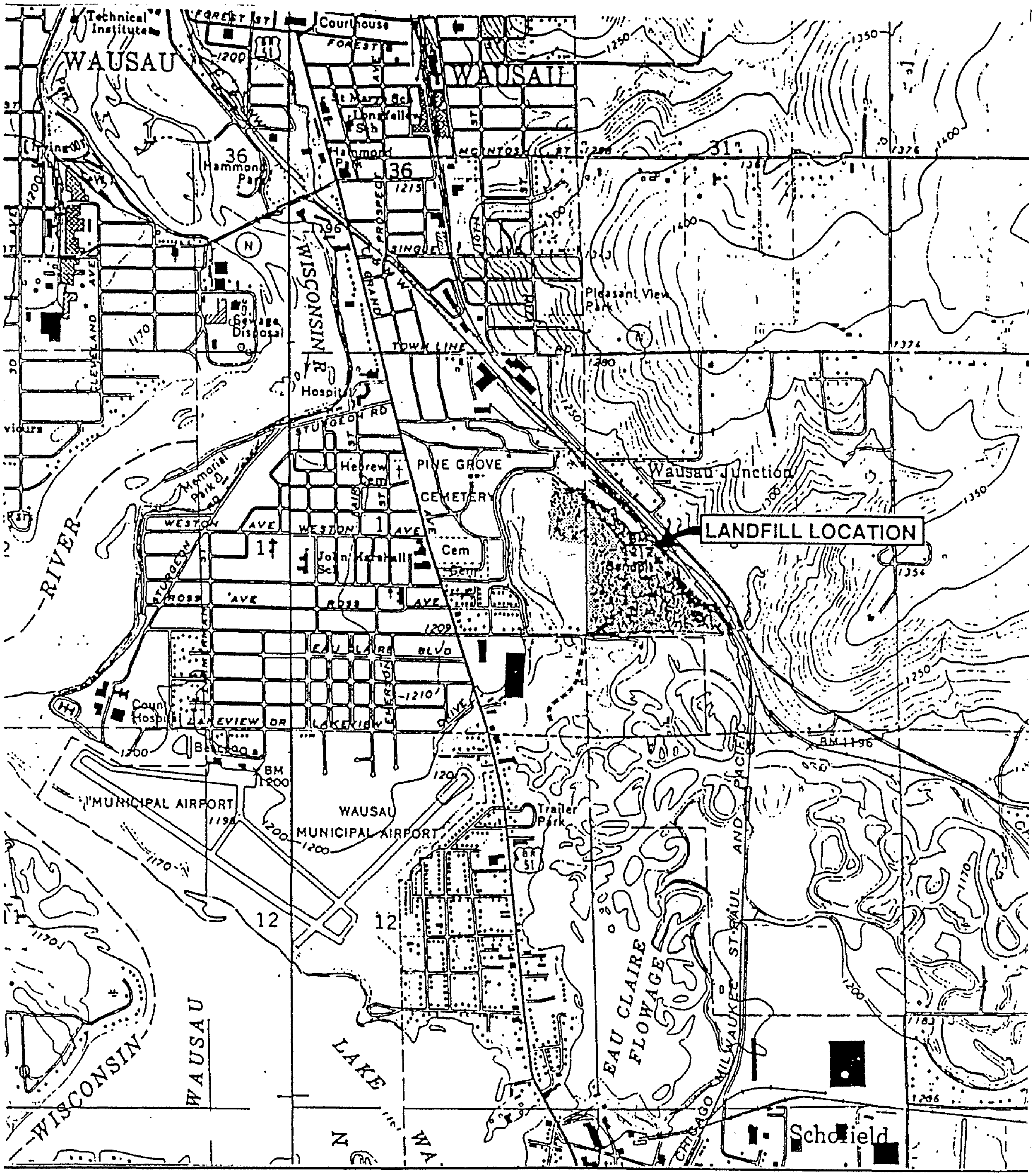
Notes:
1) Measurements made to top of rubber Fernco coupling
2) Fernco coupling elevations deterimnined by City of Wausau Survey Crew week of March 15th.
3) Correction applied for depth of PVC end cap located at bottom of well screen. Depth measurements less than 4 inches assumed attributable to liquids collected in well end cap, and not representative of leachate elevation in surroundings materials

