2011 ANNUAL MONITORING REPORT

HIGHWAY 96 SITE
WHITE BEAR TOWNSHIP, MINNESOTA

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1.0 INTRODUCTION

This report presents the results of the 2011 groundwater sampling program conducted at the Highway 96 Site (Site) pursuant to the requirements of the Response Action Plan (RAP), dated January 1994, as amended and referenced in the Consent Order.

This report covers the monitoring period from January 1, 2011 to December 31, 2011.

1.1 SITE DESCRIPTION

The Site is located in White Bear Township, Minnesota. The Site location is shown on Figure 1.1. The Site operated as a local disposal area from the 1920s until 1973. Primarily residential wastes were received and burned at the Site. Some drummed wastes were disposed at the Site in the late 1960s and early 1970s. The Site was comprised of two disposal areas, the North and South Disposal Areas, which encompassed 4.5 and 1.5 acres, respectively. A Site Plan is presented on Figure 1.2.

1.2 PROJECT BACKGROUND

In 1986, a study was conducted at the Site by the United States Environmental Protection Agency (USEPA), which identified groundwater contamination by volatile organic compounds (VOCs). The Minnesota Pollution Control Agency (MPCA) subsequently issued a Request for Response Action (RFRA) to three potentially responsible parties (PRPs): Whirlpool Corporation (Whirlpool), Reynolds Metals Company (Reynolds) and Red Arrow Waste Disposal Services. Conestoga-Rovers and Associates (CRA) was retained by Reynolds and Whirlpool in 1986 to assist with the implementation of the RFRA.

On behalf of Reynolds and Whirlpool, CRA conducted a Remedial Investigation and Feasibility Study (RI/FS). The RI involved a review of the waste disposal history, installation of monitoring wells, excavation of test pits within the waste, and groundwater monitoring of monitoring wells and nearby residential wells. The results of the RI were submitted to the MPCA in March 1988 (Ref. 1).

In response to the confirmation of groundwater contamination at the Site, Whirlpool and Reynolds proposed an Interim Response Action Plan (IRAP) (Ref. 1) involving the removal of drums found during the investigation and the installation of a groundwater extraction system.

In May 1988, the MPCA approved the RI and IRAP.

The FS involved the evaluation of remedial alternatives, which were presented in the Alternatives Analysis Report (Ref. 2), and was submitted to the MPCA in October 1988. The MPCA approved the Alternative Analysis Report in February 1989. Whirlpool and Reynolds continued with the FS by evaluating potential remedial alternatives. A Detailed Analysis Report (DAR) was submitted to the MPCA in April 1989 (Ref. 3). This evaluation included a proposed remedial plan for the Site. The MPCA did not comment on the DAR until June 1992, and approved the DAR with modifications in June 1994.

In 1993, Reynolds and Whirlpool conducted a groundwater investigation in North Oaks, Minnesota. The groundwater investigation provided a general definition of the groundwater flow system in the vicinity of the Site and the southeast portion of North Oaks. This investigation also delineated the extent of a remnant VOC plume. Vinyl chloride was the only VOC to exceed the Recommended Allowable Limit (RAL). The North Oaks Southeast Groundwater Investigation report was submitted to the MPCA in October 1993 (Ref. 4).

In January 1994, Whirlpool and Reynolds submitted the Phase I Response Action Plan (Ref. 5) to the MPCA. The Phase I Response Action Plan (Phase I RAP) outlined the activities required for the implementation of the final remedy at the Site. The MPCA approved the Phase I RAP with modifications by letter, dated March 1, 1994.

In May 1994, Whirlpool and Reynolds submitted the Phase II Response Action Plan (Ref. 6) to the MPCA. The Phase II Response Action Plan (Phase II RAP) provided additional construction details on the Phase I RAP and provided details on the installation of a dewatering sump and gas probes. The MPCA approved the Phase II RAP, with modifications by letter, dated October 3, 1994.

1.3 REMEDIAL ACTIONS

As a parallel activity to the RI/FS, interim remedial actions were implemented by Whirlpool and Reynolds. These actions included drum removal, groundwater extraction system installation, North Oaks groundwater investigation, and South Disposal Area investigation. The final remedy for the Site is divided into four operable units: Operable Unit 1 - Source Control, Operable Unit 2 - Groundwater Remediation, Operable Unit 3 - Residential Drinking Water (east of Gilfillan Lake), and Operable Unit 4 - Residential Drinking Water (west of Gilfillan Lake).

1.3.1 OPERABLE UNIT 1 - SOURCE CONTROL

During 1987 and 1988, contractors for the responsible parties removed drums containing hazardous substances from the North Disposal Area (NDA). In 1993, additional drums were removed from the South Disposal Area (SDA). In 1994, waste from the NDA and SDA were screened using a backhoe to look for any remaining drums. Drums and drum-related waste identified during the screening process were removed and transported off-Site for disposal. The contractors also drained the pond located within the NDA. All the pond water was discharged to the sanitary sewer, the sediment and material from the pond bottom were screened, and drums of waste were removed. The drums were disposed at licensed facilities in the fall of 1995.

After screening the NDA and the pond, the contractors transferred all waste material from the SDA to the NDA. Tests of the soils underlying the SDA showed no residual contamination, and the SDA was backfilled with clean soil. The results of the SDA investigation were submitted to MPCA in January 1994 (Ref. 7). All waste material at the NDA, including the waste material transferred from the SDA, was compacted, graded, and capped with two feet (ft.) of clean soil and remains on the property. Since the waste areas were combined, the NDA has been referred to as the Consolidated Waste Area (CWA).

In the spring of 1995, a total of six gas probes were installed in the CWA for methane monitoring, in accordance with the Post Closure Operation and Maintenance Plan (O&M Plan) (Ref. 8). The installation and gas probe monitoring conducted in 1995 are discussed in further detail in the Remedial Action Final Report (Ref. 9).

The Source Control Operable Unit remedy was completed in the fall of 1995 and is discussed in further detail in the Remedial Action Final Report (Ref. 9).

In response to the MPCA's comments to the Remedial Action Final Report, three passive methane vents were installed in the CWA in November of 1996 as shown on Figure 1.3. The vents were screened across the entire thickness of the unsaturated waste to allow for future drawdown due to the operation of the dewatering sump.

1.3.2 OPERABLE UNIT 2 - GROUNDWATER REMEDIATION

The Groundwater Remediation Operable Unit began as an interim remedial action and consists of continued operation of the groundwater extraction system and groundwater monitoring.

1.3.2.1 GROUNDWATER EXTRACTION SYSTEM

Since June 1989, a groundwater extraction system has been in operation at the Site. The extraction system collects groundwater from the Lower Sand and St. Peter Sandstone aquifers; it effectively limits the spread of contamination and removes contaminants from groundwater. The contaminated groundwater is discharged to the sanitary sewer for treatment.

In late 1994, after the consolidation of the NDA and SDA, a dewatering sump was installed directly into and under the CWA. The dewatering sump collects leachate and discharges it to the sanitary sewer. Leachate is produced when rain and melting snow filter through the waste and dissolve chemicals from the waste. The responsible parties operate the dewatering sump to reduce the potential for degradation of the groundwater in the deeper, drinking-water aquifers.

1.3.2.2 GROUNDWATER MONITORING PROGRAM

On-Site Monitoring

The on-Site groundwater-monitoring network includes 29 monitoring wells and 3 extraction wells screened in the perched groundwater, the unconsolidated glacial drift aquifer (Lower Sand aquifer), and the St. Peter Sandstone aquifer. The on-Site groundwater monitoring network is shown on Figure 1.2.

Groundwater samples are collected from on-Site extraction wells and select monitoring wells on an annual basis. Additional groundwater samples are collected from the on-Site extraction wells in accordance with Metropolitan Council Environmental Services (MCES) discharge permit requirements. Seven of the 29 on-Site monitoring wells (MW10B, MW12B, MW12D, MW13B, MW13D, MW16B, and MW16D) are designated as compliance wells.

Off-Site Monitoring

The off-Site groundwater-monitoring network includes residential wells, former residential wells that have been converted into monitoring wells, and monitoring wells that have been installed by the responsible parties. The off-Site groundwater monitoring network is shown on Figure 1.4.

Eleven monitoring wells and one test extraction well have been installed off-Site to monitor groundwater conditions downgradient from the Highway 96 Site in the Glacial Drift/Lower Sand, St. Peter Sandstone, and Prairie du Chien aquifers. Groundwater samples are collected from these monitoring wells on an annual basis.

Five former residential wells located east of Gilfillan Lake were converted to monitoring wells following installation of the municipal water system in 1994 (see Section 1.3.3). The five converted residential monitoring wells are located at 6 Blue Goose Road, 1 Lily Pond Road, 11 Lily Pond Road, 11 Robb Farm Road, and 6 Wren Lane. The converted residential monitoring well at 6 Wren Lane was abandoned in May 2000, at the request of the property owner (with MPCA approval). The four remaining converted residential monitoring wells are monitored on an annual basis.

From 1993 to 2004, Whirlpool/Reynolds and the MPCA monitored 51 residential wells located outside the municipal water service area on a regular basis. In 2005, the residential well monitoring network west of Gilfillan Lake was expanded to include an additional 31 residential well locations. The current residential well monitoring network west of Gilfillan Lake includes 78 residential wells. These residential well locations continue to be monitored on a routine basis.

1.3.3 OPERABLE UNIT 3 - RESIDENTIAL DRINKING WATER (EAST OF GILFILLAN LAKE)

In 1993, the MDH issued drinking water well advisories to 12 homes in North Oaks between the Site and Gilfillan Lake, because vinyl chloride had been detected in their wells at levels exceeding the health-based risk level that was in place in 1993. Reynolds and Whirlpool chose to address this off-Site contamination by connecting all 60 homes with private wells on the east side of the lake to the White Bear Township municipal water system. These connections were completed in 1994. Figure 1.5 shows the area serviced by municipal water.

