

Manitoba Environment Act Proposal Rainbow Beach Provincial Park

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Jaimee Schmidt, P.Eng



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Executive Summary

Manitoba Conservation and Water Stewardship requested The Manitoba Water Services Board (MWSB) to prepare an Environment Act Proposal for a Class 1 Development License under the Manitoba Environment Act for an upgrade to the Rainbow Beach water treatment plant (WTP). This document provides the compiled information required on Manitoba Conservation's Environment Act Proposal Report Guidelines and Supplementary Guidelines for Municipal Water Supply Systems. This Environment Act proposal includes components for a new water treatment plant and filter backwash discharge line.

Rainbow Beach Campground is located near Dauphin, Manitoba on PTH 20. The campground includes 110 basic and electrical sites. The water system supplies water to the campground, maintenance yard, office, and bunk house. There are three shower buildings and four modern washrooms. The WTP at Rainbow Beach will be in operation seasonally from May-September.

The Rainbow Beach Water Treatment Plant (WTP) was originally constructed in approximately 1980. The plant obtains water from one 125 mm artesian groundwater well located just outside the WTP. The well is 49 metres deep and consists primarily of clay and till overburden. The treatment process consists of sodium hypochlorite disinfection with contact tanks. The existing treatment system is not adequate to deal with the arsenic in the water.

The proposed development includes the construction of a 1.2 L/s manganese greensand WTP with a sodium hypochlorite or potassium permanganate feed to oxidize ammonia. Delco Water performed a pilot study and found that manganese greensand effectively removed arsenic to below the maximum acceptable concentration. The manganese greensand filters will need to be backwashed and the backwashed water will be discharged to Lake Dauphin. A new WTP building will be constructed to house the new treatment equipment.

List of Acronyms

AO	Aesthetic Objective
DWSA	Drinking Water Safety Act
EAP	Environment Act Proposal
GCDWQ	Guidelines for Canadian Drinking Water Quality
GUDI	Groundwater Under Direct Influence of Surface Water
MWSB	Manitoba Water Services Board
ODW	Office of Drinking Water
TDS	Total Dissolved Solids
THM	Trihalomethane
TOC	Total Organic Carbon
WTP	Water Treatment Plant

1.0 Introduction

Manitoba Conservation and Water Stewardship requested The Manitoba Water Services Board (MWSB) to prepare an Environment Act Proposal for a Class 1 Development License under the Manitoba Environment Act for an upgrade to the Rainbow Beach water treatment plant (WTP). This document provides the compiled information required on Manitoba Conservation's Environment Act Proposal Report Guidelines and Supplementary Guidelines for Municipal Water Supply Systems. This Environment Act proposal includes components for a new water treatment plant and filter backwash discharge line. The WTP at Rainbow Beach will be in operation seasonally from May-September.

1.1 Background Information

Rainbow Beach Campground is located near Dauphin, Manitoba on PTH 20. The campground includes 110 basic and electrical sites. The water system supplies water to the campground, maintenance yard, office, and bunk house. There are three shower buildings and four modern washrooms.

The Rainbow Beach Water Treatment Plant (WTP) was originally constructed in approximately 1980. The plant obtains water from one 125 mm artesian groundwater well located just outside the WTP. The well is 49 metres deep and consists primarily of clay and till. The treatment process consists of sodium hypochlorite with contact tanks. The existing treatment system is not adequate to deal with the arsenic in the water.

1.1.1 Previous Studies

An engineering assessment for Rainbow Beach Provincial Park was conducted by Manitoba Water Services Board in 2010 and is currently in draft format. The engineering assessment recommends an upgrade to the treatment system in order to meet the Guidelines of Canadian Drinking Water Quality (GCDWQ) health and aesthetic objectives.

1.1.2 Population

The Rainbow Beach Water System serves 110 campsites as well as any day users.

1.1.3 Current and Projected Water Use

A WTP is designed based on peak day demand. Based on past water use records Rainbow Beach has a peak day of approximately 17,000 L/day and an average day of approximately 7,700 L/day. The filters for the new WTP will be able to produce 0.7-1.2 L/s. This will be adequate to supply+++++ both the needs for public use as well as for backwash water. Since campground use happens during daylight hours, 10 hour days have been assumed for flow calculations in Table 1.1.

TABLE 1.1 – FUTURE 20 YEAR WATER DEMANDS

	Unit	
Average Demand		
Average Day Demand =	L/day	7,700
Peak Demand		
Average Day Demand	L/day	7,700
Peak Day Factor		x 2.2
Peak Day Demand	L/day	17,000
Average Day Flow (10hrs)	L/s	0.21
Peak Day Flow (10 hrs)	L/s	0.47
Treatment Capacity	L/s	1.2

1.1.4 Raw Water Source

Rainbow Beach Provincial Park obtains their water from one 125 mm groundwater well located just outside the WTP at SE5-25-17W. It is approximately 43 metres deep and consists primarily of clay and till. Raw water is pumped by two end suction pumps, chlorinated and then stored in retention tanks.

1.1.5 Water Rights Act

Rainbow Beach Provincial Park public water system does not require a Water Rights Act licence as its annual average water use is under 25,000 L/day.

1.1.6 Water Quality

The Office of Drinking Water (ODW) currently conducts annual audits of all public water systems which includes sampling and chemistry analysis every three years for secure groundwater sources and once per year for surface water and groundwater under direct influence of surface water (GUDI) supply systems. The following table outlines selected water quality parameters. In addition the operator tests chlorine residuals daily on the treated water.

The raw water has high arsenic, ammonia, total dissolved solids, iron, and sodium. The existing treatment system does not reduce all parameters below the maximum acceptable concentration or the aesthetic objective. The proposed treatment system upgrade will address all the parameters that exceed the GCDWQ.

Table 1.2 Water Quality Results (2012 ODW Sampling)

Parameter	Unit	Raw Water	Treated Water	GCDWQ
Arsenic	mg/L	0.0216	0.0201	0.01 mg/L
Hardness (Total) as CaCO ₃	mg/L	330	340	≤ 200/500 ^a
Iron	mg/L	0.828	0.719	≤ 0.3
Manganese	mg/L	0.0324	0.0284	≤ 0.05
Total Dissolved Solids	mg/L	1170	1190	≤ 500
True Colour	CU	<5	<5.0	≤ 15
Sodium	mg/L	283	262	200

^a Hardness levels greater than 200 are considered poor but tolerable. Hardness levels greater than 500 are generally considered unacceptable

1.1.7 Compliance Plan

An engineering assessment is completed in draft format by Manitoba Water Services Board. The assessment concluded that upgrades to the water treatment system are needed in order to address the water quality issues of arsenic, ammonia, hardness, total dissolved solids, iron and sodium as well as disinfection contact time. The operating licence states that the compliance plan should be submitted to address arsenic.

2.0 Description of Proposed Development

2.1 Project Description

The proposed development includes the construction of a 1.2 L/s manganese greensand WTP with a sodium hypochlorite or potassium permanganate feed to oxidize ammonia. Delco Water performed a pilot study and found that manganese greensand effectively removed arsenic the below the maximum acceptable concentration. The manganese greensand filters will need to be backwashed and the backwashed water will be discharged to Lake Dauphin. A new WTP building will be constructed to house the new treatment equipment. A drawing of the proposed WTP has been included in Appendix A and the Delco Water pilot study has been included in Appendix B.



Figure 2.1 - Location of WTP

This EAP pertains to the discharge of the manganese greensand backwash to Lake Dauphin. The reject water will be discharged twice per week into the lake with a total volume of 2,860 L per backwash. This is based on the preliminary design of a 600 mm filter and the backwash rate of 2.3 L/s.

A reject pipeline to discharge the backwash water will be directionally drilled from the WTP to the shore of Lake Dauphin to the West of the creek near the WTP. The length of this pipeline is approximately 200 metres.



Figure 2.2 – Discharge Route

2.1.1 Operation and Maintenance

Manitoba Conservation and Water Stewardship and Rainbow Beach Provincial Park will be responsible for operation and maintenance of the WTP. The current WTP operator will also operate the new WTP. In addition, the operator will be required to submit water samples for bacteriological testing in accordance with the Manitoba Drinking Water Quality Standards Regulation.

2.2 Certificate of Title

The WTP will be located on provincially owned Crown land within Rainbow Beach Provincial Park in SE 5-25-17 W, right beside the location of the existing WTP. This land is registered under Her Majesty The Queen.

2.3 Existing and Adjacent Land Use

The proposed land for the development is within a provincial park at the existing WTP property. Adjacent land is used for camping and recreation. Existing and adjacent land use will not change as a result of this development. The filter backwash discharge pipeline will be directionally drilled so there will be minimal disturbance to the land surface.

2.4 Land Use Designation and Zoning

Zoning designation for pipelines on municipal owned land is not applicable.

2.5 Project Schedule

The project is scheduled to commence and be completed in the 2014/2015 construction year depending on the receipt of all approvals.

2.6 Project Funding

This project will be funded by Manitoba Conservation and Water Stewardship through the Manitoba Water Services Board.

2.7 Regulatory Approvals

The following branches/departments will be provided with copies of plans and specifications for information purposes and for the purposes of approvals and agreements:

Manitoba Conservation and Water Stewardship
Office of Drinking Water

The contractor will be required to contact MTS, Hydro and gas utilities for utility locations and approvals.

2.8 Public Consultation

Since the development does not involve private funding or property a public consultation will not be required prior to the commencement of this project.

2.9 Storage of Petroleum Products and Other Chemicals

Fuel will not be stored on-site at any time or location along the proposed construction route or near any water source. Fuel will be supplied by fuelling trucks which are regulated under The Storage and Handling of Petroleum Products and Allied Products Regulation. Records of fuel volumes and an emergency response plan which includes spill prevention, notification and response will be implemented. No fuelling activities will be permitted within 100 m of watercourses during construction. During construction, the contractors will be required to ensure that all equipment is properly maintained to prevent leaks of fuel and motor fluids.

There will be no storage of petroleum products or other chemicals at the WTP during operation of the proposed development. Maintenance activities for the well do not require refuelling on-site. Chemicals associated with the operation of the plant (sodium hypochlorite & potassium permanganate) will be stored in designated areas within the plant complete with spill containment. General household cleaning products will also be stored at this site.

3.0 Physical Environment

3.1 Physiographic Setting and Climate

Rainbow Beach Campground is located near Dauphin, Manitoba on PTH 20. The campground includes 110 basic and electrical sites. The water system supplies water to the campground, maintenance yard, office, and bunk house. There are three shower buildings and four modern washrooms.

Based on Environment Canada climatic data, the mean annual temperature for 2013 in the area is 0.82 degrees Celsius with below zero average daily temperatures from November through April. Mean annual precipitation as recorded at Dauphin, MB, the nearest weather station, is approximately 443 mm. The WTP at Rainbow Beach will only be in operation seasonally from May-September.

TABLE 3.1 2013 ENVIRONMENT CANADA HISTORICAL WEATHER – DAUPHIN, MANITOBA

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Average
Temperature °C													
Daily Average	-14.3	-13.0	-13.0	-2.8	10.8	16.7	18.1	17.6	14.5	3.9	-5.9	-20.1	0.82
Daily Max	-10.1	-7.8	-5.7	2.8	17.4	22.9	23.8	24.5	22.0	9.7	-10.7	-24.6	6.7
Daily Min	-18.4	-18.2	-20.2	-8.0	4.1	10.4	12.3	10.7	7.0	-2.0	-1.0	-15.5	-4.9
Precipitation (mm)													Total
Precipitation	2.7	2.1	7.2	4.1	42.8	164	92.5	23.2	63.8	32.4	5.1	3.4	443

3.2 Hydrogeology

A well was drilled in Rainbow Beach Provincial Park by Arne Pedersen on October 5, 1982. The well is 43 metres deep and consists primarily of clay and till. The well log is included in Appendix D. There is no further information about hydrogeology in the surrounding area.