The Infrastructure Imperative



Figures

FIGURES



SOURCE: Composite of USGS 7.5 Minute Topographic Maps, WAUSAU EAST and WAUSAU WEST, WISCONSIN Quadrangle, 1978

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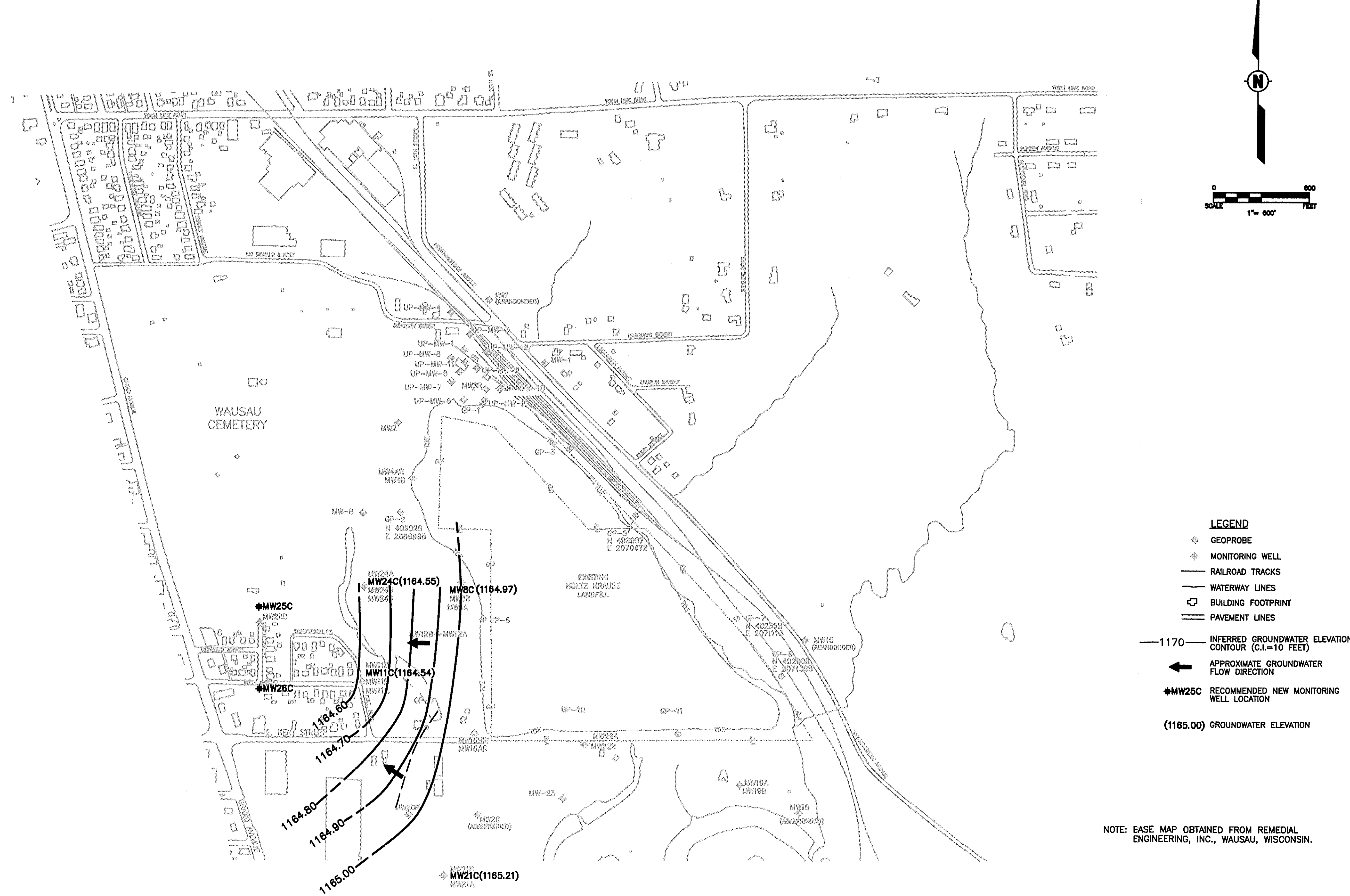
HOLTZ KRAUSE LANDFILL
WAUSAU, WISCONSIN
SITE LOCATION DIAGRAM

