COMPREHENSIVE DEVELOPMENT REVIEW (CDR)

NW SASKATOON WASTE WATER TREATMENT PLANT

Prepared for:

THE R.M. OF CORMAN PARK NO.344

Prepared By:
PINTER & Associates Ltd.

In Association With:
Proteus Waters Inc.

9 November 2016
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EXECUTIVE SUMMARY

101222478 Saskatchewan Ltd. is applying for the subdivision and rezoning of two point five (2.5) acres (the Site, subdivision) of the NE 24-37-6-W3M quarter section within the Corman Park – Saskatoon District. The land is owned by Nil-Ray Farms (the Owner) and the subdivision will require rezoning from D-Agricultural District (DAG1) to D-Regional Waste Management 1 District (DRM1) for the purpose of developing a waste water treatment plant (WWTP).

The Developer believes this location is ideal for this activity due to its proximity to the businesses that do not have access to the sanitary sewage system of the City of Saskatoon and currently haul their wastewater to the City’s Wastewater Treatment Plant. Access to the property will be from existing Range Road 3061, close to the intersection with TWP 374 (Auction Mart Road). The Developer and PINTER design team believe that the impact of this development will be minimal on surrounding properties and environment in terms of waste, traffic, noise, odour, dust and views. Services required for the development are limited to power and natural gas. In the future, the Owner may bring forward additional subdivision applications to facilitate commercial development on its property and to facilitate economic growth in the RM.

The WWTP will treat septic sewage from the City of Saskatoon and R.M. of Corman Park (RM) using Membrane Bioreactor (MBR) technology. The advantages of an MBR system over conventional biological systems include better effluent quality, smaller space requirements and ease of automation. The WWTP will be managed by Proteus Waters, a company with decades of experience in sewage treatment technology.

The effluent generated from the WWTP will meet all requirements as set by the Regulators and will be conveyed through an underground pipe off-Site to an effluent holding cell west of the WWTP. A unique aspect of the project is that the effluent will be reused for irrigation of agricultural land in the RM, thereby reducing the environmental footprint.

A contract zoning agreement is expected to limit the use of the Site to a waste water treatment plant. The proposed development is located 1.6 km north of the City limits of Saskatoon and 850m west of Highway #16. The proposed WWTP is located on land in the northeast corner of the Quarter Section that was former pasture land and it will be separated from surrounding land by newly constructed berms and chain link fencing.

Nearby residents and businesses from the Site, the City of Saskatoon and the Saskatoon Airport Authority (SAA) were informed regarding the proposed development, through face-to-face meetings, mail-outs, phone, e-mail and door-to-door contact.

A risk assessment conducted by the SAA identified the potential of an increased bird strike hazard associated with the potential increase of the surface water area due to effluent disposal. The SAA confirmed in an email that an engineered holding cell is an acceptable design and control measure to mitigate the risks.

The public consultation indicated no major concerns and the Development was generally perceived as beneficial to the area.
DEVELOPMENT CONTEXT

A two point five (2.5) acre subdivision, located in the NE corner of LSD NE 24-37-6-W3M is being proposed for a waste water treatment plant. It is understood that the entire point five (2.5) acre subdivision is proposed to be rezoned (subject to the bylaw amendment process and Council approval) using a zoning contract that will limit the use of the Site to a waste water treatment plant, located in the north east corner of the Quarter Section as presented in Figure 1 (Appendix A).

Future phases of the development are intended to accommodate other commercial development. **Future phases of the development will require a subdivision or series of subdivision applications and it is understood that a new CDR will be required at that time.**

Photographs of the development Site and surrounding area can be found in Appendix B.
1 BACKGROUND

1.1 INTRODUCTION

The purpose of this document is to provide the Rural Municipality of Corman Park No. 344 with a Comprehensive Development Review (CDR) as required by the RM’s Official Community Plan. A CDR must be prepared and submitted in support of any application to rezone or subdivide land for multi-parcel country residential, commercial, industrial, or intensive recreational purposes. The purpose of a CDR is to identify and address social, environmental, health and economic issues appropriately and to encourage the development of high quality projects.

This review provides a framework for a proposed two point five (2.5) acre subdivision, located in the NE corner of NE ¼ 24-37-6-W3M, adjacent to the intersection between Auction Mart Road and Range Road 3060 within the R.M. of Corman (RM).

101222478 Saskatchewan Ltd. is proposing to build and operate a wastewater treatment Plant (WWTP) using Membrane Bioreactor (MBR) technology. The advantages of an MBR system over conventional biological systems include better effluent quality, smaller space requirements and ease of automation. The WWTP will be managed by Proteus Waters, a company with decades of experience in sewage treatment technology.

The location was chosen due to the presence of existing access roads and the vicinity to existing and future commercial/industrial areas, which are not connected to the sewer system of the City of Saskatoon. Currently, septic haulers travel long distances, including passing through residential and high traffic areas, to transport septic sewage from the Corman Park – Saskatoon District to the City Plant. The proposed WWTP will help relieve pressure on the City Plant and expand the sewage treatment service to residents and businesses in the Corman Park – Saskatoon District.

The WWTP will treat septic sewage from the City of Saskatoon and RM of Corman Park (RM) delivered to Site by septic haulers. The effluent generated from the WWTP will meet all requirements as set by the Regulators and will be conveyed through an underground pipe off-Site to a holding cell west of the WWTP. The holding cell is located in an existing slough as presented in Figure 2 (Appendix A). The cell is designed to store approximately 26,406 m$^3$ of water with a freeboard of 3.3 m to the top of berm. The elevations of the top of the berms are 3 m above ground surface (m a.g.s) to divert surface runoff around the cell. Generated biosolids will be dewatered using a belt filter press, collected into a disposal bin and hauled off-Site to a licensed landfill.

A unique aspect of the project is that the effluent will be reused for irrigation of agricultural land in the RM, thereby reducing the environmental footprint.

Questions on the proposal or the material contained within this document should be directed to Russell McCrea (email: russell.mccrea@pinter.ca, phone: 306-244-1710).
1.2 LAND USE CONTEXT

The NE 24-37-6-W3M quadrant is currently zoned for agricultural use and consists of pasture land with sloughs. The proposed Development will require two point five (2.5) acres of the quadrant to be subdivided and rezoned for waste management use as per the Corman Park – Saskatoon Planning District Zoning Bylaw. The Site is located north of the City of Saskatoon and west of Highway 16. The surrounding land uses of the Site include country residential (to the northwest), light industrial (to the northeast) and agricultural (Appendix C).

The Existing Land Use Context of the Proposed Development is as follows:

Northwest
- Single family dwelling: 597 m west-northwest from proposed WWTP

North
- Township Road 374 and Right-of-way: Adjacent to north boundary
- Farmland pasture: Adjacent to Township Road 374

Northeast
- Road intersection: Adjacent to northeast boundary
- Light Industrial: Adjacent to road intersection

East
- Range Road 3060: Adjacent to east boundary
- Farmland pasture: Adjacent to Range Road 3060
- Light Industrial: 800 m from east boundary

Southeast
- Light Industrial: 800 m from south boundary

South & West
- Farmland pasture with sloughs: Adjacent to west and south boundaries.

1.3 POLICY CONTEXT

The proposed Development has been designed to meet the requirements of the Official Community Plan for the Corman Park – Saskatoon Planning District (dated 24 January 2014).
The following policies from Section 8: Servicing and Transportation Objectives and Policies will be met:

- **8.0.1** – The proposed Development is in the vicinity of existing and future commercial/industrial areas, which are not connected to the City of Saskatoon sanitary sewage system and currently haul their wastewater to the City’s Wastewater Treatment Plant. The WWTP will facilitate growth and development in the District in an economical and environmentally sustainable manner by reducing hauling distances and there is a potential for reusing the effluent for irrigation of agricultural land in the RM.
- **8.0.4/8.3.4** – The WWTP uses Membrane Bioreactor (MBR) technology. The advantages of MBR technology over a conventional biological lagoon system include better effluent quality, smaller space requirements and ease of automation.
- **8.1.1** – The Developer will be responsible for all costs associated with providing electricity to the Site.
- **8.2.1** – The Site is located adjacent to the Auction Mart Road & Range Road 3060 intersection.
- **8.2.3** – The Development will ensure safe access and egress from adjacent roadways, which is further explained in Section 3.1 Roadways of this review.
- **8.2.5** – The Development will not interfere with the continued safe operation of the Saskatoon Airport. Written communication on guidelines to meet, risk assessment, and recommended mitigation strategy from the Saskatoon Airport Authority (SAA) is presented in Appendix D.
- **8.2.6** – The proposed subdivision will allow for the expansion of roads where required.

The following policies from Section 9: Waste Management and Remediation Objectives and Policies will be met:

- **9.1.1** – The proposed WWTP Site location will help relieve pressure on the City of Saskatoon septic sewage treatment and facilitate commercial growth due it’s vicinity to existing and future commercial/industrial areas.
- **9.3.1** – The Site is located near an intersection of a major highway (HWY 16) and municipal road.
- **9.3.3** – The Site will have legal and year round, all weather physical access to a municipal maintained roadway. Internal private roads will be constructed and maintained at the expense of the Developer.
- **9.3.4/5b/8** – The separation distance between the WWTP and a single family dwelling is ~600 m, measured from the WWTP perimeter to the dwelling. The minimum separation distance from any multi-parcel country residential development and Liquid Waste Disposal Facility is 600 m. There is no minimum separation distance requirement for single family dwellings. Please refer to Figure 2 (Appendix A) for details on the closest dwelling.
ZONING BYLAW

The Developer is applying to rezone two point five (2.5) acres of land from D-Agricultural District (DAG1) to D-Regional Waste Management 1 District (DRM1) for the purpose of processing and recycling septic sewage generated in the District and region.

1.4 WASTEWATER TREATMENT PROCESS OVERVIEW

The proposed WWTP will treat septic sewage from the City of Saskatoon and RM of Corman Park. The treated effluent will be conveyed through an underground pipe off-Site to an effluent holding cell south west of the WWTP. This holding cell will provide storage for treated effluent during winter months (240 days), as recommended by WSA. Biosolids will be dewatered using a belt filter press, its pathogen content stabilized with lime, and hauled off-Site to a licensed landfill.

The WWTP is a packaged solution based on membrane bioreactor (MBR) technology. The proposed WWTP consists of the following units:

- Sewage receiving and equalization
- Pre-treatment (grit removal and fat, oil, and grease removal)
- Membrane bioreactor (MBR)
- UV disinfection
- Sludge dewatering and stabilization

The sewage receiving and equalization unit consists of three (3) sewage receiving stations. Each receiving station is equipped with a gate valve and PLC-based keypad system, which allow self-serve access only to authorized septic haulers. The equalization tank is a 100-cubic meter underground concrete tank. The main purpose the equalization tank is to compensate for hydraulic and organic loads during peak flow hours.

The pretreatment unit comprises a mechanical system for grit as well as fat, oil & grease (FOG) removal. After FOG removal, the wastewater flows to the MBR system.

The MBR system is a PURON® PLUS MBR system, developed and manufactured by Koch Membrane Systems (KMS). The MBR system comprises the anoxic reactor, aerobic reactor and membrane tank, as well as associated ancillary equipment (e.g., blowers, permeate tank and pumps, and instrumentation). Two membrane trains will be available during normal operations. The filtration process utilizes ultrafiltration, hollow fiber membranes designed for the treatment of municipal and industrial wastewater.

Before treated effluent discharge, and UV system will disinfect the treated wastewater. The UV disinfection unit consists of three (3) trains (one available as back up).

A sludge dewatering and stabilization unit comprises a belt filter press (BFP) and hygienization system. The BFP will reduce the water content of the wasted sludge, whereas the hygienization will decrease the pathogen content of the dewatered sludge through lime addition. The BFP includes a flocculant preparation and dosing system, which enhances the dewatering process producing a sludge cake with dry solids content of approx. 16 percent. The hygienization system comprises a lime dispenser, sludge and
lime mixer, and screw conveyor. In the hygienization system, dewatered sludge will be thoroughly mixed with lime, destroying parasites and other pathogens as a result of pH rise (up to approx. 12).

A holding cell will collect the treated effluent on Site whereas the residual biosolids will be hauled to a landfill for final disposal. The effluent pond will have the capacity for storing treated effluent during the winter months (240 days). During the summer months the water volume in the holding will be reduced by irrigation of adjacent pasture land.

**DESIGN CRITERIA**

The proposed wastewater treatment plant will treat an average daily volume of 100 m$^3$ per day as indicated in the permit to construct issued by WSA. The projected sewage characteristics and effluent quality criteria approved by WSA are shown in Table 1. It should be noted that the proposed WWTP is not intended to treat septage from grease traps or mud from solids interceptors from car washes. Similarly, industrial wastewater treatment will not be accepted. The WWTP is designed to treat sewage from holding tanks or other wastewaters from residential or commercial sources with relatively low solids content. To prevent the potential upset of the MBR system from high solids or grease, the WWTP will be equipped with a pretreatment and equalization unit.

