Rondeau Provincial Park Septic System Impact Study

Prepared by: GENIVAR Inc

Ontario Ministry of Natural Resources

January 2012

Webpage title: Rondeau Provincial Park Septic System Impact Study

Webpage description: This report summarises the results of a groundwater monitoring field program for Rondeau Provincial Park in 2011.

NOTE: The Appendices cited in this report are available in PDF format upon request. Please email requests to pascience@ontario.ca.

GENIVAR

Project No. 111-52948-00

January 20, 2012

Mr. Rob Davis
Manager, Parks and Protected Areas Policy Section
Ontario Ministry of Natural Resources
300 Water Street, 6th Floor
Peterborough, Ontario
K9J 8M5

Re: Rondeau Provincial Park Septic System Impact Study

Dear Sir:

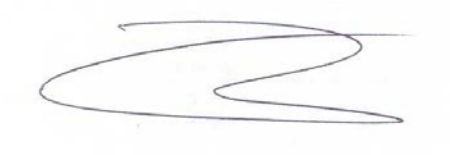
GENIVAR Inc. (GENIVAR) is pleased to submit our Sewage System Impact Study report for Rondeau Provincial Park. This report was prepared in accordance with a Request for Quotation that was received from the Ontario Ministry of Natural Resources on February 3rd, 2011, our proposal dated February 18th, 2011, and subsequent correspondence between the parties.

This report provides the results of a groundwater monitoring field program that was completed at the Park between April and September 2011. Those monitoring results are used to assess the effects of on-site sewage disposal systems at the Park on the local groundwater quality. The report provides an assessment of groundwater compliance with respect to the Ontario Drinking Water Quality Standards (ODWQS) along with associated discussions related to non-ODWQS parameters, such as phosphorous. Appended to this report are the results of the additional investigations that were completed at the North and Central comfort stations. These investigations were completed separately from the Sewage Impact Study, but were premised on some of the preliminary findings. As well, the report contains our conclusions and recommendations along with proposed mitigation measures, where appropriate.

We thank you for the opportunity to complete this assignment. Should you have any questions or concerns, please contact the undersigned.

Yours truly,

GENIVAR INC.



Michael Varty, P.Eng
Project Engineer
MHV:nah:

Executive Summary

Rondeau Provincial Park is located in the Hamlet of Morpeth, approximately 12 km east of the Town of Blenheim, in the Municipality of Chatham-Kent. The Park is a peninsula of Lake Erie and was established in 1894 and is comprised of 3,254 hectares (8,041 acres). At the park there are about 262seasonal campsites and 286 active cottage leaseholds; the campsites are serviced through three (3) comfort stations (North, Central, and South) on municipal water and private sewage disposal systems, while the cottages are served by way of private sand point wells and septic systems.

The regional groundwater table is located below the surficial sand; thus the upper sand unit is considered an unconfined aquifer. The groundwater levels range between 0.23 to 3.07 m below grade. The local topography is relatively flat. Topography at the site ranges between 175 to 176 m ASL across the majority of the Park with a gradual slope towards Lake Erie and Rondeau Bay.

The shallow groundwater flow, in general, is divided across the site in an east-west direction. Shallow groundwater flow within the western portion of the property is flows towards the west and into Rondeau Bay, whereas the shallow groundwater flow on the eastern portion of the property flows towards the east and into Lake Erie. The largest water level fluctuation during the monitoring program was 1.02 m, while the average groundwater fluctuation was observed to be 0.77 m across all 20 of the monitoring wells. Groundwater elevations generally increased from April to May, then decreased through August, and rebounded slightly in September.

Sewage effluent plumes are produced at this site by the use of both small Class IV sewage disposal systems associated with the leased cottage lands, and by larger sewage disposal systems associated with the Park's comfort stations.

The sewage effluent migrates downward through the underlying sand soil, and into the shallow groundwater table. As sewage impacted groundwater reaches the groundwater table below the sewage systems, it mixes with the groundwater flow system and moves principally in a westerly or easterly direction towards Rondeau Bay, or Lake Erie. In the groundwater table the groundwater quality fluctuates seasonally associated with periods of high Park use and lower Park use, and thus high and low septic system use.

Water quality remains generally acceptable compared to the ODWQS in many areas of the park, with the exception of nitrate within OW7, MW11-11 and MW11-12. It is inferred

that the evaluated nitrate concentrations observed at OW7 are a result of the sewage disposal systems in the immediate surrounding area in the northern cottage cluster. The impacts noted at MW11-11 and MW11-12 are inferred to be localized impacts due to the operation of the comfort station's disposal system.

As the groundwater monitoring wells are not drinking water sources, the impacts at these monitoring locations are acceptable. There is, however, potential for localized unacceptable impacts to been seen at drinking water sources, specifically the sandpoint wells located within the northern cottage cluster. This area is more susceptible than other areas given the proximity of the sandpoint wells to active sewage disposal systems.

A predictive impact assessment was employed to determine the theoretical nitrate impact from the remaining cottages throughout the site, as it would not be practical to gain reliable monitoring results to characterize such a narrow band of over 200 cottages. The results of this predictive impact assessment demonstrate that the overall impact from these sewage disposal systems would be minor in nature, even during peak use seasons. Local impacts could be greater depending on the proximity of a sample location to an active septic system.

Overall, observed septic system impacts at the park are minor in nature as negative impacts are seemingly attenuated within the property limits.

In response to the observed impacts at MW11-11 and MW11-12, GENIVAR completed a sewage system condition assessment at the North and Central comfort stations. The results from this investigation show that Ontario Parks should plan for the future replacement of the north comfort station's sewage disposal system. The central comfort station's sewage disposal system is inferred to have a longer useful life than the north comfort station's.

The comfort stations themselves are serviced through the use of municipal water, and as such, would not be susceptible to sewage related impacts created at the park.

On-site sewage disposal systems are contributing to an elevated concentration of phosphorous in the groundwater. Increases in phosphorous above background concentrations ranged from 0.2 mg/L to over 1.5 mg/L. Phosphorous increases are more pronounced within the northern cottage cluster than elsewhere on the site, likely due to laundry, dishwashing and cleaning activities in this densely populated area.

Additional monitoring and mitigative measures could be implemented to reduce the impact of the sewage disposal systems to the natural environment. Replacement of poorly operating sewage systems with ones that meet the construction requirements and clearance distances noted in the Ontario Building Code would further reduce the potential for these systems to impact nearby sandpoint wells.

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Introduction

Background

Rondeau Provincial Park is located in the Hamlet of Morpeth, approximately 12 km east of the Town of Blenheim, in the Municipality of Chatham-Kent. Originally established in 1894, Rondeau Provincial Park is located on a 3,254 hectare (8,041 acre) crescentic sand spit that extends southerly into Lake Erie. The sand spit upon which the park is situated is a provincially significant landform feature that is also home to many species at risk. Public amenities within the Park include 262 seasonal campsites (85 in North Campground & 177 in South Campground), beachfront access on Lake Erie proper and Rondeau Bay, boat launching facilities, a park store and restaurant, an Anglican and a Roman Catholic Church site, a Yacht Club, and a visitor centre for natural heritage education purposes. The location of Rondeau Provincial Park is shown on Figure 1.

All of the Park buildings within the campground areas are serviced with water from the Municipality of Chatham-Kent. The visitor centre is currently served by a sandpoint well. Sewage servicing is provided by local septic systems for the visitor centre, North Campground Comfort Station, and Central Comfort Station, and a large central septic system for all other park buildings that is located near the trailer sanitary dumping station.

The goal for Rondeau Provincial Park, based on the 1991 Rondeau Provincial Park Management Plan, is as follows:

"The goal for Rondeau Provincial Park is to protect and enhance the quality of the park environment, especially its unique Carolinian features, and to provide compatible recreational, educational and conservation activities."

In addition to the facilities described above, Rondeau Provincial Park also includes 286 active cottage leaseholds which are served by private sand point wells and septic systems, and an additional 103 former (but now vacant) cottage sites. The cottage community at the Park dates back to the late 1890s. The lease agreements expire in 2017.

It is understood that historically, the cottages were primitive huts or small cabins that were used on weekends by local residents. In recent years, many of the cottages have evolved into larger and more significant entities.

Trends occurring in regard to cottage use intensity compared to the earlier eras of weekend retreats and cabins are noted from the Ministry of Natural Resources (MNR) to be:

- Increased use as summer residences by local residents;
- A number of retirees who live in the cottage community in the late spring, summer and early fall seasons and then reside elsewhere, during the winter season;
- Many cottages being used for two and three week vacation intervals, in addition to weekend use;
- Significant extension of cottage use into early spring and late fall;
- Some evidence of year-round or near year-round utilization for a limited number of cottages.

