Manitoba Perpetual Care Sites – Winnipeg Diesel Shops and Weston Shops (EA 301) Environmental Status Report

Final Report

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Environmental Services

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EXECUTIVE SUMMARY

Dillon Consulting Limited (Dillon) was retained by the Canadian Pacific Railway (CPR) to provide an environmental review of the Winnipeg Diesel Shops and Weston Shops and to deliver a strategic process for rationalizing the ramp-down of remedial activities including groundwater monitoring and sampling as well as the decommissioning of select monitoring wells.

A liquid phase hydrocarbon (LPH) plume stability assessment was conducted for the LPH plume identified in the Former Locomotive Fueling Facility. The results of the LPH plume stability assessment indicate that the LPH plume is not mobile and has stabilized.

A dissolved phase plume stability assessment was conducted on available Volatile Organic Compound (VOC) analytical data from the Component Shop and Wheel Shop Area using a Mann-Kendall statistical analysis of plume trends at the 90 % confidence level. Results of the trend analysis indicate that the concentrations of the dissolved plumes on-site are stable, and possibly decreasing, with minor fluctuations in terms of dissolved tetrachloroethene concentrations.

Based on our review of the information available, the identified LPH plume in the Former Locomotive Fueling Facility has been adequately defined in terms of both nature and extent. The plume is relatively stable and is not increasing in thickness or concentration, nor is it anticipated to be migrating within the Yard or off-site. The dissolved phase VOC plumes in the Component Shop and Wheel Shop Area are relatively stable in terms of concentrations; however the full extent of the plumes and their potential for migration remain unknown. Also, trend analyses could not be performed for dissolved phase petroleum hydrocarbons due to the lack of analytical data for these parameters.

Dillon undertook a risk screening of the site to determine if unacceptable risks could be present as a result of the identified LPH and dissolved phase hydrocarbons and VOCs. Dillon identified potentially unacceptable human health risks on-site, based on our current understanding of the site's characteristics. However, Dillon did not identify the potential for unacceptable risk to human health off-site or unacceptable ecological risk on-site or off-site. The risk screening was limited to LPH and VOCs and did not include metals impact to soil or groundwater since the results of the initial site investigation did not identify impacts exceeding applicable criteria.

Because the dissolved phase hydrocarbon plumes have not been adequately defined, coupled with the potential for unacceptable risk to human health identified on-site, it is appropriate to recommend annual monitoring and/or sampling of select wells within the Yard.

Dillon is also recommending that select wells be taken out of service as deemed obsolete by our well inventory and assessment. By adjusting the number and frequency of wells to be included in the monitoring and sampling program, and eliminating select wells within the monitoring network, Dillon has

begun optimizing the monitoring program on-site and preparing to initiate the ramp-down strategy for the Yard. The ramp-down strategy has been designed to target monitoring efforts in relation to mobility of the identified impacts and associated risk drivers, and can be viewed as the initial phase of a perpetual care monitoring strategy.

1 INTRODUCTION

Canadian Pacific Railway (CPR) identified the requirement to examine the management of site-specific environmental accrual program (EAP) projects in order to determine if there were any synergies to take advantage of with respect to the overall management of the accrual program, as well as the management of specific components within each project. CPR believes there may be overlaps and inefficiencies in third party management of specific projects, and that it may be more efficient for Dillon Consulting Limited (Dillon) to assume management of the perpetual care sites in Manitoba and Saskatchewan, in addition to the EAP management. Dillon was thus retained to provide CPR with an evaluation of each of the perpetual care sites in Manitoba and Saskatchewan and to deliver a strategic process for rationalizing the ramp-down of remedial activities including groundwater monitoring and sampling.

This report discusses the Winnipeg Diesel Shops and Weston Shops (EA 301). Information reviewed as part of this evaluation includes:

- Wardrop Engineering Consultants, 1986. CP Rail Weston Yards Flooding and Pollution Study.
- CP Rail, Office of the Chief Engineer, 1991. Draft Phase I – Site Assessment, Weston Yard, Winnipeg, Manitoba.
- Morrow Environmental Consultants Inc., 1998. CP Rail System Project Summary, Weston Rail Yard.
- Morrow Environmental Consultants Inc., 1999. CP Rail System 1999 Project Summary, Winnipeg Diesel Shops & Weston Shops.
- Morrow Environmental Consultants Inc., 2000a. Indoor Air Quality Sampling – Component Shop and Wheel Shop, Weston Shops, Winnipeg, Manitoba.
- Morrow Environmental Consultants Inc., 2000b. Phase II Environmental Site Assessment, Winnipeg Diesel Shops & Weston Shops, Winnipeg, Manitoba.
- Morrow Environmental Consultants Inc., 2000c. May 2000 to September 2000 Site Monitoring Report, Winnipeg Diesel Shops and Weston Shops, Winnipeg, Manitoba.
- Morrow Environmental Consultants Inc., 2001a. Groundwater Sampling – Component Shop and Wheel Shop, Weston Shops, Winnipeg, Manitoba.
- Morrow Environmental Consultants Inc., 2001b. Supplemental Drilling Investigation and Site Monitoring Report, Winnipeg Diesel Shops and Weston Shops, Winnipeg, Manitoba.
- Morrow Environmental Consultants Inc., 2002. 2001 Site Monitoring Report, Winnipeg Diesel Shops and Weston Shops, Winnipeg, Manitoba.
- Morrow Environmental Consultants Inc., 2003. 2003 Site Monitoring Report, Winnipeg Diesel Shops and Weston Shops, Winnipeg, Manitoba.

- Morrow Environmental Consultants Inc., 2004. Recommendations for Management of Hydrocarbon Impact, Winnipeg Diesel Shops and Weston Shops, Winnipeg, Manitoba.
- Morrow Environmental Consultants Inc., 2005. 2004 Summary – Management of Hydrocarbon Impact, Winnipeg Diesel Shops and Weston Shops, Winnipeg, Manitoba, EA301.

1.1 Objectives

Long-term groundwater monitoring programs are often designed for sites that are impacted by petroleum hydrocarbons, specifically liquid phase hydrocarbons (LPH) and associated dissolved phase impacts in the subsurface. Monitoring programs of this nature strive to provide a framework for making sound, scientifically based decisions for LPH management that incorporates risk, regulatory components (where required), land use considerations and technical limitations. A key component of long-term monitoring programs is to develop a long-term vision and establish interim goals with regards to LPH management at a particular site. The process is iterative and will be continually re-assessed as more data becomes available and interim monitoring goals are met.

As such, the objectives of this work program are as follows:

- Review the work completed to date for the site in the context of understanding the distribution and characteristics of subsurface impacts, and optimizing the groundwater monitoring program going forward including any active remedial systems;
- Conduct a well inventory to assess the condition, location and function of the wells included within the monitoring network with respect to the monitoring goal;
- Conduct a limited risk screening of the identified impacts and initiate a ramp-down strategy for the site.

An underlying hypothesis for the sites where an assessment for long-term groundwater monitoring is undertaken is that the LPH plumes at the sites are currently stabilized. If the LPH plumes are stabilized then the requirements for future monitoring should take this into consideration in terms of the frequency and amount of monitoring effort required. The methods outlined in the following section discuss the various technical approaches used to evaluate the stability and mobility of the LPH plumes.

1.2 Methodology

Since the front-end of this work plan involves optimizing the monitoring program on-site, the methodologies used to achieve this goal are many, and can be described as both qualitative and quantitative. Qualitative techniques rely on the use of professional judgment to assess the adequacy of the monitoring network, list of analytes and sampling frequency. These techniques are illustrated in

Figure 1 (attached), which presents the logic and rationale that was followed for this particular task. This rationale can be summarized as follows:

- An elimination of unnecessary analytes, including:
  - Analytes not found in initial samples, not associated with past/present land use, or for which there is no evidence of a release;
  - Analytes not identified above detection limits in three (3) successive samples (assuming the detection limits meet current guideline limits), and;
  - Analytes detected at less than half the assessment criteria for at least three (3) successive samples and displaying a static or decreasing trend.
- An elimination of redundant wells, including:
  - Wells in the interior of plumes whose boundaries are defined by other wells (these wells may be required to support any remedial system monitoring);
  - Wells outside plumes and not deemed to be in the pathway of on-coming plumes and not required to establish background;
  - Wells duplicated by proximate wells on the same isopleths;
  - Wells for which analytical data will have no clear use in future decision making such as consideration of when to implement a contingency, and;
  - Wells located within the right of way (ROW).
- A reduction in sampling frequency:
  - Initial quarterly sampling is needed to establish seasonal variations. Annual monitoring helps identify variations from changes in precipitation (wet versus dry years). Beyond these distinctions, sampling frequency should be selected on the basis of the slope of the observed trends, the degree to which data is predictable, and the relative velocity of groundwater. The more predictable the data is, the less need there is for frequent information;
  - Monitoring is only required when there is uncertainty as to the fate and transport of contaminants and the effectiveness of remedial systems that are employed. As the uncertainty is reduced, or as its consequences become less significant, the need for further monitoring is less.

Quantitative approaches were also employed within this work plan to optimize the monitoring program on-site and included the use of numerical tools such as Mann Kendall trend analyses, API LNAPL mobility models and review of bail-down tests to determine the stability, recoverability and mobility of subsurface impacts. These approaches are further described below.

1.2.1 LPH Assessment

Understanding the mobility and distribution of LPH is a fundamental component to the management of LPH impacted sites. The mobility of LPH is a function of the LPH saturation in the subsurface. LPH may occur as either a residual LPH or as mobile LPH. LPH that is held by soil capillary forces or trapped

within pore spaces and is relatively immobile is identified as residual LPH. Mobile LPH occurs when the LPH saturation exceeds the residual LPH saturation and a continuous LPH phase exits in the pore spaces. Under these conditions the mobile LPH may move both vertically and laterally. The LPH plume stability assessment is based on determining if the observed LPH is mobile at the site or if it occurs primarily as residual LPH.

A LPH plume stability assessment was conducted on the available LPH data from the monitoring well network on-site. The LPH plume stability assessment used three (3) methods to evaluate different properties of the LPH plume. The weight of evidence of the three (3) methods is then used to provide an overall assessment of the plume stability.