The proposed WWTP includes an MBR system, which has a maximum daily capacity of 255 m$^3$ (10.6 m$^3$ per hour) for the projected raw sewage characteristics (Table 1). However, the WWTP will have an automated control system at the sewage receiving stations to prevent day flows beyond 100 m$^3$. Thus, daily volume acceptance will be limited to a maximum volume of 100 m$^3$.

**Table 1. Projected raw sewage characteristics and approved effluent quality criteria**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Raw Sewage</th>
<th>Treated Effluent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temp. (°C)</td>
<td>7-20</td>
<td>-</td>
</tr>
<tr>
<td>Carbonaceous Biochemical Oxygen Demand, CBOD5 (mg/L)</td>
<td>≤500</td>
<td>≤25</td>
</tr>
<tr>
<td>Chemical Oxygen Demand, COD (mg/L)</td>
<td>≤1000</td>
<td>-</td>
</tr>
<tr>
<td>Total Suspended Solids, TSS (mg/L)</td>
<td>≤360</td>
<td>≤25</td>
</tr>
<tr>
<td>Total Nitrogen, TN (mg/L)</td>
<td>≤200</td>
<td>-</td>
</tr>
<tr>
<td>Total Phosphorous, TP (mg/L)</td>
<td>≤22</td>
<td>-</td>
</tr>
<tr>
<td>pH</td>
<td>6≤pH≤9</td>
<td>6.5≤pH≤8.5</td>
</tr>
<tr>
<td>Total Coliforms, MPN/100 mL</td>
<td>-</td>
<td>≤1000</td>
</tr>
</tbody>
</table>

**MAXIMUM DAILY FLOW AND ORGANIC LOADING**

PURON® PLUS MBR system has been designed to treat a maximum daily loading of approximately 124 kg in terms of BOD loading. Thus, the estimated maximum daily flow that the MBR system can process is 255 m$^3$ for raw sewage having an average BOD of 500 mg/L, as projected (Table 1). Details on the estimation of the organic loading and maximum daily flow for a given BOD value are presented in Table 2. Figure 1 shows the variation of maximum daily flow capacity of the MBR system with respect to raw sewage BOD. As shown in the graph, for a BOD concentration of 1000 mg/L the maximum daily flow is estimated at 128 m$^3$, which is still above the design daily volume of 100 m$^3$. Therefore, the MBR
design has significant buffer capacity built in for the treatment of high strength sewage. To cope of flow surges, a 100 cubic meter tank will be used for collection and equalization.

During low demand periods, the process can be adjusted to operate at a lower intensity. It should be noted that, in contrast to conventional activated sludge process, MBR process has a wider range of organic and hydraulic loadings for operations (e.g., F/M ratios between 0.04 to 0.2 g BOD/(g MLSS d)). This can be achieved by using dissolved oxygen (DO), level, and pH sensors in the aerobic reactor and having equipment with variable frequency drive (VFD) motors, such as blowers and pumps (feed and permeate). At the low end of organic and/or hydraulic loadings, a carbon source (methane) will available to sustain the activated sludge.

Table 2. Biological design parameters & estimation of maximum daily capacity

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Units</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>F/M Ratio</td>
<td>0.25</td>
<td>kg/kg*d</td>
<td>0.15-0.25</td>
</tr>
<tr>
<td>MLSS</td>
<td>10</td>
<td>kg/m3</td>
<td>8-10</td>
</tr>
<tr>
<td>Bioreactor Volume</td>
<td>51</td>
<td>m3</td>
<td>-</td>
</tr>
<tr>
<td>Bioreactor Volume (aerobic)</td>
<td>510</td>
<td>kg</td>
<td>-</td>
</tr>
<tr>
<td>M (= MLSS x Volume)</td>
<td>127.5</td>
<td>kg</td>
<td>-</td>
</tr>
<tr>
<td>BOD</td>
<td>0.5</td>
<td>kg/m3</td>
<td>-</td>
</tr>
<tr>
<td>Daily Capacity</td>
<td>255</td>
<td>m3</td>
<td>-</td>
</tr>
</tbody>
</table>

Performance indicators for continuous monitoring include pH and DO in the aerobic tank, effluent turbidity, transmembrane pressure (TMP), and effluent transmittance (UVT).

Figure 1: NeighbOhouring residents of proposed WWTP Site
EFFLUENT MANAGEMENT (DISPOSAL & MONITORING)

The effluent generated from the WWTP will meet all requirements as set by Saskatchewan Water Security (WSA). The treated effluent will be conveyed through an underground pipe off-Site to an effluent holding cell south west of the WWTP. This holding cell will provide storage for treated effluent during winter months (240 days) as recommended by WSA. A Site Plan for the proposed Development, including the effluent holding cell, is shown in Figure 3 in Appendix A. For details on the requirements set by WSA, please refer to Appendix E (Permit to Construct) or Table 1.

A unique aspect of the project is that the effluent will be reused for irrigation of agricultural land in the RM, thereby reducing the environmental footprint. To ensure the projected effluent volumes and quality are compatible with the available agricultural land, the Ministry of Agriculture (Crops and Irrigation Branch) has conducted a Soil Investigation Study and Preliminary Irrigation Design. The Soil Investigation Study indicates that the land is suitable for effluent irrigation following certain recommendations. The Preliminary Irrigation Study provides guidelines for the irrigation area, location, and equipment. The Soil Investigation Study and Preliminary Irrigation Design are available in Appendix F.

The use of the holding cell for treated effluent storage during winter months was selected based on recommendations provided by WSA and consultations with Saskatoon Airport Authority (SAA). A risk assessment conducted by the SAA identified the potential of an increased bird strike hazard associated with the potential increase of the surface water area due to effluent disposal. The SAA confirmed in an email that an engineered holding cell is an acceptable design and control measure to mitigate the risks. A Letter of Clearance signed by Andrew Leeming, Vice President Operational Excellence from SAA, is available in Appendix G.

Groundwater will be monitored for the proposed effluent storage cell to ensure the exfiltration does not pose significant impact on the local environment. Four monitor wells will be installed around the effluent holding cell and the baseline groundwater quality will be determined prior to operating the plant by collecting and analyzing water samples. Each monitor well will be sampled at a known frequency for specific parameters outlined in the Permit to Operate from WSA.

BIOSOLIDS MANAGEMENT

Sludge generated during the sewage treatment process will be dewatered and stabilized at the plant before disposal. Biosolids daily production rate is estimated at 187 kg/day with a moisture content of over 20 percent after lime addition. The excess biomass produced is expected to have similar properties to those of generated by the conventional activated sludge process.

Chemicals utilized in the MBR process and during sludge dewatering and stabilization are not expected to affect the toxicity of the final sludge. In the MBR process, citric acid and sodium hypochlorite are chemicals to be used for membrane cleaning. For sludge dewatering a polyacrylamide flocculant (Flopam EM 840) is employed. This water-soluble polymer is NSF/ANSI 60 certified flocculant for drinking water clarification. During sludge stabilization hydrated lime is added to dewatered sludge. Alkaline stabilization, through the addition of lime, is a common process widely employed in Nova Scotia and other provinces in Canada. The resulting stabilized biosolids are typically used as a soil amendment, lime substitute, landfill cover, and land reclamation.
Biosolids produced by the WWTP will be hauled to the Northern Landfill, located at SE 16-38-05W3. An offer from Loraas Disposal Services Ltd. has been received for the collection, transportation, and disposal of the biosolids. A copy of the offer can be found in Appendix H.

Biosolids produced by the proposed sewage works are able to meet the Toxicity Characteristic Leaching Procedure (TCLP) required by the landfill. This assessment is based on the system’s influent being strictly municipal sewage, as well as the chemicals used in the MBR and sludge treatment processes. The proposed it is not intended to treat industrial wastewater. Therefore, results from TCLP tests should be within acceptable limits for all the categories of chemical species, i.e., heavy metals, pesticides, and volatile compounds.

The Operations Manager will conduct regular testing and submit the sludge test results to Loraas and WSA, as outlined in the Permit to Operate, to ensure that the sludge characteristics remains within acceptable limits.

2 OTHER

2.1 ECOLOGICAL AND HERITAGE CONCERNS

The proposed Site does not include areas of ecological significance and is identified as not heritage sensitive. The Environmental Screening Map generated for the project by the Ministry of Environment’s Conservation Data and a copy of the Heritage Sensitivity Search Report can be found in Appendix I.

2.2 FINANCIAL ASSURANCE AND ENVIRONMENTAL SITE LIABILITY INSURANCE

A revised Decommissioning Plan for the proposed development was prepared and presented to WSA on September 28, 2016 (Appendix J). The plan provides a description of the activities to be undertaken when the proposed facility will be decommissioned in order to restore the project site to pre-development conditions. Also, Financial Assurance for decommissioning activities and provisions for an Environmental Site Liability Insurance in case of site remediation are addressed.

<table>
<thead>
<tr>
<th>Item</th>
<th>Estimated Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decommissioning of Structure &amp; Equipment</td>
<td>$ 10,000</td>
</tr>
<tr>
<td>Management of Excess Material &amp; Waste</td>
<td>5,000</td>
</tr>
<tr>
<td>Restoration of Land</td>
<td>5,000</td>
</tr>
<tr>
<td>Post-closure monitoring</td>
<td>5,000</td>
</tr>
<tr>
<td>Contingency Costs (10%)</td>
<td>2,500</td>
</tr>
<tr>
<td><strong>Total Cost</strong></td>
<td><strong>$ 27,500</strong></td>
</tr>
</tbody>
</table>

The decommissioning costs of the proposed WWTP have been calculated based on the activities involved in the decommissioning of structure and equipment and management of excess material and waste. Monitoring costs for five (5) years of post-closure monitoring have been estimated to be $5,000. A 10%
contingency cost has been added to the estimated decommissioning costs. Table 2 summarizes the decommissioning costs for based on present value costs.

101222478 Saskatchewan Ltd. will provide financial assurance to cover the WWTP decommissioning costs. The financial assurance will be provided to WSA during the Application for Permit to Operate, as outlined in Phase 2 of the Permit to Construct (Appendix E).

Potential environmental impacts on the land have been assessed to determine minimum requirements for the Environmental Site Liability Insurance. Potential environmental impacts caused during operations of the sewage treatment plant are limited to accidental spills and releases of on-site chemicals or sewage from the equalization and process tanks. Spills of any product will be reported to WSA and cleaned up when the spill occurs and the Site restored at that time to prevent the migration of any materials from entering the surrounding environment.

Residual biosolids will be stabilized and hauled away from the site for disposal at a licensed landfill. Therefore, the biosolids generated do not pose a threat to the existing environment on site.

Since treated effluent will be released in the land adjacent to the proposed site, precautionary measures will be taken to monitor groundwater quality. These measures include installation and periodic sample analysis of groundwater monitor wells around the development and reporting of treated effluent quality in accordance to the Permit to Operate.

Based on the potential environmental impact assessed, 101222478 Saskatchewan Ltd. will provide the landlord with an Environmental Site Liability Insurance policy for the minimum amount of $2 million. This insurance policy will cover property damage, remediation costs, and related legal expenses for pollution conditions on, at under or migrating from the insured property. The insurance will be in place before operations and renewed on an annual basis during once the WWTP start operations. WSA has reviewed the proposed amount and agreed to be appropriate for the project. WSA has confirmed their approval of the proposed Decommissioning Plan and indicated that it addresses remediation of the site (Appendix K).

### 3 SERVICING

#### 3.1 ROADWAYS

The Site is located adjacent to the intersection between Auction Mart Road and Range Road 3060 within the RM of Corman Park and ~900 m west of HW16 access. Access to the Site will be from Range Road 3060 via a new approach road (Figure 4 in Appendix A). Auction Mart Road is paved and doesn’t require upgrades prior to plant startup. Range Road 3060 is a gravel road, which will require upgrades and widening to meet the RM of Corman Park grid road specifications or approved alternatives. 101222478 Saskatchewan Ltd. will work with the RM of Corman Park to ensure their satisfaction with the upgrades required for Range Road 3060 to become a primary haul road. Originally 15m was the proposed length of road to be constructed at a 10m width, and with 4:1 side slopes. There will be cooperation from the developer to participate in any additional planning and construction. The intent is to make the upgrades in conformance with the recommendations made by the RM of Corman Park and with the Primary Grid Road & Heavy Haul Road Access Road Specifications.
The Permit to Construct from WSA allows for a maximum daily flow of 100 m³, which equals on average 17 hauling trucks per day. A copy of the Permit is presented in Appendix E. Other traffic includes the hauling of potable water and biosolids twice a month. The Site will have no parking traffic as vehicles cycle in and out at the three drop-off points (delivery duration: ~15-20 minutes). The presence of the operator will be intermittent and only as required. Facilities on-Site are limited and no business will be conducted.