1.3.4 OPERABLE UNIT 4 - RESIDENTIAL DRINKING WATER (WEST OF GILFILLAN LAKE)

In October 2004, during routine monitoring of residential wells in North Oaks, low levels of vinyl chloride were detected in water samples collected from two residential well locations (12 West Shore Road and 13 West Shore Road). Since October 2004, Reynolds and Whirlpool have conducted extensive studies, under the supervision of the MPCA, to investigate the nature and extent of VOC contamination in residential wells located west of Gilfillan Lake. These studies included:

- 21 rounds of residential well sampling;
- Installation of 13 new monitoring wells;
- Vertical aquifer profiling (VAP) to provide vertical delineation of groundwater quality;
- Installation of a test extraction well west of Gilfillan Lake in the Ski Lane Ravine;
- A subsurface geophysical survey of Gilfillan Lake; and
- Continued monitoring at existing wells in North Oaks and at the Highway 96 Site in White Bear Township.

CRA has submitted various reports to MPCA that present the results of the studies listed above (Ref. 10, Ref. 11, Ref. 12, Ref. 13, and Ref. 14).

In June 2007, the MPCA requested that Reynolds and Whirlpool complete a Feasibility Study (FS) to evaluate potential response actions for vinyl chloride contaminated groundwater on the west side of Gilfillan Lake. In July 2007, on behalf of Reynolds and Whirlpool, CRA submitted the FS Report (Ref. 15) to MPCA. In September 2007, MPCA provided comments on the FS Report to CRA. In October 2007, CRA provided responses to MPCA's comments on the FS Report. MPCA approved the FS Report, with modifications, in November 2007.

The MPCA used the FS Report to develop a Proposed Plan for an amendment to the Minnesota Decision Document (MDD) for the Highway 96 Site. The Proposed Plan outlined the preferred remedial alternative(s) for the area west of Gilfillan Lake (Operable Unit 4). The Proposed Plan was issued by MPCA on February 15, 2008. MPCA held a public meeting on February 26, 2008 and public comments on the Proposed Plan were accepted until March 21, 2008.

The MPCA reviewed the public comments on the Proposed Plan and prepared an amendment to the MDD and a Responsiveness Summary Document. The MDD amendment, which includes the Responsiveness Summary, was signed by MPCA on August 26, 2008. As outlined in the MDD amendment, the final MPCA-selected remedy for homes located within Operable Unit 4 of the Site includes:

- Provision of a new/deeper residential well in the Prairie du Chien aquifer for homes that are issued a well advisory due to Site-related VOCs;
- Long term groundwater monitoring; and
- Conditional installation and operation of a pumpout system in the Ski Lane Ravine (in the event that vinyl chloride or another Site-related VOC exceeds its respective health risk limit (HRL) in any of the Ski Lane Ravine monitoring wells).

As part of the long term groundwater monitoring component associated with the MPCA-selected remedy for Operable Unit 4, the MDD Amendment called for installation of two or three angled monitoring wells beneath Gilfillan Lake, while noting that "obtaining access to residential property for the placement of the additional monitoring wells could be a potentially complicating factor." During the period from November 2007 through March 2009, CRA, on behalf of Reynolds and Whirlpool, made several attempts to negotiate access agreements with private property owners for installation of the angled wells. In a letter dated June 1, 2009, CRA provided MPCA with documentation of the access negotiations. Despite reasonable efforts, access for the angled well installations could not be obtained. In a letter dated September 8, 2009, the MPCA acknowledged the attempts made by Reynolds and Whirlpool to obtain access and stated:

> "*…at this time, the MPCA will not require the Responsible Parties to continue their attempts to obtain access to private parties in order to install the proposed angle monitoring wells, nor will the Agency use its statutory authorities, such as condemnation, to gain access to private properties along the western shore of Gilfillan Lake for the purpose of installing the proposed angle monitoring wells.*"

2.0 SCOPE OF THE 2011 ANNUAL MONITORING REPORT

The Annual Monitoring Report is established to report on required activities at the Site as described in the RAP, which include:

- A summary of groundwater elevation data;
- A plot of the groundwater elevations for the perched groundwater system;
- Groundwater elevation contours for the Lower Sand, St. Peter Sandstone, and Prairie du Chien aquifers;
- A plot of total volatile organic compounds (TVOCs) with respect to time for selected wells;
- A figure for each monitored groundwater zone showing TVOCs at each monitoring station; and
- An assessment of the monitoring parameters and sampling frequencies and recommendations for the addition or deletion of monitoring stations.

3.0 HYDROGEOLOGIC UPDATE

This section provides a hydrogeologic summary for the Site that includes 2011 groundwater elevation data and performance assessments of the extraction wells and the perched groundwater dewatering sump.

3.1 GEOLOGY

The near surface geology of the Site consists of unconsolidated glacial deposits overlying Paleozoic sedimentary bedrock. The topography of the Site is undulating, which is typical of a glacial terrain. The ground surface elevation ranges from 930 to 970 feet above mean sea level (AMSL).

The unconsolidated sediment is highly variable, ranging from clay to gravel size particles. This area has been defined as a complex intermixed deposit of glacial till with sandy loam and sandy clay loam (Ref. 16). The glacial deposit ranges in thickness from 50 to 150 feet.

The glacial deposits are typically underlain by the St. Peter Sandstone. However, erosional remnants of the younger Platteville Limestone and Glenwood Shale exist. The St. Peter Sandstone is classified as a white, fine to medium grained, well-sorted, silica sandstone. The St. Peter Sandstone ranges in thickness from 0 to 150 feet. A 13- to 20-foot thick shale layer typically separates the upper St. Peter Sandstone aquifer from the basal portion of the St. Peter Sandstone aquifer.

The St. Peter Sandstone is underlain by the Prairie du Chien Group. The Prairie du Chien Group consists of interbedded dolomitic limestone and sandstone. Regionally, the Prairie du Chien ranges in thickness from 0 to 250 feet.

Geologic cross-sections have been constructed west (A-A’), northwest (B-B’), and southwest (C-C') from the Site, through North Oaks (Appendix A). The cross-section lines are located on Figure 3.1. Geologic cross section A-A' extends from the Highway 96 Site westward across Gilfillan Lake through the Ski Lane Ravine area to the North Oaks Golf Course. Geologic cross-section B-B' extends from the Highway 96 Site northwest along Duck Pass Road on the northern shore of Gilfillan Lake. Geologic cross-section C-C' extends from the Dove Lane area (southwest of the Highway 96 Site) to the western shore of Gilfillan Lake.

3.2 HYDROGEOLOGY

There are four hydrostratigraphic units: the perched groundwater, the unconsolidated glacial drift aquifer (Lower Sand aquifer), the St. Peter Sandstone aquifer, and the Prairie du Chien aquifer.

Groundwater elevations have been monitored at the Site since July 1987. A historical summary of groundwater elevations is presented in Appendix B. A summary of recent groundwater elevation measurements (collected October 10, 2011) is presented in Table 3.1.

The perched groundwater system is the uppermost water-bearing unit at the Site. Perched groundwater units are topographically restricted and are typically associated with enclosed basins that collect surface runoff. Perched groundwater is observed at the North Disposal Area and the former South Disposal Area. The perched groundwater at the North Disposal Area is of greater areal extent and is likely influenced by the wetland area located immediately to the east. Perched groundwater at the former South Disposal Area covers a smaller area and is not associated with the perched groundwater in the North Disposal Area.

Perched groundwater elevations historically have ranged from 909 feet to 945 feet AMSL. Groundwater flow within this unit is primarily downward to the Lower Sand aquifer. However, some horizontal migration does occur. October 2011 perched groundwater elevations are presented on Figure 3.2.

The Lower Sand aquifer is the uppermost aquifer at the Site. Groundwater is encountered within this unit at an approximate elevation of 900 feet AMSL. Regional groundwater flow within this unit (unaffected by groundwater pumping) is towards the west. The hydraulic conductivity within the Lower Sand aquifer varies due to its heterogeneous nature and ranges from $2x10^{-3}$ cm/s to $4x10^{-5}$ cm/s. The average linear groundwater flow velocity is estimated to be 40 ft/yr (Ref. 4).

The St. Peter Sandstone aquifer is hydraulically connected to the overlying Lower Sand aquifer. The potentiometric surface of the St. Peter Sandstone aquifer is approximately 896 feet AMSL. Hence, a downward flow component exists between the Lower Sand and St. Peter aquifers, under non-pumping conditions. Similar to the Lower Sand aquifer, groundwater flow within the St. Peter Sandstone aquifer is to the west, except in areas affected by groundwater pumping. In the vicinity of the Site, the average hydraulic conductivity of the upper portion of the St. Peter Sandstone aquifer is calculated at $5x10^{-3}$ cm/s. The average linear groundwater flow velocity for the upper portion of the St. Peter Sandstone aquifer in the vicinity of the Site is estimated at 80 ft/yr (Ref. 4).

October 2011 on-Site groundwater contours for the Lower Sand/St. Peter Sandstone aquifers are presented on Figure 3.3. The groundwater contours depict the influence of the groundwater extraction system (see Section 3.3). Overall, groundwater elevations continue to reflect the heterogeneous nature of the Lower Sand aquifer. As noted on Figure 3.3, some Lower Sand aquifer monitoring locations (e.g., MW10D) are not used for groundwater contouring because they are screened in areas of low permeability soil (i.e., higher silt/clay content).