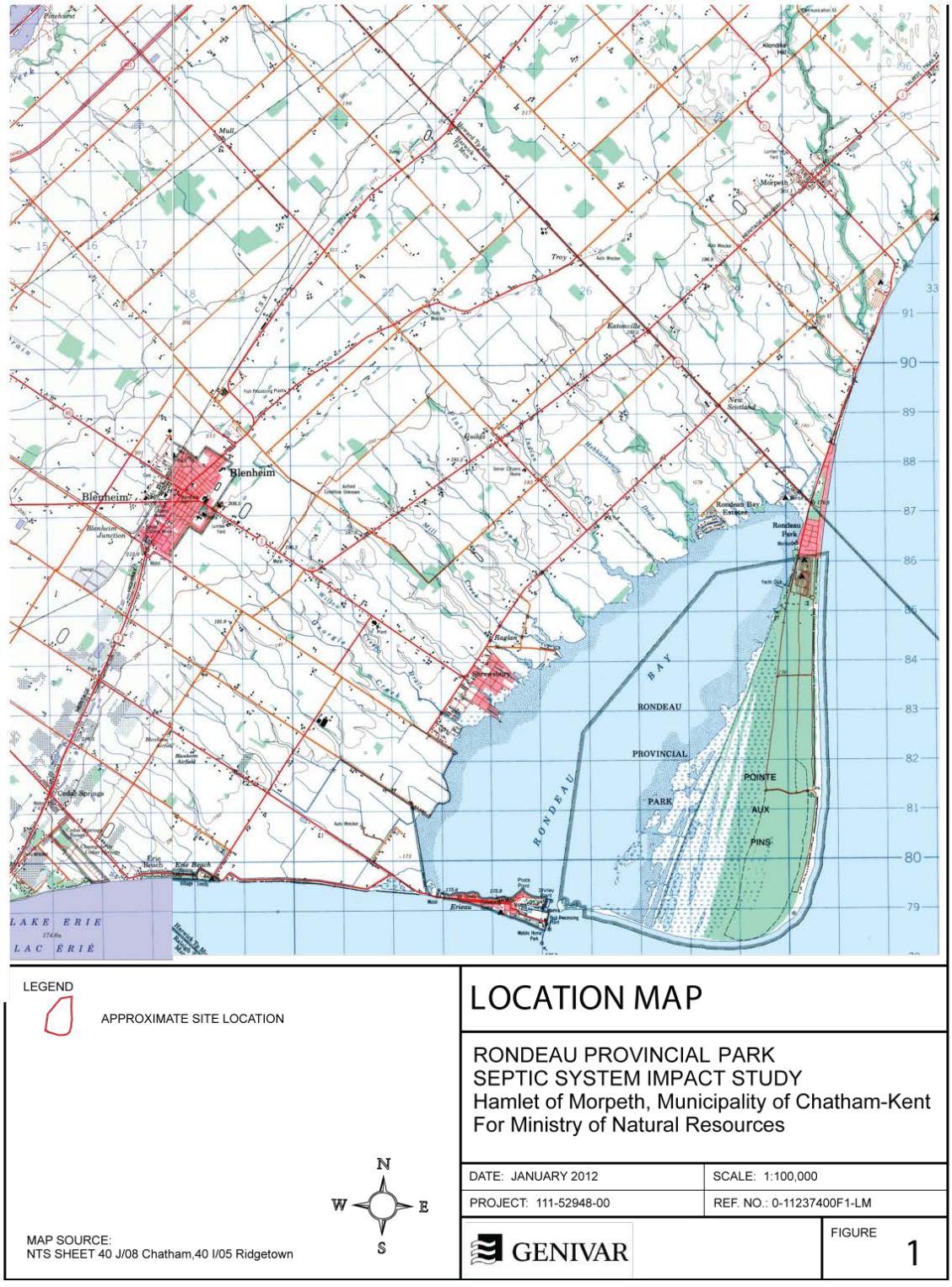

Figure 1. Rondeau Provincial Park Location Map

In August 2003, the Rondeau Cottagers Association retained R.J. Burnside & Associates Ltd. to complete a septic system (groundwater) impact study. The results of that investigation (based on one round of sampling for 10 monitor wells) suggested that the leaseholder's septic systems were not negatively impacting the environment. In a reply letter dated July 16th, 2004, the Ministry of the Environment's (MOE) Southwest Regional groundwater evaluator at that time (T.Beukeboom) reported that although the study results did not indicate any evidence of groundwater impact based on the "one time sampling event", he felt that a longer duration study with more sampling events would provide more conclusive evidence regarding "groundwater quality in the long term". A copy of the R.J. Burnside report and MOE response letter is provided in Appendix A.

Objectives and Scope

The objectives of the present study, was designed to address the MOE's previous comments towards the J. Burnside & Associates Ltd. report, are summarized as follows.

- To prepare a pre-consultation letter report for the MOE with respect to the current work program.
- To prepare a pre-consultation letter report for the MOE with respect to the current work program.
- To locate and assess the functionality of the historic groundwater monitors.
- To install a suitable network of additional groundwater monitors in the densely occupied area of the site, and near the Park owned / operated sewage systems.
- To topographically survey the monitoring network relative to one another.
- To carry out a six (6) month groundwater monitoring program during the park's operating season (April 2011 through September 2011).
- To collate the water level and groundwater quality data.
- To assess the effects of the septic systems on local groundwater resources based on the monitoring results.
- To prepare a report to document the study findings.

The interpretation addresses the effects of septic systems on local groundwater resources within the shallow overburden aquifer. This assessment then provides a basis for determining if groundwater contamination is identified as a concern.

An additional study was completed based on the results of the above assessment. The scope of the additional study was to:

- To complete a non-destructive on-site investigation to determine the location and condition of the existing comfort station sewage disposal systems (North and Central).
- To collect and test representative soil samples from the existing leaching bed areas To determine the percolation rate of the native soil in each of the leaching bed areas
- To assess the ability of the existing sewage systems to continue servicing their respective comfort stations, while mitigating potential environmental impacts.
- To collect additional groundwater samples at MW11-11 and MW11-12 to supplement the data gathered in the Septic System Impact Study (GENIVAR, 2011)
- To prepare a report to document the study findings.

Methodology

Schedule

The sewage system impact study program consisted of the following tasks.

1. Locating the historic groundwater monitors at the site. (March 30th, 2011)
2. Meeting with MNR staff with respect to the proposed work program. (April 6th, 2011)
3. Installation of twelve (12) new groundwater monitors at the site. (April 19th and 20th, 2011)
4. Development and surveying of the groundwater monitoring network. (April 26th and 27th, 2011)
5. Preparation of a pre-consultation letter report for the MOE. (April 29th, 2011, Appendix A)
6. Collection of groundwater samples at the following locations.

- Historic groundwater monitors: OW2, OW3, OW4, OW5, OW6, OW7, OW9, and OW10.
- New groundwater monitors: MW11-1, MW11-2, MW11-3, MW11-4, MW11-5, MW11-6c, MW11-7, MW11-8, MW11-9, MW11-10, MW11-11, and MW11-12.
- Private cottage wells as identified with numbers: 11340 and 11345.

Groundwater monitors were sampled on:

- April 26th or 27th, 2011,
- May 24th, 2011,
- June 27th, 2011,
- July 25th, 2011,
- August 29th, 2011, and
- September 21st, 2011

Groundwater samples were also collected from the two (2) cottages wells on the above-noted dates, with the exception of the April monitoring event.

7. Water level measurement in the groundwater monitors during each monitoring event.

The additional sewage system investigations at the comfort stations consisted of the following tasks:

- Species at Risk (SAR) screening and utility locates completed by the MNR and Kent Locating Services Inc. respectively for the study area.
- The advancement of six (6) test pits in and around the North and Central comfort station leaching beds using a Bobcat mini excavator. (November 10, 2011)
- Collection of groundwater samples at MW11-11 and MW11-12. (November 10, 2011)
- Preparation of a technical report based on the results of the investigations for the MOE.

Protocols

The water level was measured and recorded from within each monitor, prior to purging and sampling, excluding the private cottage wells. Prior to sampling, the monitors were developed by removing three (3) wellbore volumes of water, or until purged dry. Private cottage well water samples were taken from outside taps and, where necessary, the garden hose removed.