To prevent any traffic congestion, due to unexpected growth, traffic to Site will be capped at 30 hauling trucks/day from start-up. Each load that is hauled to the site will be logged, dated, and tracked to project if there is a possibility of the daily trips exceeding our limit. Upon the earliest indication that our site will exceed the limit, the commissioning of a Traffic Impact Assessment within 60 days of the exceedance if the thirty (30) daily limit. Additional daily traffic to Site will require the completion of a traffic impact assessment and any associated upgrades to the surrounding infrastructure. Traffic to Site will be regulated through an electronic sign-in/sign-out system at the gate. Site access logs for review will be provided upon request.

The intersection of Auction Mart Road and Range Rd 3060 does not provide the ability to queue for westbound nor eastbound traffic, due to the absence of passing lanes. Destination traffic heading westbound will be informed of a bypass route via Yellow head Road (highway 16) towards Range Road 3060 north of the intersection to improve traffic safety. These roads are well maintained gravel roads and it is not anticipated that they will need upgrades with the current destination traffic limit.

Warning (e.g. Approach and Turning Truck signs) and speed limit signs are proposed for placement along Auction Mart Road. Figure 4 in Appendix A illustrates the proposed Traffic Management Plan. The access road to the Site will follow the basic specifications and surfacing standards, as defined by the RM’s Heavy Haul Access Road Program (Appendix L) or approved alternatives. The total road length will be approximately 50 m.

### 3.2 DRAINAGE

The topography of the Site is relatively flat along the northern and eastern borders with existing drainage ditches and along the western border with a slough. The WWTP will have berms all around the perimeter with a 1 foot deep ditch to collect and contain any surface runoff. Grading will direct surface runoff towards the WWTP perimeter ditch and via a channel towards a stormwater holding pond onsite. In the process of the Preliminary Hydrogeological & Geotechnical Study (Appendix M), the local geology and topography were analysed to ensure that all effluent and stormwater would remain onsite. A Site Plan for the proposed Development, including the stormwater holding pond, is shown in Figure 3 in Appendix A. Appendix N (Stormwater Plan Assurance and Comparison of Specifications – Wet Ponds) illustrates the specifications followed in the design and how they relate to the City of Saskatoon Stormwater Design Standards.

### 3.3 UTILITIES & WASTE

Plant service water will be supplied to a holding tank on Site. Portable fire extinguishers will be available in each process unit to meet requirements of the NBC and NFPA. A fire alarm system will be implemented as indicated by the Building Code and NFPA 820 standard. The distance to the nearest Saskatoon Fire Station (Station #4) is ~7.3 km (approximately 7 minutes).
Power and natural gas providers have been contacted and confirmed they can be supplied to the facility. A 347/600 V, three phase, four wire electrical service has been requested from SaskPower. The anticipated size is 200 A, allowing for the planned loading. New gas natural service has been requested to SaskEnergy for a projected load of 320 MBTU with a delivery pressure of 0.25 psi.

The waste water hauled to Site will be monitored through random testing to ensure that delivered raw sewage is within design specifications and the terms and conditions of the Permit to Operate are not violated. In addition, the sewage acceptance units will be equipped with pH, temperature, and conductivity sensors to monitor and control the quality of the sewage being delivered to the plant. In case these parameters are beyond allowable limits, a pneumatic valve will shut off automatically and prevent the delivery out-of-specification waste water.

Access to the WWTP will be allowed only to authorized septic haulers and personnel. A card reading system will allow haulers to unload their sewage into the WWTP. Septic haulers will be required to sign a contract indicating sewage volumes and specifications for delivery. The membership contracts with each hauler will ensure only sanitary wastewater is delivered to site with attached liability if any of the terms contract is broken. In addition to regulatory tests, further validation of raw sewage specifications includes Quality Audits (created by ISO 9000 Auditors) and the ability of each drop off station to match drop off loads to individual haulers or hauler groups.

Current legislation allows for dewatered (cake-like) biosolids to be disposed of in licensed landfills. The current plan is to take the biosolids produced by the WWTP to Loraas Landfill, which has already provided an offer for collection, transportation, and disposal of the biosolids (Appendix H). Other more sustainable options include mixing the biosolids with lime and spreading them on agricultural land for the use of fertilizer, which has been requested by local farmers. The current sludge handling design includes a lime dosing and mixing system, which will be available for operation. However, this will be part of future plans and will involve the Ministry of Agriculture recommendations before any land application takes place. Composition of biosolids produced by the proposed WWTP will be closely monitored and assessed by the Ministry of Agriculture prior to land application.

3.4 HYDROGEOLOGIC AND GEOTECHNICAL

The regional hydrogeological characteristics, obtained from the WSA groundwater mapping of the Saskatoon Map sheet 73B2, indicate Saskatoon is part of the prehistoric Lake Saskatchewan during the deglaciation era. The surficial geology at the site consists mainly of the Haultain Alloformation. The Alloformation consists (in descending order) of lacustrine silt and clay layer (Grasswood Allomember) followed by deltaic silt and sand (Furdale Allomember) layer. Generally, the Haultain Alloformation is a relatively coarse texture formation, which increases towards the surface due to increase of sand and silt contents.

The main surficial groundwater aquifer in the area is the Dalmeny Aquifer, which is protected by a thick aquitard clay and silt till layer (Grasswood Allomember) ranges in depth from approximately 25 – 75 m. The area is serviced by Saskatoon Water with drinking water, which explains the low number of groundwater wells (a total of five (5)) within 1.6 km of the site.

There are four (4) groundwater monitoring wells installed on the plant site. Three (3) wells are positioned north, south and east of the sloughs in the centre of the quarter section and one (1) well on the west. A hydrogeologic and geotechnical investigation of the Site is available in Appendix M for further details.
3.5 PUBLIC CONSULTATION

The Proposed Development has agricultural, residential and commercial neighbours within 1.6 km of the proposed Site. Further the Development is located under the approach surface to runway 15 of the John G. Diefenbaker International Airport.

From January through March 2015 surveys were conducted to identify if there was public and commercial support and/or concerns for a Septic Receiving Station in the area of Hwy 16 and Auction Mart Road.

3.6 SURVEY SUMMARY

All businesses that were contacted and visited, responded positively to projected lower costs for septic hauling, due to shorter travel distances. The businesses also supported the innovative and new treatment technology to be introduced in Saskatchewan.

The following businesses were contacted over the phone in Yellowhead Industrial Park (located NE from the Site):

- Moody's New Holland (contact: Rick Rivett)
- Agco (contact: Terry Swystun)
- Lonesome Prairie (contact: Harlod Derkson)
- CTR Industrial Investments (contact: Reception)
- Trimac Transport Services (contact: Reception)
- 3Twenty Modular (contact: Bryan McCrea)

Jason Tratch (Developer) talked to Bryan McCrea, CEO of 3Twenty Modular about the project. He was interested to support the manufacturing and customizations of the plant. He also supports the sustainable reuse of sewage and wastewater and had no issues or concerns regarding the Development.

In May 2015 the Developer called with management of BizHub (located E from the Site). An information package regarding the Development (including design and operations plan) was emailed to Kyle Chatterson at Concorde Group. No response was provided.

In September 2015 the Developer followed up with management of Bizhub to confirm the information package was received. An information package was emailed to a different manager, Michael Bischoff at the Concorde Group. No response was provided.

On 26 October 2015, Greg Porter from CTR Industrial Investments (less than 800 m from Site) was contacted over the phone. A package regarding the Development was emailed to him and a meeting was requested by the Developer. Mr. Porter indicated that he would review the package first and would contact the Developer if required.

On 26 October 2015, Karla Folstad from Trimac Transport (adjacent to CTR Industrial Investments) was contacted over the phone. A package regarding the Development was emailed to her and a meeting was requested by the Developer. Ms. Folstad forwarded the package and request to the operations manager and he would follow up if required.
The following businesses were contacted north of the Auction Mart Road/Hwy 16 intersection:

- Redhead Case (contact: Wade Sandoff)
- John Deere (contact: Kelly Gilcrest)

From January through October 2015, presentations and packages about the Development were provided to the local stakeholders to create awareness about the project. Informed stakeholders include the Mayor of Saskatoon (Don Atchison), Reeve of Corman Park (Judy Haywood), members of the City of Saskatoon Wastewater Plant and each major Septic Hauling Company in NW Saskatoon.

The following septic hauling companies were consulted in person, over the phone and through email:

- Envirotec Services Incorporated - Ray Poppl
- McGill's Industrial Services Inc. - Jeff McGill
- Econo Septic & Sewer Services - Eddie & Jan Paproski
- Diamond Septic Service - Mike Schettler
- B&D Septic - Dave Loewen
- Sani Sewer - Ray Loewen

In April 2015 the Developer visited the residence located ~530 m northwest from the Site (Resident 1 in figure below). The Developer provided a summary of the proposed Development to the residents (Mark and Anne Summach) and his contact information for any further questions and concerns.

Councillor Randy Rooke of the RM of Corman Park received a one-on-one presentation on 29 October 2015.

On 10 November 2015 the Developer met with resident Anne Summach (Resident 1) to address any questions and/or concerns that commenced since the last meeting. The Developer provided more details regarding MBR technologies, development projects & permitting, effluent water quality & volume, Site grading and stormwater management.

The following concerns and challenges were found during this meeting:

- What is the impact on the (proposed) Korpan Project (north of Auction Mart Road) and how will their stormwater be managed?
- What to ask and study from the Korpan Project water management plan (what studies and drawings do they have and will they do)

The stormwater concerns can be integrated into the Development as follows:

- Collected stormwater can be mixed with produced effluent and directed towards the central slough area to evaporate over time or be re-used for irrigation projects in the area.

The Developer also visited the residents located further west of the WWTP Site along Auction Mart Road (> 1km from Site). These residents were provided with a project summary and contact information from Developer and RM for any additional questions or concerns. The residents visited were Ken Burkevitch (Resident 2) and Ben & Lois Machnee (Resident 3).
On 15 March 2016, Clive Stromberg, from Compliance/Public Safety and Risk Department, from SAA was contacted. He provided guidelines for height limits, design of exterior lighting, and prevention from visibility obstruction. It was found that the proposed project meets these guidelines.

A risk assessment conducted by the SAA identified the potential of an increased bird strike hazard caused by an increase in size of the water bearing slough area. The SAA recommended specific design and control measures for the existing sloughs, which can be an effective mitigation strategy. The recommendations include minimizing the surface area of the slough area, incorporating steep banks lined with rip rap, and avoiding the buildup of cover vegetation such as cattails and bulrushes around the edges.

Also on 15 March 2016, Jake Chen, project engineer with City of Saskatoon, was contacted. Proteus Waters provided details on the project location and use of the intersection of highway 16 and Township Rd 374 by septic haulers to access the proposed site for the Development. During a phone conversation on 21 March 2016, Mr. Chen expressed that he did not find any negative impact or public safety concerns that the proposed development may cause on the aforementioned intersection.

On 16 March 2016 a project summary and contact information from Developer was mailed-out by the RM of Corman Park to all residents, landowners and –users within 1.6 km of the Site. Four communications were received:

- Email from Keith Wright (representing The Moosomin First Nation), living to the north.
- Phone call from a Lawrence Deptuck (resident) living about 1.5 km to the southwest.
- Email from Moodys New Holland (local business) with commercial purpose, 1 km away.
- Phone call from a local business with commercial purpose.

The Moosomin First Nation had an initial concern that the project would include a lagoon type sewage treatment. The concern was addressed by providing additional information about the project, technology and objectives through e-mail. No further communications were received.

Figure 2: Neighbouring residents of proposed WWTP Site
3.7 CONCLUSION AND PATH FORWARD

No major concerns and challenges were found throughout the public consultation process from nearby residents and commercial business owners regarding the Development. To address the concerns from the SAA the following wildlife control measures will be implemented as per Wildlife Control Procedures Manual TP11500E:

- The berms of the cell will be cleared of cover vegetation such as cattails and brush to prevent birds from nesting; and,

- Placement of scarecrows, flags and reflective streamers in and along the cell to deter birds from resting.

If the control measures mentioned above are not found adequate, we propose installing fine wires or monofilament strands (less than 0.5 mm in diameter) over the cell to deter birds by interrupting their flight patterns.

Summaries and correspondence of the public consultation can be found in Appendix D.
Appendices
Appendix A

Figures
Subject Property - Approximate Location

NOTES:
1. This drawing is prepared for illustrative purposes only.
2. This is not a legal survey.
3. All measurements are in metres.
4. Locations of all marked utilities are approximate.