The St. Peter Sandstone can be divided into two stratigraphic sub-units immediately west of the Highway 96 Site: the upper St. Peter Sandstone and the basal St. Peter Sandstone. Lateral groundwater flow is towards the west for both the upper and basal portions of the St. Peter Sandstone aquifer. The basal St. Peter has a lower permeability compared to the upper St. Peter aquifer due to its shale content. A shale layer separates the upper and basal portions of the St. Peter Sandstone aquifer and acts as an aquitard.

October 2011 off-Site groundwater contours for the upper St. Peter Sandstone aquifer are presented on Figure 3.4. For the upper St. Peter aquifer, groundwater flow conditions are characterized by the St. Peter Sandstone monitoring wells at the Highway 96 Site along with off-Site monitoring wells located east of Gilfillan Lake (MW-17A) and west of Gilfillan Lake (MW-18A, MW-19A, and MW-21A).

October 2011 off-Site groundwater contours for the basal St. Peter Sandstone aquifer are presented on Figure 3.5. Groundwater flow conditions in the basal St. Peter Sandstone aquifer are characterized by off-Site monitoring wells (MW-17B, MW-18B, MW-19B, and MW-20B), converted residential monitoring wells (1 Lily Pond, 11 Lily Pond, 6 Blue Goose and 11 Robb Farm Road), and two active residential wells located on the west side of Gilfillan Lake (6 West Shore Road and 38 East Oaks Road). Lateral groundwater flow in the basal St. Peter aquifer is approximately 10 times slower than in the upper St. Peter Sandstone aquifer.

October 2011 off-Site groundwater contours for the Prairie du Chien aquifer are presented on Figure 3.6. Groundwater flow conditions in the Prairie du Chien aquifer are characterized by off-Site monitoring wells MW-17L, MW-18L, and MW-19L. Lateral groundwater flow in the Prairie du Chien aquifer is regionally toward the west (Ref. 17).

The Prairie du Chien aquifer underlies the basal St. Peter Sandstone aquifer. The Prairie du Chien has a higher hydraulic conductivity compared to the St Peter Sandstone, which is attributed to its high fracture density. Based on single well response test data, the hydraulic conductivity of the Prairie du Chien aquifer ranges from 0.03 cm/s to 0.07 cm/s (72 ft/d to 187 ft/d) (Ref. 12), which is comparable to known published values. Applying a regional hydraulic gradient of 0.001 ft/ft and an effective porosity of 0.056 (Ref. 17), the groundwater flow velocity in the Prairie du Chien ranges from 470 to 1,220 ft/yr. This range of flow velocity is attributed to the varying degrees of fractures present in the Prairie du Chien aquifer.

3.3 GROUNDWATER EXTRACTION SYSTEM PERFORMANCE ASSESSMENT

Since June 1989, operation of a groundwater extraction system in the Lower Sand/St. Peter Sandstone aquifers (EW1/EW1A/EW1B and EW2) has prevented migration of VOCs from the Site. In addition to providing hydraulic containment, the extraction system removes VOCs from the Lower Sand/St. Peter Sandstone aquifers. The extracted water is discharged directly into the sanitary sewer under an MCES special discharge permit.

Hydraulic containment and VOC removal associated with the groundwater extraction system has been achieved through operation of the following extraction wells:

EW1

- Installed in 1989 (Lower Sand aquifer)
- Replaced in 2005 by EW2 (see below)
- Currently used for hydraulic monitoring (only)

EW1A

- Installed in 1995 (Lower Sand aquifer) to supplement EW1
- Replaced in 2010 by EW1B (see below)
- Currently used for hydraulic monitoring (only)

EW2

- Installed in 2005 (Upper St. Peter Sandstone aquifer) to replace EW1
- Current/active pumping well (see Table 3.2 for 2011 operation summary)

EW1B

- Installed in 2010 (Lower Sand aquifer) to replace EW1A
- Current/active pumping well (see Table 3.2 for 2011 operation summary)

The gradual decline of the pumping capacity at the original extraction well (EW1) had been noted in previous annual monitoring reports. The decline of EW1 was attributed to iron fouling and possible deterioration of the well casing. The decline was expected to continue and the need for a replacement well was inevitable in order to maintain flexibility within the groundwater extraction system and ensure hydraulic containment. A new extraction well (EW2) was installed in September 2005 and began operation in January 2006, replacing EW1. A hydraulic response to pumping at EW2 was observed in both the Lower Sand and St. Peter Sandstone aquifers and the installation and operation of EW2 met MPCA's requirements with respect to pumping rate and effluent water quality. Installation and performance testing results were presented to MPCA in February 2006 (Ref. 11).

After 15 years of operation, EW1A productivity declined due to bio-fouling of the well screen and surrounding formation. As noted in previous annual monitoring reports, numerous well rehabilitation events had been performed to address the fouling issues and reestablish productivity at EW1A. In 2009, EW1A showed minimal improvement to rehabilitation efforts. Continued groundwater extraction from the Lower Sand aquifer is needed to maintain a factor of safety in hydraulic capture and provide operational flexibility in the extraction system (i.e., avoid sole reliance on EW2). Therefore, CRA proposed to replace EW1A with a new extraction well (EW1B). In February 2010, CRA submitted a Work Plan to MPCA for installation of a new/replacement extraction well (Ref. 18). MPCA approved the Work Plan, with comments on March 10, 2010. The new extraction well (EW1B) was installed in April 2010 and began operation in May 2010, replacing EW1A. A hydraulic response to combined pumping at EW1B and EW2 was observed in both the Lower Sand and St. Peter Sandstone aquifers. Installation and performance testing results were presented to MPCA in July 2010 (Ref. 19).

The 2011 average monthly extraction rates for EW1B and EW2 are summarized in Table 3.2. EW1B and EW2 operation and maintenance activities from December 2010 through December 2011 are summarized in Table 3.3.

From January 1, 2011 through December 31, 2011, approximately 4.8 million gallons of groundwater were extracted by EW1B, removing approximately 6.3 pounds of VOCs from the Lower Sand/St. Peter Sandstone aquifers. Since 1989, approximately 157 pounds of VOCs have been removed by EW1/EW1A/EW1B. Figure 3.7 illustrates the pounds of TVOCs removed annually by EW1/EW1A/EW1B since 1989. Figure 3.8 illustrates the VOC removal efficiency (in pounds per million gallons) of EW1/EW1A/EW1B since 1989. Figure 3.9 shows cumulative VOC mass removal by EW1/EW1A/EW1B since 1989.

From January 1, 2011 through December 31, 2011, approximately 5.6 million gallons of groundwater were extracted by EW2, removing approximately 1.7 pounds of VOCs from the Lower Sand/St. Peter Sandstone aquifers. Since 2006, approximately 13 pounds of VOCs have been removed by EW2. Figure 3.7 illustrates the pounds of TVOCs removed annually by EW2 since 2006. Figure 3.8 illustrates the VOC removal efficiency (in pounds per million gallons) of EW2 since 2006. Figure 3.9 shows cumulative VOC mass removal by EW2 since 2006.

Since 1989, approximately 260 million gallons of groundwater have been extracted by EW1/EW1A/EW1B and EW2. The number of pore volume exchanges since groundwater extraction began can be estimated based on an assumed contaminated aquifer volume. The area would encompass the CWA, which would be from EW1/EW1A/EW1B/EW2 to P3 in an east-west direction (500 feet), and MW1D to P4 in a north-south direction (450 feet). Assuming an aquifer thickness of 60 feet and a porosity of 30 percent, the aquifer volume would be 4,050,000 ft^3, or approximately 30 million gallons. Therefore, approximately 8.6 aquifer pore volumes have been removed since 1989.

A groundwater capture analysis was presented in CRA's July 2010 report (Ref. 19). The report recommended the groundwater extraction system operate at a combined pumping rate (of EW1B and EW2) between 13 and 20 gpm to obtain a groundwater capture width of 200-300 ft and achieve sufficient hydraulic containment. Based on the 2011 average combined pumping rate of 19.9 gpm (see Table 3.2), the groundwater capture width in the Lower Sand aquifer and the upper portion of the St. Peter Sandstone aquifer is approximately 300 feet (measured at the pumping source). Groundwater elevation measurements collected on October 10, 2011 also provide verification of hydraulic containment of the VOC plume (see Figure 3.3).

Figure 3.10 shows historic TVOC concentrations over time for EW1/EW1A/EW1B and EW2. As typically seen in groundwater extraction systems, TVOCs declined during the initial pumping years of 1989 through 1996 at EW1/EW1A. From 1996 through 2005, TVOCs remained at levels between 50 and 100 µg/L. In 2006, TVOCs began increasing to levels between 100 µg/L and 300 µg/L. The increase in TVOC concentrations at EW1A/EW1B was due almost entirely to increased trichloroethene (TCE) concentrations. Increased TCE concentrations are likely attributed to a combination of delayed migration from the CWA and changes in the volume of groundwater extracted from the Lower Sand aquifer. Delayed migration refers to the later release of VOCs to the Lower Sand aquifer. The CWA is located above a perched groundwater unit that is hydraulically isolated from the regional water table aquifer such that the downward migration of VOCs to the water table aquifer occurs through a zone of partially saturated soil. The rate of downward migration through this partially saturated zone is substantially less than under saturated soil conditions and is dependent on several variable parameters, such as moisture content, soil permeability, and pressure head. Hence, the downward migration rate and time required to reach the water table aquifer can vary both spatially and temporally underneath the CWA. Since 2006, the total volume of groundwater extracted from the Lower Sand aquifer has fluctuated, in conjunction with combined groundwater extraction from the Upper St. Peter Sandstone aquifer (EW2). TCE concentrations in the Lower Sand aquifer increased following commission of EW2 in 2006 and as production decreased at EW1A due to bio-fouling issues. TCE concentrations in the Lower Sand aquifer have generally decreased since commission of EW1B in May 2010, with the exception of increased concentrations observed in October 2011 when EW1B was temporarily shutdown for repair (see Table 3.2). TCE has not been observed in monitoring locations downgradient of the extraction system.