DRAWN BY	PDP/SNL	2-3-99
CHECKED BY	MDS	2-3-99
APPROVED BY	JMT	2-3-99
CADFILE G454A001	SCALE 1" = 2000'	
STS PROJECT NO. 21954XA	FIGURE NO. 1	



RECOMMENDED NEW MONITORING WELL LOCATIONS
HOLTZ KRAUSE LANDFILL
WAUSAU, WISCONSIN

DRAWN BY	CMS/WDB	DATE	10/14/02
CHECKED BY	M.M.M.	DATE	10/14/02
APPROVED BY	M.M.M.	DATE	10/14/02
CADFILE	X:\PROJECTS\21954\XA\G454A-002-FIG2.dwg		

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STS PROJECT NO. 21954XA

STS PROJECT FILE

SCALE 1"= 600'

FIGURE NO. 2

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Appendix

A

THE INFRASTRUCTURE IMPERATIVE

APPENDIX A

STS Operating Procedures

1.0 SOIL SAMPLING PROCEDURES

1.1 Auger Drilling

Typically, 4-1/4 or 6-1/4 inch hollow stem augers are utilized to advance boreholes during auger drilling. The augers are advanced using a truck or all-terrain vehicle (ATV) mounted auger drilling rig. Soil samples are collected at 2.5 or 5-foot intervals, using standard split-barrel sampling procedures. A copy of the American Society for Testing and Materials (ASTM) Procedure (ASTM D-1586) is appended at the end of this section. Drilling equipment is decontaminated in accordance with procedures outlined in Section 4.1. Soil cuttings generated during the drilling procedure are handled in accordance with the procedures outlined in Section 5.1.

1.2 Soil Screening

Each soil sample collected during auger drilling methods is split to form duplicate samples, upon collection. A portion of the sample, to be utilized for screening purposes and classification is placed in an 8-ounce glass jar, covered with aluminum foil and sealed with a screw-on lid. The remainder of the sample is placed in laboratory provided jars, if the sample is to be submitted to a laboratory for analytical testing (Section 1.4).

1.2.1 PID Screening

STS utilizes an HNu Model PI-101 photoionization detector (PID) equipped with a 10.2 electron volt (eV) lamp or a MiniRae Plus (PGM-76) Professional PID equipped with a 10.6 eV lamp. Both instruments are capable of detecting certain volatile organic compounds (VOCs), including many of the volatile organic components characteristic of petroleum products and common solvents with ionization energies less than or equal to 10.6 eV.

PID screening is performed by first allowing the screening sample to warm to approximately room temperature (70° F). The sample is shaken vigorously for several seconds. This procedure breaks up the soil and increases the surface area of the soil particles exposed to the air inside of the jar. The tip of the PID probe is inserted about one inch into the jar through the aluminum foil. The highest value read off of the meter during the first few seconds after inserting the probe tip is recorded as the PID reading for the soil sample.

Because organic compounds have varying ionization potentials, the response of the PID depends on the compounds being ionized. In addition, because the PID responds only to compounds which are present in the vapor phase, the relative volatility is also a factor in the response. As a result, when a variety of VOCs are present in the screening sample, the meter reading does not necessarily indicate the concentrations of any specific VOC, but a response to total VOCs present relative to the concentrations and ionization potential of each compound.