Water samples were collected using pre-cleaned, laboratory supplied sample containers with a tamper- proof seal placed over each container cap. After filling each container with the sampled water, the containers were placed within a clean cooler containing loose ice to ensure cold transport to the laboratory. A suitable cold storage environment

within each cooler was maintained throughout the sampling event by replacement of the ice packs until the coolers were shipped to the laboratory.

Samples were analysed by Exova Group Ltd. (Accutest) for the following parameters:

Ammonia
Nitrate
Nitrite
pH
Total Kjeldahl Nitrogen
Total Phosphorous
Chloride

On receipt of the laboratory results, the data were collated and analysed, and the study findings were then documented in this report.

Field measurement of pH, electrical conductivity, and temperature was also completed at each sampling location during the monitoring events.

Study Findings

Physical Setting

Rondeau Provincial Park is located on a crescentic sand spit that extends southerly into Lake Erie. The Park entrance is located just south of the intersection of Kent Bridge Road and Rose Beach Line in the Hamlet of Morpeth, Municipality of Chatham-Kent.

The Park lies within the Erie Spits Region, as described by the Ontario Geological Survey (Chapman and Putnam, 1984). This area is comprised of three (3) major sand spits, one of which is Rondeau Park. These sand spits are made up of sand and gravel sediment washed out from rivers/streams or bluffs on the main land.

A review of available surficial geological mapping of the area (Figure 2) indicates that the overburden soils across the site are generally gravelly in nature; however observations made during our recent field work (see the Field Investigations section) indicate that the surficial soils found at the site are composed predominately of sand.

The regional topography, as illustrated in Figure 3, shows that the sand spit is relatively flat. Ground surface elevations generally range between about 175 m ASL and 176 m

ASL across the majority of the Park with a gradual slope down to approximately 174 m ASL along the western edge (shoreline of Rondeau Bay). The western edge of the Park is at, or slightly below the lake level thus creating a marshy area; while on the eastern portion of the Park there is an extensive dune system.

Surface water is inferred to drain towards Lake Erie or Rondeau Bay via natural drainage pathways or along storm water ditches that are located in the developed area in the Northern portion of the Park property.