The first method considers the site-scale stability of the plume, which is defined as the LPH plume-scale expansion or migration. The historic occurrence of LPH is reviewed to determine if the extent, or 'footprint' of the LPH plume is stable, increasing in size or decreasing in size.

The second method is based on calculating the LPH mobility in the subsurface using the inherent LPH mobility/LPH velocity technique as presented in the API Interactive LNAPL Guide (Appendix A). This method estimates the potential velocity of the mobile LPH plume as expressed in m/day. Because the inherent oil mobility directly related to the hydraulic conductivity of the soil matrix and the LPH product types (i.e. gasoline, diesel, lube oil, etc.) a minimum value for LPH conductivity was established below which it is assumed there is no significant LPH mobility. This value was set at 8.64×10^{-4} m/day based on default parameters from the API Interactive LNAPL Guide. The calculated LPH plume velocity is also based on the maximum observed thickness of LPH, which may overestimate the potential mobility of the entire plume. Because LPH saturation decreases to residual towards the fringe of the plume, the fringe of the plume may be immobile while the body of the plume may have limited mobility while still being considered stable.

The third method addresses the potential recoverability of the LPH, which is defined as the ability to extract the LPH from the soil matrix. This method incorporates information from the previous methods and is based on comparison of site-specific information to a series of Recoverability Screening Charts from the API Interactive LNAPL Guide. These charts were developed through a series of numerical modeling exercises in conjunction with empirical observations. The charts illustrate the relationship between the type of LPH, the thickness of the LPH (as represented by apparent product thickness measured in monitoring wells), and the hydraulic conductivity of the soil matrix. For each set of conditions the potential LPH recoverability is assessed as either 'not likely recoverable' or 'potentially recoverable' based on the position the site-specific conditions plot on the charts.

1.2.2 Dissolved Phase Hydrocarbon Assessment

Mann Kendall analyses were conducted on dissolved phase hydrocarbon data in order to assess the stability of the dissolved plume observed at the Winnipeg Diesel Shops and Weston Shops. This type of statistical analysis provides a quantitative approach to the assessment of trends in hydrocarbon concentrations fluctuations over time. A Mann Kendall analysis does not provide information about the size or movement of a plume, rather it shows if dissolved concentrations are stable, increasing or decreasing over time in monitoring wells used in the analysis. The assessment of trends in plume size

variations and migration is then conducted by the site professional and subject to their judgment. A Mann Kendall analysis also provides qualitative information about the confidence level associated with the observed trend.

In summary, a Mann Kendall analysis consists of arranging groundwater analytical data from a single well chronologically, comparing results of each monitoring event with all previous events and calculating the "S" statistic based on these comparisons. The "S" statistic is defined as the number of positive changes minus the number of negative changes in the data sequence. Once the "S" statistic is calculated, the result is plotted on a grid as a function of the number of monitoring events. The result will either fall in a field showing "no trend" or "trend probably present" (with a 90% confidence level). In addition to that, a coefficient of variation is calculated for the dissolved hydrocarbon data, which corresponds to the ratio of the standard deviation over the mean of the population of results. The coefficient of variation provides the analyst with a qualitative measure of the confidence in the trend analysis by comparing the significance of data fluctuations with their average value. See Appendix B for more details on Mann Kendall analysis calculations.

1.2.3 Dissolved Metals Assessment

The scope of this work program did not include an assessment of metals impact to soil or groundwater since the results of the initial site investigations did not identify impacts of this nature on-site (Morrow, 1998; Morrow, 1999). The investigations conducted by Morrow targeted areas of the site with potential metals impacts as determined by past and present site operations. Their investigation included the submission of eight (8) soil samples and nine (9) groundwater samples for metals analysis. Exceedances of non-potable assessment criteria were not identified in either media.

1.2.4 Risk Screening

A risk screening was also conducted for the site to determine if unacceptable risks could be present as a result of the identified subsurface impacts, and to assist with the rationalization of a ramp-down strategy

for the site that includes a potential reduction in sampling parameters/frequency and the potential decommissioning of obsolete monitoring wells. The risk screening included an evaluation of potential chemicals of concern with respect to human health and the environment, potential human receptors, potentially complete pathways from subsurface impacts to human receptors, and an exposure assessment relative to ecological habitats.

In order for a human health or ecological risk to occur, three (3) conditions must be fulfilled. There must be:

- A chemical found at such concentration to be of potential concern (CoC) to human health or the environment;
- A human or ecological receptor that would be exposed to the CoC and;
- At least one (1) complete exposure pathway through which the receptor(s) would be exposed to the CoC(s).

The risk screening process included in this report was based on the principles described above. Risks to human health and the environment were assessed for the listed on-site and off-site receptors. For each scenario, the presence/absence of CoCs, human or ecological receptors and complete pathways were noted. If these three (3) elements were encountered in any scenario, unacceptable risk may potentially occur. If, however, none of the scenarios comprised all three (3) elements, the site was considered not to present a potential for unacceptable risk to human health or the environment.

1.3 Reference Material

The following list of reference material was used for guidance on this project with respect to methodology:

- Radian International, 2000. Guide to Optimal Groundwater Monitoring. Prepared for: Naval Facilities Engineering Service Center, Port Hueneme, California;
- United States Environmental Protection Agency, Offices of Research and Development and Solid Waste and Emergency Response, 2004. A Decision-Making Framework for Cleanup of Sites Impacted with Light Non-Aqueous Phase Liquids (LNAPL). EPA/542-R-04-011;
- United States Department of Energy, Office of Environment, Safety and Health, 2004. Ground Water Surveillance Monitoring Implementation Guide for Use with DOE O 450.1, Environmental Protection Program;
- United States Army Corps of Engineers, 2005. Roadmap to Long-Term Monitoring Optimization. EPA/542-R-05-003.

2 BACKGROUND INFORMATION

The site characteristics of the Winnipeg Diesel Shops and Weston Shops are summarized in the following sections.

2.1 General Site Description

The Winnipeg Diesel Shops and Weston Shops are located in Winnipeg, Manitoba, and are bounded by Selkirk Avenue to the north, McPhillips Street to the east, Keewatin Street to the west, and the CPR main lines to the south. Surrounding land uses are residential to the north (20 m), commercial and parkland to the east (50 m), residential and parkland to the south (20 m) and commercial to the west (70 m). The nearest surface water is a man-made stormwater retention pond, located approximately 450 m to the west, in Woodsworth Park. In addition, Omand's Creek is approximately 3.2 km east of the eastern boundary (Morrow, 2000b). Figure 2 (attached) illustrates the premises.

2.2 Site Geology and Hydrogeology

Based on previous investigations, the stratigraphy across the site generally consisted of fill material, which ranged in depth from 0.3 m to 4.0 m below grade and was underlain by clay, which was underlain by silt. The clay ranged in thickness from 0.2 m to 1.0 m and the silt varied in depth from 0.8 m to 4.3 m below grade. Beneath the silt was a clay unit, which extended to the maximum depth of investigation (6.1 m below grade) (Morrow, 2003).

Based on available geological maps of the area including the site, the major surficial units in the area were identified as deep basin deposits of clay and silt up to 30 m thick forming extensive lake plains and a discontinuous veneer reflecting the form of the underlying topography. The clay and silt deposits are underlain by glacial till deposits and carbonate bedrock (Morrow, 2003).

The depth to the shallow groundwater at the site has historically ranged from between 0.4 m to 5.9 m below grade. The apparent direction of shallow groundwater flow varied across the site with horizontal hydraulic gradients ranging from 0.003 m/m to 0.05 m/m. The shallow groundwater flows are likely influenced by local underground structures and buried utilities (Morrow, 2003).

There are four (4) registered water wells located within 1,600 m of the Winnipeg Diesel Shops and Weston Shops. The water well records indicated that of the four wells, two are registered for industrial use, one is registered for air conditioning use, and one is registered as an observation well. The wells are cased through the overburden to depths of approximately 14.3 m to 28.3 m below grade and completed as

open holes in the carbonate bedrock to depths ranging from 29 m to 100 m below grade. The present status of these wells is unknown, but they are expected to be active. The shallow groundwater in the overburden is not a source of potable water in Winnipeg (Morrow, 2003).

The site characteristics are summarized in the following table.

Table 1: Summary of Site Characteristics

Land and Groundwater Uses			
On-Site			
Land Use		***Groundwater Use***	
Current	Industrial/Commercial	***Current***	Non-potable
Predicted	Industrial/Commercial	***Predicted***	Non-potable
Off-Site (hydraulically down gradient)			
Land Use		***Groundwater Use***	
Current	Industrial/Commercial/Residential	***Current***	Non-potable
Predicted	Industrial/Commercial/Residential	***Predicted***	Non-potable
Site Access			
Site access	Not fenced, accessible to general public		
Geology			
Soil type		***Depth intervals***	
Fill (Sand)		Grade to 1.2 m below grade	
Clay		1.2 m to 1.6 m below grade	
Silt		1.6 m to 3.1 m below grade	
Clay		3.1 m to 6.1 m below grade	

Hydrogeology				
Aquifer	***Depth to Water (m)***	***Mean K (m/s)***	***Horizontal Hydraulic Gradient***	***Groundwater Flow Direction***
1	1.3	1×10^{-8} m/s	0.03	Southeast

3 PREVIOUS MONITORING PROGRAM

3.1 Initial Monitoring Objectives

Beginning in 1998, the objectives of the groundwater monitoring program were to:

- Evaluate groundwater levels, apparent liquid phase hydrocarbon (LPH) thicknesses and soil gas concentrations throughout the entirety of the Yard on a quarterly, semiannual or annual basis;
- Evaluate groundwater chemistry with respect to dissolved phase volatile organic compounds throughout select areas of the Yard on a quarterly, semiannual or annual basis;
- Identify any changes in groundwater levels, LPH thicknesses or groundwater chemistry.

In total, between thirty-nine (39) and fifty-three (53) monitoring wells were monitored quarterly, semiannually or annually throughout the Yard. Groundwater sampling and analysis was also conducted on select monitoring wells throughout the Yard.

3.2 Description of Field Procedures and Analytes

Between 1998 and 2003, each of the wells was monitored for headspace hydrocarbon vapour concentration, groundwater elevation and LPH thickness (Morrow, 2003).