Prior to screening, the meter is zeroed and calibrated to an isobutylene standard per the manufacturer's specifications. All PID readings are reported in PID Instrument Units (IU). The readings are similar to parts per million, using an isobutylene equivalent to address the variability of the response factor. This nomenclature is recommended by the equipment manufacturer and required by the Wisconsin Department of Natural Resources (WDNR) field screening procedures guidance document.

1.2.2 FID Screening

The FID screening procedures are similar to the PID procedures. The sample is warmed and shaken before the FID probe is inserted into the jar. The highest reading is the FID reading recorded for the sample.

The Sensidyne flame ionization detector (FID) is a portable instrument used to measure organic vapors and gasses in the air. The air containing organic vapors is mixed with hydrogen and burned in a hydrogen flame near two high-voltage electrodes. Organic compounds in the gas stream cause an increase in electric current proportional to the concentration. The FID is calibrated with methane, but responds to nearly all volatile compounds containing carbon.

Prior to screening, the FID is calibrated to a methane standard per the manufacturer's specifications. All FID readings are reported in FID Instrument Units. The readings are in parts per million based on the methane standard.

1.3 Soil Classification

The soil samples are preliminarily classified in the field, at the time of collection. Drilling notes regarding soil types, drilling conditions, PID screening, depth to water and location of stratigraphic changes are documented on the field boring logs. The soil samples are re-classified in the STS laboratory by a geologist or engineer. Soil classification is based upon the texture and plasticity of the soil, in general accordance with the Unified Soil Classification System (USCS). An abridged version of the USCS and "STS General Notes" are appended. The "STS General Notes" sheet describes nomenclature used on the final boring logs. Additional information regarding the preparation of the final boring logs from field logs and laboratory data is described on the sheets entitled "Field and Laboratory Procedures" and "STS Standard Boring Log Procedures" which are also appended.

The soil stratification indicated on the logs was selected by the geologist/engineer based upon the field log information and sample observations. Stratification lines should be considered as approximate. The transition between soil types in-situ may be gradual in both the horizontal and vertical directions.

1.4 Sample Preservation

Soil samples to be submitted for analytical testing are collected in accordance with standard WDNR protocol. The soil sample jar is labeled with the sample designation, sample date and time, sampler's initials and project number. The samples are preserved by packing the samples in ice and maintained at a temperature of 4° C, or less.

1.5 Chain of Custody

A chain-of-custody form is completed immediately after sample collection and accompanies the samples from time of collection until received at the laboratory. Any notes regarding soil sample collection are included in the field book while in the field.

2.0 NR 141 MONITORING WELL INSTALLATION PROCEDURE

Monitoring wells are installed in general accordance with the installation procedures in Chapter NR 141 of the Wisconsin Administrative Code (WAC). This section describes the typical well installation procedure. Any deviations from this procedure will be discussed in the text of this report.

Groundwater monitoring wells are installed at locations in which a borehole has been advanced using 4-1/4 inch or 6-1/4 inch diameter hollow stem augers. The well materials are placed while the augers are in the ground, and the well material is inserted inside of the hollow stem augers. If the borehole was advanced beyond the depth the well is to be installed, the borehole is backfilled with bentonite chips prior to installing the well materials. The well consists of a two-inch diameter, 10-foot long section of Schedule 40 polyvinyl chloride (PVC) screen threaded onto an end cap. The slot size of the screened portion depends upon the characteristics of the soil, though typically 0.006-slot screen is used in clayey and silty soils and 0.010-slot screen is used in sandy soils. The screened portion is threaded onto 5 or 10 foot sections of two-inch diameter PVC pipe (unscreened) which extends to either the ground surface or to no more than 2-feet above the ground surface at locations in which a stick-up well protector is required. A cap fitted with an expandable gasket and a lock is placed on top of the well casing.