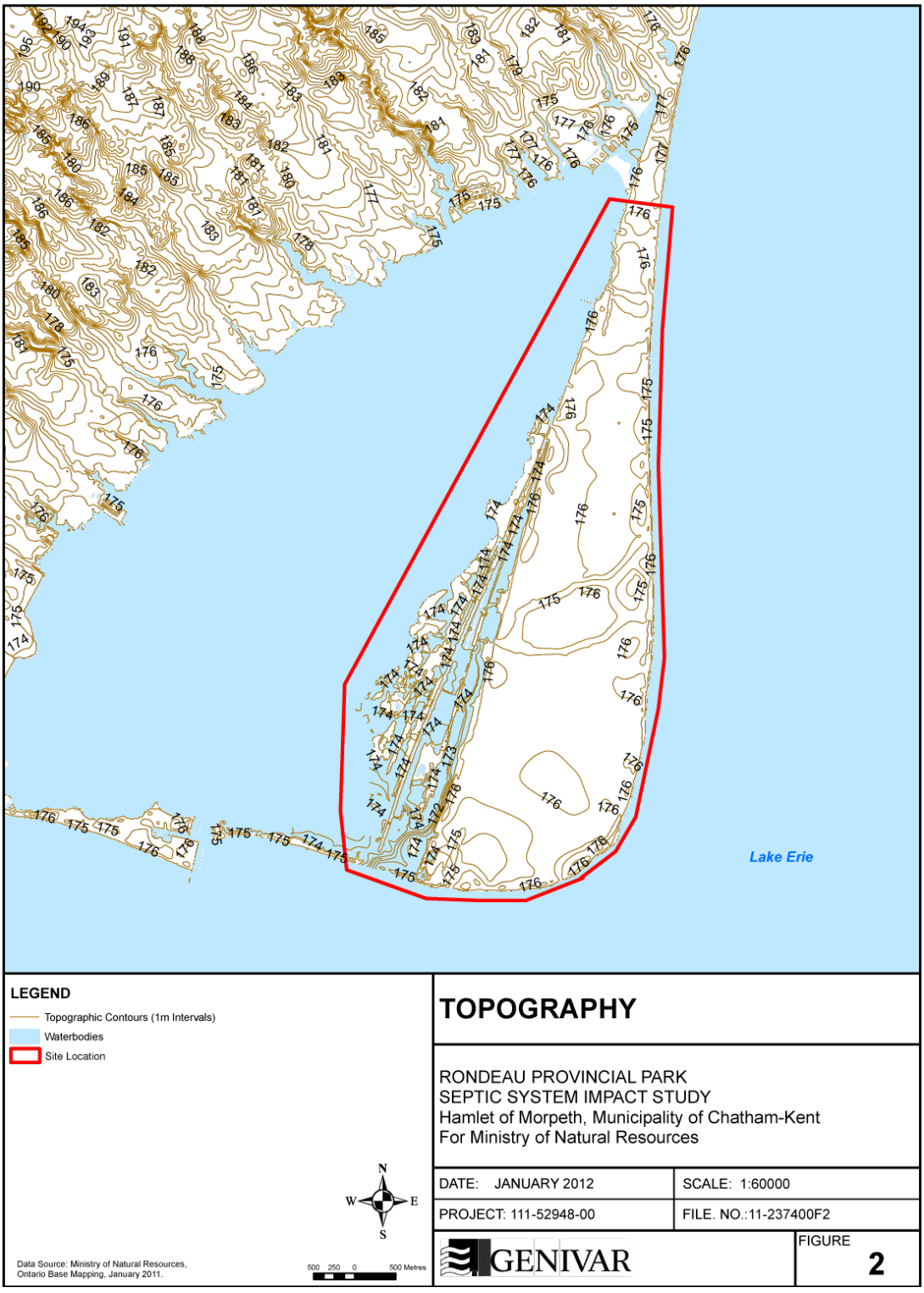

Figure 2. Rondeau Provincial Park Topography

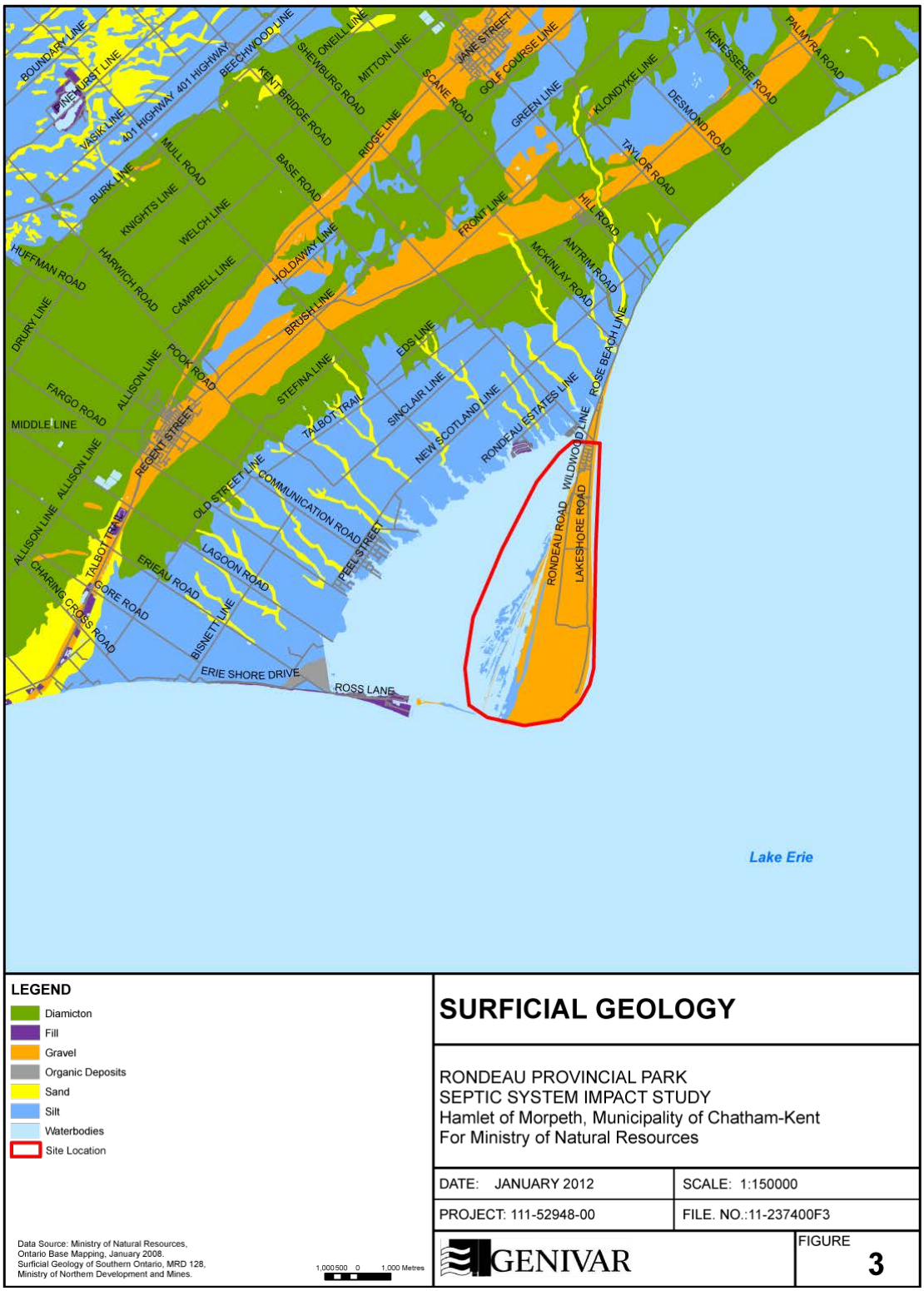

Figure 3. Rondeau Provincial Park Surficial Geology

Field Investigations

Field investigations were previously conducted at Rondeau Provincial Park by R.J. Burnside & Associates in 2003 and Hydro-Geo Limited in 2001. Those field investigations involved the installation of ten (10) shallow groundwater monitoring wells; eight (8) of which were located during GENIVAR's preliminary site visit on March 30th, designated OW2 to OW7, OW9 and OW10. These wells were incorporated into our sampling program. Monitoring well locations are shown on Figure 4. In addition to the drilled monitoring wells, a series of five (5) hand augured boreholes were also completed as part of historic site investigations, the results of which indicated that the shallow stratigraphy consisted of a thin layer of topsoil overlying a predominately sand based soil. Laboratory testing of the soils indicated that the composition was greater than 98% sand and less than 2% silt.

In April, 2011, GENIVAR supervised the installation of twelve (12) new shallow groundwater monitoring wells as a supplement the existing historical well network. The location of the new monitoring wells, designated MW11-1 to MW11-12, are illustrated on Figure 4.

The new monitoring wells were installed by B.U.D Environmental Services Ltd. on April 19th and 20th, 2011. The wells were drilled using a truck mounted rig equipped with a 200 mm diameter hollow stem auger. The wells were installed as 51 mm diameter PVC wells. The base of each well was outfitted with 1.5 m long section of slotted screen. The annular space surrounding the well screen was backfilled with Grade 3 silica sand to approximately 0.30 m above the screened interval. A bentonite seal was then placed on top of the sand and brought up to grade to protect the well from surface water infiltration. Monitoring wells MW11-1 and MW11-10 were completed as flush-mount monitor, whereas the remaining monitors were extended above grade with a protective casing. Detailed borehole logs for monitors MW11-1 to MW11-12 are provided in Appendix B.

A split spoon sampler was used during the drilling program to sample and describe the soils at each borehole location. A 0.6 metre sample was collected at each 0.76 metre interval. A discussion regarding the soil characteristics and depth to the shallow groundwater table is provided below.

Six (6) test pits were completed in the general area the North and Central comfort station leaching bed disposal system, designated TP11-1, through TP11-6. The investigations are detailed in the attached technical report (Appendix F).

Surficial Hydrogeology

Surficial soil characteristics and depth to the shallow groundwater table across the site have been interpreted based on observations made during the monitoring well installation program discussed above.

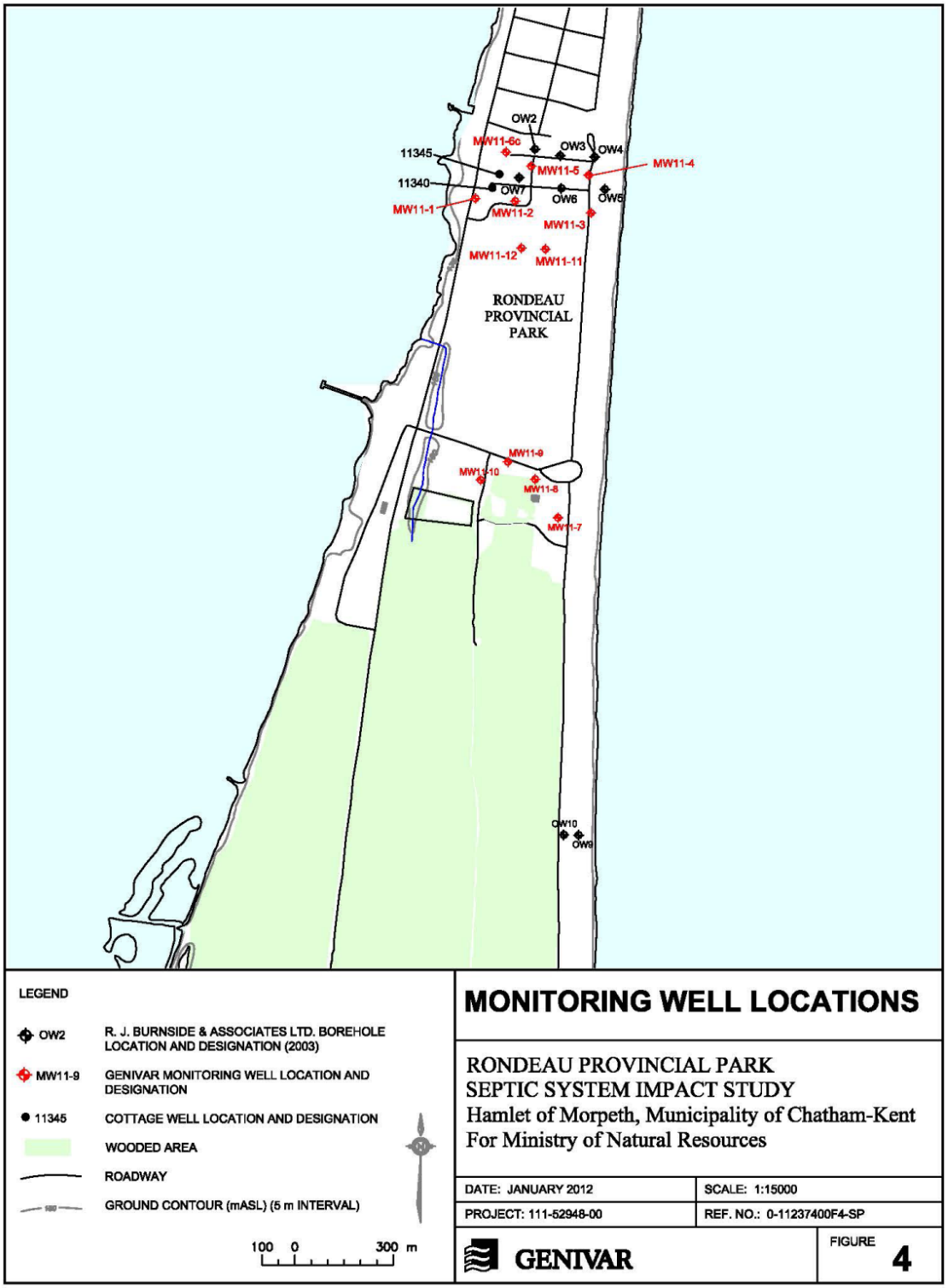

Figure 4. Rondeau Provincial Park Monitoring Well Locations

Based on the borehole logs, the shallow soils are comprised of a fine to medium sand, with trace to some silt to approximately 3 m below grade.

The static water levels within all twenty (20) monitoring wells were recorded during the well development stage (April 2011) and during subsequent sampling event in May, June, July, August, and September, 2011. A summary of the shallow groundwater levels are provided in Appendix C. Measured groundwater levels within the monitoring wells ranged between 0.23 m and 3.07 m below grade. The groundwater levels within the wells during the May sampling event are shown on Figure 5 and are displayed as relative elevations to the top of monitor well MW11-1 (assumed elevation of 100 m). Monitors OW9 and OW10 were not included in Figure 5 due to their remote location from the other monitors, however water levels were also obtained at these monitors each month.

Based on Figure 5, the recorded shallow groundwater flow, in general, is divided across the site in an east-west direction. Shallow groundwater flow within the western portion of the property flows towards the west and into Rondeau Bay, whereas the shallow groundwater flow in the eastern portion of the property flows towards the east and into Lake Erie.

During the 2011 field work program, the largest water level fluctuation of 1.02 m occurred at Monitor MW11-5, while the average groundwater fluctuation was observed to be 0.77 m across all 20 of the monitoring wells. During 2011, the groundwater elevations generally increased from April to May, then decreased through August, and rebounded slightly in September.