3.3 Hydrology

There is no drain index information available for Rainbow Beach Provincial Park. There is a creek just north of the proposed WTP location as well as a larger creek north of the three campsite bays. The filter backwash will be discharged on the shore to the West of the mouth of the creek near the WTP. The location of this discharge will not affect the existing spawning grounds.



FIGURE 3.1 – HYDROLOGY FEATURES NEAR THE PROPOSED DEVELOPMENT

3.4 Fish and Fish Habitat

Potential fish habitat in the project area includes Lake Dauphin associated tributaries. A list of fish species found in Lake Dauphin was not available at the time of finalizing this report. The Owner will work to address any concerns raised and minimize any effects to fish or fish habitat.

3.5 Wildlife Habitat and Vegetation

The project area is located within the Prairie Ecoregion of Lake Manitoba Plain ecozones (Agriculture and Agri-Food Canada). The ecoregion is transitional between areas of boreal forest to the north and the aspen parkland of the southwest. It is a mosaic of trembling aspen/oak groves and rough fescue grasslands. Trembling aspen and shrubs occur on moist sites, and bur oak and grass species occupy increasingly drier sites on loamy to clayey, Black Chernozemic soils. Poorly drained, Gleysolic soils support willow and sedge communities. Lower and smoother than the Saskatchewan Plain to the west (Aspen Parkland ecoregion), the surface of the plain has an elevation ranging from about 410 m asl near the Manitoba Escarpment to 218 m asl at Lake Winnipeg. This low-relief ecoregion, underlain by limestone bedrock, is covered by extremely calcareous, broadly ridged glacial till in its northern half and by smooth, level, lacustrine sands, silts, and clays in its southern half. Wildlife includes significant waterfowl, as well as white-tailed deer, coyote, rabbit, and ground squirrel. Its growing season length, available heat, and precipitation permit the production of corn, spring wheat, and other cereal grains by dryland

continuous cropping methods. Oilseeds, hay, and livestock production are more prevalent in the northern section owing to topography and stoniness limitations. Hunting and water-oriented recreation are additional significant uses of land (Ecological Framework of Canada).

3.6 Socioeconomic

The project area is located within Rainbow Beach Provincial Park. The park is funded by the Province of Manitoba and provides camping and day use areas to the general public.

3.7 Heritage Resources

Most project activities will occur in previously disturbed municipal and provincial right of ways. The proponent will work with Heritage Resources Branch to mitigate any concerns as required.

4.0 Potential Environmental Effects

An environmental effect includes any change that the project may cause to the environment. Environmental effects were identified from interactions between proposed project activities and environmental components. Mitigation measures and follow-up activities were identified for environmental effects determined to be adverse.

4.1 Air Quality

During construction, dust will be raised by construction equipment and there will be gaseous and particulate emissions from the construction equipment. Water spraying is an important, common and practical procedure that would be applied as required to alleviate potential dust problems. Emissions of gases and particulates would be minimized by keeping machinery in good working order. Any effects would be localized, temporary and insignificant. During operation of the development there will be no releases of pollutants to the air.

4.2 Soils

During construction, there is a risk of fuel or lubricant spills from heavy equipment and vehicle operation. The storage of fuel or lubricants within the area of the water supply will not be allowed. Therefore, the potential spills will be very small in size and standard construction spill clean-up procedures, including the removal of any impacted soil, will be used to prevent impact.

During operation, project activities are limited to regular monitoring and maintenance activities that have a negligible effect on soil disturbance and compaction because of low vehicle traffic and the use of established routes to access the wells and water treatment plant. Regular monitoring and maintenance activities will have a negligible effect on soil contamination since fuel trucks and other hazardous substances will not be brought on-site on a regular basis. The potential adverse effect on soil quality is assessed to be minor.

4.3 Surface Water, Fish and Fish Habitat

Minor and short term impacts on surface water may occur as a result of construction activity in road allowance ditches during runoff events. The impact on surface water would include sediment that may be eroded from excavation activities, minor engine leaks and potential fuel spills should runoff events occur during construction. Horizontal directional drilling will be conducted to install the discharge pipeline. This will eliminate excavation within the riparian zone and minimize impacts. There is potential for some loss of drilling mud to surface water. Impacts to fisheries and fish habitat are considered minor.

Filter backwash consists of minerals removed from the raw water. The projected backwash water quality is summarized in Table 4.1. This has assumed a worst case scenario of 75% of the concentrate in the filter being released in the first five minutes of backwash. Projections for both this scenario as well as for the concentrate being released at an even pace over the 20 minute

backwash have been included in Appendix E. The estimated discharge of backwash is 2860 litres twice per week during the operating season. Filter concentrate has been discharged to surface water bodies in other locations across Manitoba without having significant adverse effects to water quality. Lake Dauphin has a surface area of 520 km² and a drainage basin of 8,400 km². Because the backwash water is being discharged to a large body of water it is estimated that due to the large dilution factor, water quality effects on Lake Dauphin will be negligible.

Table 4.1 Filter Backwash Water Quality

Parameter	Raw	Greensand	Rejection	Remaining	Filter Backwash
Alkalinity	351	349	0.0057	0.9943	372.72
Bicarbonate	428	425	0.007	0.993	460.52
Chloride	98.4	103	0	1	98.4
Fluoride	0.75	0.79	0	1	0.75
Sulfer (as SO ₄)	452	453	0	1	452
Hardness	345	344	0.0029	0.9971	355.86
TDS	1160	1150	0.0086	0.9914	1268.29
pH	7.51	7.61	0	1	7.51
Conductivity (us/cm)	1790	1800	0	1	1790
Total Organic Carbon	1.5	1.5	0	1	1.5
Arsenic	0.0196	0.00263	0.8658	0.1342	0.2038
Calcium	79.6	77.7	0.0239	0.9761	100.25
Iron	0.653	0	1	0	7.74
Magnesium	33.3	36.6	0	1	33.3
Manganese	0.0255	0.192	0.9	0.1	0.27
Potassium	9.79	10.9	0	1	9.79
Silicon	10	9.61	0.039	0.961	14.23
Sodium	268	269	0	1	268
Uranium (ug/L)	0.00133	0.00178	0	1	0.0013

*All units in mg/L unless otherwise stated

*These projections are assuming 75% of concentrate in the filter is released in the first five minutes of backwash.

4.4 Water Quality

Raw water quality can be impacted by surface activities. Mitigation measures are necessary to protect water quality during construction activities. The proposed activities are unlikely to result in adverse changes to water quality.

4.5 Groundwater Levels

Groundwater monitoring is not currently required at Rainbow Beach Provincial Park.

4.6 Vegetation

Construction will occur in the Rainbow Beach day use area which is regularly managed and comprised primarily of grasses. As the areas are already disturbed, they are unlikely to contain rare plant species. The discharge pipeline will be directionally drilled which will not cause disturbance to vegetation. The amount of vegetation disturbance for the project is expected to be minimal.

During operation, monitoring and maintenance activities will be restricted to designated and previously disturbed areas. Potential effects to vegetation are considered to be negligible.

4.7 Wildlife Habitat and Vegetation

The construction and operation activities associated with this project will be limited to areas already developed for urban or agricultural uses. The potential adverse effects of wildlife habitat loss were assessed to be negligible to minor.

4.8 Noise and Vibration

During the construction phase of the project, there will be several sources of sound emissions including equipment used for construction. The types of noises heard due to construction are dominated by equipment engines. However, miscellaneous short term impact noises (ie: dump truck gates, back hoe buckets) are often heard. The noise will be in addition to regular community and highway activities, and the effects are considered minor.

Scheduling of various site activities can minimize the impact of noise. This would include scheduling construction for day-time hours to avoid sleep disturbance and the disruption of evening domestic activities. All equipment used on site will be fitted with appropriate mufflers and will be maintained in good working order to minimize noise levels.

4.9 Employment/Economy

Socio-economic implications are not expected as a result of environmental impacts as impacts are considered minor and short-term. The project will be funded by Manitoba Conservation and Water Stewardship. There may be some local economic benefit during construction.

The proposed project will address the issue of poor water quality and an aging WTP. The potential effects of the project on employment and the economy were assessed to be positive.

4.10 Human Health and Well Being

The potential adverse effects of the project on human health are assessed to be negligible to minor. Short term temporary increases in noise and dust emissions during construction are considered to be minor effects. During operation, there will be a minor increase in vehicular

traffic associated with monitoring and maintenance activities. The potential effects are considered minor.

The project will result in the construction of a water treatment plant designed and operated to produce a treated water supply to meet current water quality standards. The effects of this on human health and well being are considered positive.

4.11 Climate Change

There are no predicted impacts to climate as a result of the project activities.

5.0 Environmental Management Measures

Environmental management practices proposed to prevent or mitigate environmental effects that were determined to be adverse are identified and described below.

5.1 Air Quality

Emissions resulting from construction and transportation equipment may be mitigated by the utilization of well maintained and operating vehicles while reducing unnecessary vehicle idling.

The impact of dust may be mitigated by the use of an approved dust suppressant, limiting construction during high wind periods, and re-establishment of vegetation as soon as possible.

5.2 Soils

Mitigation to potential impacts to soil by contamination from petroleum products include preparation of an emergency response plan for potential spills, use of spill clean-up equipment and materials, using properly maintained equipment, and using appropriate fuelling equipment.

Re-establishment of vegetation as soon as possible after disturbance will limit loss of soil due to wind or water erosion. Backfilling with soil stockpiles as soon as possible and minimizing the amount of soil disturbance can be implemented.

5.3 Surface Water

Mitigation of surface water issues may be achieved by limiting open cut trenching to within 30 m ahead or behind the pipe laying, redirecting surface water runoff, pumping accumulated water to adjacent ditches and providing erosion control practices as required. The Manitoba Water Services Board Guidelines for Watercourse Crossings has been included in Appendix E.

Petroleum leaks or spills will be mitigated by use of properly maintained equipment, use of spill clean-up equipment and materials, and use of appropriate fuelling equipment. A prepared emergency response plan can be implemented in the event of a significant spill. In the event of a reportable spill, Manitoba Conservation and Water Stewardship will be notified through the emergency response line and appropriate measures will be taken according to Manitoba Conservation and Water Stewardship requirements.

A 100 m setback to watercourses will be maintained for fuelling activities. Horizontal directional drilling will be implemented at watercourse crossings. Vehicles will avoid entering the riparian zones. Re-establishment of vegetation will occur as soon as possible on areas of disturbed soil.

Chlorinated water used to disinfect pipelines will be de-chlorinated and not released to surface waters.

5.4 Groundwater

Mitigation of potential groundwater impacts from petroleum products can be mitigated as described in Section 5.3.

5.5 Vegetation and Wildlife

Re-establishment of vegetation will occur as soon as possible on disturbed areas. Impacts to wildlife habitat can be limited by minimizing the area of construction, soil disturbance and vegetation disturbance. Other impacts resulting from dust or smoke will be minimized as previously indicated. Noise disturbance will be limited by use of muffling vehicles and equipment, limiting idling and limiting the construction area.

5.6 Fisheries

Fisheries impacts will be minimized by implementing practices to reduce soil and contaminate runoff as previously mentioned in Sections 5.3 and 5.5. In addition, horizontal directional drilling will occur under all watercourses containing water. The required excavation needed to introduce the drilling equipment will be maintained outside watercourse riparian zones.

5.7 Noise and Vibration

Limiting any noise-creating activities, including regular maintenance and monitoring activities to normal working hours, and limiting unnecessary long-term idling can mitigate any potential increased noise and vibration effects.

5.8 Water Conservation

Since the water system supplies water to day users and campers, it is not expected that the wasting of water will be an issue. Water is obtained through stand pipes. Water conservation methods include coin operated showers that dispense a set amount of water only when money is inserted.