LEGEND
Fence
Slough
MONITORING WELL
BERM
MAX SLOUGH SIZE

SITE LOCATION
FIGURE 1

DATE:
FILENAME:
DRAWN BY:
CHECKED BY:

1) Projects
719-4th Street East
Saskatoon SK S7K 5B4
306.244.1710
pintermain@pinter.ca

WHERE:
H:\2) Projects\1889 Proteus Waters, NW WWTP\1889 Report\Appendices\Appendix A

SLough 1
10,793.25m²

SLough 2
30,223.5m²

SLough 3
15,433.22m²

SLough 4
11,290.5m²

AREA = 177,618.40m²

AREA = 477,215.1m²

AREA = 58,013m²

MONITORING WELL
MEASURED 10 JUNE 2015
MAX SLOUGH SIZE

SURFACE WATER ELEV.

N
SCALE: 1:5000

1. THIS DRAWING IS PREPARED FOR ILLUSTRATIVE PURPOSES ONLY.
2. THIS IS NOT A LEGAL SURVEY.
3. ALL MEASUREMENTS ARE IN METRES.
4. LOCATIONS OF ALL MARKED UTILITIES ARE APPROXIMATE.

MONITORING WELL
BERM
MAX SLOUGH SIZE

AREA = 177,618.40m²

AREA = 477,215.1m²

AREA = 58,013m²

MONITORING WELL
MEASURED 10 JUNE 2015
MAX SLOUGH SIZE

SURFACE WATER ELEV.

N
SCALE: 1:5000

1. THIS DRAWING IS PREPARED FOR ILLUSTRATIVE PURPOSES ONLY.
2. THIS IS NOT A LEGAL SURVEY.
3. ALL MEASUREMENTS ARE IN METRES.
4. LOCATIONS OF ALL MARKED UTILITIES ARE APPROXIMATE.
NOTE: DUGOUT OPERATIONAL VOLUME IS 26,406 m³

NOTE: SINGLE FAMILY DWELLING LOCATED IN WEST NORTH WEST 597 m FROM W.T.P. BUILDING

CROSS SECTION A-A' SCALE 1:2000
10:1 VERTICAL EXAGGERATION

CROSS SECTION B-B' SCALE 1:2000
10:1 VERTICAL EXAGGERATION

CROSS SECTION C-C' SCALE 1:70

FIGURE 3
SUBJECT PROPERTY LAYOUT
25 AUGUST 2016
HBBB - PROTEUS WATERS, NW WTP, SK.

SCALE: AS SHOWN
CHECKED BY: PM
DRAWN BY: MS. HE & AV
SIGNATURE / DATE: 25/08/2016

SCALE: 1:700

NOTES:
1. THIS DRAWING IS PREPARED FOR ILLUSTRATIVE PURPOSES ONLY.
2. THIS IS NOT A LEGAL SURVEY.
3. ALL MEASUREMENTS ARE IN METRES UNLESS OTHERWISE NOTED.
4. LOCATIONS OF ALL ANNOTATED UTILITIES ARE APPROXIMATES.
EXISTING STOP SIGN

PROPOSED TRUCK CROSSING SIGN

PROPOSED STOP SIGN

PROPOSED STOP SIGN

PROPOSED SPEED LIMIT SIGN (SPEED AHEAD WARNING SIGN TO BE PLACED 50m TOWARDS WEST)

PROPOSED SPEED LIMIT SIGN

EXISTING SPEED LIMIT SIGN

EXISTING SPEED LIMIT SIGN

SEE FIG.3 FOR DETAILS ON THIS AREA

EASTBOUND TRAFFIC

WESTBOUND TRAFFIC

RANGE RD 3060

Auction Mart Rd

1. THIS DRAWING IS PREPARED FOR ILLUSTRATIVE PURPOSES ONLY.
2. THIS IS NOT A LEGAL SURVEY.
Appendix B

Photographs
Figure 1: Site, looking southwest.

Figure 2: Drainage ditch and Auction Mart Road along north side of Site, looking west.
Figure 3: Drainage ditch along north side of Site, looking west.

Figure 4: Range Road 3060 along eastern boundary of Site, looking south.
Figure 5: Culverts under Range Road 3060, looking east.

Figure 6: Drainage ditch along eastern boundary of Site, looking south.
Figure 7: Pasture land with sloughs in the background, looking south.

Figure 8: Installation of monitoring well as part of geotechnical investigation.
Appendix C

District Zoning Map
Appendix D

Public Consultation Summary
NW Saskatoon Wastewater Treatment and Recovery Plant (WWTRP) – Project Summary

NW Saskatoon Wastewater Treatment and Recovery Plant (WWTRP) is a utility project intended to provide clean water for irrigation from sources of wastewater (municipal sewage) treatment. It is to be available for the City of Saskatoon and the Rural Municipality (RM) of Corman Park by the summer of 2016. The Project will be located North West of Saskatoon in portions of the NE ¼ 24-37-6-W3M near the intersection between Auction Mart Road and Range Road 3060 within the RM of Corman Park.

The location was chosen due to presence of existing access roads and the vicinity to existing and future commercial/industrial areas lacking access to sanitary sewer. Currently, residents and businesses collect their sewage in holding tanks, which must be hauled away on a weekly or daily basis. For proper treatment and disposal, septic haulers must travel long distances, including passing through residential and high traffic areas, to transport septic sewage from the Corman Park – Saskatoon District to the City Plant. Thus, the proposed WWTRP will help relieve pressure on the City Plant and expand the sewage treatment service to residents and businesses in the RM of Corman Park. Key value is to also develop a more sustainable message that wastewater is valuable and can deliver reliable, sustainable, high quality water for agriculture and irrigation purposes.

The WWTRP is a packaged solution based on membrane bioreactor (MBR) technology, developed, proven and manufactured by Koch Membrane Systems (part of the Billion Dollar Group of Companies called Koch Industries). The filtration process utilizes ultrafiltration, hollow fiber membranes designed for the treatment of municipal and industrial wastewater. The advantages of an MBR system over conventional biological systems include better effluent quality, smaller space requirements and ease of automation. Before discharge the effluent will be disinfected using UV radiation. Biosolids will be dewatered using a belt filter press and stabilized using lime.

An effluent pond will collect the treated effluent water whereas the residual biosolids will be hauled to a landfill for final disposal. The effluent pond will have the capacity for storing treated effluent during the winter months. Another aspect of the property is that there is a potential for reusing the treated waste water effluent for irrigation of agricultural land in the Rural Municipality, thereby reducing the environmental footprint. Thus, in summer the treated effluent will be reuse for irrigation.
The WWTRP will be managed by Proteus Waters, a company with over a decade of experience in membrane technology in Europe and Canada. Koch Membrane Systems is the membrane and MBR system supplier for the project. Koch Membrane Systems has been a world-class developer and manufacturer of the membranes filtration systems for half a century. The design and regulatory team is led by PINTER & Associates, an environmental award-winning consulting firm from Saskatchewan with almost three decades of experience in the geo-environmental sector.

For any questions or additional details please contact Jason Tratch at (306) 715-1589 or jason.tratch@proteuswaters.com.

**Proposed Plant Location**
Public Consultation

From Jan to Oct, 2015, presentations and packages were provided for the local government groups, including the Mayor of Saskatoon (Don Atchison), Reeve of Corman Park (Judy Haywood) and members of the Saskatoon City Wastewater Plant and each major Septic Hauling Company in NW Saskatoon. Each group is aware of the project. It must also be noted that each group is also aware of the Non-Profit Organization involved to support the project, called SWAN (SK Water Action Network). SWAN supports the advancement of sewage treatment and the recovery of wastewater into clean effluent that can be recycled/reused.

The names of the Septic Companies presented to (multiple times in person, over phone and email) include:

- Envirotec Services Incorporated - Ray Poppl
- McGill's Industrial Services Inc. - Jeff McGill
- Econo Septic & Sewer Services - Eddie & Jan Paproski
- Diamond Septic Service - Mike Schettler
- B&D Septic - Dave Loewen
- Sani Sewer - Ray Loewen

Next Steps
Currently the Councillor of the RM of Corman Park is receiving a one-on-one presentation on Oct. 29, 2015.

From Jan to March (2015), surveys were conducted to identify if there was support to have a Septic Receiving Station in the area of Hwy 16 and Auction Mart Road. All businesses that were visited provided a positive response and wanted to see lower prices for Septic Hauling.

Currently they are not happy with the cost of Septic Hauling. All businesses also supported the innovation of bringing new technology into SK and having the ability to treat sewage and recovery clean water. The businesses contacted include:

- Yellowhead Industrial Park (NW corner of Auction Mart Rd and Hwy 16)
- Moodys New Holland, Rick Rivett
- Agco, Terry Swystun
- Lonesome Prairie, Harlod Derkson
- CTR Industrial Investments, Reception
- Trimac Transport Services, Reception
- BizHub (SW corner of Auction Mart Rd and Hwy 16)
- 2twenty Modular (Bryan McCrea)

**Private Businesses (NE corner of Auction Mart Rd and Hwy 16)**
- Redhead Case, Wade Sandoff
- John Deere, Kelly Gilcrest
**Recent Actions**

*Businesses less than 800 meters*

CTR Industrial Investments, Greg Porter

The closest business is NE of the WWTP, this 10 acre site is owned by CTR Industrial. Greg Porter was contacted on Oct. 26, 2015 and a telephone conversation occurred. A package was emailed to him describing the project where it is currently at. A meeting was requested by Jason Tratch however Mr. Porter was busy and stated that he will look at the package first and then contact Jason Tratch if needed.

Adjacent to CTR is a truck depot owned by Trimac Transport. Karla Folstad was contacted on Oct. 26, 2015 and a telephone conversation occurred. A package was emailed to her describing the project where it is currently at. A meeting was requested by Jason Tratch however Karla will forward it to the operations manager and he will decide actions if necessary.

Directly East of the site (on the South side of Auction Mart Road) is the office of 3Twenty Modular Solutions. Jason Tratch talked to CEO Bryan McCrea about the project and they are interested to support the manufacturing and customizations of the plant. They currently support the sustainable reuse of sewage and wastewater and had no issues with the plant.

- **door-to-door contact for residences;**

In the month of April, 2015, Jason Tratch visited the residence that is closest to the plant (North side of Auction Mart Road and approximately 700 meters to the West). That house is owned by Mark and Anne Summach. Jason provided a summary of what was to be built in the upcoming year (NW Saskatoon Plant). He provided his contact information and explained that he was available for questions or concerns and explained that a Sewage Treatment and Water Recovery plant was going to be built in their area that would utilize MBR technology. He stated that he would contact them again in future when the details of the plant and location were finalized. A meeting is currently set for Oct. 30th to meet again with both owners and explain the project and gather their feedback. This resident is illustrated as Resident 1 (please see map in Appendix 1).

In addition, Jason Tratch visited the other two residents that were located West of the WWTP site situated on Auction Mart Road. These residents are in excess of 1 km away and will not experience the trucks however Mr. Tratch provided them with his contact information and told them to contact him or the RM of Corman Park for additional questions or details at any time. The residents contacted included:
- Resident 2 = Ken Burkevitch
- Resident 3 = Ben and Lois Machnee.

Please see Appendix 1 diagram for details of houses visited.

After the meeting occurs with Resident 1 (as described above), an updated package will be emailed to Residents 1, 2 and 3 so all residents are on the same page. It will also be stated that Jason Tratch is available for one-on-one meetings if needed.

- **other businesses**

Biz Hub is the development located directly East of the site.

In May, 2015, a phone call occurred with Management of BizHub (development directly East of
the WWTP Site). They seemed interested in connecting to the plant so a complete package was emailed to: Kyle Chatterson at Concorde Group kchatterson@concordegrou.com. The package contained 25 slides of the project, what it is, where located, how septic trucks will be dropping off sewage, etc. No response was provided.

In September, 2016, a phone call occurred with Management of BizHub and Jason Tratch asked for a different Bizhub manager to ensure the message was received. They seemed interested in connecting to the plant so a complete package was emailed to: Michael Bischoff at Concorde Group mbischoff@concordegrou.com. The package contained 25 slides of the project, what it is, where located, how septic trucks will be dropping off sewage, etc. No response was provided.

2A.) What is the value of the clients investment? (# of business Clients signed up, price, who they are, who could be potentially)

Response
Clients (end-users) of the WWTP include Septic Hauling Companies in the Saskatoon and Surrounding Area. Currently the clients that have verbally committed to haul on average 50% of their sewage include:

- Envirotec Services
- McGill's Industrial Services
- Econo Septic & Sewer Services
- Diamond Septic Service
- B&D Septic
- Sani Sewer
- Several small private septic hauling companies

Note: initially, these hauling companies have committed on average an approximate volume of 82 meters cubed per day. This approximately 50% of their daily volumes. If the plant meets requirements, then they would commit to bring the majority of their sewage to the plant. The average volume estimated to be received as per the business model is between 100-125 meters cubed per day.