Figure 3.11 presents a cross-section that depicts subsurface conditions in the vicinity of the groundwater extraction system. As shown on Figure 3.11, the groundwater extraction system effectively captures contaminated groundwater from upgradient areas (e.g., as screened by monitoring wells MW4D and MW8B). The effectiveness of the groundwater extraction system is demonstrated by low to non-detectable VOC concentrations at downgradient compliance wells and the converted residential monitoring wells.

3.4 DEWATERING SUMP PERFORMANCE ASSESSMENT

Since July 1995, operation of the dewatering sump has resulted in the removal of VOCs from the perched groundwater system within the North Disposal Area. The extracted water is discharged directly into the sanitary sewer under an MCES Special Discharge Permit.

The 2011 average monthly extraction rates for the dewatering sump are summarized in Table 3.2. Sump operation and maintenance activities from December 2010 through December 2011 are summarized in Table 3.3.

From January 1, 2011 through December 31, 2011, approximately 1.8 million gallons of groundwater were extracted by the dewatering sump, removing approximately 1.2 pounds of VOCs from the perched groundwater unit. Since 1995, approximately 84 pounds of VOCs have been removed by the dewatering sump. Figure 3.7 illustrates the pounds of TVOCs removed annually by the dewatering sump since 1995. Figure 3.8 illustrates the VOC removal efficiency (in pounds per million gallons) of the dewatering sump since 1995. Figure 3.9 shows cumulative VOC mass removal by the dewatering sump since 1995.

In December 2010, while performing routine maintenance on the extraction system, CRA personnel observed a significant drop in system pressure and ponding water in the vicinity of the dewatering sump discharge line, indicating a break in the underground portion of the discharge line; the sump pump was subsequently turned off. On February 9, 2011, MPCA issued a letter approving CRA's request to schedule repair of the dewatering sump discharge line in spring 2011 or as soon as weather conditions (i.e.,ground thaw) allowed. In accordance with the MPCA letter, a Work Plan for repair of the discharge line was submitted to MPCA on March 10, 2011 and approved by MPCA on March 22, 2011. On April 14, 2011, Stevens Drilling and Environmental (SDE) excavated the discharge line and found the break in a previously-spliced section of the discharge pipe. The spliced section of pipe was replaced and pressure-tested to assure there was no leakage. The excavated area was then backfilled and restored.

3.5 ASSESSMENT OF POTENTIAL EFFECTS FROM ST. PAUL REGIONAL WATER SERVICE (SPRWS) SUPPLY WELLS

As stated in a letter from CRA to MPCA dated July 26, 2007, Whirlpool and Reynolds share the City of North Oaks and North Oaks Home Owners Association (NOHOA) concern that future pumping of certain St. Paul Regional Water Services (SPRWS) supply wells located in the Vadnais Heights area may affect contaminant migration in North Oaks. As such, Whirlpool and Reynolds made the commitment to include as part of the Highway 96 Site Annual Reports, an annual assessment of the SPRWS activities.

In 2004, the engineering firm of Bonestroo, Rosene, Anderlik & Associates (Bonestroo), on behalf of the SPRWS, developed a groundwater model for the SPRWS to evaluate the effects of their proposed water supply system on the regional municipal water supply aquifers. Based on a proposed pumping rate of 50 million gallons per day (Mgpd), the 2004 groundwater model predicted up to 20 feet of drawdown in the Prairie du Chien (PdC) aquifer and up to 10 feet of drawdown in the St. Peter Sandstone aquifer, in the vicinity of North Oaks.

In May/June 2005, Bonestroo conducted a 30-day pumping test of the four municipal wells in the Lake Vadnais area, located approximately 12,000 feet southwest of Gilfillan Lake. During the pumping test, the MDNR monitored a PdC aquifer well located near Sucker Lake (approximately 5,000 feet west of Gilfillan Lake), a former Shoreview PdC/Jordan aquifer production well located near County Road E and Lexington Avenue (approximately 22,000 feet west/southwest of Gilfillan Lake), and a PdC/Jordan well located near the White Bear Township Municipal Building (approximately 8,300 feet east/northeast of Gilfillan Lake). The combined pumping rate during the 30-day pumping test was 19 Mgpd (approximately 3,500 gpm, per well). The pumping test results showed that the well located near Sucker Lake and the former Shoreview production well exhibited 4 to 5 feet of drawdown. The pumping test results also showed that the well located near the White Bear Township Municipal Building was outside the pumping influence. Based on the 2005 pumping test results, the MDNR determined that the 2004 groundwater model overpredicted drawdown in the vicinity of North Oaks. The MDNR attributed the drawdown differences between the model and the pumping test to a low transmissivity value used in the model. The SPRWS indicated they do not plan to update the model, but would do so if requested by the MDNR.

According to SPRWS, their goal is still to have a water supply system capable of pumping 50 Mgpd. Currently, there are six supply wells, which pump at a combined rate of 27 Mgpd. The MDNR and SPRWS are proceeding in a step-wise fashion that will likely take several years and involve commission of another four supply wells before the SPRWS can reach their 50 Mgpd capacity goal.

The MDNR requires that a pumping test be performed on any new municipal supply well in order to verify its yield, define the surrounding aquifer hydraulic properties, and examine possible well interference effects with other municipal supply wells. CRA informed the MDNR that the Highway 96 Group would allow use of the existing monitoring wells in North Oaks as part of any upcoming aquifer tests.

4.0 GROUNDWATER ASSESSMENT

Groundwater sampling associated with the Highway 96 Site has been conducted since 1986. A total of 66 rounds of groundwater sampling have been conducted at on-Site monitoring wells, off-Site monitoring wells, and residential wells. A summary of historic groundwater sampling events is provided in Table 4.1.

Groundwater sampling events conducted during 2011 are summarized in the following paragraphs.

April 2011 - Residential Well Sampling Event

During the period from April 26 - 27, 2011, 28 residential wells were sampled in general accordance with the long-term monitoring program outlined in CRA's Feasibility Study Report (dated July 26, 2007 and approved by the Minnesota Pollution Control Agency (MPCA) on November 7, 2007) and as proposed in CRA's letter to MPCA dated April 11, 2011. A complete description of the April 2011 residential well sampling event and the associated analytical results was previously submitted to MPCA in CRA's "April 2011 Residential Well Data Report", dated July 11, 2011.

October 2011 - Residential Well Sampling Event

During the period from October 3 - 6, 2011, 66 residential wells were sampled in general accordance with the long-term monitoring program outlined in CRA's Feasibility Study Report (dated July 26, 2007 and approved by the Minnesota Pollution Control Agency (MPCA) on November 7, 2007) and as proposed in CRA's letter to MPCA dated September 15, 2011. A complete description of the October 2011 residential well sampling event and the associated analytical results was previously submitted to MPCA in CRA's "October 2011 Residential Well Data Report", dated January 4, 2012.

October 2011- Annual Monitoring Well Sampling Event

During the period from October 10 - 14, 2011, on-Site and off-Site monitoring wells and the four converted residential monitoring wells were sampled as part of the Routine Annual Monitoring Well Sampling Program. A technical memo that summarizes the October 2011 Annual Monitoring Well Sampling Event is presented in Appendix C.

4.1 SUMMARY OF SITE CLEANUP LEVELS

Two sets of Site cleanup levels are used to evaluate groundwater data associated with the Highway 96 Site: Site Cleanup Goals (SCGs) and Health Risk Limits (HRLs).

Site Cleanup Goals (SCGs)

SCGs are established in Amended Table 1 of the 1993 MDD and apply to monitoring wells in Operable Unit 2. The 1993 MDD originally stipulated that SCGs applied to all current and future groundwater monitoring points on the Site (defined as all wells east of Robb Farm Road). Since 1993, the list of monitoring points where SCGs apply has been modified by MPCA. The current list of compliance monitoring wells in Operable Unit 2 where SCGs apply includes: MW10B, MW12B, MW12D, MW13B, MW13D, MW16B, and MW16D. The list of SCGs (Amended Table 1 of the 1993 MDD) is provided in Appendix D.1.

In May 2010, Wenck Associates (on behalf of the City of North Oaks) requested that this section of the Annual Monitoring Report include clarification provided by MPCA in a letter dated August 26, 2009 regarding the rationale for the selection of the SCG for vinyl chloride. In their letter dated August 26, 2009, the MPCA stated:

> *"Groundwater cleanup levels in the original Table 1 of the October 7, 1993 MDD included the Minnesota Department of Health (MDH) Recommended Allowable Limit (RAL) for vinyl chloride of 0.1 ug/L. After submitting a Response Action Plan on January 26, 1994, the RPs took the position that the cleanup level for vinyl chloride was unattainable using a groundwater extraction/containment-type technology. On March 25, 1994, MPCA staff met with the RPs, and agreed to re-examine the cleanup level for vinyl chloride. On April 13, 1994, Whirlpool and Reynolds proposed an amended cleanup level for vinyl chloride of 2 ug/L that was based on a technical rationale (i.e., Site specific information). The technical rationale was based, in part, on the observed attenuation of 1,1-dichloroethane (1,1-DCA), another contaminant of concern at the Site, versus migration distance from the Site and on the assumption that the attenuation of vinyl chloride would parallel that of 1,1-DCA. This rationale predicted that a vinyl chloride concentration of 2 ug/L at the Site would attenuate to less than 0.03 ug/L at the west shore of Gilfillan Lake. On October 3, 1994, after several meetings and discussions with the RPs, the MPCA concluded that a cleanup level of 2 ug/L for vinyl chloride "[was] protective of human health, welfare and the environment, and [did] not allow for further degradation of the groundwater resources of the area." The MPCA agreed to*

change the Site cleanup level for vinyl chloride to 2 ug/L, following the execution of the Consent Order (CO). The CO, which included the MDD with amended Table 1 as Exhibit A, was executed on January 9, 1995.