5.9 Socio-Economic Implications

There are no known negative environmental socio-economic impacts that need mitigation. Since the proposed development would provide a reliable healthy drinking water supply, it would be expected to enhance quality of life and economic viability for the Park. The proposed project may provide some economic benefits to the area for local businesses and employment opportunities during construction phase.

6.0 References

Agriculture and Agri-Food Canada. A National Ecological Framework for Canada 28 January 2014
<<http://sis.agr.gc.ca/cansis/nsdb/ecostrat/index.html>>

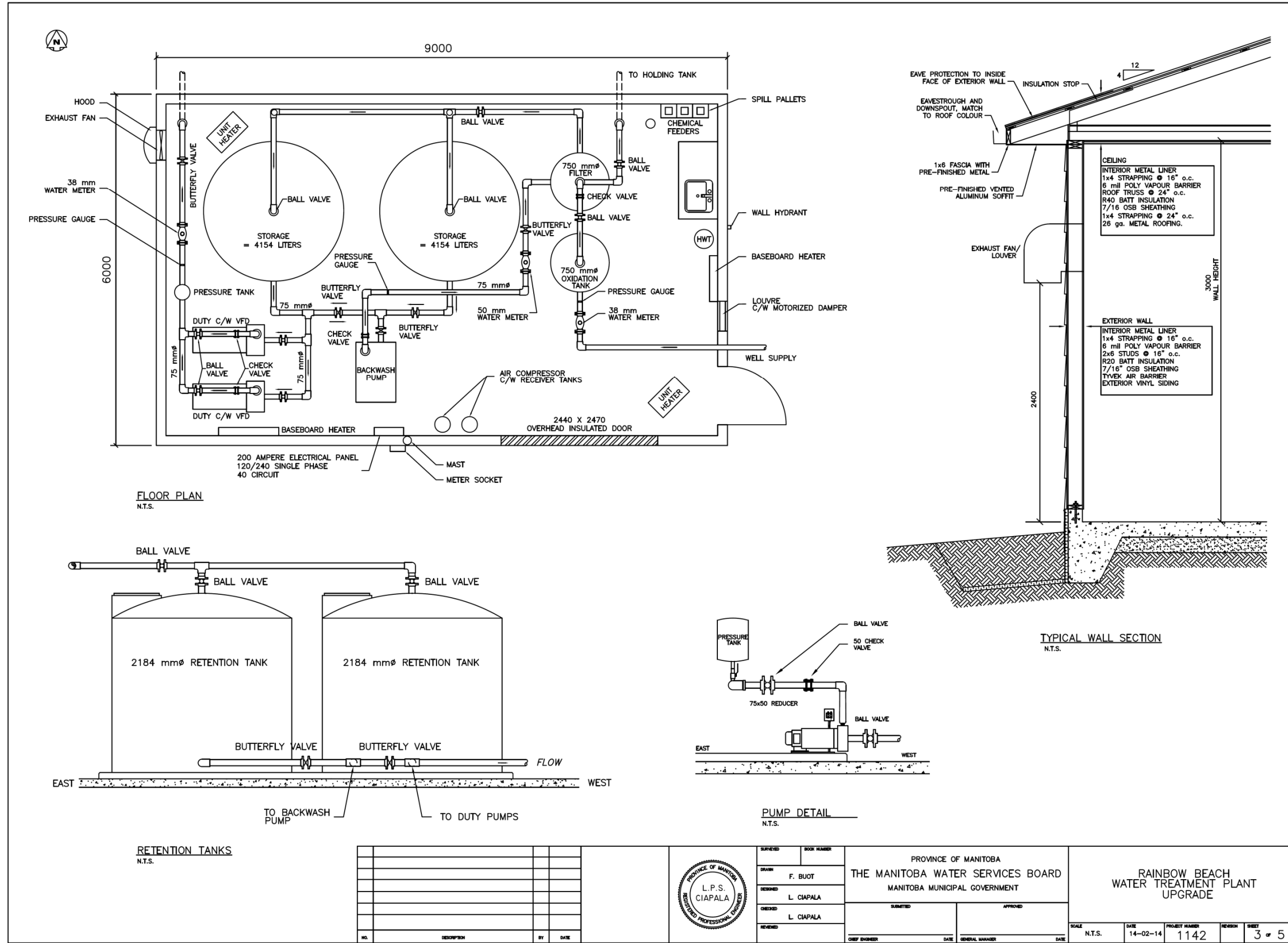
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<http://climate.weather.gc.ca/climateData/dailydata_e.html?StationID=48868&timeframe=2&Year=2013&Month=12&cmdB1=Go&Day=1>

Pedersen, Arnie, P.Eng. Rainbow Beach Well Installation Report. Manitoba Water Services Board files, 1982.

Appendix A

Preliminary Floor Plan

Preliminary Backwash Pipeline Route



FLOOR PLAN
N.T.S.

TYPICAL WALL SECTION
N.T.S.

RETENTION TANKS
N.T.S.

PUMP DETAIL
N.T.S.

NO.	DESCRIPTION	BY	DATE



SURVEYED	BOOK NUMBER	PROVINCE OF MANITOBA	
DRAWN	F. BUOT	THE MANITOBA WATER SERVICES BOARD	
DESIGNED	L. CIAPALA	MANITOBA MUNICIPAL GOVERNMENT	
CHECKED	L. CIAPALA	SUBMITTED	APPROVED
REVIEWED			

RAINBOW BEACH WATER TREATMENT PLANT UPGRADE				
SCALE	DATE	PROJECT NUMBER	REVISION	SHEET
N.T.S.	14-02-14	1142		3 of 5



NO.	DESCRIPTION	BY	DATE



DESIGNED BY	F. BUOT
CHECKED BY	L. CIAPALA
DATE	

PROVINCE OF MANITOBA	
THE MANITOBA WATER SERVICES BOARD	
MANITOBA MUNICIPAL GOVERNMENT	
SUBMITTED BY	APPROVED BY
DATE	DATE

RAINBOW BEACH WATER TREATMENT PLANT UPGRADE			
SCALE	DATE	PROJECT NUMBER	REVISION
N.T.S.	14-02-14	1142	

Appendix B

Delco Water Pilot Study



**MWSB Pilot
Reporting –
Rainbow Beach**

Prepared by:
Mark Lewis, Warren
Loeffelholz

Nov 5, 2012



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Rainbow Beach – MWSB Pilot Testing

Introduction

The Rainbow Beach pilot testing was conducted from September 11-12, 2012 in accordance to the pilot testing plan laid out in Delco Water's proposal – Engineering Services for Eden, Rainbow Beach, and Birch River Water Treatment Pilot Study submitted to the Manitoba Water Services Board on June 15, 2012.

Apparatus Set-up

A connection was made into the plant's raw water line and then separated into the two process streams. The first process consisted of DelcoWater's Reverse Osmosis Single Element (ROSE) unit connected in series to an activated alumina filled fibreglass pressure vessel. The activated alumina (AA) was added to the originally proposed testing protocol as we have had good success with this setup in other locations utilizing an RO system for treatment, but having issues with the arsenic levels remaining in the permeate.



Figure 1: Raw Water Tap



Figure 2: Treatment Process Equipment

Activated alumina removes arsenic through adsorption while the membrane rejects arsenic through to the concentrate stream. Activated alumina would not be suitable as an independent treatment, as it has no significant effect on total dissolved solids. Activated alumina is typically used as post-treatment to a process such as reverse osmosis to filter items like fluoride, arsenic, and boron.

The second process consisted of a greensand filter preceded by 12% NaOCl injection. Greensand plus media was utilized to provide actual onsite data on the performance expectations of a full scale greensand filter on this source water.

Operation

ROSE

The ROSE, using the ESPA4-4040 membrane from Hydranautics, was flushed out for 30 minutes to ensure that the previous water tested for MWSB piloting was removed from any testing results. The operational flow rates were chosen based on a maximum recommended recovery rate of 15%, and a flux of roughly 13 GFD, a typical, conservative design set point of RO systems treating well water in Manitoba.

Table 1: ROSE operating characteristics

	Feed	Permeate
Temperature (deg C)	7.6	
Conductivity (us/cm)	1787	34
pH	7.44	6.14
Turbidity (NTU)	1.8	0.04
Flow (USGPM)	4.254	0.752
Recovery	15.02%	
Flux (GFD)	12.74	

Activated Alumina

The activated alumina unit filtered the permeate water from the ROSE. It was backwashed for 15 minutes with raw water before permeate water began to filter.

Table 2: Activated Alumina operating characteristics

	Feed	Filtrate
Temperature (deg C)	7.6	
pH	6.14	9.14
Flow (USGPM)	0.752	
Flux (USGPM/Sq Ft)	1.70	

Greensand Filter

The greensand filter consisted of a gravel base with 4 different grades, then 20" of greensand plus media, topped off with 10" of anthracite. There was a two-step backwash process for the greensand plus separately, then the combined greensand plus/anthracite media. The fine media particles filtered to the top were skimmed before the unit was put into operation for best

operation practice as the ultrafine particles could impose a large pressure differential. The flux rate was driven up on the filter during pilot testing higher than what would be normally observed in full scale operation (max 3.0 GPM/Sq Ft - typically) to provide a worst case scenario for iron, and subsequently arsenic removal. All of the processes were run for four hours of steady state operation before it was deemed appropriate to take samples for the lab. Below is a list of operational parameters and data obtained during these operations.

Table 3: Greensand Filter operating characteristics

Temperature (deg C)	7.6	
Conductivity (us/cm)	1787	1781
pH	7.44	7.08
ORP	-54	368
Turbidity (NTU)	1.8	0.08
Flow (USGPM)	2.8	
Flux (USGPM/Sq Ft)	3.57	

All of the processes were run for four hours of steady state operation before it was deemed appropriate to take samples for the lab. The systems were sampled and parameters checked with handheld and onsite equipment repeatedly throughout this 4 hour operational period and all important parameters were deemed to be at a steady state when lab sampling occurred.

Results

The results from the ALS environmental lab have been attached. Below is a review of the parameters of importance. Note that all units are in mg/L unless otherwise specified.

Table 4: ALS Lab Results

Analyte	Measurements				Rejections		
	Raw	RO	AA	GS	RO	AA	GS
Alkalinity	351	9.3	23	349	97.35%		0.57%
Bicarbonate	428	11.3	28.1	425	97.36%		0.70%
Chloride	98.4	3.7	3.4	103	96.24%		-4.67%
Fluoride	0.75	0	0	0.79	100.00%		-5.33%
Sulfur (as SO4)	452	3.1	0	453	99.31%	100.00%	-0.22%
Hardness	345	0	3	344	100.00%		0.29%
TDS	1160	20.3	29.8	1150	98.25%		0.86%
pH	7.51	6.16	8.38	7.61			-1.33%
Conductivity (us/cm)	1790	34	56	1800	98.10%		-0.56%
True Colour (TCU)	9	0	3	0	100.00%		100.00%
Total Organic Carbon	1.5	0	0	1.5	100.00%		0.00%
Arsenic (ug/L)	19.6	10.5	0	2.63	46.43%	100.00%	86.58%
Calcium	79.6	0	0.98	77.7	100.00%		2.39%
Iron	0.653	0	0	0	100.00%		100.00%
Magnesium	33.3	0	0.425	36.6	100.00%		-9.91%
Manganese	0.0255	0	0.00082	0.192	100.00%		-652.94%
Potassium	9.79	0	0.73	10.9	100.00%		-11.34%
Silicon	10	0.472	0	9.61	95.28%	100.00%	3.90%
Sodium	268	7.9	9.62	269	97.05%		-0.37%
Uranium (ug/L)	0.00133	0	0	0.00178	100.00%		-33.83%

Table 5: Arsenic Results

	As (III) (ug/L)	As (V) (ug/L)	Rejection		
			As (III)	As (V)	Combined
Raw Water	16.4	1.91			
RO Permeate	11.3	0.363	31.10%	80.99%	36.30%
Greensand Filter Filtrate	1.53	0.907	90.67%	52.51%	86.69%

Discussion

ROSE – Hydranautics ESPA4 RO Membrane Element

The ROSE unit performed as we expected. The total arsenic rejection came back at 36.3% -below the expected 50% rejection but it should be noted the unequal distribution between As (III) and As (V). This included 80.99% rejection of As (V) and 31.1% rejection of AS (III). Parameters like TDS and sodium rejections were confirmed on par with the membrane manufacturer's specification, indicating that the membrane was integral throughout the testing period, and our rejection results can be used for full scale projection purposes.