Septic Haulers have asked for this and are the source of revenue for the plant. Benefits they receive include: 15% lower drop-off fee (est. at $50 per load of 1000 gallons), multiple drop off stations to avoid line-ups, strategic location at edge of city (no residential traffic/schools), clean and maintained, not open to public (members only) and possible rebates based on volumes. Thus, the primary septic haulers have already committed sewage volumes for this new plant (a committed source of revenue) with options to bring more (strong potential growth and upside).
Meeting Minutes

Topic: NW Saskatoon Plant (RE: Wastewater Treatment & Water Recovery)

Meeting Date: Oct. 30

Attendees: Jason Tratch, Mary Burkovitch, Anne Summach, partially Carlos Guzman (introductions)

Topics, questions, answers and discussions covered include:

- Introductions
- Review of what was dropped off at residents approx. 8 months ago (cards, background, etc)
- History and project description of NW Saskatoon Plant
- Questions related to pre-meeting handout presentations, videos, etc.
- Education and information on Wastewater and Treatment methods in general with a link to a more sustainable (Agricultural) understanding vs. engineered and system approach
- Discussions of regulatory involvement, approvals, permits and developments in general
- MBR technologies and leading companies in the industry (KOCH, GE, Proteus)
- SWAN background and focus, SWAN members and support of the project
- Water management plans for NW Saskatoon and the surrounding area
- Engineering studies, documents, maps of the NW Saskatoon Plant and the surrounding area
- Open questions, concerns

The meeting ended by asking if there are any concerns open or unaddressed. The attendees felt it was a good meeting and a lot was covered. There were no open questions.

It was suggested to have another follow-up meeting and invite others in the area if there was any interest. Maybe new questions could arise.

A future meeting is set for Nov. 10 to discuss synergies the NW Saskatoon Plant has with local residents concerns over other developments (e.g. Proteus to share information and experience to help manage risks related to water run-off from an upcoming development related to Korpan Tractor).

A second future meeting is planned to see if anyone else would be interested to ask questions about anything related to the plant (focus on surrounding residents and friends) and this date is scheduled for late Nov/early Dec.

Meeting minutes scribed by:

Jason Tratch, 3063-2700-2989 or Jason.tratch@galexgroup.com
Meeting Minutes

Topic: NW Saskatoon Plant (RE: Wastewater Treatment & Water Recovery)

Meeting Date: Nov. 10, 2016

Location/Time: Bessborough, 1:00 – 3:00

Attendees: Jason Tratch, Anne Summach

Topics, questions, answers and discussions included:

- Questions related to last meeting
- More details and education and understanding of what impact to the water will occur from Proteus plant, discuss the grade of the land and where water will flow
- Look at pictures and emails sent to Jason from Anne
- Discuss the impact of the Korpan project (across the road) and how their stormwater will be managed
- Discussions on what to ask and study from the Korpan water management plan (what studies and drawings do they have and will they do)
- Discussions of regulatory involvement, approvals, permits and developments in general and what their jobs are and what they can be approached for
- MBR technologies and cleanliness and volumes of water from our plant

Discussed how can there be a win-win for the Korpan project. Can Proteus project utilize some of the collected stormwater for irrigation, since most of our water will be evaporated from within the central pond within the section of land. We wanted to partner with U of S for irrigation projects so this could be an option to further discuss as the project progresses.

Anne and Jason to continue to email back and forth to discuss options/questions, etc.

A future meeting is set for Nov. 30 to involve more neighbours in the surrounding area. Discuss synergies the NW Saskatoon Plant has with local residents and also any questions, concerns or learnings.

Meeting minutes scribed by:

Jason Tratch, 3063-2700-2989 or Jason.tratch@galexgroup.com
Subject: RE: NW Saskatoon WWTRP - Project Summary
From: Clive Stromberg <CliveStromberg@yxe.ca>
Date: 3/22/2016 9:32 AM
To: Carlos Guzman <carlos.guzman@proteuswaters.com>
CC: Andrew Leeming <AndrewLeeming@yxe.ca>, Richard Jasieniuk <RichardJasieniuk@yxe.ca>, Zachary Berglund <ZacharyBerglund@yxe.ca>

Carlos,

I have reviewed your proposal with respect to the development of a Waste Water Treatment Facility site located at the northeast corner of NE1/4 24-37-6 W3M and have the following comments for your consideration.

The Saskatoon Airport Zoning Regulations require that no building or object of natural growth exceed the height of an approach surface at any time. As the building site of this proposal lies directly under the approach surface to runway 15 at the John G. Diefenbaker International Airport, the maximum height allowed by the Airport Zoning Regulations within the area occupied by the WWTF building is approx. 541 MSL.

The design of exterior lighting at his facility should be planned so as not to direct a bright light source directly into the paths of approaching and departing aircraft.

The design and operation of the facility should ensure that it does not produce any significant obstruction to visibility (such as steam or smoke) which would obstruct the visibility of flight crews operating in the immediate vicinity of the airport.

Risk Assessment – Potential Bird Strike Hazard

A Risk Assessment for the construction and operation of a proposed effluent pond at the WWTF site was conducted with a focus on the potential for a bird strike hazard. The following causal factors contribute to this hazard.

- The center of the proposed effluent pond is at a location which is approx. 400m west of the extended centerline and 2450m north of the threshold of runway 15. Aircraft approaching the airport from the north are therefore intentionally lining up for an approach to runway 15 almost directly in line with this pond, descending from an altitude of approximately 450 ft AGL on their way down to the runway (based on a standard 3 degree glide slope).

- Based on 2014 annual data, 3390 aircraft flew over this area on approach to runway 15 and 3083 aircraft departed northbound over this area from runway 33. Therefore approximately 10% of our annual traffic would be expected to be landing or departing over this area on an ongoing basis well into the future.

- As the intent of this pond is to store water for future use the pond will by definition never be dry. Water bodies of any size attract gulls and other migratory birds such as geese. With a potential surface area of over 30,000 m² it is possible that migratory birds such as geese and gulls will be attracted to this pond as a feeding and nesting area. As geese habituate to the same nesting sites year after year, there is a potential risk for large flocks of geese and other birds such as gulls to make this their permanent summer nesting/roosting area.

Without appropriate mitigation efforts in the design and ongoing operation of this proposed facility, the combined effect of the above factors together increases the potential for repeated bird strikes over this area.

Risk Mitigation
To minimize the risk to aviation safety which may be posed by this effluent pond in terms of an ongoing bird strike hazard, incorporating specific design considerations can be an effective mitigation strategy. An example of this is to minimize the surface area of such ponds as much as possible, incorporate steep banks lined with rip rap and avoid the buildup of cover vegetation such as cattails and bulrushes around the edges.

For your information and consideration, the following is taken from Transport Canada’s publication “Wildlife Control Procedures Manual” TP11500E (see section C.11)

(http://www.tc.gc.ca/publications/en/tp11500/pdf/hr/tp11500e.pdf)

Water-body management

_Birds in search of food, drink, shelter and bathing opportunities are attracted to all airport water features: shorelines, marshes, lakes, ponds, pits, creeks, canals, ditches, gullies, wet meadows, and pools—even puddles. In addition, water bodies—even temporary ones—often support large insect populations._

_Water bodies also attract aquatic mammals such as Muskrat and Beaver. Not only can both of these species inflict severe damage through lodge and dam construction, but they are also attractants, luring carnivorous animals to airports. While there may be some controversy regarding desirable grass lengths, there is general agreement that standing water is a major bird attractant. All manuals and instruction pamphlets recommend that standing water on airfields should be drained or backfilled, and that access to open water should be eliminated whenever possible._

_Suggested control_

_Eliminating water bodies is the best solution, although measures such as replacing drainage ditches with buried culverts can be costly. If water-body elimination is not suitable, the following guidelines should be followed: All water bodies should be cleared of emergent and submerged aquatic vegetation by cutting, dredging, or through the use of herbicides. The banks should also be cleared of cover vegetation such as cattails and brush. The banks of water bodies (particularly ponds, streams) should be graded to a 4-to-1 slope, which will discourage burrowing by Muskrats and damming by Beavers. Steep banks also discourage birds from using water, as they then find it more difficult to spot predators. Steep banks also create a clearly defined edge to which grass can be easily mowed, thereby reducing boundary habitats. Low areas, where temporary pools form after rainstorms and spring melt, should be filled or fitted with improved drainage systems. In areas where gulls and waterfowl cause major problems, physical barriers should be erected to prevent access to water. Barriers are available in the form of nylon mesh or wires that are strung across the surface to prevent birds from settling on the water. Wires should be strung across the surface of ponds at a height of roughly 18 cm and at intervals of 36 cm. To protect birds from flying into these barely visible barriers, streamers should be attached to the wires. Fences should also be installed around the perimeter of the water so that birds cannot walk beneath the wires. One alternative to wire and netting is Bird Balls™, which have been used successfully in the western United States since 1993. Bird Balls™ can be spread out over small water bodies to trick birds into thinking that there is no water in the area. The balls are superior to netting and wire because they adjust to fluctuating water levels and snow loads, readily shift to accommodate in-water obstacles, are unaffected by the strongest winds, are very easy to install and require little maintenance. Bird Balls are, however, relatively expensive. If water bodies cannot be covered or drained, dredging will increase the water depth and, as a result, decrease the surface area._
For your information, the Saskatoon Airport Authority is currently in the process of revising the existing Airport Zoning Regulations to be more intentional with respect to the development of new permanent water bodies within 4km of the airport. Although the intention of the regulation is not to prevent landowners from developing future water bodies, it does prescribe that they must take all reasonable measures to prevent the attraction of birds that create a hazard to aviation safety. This is accomplished by incorporating an appropriate mitigating design upfront and employing effective land use management practices going forward which work together to prevent the particular land use from becoming an attractant to birds.

If you would like to discuss this further, please give me a call.

Thanks!!

Clive Stromberg
Compliance/Public Safety and Risk

Ph (306) 975-6465
Fx (306) 975-4233
Email clivestromberg@yxeca

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From: carlos.guzman@galexgroup.com [mailto:carlos.guzman@galexgroup.com] On Behalf Of Carlos Guzman
Sent: March-17-16 4:31 PM
To: Clive Stromberg <CliveStromberg@yxeca>
Subject: Re: NW Saskatoon WWTRP - Project Summary

Hello Clive,

As discussed this morning, please find attached a PDF copy of the site plan for the proposed location of the project. The drawing shows the existing sloughs in the quarter section where the plant will be located. The effluent will be discharged in the largest slough as indicated by the Effluent Pipe line.

Please feel free to contact me if you require additional information.

Thank you,

Carlos Guzman, P.Eng., M.Sc., PMP
Project Engineer
On Tue, Mar 15, 2016 at 10:56 AM, Carlos Guzman <carlos.guzman@proteuswaters.com> wrote:

Hello Clive,

Further to our phone conversation this morning, I am attaching a two-page project summary for the NW Saskatoon Wastewater Treatment and Recovery Plant (WWTRP). Please review it and let me know your comments and recommendations on any impacts that the project may have on the airport.

As I mentioned, our lead engineering consultant is PINTER & Associates. The project manager is Russell McCrea, who I have CC'd on this message. Please feel free to contact me or Russell if you have any technical questions or need additional details.

Thank you,

Carlos Guzman, P.Eng., M.Sc., PMP
Project Engineer
Proteus Waters Inc.
Ph: (306) 715-1589
www.proteuswaters.com
Fwd: Water treatment plant

Jason Tratch <jason.tratch@galexgroup.com>  Mon, Apr 4, 2016 at 4:05 PM
To: Hugo Beenke <hugo.beenke@pinter.ca>, Carlos Guzman <carlos.guzman@galexgroup.com>

NW Saskatoon communication forwarded, as per last email...........

Jason Tratch
CEO, Galex Group Corp.
www.galexgroup.com
O: 306-715-1589
C: 306-270-2989
702-601 Spadina Cres., Saskatoon, SK S7K 3G8
parent company to: NexLev, Proteus Waters
www.nexlevinc.com and www.proteuswaters.com
Blog: www.jasontratch.com

Canada's new anti-spam laws come into effect July 1, 2014. We would like to ensure we have your consent to continue sending you updates, event invitations and other communications about our company. If you do not wish to receive further electronic communications from us please reply to this email stating to remove your name from our email lists.

------- Forwarded message -------
From: Jason Tratch <jason.tratch@galexgroup.com>
Date: Tue, Mar 22, 2016 at 1:55 PM
Subject: Re: Water treatment plant
To: Rick Rivett <Rick@moodysequipment.com>

Hi Rick

Great to hear from you, yes, we hope to be operational by July this year.

Accepted sewage is typical municipal wastewater and also car/tractor wash (as per your washbay).

We have not finalized the dumping fees, they should be 10-15% lower cost than the city of saskatoon (e.g. $55 per 1000 gallons). We will not allow public to drop off, will need a code to open the gate and then drop off.