The material filling the annular space between the borehole walls and the well casing is poured inside of the augers and the augers are pulled up during placement of the fill material. Approximately 6-inches of fine grained, washed silica sand is placed below the well screen. Silica sand is placed as a filter pack, around the screened portion of the well. The grain size is selected to retain a minimum of 50% of the surrounding formation. The filter pack is placed from 6-inches below the well to approximately 2-feet above the well screen. Above the filter pack, two feet of fine-grained sand is typically placed. If the depth to groundwater prohibits the placement of two feet of filter pack and/or fine sand, the thickness of these layers are reduced to no less than 6-inches of each material above the top of the well screen. Above the fine sand, a bentonite seal is placed and consists of a minimum of 2-feet of chipped bentonite or bentonite pellets (the type of material used depends upon the depth to groundwater). Bentonite is used to fill the remaining annular space from the top of the seal to the bottom of the protector pipe which is placed at the top of the well to protect the well from damage.

At the top of the bentonite, either a flush mounted or a stick-up protector pipe is installed over the well. Typically, flush mounted protector pipes are used in areas in which a concrete or asphalt surface is present. In some instances, it is necessary to install a flush mounted protector pipe in a gravel traffic area. In these instances, a concrete pad is constructed around the pipe. The flush mounted protector pipe consists of a 10- or 12-inch diameter steel casing, 12-inches in length which is cemented flush with the surrounding concrete or asphalt improvement. The stick-up protector pipe consists of either a 5-foot or a 7-foot steel pipe inserted over the well casing that extends above the ground surface. A 5-foot pipe is used when a shallow water table is present. For PVC wells, the standard stick-up above the ground surface is approximately two feet. The steel protector pipe is installed over the PVC, with the top at 2.5 feet above the surrounding ground surface (PVC is approximately 6-inches below the top of the protector pipe). The remainder of the protector pipe is installed below ground. No fill material is placed between the well and the protector pipe, to eliminate heaving due to frost. Either bentonite or cement is used around the outside of the protector pipe, to secure it in place.

During well installation, a field boring log is completed as outlined in Section 1.4 and WDNR form 4400-113A (monitoring well construction form) are completed in the field. Copies of the boring logs (4400-133A) are provided to WDNR in the final report. Soil cuttings generated during the advancement of the borehole are handled in accordance with the procedure outlined in Section 5.1. All well material used in the well construction is new and care is taken to prevent contaminating the well material during installation.

Upon completion of the well installation activities, an elevation survey referenced to Mean Sea Level (MSL) or a local benchmark is completed. The elevation of the PVC casing and the ground surface are recorded. This survey information is used to determine the elevation of the groundwater surface and to determine groundwater flow direction at the site.

3.0 GROUNDWATER SAMPLING PROCEDURES

3.1 Well Development

Well development is conducted using either a bailer or a pump. Typically, when it is necessary to remove a large volume of water, or the water is very turbid, a pump is used. If the well is anticipated to bail dry, due to low aquifer hydraulic conductivity, a bailer is used.

Prior to developing the well, the water level is measured, using an electronic water level indicator (m-scope). The water level is measured to the nearest 0.01-foot. Each well is developed by surge and purge methods and by removing 10 well volumes of water, calculated using the formula provided in chapter NR 141, WAC. If 10 well volumes of water can not be removed from the well because it bails dry (due to the presence of low permeability soils), the well is slowly purged dry several times or until the turbidity of the water is reduced. WDNR form 4400-113B (monitoring well development form) is completed in the field, during the development activities. A copy of the form is provided to WDNR with the final project report. Handling of well development purge water is discussed in Section 5.3.

3.2 Groundwater Sampling

Typically, more than 24-hours are allowed between well development and the first groundwater sampling event. The following section provides details relating to groundwater sampling.

3.2.1 Purging

Prior to collection of groundwater samples, the water level is again measured and each well is purged. If possible, four well volumes of water are removed from the well. If the well bails dry, the stagnant water is removed from the well and water is allowed to recharge into the well. Time permitting, the well is bailed dry again and allowed to recharge prior to collection of samples.