From a design standpoint, the Hydranautics ESPA4 reverse osmosis element would not be sufficient as a standalone unit if raw water arsenic levels were expected around the 20 ug/L range. For ammonia, the feed water pH was consistently measured to be roughly 7.44, thus remaining in the NH₄⁺ state and should be rejected excellently by the element as it was in Birch River. ALS labs failed to provide testing results for Ammonia on the samples that were submitted. These results were requested when the samples were submitted, but not delivered. Without a complete re-installation of the system and re-testing, the ammonia results will not be available for this site. Based on the previous lab work done in Birch River and Eden, it is expected that the membrane treatment unit will do an excellent job of removing ammonia from the Rainbow Beach source water, and the greensand filter should not remove any of the ammonia content.

Activated Alumina

The activated alumina filter took the remaining arsenic that was not rejected by the reverse osmosis system and adsorbed nearly all of the remaining traces. This verifies activated alumina as a process well suited for the post treatment of RO permeate water to completely eliminate any arsenic level concerns in the final product water.

With the rest of the results for dissolved solids, etc., there was a small amount of error in the experiment's results. The activated alumina filter was run for four hours at 0.75 GPM, but actually required much more run time to eliminate the effects of the backwash water and to "wash" the media down. Over this time we passed 180 gallons through the media. Analytical lab results show an increase in many of the parameters listed; however the desired results of excellent arsenic removal was proven.

Greensand

Greensand filtration was tested with the intention of removing primarily iron, manganese and arsenic. In order, the rejections were 100%, -652.94% and 86.6% respectively. The rejection value of the Manganese is not as expected, and attributed to error. The flux should not have been high enough to be sloughing particles off of the media, especially at a runtime period of only four hours. As expected the greensand provided negligible rejection of overall dissolved solids. Any of the values of analytes that increased through the filter can be attributed to accuracy error of the lab tests, and these would not be expected to be sustained higher than the raw water levels with long term filter operation.

Through miscommunication, there were insufficient samples delivered to ALS to perform ammonia testing. However, the addition of chlorine to the raw water stream ahead of the greensand filter would cause the ammonia to be used up in the formation of chloramines. Chlorine dosing would have to be sufficient to create chloramines with ammonia present, plus additional dosing sufficient to generate a desired free chlorine residual.

Conclusions and Recommendations

Based upon the observed pilot testing results included here, all of the equipment deployed to Rainbow Beach's water treatment plant performed up to our expectations regarding arsenic rejection, as well as all other parameters studied.

The RO elements tested provided roughly 50% arsenic reduction along with an expected excellent reduction in ammonia level. The greensand plus media reduced the arsenic levels by 86%, but would not reduce the ammonia level in the water.

In the request for proposal for this pilot study, the following items were requested in the scope of supply, under 2.0 – Description.

Recommending appropriate treatment technology for each of the full scale systems considering

- o 1- Effectiveness in meeting health based water quality parameters alone
- o 2- Effectiveness in meeting both health based and aesthetic objective parameters
- o 3- Full scale treatment equipment requirements
- o 4- Class D Cost estimates for full scale treatment equipment

Effectiveness in meeting health based water quality parameters alone

- In order to meet the health – only parameters, a greensand plus filter would be applicable treatment technology to implement. The arsenic level observed from the effluent of the greensand was 2.63 ug/L, which is considerably below the 10 ug/L requirement. The issues with chloramine formation would not be solved by implementing this type of treatment. With the stated peak day requirement of 17,000 L/day, there would be concern for a system sized to only put this peak flow out to keep up during peak demand hours within the day with only 1800L of storage capacity in the system. For budgetary purposes here, we have chosen a 7.5 USGPM production capacity as the minimum required to meet this demand comfortably.
- Because of the standard filter packages available from our supplier, a dual filter (parallel) setup each capable of 5 USGPM would fit this application best. There would need to be storage and pumping available in the system to allow for a 5 USGPM backwash flow for a maximum of 20 minutes to properly backwash this type of greensand filter. Total production capacity would be 10 USGPM if necessary.

- A preliminary estimate for this type of system including 10 USGPM rated pressure filter, greensand plus media, manual backwash functionality, flow monitoring, and chemical feed system (excluding all installation and startup costs) would be \$3500.00.

Effectiveness in meeting both health based and aesthetic objective parameters

- In order to meet both the health and aesthetics parameters, we would recommend a RO system with activated alumina post treatment. To achieve this we would supply a 7.5 USGPM single train RO system and pressure filter loaded with activated alumina in series. The RO system would operate at a minimum of 75% recovery. This setup would provide treated water with excellent physical properties, arsenic levels would be <0.1 ug/L, ammonia also would be expected to be <0.10 mg/L (although not confirmed in this testing), as well as hardness <1 mg/L.
- A preliminary estimate for this type of system including a fully automated RO system, activated alumina media in a pressure filter, and required chemical feed systems for antiscalant and chlorine would be \$22,000.00 (again, excluding installation and startup costs)

Appendix A – Operating Logs

RO							
Time	18:30	19:00	19:30	20:00	20:30	21:00	21:30
Temperature	8	7.7	7.4	7.5	7.3	7.3	7.3
Conductivity	1790/34	1770/34	1786/33	1788/33	1790/35	1781/33	1785/33
pH	7.20/5.7	7.52/6.23	7.51/6.1	7.4/6.21	7.27/6.34	7.28/6.09	7.49/6.15
ORP	-42	-52	-30	-24	-31	-20	-30
Pressure:							
Feed	48/37	31/23	27/18	28/19	30/20	32/24	31/22
S1 Feed	87	85	84	85	85	85	85
Concentrate	85	84	82	84	84	84	84
Flow:							
Permeate	0.78	0.733	0.74	0.754	0.766	0.766	0.75
Concentrate	4.31	4.18	4.2	4.24	4.252	4.26	4.227
		Turbidity	Iron				
	Raw	0.24, 2.552.87	0.347, 0.439				
	RO Perm	0.04, 0.05	0.044				
	GS	0.10, 0.06	0.046				
	AA	0.25,0.28	0.041				

Greensand							
Time	18:30	19:00	19:30	20:00	20:30	21:00	21:30
Temperature							
Conductivity	1767	1780	1790	1785	1790	1790	1774
pH	6.47	7.1	7.21	7.16	7.17	7	6.97
ORP	87	9	300	350	440	390	420
Pressure:	4	4	4	4	4	4	4
Flow:	2.872	2.65	2.75	2.782	2.812	2.991	2.743

Activated Alumina							
Time	18:30	19:00	19:30	20:00	20:30	21:00	21:30
Temperature							
Conductivity	560	290	143	110	80	75	63
pH	8.95	8.84	9.16	9.28	9.26	9.13	9.19
ORP							
Pressure:	0	0	0	0	0	0	0

Appendix B – Lab Results

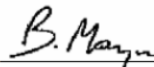
Delco Automation Inc.
ATTN: MARK
3735 THATCHER AVENUE
SASKATOON SK S7R 1B8

Date Received: 13-SEP-12
Report Date: 02-OCT-12 18:50 (MT)
Version: FINAL

Client Phone: 306-244-6449

Certificate of Analysis

Lab Work Order #: L1208966
Project P.O. #: PO# 4120932-12010
Job Reference: 4120932
C of C Numbers: 10-207683
Legal Site Desc:



Brian Morgan
Account Manager

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ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1208966-1 RAINBOW RAW							
Sampled By: CLIENT on 11-SEP-12 @ 22:30							
Matrix: WATER							
General Chemical							
Alkalinity, Total							
Alkalinity, Total (as CaCO3)	351		5.0	mg/L	14-SEP-12	14-SEP-12	R2438109
Bicarbonate (HCO3)	428		5.0	mg/L	14-SEP-12	14-SEP-12	R2438109
Hydroxide (OH)	<5.0		5.0	mg/L	14-SEP-12	14-SEP-12	R2438109
Carbonate (CO3)	<5.0		5.0	mg/L	14-SEP-12	14-SEP-12	R2438109
Chloride (Cl)							
Chloride (Cl)	98.4	DLA	2.0	mg/L	17-SEP-12	17-SEP-12	R2437438
Fluoride (F)							
Fluoride (F)	0.75		0.10	mg/L	14-SEP-12	14-SEP-12	R2438434
ICP Cations							
Calcium (Ca)	76.4		1.0	mg/L	17-SEP-12	17-SEP-12	R2438226
Potassium (K)	11.4		1.0	mg/L	17-SEP-12	17-SEP-12	R2438226
Magnesium (Mg)	37.4		1.0	mg/L	17-SEP-12	17-SEP-12	R2438226
Sodium (Na)	277		2.0	mg/L	17-SEP-12	17-SEP-12	R2438226
Sulfur (as SO4)	452		3.0	mg/L	17-SEP-12	17-SEP-12	R2438226
Ion Balance Calculation							
Ion Balance	100			%		19-SEP-12	
Cation - Anion Balance	0.0			%		19-SEP-12	
Computed Conductivity	1680			uS/cm		19-SEP-12	
Conductivity % Difference	-8.4			%		19-SEP-12	
TDS (Calculated)	1160			mg/L		19-SEP-12	
Anion Sum	19.2			me/L		19-SEP-12	
Cation Sum	19.2			me/L		19-SEP-12	
Saturation pH	7.14			pH		19-SEP-12	
Langelier Index	0.4					19-SEP-12	
Hardness (as CaCO3)	345			mg/L		19-SEP-12	
Nitrate+Nitrite-N							
Nitrate+Nitrite-N	<0.50	EHT	0.50	mg/L	14-SEP-12	14-SEP-12	R2435839
Total Dissolved Solids							
Total Dissolved Solids	1140		20	mg/L	17-SEP-12	18-SEP-12	R2439171
pH and Conductivity							
pH	7.51	EHT	0.10	pH	13-SEP-12	13-SEP-12	R2435925
Conductivity (EC)	1790		10	uS/cm	13-SEP-12	13-SEP-12	R2435925
Miscellaneous Parameters							
Color, True	9.0		2.5	T.C.U.	13-SEP-12	13-SEP-12	R2435580
Mercury (Hg)-Total	<0.000020		0.000020	mg/L		18-SEP-12	R2438049
Total Organic Carbon	1.5		1.0	mg/L		29-SEP-12	R2446224
Total Metals in Water by CRC ICMS							
Aluminum (Al)-Total	<0.010	DLA	0.010	mg/L		19-SEP-12	R2438997
Antimony (Sb)-Total	<0.00020	DLA	0.00020	mg/L		19-SEP-12	R2438997
Arsenic (As)-Total	0.0196	DLA	0.00020	mg/L		19-SEP-12	R2438997
Barium (Ba)-Total	0.00717	DLA	0.00020	mg/L		19-SEP-12	R2438997
Beryllium (Be)-Total	<0.0010	DLA	0.0010	mg/L		19-SEP-12	R2438997
Bismuth (Bi)-Total	<0.0010	DLA	0.0010	mg/L		19-SEP-12	R2438997
Boron (B)-Total	1.06	DLA	0.020	mg/L		19-SEP-12	R2438997
Cadmium (Cd)-Total	<0.000020	DLA	0.000020	mg/L		19-SEP-12	R2438997
Calcium (Ca)-Total	79.6	DLA	0.40	mg/L		19-SEP-12	R2438997
Chromium (Cr)-Total	<0.00020	DLA	0.00020	mg/L		19-SEP-12	R2438997
Cobalt (Co)-Total	0.00020	DLA	0.00020	mg/L		19-SEP-12	R2438997
Copper (Cu)-Total	0.0020	DLA	0.0010	mg/L		19-SEP-12	R2438997
Iron (Fe)-Total	0.653	DLA	0.020	mg/L		19-SEP-12	R2438997
Lead (Pb)-Total	0.00027	DLA	0.00010	mg/L		19-SEP-12	R2438997