Currently there is no plan for a permanent pipe to the plant, that will be looked at in year 2 once the plant is running.

You are eligible to bring your wastewater if you wish.

WE plan to be putting up signs in June and approaching businesses, please call me if we take too long to come visit you and I will prioritize your business :)

Jason Tratch
CEO, Galex Group Corp.
www.galexgroup.com
O: 306-715-1589
Canada's new anti-spam laws come into effect July 1, 2014. We would like to ensure we have your consent to continue sending you updates, event invitations and other communications about our company. If you do not wish to receive further electronic communications from us please reply to this email stating to remove your name from our email lists.

On Thu, Mar 17, 2016 at 10:07 AM, Rick Rivett <Rick@moodysequipment.com> wrote:

Received the announcement in the mail today about the plant being built. Do you have any more information on this?

What will we be looking at for dumping fees?

Are there any restrictions as to what waste water they will be accepting?

Are they planning to install any underground delivery systems to connect businesses to the facility?

These are the first questions that came to mind.

Thanks

Rick Rivett

Branch Manager
Moody's Equipment
Saskatoon, Sask
Ph 306-934-4686
Direct 306-657-4516
Cell 306-237-7659
Fax 306-931-8803
rick@moodysequipment.com
Fwd: Supporting Information - Water Recovery & Wastewater Treatment Plant (NW Saskatoon)

Jason Tratch <jason.tratch@galexgroup.com>  
Mon, Apr 4, 2016 at 4:05 PM  
To: Hugo Beenke <hugo.beenke@pinter.ca>, Carlos Guzman <carlos.guzman@galexgroup.com>  

NW Saskatoon communication forwarded, as per last email............

Jason Tratch  
CEO, Galex Group Corp.  
www.galexgroup.com  
O: 306-715-1589  
C: 306-270-2989  
702-601 Spadina Cres., Saskatoon, SK  S7K 3G8  
parent company to: NexLev, Proteus Waters  
www.nexlevinc.com  and  www.proteuswaters.com  
Blog:  www.jasontratch.com

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-------- Forwarded message --------

From: Jason Tratch <jason.tratch@galexgroup.com>  
Date: Fri, Apr 1, 2016 at 4:23 PM  
Subject: Supporting Information - Water Recovery & Wastewater Treatment Plant (NW Saskatoon)  
To: deptuckrocks@sasktel.net  
Cc: Carlos Guzman <carlos.guzman@proteuswaters.com>

Hi Mr. Lawrence Deptuck,

Was great to talk to you today.

As discussed, attached is a presentation from the Network group involved for this project (small businesses, University, PolyTechnical and Government). Also attached is the links to videos that help explain the technology (that comes from Koch Industries) which is the leading membrane system for USA.

Please don't hesitate to call or email me with any other questions you may have, or call and come for a coffee at our office (address below).

I also look forward to seeing your composting operation and thank you for looking at things in a more sustainable manner.

Talk soon,

Jason Tratch  
CEO, Galex Group Corp.  
www.galexgroup.com  
O: 306-715-1589
Canada's new anti-spam laws come into effect July 1, 2014. We would like to ensure we have your consent to continue sending you updates, event invitations and other communications about our company. If you do not wish to receive further electronic communications from us please reply to this email stating to remove your name from our email lists.

2 attachments

- **2016-01-01 NW Saskatoon - SWAN Presentation.pdf**
  - 2340K

- **Puron Membrane Video Links.docx**
  - 15K
Fwd: Fw: Project summery

Jason Tratch <jason.tratch@galexgroup.com>                          Mon, Apr 4, 2016 at 4:04 PM
To: Hugo Beenke <hugo.beenke@pinter.ca>, Carlos Guzman <carlos.guzman@galexgroup.com>

NW Saskatoon communication forwarded, as per last email..........  

Jason Tratch
CEO, Galex Group Corp.
www.galexgroup.com
O: 306-715-1589
C: 306-270-2989
702-601 Spadina Cres., Saskatoon, SK S7K 3G8
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------ Forwarded message ------
From: Jason Tratch <jason.tratch@galexgroup.com>
Date: Wed, Mar 23, 2016 at 2:24 PM
Subject: Re: Fw: Project summery
To: keith wright <kwightmoosomin@yahoo.ca>
Cc: Carlos Guzman <carlos.guzman@proteuswaters.com>

Hi Mr. Wright,

Very sorry, my mistake. Yes, you are referring to the NW Saskatoon Project within the RM of Corman Park, 1 km away from the Hwy 16 and Auction Mart Road. Thank you very much for your interest, and if needed I would be more than happy to meet you in person to help address any questions if this email is not sufficient.

The plant you are referring to is a temporary plant, scheduled to be there for approx. 7-10 years then would be moved. It does not have any open pit type of sewage treatment (like a common bacterial system). The plant is manufactured and resides within sea containers (approx. 6 sea containers that are 40 feet long). The plant will divert septic trucks in the area of Biz Hub and surrounding by giving trucks an option to drop off their septic loads at the plant, verses going all the way into the City to the Saskatoon City Sewage Plant. We expect 10-20 trucks per day.

The plant is also sponsored by a Water Action Network in partnership with the University and Government. I have attached a presentation that I hope gives more info. I also have included an example video link below that shows the type of plant (however it is not in a building, it is within sea containers so we can move it as needed).

Video Link:

Reminder: The main objective is to show the city and surrounding communities that water is extremely valuable and sewage is 99% water so thus is also valuable. Once we properly clean sewage (make it bacteria free and odour free) then we can utilize that water for irrigation. The plant will be using the water on the adjacent farmers field and thus provide a sustainable way to better manage our resources.

FYI: at first I thought your community was asking for a proposal. Currently there are several communities that approached us to have one of these plants built. It is a very environmentally friendly approach to sewage treatment and water recovery and also provides potential work and training. E.g. we have a First Nation community (approx. 1250 people) that wants to get rid of their leaky lagoon. Our plant is a fully automated membrane based plant and would take up approx. 3000 square feet plus a small underground collection tank, for a capital cost of approx. 1.5 to 2 million.

Please let me know if this addresses your questions, or also as mentioned, I am happy to talk to you over phone, in person, or with additional email/text.

Thank you again for your interest,

Jason Tratch
CEO, Galex Group Corp.
www.galexgroup.com
O: 306-715-1589
C: 306-270-2989
732-631 Spadina Cres., Saskatoon, SK S7K 3G8
parent company to: NexLev, Proteus Waters
www.nexlevinc.com and www.proteuswaters.com
Blog: www.jasontratch.com

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On Wed, Mar 23, 2016 at 9:20 AM, keith wright <kwrightmoosomin@yahoo.ca> wrote:
    Jason the letter was sent from your company, in regards to a waste water recovery plant near property of the Moosomin First Nation.

From 🐹Kwrightmoosomin@yahoo.ca действие

On Tuesday, March 22, 2016 1:46 PM, Jason Tratch <jason.tratch@galexgroup.com> wrote:

Hi Keith,

Sorry to bother you, but we did not yet receive any letter or request.

Could you please confirm the address it was sent to, or by chance scan and email it to us.
Address: Proteus Waters  
702-601 Spadina Cres., Saskatoon, SK S7K 3G8

Thank you, or please call me anytime with questions

Jason Tratch  
CEO, Galex Group Corp.  
www.galexgroup.com  
O: 306-715-1589  
C: 306-270-2989  
702-601 Spadina Cres., Saskatoon, SK S7K 3G8  
parent company to: NexLev, Proteus Waters  
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Canada's new anti-spam laws come into effect July 1, 2014. We would like to ensure we have your consent to continue sending you updates, event invitations and other communications about our company. If you do not wish to receive further electronic communications from us please reply to this email stating to remove your name from our email lists.

On Thu, Mar 17, 2016 at 6:39 PM, Jason Tratch <jason.tratch@galexgroup.com> wrote:  
Hi, thank you for your email.  
Sorry, I am travelling this week, so have not seen the letter yet.  
I look forward to providing multiple options, with the key aspect of being environmentally sustainable, modular (scalable) but also potential to move if needed without leaving a huge lagoon behind with polluted land.  
If possible to email it to me I can start earlier to respond, otherwise am back in Saskatoon on Monday.

Thank you,  
Jason Tratch  
306-270-2989  
www.proteuswaters.com

Jason Tratch  
CEO, Galex Group Corp.  
www.galexgroup.com  
O: 306-715-1589  
C: 306-270-2989  
702-601 Spadina Cres., Saskatoon, SK S7K 3G8  
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communications about our company. If you do not wish to receive further electronic communications from us please reply to this email stating to remove your name from our email lists.

On Thu, Mar 17, 2016 at 2:44 PM, keith wright <kwrightmoosomin@yahoo.ca> wrote:

From 🖤Kwrightmoosomin@yahoo.ca🖤

On Thursday, March 17, 2016 2:38 PM, keith wright <kwrightmoosomin@yahoo.ca> wrote:

Hi Jason, In regards to the letter dated March 15th 2016 , The Moosomin First Nation would like to get more information in regards to the recovery plant proposed and , if its going to be an open collection type pit or dug out , can we please get more information in regards to the construction of the proposed project ?

thanks Keith wright Moosomin Lands and Resources.

From 🖤Kwrightmoosomin@yahoo.ca🖤

2016-01-01 NW Saskatoon - SWAN Presentation.pptx
5399K
Appendix E

Permit to Construct - Water Security Agency
August 15, 2016

Mr. Jason Tratch
101222478 Saskatchewan Ltd.
702-601 Spadina Crescent E
SASKATOON SK S7K 3G8

Dear Mr. Tratch:

Re: Permit for Construction – Phase 1: NW Saskatoon Wastewater Treatment Plant
Permit No. 00066612-00-00

Enclosed is a Permit for Construction of Sewage Works. The Water Security Agency issues this permit under The Environmental Management and Protection Act, 2010 (EMPA) to 101222478 Saskatchewan Ltd. for construction of works located in the NE-24-37-6-W3M within the Corman Park- Saskatoon District. This permit allows for the construction of Phase 1 of the wastewater treatment plant with maximum daily flow of 100 m³/day, including the installation of a membrane bioreactor wastewater treatment system (MBR) consisting of equalization tanks, a pre-treatment unit for screenings removal, grit separation, and fat, oil & grease (FOG) removal, anoxic and aerobic tanks, membrane filtration tanks, UV systems, sludge dewatering units, as well as related structural, mechanical, electrical, and instrumentational components. The permit also allows for the construction of a treated effluent holding cell with capacity of 26,406 m³ for effluent storage prior to the irrigation.

The construction of the approved works for the 101222478 Saskatchewan Ltd. is to be completed in accordance with information provided to the Water Security Agency between September 18, 2015 and August 12, 2016, including:

(a) "Application for Permit to Construct and/or Operate a Sewage Works" dated September 18, 2015;
(b) The letter dated August 12, 2016 prepared by 101222478 Saskatchewan Ltd;
(c) The land lease agreement and addendum signed between 101222478 Saskatchewan Ltd. and Nil-Ray Farms Ltd;
(d) The letter regarding the sludge disposal dated May 27, 2016 submitted by Love Professional Services;
(e) The Decommissioning Plan for NW Saskatoon Wastewater Treatment Plant prepared by PINTER & Associates Ltd;
(f) The design brief for the project prepared by PINTER & Associates Ltd;
(g) The project drawings including structural, mechanical, electrical, and instrumentational plans and system shop drawings; and
(h) All other application correspondence and information relating to these projects which were received by the Water Security Agency.

It is the responsibility of the 101222478 Saskatchewan Ltd to follow the requirements set out in the attached permit and all referenced design standards and guideline documents. Failure to comply with any of...
the permit conditions may lead to the suspension or cancellation of this permit, or other appropriate enforcement action.

The following section provides additional details on portions of the attached permit, as well as other items relating to this project. Please note that all clauses listed in the Permit for Construction are of equal importance and must be adhered to regardless of whether they are discussed in this covering letter.

1. **This permit is issued on the condition that an irrigation feasibility report and associated irrigation system information (as Phase 2 of the project) will be submitted for approval by no later than September 30, 2016.** Please note if the irrigation is not a viable effluent disposal option based on the irrigation study results, a Permit to Operate the wastewater treatment system will not be issued until an appropriate effluent disposal plan is approved.

2. The issuance of this permit for Phase 1 of the project does not guarantee that a permit will be issued for Phase 2 of the project.

3. The maximum daily average flow to the wastewater treatment system is limited to 100 m³/day due to the size of the effluent holding cell capacity. The treatment system shall be equipped with device to monitor and record the daily sewage inflow volume.

4. The wastewater treatment system shall produce a treated effluent that has CBOD₅ and TSS levels less than 25 mg/L and meets all irrigation effluent quality guidelines listed in the Table 1 and Table 2 of EPB 235: Treated Municipal Wastewater Irrigation Guidelines (e.g. fecal coliforms or E.Coli <1000/100 ml).