Health Risk Limits (HRLs)
HRLs are established by the Minnesota Department of Health and apply to residential wells in Operable Unit 4, as stipulated in Sections 2.2 and 6.0 of the 2008 MDD Amendment. Specifically, Section 2.2 of the 2008 MDD Amendment states "(the) HRL is the cleanup standard used by the MPCA for vinyl chloride for OU4". Operable Unit 4 is defined as residential areas without municipal water, as shown on Figure 1 of the 2008 MDD Amendment. The 2008 MDD Amendment (including Figure 1) is provided in Appendix D.2.

4.2 HISTORICAL OVERVIEW OF GROUNDWATER DATA

Groundwater analytical laboratory data are validated for quality assurance by CRA and compiled into a computer database for the purpose of data management and reporting.

Groundwater data are managed according to five well groupings:

- Perched groundwater unit;
- Lower Sand aquifer;
- St. Peter Sandstone aquifer;
- Prairie du Chien aquifer; and
- Residential wells.

An historical data summary, which identifies chemical concentrations of VOCs over time at each monitoring location, is presented in Appendix E. Historical VOC data for the current compliance monitoring wells (MW10B, MW12B, MW12D, MW13B, MW13D, MW16B, and MW16D) are provided in Appendix E.1. Historical VOC data for all other monitoring wells are provided in Appendix E.2. Historical VOC data for residential wells are presented in Appendix E.3.

A series of graphs showing TVOC concentrations over time for select wells are presented on Figures 3.10 and 4.1 through 4.10.

TVOC concentrations in the perched groundwater unit are represented by LW3 (Figure 4.1).

- LW3 data represent perched groundwater beneath the limits of the CWA. Figure 4.1 illustrates TVOC concentrations in the perched groundwater unit decreasing from 1987 through 1991, and remaining relatively stable and less than 50 μg/L since 2001. In October 2011, the maximum TVOC concentration at LW3 was 16.1 μg/L.

TVOC concentrations in the Lower Sand aquifer are represented by MW4D (Figure 4.2), EW1/EW1A/EW1B (Figure 3.10), and MW12D (Figure 4.3).

- MW4D data represent groundwater in the Lower Sand aquifer immediately downgradient of the CWA. Figure 4.2 illustrates TVOC concentrations at MW4D decreasing from 1987 though 1991, and ranging from 50 μg/L to 500 μg/L since 1991. In October 2011, the TVOC concentration at MW4D was 169.6 μg/L.
- EW1/EW1A/EW1B data represent groundwater from the Lower Sand and St. Peter Sandstone aquifers that is captured by the extraction system. Figure 3.10 illustrates TVOC concentrations at EW1/EW1A/EW1B (see Section 3.3.).
- MW12D data represent groundwater in the Lower Sand aquifer downgradient of the extraction system. Figure 4.3 illustrates TVOC concentrations at MW12D, which have historically remained below 3 μg/L since 1997. In October 1996, the TVOC concentration was near 400 μg/L. That sample result is considered anomalous because TVOC concentrations were not observed at or near that level prior to or after that sample date. In October 2011, there were no VOCs detected at MW12D.

TVOC concentrations in the St. Peter Sandstone aquifer, are illustrated by MW8B (Figure 4.4), EW2 (Figure 3.10), MW12B (Figure 4.5), and four converted (former) residential monitoring wells (Figures 4.6 through 4.9).

- MW8B is located between the CWA and the groundwater extraction system. MW8B data represent groundwater in the St. Peter Sandstone aquifer immediately downgradient of the CWA. Figure 4.4 illustrates TVOC concentrations at MW8B, which have ranged from 1 μg/L to 300 μg/L over the past 20 years. In October 2011, the TVOC concentration at MW8B was 26.64 μg/L. TVOC concentrations at MW8B have decreased significantly since the commission of extraction well EW2 in January 2006.
- EW2 data represent groundwater from the Lower Sand and St. Peter Sandstone aquifers that is captured by the extraction system. EW2 was installed in

September 2005 and commissioned in January 2006. Figure 3.10 illustrates TVOC concentrations at EW2, which have remained below 100 µg/L since 2005.

- MW12B data represent groundwater in the St. Peter Sandstone aquifer downgradient of the extraction system. Figure 4.5 illustrates TVOC concentrations at MW12B which have historically remained below 6 µg/L since 1997. In October 2011, there were no VOCs detected at MW12B.
- Data from the four converted residential monitoring wells represent groundwater in the St. Peter Sandstone aquifer further downgradient of the Highway 96 Site. Figure 4.6 illustrates TVOC concentrations at 11 Robb Farm Road decreased from 1989 through 1992 and have remained relatively stable (below 10 µg/L) since 1990. In October 2011, the TVOC concentration at 11 Robb Farm Road was 0.54 µg/L. Figure 4.7 illustrates TVOC concentrations at 1 Lily Pond Road have fluctuated between not detected and 30 µg/L since sampling began in 1990. In October 2011, the TVOC concentration at 1 Lily Pond Road was 22.29 µg/L. Figure 4.8 illustrates TVOC concentrations at 11 Lily Pond Road have typically remained below 5 µg/L since 1996. In October 2011, there were no VOCs detected at 11 Lily Pond Road. Figure 4.9 illustrates TVOC concentrations at 6 Blue Goose Road have remained below 5 µg/L since 1997. In October 2011, there were no VOCs detected at 6 Blue Goose Road. The overall decline of TVOC concentrations at the four converted residential well locations can be attributed to Site remediation activities and natural attenuation.

TVOC concentrations in the Prairie du Chien aquifer are illustrated by MW17L (Figure 4.10).

- Data from MW17L represent groundwater in the Prairie du Chien aquifer downgradient of the Highway 96 Site. Figure 4.10 illustrates TVOC concentrations at MW17L have remained below 10 µg/L since sampling began at this location in 2005. In October 2011, the TVOC concentration at MW17L was 0.28 µg/L.

TVOC concentrations will continue to be evaluated through future groundwater monitoring.

4.3 2011 DATA PRESENTATION

Laboratory analytical reports for samples collected in 2011 are presented in Appendix F. Analytical data quality assessment and validation of all results was conducted by the

CRA quality control/quality assurance (QA/QC) officer. Data quality assessment and validation memos are also presented in Appendix F.

Analytical results for samples collected in 2011 from the perched groundwater unit, Lower Sand aquifer, St. Peter Sandstone aquifer, and Prairie du Chien aquifer monitoring wells are presented in Tables 4.2 through 4.5, respectively. Analytical results for samples collected in 2011 from residential wells are presented in Table 4.6.

To illustrate the data, Figures 4.11 through 4.16 show the distribution of TVOCs detected in 2011 in the perched groundwater unit, Lower Sand aquifer, St. Peter Sandstone aquifer (on-Site monitoring wells), St. Peter Sandstone aquifer (off-Site monitoring wells), Prairie du Chien aquifer, and in residential wells, respectively.

4.3.1 PERCHED GROUNDWATER UNIT

Five perched groundwater wells (LW2, LW3, MW1S, MW4U and the dewatering sump) were sampled in 2011. One perched groundwater monitoring well (LW1) was not sampled due to insufficient available water (i.e.,low groundwater conditions). Perched groundwater analytical results from 2011 are presented in Table 4.2 and on Figure 4.11. Historical perched groundwater VOC results are presented in Appendix E.2.

Compliance Monitoring Wells

None of the perched monitoring well locations are included in the current list of compliance monitoring wells.

Monitoring Wells

VOCs detected in 2011 in perched groundwater samples included 1,1-dichloroethane, 1,1-dichloroethene, 1,2-dichloroethane, acetone, benzene, chloroethane, cis-1,2-dichloroethene, dichlorodifluoromethane, dichlorofluoromethane, ethyl ether, ethylbenzene, isopropyl benzene, methyl ethyl ketone, methyl isobutyl ketone, toluene, trans-1,2-dichloroethene, trichloroethene, vinyl chloride, and xylenes. Detections of these VOCs are generally consistent with historical sampling results.

For comparison purposes, 1,1-dichloroethane, 1,2-dichloroethane, benzene, cis-1,2-dichloroethene, trichloroethene and vinyl chloride were the only VOCs detected in perched groundwater monitoring well samples collected in 2011 at concentrations above their respective SCGs (established for compliance wells only). In 2011, 1,1-dichloroethane was detected above its SCG (70 µg/L) at MW4U (160 µg/L), 1,2-dichloroethane was detected above its SCG (4 µg/L) at MW4U (4.3J µg/L), benzene was detected above its SCG (5 µg/L) at MW4U (8.6J µg/L), cis-1,2-dichloroethene was detected above its SCG (70 µg/L) at MW4U (230 µg/L), trichloroethene was detected above its SCG (5 µg/L) at MW4U (5.3 µg/L) and vinyl chloride was detected above its SCG (2 µg/L) at the dewatering sump (maximum concentration reported was 31 µg/L) and MW4U (290 µg/L). MW4U is located between the CWA and the groundwater extraction system and represents perched groundwater conditions immediately downgradient of the CWA. The dewatering sump is located in the center of the CWA and captures perched groundwater at this location.