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

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Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1208966-1 RAINBOW RAW							
Sampled By: CLIENT on 11-SEP-12 @ 22:30							
Matrix: WATER							
Total Metals in Water by CRC ICPMS							
Lithium (Li)-Total	0.151	DLA	0.010	mg/L		19-SEP-12	R2438997
Magnesium (Mg)-Total	33.3	DLA	0.10	mg/L		19-SEP-12	R2438997
Manganese (Mn)-Total	0.0255	DLA	0.00080	mg/L		19-SEP-12	R2438997
Molybdenum (Mo)-Total	0.0102	DLA	0.00040	mg/L		19-SEP-12	R2438997
Nickel (Ni)-Total	<0.0010	DLA	0.0010	mg/L		19-SEP-12	R2438997
Potassium (K)-Total	9.79	DLA	0.40	mg/L		19-SEP-12	R2438997
Phosphorus (P)-Total	<0.60	DLA	0.60	mg/L		19-SEP-12	R2438997
Selenium (Se)-Total	<0.00020	DLA	0.00020	mg/L		19-SEP-12	R2438997
Silicon (Si)-Total	10.0	DLA	0.10	mg/L		19-SEP-12	R2438997
Silver (Ag)-Total	<0.000020	DLA	0.000020	mg/L		19-SEP-12	R2438997
Sodium (Na)-Total	268	DLA	2.0	mg/L		19-SEP-12	R2438997
Strontium (Sr)-Total	1.00	DLA	0.00020	mg/L		19-SEP-12	R2438997
Thallium (Tl)-Total	<0.00020	DLA	0.00020	mg/L		19-SEP-12	R2438997
Tin (Sn)-Total	0.00021	DLA	0.00020	mg/L		19-SEP-12	R2438997
Titanium (Ti)-Total	<0.020	DLA	0.020	mg/L		19-SEP-12	R2438997
Uranium (U)-Total	0.00133	DLA	0.000020	mg/L		19-SEP-12	R2438997
Vanadium (V)-Total	<0.0020	DLA	0.0020	mg/L		19-SEP-12	R2438997
Zinc (Zn)-Total	0.0152	DLA	0.0080	mg/L		19-SEP-12	R2438997
L1208966-2 RAINBOW RO							
Sampled By: CLIENT on 11-SEP-12 @ 22:30							
Matrix: WATER							
General Chemical							
Alkalinity, Total							
Alkalinity, Total (as CaCO3)	9.3		5.0	mg/L	14-SEP-12	14-SEP-12	R2438109
Bicarbonate (HCO3)	11.3		5.0	mg/L	14-SEP-12	14-SEP-12	R2438109
Hydroxide (OH)	<5.0		5.0	mg/L	14-SEP-12	14-SEP-12	R2438109
Carbonate (CO3)	<5.0		5.0	mg/L	14-SEP-12	14-SEP-12	R2438109
Chloride (Cl)							
Chloride (Cl)	3.7		1.0	mg/L	17-SEP-12	17-SEP-12	R2437438
Fluoride (F)							
Fluoride (F)	<0.10		0.10	mg/L	14-SEP-12	14-SEP-12	R2436434
ICP Cations							
Calcium (Ca)	<1.0		1.0	mg/L	17-SEP-12	17-SEP-12	R2438226
Potassium (K)	<1.0		1.0	mg/L	17-SEP-12	17-SEP-12	R2438226
Magnesium (Mg)	<1.0		1.0	mg/L	17-SEP-12	17-SEP-12	R2438226
Sodium (Na)	7.9		2.0	mg/L	17-SEP-12	17-SEP-12	R2438226
Sulfur (as SO4)	3.1		3.0	mg/L	17-SEP-12	17-SEP-12	R2438226
Ion Balance Calculation							
Ion Balance	Low EC			%		02-OCT-12	
Cation - Anion Balance	Low EC			%		02-OCT-12	
Computed Conductivity	36.9			uS/cm		02-OCT-12	
Conductivity % Difference	8.2			%		02-OCT-12	
TDS (Calculated)	20.3			mg/L		02-OCT-12	
Anion Sum	0.35			me/L		02-OCT-12	
Cation Sum	0.34			me/L		02-OCT-12	
Saturation pH	Low Calcium			pH		02-OCT-12	
Langelier Index	Low Calcium					02-OCT-12	
Hardness (as CaCO3)	<1.0			mg/L		02-OCT-12	
Nitrate+Nitrite-N							
Nitrate+Nitrite-N	<0.50	EHT	0.50	mg/L	14-SEP-12	14-SEP-12	R2435839
pH and Conductivity							

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

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Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1208966-2 RAINBOW RO Sampled By: CLIENT on 11-SEP-12 @ 22:30 Matrix: WATER							
pH and Conductivity							
pH	6.16	EHT	0.10	pH	13-SEP-12	13-SEP-12	R2435925
Conductivity (EC)	34		10	uS/cm	13-SEP-12	13-SEP-12	R2435925
Miscellaneous Parameters							
Color, True	<2.5		2.5	T.C.U.	13-SEP-12	13-SEP-12	R2435580
Mercury (Hg)-Total	<0.000020		0.000020	mg/L		18-SEP-12	R2438049
Total Organic Carbon	<1.0		1.0	mg/L		26-SEP-12	R2446224
Total Metals in Water by CRC ICPMS							
Aluminum (Al)-Total	<0.0050		0.0050	mg/L		19-SEP-12	R2438997
Antimony (Sb)-Total	<0.00010		0.00010	mg/L		19-SEP-12	R2438997
Arsenic (As)-Total	0.0105		0.00010	mg/L		19-SEP-12	R2438997
Barium (Ba)-Total	<0.00010		0.00010	mg/L		19-SEP-12	R2438997
Beryllium (Be)-Total	<0.00050		0.00050	mg/L		19-SEP-12	R2438997
Bismuth (Bi)-Total	<0.00050		0.00050	mg/L		19-SEP-12	R2438997
Boron (B)-Total	0.757		0.010	mg/L		19-SEP-12	R2438997
Cadmium (Cd)-Total	<0.000010		0.000010	mg/L		19-SEP-12	R2438997
Calcium (Ca)-Total	<0.20		0.20	mg/L		19-SEP-12	R2438997
Chromium (Cr)-Total	<0.00010		0.00010	mg/L		19-SEP-12	R2438997
Cobalt (Co)-Total	<0.00010		0.00010	mg/L		19-SEP-12	R2438997
Copper (Cu)-Total	<0.00050		0.00050	mg/L		19-SEP-12	R2438997
Iron (Fe)-Total	<0.010		0.010	mg/L		19-SEP-12	R2438997
Lead (Pb)-Total	<0.000050		0.000050	mg/L		19-SEP-12	R2438997
Lithium (Li)-Total	<0.0050		0.0050	mg/L		19-SEP-12	R2438997
Magnesium (Mg)-Total	0.093		0.050	mg/L		19-SEP-12	R2438997
Manganese (Mn)-Total	<0.00030		0.00030	mg/L		19-SEP-12	R2438997
Molybdenum (Mo)-Total	<0.00020		0.00020	mg/L		19-SEP-12	R2438997
Nickel (Ni)-Total	<0.00050		0.00050	mg/L		19-SEP-12	R2438997
Potassium (K)-Total	<0.20		0.20	mg/L		19-SEP-12	R2438997
Phosphorus (P)-Total	<0.30		0.30	mg/L		19-SEP-12	R2438997
Selenium (Se)-Total	<0.00010		0.00010	mg/L		19-SEP-12	R2438997
Silicon (Si)-Total	0.472		0.050	mg/L		19-SEP-12	R2438997
Silver (Ag)-Total	<0.000010		0.000010	mg/L		19-SEP-12	R2438997
Sodium (Na)-Total	6.47		0.20	mg/L		19-SEP-12	R2438997
Strontium (Sr)-Total	0.00225		0.00010	mg/L		19-SEP-12	R2438997
Thallium (Tl)-Total	<0.00010		0.00010	mg/L		19-SEP-12	R2438997
Tin (Sn)-Total	<0.00010		0.00010	mg/L		19-SEP-12	R2438997
Titanium (Ti)-Total	<0.010		0.010	mg/L		19-SEP-12	R2438997
Uranium (U)-Total	<0.000010		0.000010	mg/L		19-SEP-12	R2438997
Vanadium (V)-Total	<0.0010		0.0010	mg/L		19-SEP-12	R2438997
Zinc (Zn)-Total	<0.0030		0.0030	mg/L		19-SEP-12	R2438997
L1208966-3 RAINBOW GS Sampled By: CLIENT on 11-SEP-12 @ 22:30 Matrix: WATER							
General Chemical							
Alkalinity, Total							
Alkalinity, Total (as CaCO3)	349		5.0	mg/L	14-SEP-12	14-SEP-12	R2438109
Bicarbonate (HCO3)	425		5.0	mg/L	14-SEP-12	14-SEP-12	R2438109
Hydroxide (OH)	<5.0		5.0	mg/L	14-SEP-12	14-SEP-12	R2438109
Carbonate (CO3)	<5.0		5.0	mg/L	14-SEP-12	14-SEP-12	R2438109
Chloride (Cl)							
Chloride (Cl)	103	DLA	2.0	mg/L	17-SEP-12	17-SEP-12	R2437438
Fluoride (F)							