Typically groundwater samples were collected from monitoring wells 98-33 and 98-35 using dedicated samplers. Field duplicates, trip blanks and field blanks were submitted to the analytical laboratory along with the groundwater samples. Sample preservation and chain-of-custody procedures were followed while the samples were shipped to the laboratory (Morrow, 2003).

Groundwater samples were typically submitted to the laboratory for analysis of the following parameters:

- Total Volatile Organic Compounds (VOCs).

On one year, samples from select monitoring wells were also submitted to the laboratory for analysis of some or all of the following parameters:

- Total extractable hydrocarbons (TEHs);
- Total volatile hydrocarbons (TVHs);
- Benzene, toluene, ethylbenzene and xylenes (BTEX);
- Polycyclic Aromatic Hydrocarbons (PAHs), and;
- Metals.

3.3 LPH Removal Operations

Between 1998 and 2003, LPH was recovered from the site by manual bailing and passive skimmers. As of 2003, passive skimmers were not operational.

4 SITE EVALUATION

4.1 Previous Scope of Monitoring Program

During the most recent monitoring and sampling events (December of 2003), a total of thirty-nine (39) wells were monitored (Morrow, 2003). Of these thirty-nine (39), two (2) monitoring wells were sampled and analyzed for VOCs, and targeted the Component Shop and Wheel Shop Area.

4.2 Nature and Extent of Hydrocarbons

A summary of the nature and extent of hydrocarbons identified on-site is presented in the following sections, followed by a brief discussion.

4.2.1 Liquid Phase Hydrocarbons and Dissolved Phase Volatile Organic Compounds

4.2.1.1 Component Shop and Wheel Shop Area

The monitoring wells located adjacent to the Component Shop (98-35 and 99-60 through 99-63) and the Wheel Shop (98-33, 99-55, 99-56 and 99-59) were monitored for dense non-aqueous phase liquids (DNAPLs) as degreasers were formerly used in these areas (Morrow, 2003) and dissolved VOCs were detected at concentrations above applicable criteria in some of the above-mentioned monitoring wells. To date, DNAPLs have not been detected in the monitoring wells located in the Component Shop and Wheel Shop Area. This area of the site is illustrated in Figure 3 (attached).

4.2.1.2 Former Locomotive Fueling Facility and the Active Locomotive Fueling Facility and Diesel Heavy Repair Shop Areas

Current and historical data suggest that two (2) LPH plumes span the Former Locomotive Fueling Facility and the Active Locomotive Fueling Facility and Diesel Heavy Repair Shop Areas. In 2003, LPH was detected in monitoring wells 98-3, 99-67 and 00-70 at a thickness of 142 mm, 425 mm and 793 mm, respectively. Historically, LPH was detected at a maximum thickness of 1.149 m in monitoring well 00-70 and at a minimum depth of 0.34 m in monitoring well 99-67. These areas of the site are illustrated in Figure 4 (attached).

A total of approximately forty-two (42) L of LPH was removed from the subsurface during Morrow's operation of the passive skimmers and manual bailing between 1998 and 2003.

4.2.1.3 LPH Plume Stability Assessment

As part of Dillon's 2006 work program, an LPH plume stability assessment was conducted for the LPH plume situated in the Former Locomotive Fueling Facility. This plume was selected for the assessment since it is the larger of the two (2) identified LPH plumes, and represents a worst-case scenario. The results of the LPH mobility calculation for this plume indicate that the calculated plume velocity is low (~2 mm/year) and that there is virtually no potential for plume migration. The assessment of the potential recovery of the observed LPH based on the site conditions indicates the LPH is not likely to be recoverable, which is confirmed by low LPH recoveries between 1998 and 2003.

Based on the above assessment, the identified LPH phase plume in the Former Locomotive Fueling Facility has been adequately defined in terms of both nature and extent. The plume is relatively stable and is not increasing in thickness or concentration, nor is it anticipated to be migrating within the Yard or off-site. The output results from the API Interactive LNAPL Guide models are provided in Appendix A. A table summarizing the results of the LPH plume assessment conducted for the site has been included in Appendix C, as Table C-1.

4.2.2 Dissolved Phase VOCs and Hydrocarbons

4.2.2.1 Component Shop and Wheel Shop Area

Groundwater samples were collected in 2003 from monitoring wells in the Component Shop and Wheel Shop Area and submitted for VOC analyses. Concentrations of dissolved 1,1-dichloroethene, cis-1,2-dichloroethene, 1,1,1-trichloroethane, trichloroethene, tetrachloroethene and vinyl chloride exceeded MOE (2004) comparative guidelines in monitoring well 98-35 (see Figure 3). Concentrations of trichloroethene and tetrachloroethene exceeded comparative criteria in monitoring well 98-33. 1,1-dichloroethane was detected in monitoring wells 98-33, 98-35, 99-60, 99-61 and 99-63.

TEH and/or TVH were identified above background concentrations in monitoring wells 98-33 and 98-35.

4.2.2.2 Former Locomotive Fueling Facility and Active Locomotive Fueling Facility and Diesel Heavy Repair Shop Areas

Groundwater samples were collected in the Active and Former Locomotive Fueling Facility Areas during Phase II investigations conducted by Morrow Environmental in 1998 and 1999. TEH and/or TVH were identified above background concentrations in monitoring wells 98-2, 98-4 and 98-8 (see Figure 4). To date, these monitoring wells have not been re-sampled for petroleum hydrocarbons.

4.2.2.3 Former Tank Car Cleaning and Frog Shop and Mobile Equipment Repair Facility Areas

TEH and/or TVH were identified above background concentrations in monitoring wells 98-24 in 98-34 in 1998 and 1999 in the Former Tank Car Cleaning Area and the Frog Shop and Mobile Equipment Repair Facility Area, respectively (see Figure 2). However, these detections are limited to the two (2) wells listed above.

4.2.2.4 Dissolved Phase Plume Stability Assessment

As part of Dillon's 2006 work program, a dissolved phase plume stability assessment was conducted on available dissolved VOC analytical data using a Mann Kendall statistical analysis of plume trends at the 90 % confidence level. The statistical analysis was conducted for two (2) wells that were sampled on at least four (4) occasions and for which VOC analytical results showed detectable concentrations. Analytical results from the following two (2) monitoring wells were included in the Mann-Kendall analysis:

- 98-33, and;
- 98-35.

Results of the trend analysis indicate that the dissolved VOC plumes on-site are relatively stable in terms of concentration, with some fluctuations in tetrachloroethene (PCE) concentrations in monitoring well 98-35. The full extent of the VOC plumes and their potential for migration remain unknown. Further groundwater sampling is recommended for select monitoring wells in order to increase the number of analytical results and reduce the significance of variability in dissolved concentrations over time. A greater number of samples would also provide sufficient data to address potential seasonal fluctuations in these wells. Detailed Mann-Kendall analysis calculations are provided in Appendix B. A table summarizing the dissolved phase hydrocarbon characteristics on-site has been included in Appendix C, as Table C-2.

Trend analyses could not be performed for dissolved phase petroleum hydrocarbons in other areas of the site due to the lack of analytical data for these parameters. Additional sampling is recommended in order to allow for delineation and a better understanding of trends over time, given that dissolved hydrocarbon data were not collected recently.

4.2.3 Dissolved Metals Assessment

The scope of this work program did not include an assessment of metals impact to soil or groundwater since the results of the initial site investigation did not identify impacts of this nature on-site (Morrow, 1998, Morrow, 1999). The investigation conducted by Morrow targeted areas of the site with potential

metals impacts as determined by past and present site operations. Their investigation included the submission of eight (8) soil samples and nine (9) groundwater samples for metals analysis. Exceedances of non-potable assessment criteria were not identified in either.

4.3 Well Inventory and Assessment

Dillon completed a well inventory and assessment for the site and classified monitoring wells based on measured LPH thicknesses, dissolved phase hydrocarbon concentrations, groundwater gradients,

velocities and flow directions, and wells that have been reported as destroyed or damaged. Using the flow diagram included as Figure 1 (attached), monitoring wells were classified into one of the four (4) following groups:

- Plume (Plume wells are those wells located within the identified hydrocarbon plumes that have historically produced measurable LPH thicknesses);
- Source (Source wells are those wells located where detectable dissolved phase hydrocarbons have been reported at concentrations greater than the applicable assessment criteria);
- Background (Background wells are those wells located in areas with no LPH thicknesses reported and dissolved phase hydrocarbon concentrations less than the applicable assessment criteria or altogether below laboratory method detection limits) or;
- Destroyed/Damaged (Destroyed or damaged wells are monitoring wells reported destroyed or damaged at one time or another, whereby the integrity of the well could be called into question and the validity of the data collected from these locations suspect. For these reasons, destroyed or damaged wells are likely candidates for well closure).

A total of fifty-eight (58) wells were identified on-site. Based on the information contained within the background reports, the following table lists the wells that fall into each category.

Table 2: Well Classification – Winnipeg Diesel Shops and Weston Shops

Source Wells		
98-3	98-12	99-66
98-4	98-13	99-67
98-9	99-36	99-68
98-10	99-42	00-70
Plume Wells		
98-8	98-35	99-62
98-24	99-56	99-63
99-33	99-59	
98-34	99-61	
Background Wells		
98-1	98-22	99-44
98-6	98-23	99-55
98-7	98-25	99-60
98-11	98-26	99-69
98-14	98-27	00-71
98-15	98-28	00-72
98-16	98-29	00-73
98-17	98-30	03-74
98-18	98-31	03-75
98-19	98-32	03-76
98-20	99-41	
98-21	99-43	
Destroyed/Damaged Wells		
98-2	98-5	

This information was used to determine which wells are to be taken out of service (discussed in detail in Section 5.2.2).

4.4 Risk Screening

Dillon undertook a risk screening of the site to determine if unacceptable risks could be present as a result of the identified liquid and dissolved phase hydrocarbons, and to assist with the rationalization of a ramp-down strategy for the site that includes a potential reduction in sampling parameters/frequency and the potential decommissioning of obsolete monitoring wells.