Typically, wells are purged using a Teflon© bailer or a disposable polyethylene bailer. In some instances, when it is necessary to remove a large volume of water from the well, a pump is used to purge the well. In these instances, a small submersible pump is used to purge the well. The pump and the hosing are decontaminated prior to inserting into the well. Handling of purge water is discussed in Section 5.3.

Wisconsin Department of Natural Resources
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January 27, 2005

3.2.2 Well Sampling

Typically, wells are sampled using a disposable polyethylene bailer or a Teflon© bailer. In order to minimize disturbance of the water in the well, the bailer is slowly lowered using a rope tied to the top of the bailer, to the water table. The bailer is allowed to fill from the bottom of the bailer. Once the bailer is filled, it is gently brought to the surface and emptied into sample containers.

Duplicate samples and equipment blanks are collected from each site at a minimum of 10% of the total number of samples collected. This procedure complies with WDNR quality assurance/quality control requirements. The equipment blank is collected at the site by pouring distilled water through an unused bailer and collecting it in the specific vials required by the analytical method. If samples that require filtering are to be collected, the equipment blank is run through filtering equipment prior to transfer to sample containers.

Each cooler is sent to the laboratory with a trip blank and a temperature blank. The trip blank is prepared by the laboratory by filling a VOC vial with distilled water and sealing the bottle. The bottle remains sealed and stays with the sample bottles through shipment from the laboratory until it reaches the laboratory again. The water sample contained in the trip blank is analyzed by the laboratory, to verify that the samples were not affected by contaminants during transportation. The temperature blank is used to verify that the samples reached the laboratory at a temperature of 4°C, or less. The blank consists of a water sample in an unspecified type of container. No other analytical tests are performed on this sample.

VOC Sampling - A VOC sampling port is inserted into the bottom of the bailer, to allow for regulation of water flow from the bailer. This allows for minimization of disturbance of the sample.

The water is slowly discharged directly into laboratory provided 40-ml VOC vials containing hydrochloric acid (HCl) preservative. The bottle is filled to a positive meniscus and covered with a cap fitted with a Teflon© septum. The bottle is inverted and gently tapped to verify that air bubbles are not present in the sample. Each bottle is labeled, typically with a label provided by the laboratory, with the well No., sample No., date, sampler's initials, project No. and preservatives added. After labeling, the samples are placed in a cooler with the chain of custody, on ice, for shipment to the analytical laboratory.

Metals Sampling - Water samples to be analyzed for total metals are collected from the wells as described in Section 3.2.2, however, a VOC sampling port is not necessary for discharging the water sample into the sample container, since disturbance by air is not a factor which affects sample integrity. The water is discharged from the bailer into a laboratory provided, clean plastic container, prior to filtering.

A filtering apparatus consisting of a disposable 0.045-micron filter fitted with silicon tubing is inserted into a peristaltic pump. The pump draws the water from the plastic container, up through the tubing and the filter and discharges the water out the bottom of the filtering apparatus. The filtered water sample is discharged directly into a 250-ml or 500-ml plastic laboratory provided bottle, containing nitric acid (NO_3) preservative. The bottle is filled to the neck of the bottle and capped. The bottle is inverted several times to mix the preservative into the sample and the bottle is placed in a cooler on ice for shipment to the laboratory.

3.2.3 In-Field Testing

Several in-field tests are often conducted prior to completion of sampling at each well location. These tests include testing the conductivity, pH and temperature of each sample after it is collected. The testing for pH, conductivity and temperature are usually conducted using one instrument that records all three measurements. Various brands of instruments are available and used for conducting this testing. Water color, odor and turbidity are also recorded by the technician in the field, for each sample.

The water sample to be collected for in-field testing is collected at the time of well sampling. The sample is collected after the samples to be laboratory tested are collected and placed in coolers. The field tested sample is collected using the same bailer used to collect the samples for analytical testing. The water is discharged from the bailer into an 8-ounce clear glass container. The instrument probe is inserted into the water sample and slowly swirled in the water until the instrument equilibrates. The measurements are recorded in a field book. The visual observations noted at this time are recorded in the field book.