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

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Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1208966-3 RAINBOW GS							
Sampled By: CLIENT on 11-SEP-12 @ 22:30							
Matrix: WATER							
Fluoride (F)							
Fluoride (F)	0.79		0.10	mg/L	14-SEP-12	14-SEP-12	R2436434
ICP Cations							
Calcium (Ca)	78.1		1.0	mg/L	17-SEP-12	17-SEP-12	R2438226
Potassium (K)	11.4		1.0	mg/L	17-SEP-12	17-SEP-12	R2438226
Magnesium (Mg)	37.3		1.0	mg/L	17-SEP-12	17-SEP-12	R2438226
Sodium (Na)	278		2.0	mg/L	17-SEP-12	17-SEP-12	R2438226
Sulfur (as SO4)	453		3.0	mg/L	17-SEP-12	17-SEP-12	R2438226
Ion Balance Calculation							
Ion Balance	99.5			%		19-SEP-12	
Cation - Anion Balance	-0.2			%		19-SEP-12	
Computed Conductivity	1690			uS/cm		19-SEP-12	
Conductivity % Difference	-6.5			%		19-SEP-12	
TDS (Calculated)	1170			mg/L		19-SEP-12	
Anion Sum	19.3			me/L		19-SEP-12	
Cation Sum	19.3			me/L		19-SEP-12	
Saturation pH	7.14			pH		19-SEP-12	
Langelier Index	0.5					19-SEP-12	
Hardness (as CaCO3)	344			mg/L		19-SEP-12	
Nitrate+Nitrite-N							
Nitrate+Nitrite-N	<0.50	EHT	0.50	mg/L	14-SEP-12	14-SEP-12	R2435839
Total Dissolved Solids							
Total Dissolved Solids	1150		20	mg/L	17-SEP-12	18-SEP-12	R2439171
pH and Conductivity							
pH	7.61	EHT	0.10	pH	13-SEP-12	13-SEP-12	R2435925
Conductivity (EC)	1800		10	uS/cm	13-SEP-12	13-SEP-12	R2435925
Miscellaneous Parameters							
Color, True	<2.5		2.5	T.C.U.	13-SEP-12	13-SEP-12	R2435580
Mercury (Hg)-Total	<0.000020		0.000020	mg/L		18-SEP-12	R2438049
Total Organic Carbon	1.5		1.0	mg/L		29-SEP-12	R2446224
Total Metals in Water by CRC ICMS							
Aluminum (Al)-Total	<0.010	DLA	0.010	mg/L		19-SEP-12	R2438997
Antimony (Sb)-Total	<0.00020	DLA	0.00020	mg/L		19-SEP-12	R2438997
Arsenic (As)-Total	0.00283	DLA	0.00020	mg/L		19-SEP-12	R2438997
Barium (Ba)-Total	0.00100	DLA	0.00020	mg/L		19-SEP-12	R2438997
Beryllium (Be)-Total	<0.0010	DLA	0.0010	mg/L		19-SEP-12	R2438997
Bismuth (Bi)-Total	<0.0010	DLA	0.0010	mg/L		19-SEP-12	R2438997
Boron (B)-Total	1.19	DLA	0.020	mg/L		19-SEP-12	R2438997
Cadmium (Cd)-Total	0.000071	DLA	0.000020	mg/L		19-SEP-12	R2438997
Calcium (Ca)-Total	77.7	DLA	0.40	mg/L		19-SEP-12	R2438997
Chromium (Cr)-Total	<0.00020	DLA	0.00020	mg/L		19-SEP-12	R2438997
Cobalt (Co)-Total	<0.00020	DLA	0.00020	mg/L		19-SEP-12	R2438997
Copper (Cu)-Total	<0.0010	DLA	0.0010	mg/L		19-SEP-12	R2438997
Iron (Fe)-Total	<0.020	DLA	0.020	mg/L		19-SEP-12	R2438997
Lead (Pb)-Total	<0.00010	DLA	0.00010	mg/L		19-SEP-12	R2438997
Lithium (Li)-Total	0.161	DLA	0.010	mg/L		19-SEP-12	R2438997
Magnesium (Mg)-Total	36.6	DLA	0.50	mg/L		19-SEP-12	R2438997
Manganese (Mn)-Total	0.192	DLA	0.00060	mg/L		19-SEP-12	R2438997
Molybdenum (Mo)-Total	0.0105	DLA	0.00040	mg/L		19-SEP-12	R2438997
Nickel (Ni)-Total	<0.0010	DLA	0.0010	mg/L		19-SEP-12	R2438997
Potassium (K)-Total	10.9	DLA	2.0	mg/L		19-SEP-12	R2438997
Phosphorus (P)-Total	<0.60	DLA	0.60	mg/L		19-SEP-12	R2438997

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

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Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1208966-3 RAINBOW GS							
Sampled By: CLIENT on 11-SEP-12 @ 22:30							
Matrix: WATER							
Total Metals in Water by CRC ICPMS							
Selenium (Se)-Total	0.00022	DLA	0.00020	mg/L		19-SEP-12	R2438997
Silicon (Si)-Total	9.61	DLA	0.10	mg/L		19-SEP-12	R2438997
Silver (Ag)-Total	<0.000020	DLA	0.000020	mg/L		19-SEP-12	R2438997
Sodium (Na)-Total	269	DLA	2.0	mg/L		19-SEP-12	R2438997
Strontium (Sr)-Total	1.03	DLA	0.00020	mg/L		19-SEP-12	R2438997
Thallium (Tl)-Total	<0.00020	DLA	0.00020	mg/L		19-SEP-12	R2438997
Tin (Sn)-Total	<0.00020	DLA	0.00020	mg/L		19-SEP-12	R2438997
Titanium (Ti)-Total	<0.020	DLA	0.020	mg/L		19-SEP-12	R2438997
Uranium (U)-Total	0.00178	DLA	0.000020	mg/L		19-SEP-12	R2438997
Vanadium (V)-Total	<0.0020	DLA	0.0020	mg/L		19-SEP-12	R2438997
Zinc (Zn)-Total	<0.0060	DLA	0.0060	mg/L		19-SEP-12	R2438997
L1208966-4 RAINBOW AA							
Sampled By: CLIENT on 11-SEP-12 @ 22:30							
Matrix: WATER							
General Chemical							
Alkalinity, Total							
Alkalinity, Total (as CaCO3)	23.0		5.0	mg/L	14-SEP-12	14-SEP-12	R2438109
Bicarbonate (HCO3)	28.1		5.0	mg/L	14-SEP-12	14-SEP-12	R2438109
Hydroxide (OH)	<5.0		5.0	mg/L	14-SEP-12	14-SEP-12	R2438109
Carbonate (CO3)	<5.0		5.0	mg/L	14-SEP-12	14-SEP-12	R2438109
Chloride (Cl)							
Chloride (Cl)	3.4		1.0	mg/L	17-SEP-12	17-SEP-12	R2437438
Fluoride (F)							
Fluoride (F)	<0.10		0.10	mg/L	14-SEP-12	14-SEP-12	R2438434
ICP Cations							
Calcium (Ca)	1.2		1.0	mg/L	17-SEP-12	17-SEP-12	R2438226
Potassium (K)	<1.0		1.0	mg/L	17-SEP-12	17-SEP-12	R2438226
Magnesium (Mg)	<1.0		1.0	mg/L	17-SEP-12	17-SEP-12	R2438226
Sodium (Na)	11.4		2.0	mg/L	17-SEP-12	17-SEP-12	R2438226
Sulfur (as SO4)	<3.0		3.0	mg/L	17-SEP-12	17-SEP-12	R2438226
Ion Balance Calculation							
Ion Balance	Low EC			%		02-OCT-12	
Cation - Anion Balance	Low EC			%		02-OCT-12	
Computed Conductivity	53.2			uS/cm		02-OCT-12	
Conductivity % Difference	-5.1			%		02-OCT-12	
TDS (Calculated)	29.8			mg/L		02-OCT-12	
Anion Sum	0.56			me/L		02-OCT-12	
Cation Sum	0.56			me/L		02-OCT-12	
Saturation pH	9.85			pH		02-OCT-12	
Langelier Index	-1.5					02-OCT-12	
Hardness (as CaCO3)	3.0			mg/L		02-OCT-12	
Nitrate+Nitrite-N							
Nitrate+Nitrite-N	<0.50	EHT	0.50	mg/L	14-SEP-12	14-SEP-12	R2435839
pH and Conductivity							
pH	8.38	EHT	0.10	pH	13-SEP-12	13-SEP-12	R2435925
Conductivity (EC)	56		10	uS/cm	13-SEP-12	13-SEP-12	R2435925
Miscellaneous Parameters							
Color, True	3.0		2.5	T.C.U.	13-SEP-12	13-SEP-12	R2435580
Mercury (Hg)-Total	<0.000020		0.000020	mg/L		18-SEP-12	R2438049
Total Organic Carbon	<1.0		1.0	mg/L		29-SEP-12	R2446224
Total Metals in Water by CRC ICPMS							

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

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Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1208966-4 RAINBOW AA Sampled By: CLIENT on 11-SEP-12 @ 22:30 Matrix: WATER							
Total Metals in Water by CRC ICPMS							
Aluminum (Al)-Total	0.243		0.0050	mg/L		19-SEP-12	R2438997
Antimony (Sb)-Total	<0.00010		0.00010	mg/L		19-SEP-12	R2438997
Arsenic (As)-Total	<0.00010		0.00010	mg/L		19-SEP-12	R2438997
Barium (Ba)-Total	0.00025		0.00010	mg/L		19-SEP-12	R2438997
Beryllium (Be)-Total	<0.00050		0.00050	mg/L		19-SEP-12	R2438997
Bismuth (Bi)-Total	<0.00050		0.00050	mg/L		19-SEP-12	R2438997
Boron (B)-Total	0.345		0.010	mg/L		19-SEP-12	R2438997
Cadmium (Cd)-Total	<0.000010		0.000010	mg/L		19-SEP-12	R2438997
Calcium (Ca)-Total	0.98		0.20	mg/L		19-SEP-12	R2438997
Chromium (Cr)-Total	<0.00010		0.00010	mg/L		19-SEP-12	R2438997
Cobalt (Co)-Total	<0.00010		0.00010	mg/L		19-SEP-12	R2438997
Copper (Cu)-Total	<0.00050		0.00050	mg/L		19-SEP-12	R2438997
Iron (Fe)-Total	<0.010		0.010	mg/L		19-SEP-12	R2438997
Lead (Pb)-Total	<0.000050		0.000050	mg/L		19-SEP-12	R2438997
Lithium (Li)-Total	<0.0050		0.0050	mg/L		19-SEP-12	R2438997
Magnesium (Mg)-Total	0.425		0.050	mg/L		19-SEP-12	R2438997
Manganese (Mn)-Total	0.0082		0.00030	mg/L		19-SEP-12	R2438997
Molybdenum (Mo)-Total	<0.00020		0.00020	mg/L		19-SEP-12	R2438997
Nickel (Ni)-Total	<0.00050		0.00050	mg/L		19-SEP-12	R2438997
Potassium (K)-Total	0.73		0.20	mg/L		19-SEP-12	R2438997
Phosphorus (P)-Total	<0.30		0.30	mg/L		19-SEP-12	R2438997
Selenium (Se)-Total	<0.00010		0.00010	mg/L		19-SEP-12	R2438997
Silicon (Si)-Total	<0.050		0.050	mg/L		19-SEP-12	R2438997
Silver (Ag)-Total	<0.000010		0.000010	mg/L		19-SEP-12	R2438997
Sodium (Na)-Total	9.82		0.20	mg/L		19-SEP-12	R2438997
Strontium (Sr)-Total	0.00545		0.00010	mg/L		19-SEP-12	R2438997
Thallium (Tl)-Total	<0.00010		0.00010	mg/L		19-SEP-12	R2438997
Tin (Sn)-Total	<0.00010		0.00010	mg/L		19-SEP-12	R2438997
Titanium (Ti)-Total	<0.010		0.010	mg/L		19-SEP-12	R2438997
Uranium (U)-Total	<0.000010		0.000010	mg/L		19-SEP-12	R2438997
Vanadium (V)-Total	<0.0010		0.0010	mg/L		19-SEP-12	R2438997
Zinc (Zn)-Total	<0.0030		0.0030	mg/L		19-SEP-12	R2438997
L1208966-5 EDEN RAW Sampled By: CLIENT on 12-SEP-12 @ 22:30 Matrix: WATER							
General Chemical							
Alkalinity, Total							
Alkalinity, Total (as CaCO3)	430		5.0	mg/L	14-SEP-12	14-SEP-12	R2438109
Bicarbonate (HCO3)	499		5.0	mg/L	14-SEP-12	14-SEP-12	R2438109
Hydroxide (OH)	<5.0		5.0	mg/L	14-SEP-12	14-SEP-12	R2438109
Carbonate (CO3)	12.6		5.0	mg/L	14-SEP-12	14-SEP-12	R2438109
Chloride (Cl)							
Chloride (Cl)	227	DLA	2.0	mg/L	17-SEP-12	17-SEP-12	R2437438
Fluoride (F)							
Fluoride (F)	0.70		0.10	mg/L	14-SEP-12	14-SEP-12	R2436434
ICP Cations							
Calcium (Ca)	13.6		1.0	mg/L	17-SEP-12	17-SEP-12	R2438226
Potassium (K)	10.6		1.0	mg/L	17-SEP-12	17-SEP-12	R2438226
Magnesium (Mg)	4.7		1.0	mg/L	17-SEP-12	17-SEP-12	R2438226
Sodium (Na)	381		2.0	mg/L	17-SEP-12	17-SEP-12	R2438226
Sulfur (as SO4)	125		3.0	mg/L	17-SEP-12	17-SEP-12	R2438226

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Appendix C

Fish Species in Lake Dauphin

Not available at time of printing.