The risk screening included an evaluation of potential human receptors, potentially complete pathways to human receptors, and an exposure assessment relative to ecological habitats. This evaluation of potential human health and/or ecological risks is based on the site layout information provided in the documents used in the preparation of this report. The conclusions related to potential risks associated with vapour

migration are based on current building location in relation to any hydrocarbon plumes that may exist on-site. It should also be noted that conclusions related to the presence or absence of potential risks on the site are related solely to presence (or absence) of LPH and dissolved VOCs on-site.

4.4.1 Potential Human Health Receptors

In summary, there are some buildings on-site that are either above or downgradient of identified impacts. Potential receptors on-site include adult CPR staff, adult construction workers and casual visitors of all age groups. Casual visitors were included in the risk screening given that previous investigations did not indicate that the site access is controlled and that there is therefore a potential for people from the general public to spend some time on-site.

Residential/commercial/industrial buildings were identified off-site that are downgradient of identified impacts. Potential receptors off-site include adult staff of various commercial/industrial operations, private residents of all age groups, and adult construction workers.

A table summarizing potential human health receptors on-site is included in Appendix C, as Table C-3.

4.4.2 Potentially Complete Pathways from LPHs to Human Receptors

Exposure pathways are divided by location (on-site versus off-site) and by media (soil, air and drinking water). For each media, all exposure routes through which chemicals of concern to human health may enter the human body are evaluated. These exposure routes comprise inhalation, ingestion and ingestion processes. Depending on the media in which impacts are assessed, all exposure routes may not be applicable. For example, hydrocarbons in ambient air will mostly enter the human body through inhalation. Ingestion and dermal uptake of vapours are not significant exposure routes for hydrocarbon vapours.

For each media, applicable exposure routes comprise one or a few pathways through which exposures to chemicals may occur. These pathways are reflective of site-specific conditions causing the chemicals to potentially enter into contact with human receptors. They can involve the direct exposure of human receptors to chemicals in an impacted media (e.g. dermal contact with soil) as well as an indirect exposure through physical/chemical/biological processes (e.g. uptake into animals through plants and consumption of animal products).

At the Winnipeg Diesel Shops and Weston Shops, the inhalation of compounds in indoor air is considered to be a potentially complete exposure pathway as the Component Shop and Wheel Shop buildings are located downgradient and/or over the dissolved VOC plumes. Therefore, vapours could potentially

migrate to enclosed space. Other pathways were considered incomplete given that impacts are located in subsurface soil, groundwater is not used as a drinking water source and vapour migration to outdoor air will not make a measurable contribution to ambient air concentrations.

Off-site and downgradient of the impacts, the inhalation of compounds in indoor air is also the only potentially complete exposure pathway should there be migration of the LPH or dissolved hydrocarbon and/or VOC plumes, as residential/commercial/residential buildings are present off/site and downgradient of the impacts. However, it is unlikely that such migration has occurred or will occur given the low hydraulic conductivity of the silt and clay beds observed on-site. Other pathways, as for on-site locations, are considered incomplete.

A table summarizing potentially complete pathways from identified LPHs to the human health receptors on-site is included in Appendix C, as Table C-4.

4.4.3 Screening Level Exposure Assessment Relative to Ecological Habitat

As a part of the risk screening of the site, ecological habitats that could be affected by on-site or potential off-site impacts should there be LPH or dissolved phase hydrocarbon migration must be considered. Risk screening for ecological receptors typically consists of identifying sensitive ecological habitats in the area surrounding the impacts and assessing potentially complete exposure pathways for ecological receptors. A table summarizing the screening level exposure assessment relative to ecological habitats on-site is included as Appendix C, as Table C-5.

For the Winnipeg Diesel Shops and Weston Shops, ecological habitats that could potentially be exposed to LPHs were assessed over a distance of approximately 500 m downgradient of impacts (i.e. 45° either way from main groundwater and/or surface water flow direction), as recommended in the 2006 Saskatchewan Environment Risk-Based Corrective Action for Petroleum Hydrocarbon Impacted Sites document. The Saskatchewan Environment guidelines were used for assessment of the Winnipeg Diesel Shops and Weston Shops since comparable guidelines do not exist within Manitoba.

No species or habitats of concern were identified within a 500 m radius of the impacted areas. Therefore, no further action is required with respect to ecological risk.

4.4.4 Possible Risk Drivers from the LPH and Dissolved Phase Plumes

In order for a human health or ecological risk to occur, three (3) conditions must be fulfilled. There must be:

- A chemical found at such concentration to be of potential concern (CoC) to human health or the environment;
- A human or ecological receptor that would be exposed to the CoC and;
- At least one (1) complete exposure pathway through which the receptor(s) would be exposed to the CoC(s).

The results of the risk screening are presented based on the principle described above.

In October 1999, Morrow Environmental conducted indoor air quality sampling at the Component and Wheel Shops (Morrow, 2000a) in order to address the potential risk to human health posed by the VOCs identified in soil and groundwater. Results of their monitoring indicated that indoor air concentrations of VOCs were below acceptable benchmarks, and that the inhalation of compounds in indoor air exposure pathway was not a concern. However, Dillon's review of the Indoor Air Quality sampling report (Morrow, 2000a) raised some concerns regarding the methodology that was used during the air sampling program and the calculations that were made to translate analytical VOC concentrations in the carbon traps into ambient air concentrations. The review of the report indicated that the pumping rate at which the test conducted may have been inappropriate. The airflow rate mentioned in the report exceeds flow rates typically used for VOC testing by more than three (3) orders of magnitude. Also, based on flow rates and pumped volumes mentioned in the report, the tests would have been run for approximately 20 minutes, which is well below the two (2) to six (6) hours typically required in order to get a representative VOC sample. Finally, the air volumes presented on the summary of analytical results table do not reflect pumping rates and volumes mentioned in the text. Part of these discrepancies could be explained by unit conversion mistakes. Nevertheless, pumped volumes and test durations remain inappropriate. Based on these observations, Dillon recommends conducting additional below-slab vapour sampling before further assumptions can be made regarding potential exposures through the indoor air inhalation pathway for the on-site receptor.

From a human health perspective, there are potentially unacceptable risks for on-site receptors because all three (3) conditions are potentially fulfilled. For on-site exposures, CoCs (in the form of VOCs) and human receptors were identified and there may be one (1) complete exposure pathway through which human receptors would be exposed to the CoCs. For off-site exposures, human receptors and a potentially complete exposure pathway were identified but migration of the LPH and/or dissolved phase plumes off-site is unlikely, therefore unacceptable risks to human health were not identified.

From an ecological perspective, there are no potentially unacceptable risks for on-site or off-site ecological receptors despite the presence of CoCs on-site, since sensitive habitats and complete exposure pathways were neither identified on-site or off-site.

In summary, Dillon identified potentially unacceptable human health risks on-site and off-site, based on our current understanding of the site's characteristics. However, Dillon did not identify the potential for unacceptable ecological risk on-site or off-site. A table summarizing the possible human health and ecological risk drivers resulting from the plumes is included in Appendix C, as Table C-6.

5 SUMMARY AND RECOMMENDATIONS

5.1 Summary

Based on our review of the information available, the identified LPH plume at the Former Locomotive Fueling Facility has been adequately defined in terms of both nature and extent. The plume is relatively stable and is not increasing in thickness or concentration, nor is it anticipated to be migrating within the Yard or off-site. The dissolved phase VOC plumes in the Component Shop and Wheel Shop Area are relatively stable in terms of concentrations; however the full extent of the plumes and their potential for migration remain unknown. Also, trend analyses could not be performed for dissolved phase petroleum hydrocarbons due to the lack of analytical data for these parameters. Multiple additional rounds of groundwater sampling from select wells would be required to delineate the impacts and assess the trends in concentrations over time.

Dillon identified potentially unacceptable human health risks on-site and off-site, based on our current understanding of the site's characteristics. However, Dillon did not identify the potential for unacceptable ecological risk on-site or off-site. The risk screening was limited to hydrocarbons and did not include metals impact to soil or groundwater since the results of the initial site investigation did not identify impacts exceeding applicable criteria.

5.2 Recommendations

5.2.1 Frequency of the Monitoring and Sampling Program

Because the dissolved phase hydrocarbon plumes have not been adequately defined, coupled with the potentially unacceptable risks to human health identified on-site and off-site, it is appropriate to recommend annual monitoring and/or sampling of select wells within the Yard.

The proposed sampling and monitoring program would include:

- Evaluating groundwater levels, apparent liquid phase hydrocarbon (LPH) or DNAPL thicknesses and combustible vapour concentrations;
- Evaluating groundwater chemistry with respect to dissolved phase hydrocarbons and VOCs;
- Identifying any changes in groundwater levels, LPH or DNAPL thicknesses or groundwater chemistry relative to historical results.

Using the Mann-Kendall analysis, each well's chemical concentrations were plotted as a function of time, and overall concentration trends for target analytes were observed to be mainly stable. After identifying the need for additional dissolved phase hydrocarbon data, an annual monitoring/sampling frequency was

selected for 2007. This will create a dataset that will provide sufficient information for a proper trend analysis to be conducted on dissolved phase hydrocarbon concentrations over time. Moreover, additional annual data will help determine seasonal variations in dissolved phase hydrocarbon concentrations. Groundwater monitoring and sampling for dissolved phase hydrocarbon analyses will be conducted in select sentry wells and in wells where LPH, VOCs or dissolved phase hydrocarbons have historically been observed.

Dillon recommends the following wells be included in annual monitoring and sampling events going forward. The rationale behind their inclusion on the list is also presented. Monitoring would consist of water level and LPH thickness measurement. Sampling would consist of collection and laboratory analysis of groundwater samples from select wells for BTEX and petroleum hydrocarbons. VOCs would also be included in the sampling program for two wells. PAHs, although historically detected in wells on-site, would not be included in future sampling events since historical detections have been well below non-potable criteria.