5. Groundwater monitoring will be required for the proposed effluent storage cell to ensure the exfiltration does not pose significant impact on the local environment.

6. The permittee is required to submit the sludge test results for Toxicity Characteristic Leaching Procedures (TCLP) to the Water Security Agency once the system is up running.

7. Qualified operator should be assigned to operate the new water treatment plant. For detailed direction on facility classification and certified operators, please contact Mr. Ron Cummins at 306-236-7633.

8. Copies of our EPB documents can be found online at: [www.saskh2o.ca/DWBinder.asp](http://www.saskh2o.ca/DWBinder.asp).

9. Please contact your Environmental Project Officer (EPO), Mr. Lee Reinhart, if you have any questions on commissioning requirements. He may be contacted by phone at (306) 933-8367, or by email at Lee.Reinhart@wask.ca.

10. **This project may require permits from other agencies, regulators or other divisions of the Water Security Agency before construction may commence.** The issuance of a Permit for Construction indicates only that a project meets the construction requirements set out in *The Waterworks and Sewage Works Regulations*, and the applicable Water Security Agency construction guidelines (found at the link above). Please note that our review is not a detailed engineering review of the application.
11. You must contact your EPO prior to commencing construction. Upon completion of construction, you must notify the EPO of completion, and submit "as-constructed" drawings. For new treatment works, operation and maintenance manuals must be submitted to the EPO as well.

To report an emergency or upset condition, please contact either your EPO or the 24-hour Upset Report Line at 1-844-536-9494. If you have any questions about this permit, please feel free to call me at 306-787-9166, or email the Engineering and Approvals Unit at WSA.EngineeringandApprovals@wsask.ca.

Yours truly,

Jasmine Wang, M.Sc., P.Eng
Engineering & Approvals
Environmental and Municipal Management Services Division
Saskatchewan Water Security Agency

cc: Russell McCrea, PINTER & Associates Ltd., Saskatoon
    Stacey Love, Love Professional Services, Saskatoon
    Brent Latimer, Saskatoon Regional Health Authority, Saskatoon
    Lee Reinhart, Water Security Agency, Saskatoon

Enclosure
To: 101222478 Saskatchewan Ltd. (Permittee).

PURSUANT to section 27(2)(a) of The Environmental Management and Protection Act, 2010, a permit for construction of works located in NE-24-37-6-W3M within Corman Park-Saskatoon District is issued in accordance with the attached Terms and Conditions. This permit allows for the construction of Phase 1 of the wastewater treatment plant with maximum daily flow of 100 m³/day, including the installation of a membrane bioreactor wastewater treatment system (MBR) consisting of equalization tanks, a pre-treatment unit for screenings removal, grit separation, and fat, oil & grease (FOG) removal, anoxic and aerobic tanks, membrane filtration tanks, UV systems, sludge dewatering units, as well as related structural, mechanical, electrical, and instrumentational components. The permit also allows for the construction of a treated effluent holding cell with capacity of 26,406 m³ for effluent storage prior to the irrigation.

This Permit takes effect on the 15th day of August, 2016.

This Permit expires on the 15th day of August, 2017, unless cancelled or suspended before that date.

Issued:

[Signature]

Jasmine Wang, M. Sc., P. Eng.,
Engineering & Approvals
Environmental and Municipal Management Services Division
Water Security Agency
Terms and Conditions

Section One: Definitions

1.1 All words and phrases have the same definitions as set out in The Environmental Management and Protection Act, 2010, and The Waterworks and Sewage Works Regulations, as the case may be.

1.2 In this Permit:
   (a) “Act” means The Environmental Management and Protection Act, 2010;
   (b) “Regulations” means The Waterworks and Sewage Works Regulations;
   (c) “Environmental and Municipal Management Services Division” means the Environmental and Municipal Management Services Division of the Water Security Agency;
   (d) “Approvals Engineer” refers to the Approvals Engineer or Drinking Water Engineer of the Environmental and Municipal Management Services Division; and
   (e) “Environmental Project Officer” refers to the Environmental Project Officer for the corresponding geographical administration area of the Environmental and Municipal Management Services Division.

Section Two: Construction

2.1 A copy of this cover letter and permit must be given to the person(s) supervising those performing the construction work, such as the contractor or employee.

2.2 Prior to commencing construction, the Permittee shall notify the Environmental Project Officer.

2.3 The construction of the approved works for the 101222478 Saskatchewan Ltd. is to be completed in accordance with information provided to the Water Security Agency between September 18, 2015 and August 12, 2016, including:

   (a) “Application for Permit to Construct and/or Operate a Sewage Works” dated September 18, 2015;
   (b) The letter dated August 12, 2016 prepared by 101222478 Saskatchewan Ltd.;
   (c) The land lease agreement and addendum signed between 101222478 Saskatchewan Ltd. and Nil-Ray Farms Ltd.;
   (d) The letter regarding the sludge disposal dated May 27, 2016 submitted by Love Professional Services;
   (e) The Decommissioning Plan for NW Saskatoon Wastewater Treatment Plant prepared by PINTER & Associates Ltd.;
   (f) The design brief for the project prepared by PINTER & Associates Ltd.;
   (g) The project drawings including structural, mechanical, electrical and instrumental plans and system shop drawings; and
   (h) Any other application correspondence or information relating to these projects which were received by the Water Security Agency.

2.4 By no later than September 30, 2016, the Permittee shall submit the irrigation feasibility study results and irrigation equipment information as Phase 2 of the project for approval.

2.5 The issuance of this permit for Phase 1 of the project does not guarantee that a permit will be issued for Phase 2 of the project.
2.6 Sewage inflow volume control device shall be provided to ensure the maximum daily average flow is limited to 100 m³/day.

2.7 The wastewater treatment system shall produce a treated effluent that has CBOD₅ and TSS levels less than 25 mg/L and meets all irrigation effluent quality guidelines listed in Table 1 and Table 2 of EPB 235: Treated Municipal Wastewater Irrigation Guidelines (e.g. fecal coliforms or E.Coli <1000/100 ml).

2.8 The permittee shall ensure that all pipe, fittings and appurtenances conform to applicable standards or specifications issued by AWWA, CSA, CGSB or other acceptable references.

2.9 There shall be no changes to or deviations from the approved application materials without the prior written consent of the Water Security Agency. Any proposed change or deviation shall be submitted in writing to the Engineering and Approvals Section of the Water Security Agency for approval.

2.10 Upon completion of construction, the Permittee shall:
(a) notify the Environmental Project Officer; and
(b) submit "as-constructed" drawings to the Environmental Project Officer; and
(c) submit operation and maintenance manuals for new treatment works to the Environmental Project Officer.

Section Three: General

3.1 This Permit takes effect on the date shown on the Permit.

3.2 The Permittee shall complete construction of the works in accordance with the Permit by the date shown on the Permit.

3.3 If the Permittee is unable to complete the construction by the expiry date shown on the Permit, the Permittee shall advise the Approvals Engineer in writing, not less than thirty (30) days prior to the Permit expiry date, stating the reasons for non-completion and requesting an extension of the Permit.

3.4 This Permit is not an authorization of approval to operate the works without first obtaining a separate permit to do so in accordance with the Act and Regulations.

3.5 This approval is subject to cancellation, alteration, or suspension as provided by the Act.

3.6 Where any notice or reporting is required to be given by the Permittee, it shall be provided to:

(a) in the case of the Approvals Engineer:
Water Security Agency
Environmental and Municipal Management Services Division
420 – 2365 Albert Street
REGINA SK S4P 4K1
Telephone: (306) 787-6504
Fax: (306) 787-0780
(b) in the case of the Environmental Project Officer:
  Water Security Agency
  Environmental and Municipal Management Services Division
  101-108 Research Drive
  SASKATOON SK S7N 3R3
  Telephone (306) 933-8367
  Fax: (306) 933-6820
October 17, 2016

Mr. Jason Tratch
101222478 Saskatchewan Ltd.
702-601 Spadina Crescent E
SASKATOON SK S7K 3G8

Dear Mr. Tratch:

Re: Permit for Construction – Phase 2: NW Saskatoon Wastewater Treatment Plant- Effluent Irrigation
   Permit No. 00066824-00-00

Enclosed is a Permit for Construction of Sewage Works. The Water Security Agency issues this permit under The Environmental Management and Protection Act, 2010 (EMPA) to 101222478 Saskatchewan Ltd. for construction of works located in the NE-24-37-6-W3M within the Corman Park- Saskatoon District. This permit allows for the construction of Phase 2 of the wastewater treatment plant including installation of irrigation systems for effluent disposal.

The construction of the approved works for the 101222478 Saskatchewan Ltd. is to be completed in accordance with information provided to the Water Security Agency between September 21, 2016 and October 14, 2016, including:

(a) “Application for Permit for Construction of Waterworks or Sewage Works” dated October 13, 2016;
(b) The Agro Environmental Report and Effluent Irrigation Plan prepared by the Ministry of Agriculture;
(c) The Decommissioning Plan Report for NW Saskatoon Wastewater Treatment Plant prepared by the PINTER & Associates dated September 28, 2016, and
(d) All other application correspondence and information relating to these projects which were received by the Water Security Agency.

It is the responsibility of the 101222478 Saskatchewan Ltd to follow the requirements set out in the attached permit and all referenced design standards and guideline documents. Failure to comply with any of the permit conditions may lead to the suspension or cancellation of this permit, or other appropriate enforcement action.

The following section provides additional details on portions of the attached permit, as well as other items relating to this project. Please note that all clauses listed in the Permit for Construction are of equal importance and must be adhered to regardless of whether they are discussed in this covering letter.
1. The installation of irrigation system should avoid areas of lower elevation to ensure long term productivity and ease irrigation system trafficability. The effluent quality is marginally suitable for use on this soil type and careful monitoring of the electrical conductivity (EC) and sodium adsorption ratio (SAR) is required.

2. The permittee shall provide the Water Security Agency with a copy of financial assurance for decommissioning activities and a copy of Environmental Liability Insurance prior to obtaining the Permit to Operate.

3. Copies of our EPB documents can be found online at: www.saskh2o.ca/DWBinder.asp.

4. Please contact your Environmental Project Officer (EPO), Mr. Lee Reinhart, if you have any questions on commissioning requirements. He may be contacted by phone at (306) 933-8367, or by email at Lee.Reinhart@wasask.ca.

5. **This project may require permits from other agencies, regulators or other divisions of the Water Security Agency before construction may commence.** The issuance of a Permit for Construction indicates only that a project meets the construction requirements set out in *The Waterworks and Sewage Works Regulations*, and the applicable Water Security Agency construction guidelines (found at the link above). Please note that our review is not a detailed engineering review of the application.

6. You must contact your EPO **prior** to commencing construction. Upon completion of construction, you must notify the EPO of completion, and submit “as-constructed” drawings. For new treatment works, operation and maintenance manuals must be submitted to the EPO as well.

To report an emergency or upset condition, please contact either your EPO or the 24-hour Upset Report Line at 1-844-536-9494. If you have any questions about this permit, please feel free to call me at 306-787-9166, or email the Engineering and Approvals Unit at WSA.EngineeringandApprovals@wsask.ca.

Yours truly,

Jasmine Wang, M.Sc., P.Eng  
Engineering & Approvals  
Environmental and Municipal Management Services Division  
Saskatchewan Water Security Agency

cc:  
Russell McCrea, PINTER & Associates Ltd., Saskatoon  
Kari Engele-Carter, Saskatoon Regional Health Authority, Saskatoon  
Lee Reinhart, Water Security Agency, Saskatoon

Enclosure
Permit for Construction of Sewage Works

Environmental and Municipal Management Services Division

Issued Pursuant to Section 27 of
The Environmental Management and Protection Act, 2010

To: 101222478 Saskatchewan Ltd. (Permittee).

PURSUANT to section 27(2)(a) of The Environmental Management and Protection Act, 2010, a permit for construction of works located in NE-24-37-6-W3M within Gorman Park-Saskatoon District is issued in accordance with the attached Terms and Conditions. This permit allows for the construction of Phase 2 of the wastewater treatment plant including installation of irrigation systems for effluent disposal.

This Permit takes effect on the 17th day of October 2016.

This Permit expires on the 17th day of October, 2017, unless cancelled or suspended before that date.

Issued:

[Signature]
Jasmine Wang, M.Sc., P. Eng.,
Engineering & Approvals
Environmental and Municipal Management Services Division
Water Security Agency
Terms and Conditions

Section One: Definitions
1.1 All words and phrases have the same definitions as set out in The Environmental Management and Protection Act, 2010, and The Waterworks and Sewage Works Regulations, as the case may be.