MW4U has not been sampled since 2006 because little or no water was available for sampling (i.e.,low perched groundwater conditions). However, this well was able to be sampled in October 2011 and the analytical results indicate that a VOC mass is still present within the perched groundwater system. The perched groundwater system is hydraulically isolated from the regional water table aquifer. The VOC mass present in the perched groundwater system at MW4U migrates downward into the Lower Sand Aquifer through a zone of partially saturated soil and is subsequently captured by the groundwater extraction system.

The 2011 chloride concentrations in the perched groundwater unit ranged from 7.2 mg/L (MW1S) to 210 mg/L (MW4U). Chloride has historically been detected in groundwater samples from perched groundwater wells at concentrations within this range.

4.3.2 LOWER SAND AQUIFER

Nine Lower Sand aquifer monitoring wells (EW1B, MW1D, MW4S, MW4D, MW10D, MW11D, MW12D, MW13D and MW16D) were sampled in 2011. Lower Sand aquifer analytical results from 2011 are presented in Table 4.3 and on Figure 4.12. Historical Lower Sand aquifer VOC results at the current compliance monitoring wells and other monitoring wells are presented in Appendix E.1 and Appendix E.2, respectively.

Compliance Monitoring Wells

The Lower Sand aquifer compliance monitoring wells (MW12D, MW13D, and MW16D) are located along Robb Farm Road and represent Lower Sand aquifer groundwater immediately downgradient of the on-Site extraction system. VOCs detected in 2011 in Lower Sand aquifer compliance well samples included 1,1-dichloroethane, chloroethane, and cis-1,2-dichloroethene. All 2011 analytical results from the Lower Sand aquifer compliance monitoring wells were below their respective SCGs.

Other Monitoring Wells

The remaining Lower Sand aquifer monitoring wells are located on-Site. VOCs detected in 2011 in the other Lower Sand aquifer monitoring well samples included 1,1-dichloroethane, 1,2-dichloroethane, acetone, benzene, chloroethane, cis-1,2-dichloroethene, dichlorodifluoromethane, dichlorofluoromethane, ethyl ether, methyl ethyl ketone, methyl isobutyl ketone, methylene chloride, toluene, trans-1,2-Dichloroethene, trichloroethene, and vinyl chloride. Detections of these VOCs are generally consistent with historical sampling results.

For comparison purposes, 1,1-dichloroethane, 1,2-dichloroethane, trichloroethene and vinyl chloride were the only VOCs detected in non-compliance Lower Sand aquifer monitoring well samples collected in 2011 at concentrations above their respective SCGs (established for compliance wells only). In 2011, 1,1-dichloroethane was detected above its SCG (70 µg/L) at MW4S (97 µg/L), 1,2-dichloroethane was detected above its SCG (4 µg/L) at MW4D (10 µg/L), trichloroethene was detected above its SCG (5 µg/L) at EW1B (maximum concentration reported was 240 µg/L), and vinyl chloride was detected above its SCG (2 µg/L) at EW1B (maximum concentration reported was 6.9 µg/L) and MW4S (77 µg/L). MW4S and MW4D are located between the CWA and the groundwater extraction system and represent Lower Sand aquifer groundwater conditions immediately downgradient of the CWA. EW1B represents groundwater from the Lower Sand and St. Peter Sandstone aquifers that is captured by the extraction system.

MW4S has not been sampled since 2008 because little or no groundwater was present in the well (i.e., the regional water table elevation was lower than the well screen interval of MW4S). However, this well was able to be sampled in October 2011 and the analytical results show elevated VOC concentrations in the upper portion of the Lower Sand aquifer, which is attributed to downward migration of VOCs from the perched groundwater system (see Section 4.3.1). VOC concentrations further into the Lower Sand aquifer (at MW4D) are approximately 50% less than VOC concentrations in the Lower Sand aquifer at MW4S. The VOC mass present in the Lower Sand aquifer at MW4S/MW4D is subsequently captured by the groundwater extraction system.

The 2011 chloride concentrations in the Lower Sand aquifer ranged from 19 mg/L (MW10D) to 1,400 mg/L (MW4S). Chloride has historically been detected in groundwater samples from Lower Sand aquifer wells at concentrations below 1,000 mg/L.

4.3.3 ST. PETER SANDSTONE AQUIFER

Nineteen St. Peter Sandstone aquifer monitoring wells (MW8B, MW10B, MW12B, MW13B, MW16B, MW17A, MW17B, MW18A, MW18B, MW19A, MW19B, MW20B, MW21A, EW2, EW3, and the four converted residential monitoring wells) were sampled in 2011. St. Peter Sandstone aquifer analytical results from 2011 are presented in Table 4.4 and on Figure 4.13 (on-Site monitoring locations) and Figure 4.14 (off-Site monitoring locations). Historical St. Peter Sandstone aquifer VOC results at the current compliance monitoring wells, and other monitoring wells are presented in Appendix E.1 and Appendix E.2, respectively.

Compliance Monitoring Wells

The St. Peter Sandstone aquifer compliance monitoring wells (MW10B, MW12B, MW13B, and MW16B) are located along Robb Farm Road and represent St. Peter Sandstone aquifer groundwater immediately downgradient of the on-Site extraction system. VOCs detected in 2011 in the St. Peter Sandstone aquifer compliance well samples included dichlorodifluoromethane and dichlorofluoromethane. All 2011 analytical results from the St. Peter Sandstone aquifer compliance monitoring wells were below their respective SCGs.

Other Monitoring Wells

The remaining St. Peter Sandstone aquifer monitoring wells are located both on-Site and off-Site.

St. Peter Sandstone aquifer monitoring wells MW8B and EW2 are located on-Site. MW8B is located between the CWA and the groundwater extraction system, and represents St. Peter Sandstone aquifer groundwater immediately downgradient of the CWA. EW2 represents groundwater from the St. Peter Sandstone aquifer that is captured by the extraction system.

VOCs detected in 2011 in the St. Peter Sandstone aquifer samples collected from on-Site monitoring locations included 1,1-dichloroethane, 1,2-dichloroethane, benzene, chloroethane, cis-1,2-dichloroethene, dichlorodifluoromethane, dichlorofluoromethane, toluene, trichloroethene and vinyl chloride. Detections of these VOCs are generally consistent with historical sampling results.

For comparison purposes, vinyl chloride was the only VOC detected in on-Site, non-compliance St. Peter Sandstone aquifer monitoring well samples collected in 2011 at a concentration above its respective SCG (established for compliance wells only). In 2011, vinyl chloride was detected above its SCG (2 µg/L) at EW2 (maximum concentration reported was 4.1 µg/L) and MW8B (2.7 µg/L).

St. Peter Sandstone aquifer monitoring wells MW17A, MW17B, MW18A, MW18B, MW19A, MW19B, MW20B, MW21A, EW3, and the four converted residential monitoring wells (6 Blue Goose Road, 1 Lily Pond Road, 11 Lily Pond Road, and 11 Robb Farm Road) are located off-Site and represent groundwater in the St. Peter Sandstone aquifer, downgradient of the Highway 96 Site.

VOCs detected in 2011 in the St. Peter Sandstone aquifer samples collected from off-Site monitoring locations included 1,1-dichloroethane, 1,2-dichloroethane, chloroethane, cis-1,2-dichloroethene, dichlorodifluoromethane, dichlorofluoromethane, toluene, and vinyl chloride. Detections of these VOCs are generally consistent with historical sampling results, with the exception of the October 2011 detection of vinyl chloride at MW18B. MW18B is a basal St. Peter Sandstone monitoring well that was installed in 2006. The October 2011 vinyl chloride detection at MW18B is the first detection at this monitoring location (and the first detection of vinyl chloride in the off-Site monitoring well network west of Gilfillan Lake). However, the detection of vinyl chloride at M-18B is consistent with historic detections of vinyl chloride in adjacent basal St. Peter Sandstone former residential wells (e.g., 12 West Shore Road and 15 West Shore Road).

For comparison purposes, vinyl chloride was the only VOC detected in 2011 in off-Site St. Peter Sandstone aquifer monitoring well samples at a concentration above its MDH HRL (established for private drinking water supplies). In 2011, vinyl chloride was detected above its HRL (0.2 µg/L) at MW17A (0.34 µg/L) and MW17B (0.32 ug/L). The concentrations of vinyl chloride in the St. Peter Sandstone aquifer on the east side of Gilfillan Lake, as represented by MW17A and MW17B, are generally lower compared to historical sampling results from 1993/1994 in the 15 Gilfillan Road/17 Gilfillan Road/8 Edgewater Lane area. The lower vinyl chloride concentrations are attributed to Site remediation activities and natural attenuation.

The 2011 chloride concentrations in the St. Peter Sandstone aquifer ranged from 2.0 mg/L (MW12B) to 72 mg/L (MW19A). Chloride has historically been detected in groundwater samples from St. Peter Sandstone aquifer wells at similar concentrations.

4.3.4 PRAIRIE DU CHIEN AQUIFER

Three Prairie du Chien aquifer monitoring wells (MW17L, MW18L, and MW19L) were sampled in 2011. Prairie du Chien aquifer analytical results from 2011 are presented on Table 4.5 and Figure 4.15. Historical Prairie du Chien aquifer VOC results are presented in Appendix E.2.

Compliance Monitoring Wells
None of the Prairie du Chien aquifer monitoring well locations are included in the current list of compliance monitoring wells.

Other Monitoring Wells
MW17L, MW18L, and MW19L are located off-Site and represent groundwater in the Prairie du Chien aquifer, downgradient of the Highway 96 Site. In 2011, the only VOC detected in the Prairie du Chien aquifer monitoring wells was toluene.

For comparison purposes, all 2011 VOC detections in samples collected from the Prairie du Chien aquifer monitoring wells were below MDH HRLs (established for private drinking water supplies).