Table 3: Wells Recommended for 2007 Annual Monitoring & Sampling

Well	Monitor in 2007	Sample in 2007	Rationale
98-3	•		Detectable LPH thicknesses in 2003
98-4	•		Detectable LPH thicknesses in 1999
98-8	•	•	Detectable dissolved concentrations in 1998
98-9	•		Trace LPH thicknesses in 2001
98-10	•		Detectable LPH thicknesses in 2001
98-12	•		Detectable Sheen in 2001
98-13	•		Detectable LPH thicknesses in 2001
98-15	•		Background and groundwater flow direction
98-16	•		Background and groundwater flow direction
98-17	•		Background and groundwater flow direction
98-18	•		Background and groundwater flow direction
98-19	•		Background and groundwater flow direction
98-21	•	•	Sentry well
98-24	•	•	Detectable dissolved concentrations in 1998
98-33	•	•[1]	VOC exceedances in 2003
98-34	•	•	Detectable dissolved concentrations in 1998
98-35	•	•[1]	VOC exceedances in 2003
99-36	•		Detectable LPH thicknesses in 2001
99-41	•	•	Sentry well
99-42	•		Detectable LPH thicknesses in 2001
98-62	•	•[1]	VOC exceedances in 2003
99-66	•		Detectable Sheen in 2001
99-67	•		Detectable LPH thicknesses in 2003
99-68	•		Trace LPH thicknesses in 2001
00-70	•		Detectable LPH thicknesses in 2003
00-71	•	•	Sentry well
00-73	•	•	Sentry well
03-75	•	•	Sentry well
03-76	•	•	Sentry well

1- Sampling for VOCs would also be conducted on an annual basis at this location.

It is expected that with additional data the stability of the dissolved phase hydrocarbon plumes can be more definitively assessed and will result in a reduction in monitoring effort in the future (coincident with a reduction in well monitoring). Decommissioning of the on-site monitoring well network would also take place to reflect the changes to the monitoring program over time. The end result of the above process will be a monitoring program conducted on specific sentry monitoring wells on-site. The

frequency of monitoring and parameters selected for sampling will be determined by future monitoring results and assessment of the long-term data trends.

Dillon also recommends that indoor air quality testing be conducted in the Component Shop and the Wheel Shop in order to address the potential inhalation of VOCs in indoor air by building occupants.

5.2.2 Well Decommissioning

Since long-term monitoring and sampling has not been established at the site for dissolved phase hydrocarbons, an evaluation of monitoring wells with respect to potential closure was conducted in areas of the site displaying background concentrations. Although it is important to ensure that an adequate number of wells remain on-site to provide flexibility to the monitoring program, it is equally important to remove wells that do not provide meaningful data or wells that are damaged/destroyed. Proper well decommissioning achieves the following:

- Elimination of the physical hazard presented by the hole in the ground;
- Elimination of a conduit for migration of impacts from the surface;
- Prevention of hydrologic changes to the aquifer system such as changes to the hydraulic head.

Dillon recommends the following wells be properly decommissioned and taken out of service.

Table 4: Wells Targeted for Decommissioning in 2007

Well	Rationale
98-2	Damaged/Destroyed
98-5	Damaged/Destroyed
98-11	No history of LPH
98-14	No history of LPH or dissolved phase detections
98-25	No history of LPH or dissolved phase detections
98-26	No history of LPH or dissolved phase detections
98-27	No history of LPH or dissolved phase detections
98-28	No history of LPH or dissolved phase detections
98-29	No history of LPH or dissolved phase detections
98-30	No history of LPH or dissolved phase detections
98-31	No history of LPH or dissolved phase detections
98-32	No history of LPH or dissolved phase detections

Prior to the decommissioning program, Dillon recommends that a brief well inventory be conducted for all the monitoring wells on-site. For wells that cannot be readily found, attempts to locate them using

either a Global Positioning System (GPS) or a metal detector, or both, should be made. As part of the inventory, the condition of each wellhead should be noted, particularly those wells that are to remain in service. Recommendations for any improvements or additional well closures should also be made as warranted.

5.2.3 Duration of the Monitoring and Sampling Program

By adjusting the number and frequency of wells to be included in the monitoring and sampling program, and eliminating select wells within the monitoring network, Dillon has begun optimizing the monitoring program on-site and preparing to initiate the ramp-down strategy for the Yard. The ramp-down strategy has been designed to target monitoring efforts in relation to mobility of the identified impacts and associated risk drivers, and can be viewed as the initial phase of a perpetual care monitoring strategy. Since the LPH plume is stable, yet not likely recoverable, and the associated dissolved phase plume requires more data to allow better assessment of the mobility/stability, additional monitoring for the site will be required. The level of effort and frequency of perpetual monitoring will be re-assessed on an annual basis following each monitoring and sampling event. The collected data, together with the available historical site information will determine which wells remain in service, which wells may be subject to closure and the frequency of future monitoring/sampling events. If, after a given period of time, the majority of wells on-site are similarly eliminated from the monitoring program and only a select few wells remain for sentry purposes, the frequency of monitoring and sampling could potentially be further reduced to a bi-annual or potentially a tri-annual basis based on site-specific requirements. However, as discussed in previous sections, additional dissolved phase hydrocarbon data from select wells will be required on at least four occasions before a proper trend analysis can be conducted and further recommendations can be made regarding future monitoring frequencies and duration.

5.2.4 LPH Removal Operations

Given the operation of the passive skimmers and manual bailing removed a marginal amount of LPH (approximately forty-two (42) L) from the site over a six (6) year period, coupled with our LPH analysis that determined the LPH plume is not likely recoverable, it is recommended that the skimmers not be reinstalled due to diminishing recovery and be considered a candidate for commissioning elsewhere within the CPR network.

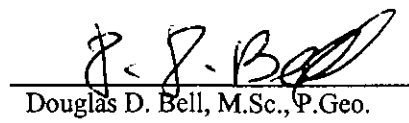
6 CLOSURE

This report was prepared exclusively for the purposes, project, and site location outlined in the report. The report is based on information provided to, or obtained by Dillon as indicated in the report, and applies solely to site conditions and the regulatory and planning frameworks existing at the time of the site investigation. Although Dillon conducted a reasonable investigation, Dillon's investigation was by no means exhaustive and cannot be construed as a certification of the absence of any contaminants from the site. Rather, Dillon's report represents a reasonable review of available information within an established work scope and schedule.

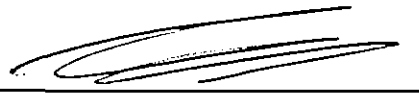
Dillon prepared this report for the sole benefit of our client, Canadian Pacific Railway. The material in it reflects Dillon's best judgment in light of the information available to it at the time of preparation. Any use which a third party makes of this report, or any reliance on or decisions made based on it, are the responsibilities of such third parties. Dillon accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

Respectfully submitted,

Dillon Consulting Limited



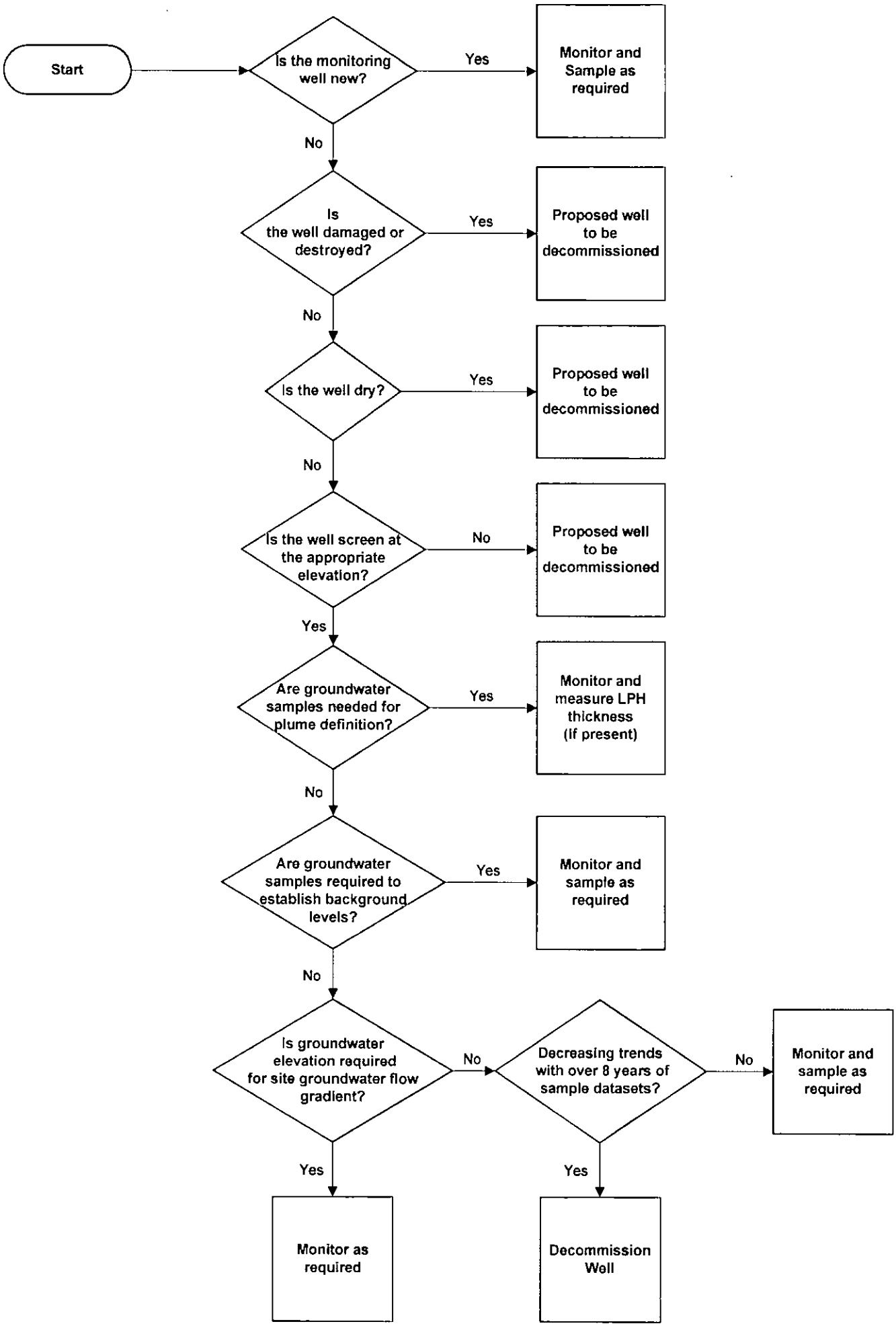
Douglas D. Bell, M.Sc., P.Geo.
Project Manager