Appendix D

Well Log

PS-1-25

MANITBA
Inter-Departmental Memo

To R.M. Lawrence
Regional Engineer
Western Region
Engineering & Construction
Dauphin.

From A. Pedersen, P. Eng.
Senior Groundwater Engineer

FILE: 5.7.4.5.

Telephone 786-9590

Subject Well Installation at Rainbow Beach
Park.

As requested, a new well was installed at Rainbow Beach. The log and construction details are given on the attached drillers report. A water analysis is also attached.

The well flows and has high capacity and can be equipped with either a suction or submersible pump.

The maximum recommended pumping rate is 100 IGFM from a pump intake setting of 30 feet below ground.

AP
A. Pedersen, P. Eng.

AP:dlm
Attachment

c.c. R. Stokes.

First Fold

DRILLER'S REPORT

QTR. S.E. SEC. 5 TWP. 20 RGE. 17 E. W.

R. LOT _____ PARISH _____

REMARKS Rainbow Beach

WELL OWNER NAME Parks Branch

ADDRESS _____ PHONE _____

WELL IDENTIFICATION (NO., NAME) _____

WELL USE PRODUCTION TEST WELL RECHARGE OBSERVATION WELL

WATER USE DOMESTIC LIVESTOCK MUNICIPAL INDUSTRIAL IRRIGATION

AIR-CONDITIONING OTHER (Specify) _____

DATE WELL COMPLETED: DAY 5 MONTH Oct 1982

LOCATION SKETCH OF WELL

WELL LOG	DEPTH BELOW GROUND IN FEET		DESCRIPTION	WATER RECORD (KIND OF WATER)
	FROM	TO		
			<u>leg by Wilf Hnatuk</u>	
	<u>0</u>	<u>1</u>	<u>Soil</u>	
	<u>1</u>	<u>11</u>	<u>Clay; brown</u>	
	<u>11</u>	<u>22</u>	<u>Till; brown stoney</u>	
	<u>22</u>	<u>47</u>	<u>Till; brown-grey</u>	
	<u>47</u>	<u>67</u>	<u>Clay; dark grey</u>	
	<u>67</u>	<u>82</u>	<u>Till; brown</u>	
	<u>82</u>	<u>83</u>	<u>Gravel</u>	
	<u>83</u>	<u>98</u>	<u>Clay; dark grey</u>	
	<u>98</u>	<u>132</u>	<u>Sand and gravel; coarse</u>	
	<u>132</u>	<u>140</u>	<u>Till; grey</u>	
			<u>Used bentonite mud only</u>	

WELL CONSTRUCTION	DEPTH BELOW GROUND LEVEL IN FEET		CASING	OPEN HOLE PERFORATIONS	GRAVEL PACK	CASING GROUT	PITLESS UNIT	INSIDE DIAMETER INCHES	OUTSIDE DIAMETER INCHES	SCREEN SLOT SIZE NO. OR INCH	TYPE	MATERIAL	MAKE
	FROM	TO											
	<u>+2.4</u>	<u>115</u>	<u>X</u>					<u>5</u>			<u>Series 200</u>	<u>PVC</u>	
	<u>115</u>	<u>130</u>		<u>X</u>				<u>4</u>		<u>15</u>	<u>5-inch Telescope, W.W. 55.</u>		
	<u>?</u>	<u>133</u>			<u>X</u>			<u>5</u>			<u>2200 lbs</u>	<u>12-20 Unimin</u>	
	<u>0</u>	<u>?</u>				<u>X</u>		<u>5</u>			<u>10 bags neat cement</u>		

TOP OF CASING OR APPLICABLE UNIT +2.4 FEET ABOVE BELOW GROUND LEVEL

REMARKS: develop with air-ise block @ 30 gpm
- pump 7200 I.G.P.M. with big air out of 5-inch casing for 45 minutes
- took ~ 1/2 hour to recover to top of casing
- well flows at 30 I.G.P.M. from AP of 2.4 ft.

Field Test
Elect. Cond. - 1700 μ mhos
Hardness - 20 g.p.g.
CaCl - 150 mg/l
Iron - 0.9 mg/l
Clear 3 days later

PUMPING TEST	DATE OF TEST: DAY _____ MONTH _____ 19 _____	
	PUMPING <input checked="" type="checkbox"/> FLOWING <input type="checkbox"/>	RATE <u>59-55</u> I.G.P.M.
WATER LEVEL BEFORE PUMPING _____ FT. ABOVE <input checked="" type="checkbox"/> BELOW <input type="checkbox"/> GRD. LEVEL		
PUMPING LEVEL AT END OF TEST <u>1.05</u> FT. ABOVE <input checked="" type="checkbox"/> BELOW <input type="checkbox"/> GRD. LEVEL		
DURATION OF TEST _____ HOURS <u>120</u> MINUTES <u>+ Incomplete Recovery</u>		
WATER TEMPERATURE _____ °F		
RECOMMENDED PUMPING RATE <u>100</u> I.G.P.M. <u>w sub or w suction</u>		
WITH PUMP INTAKE AT <u>30</u> FEET BELOW GROUND LEVEL.		

LICENCE NO. _____
NAME <u>Wescan Drilling Ltd</u>
ADDRESS <u>Dauphin Man</u>
DRILL OPERATOR <u>Wilf Hnatuk</u>
Signature of Contractor _____

FORM MQ-2436 DRILLING CONTRACTOR'S COPY

Appendix E

MWSB Guidelines for Watercourse Crossings

WATERCOURSE CROSSINGS

Mitigation Measure

1. All watercourse crossings will be directionally drilled.
2. A minimum undisturbed buffer zone of 15 metre will be maintained between directional drill entry/exit areas and banks of watercourse.
3. Heavy equipment (caterpillars, tractors) shall not be allowed within the buffer zone.
4. Enforce measures regarding fuelling or servicing equipment within 100 metre of watercourse.
5. Waste drill mud and cuttings will be prevented from entering surface water.
6. Should erosion control measures be implemented, post construction monitoring shall be conducted to ensure effectiveness.
7. Further erosion control measures will be implemented as necessary.

Reclamation

1. Restore all disturbed areas to original contours.
2. Install erosion control measures, if warranted, and maintain until vegetation becomes established.

Pressure Loss/Fluid Loss Response

To avoid or minimize the potential for drilling fluids and drill cuttings from entering watercourses because of a frac-out, the following monitoring and response plan will be followed:

1. A record of drilling progress will be maintained to always know the location of the drill head relative to the point of entry.
2. A record of drilling component usage (type and quantity) will be maintained throughout each drilling operation.
3. A record of drilling fluid volume used and returned will be maintained to detect any significant fluid losses. Drilling fluid pump pressure will be continuously monitored. Abnormal loss of returned fluids or loss of fluid pressure that may be indicative of a frac-out will be reported immediately to MWSB/PFRA construction field supervisor.
4. At watercourse crossings where water clarity permits, a view of the stream bottom, an observer will continuously check for signs of mud escapement to the watercourse.

Loss of Fluid and Frac-out Response Plan

1. If an abnormal loss of fluid, drop in pressure or visible plume is observed indicating a frac-out or possible frac-out, drilling is to stop immediately.
2. The contractor will notify the MWSB/PFRA construction field supervisor of the frac-out condition or potential condition and decide on the appropriate action as follows:
 - a) Assign a person to visually monitor for the presence of muddy plume.

- b) Make adjustments to the mud mixture; add lost circulation material (LCM) to the drilling fluid in an attempt to prevent further loss of fluid to the ground formation and/or watercourse.
- c) Where conditions warrant and permit (i.e., shallow depth, clear water, low water velocity, potentially sensitive habitat) and where a frac-out has been visually detected, attempt to isolate the fluid release using a large diameter short piece of culvert.
- d) Under circumstances where a frac-out has occurred, and where conditions do not permit containment and the prevention of drilling fluids release to the watercourse, attempts to plug the fracture by pumping LCM are not to continue for more than 10 minutes of pumping time.
- e) If the frac-out is not contained within this time, MWSB/PFRA construction supervisor will halt any further attempts until a course of action (either abandon directional drilling or further consultation with MWSB engineers) is decided upon.

Appendix F

Projected Backwash Quality

Assuming 75% of filter concentrate is released in first five minutes of backwashing.

All units in mg/L unless otherwise stated

Total Backwash Volume	2860 L
Amount of water through filters between backwashes	26950 L
Backwash Volume in first 5 minutes	1705 L

Parameter	Raw	Greensand	Rejection	Remaining	Filter Backwash
Alkalinity	351	349	0.0057	0.9943	372.72
Bicarbonate	428	425	0.007	0.993	460.52
Chloride	98.4	103	0	1	98.4
Fluoride	0.75	0.79	0	1	0.75
Sulfer (as SO4)	452	453	0	1	452
Hardness	345	344	0.0029	0.9971	355.86
TDS	1160	1150	0.0086	0.9914	1268.29
pH	7.51	7.61	0	1	7.51
Conductivity (us/cm)	1790	1800	0	1	1790
Total Organic Carbon	1.5	1.5	0	1	1.5
Arsenic	0.0196	0.00263	0.8658	0.1342	0.2038
Calcium	79.6	77.7	0.0239	0.9761	100.25
Iron	0.653	0	1	0	7.74
Magnesium	33.3	36.6	0	1	33.3
Manganese	0.0255	0.192	0.9	0.1	0.27
Potassium	9.79	10.9	0	1	9.79
Silicon	10	9.61	0.039	0.961	14.23
Sodium	268	269	0	1	268
Uranium (ug/L)	0.00133	0.00178	0	1	0.0013

Assuming concentrate is released evenly over 20 minute backwash

Parameter	Raw	Greensand	Rejection	Remaining	Filter Backwash
Alkalinity	351	349	0.0057	0.9943	367.85
Bicarbonate	428	425	0.007	0.993	453.24
Chloride	98.4	103	0	1	98.4
Fluoride	0.75	0.79	0	1	0.75
Sulfer (as SO4)	452	453	0	1	452
Hardness	345	344	0.0029	0.9971	353.43
TDS	1160	1150	0.0086	0.9914	1244.03
pH	7.51	7.61	0	1	7.51
Conductivity (us/cm)	1790	1800	0	1	1790
Total Organic Carbon	1.5	1.5	0	1	1.5
Arsenic	0.0196	0.00263	0.8658	0.1342	0.1625
Calcium	79.6	77.7	0.0239	0.9761	95.62
Iron	0.653	0	1	0	6.15
Magnesium	33.3	36.6	0	1	33.3
Manganese	0.0255	0.192	0.9	0.1	0.22
Potassium	9.79	10.9	0	1	9.79
Silicon	10	9.61	0.039	0.961	13.29
Sodium	268	269	0	1	268
Uranium (ug/L)	0.00133	0.00178	0	1	0.0013

Appendix G

Water Quality Results



Office of Drinking Water
ATTN: DON MICHALYK
Box 10, 27 - 2nd Avenue SW
Dauphin MB R7N 3E5

Date Received: 19-JUL-12
Report Date: 13-AUG-12 08:06 (MT)
Version: FINAL

Client Phone: 204-622-2153

Certificate of Analysis

Lab Work Order #: L1180886
Project P.O. #: 17523
Job Reference: RAINBOW BEACH PWS [173.00]
C of C Numbers:
Legal Site Desc:

Paul Nicolas

Paul Nicolas
Account Manager

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ANALYTICAL REPORT

L1180886 CONTD....
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Physical Tests (WATER)

Analyte	Unit	Guide Limit		ALS ID	L1180886-1	L1180886-2
		#1	#2	Sampled Date	Sampled Time	Sampled Time
				Sample ID	09:00	09:00
					RAINBOW BEACH 1 - RAW	RAINBOW BEACH 2 - TREATED
Colour, True	CU	15	-		<5.0	<5.0
Conductivity	umhos/cm	-	-		1620	1630
Langelier Index (4 C)	No Unit	-	-		0.78	0.63
Langelier Index (60 C)	No Unit	-	-		1.5	1.4
pH	pH units	6.5-8.5	-		8.10	7.98
Total Dissolved Solids	mg/L	500	-		1170	1190
Transmittance, UV (254 nm)	% T	-	-		94.0	93.8
Turbidity	NTU	-	-		8.11	0.61

Federal Guidelines for Canadian Drinking Water Quality (JAN, 2011)

#1: GCDWQ - Aesthetic Objective

#2: GCDWQ - Maximum Acceptable Concentrations (MACs)

Detection Limit for result exceeds Guide Limit. Assessment against Guide Limit cannot be made.