Analytical results from MW17L, MW18L, and MW19L demonstrate that the Prairie du Chien aquifer is not impacted and continues to represent a suitable alternative water supply for the MPCA-selected remedy outlined in the 2008 MDD Amendment (i.e.,installation of new/deeper wells for homes located in Operable Unit 4 that are issued a well advisory due to Site-related VOCs.)

The 2011 chloride concentrations in the Prairie du Chien aquifer ranged from 12 mg/L (MW19L) to 14 mg/L (MW17L and MW18L). Chloride has historically been detected in groundwater samples from Prairie du Chien aquifer wells at similar concentrations.

4.3.5 RESIDENTIAL WELLS

A total of 70 residential well locations were sampled in 2011. Residential well analytical results from 2011 are presented in Table 4.6 and on Figure 4.16. Historical residential well VOC results are presented in Appendix E.3.

In 2011, vinyl chloride was detected at three residential well locations (2 Heron Lane, 50 East Oaks Road, and 15 West Shore Road). The vinyl chloride detections are discussed separately, in the paragraphs below.

Vinyl chloride was detected in the October 2011 sample collected from 2 Heron Lane at an estimated (J) concentration of 0.11J µg/L. Because vinyl chloride had not been detected previously at this location or within its general vicinity (i.e.,Area 5 west of Gilfillan Lake), it was decided to collect a second groundwater well sample with the property owner's permission. Vinyl chloride was detected in the December 2011 resample at an estimated (J) concentration of 0.12J µg/L. The well construction log for 2 Heron Lane indicates the well is in the basal St. Peter Sandstone aquifer, which is common for residential wells in Areas 3, 4, and 5 (Ref. 10, 11, 12). Although the October and December 2011 vinyl chloride detections at 2 Heron Lane are below its HRL (0.2 µg/L) and as requested in MPCA's email dated January 26, 2012, 2 Heron Lane will be added to the list of wells scheduled for sampling in April 2012. Potential modifications to the long term monitoring program will be evaluated following review of subsequent sampling results.

Vinyl chloride was detected in the April 2011 sample collected from 50 East Oaks Road at a concentration of 0.12J µg/L. Vinyl chloride had not been detected previously at 50 East Oaks Road. 50 East Oaks Road is located adjacent to other locations where vinyl chloride has been detected (13 West Shore Road, 15 West Shore Road, and 2 Hummingbird Hill). The April 2011 vinyl chloride detection at 50 East Oaks Road is below its HRL (0.2 µg/L). CRA/MPCA attempted to collect a sample from 50 East Oaks Road during the October 2011 sampling event, but a response to the sampling request was not received. The next routine sampling event at 50 East Oaks Road is scheduled for April 2012.

Vinyl chloride was detected in the April 2011 and October 2011 samples collected from 15 West Shore Road at concentrations of 0.12J µg/L and 0.20 µg/L, respectively. The presence of vinyl chloride at 15 West Shore Road is consistent with previous sampling results. As of October 2011, vinyl chloride detections from samples collected from 15 West Shore Road location remain at or below its HRL (0.2 µg/L). The next routine sampling event at 15 West Shore Road is scheduled for April 2012.

Figure 4.17 presents the maximum vinyl chloride concentrations detected in residential wells in 2011. As shown, vinyl chloride was not detected above the HRL (0.2 µg/L) at any of the residential well locations sampled in 2011. Figure 4.17 also presents the maximum vinyl chloride concentrations detected in off-Site monitoring well locations in

2011. As shown, vinyl chloride was detected above the HRL (0.2 μg/L) at two monitoring well locations, MW17A (0.34 μg/L) and MW17B (0.32 μg/L), in 2011 (see Section 4.3.3).

Residential well sampling conducted during the period from October 2004 through October 2011 of over 80 residential wells located in the southeast portion of North Oaks has shown that the number of residential wells west of Gilfillan Lake with detectable concentrations of vinyl chloride is limited to seven locations:

- 2 Heron Lane;
- 2 Hummingbird Hill (replaced/abandoned);
- 50 East Oaks Road;
- 10 West Shore Road;
- 12 West Shore Road (replaced/abandoned);
- 13 West Shore Road (replaced/abandoned); and
- 15 West Shore Road.

Three of the seven wells (2 Hummingbird Hill, 12 West Shore Road, and 13 West Shore Road) have been replaced with new/deeper residential wells (see Section 4.3.5.2). Graphs of vinyl chloride trends at active residential wells and off-Site monitoring well locations where vinyl chloride has been detected (i.e.,2 Heron Lane, 50 East Oaks Road, 10 West Shore Road, 15 West Shore Road, MW-17A, MW-17B, and MW-18B) are presented in Appendix G.

The remaining VOCs detected in the residential well samples collected in 2011 included 1,1-dichloroethane, cis-1,2-dichlorethene, dichlorodifluoromethane and dichlorofluoromethane. All detected concentrations were below their respective HRLs.

The 2011 chloride concentrations in the residential wells ranged from 0.92 mg/L (1 Poplar Lane) to 130 mg/L (4 Thompson Lane). Chloride has historically been detected at similar concentrations in residential well samples.

4.3.5.1 <u>NEW RESIDENTIAL WELL INSTALLATIONS</u>

As stipulated in the recent MDD amendment for the Highway 96 Site (signed August 26, 2008), the MPCA-selected remedy, for homes located within Operable Unit 4 of the Site that have been issued a well advisory due to Site-related VOCs, is provision of a new/deeper residential well in the Prairie du Chien aquifer.

To date (March 2012), MDH has only issued well advisories to two locations in Operable Unit 4 due to Site-related VOCs: 12 West Shore Road and 13 West Shore Road.

12 West Shore Road

On December 8, 2008, the MDH issued a well advisory to 12 West Shore Road based on the October/November 2008 detections of vinyl chloride above the HRL. On December 16, 2008, Whirlpool and Reynolds sent a letter to the homeowner at 12 West Shore Road to initiate arrangements for installation of a new residential well in the Prairie du Chien aquifer, in accordance with the MDD amendment. In August 2009, the homeowners at 12 West Shore Road agreed to allow installation of a new residential well. Coordination of the new residential well installation at 12 West Shore Road began in September 2009. An inoperable well was discovered in the basement of the home that predated the homeowner's current well. Further investigation was necessary to verify abandonment of the inoperable well before installation of the new/deeper residential well. In March 2010, the inoperable well was abandoned in accordance with MDH requirements. Installation of the new residential well at 12 West Shore Road was completed in August 2010. As part of the well installation planning process, the homeowners decided, at their own expense, to have the new residential well advanced into the underlying Jordan Sandstone aquifer for their drinking water source. The former residential well at 12 West Shore Road was abandoned in August 2010, at the request of the homeowner (with MPCA approval).

13 West Shore Road

On August 15, 2007, the MDH issued a well advisory to 13 West Shore Road based on the April 2007 detection of vinyl chloride equal to the HRL and the additive risk associated with additional VOC detections. On October 10, 2008, Whirlpool and Reynolds sent a letter to the homeowner at 13 West Shore Road to initiate arrangements for installation of a new residential well in the Prairie du Chien aquifer, in accordance with the MDD amendment. In January 2009, the homeowners at 13 West Shore Road agreed to allow installation of a new residential well. Installation of the new residential well at 13 West Shore Road was completed in March 2009. As part of that well installation, the homeowners decided, at their own expense, to have the new residential well advanced into the underlying Jordan Sandstone aquifer for their drinking water source. The former residential well at 13 West Shore Road was abandoned in March 2009, at the request of the homeowner (with MPCA approval).

In 2009, two additional residential wells in Operable Unit 4 were replaced with new/deeper wells in the Jordan Sandstone aquifer: 2 Hummingbird Hill and 2 Thompson Lane.

2 Hummingbird Hill

Although not required by MPCA under the MDD amendment, Whirlpool and Reynolds also extended a voluntary offer to provide a new residential well in the Prairie du Chien aquifer to the homeowner at 2 Hummingbird Hill. In January 2009, the homeowner at 2 Hummingbird Hill accepted Whirlpool's and Reynolds' voluntary offer to install a new residential well. Installation of the new residential well at 2 Hummingbird Hill was completed in March 2009. As part of that well installation, the homeowner decided, at their own expense, to have the new residential well advanced into the underlying Jordan Sandstone aquifer for their drinking water source. The former residential well at 2 Hummingbird Hill was abandoned in September 2009, at the request of the homeowner (with MPCA approval).

2 Thompson Lane

In July 2009, a new/deeper residential well was installed at 2 Thompson Lane. The well replacement at 2 Thompson Lane was not required by MPCA under the MDD amendment. The existing well was replaced by the homeowner reportedly due to failure of the well casing (i.e.,sand in the water supply). The homeowners decided, at their own expense, to replace their existing residential well in the St. Peter Sandstone aquifer with a new residential well advanced into the underlying Jordan Sandstone aquifer. The former residential well at 2 Thompson Lane was abandoned, in accordance with MDH well code requirements.

4.3.5.2 STATUS OF MDH HRL RULE REVISION FOR VINYL CHLORIDE

In a letter from CRA to MPCA dated July 26, 2007, Whirlpool and Reynolds made the commitment to include as part of the Highway 96 Site Annual Report, a status update on the MDH HRL Rule Revision for vinyl chloride.

- The current HRL for vinyl chloride (0.2 μg/L) was established by the MDH in 1993/1994.
- In December 2004, the MDH proposed a draft revised HRL for vinyl chloride (0.08 μg/L), as part of the 2004 Draft HRL Rule Revision.
- In April 2007, the MDH withdrew the proposed draft revised HRL for vinyl chloride.