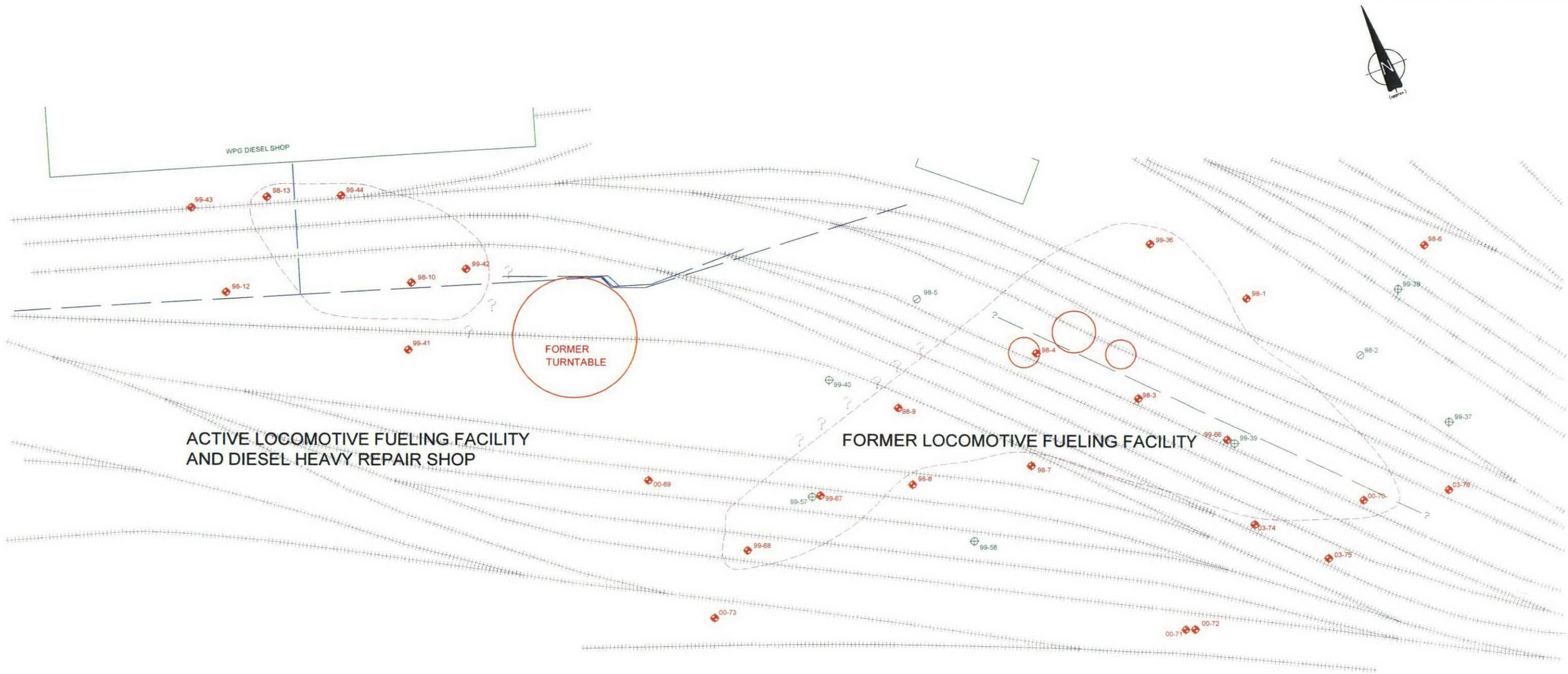


Bryan Leece, PhD
Risk Assessment Specialist

FIGURES

Figure 1: Well Inventory and Assessment Rationale





LEGEND

MW-96033 Monitoring Well (Location)
BH96015 Borehole (Location)
Decommissioned Well

Tracks
Former Structure
Structure
Water Line
Approximate Extent of LPH Plumes

Scale

DILLON CONSULTING

NO.	REVISIONS	DATE	BY

ORIGINAL: Morrow–2003
DRAWN: PMW
CHECKED: GCC
APPROVED:
DATE: 04/02/07
SCALE: as shown

Siteplan and Apparent LPH Thickness Contour Map

ACTIVE LOCOMOTIVE FUELING FACILITY AND DIESEL HEAVY REPAIR SHOP AND FORMER LOCOMOTIVE FUELING FACILITY

Canadian Pacific Railway
Winnipeg Diesel Shops and Weston Shops
Winnipeg, Manitoba

FILE NO. 0663132000
DRAWING NO. 4

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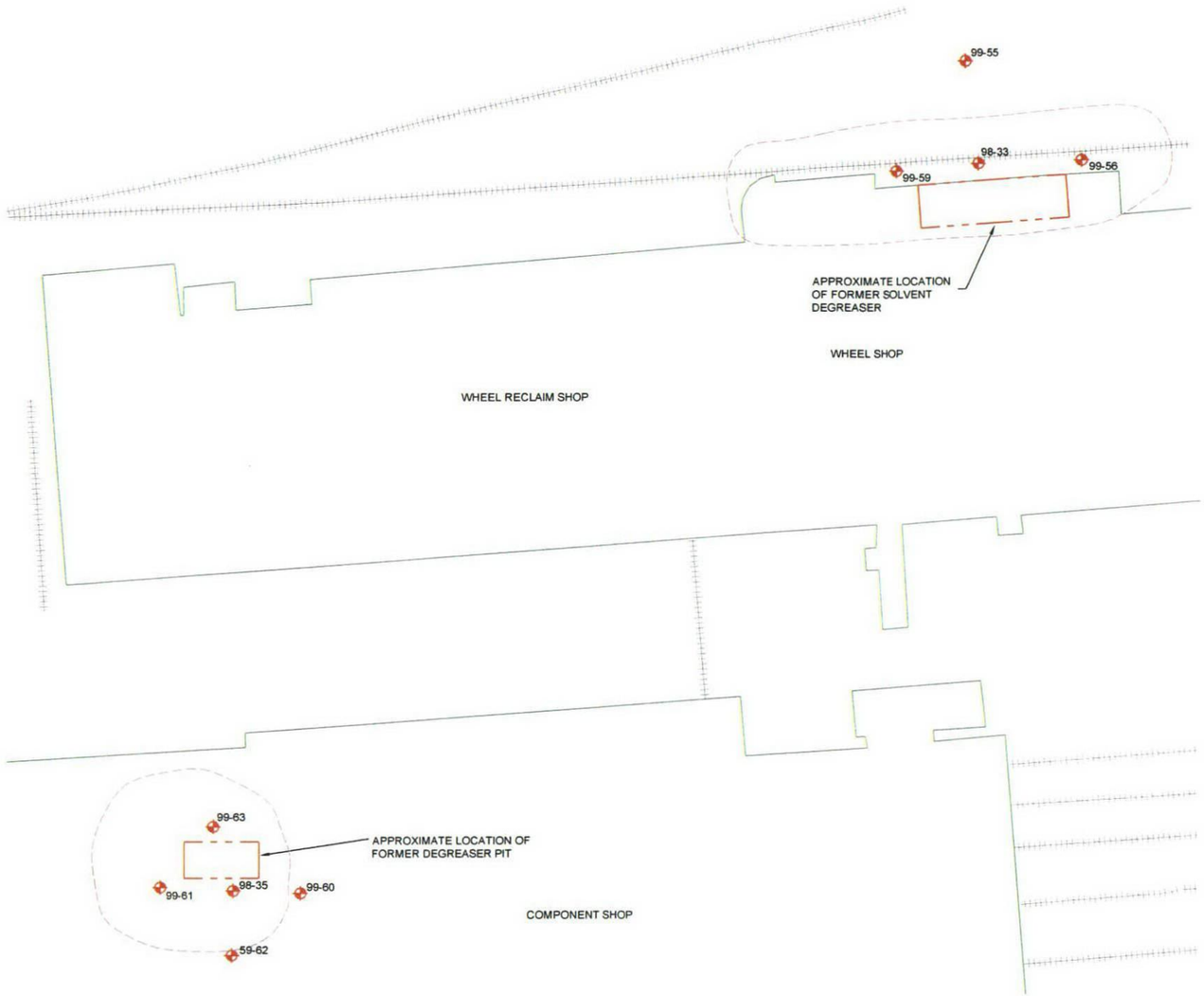

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NO.	REVISIONS	DATE	BY

ORIGINAL: Morrow-2003
DRAWN: PMW
CHECKED: GCC
APPROVED:
DATE: 04/02/07
SCALE: as shown

Siteplan and Apparent Dissolved VOC Impacts
Component Shop and Wheel Shop Area

Canadian Pacific Railway
Winnipeg Diesel Shops and Weston Shops
Winnipeg, Manitoba