Analytical result for this parameter exceeds Guide Limit listed on this report.

* Please refer to the Reference Information section for an explanation of any qualifiers noted.



ANALYTICAL REPORT

L1180886 CONTD....
PAGE 3 of 9
13-AUG-12 08:06 (MT)

Anions and Nutrients (WATER)

Analyte	Unit	ALS ID		L1180886-1	L1180886-2
		Sampled Date	Sampled Time		
		Guide Limit #1	Guide Limit #2	RAINBOW BEACH 1 - RAW	RAINBOW BEACH 2 - TREATED
Alkalinity, Total (as CaCO3)	mg/L	-	-	338	337
Ammonia, Total (as N)	mg/L	-	-	1.01 ^{DLA}	0.96 ^{DLA}
Bicarbonate (HCO3)	mg/L	-	-	413	412
Bromide (Br)	mg/L	-	-	<0.50	<0.50
Carbonate (CO3)	mg/L	-	-	<12	<12
Chloride	mg/L	250	-	108	110
Computed Conductivity	uS/cm	-	-	1610	1630
Conductivity % Difference	%	-	-	-0.4	0.2
Fluoride	mg/L	-	1.5	0.62	0.66
Hardness (as CaCO3)	mg/L	-	-	330	340
Hydroxide (OH)	mg/L	-	-	<6.8	<6.8
Iodide (I)	mg/L	-	-	<2.0	<2.0
Ion Balance	%	-	-	96.1	97.9
Langelier Index	No Unit	-	-	0.9	0.8
Nitrate and Nitrite as N	mg/L	-	10	<0.025	<0.025
Nitrate-N	mg/L	-	10	<0.025	<0.025
Nitrite-N	mg/L	-	1	<0.0050	<0.0050
Total Kjeldahl Nitrogen	mg/L	-	-	1.05	0.97
Total Nitrogen	mg/L	-	-	1.05	0.97
Saturation pH	pH	-	-	7.15	7.14
TDS (Calculated)	mg/L	500	-	1110	1120
Sulfate	mg/L	500	-	423	426
Anion Sum	me/L	-	-	18.7	18.8
Cation Sum	me/L	-	-	17.9	18.4
Cation - Anion Balance	%	-	-	-2.0	-1.1

Federal Guidelines for Canadian Drinking Water Quality (JAN, 2011)

#1: GCDWQ - Aesthetic Objective

#2: GCDWQ - Maximum Acceptable Concentrations (MACs)

Organic / Inorganic Carbon (WATER)

Analyte	Unit	ALS ID		L1180886-1	L1180886-2
		Sampled Date	Sampled Time		
		Guide Limit #1	Guide Limit #2	RAINBOW BEACH 1 - RAW	RAINBOW BEACH 2 - TREATED
Dissolved Organic Carbon	mg/L	-	-	<1.0	<1.0
Total Inorganic Carbon	mg/L	-	-	86.7	89.8
Total Organic Carbon	mg/L	-	-	<1.0	<1.0

Federal Guidelines for Canadian Drinking Water Quality (JAN, 2011)

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ANALYTICAL REPORT

L1180886 CONTD...
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Total Metals (WATER)

Analyte	Unit	ALS ID		L1180886-1	L1180886-2
		Sampled Date	Sampled Time	18-JUL-12	18-JUL-12
		Guide Limit #1	Guide Limit #2	09:00	09:00
				RAINBOW BEACH 1 - RAW	RAINBOW BEACH 2 - TREATED
Aluminum (Al)-Total	mg/L	0.1	-	<0.050 DLM	<0.050 DLM
Antimony (Sb)-Total	mg/L	-	0.006	<0.0020 DLM	<0.0020 DLM
Arsenic (As)-Total	mg/L	-	0.01	0.0216 DLM	0.0201 DLM
Barium (Ba)-Total	mg/L	-	1	0.0082 DLM	0.0078 DLM
Beryllium (Be)-Total	mg/L	-	-	<0.0020 DLM	<0.0020 DLM
Bismuth (Bi)-Total	mg/L	-	-	<0.0020 DLM	<0.0020 DLM
Boron (B)-Total	mg/L	-	5	1.01 DLM	0.96 DLM
Cadmium (Cd)-Total	mg/L	-	0.005	<0.00010 DLM	<0.00010 DLM
Calcium (Ca)-Total	mg/L	-	-	92.9 DLM	85.9 DLM
Cesium (Cs)-Total	mg/L	-	-	<0.0010 DLM	<0.0010 DLM
Chromium (Cr)-Total	mg/L	-	0.05	<0.010 DLM	<0.010 DLM
Cobalt (Co)-Total	mg/L	-	-	<0.0020 DLM	<0.0020 DLM
Copper (Cu)-Total	mg/L	1	-	0.0034 DLM	<0.0020 DLM
Iron (Fe)-Total	mg/L	0.3	-	0.828 DLM	0.719 DLM
				<1.0 DLM	<1.0 DLM
Lead (Pb)-Total	mg/L	-	0.01	<0.00090 DLM	<0.00090 DLM
Lithium (Li)-Total	mg/L	-	-	0.156 DLM	0.152 DLM
Magnesium (Mg)-Total	mg/L	-	-	42.5 DLM	38.7 DLM
Manganese (Mn)-Total	mg/L	0.05	-	0.0324 DLM	0.0284 DLM
Molybdenum (Mo)-Total	mg/L	-	-	0.0114 DLM	0.0097 DLM
Nickel (Ni)-Total	mg/L	-	-	<0.020 DLM	<0.020 DLM
Phosphorus (P)-Total	mg/L	-	-	<1.0 DLM	<1.0 DLM
Potassium (K)-Total	mg/L	-	-	12.3 DLM	11.4 DLM
Rubidium (Rb)-Total	mg/L	-	-	0.0031 DLM	0.0027 DLM
Selenium (Se)-Total	mg/L	-	0.01	<0.010 DLM	<0.010 DLM
Silicon (Si)-Total	mg/L	-	-	10.1 DLM	9.14 DLM
Silver (Ag)-Total	mg/L	-	-	<0.0010 DLM	<0.0010 DLM
Sodium (Na)-Total	mg/L	200	-	283 DLM	262 DLM
Strontium (Sr)-Total	mg/L	-	-	1.11 DLM	1.02 DLM
Tellurium (Te)-Total	mg/L	-	-	<0.0020 DLM	<0.0020 DLM
Thallium (Tl)-Total	mg/L	-	-	<0.0010 DLM	<0.0010 DLM
Thorium (Th)-Total	mg/L	-	-	<0.0010 DLM	<0.0010 DLM
Tin (Sn)-Total	mg/L	-	-	<0.0020 DLM	<0.0020 DLM
Titanium (Ti)-Total	mg/L	-	-	0.0100 DLM	0.0109 DLM

Federal Guidelines for Canadian Drinking Water Quality (JAN, 2011)

#1: GCDWQ - Aesthetic Objective

#2: GCDWQ - Maximum Acceptable Concentrations (MACs)

Yellow box: Detection Limit for result exceeds Guide Limit. Assessment against Guide Limit cannot be made.

Red box: Analytical result for this parameter exceeds Guide Limit listed on this report.

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ANALYTICAL REPORT

L1180886 CONTD....
PAGE 5 of 9
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Total Metals (WATER)

		ALS ID		L1180886-1	L1180886-2
		Sampled Date		18-JUL-12	18-JUL-12
		Sampled Time		09:00	09:00
		Sample ID		RAINBOW	RAINBOW
				BEACH 1 - RAW	BEACH 2 - TREATED
Analyte	Unit	Guide Limit #1	Guide Limit #2		
Tungsten (W)-Total	mg/L	-	-	<0.0010 ^{DLM}	<0.0010 ^{DLM}
Uranium (U)-Total	mg/L	-	0.02	0.0015 ^{DLM}	0.0014 ^{DLM}
Vanadium (V)-Total	mg/L	-	-	<0.0020 ^{DLM}	<0.0020 ^{DLM}
Zinc (Zn)-Total	mg/L	5	-	0.088 ^{DLM}	0.027 ^{DLM}
Zirconium (Zr)-Total	mg/L	-	-	<0.0040 ^{DLM}	<0.0040 ^{DLM}

Federal Guidelines for Canadian Drinking Water Quality (JAN, 2011)

#1: GCDWQ - Aesthetic Objective

#2: GCDWQ - Maximum Acceptable Concentrations (MACs)

Dissolved Metals (WATER)

		ALS ID		L1180886-1	L1180886-2
		Sampled Date		18-JUL-12	18-JUL-12
		Sampled Time		09:00	09:00
		Sample ID		RAINBOW	RAINBOW
				BEACH 1 - RAW	BEACH 2 - TREATED
Analyte	Unit	Guide Limit #1	Guide Limit #2		
Aluminum (Al)-Dissolved	mg/L	0.1	-	<0.020 ^{DLM}	<0.020 ^{DLM}

Federal Guidelines for Canadian Drinking Water Quality (JAN, 2011)

#1: GCDWQ - Aesthetic Objective

#2: GCDWQ - Maximum Acceptable Concentrations (MACs)

Detection Limit for result exceeds Guide Limit. Assessment against Guide Limit cannot be made.

Analytical result for this parameter exceeds Guide Limit listed on this report.

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ANALYTICAL REPORT

L1180886 CONTD....
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 13-AUG-12 08:06 (MT)

Volatile Organic Compounds (WATER)

		ALS ID		L1180886-1
		Sampled Date		18-JUL-12
		Sampled Time		09:00
		Sample ID		RAINBOW
				BEACH 1 - RAW
Analyte	Unit	Guide Limit #1	Guide Limit #2	
Benzene	ug/L	-	5	<0.10
1,1-Dichloroethylene	ug/L	-	14	<0.10
Dichloromethane	ug/L	-	50	<0.50
Ethyl Benzene	ug/L	2.4	-	<0.10
MTBE	ug/L	15	-	<0.10
Tetrachloroethylene	ug/L	-	30	<0.10
Toluene	ug/L	24	-	<0.10
1,1,1-Trichloroethane	ug/L	-	-	<0.10
1,1,2-Trichloroethane	ug/L	-	-	<0.10
Trichloroethylene	ug/L	-	5	<0.10
o-Xylene	ug/L	-	-	<0.070
m+p-Xylenes	ug/L	-	-	<0.070
Xylenes (Total)	ug/L	300	-	<0.14
Surrogate: 4-Bromofluorobenzene	%	-	-	116.2
Surrogate: 1,2-Dichloroethane d4	%	-	-	97.1
Surrogate: Toluene-d8	%	-	-	97.7

Federal Guidelines for Canadian Drinking Water Quality (JAN, 2011)

#1: GCDWQ - Aesthetic Objective

#2: GCDWQ - Maximum Acceptable Concentrations (MACs)

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Analytical result for this parameter exceeds Guide Limit listed on this report.

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