- In September 2007, the MDH recommended that the HRL for vinyl chloride be included on the list of compounds to be reviewed as part of the Draft HRL Rule Revision.
- ***In February 2008, MDH completed their review of the HRL for vinyl chloride and proposed that the HRL remain at 0.2 µg/L (no change).***
- In July 2008, MDH posted a draft of the Proposed HRL Rule Revision and Statement of Need and Reasonableness (SONAR), a technical document explaining and supporting the revised Rules.
- In September 2008, a copy of the July 2008 Proposed HRL Rule Revision was published in the State Register.
- In October 2008, a public hearing on the July 2008 Proposed HRL Rule Revision was held before an Administrative Law Judge. The hearing was followed by a 20-day comment period (ending October 30, 2008) and a five-day rebuttal period (ending November 6, 2008).
- ***In April 2009, the July 2008 Proposed HRL Rule Revision was adopted (Minnesota Administrative Rules Parts 4717.7810 through 4717.7900).***

Specific information regarding the MDH HRL Rule Revision can be obtained by contacting the MDH or by visiting the MDH website:

http://www.health.state.mn.us/divs/eh/risk/guidance/gw/index.html

4.3.5.3 STATUS OF BOTTLED WATER DELIVERY

As a voluntary interim precautionary measure, Whirlpool and Reynolds originally began providing bottled water to homes where vinyl chloride was detected at concentrations above the proposed draft HRL (0.08 µg/L). Whirlpool and Reynolds began providing bottled water to 12 West Shore Road and 13 West Shore Road in March 2005. Whirlpool and Reynolds began providing bottled water to 2 Hummingbird Hill and 15 West Shore Road in May 2005 and November 2007, respectively.

In a letter to MPCA dated August 23, 2007, CRA stated:

> *"…Whirlpool and Reynolds will also, for the immediate future, continue to provide bottled water to homes where vinyl chloride is detected above a concentration of 0.08 µg/L. Even after an amended MDD is issued, Whirlpool and Reynolds will continue*

to provide bottled water to those homes until the current HRL rulemaking is concluded and either the current HRL for vinyl chloride is confirmed or a new one is adopted."

As discussed in Section 4.2.5.1, the proposed HRL of 0.08 μg/L was withdrawn in April 2007. The current HRL for vinyl chloride (0.2 μg/L) was confirmed in February 2008 and adopted into rule in April 2009.

Bottled water delivery to 12 West Shore Road, 13 West Shore Road and 2 Hummingbird Hill was discontinued, following installation of new/deeper replacement wells at these locations (see Section 4.3.5.2).

Bottled water delivery to 15 West Shore Road has been discontinued, as vinyl chloride concentrations at this location remain at or below the current HRL (0.2 μg/L) and no well advisory has been issued.

Bottled water has not been provided to 10 West Shore Road or 2 Heron Lane because vinyl chloride was first detected at these locations after the current HRL (0.2 μg/L) was adopted into rule and vinyl chloride concentrations at these locations remain below the current HRL.

5.0 GAS PROBE MONITORING

During the second and third quarters of 2011, the six gas probe locations shown on Figure 5.1 were monitored for combustible gas. Per MPCA approval, a LandTec GEM 500 portable gas meter was used to perform combustible gas monitoring. Table 5.1 presents the results of the gas probe monitoring conducted using an MSA combustible gas meter from 1995 through 2001. Table 5.2 presents the results of gas probe monitoring using the LandTec GEM 500 from 1999 to date.

Results from the monitoring program described in the O&M Plan (Ref. 8) indicate the presence of measurable levels of combustible gas within the buried waste of the reconsolidated North Disposal Area. Typical readings for other landfill sites have ranged from 0.5 to 65 percent combustible gas. As Table 5.1 shows, readings from the Highway 96 Site range from 0 to 93 percent combustible gas. This is likely an indication that all combustible gas may not be landfill related and may also be attributed in part to the wetlands (swamp) setting.

The LandTec meter reads the percentage by volume of methane (CH_4), oxygen (O_2), and carbon dioxide (CO_2). Typical concentrations of these parameters recorded at other landfills sites are: CH_4 (30 to 60%), CO_2 (20 to 50%), and O_2 (<2%). The results on Table 5.2 are generally within or below the typical concentrations. The CH_4 results from the LandTec meter generally corresponded to the combustible gas readings observed using the MSA meter. As such, monitoring with both the MSA meter and the LandTec meter was not needed, and discontinued per MPCA approval.

Figures 5.2 through 5.7 show the percent combustible gas vs. time graphs for GP1 through GP6, respectively. Data were collected from the MSA meter from 1995 to January 2001. Data after January 2001 were collected using the LandTec meter. Over the 10 years that combustible gas has been monitored at the Site, no clear Site-wide trend has emerged.

Each probe was also monitored for positive pressure using the Land Tec meter (accurate to 0.1 inch of H_2O). Pressure readings were between 0.0 inch of H_2O and 0.1 inch of H_2O at all locations. The lack of appreciable pressure observed at the gas probes indicates that the passive gas venting system is relieving any potential pressure build-up from combustible gas generation. Off-cap monitoring should be conducted in the areas of future development prior to any construction.

In accordance with the O&M Plan (Ref. 8), gas probe monitoring is scheduled to continue through 2014.

MEH commenced construction activities for the Weston Woods townhome development at the Site during the spring of 2001. MEH installed 10 gas probes, and two gas interceptor trenches to prevent lateral gas migration. In July 2005, MEH installed six passive gas vents on the landfill cap in order to augment the passive gas remedy. The location of the gas probes, gas vents, and gas interceptor trench are illustrated in Figure 5.8. MEH conducted routine gas monitoring under MPCA's Voluntary Investigation and Clean-up (VIC) program to evaluate the potential of lateral gas migration. MEH's gas monitoring data and migration evaluation is not included in this report.

In 2010, the MPCA provided approval for MEH to discontinue landfill gas monitoring because methane no longer exceeded 25% of the lower explosive limit (LEL) at the landfill perimeter. The MPCA requested that MEH monitoring probes remain available for future potential monitoring, and this request has been complied with.

6.0 SOIL CAP INSPECTIONS

In accordance with the O&M Plan (Ref. 8), and MPCA-approved modifications on July 19, 2001, routine inspection of the Site was performed during the second and fourth quarters of 2011. The following items were evaluated during the inspections:

- The soil cover was inspected for detrimental erosion, settlement and stressed or overgrown vegetation;
- Access roads were inspected for physical damage and obstructions; and
- Methane gas monitoring probes and groundwater monitoring wells were inspected for physical damage.

A record of each inspection is maintained on a checklist. To date, the cover has shown no signs of detrimental erosion or stressed vegetation. Minor settlement has been detected and repaired by placing fill. The cap vegetation is well established. Gas probes and monitoring wells are in good condition.

In accordance with the O&M Plan (Ref. 8), cap inspections are scheduled to continue until 2014.

7.0 CONCLUSIONS

Based on the information presented in this 2011 Annual Monitoring Report, the following conclusions are made:

1. The groundwater extraction system is effectively capturing VOCs from the CWA based on the evaluation of hydraulic conditions (i.e.,groundwater elevation contours) and groundwater chemistry (i.e.,analytical results from downgradient compliance wells).
2. Groundwater samples from monitoring wells continue to indicate that vinyl chloride is not present in wells screened in the unconsolidated Glacial Drift aquifer (Lower Sand aquifer) in North Oaks.
3. Groundwater samples from monitoring wells continue to indicate that vinyl chloride detections in wells west of Gilfillan Lake, in the St. Peter Sandstone aquifer, are of limited extent.
4. Groundwater samples from monitoring wells continue to indicate that vinyl chloride is not present in wells screened in the Prairie du Chien aquifer in North Oaks.
5. Ongoing residential well sampling of homes in North Oaks, west of Gilfillan Lake (Operable Unit 4), confirms that the number of residential wells with vinyl chloride detections is limited to seven locations near the west shore of Gilfillan Lake: 2 Heron Lane, 2 Hummingbird Hill (replaced/abandoned), 50 East Oaks Road, 10 West Shore Road, 12 West Shore Road (replaced/abandoned), 13 West Shore Road (replaced/abandoned), and 15 West Shore Road. Three of the seven wells (2 Hummingbird Hill, 12 West Shore Road, and 13 West Shore Road) have been replaced with new/deeper residential wells (see Section 4.3.5.2). Vinyl chloride concentrations at 2 Heron Lane, 50 East Oaks Road, 10 West Shore Road and 15 West Shore remain at or below the HRL (0.2 μg/L).

8.0 RECOMMENDATIONS

Based on the information presented in this 2011 Annual Monitoring Report, CRA recommends the following:

1. Operation of the on-Site groundwater extraction system should continue in the perched groundwater system (via the dewatering sump) and in the Lower Sand/St. Peter Sandstone aquifers (via extraction wells EW1B and EW2).
2. Annual groundwater sampling of on-Site and off-Site monitoring well locations should continue.
3. Residential well sampling should continue, in accordance with the long-term monitoring program outlined in Alternative A2 of CRA's Feasibility Study Report (Ref. 15) (approved by MPCA on November 7, 2007) and subsequent MPCA-approved modifications. Future residential well sampling will be based on MPCA requirements and approved modifications.
4. New residential wells in the Prairie du Chien aquifer should be provided to homes in Operable Unit 4 that have been issued a well advisory due to Site-related VOCs, as stipulated in the recent MDD amendment for the Highway 96 Site (dated August 26, 2008).
5. Gas probe monitoring should continue, as outlined in the O&M Plan (Ref. 8).
6. Soil cap inspections should continue, as outlined in the O&M Plan (Ref. 8).

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