FILE NO. 0663132000
DRAWING NO. 3

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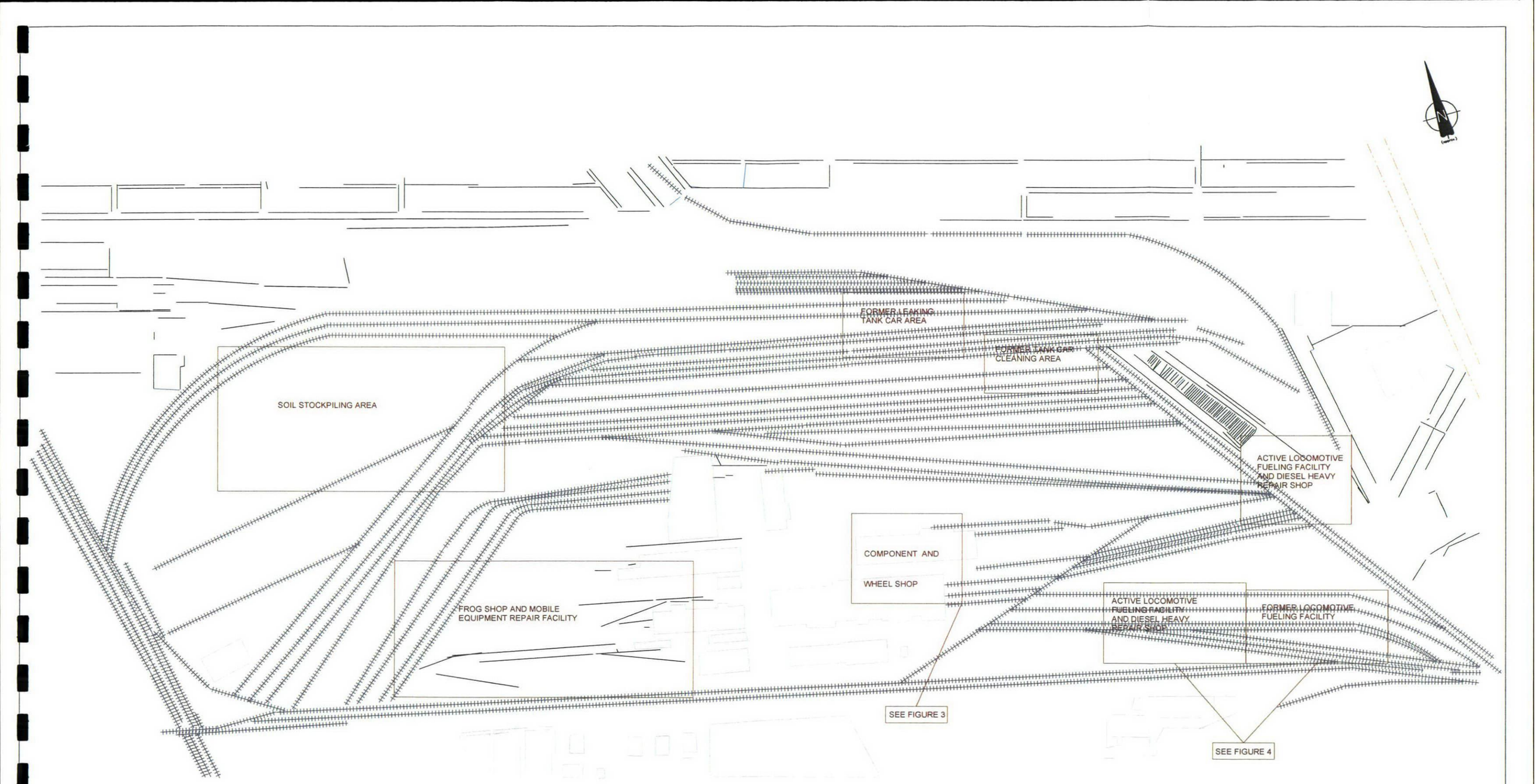

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NO.	REVISIONS	DATE	BY

ORIGINAL Morrow-2003
DRAWN PMW
CHECKED GCC
APPROVED
DATE 04/02/07
SCALE as shown

SITEPLAN

Canadian Pacific Railway
Winnipeg Diesel Shops and Weston Shops
Winnipeg, Manitoba

FILE NO. 0663132000
DRAWING NO. 2

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APPENDIX A – API Interactive LNAPL Guide Summary

Executive Summary - Mobility

Site Name:

Project Manager:

Date of Analysis: 3/28/2007

Title of Simulations: CPR Winnipeg Diesel Shops and Weston Shops

Initial Conditions

Simulation Number	Layer	Soil Type	van Genutchen Alpha (1/m)	Selected S_{ro} (%)
1	1	Clayey Silt	0.9	0.25

Simulation Number	LNAPL Type	LNAPL Zone Thickness (m)	Saturation Condition
1	Diesel	1.149	Vertical Equilibrium

Results

Simulation Number	Type Area Volume (cu m)	% Interval Greater than Field S_{ro}	Max S_o	Average S_o	Mobility (m/day)	Plume Velocity (m/day)
1	1.08E+01	0.00E+00	0.01	2.56E-03	1.94E-04	5.81E-06

User Input Parameters

Soil Properties

Simulation Number	Layer	Soil Type	van Genutchen Alpha (1/m)	van Genutchen n	Srw	Sro	K (m/d)	Total Porosity
1	1	Clayey Silt	0.90	2.33	0.67	0.25	8.00E-04	0.42

Groundwater Condition Input Parameters

Simulation Number	Groundwater Darcy Flux (m/day)	Linear Velocity (m/day)	Groundwater Gradient (m/m)
1	2.40E-05	1.73E-04	3.00E-02

Source Area Input Parameters

Simulation Number	Vertical Formation Thickness (m)	Depth to Top of LNAPL (m)	Length of LNAPL Zone (m)	Width of LNAPL Zone (m)
1	1.149	1.00	30.00	24.00

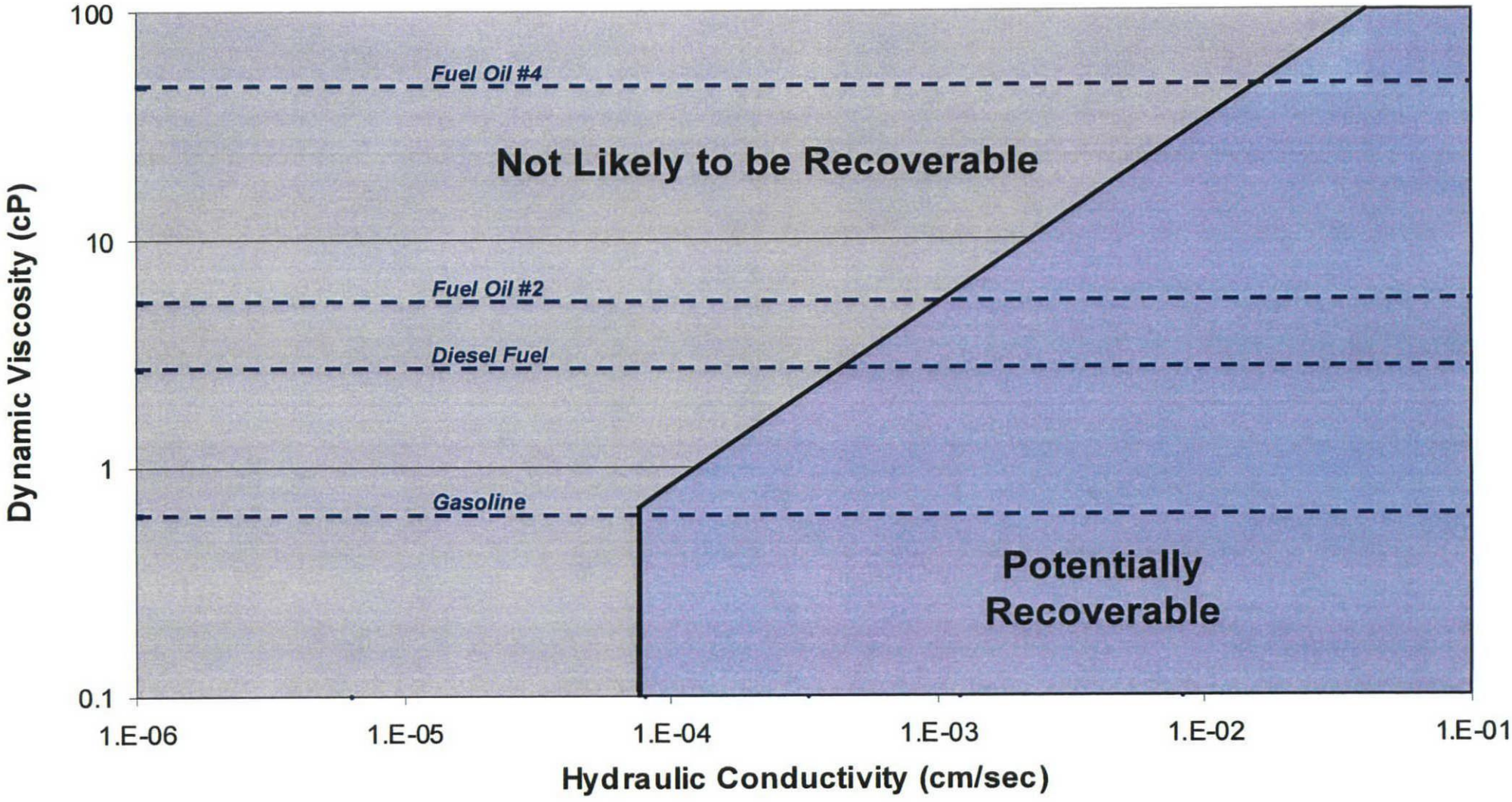
LNAPL Properties

Simulation Number	Product Type	Oil/Water IFT (dynes/cm)	Oil/Air IFT (dynes/cm)	Oil Density (gm/cc)	Viscosity (cp)
1	Diesel	50.00	25.00	0.83	2.70

Method Used to Calculate LNAPL Saturation Input Parameters

Simulation Number	Method Used To Calculate LNAPL Saturation	Source Volitilization	Criteria For Minimum Mobility (m/day)
1	Equilibrium LNAPL Distribution	Volatilization Included	8.64E-04

Potential LNAPL Recoverability for Maximum Apparent Well Product Thickness of 5.0 feet



APPENDIX B – Mann Kendall Analysis Summary

SUMMARY TABLE - **Winnipeg Diesel Shops and Weston Shops Yard, Manitoba**
Mann Kendall Statisticall Analysis of Plume Trends at the 90% confidence level.
Analysis of data from **December 1998** sampling event through to **October 2003**.

Well	Parameter	Trend @ 90% confidence level: Declining	Trend @ 90% confidence level: Stable	Trend @ 90% confidence level: Expanding	Trend: Uncertain CV>1	Statistics: No. events	Statistics: S statistic	Statistics: CV	Statistics: non-detects	Maximum Concentration mg/L	Comments
98-33	1,1-DCE	☑	☐	☐	☐	6	-10	1.45	5	2.5	
	cis-DCE	☑	☐	☐	☐	6	-9	0.69	2	2.85	
	PCE	☐	☑	☐	☐	6	3	0.50	0	154	
	TCE	☐	☑	☐	☐	6	-5	0.35	1	3.59	
	TCA	☑	☐	☐	☐	6	-10	1.45	6	2.5	All non-detects.
	VC	☑	☐	☐	☐	6	-11	1.70	5	6.25	
98-35	1,1-DCE	☐	☑	☐	☐	6	-1	0.70	2	7.32	
	cis-DCE	☐	☑	☐	☐	6	5	0.94	0	7.6	
	PCE	☐	☑	☐	☑	6	7	2.31	0	114	Fluctuating with a generally expanding trend.
	TCE	☐	☑	☐	☐	6	3	0.60	0	32.1	
	TCA	☐	☑	☐	☐	6	-7	0.88	1	1.6	
	VC	☐	☑	☐	☐	6	-1	0.88	1	1.4	
		☐	☐	☐	☐	0	0	#DIV/0!	-	0	
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S = Mann Kendall S Statistic

CV = coeffiecient of Variance

Overall Conclusion		
	☐	Further monitoring is recommended/required as trends indicate significant fluctuation or a generally expanding plume.
	☑	Further monitoring is recommended although plume stability analysis indicates a stable plume or no trend, due to concentrations remaining above applicable criteria.
	☐	No further monitoring is recommended/required as trends indicate a stable or declining plume and concentrations are below applicable criteria.