4.0 DECONTAMINATION PROCEDURES

4.1 Drilling

To avoid cross-contamination between borings, the drilling equipment (i.e., augers and rig) is decontaminated using a high pressure hot-water washer after each boring. The down hole sampling equipment is decontaminated using a wash of Alconox© soap and clean water, followed by a rinse with clean water. Equipment is scrubbed with a brush during each step of the decontamination process to remove soil particles which may adhere to the equipment.

4.2 Groundwater Sampling

Typically, disposable bailers are used during well sampling. A new bailer is used to sample each well, therefore there is no need to decontaminate down hole equipment between locations. The in-field testing equipment (pH, conductivity and temperature meter and m-scope) are decontaminated between samples using a double rinse of distilled water. The water is containerized with the decontamination water generated during the advancement of the boring/well or purge water.

If disposable bailers are not used at the site, the Teflon© bailer is decontaminated using a wash of Alconox© soap and distilled water, followed by a double rinse using distilled water. The bailers are scrubbed with brushes during the washing process and during the first rinse to remove sediment or other particles which may adhere to the bailer. New rope and gloves are used at each well location; therefore no decontamination of this equipment is necessary. If sample filters are used (i.e., for metals analysis), a new disposable filter and new tubing are used for each sample.

During hydraulic conductivity testing, all downhole equipment is decontaminated using the double wash procedure (Alconox© wash followed by clean water rinse). In addition, the tests are typically conducted in order from the least contaminated well location to the most contaminated well location.

5.0 WASTE HANDLING PROCEDURES (SITE INVESTIGATION)

5.1 Soil Cuttings

Typically, soil cuttings generated during the advancement of borings are containerized in 55-gallon Department of Transportation (DOT) approved barrels. Refer to the text for any project or site specific arrangements. Each barrel is labeled with the date it was filled, contents (soil cuttings) and telephone No. of the contact or owner. The barrel is sealed with a lid and ring assembly. Depending upon site usage, the barrels either remain adjacent to the boring locations or are placed in secured storage on the site, at a location approved by the owner or operator of the site.

The cuttings remain on-site until disposal options are reviewed and proper disposal arrangements can be made. The cuttings are the responsibility of the owner.

5.2 Decontamination Water

Water generated during the decontamination of field equipment is containerized in 55-gallon DOT approved barrels or as specified in the text of this report. If placed in barrels, each barrel is labeled with the date it was filled, contents (decontamination water) and telephone No. of the contact or owner. The location of the barrel and disposal of the contents are handled in the same manner as described in Section 5.1.

5.3 Well Development and Purge Water

Since each project is different, handling or purge water depends upon site-specific arrangements. This water could be containerized in 55-gallon drums, discharged to the storm sewer or sanitary sewer or treated. Refer to the text for the site-specific arrangements for this waste.

Wisconsin Department of Natural Resources
STS Project No. 4-21954XB
January 27, 2005

NR700 CERTIFICATIONS

"I, Mark Mejac, certify that I am a hydrogeologist as that term is defined in s.NR712.03(1), Wis. Adm. Code, and that, to the best of my knowledge, all of the information contained in this document is correct and the document was prepared in compliance with all applicable requirements in chs. NR 700 to 726, Wis. Adm. Code."

Mark M. Mejac (signature) 1-27-05

Mark Mejac, P.G.
Senior Project Scientist - Hydrogeologist

Date

"I, Jeanne Tarvin, certify that I am a hydrogeologist as that term is defined in s.NR712.03(1), Wis. Adm. Code, and that, to the best of my knowledge, all of the information contained in this document is correct and the document was prepared in compliance with all applicable requirements in chs. NR700 to 726, Wis. Adm. Code."

Jeanne M. Tarvin/mmm (signature) 1-27-05

Jeanne Tarvin, P.G., C.P.G.
Senior Principal Scientist - Hydrogeologist

Date

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