Geochemical Results

Groundwater samples were collected and analysed in accordance with the procedures outlined in the Protocols section. The groundwater chemical results are tabulated by location unit in order to assess variations in the chemistry of each unit. The locations have been grouped as the northern cottage cluster, northern comfort station, southern comfort station, and southern cottages. Analytical results are contained in Appendix D. For each group, the following aspects are discussed.

- Annual range
- Short-term patterns and trends
- Compliance with Ontario Drinking Water Quality Standards

To assist with the interpretation of water quality trends, Figure 6 – Nitrate Concentrations, has been prepared. The short-term trends are based on the graphical results provided in Appendix D.

Sewage system related impacts tend to modify multiple parameter concentrations over time rather than single value. For example, at Monitor OW7 located in the northern cottage cluster, nitrate concentrations spiked in June and July (14.8 mg/L and 16.6 mg/L) to over ten times the April and May concentrations (0.9 mg/L and 1.25 mg/L); corresponding spikes in chloride concentrations were also noted at this monitor over this same time period ranging from 3 mg/L in April and May to 14 mg/L and 16 mg/L in June and July, respectively. These secondary parameter concentration trends assist in determining whether the impacts are a result of on-site sewage systems.

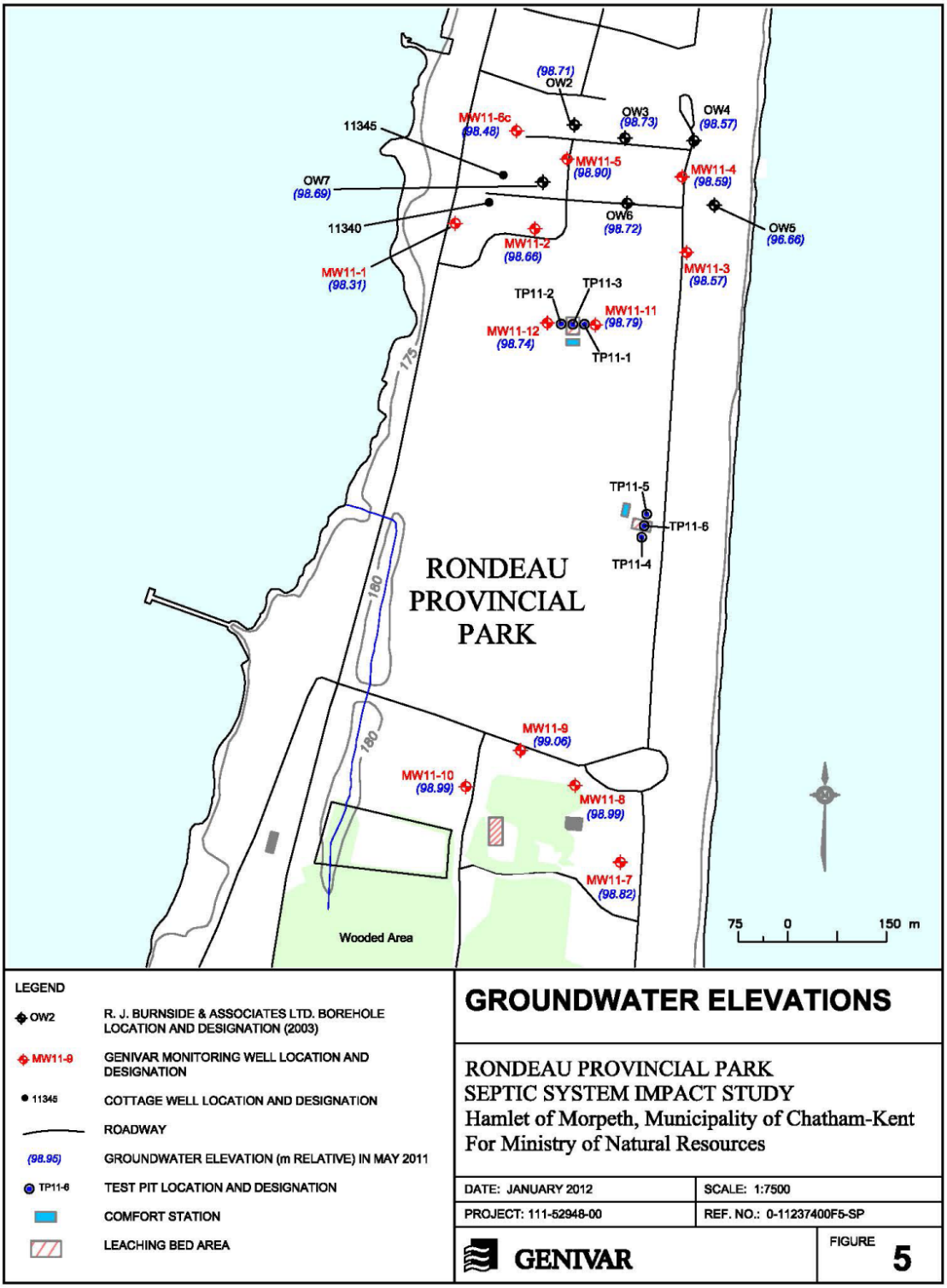

Figure 5. Rondeau Provincial Park Groundwater Elevations

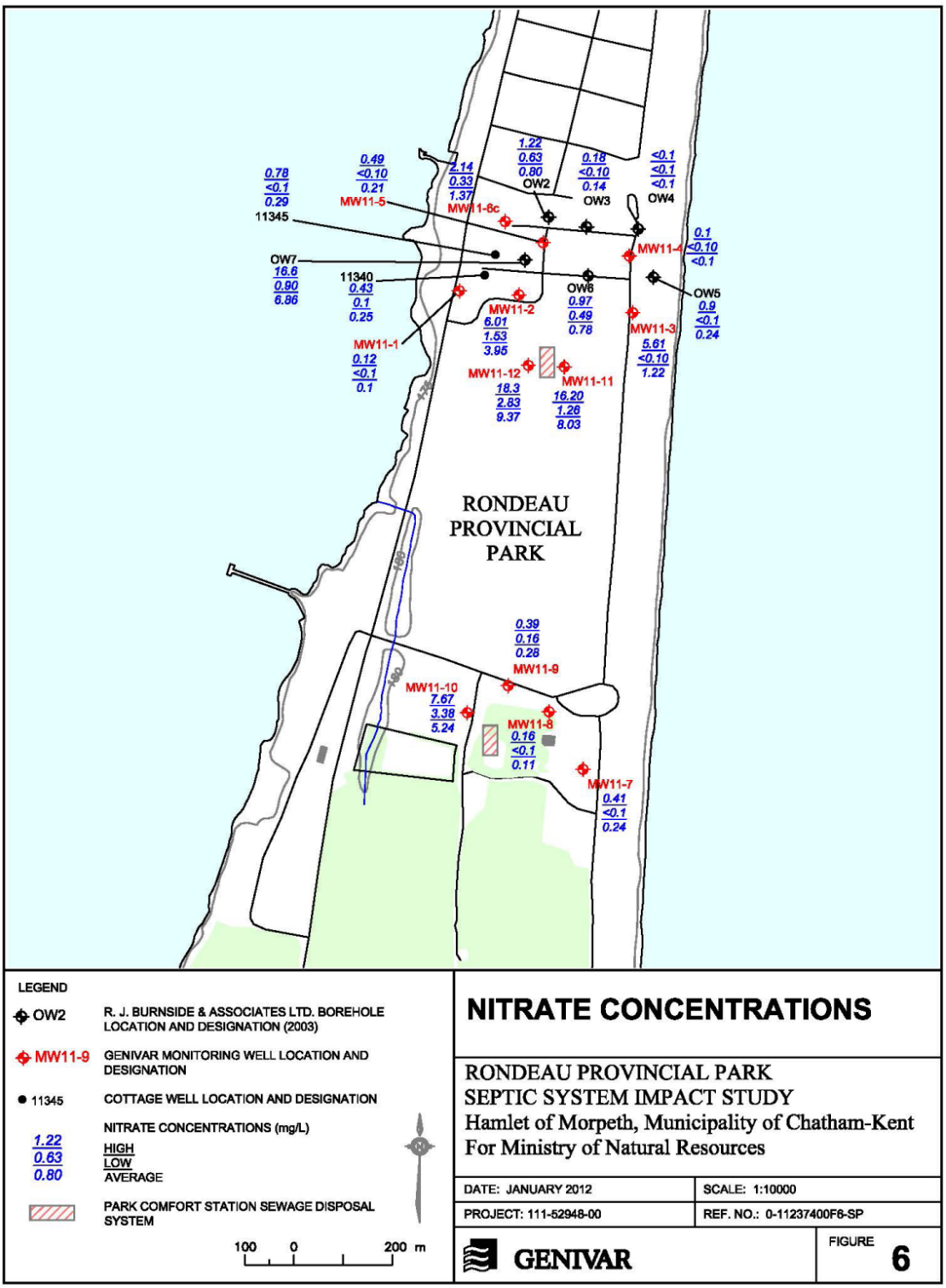

Figure 6. Rondeau Provincial Park Nitrate Concentrations

Northern Cottage Cluster

The chemical results for the northern cottage cluster are contained in Tables D-1 to D-3, Appendix D. Time-concentration graphs for nitrate, nitrite, chloride, and phosphorous, are graphically displayed in Figures D-1 to D-8, Appendix D. These parameters were selected as they are typical indicators of sewage effluent plumes.