	Trend analysis	Comment Choice
Stable	if all results are nd	All non-detects.
Declining / Stable / Expanding	No comment required	
Uncertain (CV>1) & S <-2	if more than 1/2 of analyses are nd	Generally non-detect with a generally declining trend.
Uncertain (CV>1) & S <-2	if less than 1/2 of analyses are nd	Fluctuating with a generally declining trend.
Uncertain (CV>1) & +2>S>-2	if more than 1/2 of analyses are nd	Generally non-detect with some fluctuation (no trend).
Uncertain (CV>1) & +2>S>-2	if less than 1/2 of analyses are nd	Fluctuating with no trend.
Uncertain (CV>1) & S >+2	if more than 1/2 of analyses are nd	Generally non-detect with a generally expanding trend.
Uncertain (CV>1) & S >+2	if less than 1/2 of analyses are nd	Fluctuating with a generally expanding trend.

O:\PROJECTS\DRAFT\066313\Winnipeg Diesel Shops and Weston Shops\[Mann Kendall Analysis (Weston) - Dissolved Concentrations.xls]Summary

APPENDIX C – Risk Screening Summary Tables

Table C-1: Summary of Liquid Phase Hydrocarbons

Liquid Phase Hydrocarbons (LPH)			
LPHs present? Yes			
Type of LPH			
Gasoline	Fuel/Diesel oil	Lube oil	Other: _____
Product Occurrence			
Historically observed in:	98-3, 98-10, 98-13, 99-66, 99-67, 00-70		
Last observed in:	98-3, 99-67, 00-70		
	Active and Former Locomotive Fueling Areas		
Depth (m)	0.34		
Area (m^2)	700		
Are LPHs restricted on-site?	Yes		
Distance from the property line (m)	45		
Product Stability			
	Active and Former Locomotive Fueling Areas		
Maximum Thickness (m)	1.149		
Location	00-70		
Plume Size/Stability	Stable		
Recoverability (High, Medium, Low)	Not likely recoverable		
Plume velocity (m/day)	5.81×10^{-6}		

Table C-2: Summary of Dissolved Phase Hydrocarbons

Dissolved Phase Hydrocarbons			
Parameter	TEH	TVH	VOCs
Date of Most Recent Sample	Sep. 14/99	Sep. 14/99	Oct. 1/03
Trend in Concentration over Time			
Parameter	***Mann Kendall Trend Analysis***		***Statistical Confidence***
TEH	Insufficient Data		-
TVH	Insufficient Data		-
VOCs	Stable or decreasing		Moderate
Sampling Locations			
Parameter	***Wells with concentrations exceeding guidelines/background (Specify Source of Guideline)***		
TEH	98-2, 98-4, 98-8, 98-24, 98-34 (Background)		
TVH	98-2, 98-4, 98-8, 98-33, 98-34, 98-35 (Background)		
VOCs	98-33, 98-35, 99-56, 99-59, 99-61, 99-63 (MOE)		
Extent of Contamination			
	Locomotive Fueling Facility	**Wheel Shop**	**Component Shop**
Plume area (m^2)	1000	725	600
Has the plume likely migrated beyond the property line?	No	No	No

Table C-3: Potential Human Health Receptors

Identification of Potential Receptors			
On-Site			
Commercial/Industrial	***Residential***	***Construction Worker***	***Casual Visitor***
- Adult		- Adult	- Adult
			- Teenager
			- Child
			- Toddler
			- Infant
Are there buildings/dwellings located above/downgradient of impacts? Yes			
If "yes", identify and note presence of basements.	The Component Shop and Wheel Shop are located above dissolved VOC plumes.		
Off-Site (Above or Downgradient of Impacts)			
Commercial/Industrial	***Residential***	***Construction Worker***	***Casual Visitor***
- Adult	- Adult	- Adult	
	- Teenager		
	- Child		
	- Toddler		
	- Infant		
Are there buildings/dwellings located above/downgradient of impacts? Yes			
If "yes", identify and note presence of basements.	Residential/commercial/industrial buildings in the area southeast of the site.		

Table C-4: Potentially Complete Pathways from LPHs, VOCs and Dissolved Phase Hydrocarbons to Human Receptors

On-Site				
Media	**Exposure Route**	**Pathway**	**Retained Yes/No**	**Rationale**
Soil	*Inhalation*	*Inhalation of re-entrained soil & dust*	No	Subsurface impacts at ~1.3 m below ground surface.
	Ingestion	*Ingestion of soil*	No	Subsurface impacts at ~1.3 m below ground surface.
		Uptake into plants and consumption of plants	No	Employees and visitors are not expected to consume plants from the site.
		Uptake into animals through plants and consumption of animal products	No	Employees and visitors are not expected to consume animal products gathered from the site.
	Dermal Uptake	*Dermal contact with soil*	No	Subsurface impacts at ~1.3 m below ground surface.
Air	*Inhalation*	*Inhalation of compounds in indoor air*	Yes	Component Shop and Wheel Shop above/downgradient of impacts.
		Inhalation of compounds in outdoor air	No	Vapour migration to outdoor air will not make a measurable contribution to ambient air concentrations.
Drinking Water	*Ingestion*	*Ingestion of compounds in drinking water derived from on-site groundwater*	No	Non-potable groundwater use, the site is serviced by a municipal drinking water supply.
Off-Site				
Media	**Exposure Route**	**Pathway**	**Retained Yes/No**	**Rationale**
Soil	*Inhalation*	*Inhalation of re-entrained soil & dust*	No	On-site subsurface impacts at ~1.3 m below ground surface.
	Ingestion	*Ingestion of soil*	No	No surface soil impacts were identified off-site.
		Uptake into plants and consumption of plants	No	No surface soil impacts were identified off-site.
		Uptake into animals through plants and consumption of animal products	No	No surface soil impacts were identified off-site.
	Dermal Uptake	*Dermal contact with soil*	No	No surface soil impacts were identified off-site.
Air	*Inhalation*	*Inhalation of compounds in indoor air*	Yes	Residential, commercial and industrial buildings on off-site properties downgradient of impacts.
		Inhalation of compounds in outdoor air	No	Vapour migration to outdoor air will not make a measurable contribution to ambient air concentrations.
Drinking Water	*Ingestion*	*Ingestion of compounds in drinking water derived from on-site groundwater*	No	Non-potable groundwater use, the area is serviced by a municipal drinking water supply.

Table C-5: Screening Level Exposure Assessment Relative to Ecological Habitat

Ecological Habitat	
Are there, within 500 m[1] of the site:	
Valued Wetland habitats such as marshes, swamps, tidal flats, beaches	No
Valued Aquatic habitats such as rivers, lakes or streams	No
Valued Forested habitats	No
Valued Grassland habitats	No
Provincial/National parks or ecological reserve	No
Rare, threatened or endangered species populations	No
Other critical or sensitive habitat for wildlife, migratory species	No
IF THE ANSWER IS "NO" TO ALL QUESTIONS, THEN NO SPECIES OF CONCERN ARE IDENTIFIED AND THERE IS NO FURTHER ACTION REQUIRED.	
IF THE ANSWER TO ANY ONE QUESTION IS "YES", THEN PROCEED TO THE NEXT STEP.	
Exposure Assessment	
Can dissolved hydrocarbons in groundwater reach any of the receptor habitats identified above now or in the future?	
Can LPHs reach receptor habitats identified above?	
Can hydrocarbons reach receptor habitats identified above via surface runoff?	
Is there a potential for direct absorption of contaminants through skin, or plant roots?	
Is there a potential for consumption of contaminated soils, water, or affected food items?	
Have hydrocarbons associated with the site been known to be present in any of the soils, sediments, or surface water of the receptor habitats identified above at concentrations greater than the relevant ecological criteria or guidelines?	
IF THE ANSWER TO ANY QUESTIONS ABOVE IS "YES", THEN FURTHER ASSESSMENT IS REQUIRED.	

1 Saskatchewan Environment Risk-Based Corrective Actions: 500 m downgradient, i.e. 45° either way from main groundwater and/or surface water flow direction

Table C-6: Possible Risk Drivers from the LPH, VOC and Dissolved Phase Hydrocarbon Plumes

Human Health Risk Overview				
On-Site				
CoC(s) present?	*Receptor(s) present?*		*Potential for complete exposure pathway(s)?*	*Potential for unacceptable risk?*
Yes	Yes		Yes	Yes
List of Potential Risk Drivers	*- Inhalation of compounds (VOCs) in indoor air at the Component Shop and Wheel Shop*			
Off-Site				
CoC(s) present?	*Potential for COC migration?*	*Receptor(s) present?*	*Potential for complete exposure pathway(s)??*	*Potential for unacceptable risk?*
Yes	Yes	Yes	Yes	Yes
List of Potential Risk Drivers	*- Inhalation of compounds in indoor air*			
Ecological Risk Overview				
On-Site				
CoC(s) present?	*Valued habitats present?*		*Potential for complete exposure pathway(s)?*	*Potential for unacceptable risk?*
Yes	No		No	No
List of Potential Risk Drivers	-			
Off-Site				
CoC(s) present?	*Potential for COC migration?*	*Valued habitats present?*	*Potential for complete exposure pathway(s)?*	*Potential for unacceptable risk?*
Yes	No	No	No	No
List of Potential Risk Drivers	-			