Groundwater Monitors

Concentrations of nitrate are slightly fluctuating or remaining constant at each of the monitoring locations with the exception of OW7, MW11-2, MW11-3, and MW11-6. The concentration of nitrate increased at MW11-3, MW11-2, and OW7 until peaking in May, June, or July respectively. After reaching their peak, each concentration decreased over time to levels near the background concentrations measured in April. Nitrate concentrations generally increased or fluctuated slightly at MW11-6; refer to Figures D-5 and D-6.

For most other parameters with concentrations above the method detection limit, concentrations were generally constant or slightly fluctuating the short term; exceptions to this include phosphorous and chloride. Increased chloride concentrations were noted during various sampling events in groundwater monitors OW7, MW11-2, and MW11-6. These monitors were also noted above to have indicated similar fluctuations in nitrate concentrations. Phosphorous concentrations in many monitors increased to a peak in either June or July and returned to or below the background concentrations reported in April by September.

Generally, average concentrations of most parameters were similar between monitoring locations. Exceptions to this pattern are nitrate at OW7, and MW11-2 which have average concentrations at least three times higher than at other locations; and phosphorous at all of the monitors, with phosphorous concentrations varying by up to a factor of ten (10).

Average concentrations of nitrate, nitrite, and chloride remained below the Ontario Drinking Water Quality Standards (ODWQS) at each of the monitors. The peak concentration of nitrate at OW7 exceeded the ODWQS, as noted in the June and July sampling results. Nitrate is a health related parameter with a maximum acceptable concentration of 10 mg/L; risks associated with nitrate concentrations above this level are related to blood problems in infants and small children.

It is inferred that the evaluated nitrate concentrations observed at OW7 are a result of the sewage disposal systems in the immediate surrounding area in the northern cottage cluster.

Cottage Water Supplies

Concentrations of nitrate fluctuate slightly or remain constant at each of the monitoring locations (Cottage 11340 and Cottage 11345); refer to Figure D-10. For most other parameters with concentrations above the method detection limit, concentrations were generally constant or slightly fluctuating over the short term; the exception to this was chloride at Cottage 11345. The chloride concentration at this well increased in June and remained elevated in July before returning back to lower concentrations in August and September.

Generally, average concentrations of the parameters were similar between monitoring locations. Average and peak concentrations of nitrate, nitrite, and chloride remained below the Ontario Drinking Water Quality Standards (ODWQS) at each of the cottage water supplies.

Northern Comfort Station

Concentrations of nitrate are noticeably increasing at MW11-11 and decreasing at MW11-12 throughout the duration of the monitoring program; see Figure D-15. Given how flat the groundwater table is noted to be in this specific area of the property, as noted in Table C-1, Appendix C, it is possible that the effluent plume changed orientation through the year to a more easterly direction resulting in the concentration change.

For most other parameters with concentrations above the method detection limit, concentrations were generally constant or slightly fluctuating over the short term; exceptions to this include phosphorous and chloride. Chloride concentrations were noted to be on an increasing trend throughout the sampling program at both locations, while phosphorous concentrations in both monitors increased to a peak in July and returned near the April concentrations by September.

Generally, average concentrations of most parameters were similar between both monitoring locations, with the exception being chloride which has an average concentration of nearly three (3) times higher at MW11-12 when compared to MW11-1.

Average concentrations of nitrate, nitrite, and chloride remained below the Ontario Drinking Water Quality Standards (ODWQS) at each of the monitors. Peak concentration of nitrate exceeded the ODWQS at both monitors during the sampling program; MW11-11 exceeded the ODWQS during the August and September sampling events, while MW11-12 exceeded the ODWQS in April and May. Nitrate is a health related parameter with a maximum acceptable concentration of 10 mg/L; risks associated with nitrate concentrations above this level are related to blood problems in babies and small children.

It is inferred that the localized evaluated nitrate concentrations observed at MW 11-11 and MW 11-12 are a result of the comfort stations sewage disposal.

Southern Comfort Station

Concentrations of nitrate are slightly fluctuating or remaining constant at each of the monitoring locations with the exception of MW11-10. The concentration of nitrate increased at MW11-10, peaking in May and remaining elevated through July, and then decreased over time to levels near the background concentrations measured in April. Refer to Figure D-19.

For most other parameters with concentrations above the method detection limit, concentrations were generally constant or slightly fluctuating over the short term; exceptions to this include phosphorous and chloride. Decreasing chloride concentrations were noted in MW11-7 throughout the sampling program.

Phosphorous concentrations were on a generally increasing trend from April through September, with peak concentrations occurring in May at MW11-9, July at MW11-7 and MW11-10, and September at MW11-8.

Generally, average concentrations of most parameters were similar between monitoring locations. Exceptions to this pattern are nitrate and chloride at MW11-10, which have higher average concentrations than at other locations.

Average and peak concentrations of nitrate, nitrite, and chloride remained below the Ontario Drinking Water Quality Standards (ODWQS) at each of the monitors.

Southern Cottages

Concentrations of nitrate are slightly fluctuating or remaining constant at each of the monitoring locations (OW9 and OW10); refer to Figure D-23. For most other parameters

with concentrations above the method detection limit, concentrations were generally constant or slightly fluctuating over the short term. Generally, average concentrations of the parameters were similar between monitoring locations. Average and peak concentrations of nitrate, nitrite, and chloride remained below the Ontario Drinking Water Quality Standards (ODWQS) at each of the monitors.

Predictive Impact Assessment

An important aspect of this sewage system impact study was to complete a predicative impact assessment for the Park. The assessment was designed to predict the impact of the existing sewage systems throughout the Park on local groundwater resources.

At the outset of the work program, GENIVAR reviewed the site plans and existing groundwater monitoring network locations. Given the locations of the existing monitors, the focus of the new monitors was split between the following areas:

The existing comfort station sewage disposal systems: It was noted that no monitors existed at these locations, and as such, monitors were required to determine the impact that these systems are having on the local environment. Two (2) monitors were installed in the vicinity of the northern comfort station sewage disposal bed and four (4) monitors were installed adjacent to the southern sewage disposal system. These monitors also helped to delineate impacts demonstrated at the park owned / operated sewage systems comparative to those of the leased cottage lands.

The northern leased cottage land area: Through a preliminary investigation of the Park, GENIVAR located eight (8) of the historic site monitors. GENIVAR supervised the installation of six (6) additional monitors in this area to determine background concentrations and development impacts.

These locations were the primary opportunities to evaluate the impacts on the local shallow groundwater system at Rondeau Provincial Park. Once the level of impact in these areas was understood, it would then be possible to create a mathematical model to determine the impact of the more sparsely developed areas on the environment.

Installing monitors in the more sparsely developed area would have likely been ineffective as the effluent plumes would be more difficult to capture and define in those locations. The Predictive approach also reduced the overall number of monitors that would otherwise be needed to assess the impacts from the sewage disposal systems, thus reducing the potential for impact to sensitive features at the Park.

This assessment has been completed using the concepts presented in the MOE's *Design Guidelines for Sewage Works 2008, Guideline B-7, and Procedure B-7-1*.

Critical Contaminants

As noted previously, the sewage effluent receiver of concern in this study is the shallow overburden groundwater system. As such, the critical contaminant being disposed of in the sewage effluent is nitrate.

The existing sewage disposal systems are anticipated to have effluent strengths near to that of domestic sewage in the sense that there are no industrial processes that would significantly alter the composition of the effluent stream such that the critical contaminants would change from those expected in domestic sewage. As such, the sewage strength has been assumed to contain 40 mg/L of nitrate.

Water Quality Limits

As noted in the Surficial Hydrogeology section, groundwater at the site is inferred to flow in a generally east or west direction towards Lake Erie or Rondeau Bay. As such, there are no potential off-site users of the groundwater and thus the Reasonable Use of Groundwater calculations do not apply in this circumstance, as they are specific to off-site impact.

Given that there are on-site users of the groundwater, the contaminant concentration limits are defined by the Ontario Drinking Water Quality Standards (ODWQS) as evaluated at the drinking water source. It is worth noting that the wells on the property were indicated to be sandpoints, and are therefore likely susceptible to contamination from on-site sewage disposal systems.

As nitrate has been deemed the critical contaminant, the ODWQS (2006) sets a maximum health related criteria of 10 mg/L, as nitrate nitrogen.

Although not used in the determination of groundwater quality limits, background concentrations of nitrate assist in the delineation of on-site impacts from off-site impacts. As indicated by data reported for monitoring well OW4 (all sampling events), located in the northeast portion of the site, non-detectable background nitrate concentrations do exist at the site.

Mass Balance

As recommended in the MOE's Design Guidelines for Sewage Works 2008, when calculating the impact of effluent on groundwater quality, a constant quantity of dilution that accounts for all attenuative mechanisms should be used. The recommended quantity of dilution over the area of the contamination plume is 250 mm/yr.

In the case of a subsurface disposal system, the area of the plume is typically defined by the width in which the disposal system traverses and the inferred groundwater flow direction. This area spans from the point at which the effluent enters the subsurface to the sampling point.

GENIVAR has used the mass balance approach to calculate the average daily volume of sewage that would be required, per cottage, to create the observed impacts in the monitoring wells. Once this value has been calculated, it would then be applied as the average sewage generation value for the remaining cottages to determine the theoretical sewage impacts at the other locations on the property.

Northern Cottage Cluster

Given the number of sewage systems that are located within the northern cottage cluster (approximately 55), it is inferred that the entire area of this cluster can be defined as part of the effluent plume. This cluster represents an approximate area of 400 m in the east-west direction and 200 m in the north south direction; thus the total area of this cluster is 8 ha.

The average concentration of nitrate within the twelve (12) groundwater monitors located in this area of the property was calculated as 1.3 mg/L over the duration of the sampling program. The peak average concentration during the year, occurring in July, was noted to be 2.1 mg/L.

As the average concentration of nitrate within the effluent plume is known; the annual dilution volume, total volume of sewage, and total volume of water within the northern cottage cluster have been calculated using the following formulas:

$$V_A = A_D \times k$$

$$V_T = V_A + V_s$$

$$C_{MP} = \frac{C_S \times V_S}{V_T}$$

where:
V_A = annual dilution volume (m^3);
A_D = dilution area (m^2);
V_T = total volume of water (m^3);
V_S = annual sewage volume (m^3);
C_{MP} = average concentration at the monitoring point (mg/L);
C_s = concentration in sewage prior to subsurface disposal (mg/L);
k = quantity of dilution (m).

The annual dilution volume for this site is the product of the quantity of dilution (250 mm per annum), and the dilution area 80,000 m2 (400 m X 200 m). The total annual dilution volume equates to 20,000 m3/year.

By employing an iterative approach, it is possible to determine the average volume of sewage that would be required to be generated per cottage, per day, to reach the observed concentrations in the groundwater monitors.

As displayed on Table E-1, Appendix E, this daily sewage volume is approximately 35 L/day to create an average nitrate concentration of 1.3 mg/L I the groundwater. During peak cottage use periods in June and July, this daily sewage volume would increase to approximately 55 L/day, per cottage.

It is anticipated that as the cottages are used more on specific weekends than they are during the week, and as all cottages would not be in use all of the time, the actual flow pattern would more likely be hundreds of litres per day over a span of a few days for “in-use” cottages; followed by periods of no use. The above noted value, 35 L/day, is representative of these patterns played out over time, for all cottages, and then averaged for the assessment period.

Theoretical Impact from Unmonitored Cottages

Using the results generated by modeling the impact of the sewage disposal systems in the northern cottage cluster, the theoretical impact can be calculated over the remaining portion of the Park with active cottage use.

The remaining cottage areas include a long north to south stretch along the eastern shoreline, and a shorter, more limited number of cottages along the northern portion of the western shoreline. In total, it is understood that there are approximately 232 cottages along these stretches of land.

Given the long, narrow, nature of the cottage distribution, and thus the septic system distribution for these largely unmonitored systems, GENIVAR has inferred that an approximate area of 100 m in the east-west direction (representing the approximate distance of the front lot lines to the lake) and 7,500 m in the north south direction would be representative of the approximate dilution area. The total dilution area is therefore 75 ha.

As the theoretical average volume of sewage generated per cottage is known; annual dilution volume, total volume of water, and nitrate concentration within the groundwater can be calculated using the following formulas:

$$V_A = A_D \times k$$

$$V_T = V_A + V_s$$

$$C_{MP} = \frac{C_S \times V_S}{V_T}$$

where:
V_A = annual dilution volume (m^3);
A_D = dilution area (m^2);
V_T = total volume of water (m^3);
V_S = annual sewage volume (m^3);
C_{MP} = average concentration at the monitoring point (mg/L);
C_s = concentration in sewage prior to subsurface disposal (mg/L);
k = quantity of dilution (m).

The annual average daily average sewage flow based on the findings for the northern cottage cluster was 35 L/cottage/day.

The annual dilution volume for this application is the product of the quantity of dilution (250 mm per annum), and the dilution area 75,000 m2. The total annual dilution volume over this area equates to 18,750 m3 /year.

By solving for the concentration at the monitoring point, the average theoretical concentration of nitrate is noted to be 0.6 mg/L in the groundwater for these more

sparsely located and generally unmonitored systems. During peak periods, using a sewage generation rate of 55 L/day, the theoretical concentration of nitrate in the groundwater may be up to 1 mg/L.

As displayed in the monitoring results for OW9 and OW10, located along the eastern shoreline (see Figure 6), the actual average nitrate impacted noted at these locations were 0.1 mg/L and non-detectable, respectively. Given the limited number of cottages that these monitoring results would represent (up to two), the conclusions that can be drawn from these results versus the theoretical results are limited, other than to note that they are within the same order of magnitude.

Discussion

Sewage effluent plumes are produced at this site by the use of both small Class IV sewage disposal systems associated with the leased cottage lands, and by larger sewage disposal systems associated with the Park's comfort stations and other facilities.

The sewage effluent will migrate downward through the underlying sand soil, and to the shallow groundwater table. As sewage impacted groundwater reaches the groundwater table below the sewage systems, it will mix with the groundwater flow system and move principally in a westerly or easterly direction towards Rondeau Bay or Lake Erie. Recent monitoring has shown that the local groundwater quality fluctuates seasonally, associated with periods of high Park use and lower Park use, and thus high and low septic system use.

At the on-site monitoring wells, the short-term concentrations of the diagnostic parameters at certain locations generally increased during the peak use months and declined during the off-season. Other monitoring wells showed little measurable sewage system impact throughout the duration of the study.

Water quality remains generally acceptable compared to the ODWQS in many areas of the park, with the exception of nitrate within OW7, MW11-11 and MW11-12.

Nitrate-related impacts at OW7 were observed during the months of June and July, with concentrations of 14.8 mg/L and 16.6 mg/L, respectively. It is noted that cottage wells 11340 and 11345 are located near to OW7, and over the months of June and July

nitrate concentrations of less than 1 mg/L were reported at both locations. No other monitor within the northern cottage cluster had reported nitrate concentrations of greater than 10 mg/L during the current assessment period.

Based on the above, it is inferred that some amount of groundwater degradation exists within the northern cottage cluster, with respect to drinking water, although is not widespread. This localized degradation is due to the active sewage disposal systems within the northern cottage cluster.

The reported groundwater elevations in the northern cottage cluster are indicated to typically be less than 1 metre below ground surface. During the monitoring program GENIVAR observed that many of the cottage sewage disposal systems were “in-ground” systems, and as such many of these systems do not likely meet the minimum vertical separation distances required by the OBC to ensure adequate attenuation of sewage pollutants. When effluent is introduced into saturated soils, it cannot be treated by aerobic biological processes, and thus effluent will combine with the underlying groundwater table and pollute it. This plume has the ability to contaminate clean groundwater and surface water; and as such upgrading or replacement of these systems should be considered.

Nitrate related impacts at MW11-11 were observed during August and September (16.2 mg/L and 13.5 mg/L respectively), while the impacts at MW11-12 were observed During April and May (18.3 mg/L and mg/L respectively). These localized impacts are inferred to be associated with the northern comfort station sewage disposal system. Based on the results, it appears the groundwater flow direction changes during the year from a westerly direction to an easterly direction and thus the comfort station is impacting the local groundwater groundwater quality in that area throughout the majority of the operating season. It is understood that there are no sandpoint wells in the immediate area surrounding this sewage disposal system.

As the groundwater monitoring wells are not drinking water sources, the impact at the monitoring locations are defined as acceptable. These results do however highlight the potential for unacceptable impacts to been seen at drinking water sources, specifically the sandpoint wells located in the northern cottage cluster.

In response to the observed impacts at MW11-11 and MW11-12, GENIVAR completed a sewage system condition assessment at the North and Central comfort stations. The results from this investigation show that given the northern system’s age, size, and

vertical separation from the groundwater, it would be prudent to begin planning for future system replacement. The central comfort stations useful life is likely longer than the northern system, and replacement should be planned for within that context. The technical report associated with this study is attached in Appendix F.

Results from MW11-10 indicate that at least a portion of the effluent plume generated from the southern comfort station's sewage disposal system is migrating westerly. The sampling results at MW11-10 indicate that the nitrate concentrations remained below the ODWQS limit of 10 mg/L.

A predictive impact assessment was employed to determine the theoretical impact from the remaining cottages throughout the site, as it would not be practical to gain reliable monitoring results to characterize such a narrow effluent band for over 200 cottages. The results of this predictive impact assessment demonstrate that the impact from these sewage disposal systems would be minor in nature, even during peak use seasons.

Phosphorous is rarely designed to be removed in on-site sewage effluent treatment as most soils have the ability to absorb phosphorous for many years prior to its migration to nearby surface water features. The existing sewage systems at Rondeau Park do not incorporate phosphorous removal. As sewage disposal systems age and the soil adsorption capacity is diminished, there is the potential for environmental degradation.

Elevated phosphorous concentrations have the potential to impact surface water bodies as it is one of the key nutrients required for plant growth, and have been associated with algae blooms. Based on the monitoring result trends throughout the park, on-site sewage disposal systems are contributing to an elevated concentration of phosphorous in the groundwater. As the direction of groundwater will flow is toward Lake Erie or Rondeau Bay, this has the potential to negatively impact those surface water bodies.

Increasing phosphorous trends in the groundwater from spring to summer are noted in monitors:

1. OW2, OW4, MW11-1, MW11-2, MW11-3, MW11-5 and MW11-6, all of which are located in the northern cottage cluster;
2. MW11-11, and MW11-12 associated with the northern comfort station;
3. MW11-7, MW11-9, and MW11-10, associated with the southern comfort station; and
4. OW9 and OW10 associated with the cottages along the south eastern shoreline.

Increasing phosphorous concentrations can range from 0.3 mg/L as seen in OW9, to over 1.6 mg/L, as noted in MW11-3.

Phosphorous increases are more pronounced within the northern cottage cluster than elsewhere on the site. This is likely due in part to dishwashing, clothes washing, bathing, and cleaning activities associated with a cottage that would not typically be associated with the use of comfort stations.

In summary, there is a limited degree of degradation of groundwater quality attributed to the sewage disposal systems at Rondeau Provincial Park. The degradation that has been noted is localized in nature and not widespread through the park. Overall, negative impacts associated with sewage disposal systems are being attenuated within the property limits.

Results of the supplemental studies completed at the North and Central comfort stations indicate that planning for future replacement of these systems should begin at this time. The northern system should be replaced first, followed by the central comfort station. It is noted that there were no observed, above grade, signs of failure at either system.

Phosphorous related groundwater degradation is occurring throughout the Park, however it is most pronounced during the peak use times (July) within the northern cottage cluster. Phosphorous degradation is typically associated with the use of household soaps and cleaning products.

Mitigative Measures

The septic system impact study has demonstrated that there is some localized groundwater degradation related to both nitrate and phosphorous at the Park. Although these impacts are not widespread and are minor to moderate in nature, the following recommendations are provided to further reduce the potential for environmental degradation associated with on-site sewage disposal systems.

The implementation of phosphorous removal systems at each of the 286 cottages, as well as the Park sewage disposal systems, would be both cost prohibitive and impractical. As such, GENIVAR recommends that the park implement a policy for both park owned and land leased systems that requires the use of low-phosphate or phosphate free detergents. These lower phosphate detergents can reduce the impact of

septic systems by 30 to 40 percent on the groundwater and surface water features. This recommendation is the simplest and most practical solution to reducing the impact of phosphorous on the groundwater and surface water at the Park, however public acceptance of the use of these detergents is required for this recommendation to be effective. Many major store outlets carry phosphate free soaps including "*Green Works*" and "*Method*".

Nitrate impacts are more immediately of concern to human consumption of the groundwater, rather than environmental stewardship. Groundwater monitors throughout the park demonstrate that, at a large scale, appropriate dilution of nitrate is occurring. These results are also reflected in the predictive impact assessment. There are, however, specific areas of concern where groundwater with elevated nitrate concentrations may impact sandpoint well water supplies. These areas of concern, based on the monitoring results, are specifically sandpoint wells within the northern cottage cluster. It is understood that there are no sandpoint wells in the immediate area of the northern comfort station sewage disposal system, and thus the potential for human impact is limited at this location

As nitrate reduction within a small Class IV septic system is largely impractical to achieve, GENIVAR recommends that a proactive sewage system investigation program could be implemented, similar to the study that was implemented for the comfort station systems. This program would allow for the determination of whether existing systems meet the minimum requirements of the OBC, including clearance distances from sandpoint water supplies and vertical separation distances from the groundwater table. Cottage water supplies could be sampled to determine areas of concern in this regard (microbiological indicators and nitrate); and sewage system investigations premised on these results.

Results of the supplemental studies completed at the North and Central comfort stations indicate that planning for future replacement of these systems should begin at this time. The northern system should be replaced first, followed by the central comfort station. It is noted that there were no observed, above grade, signs of failure at either system. Engineering studies should be completed during the design phase, based on actual sewage system flow values, to determine the level of treatment required to maintain acceptable impacts to the environment in this regard.

Conclusions

Based on the study findings, we conclude the following.

- The configuration of the groundwater regime in 2011 was generally split between a westward moving component, towards Rondeau Bay, and an eastward moving component towards Lake Erie.
- Septic effluent is produced at the site as a result of the cottage properties, as well as the Park owned / operated comfort stations. The sewage effluent is entering the groundwater system beneath the individual sewage disposal systems. The groundwater quality shows signs of limited seasonal degradation in some localized areas due to the sewage disposal systems.
- There is limited degradation of groundwater quality related to nitrate contamination across the site. The most pronounced nitrate impacts are noted near the northern comfort station; however it is understood that there are no sandpoint wells in this area of the property. Some nitrate impact was also noted in the northern cottage cluster; this area has a greater sensitivity to sewage impacts due to the local sandpoints wells. Sandpoint wells sampled in this area did not show signs of degradation during the 2011 monitoring program.
- There is degradation of groundwater quality related to phosphorous contamination across the site. The most pronounced phosphorous impacts are noted in the northern cottage cluster. Some phosphorous impacts were also noted at both of the Park comfort stations, however the concentrations of phosphorous measured near both these systems was lower than that observed within the northern cottage cluster.

Based on the supplemental study findings in relation to the physical condition of the North and Central comfort station sewage disposal system (See Appendix F), we conclude the following.

- It is likely that components of the North and Central comfort stations are undersized.
- There is evidence of moderate to severe biomat build-up in the North comfort station sewage disposal system; and some biomat build-up in the Central comfort station sewage disposal system.
- There is inadequate vertical separation between the base of the leaching bed trenches and the high groundwater table to properly treat the sewage effluent prior to in joining the shallow groundwater regime.

Recommendations

We respectfully submit the following recommendations for your consideration.

- Low phosphate or phosphate free soaps should be used throughout the site.
- The sewage system investigation program could be implemented to determine whether existing cottage systems meet the minimum requirements of the OBC, including clearance distances from sandpoint water supplies and vertical separation distances from the groundwater table. Cottage water supplies could be sampled to determine areas of concern in this regard (microbiological indicators and nitrate); and sewage system investigations premised on these results.
- The Ministry of Natural Resources should plan for the future replacement of the North and Central comfort station sewage disposal systems.

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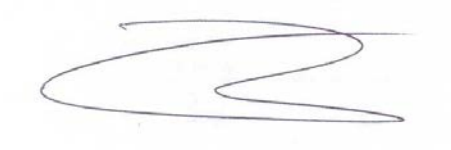

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