1.2 In this Permit:
(a) “Act” means The Environmental Management and Protection Act, 2010;
(b) “Regulations” means The Waterworks and Sewage Works Regulations;
(c) “Environmental and Municipal Management Services Division” means the Environmental and Municipal Management Services Division of the Water Security Agency;
(d) “Approvals Engineer” refers to the Approvals Engineer or Drinking Water Engineer of the Environmental and Municipal Management Services Division; and
(e) “Environmental Project Officer” refers to the Environmental Project Officer for the corresponding geographical administration area of the Environmental and Municipal Management Services Division.

Section Two: Construction
2.1 A copy of this cover letter and permit must be given to the person(s) supervising those performing the construction work, such as the contractor or employee.

2.2 Prior to commencing construction, the Permittee shall notify the Environmental Project Officer.

2.3 The construction of the approved works for the 101222478 Saskatchewan Ltd. is to be completed in accordance with information provided to the Water Security Agency between September 21, 2016 and October 14, 2016 including:
(a) “Application for Permit for Construction of Waterworks and Sewage Works” dated October 13, 2016;
(b) The Agro Environmental Report and Effluent Irrigation Plan prepared by the Ministry of Agriculture;
(c) The decommissioning Plan Report for NW Saskatoon Wastewater Treatment Plant prepared by the PINTER & Associates dated September 28, 2016; and
(d) Any other application correspondence or information relating to these projects which were received by the Water Security Agency.

2.4 The installation of irrigation system should avoid area of lower elevation to ensure long term productivity and ease irrigation system trafficking.

2.5 The Permittee shall provide the Water Security Agency with a copy of financial assurance for decommissioning activities and a copy of Environmental Liability Insurance prior to obtaining the Permit to Operate.

2.6 There shall be no changes to or deviations from the approved application materials without the prior written consent of the Water Security Agency. Any proposed change or deviation shall be submitted in writing to the Engineering and Approvals Section of the Water Security Agency for approval.
2.7 Upon completion of construction, the Permittee shall:
   (a) notify the Environmental Project Officer; and
   (b) submit "as-constructed" drawings to the Environmental Project Officer; and
   (c) submit operation and maintenance manuals for new treatment works to the Environmental Project Officer.

Section Three: General

3.1 This Permit takes effect on the date shown on the Permit.

3.2 The Permittee shall complete construction of the works in accordance with the Permit by the date shown on the Permit.

3.3 If the Permittee is unable to complete the construction by the expiry date shown on the Permit, the Permittee shall advise the Approvals Engineer in writing, not less than thirty (30) days prior to the Permit expiry date, stating the reasons for non-completion and requesting an extension of the Permit.

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   (a) in the case of the Approvals Engineer:
       Water Security Agency
       Environmental and Municipal Management Services Division
       420 – 2365 Albert Street
       REGINA SK S4P 4K1
       Telephone: (306) 787-6504
       Fax: (306) 787-0780

   (b) in the case of the Environmental Project Officer:
       Water Security Agency
       Environmental and Municipal Management Services Division
       101-108 Research Drive
       SASKATOON SK S7N 3R3
       Telephone (306) 933-8367
       Fax: (306) 933-6820
Appendix F

Soild Investigation Study and Preliminary Irrigation Design
September 16, 2015

Jason Tratch
#702-601 Spadina Crescent E
Saskatoon, SK S7K3G8

Dear Jason:

Re: Effluent Irrigation Development on NE-24-37-06-W3M

Enclosed is the Agro Environmental Report (#4549) for the recent soils investigation on the above mentioned quarter.

The NE-24-37-06-W3M is considered to be suitable for effluent irrigation development with soil and water precautions. The areas of lower elevations on this quarter were noted to have imperfect drainage. Installation of an irrigation system that avoids these areas is recommended to ensure long term productivity and ease irrigation system trafficability. The proposed effluent quality for this project fits just within the guidelines for the textures found on this quarter section. Careful monitoring of the effluent electric conductivity and sodium adsorption ratio is required. Please refer to the attached Agro Environmental Report for further details.

If you have any questions, please call me at (306) 867-5517.

Sincerely,

[Signature]

Cara Drury, PAg
Government of Saskatchewan
Irrigation Agrologist, Environmental Unit
Crops and Irrigation Branch, Ministry of Agriculture
410 Saskatchewan Avenue
Outlook, SK S0L 2N0

CC: Randy Holmlund, Crops and Irrigation Branch, Outlook
Jeff Hovdebo, Water Security Agency, Moose Jaw
SOILS ARE MEDIUM IN TEXTURE. THERE ARE SLIGHT TOPOGRAPHY LIMITATIONS. THE AREA IS VERY GENTLY ROLLING WITH 2 TO 5% SLOPES. THIS PROJECT IS RECOMMENDED FOR IRRIGATION DEVELOPMENT WITH WATER PRECAUTIONS. THE EFFLUENT QUALITY IS MARGINALLY SUITABLE FOR USE ON THIS SOIL TYPE. PROVIDING MANAGEMENT FOR SALINITY CONTROL SUCH AS GOOD DRAINAGE, BOTH SURFACE AND SUBSURFACE IF NECESSARY, IS REQUIRED. SALT-TOLERANT PLANTS SHOULD BE SELECTED. THE PROPONENT MONITORING SOIL AND EFFLUENT IS RECOMMENDED.

Issuer's Comments

The soils on this quarter are dominantly medium textured loams (L) ranging from fine sandy loam (FL) to clay loam (CL) from the Elstow and Weyburn associations. These soils have moderate infiltration rates and moderate moisture holding capacities. The areas of lower elevations on this quarter were noted to have imperfect drainage and retain water early in the spring and potentially all season (depending on precipitation). Installation of an irrigation system that avoids these areas is recommended to ensure long term productivity and ease irrigation system trafficability.

The near surface soils on this parcel were found to be dominantly slightly saline (54% of the area). Salt concentration was found to increase with depth in the soil profile. Please refer to the attached EM38 maps. The salt profile of the soil indicates a downward movement of water, but it should be noted that an increase in the water table can potentially raise these dissolved salts higher in the soil profile, impacting productivity. Careful water management that matches crop demand and the growth of higher water use, salt tolerant forages is recommended.

The proposed effluent for this project was estimated to have an electrical conductivity (EC) of 1.3-2.0 mS/cm and a sodium adsorption ratio (SAR) of 2.2-2.8. This quality of effluent fits within the guidelines for the soil textures found on this quarter section. An increase in EC above 2.0 mS/cm will no longer fit within the guidelines for the soil textures on this quarter. Careful monitoring of the effluent EC and SAR is recommended for this project.

Report prepared at the request of

Jason Tratch
#702 - 601 Spadina Crescent E
Saskatoon, SK S7K 3G8

Certificate Messages
206 961

Recommendation
SW3

Water Source

Service Agency

CD

Project #
2016-000116

Approved By

Date of Report
02/09/2016

Report #
4540
PROJECT REVIEW SUMMARY

SYSTEM RECOMMENDATIONS
Total Capacity Minimum Design Standard is 5.6 mm/day (0.22 inches/day). We recommend for this soil texture and area that the APPLICATION RATE is:

[ ] #1 sufficient; OR [ ] #2 insufficient and should be increased to

[ ] 0.26 [ ] 0.28 or [ ] 0.30 inches/day

Reasons: _______________________

PIVOT PRESSURE RANGE: [ ] High [ ] Medium [ ] LPI [ ] LPS

Reasons: _______________________

SIDE ROLL: [ ] Compatible [ ] Not Compatible Reason:

VOLUME GUN: [ ] Compatible [ ] Topography [ ] Infiltration [ ] Water Holding Capacity

Reason: _______________________

REDEVELOPMENT SOIL AND WATER SUMMARY
Redevelopment of this project is considered:

[ ] Beneficial [ ] Non-Beneficial, but not negative [ ] Negative to increasing irrigation efficiency

MINIMUM PIVOT END Pressures for Systems Under Varying Conditions of Soil Texture and Topography

<table>
<thead>
<tr>
<th>TOPOGRAPHY CONSIDERATIONS</th>
<th>COARSE</th>
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<th>FINE</th>
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<tr>
<td>None</td>
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<td>LPI</td>
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<td>High-Medium</td>
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SOIL TEXTURE RANGES

COARSE SOILS - Sand (S), Loamy Sand (LS), Sandy Loam (SL), Fine Sandy Loam (FSL)

MEDIUM SOILS - Loam (L), Silt Loam (StL), Very Fine Sandy Loam (VL)

FINE SOILS - Clay Loam (CL), Sandy Clay Loam (SCL), Sandy Clay (SC), Silty Clay Loam (SICL), Silty Clay (SiC), Clay (C), Heavy Clay (HVC)

DEFINITION OF PRESSURE RANGES BASED ON PIVOT END Pressures

| Low Pressure Spray Nozzle (LPS)   | 175 | < 25 |
| Low Pressure Impact               | 175-275 | 25-40 |
| Medium Pressure                   | 275-380 | 40-55 |
| High Pressure                     | 380+ | 55+ |

* kPa means pressure as measured in kilopascals. Approximate conversions: 1 kPa = .145 psi (1 psi = 6.9 kPa)

** psi means pressure as measured in pounds per square inch

Volume guns only recommended for use on soils with infiltration rates greater than 8 millimetres per hour (0.30 inches per hour)

SPECIAL NOTE FOR SIDEROLL OR TRAVELLING GUN IRRIGATION

If the soils to be irrigated are level to nearly level (< 2% slope), standard infiltration recommendations may be exceeded by 2 to 2.5 times, but we would not recommend this as a general practice. We feel this may be reasonable due to the nature of the topography. If the slope exceeds 2%, recommended rates should be followed.
<table>
<thead>
<tr>
<th>Depth (cm)</th>
<th>%SAT</th>
<th>EC-mS/cm</th>
<th>PH</th>
<th>S.A.R.</th>
<th>SAR(mg/l)</th>
<th>K+ (mg/l)</th>
<th>Mg++ (mg/l)</th>
<th>Ca++ (mg/l)</th>
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<td>1.2</td>
<td>7.2</td>
<td>3.4</td>
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<td>EM 38</td>
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</tbody>
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Date: August 16, 2016

Analytical Results
### Regression Analysis

#### Horizontal Regression Analysis

- Formula: $y = 6.0957x + 10.541$
- $R^2 = 0.9985$

#### Vertical Regression Analysis

- Formula: $y = 4.9138x + 14.529$
- $R^2 = 1$

### Table: Environmental Unit Outcomes (06.00.526)

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**Note:** To increase the number of samples, only copy this row as often as needed.
Elevation data obtained with RT2 GPS equipment. Elevations based on GPS autolocate.
Regression

\[ Y = 6.10 \times X + 10.49 \]

\[ R^2 = 0.98 \]
Regression

\[ Y = 4.91 \times X + 14.53 \]

\[ R^2 = 1 \]
Elevation data obtained with RT2 GPS equipment. Elevations based on GPS autolocate.
Elevation data obtained with RT2 GPS equipment. Elevations based on GPS autolocate.
This preliminary plan has been prepared by Sask Agriculture for regulatory & cost estimating purposes only. The suggested irrigation equipment is designed to meet Sask Agriculture accepted standards. Calculations are based on field elevations obtained from EU GPS topography NE 24-37-08-3.

Suggested irrigation equipment:

Lateral:
- L1: 409 m (1343') hose fed - 182.9 m (600') of 50 mm (2') Ø poly linear move system capable of delivering 19 L/s (300 US GPM) with an end pressure of 207 kPa (30 PSI) w/ underground cable guidance.

Mainline:
- M1: 424 m (1389') of 150 mm (6') Ø PIP PVC mainline rated at 885 kPa (125 PSI), field surveys to determine number & spacing of hydrants.

Installation of adequate valving, fittings & thrust blocking is required.

Pump unit:
- P1: 1 pumping unit capable of delivering 19 L/s (300 US GPM) against a TDH of 39 m (128') with an assumed efficiency of 82% w/ an electric motor capable of producing 11 kW (15 BHP).

Application rate of 6" per acre on irrigable lands.

Total irrigable area: 17 ha (42 ac)

No. Date Plan Revisions By Chk'd App'd
PRELIMINARY PLAN OF EFFLUENT IRRIGATION PROJECT FOR 101222478 SASKATCHEWAN LTD. JASON TRATCH

TWP 37 RGE 06 W3M

SCALE 1:5,000

0 50 100 150 200 250m
Appendix G

Letter of Clearance - Saskatoon Airport Authority
September 6, 2016

Mr. Carlos Guzman  
P. Eng., M.Sc., PMP, Project Engineer  
Proteus Waters Inc.  
702 – 601 Spadina Crescent E  
Saskatoon, SK S7K 3G8

Dear Mr. Guzman:

Re: NW Saskatoon WWTP – Engineered Dugout Approval

The SAA has reviewed your revised concept utilizing an engineered dugout with a surface area of 80m x 150m (12,000m²) as a replacement for existing slough 1 together with the addition of a storm water collection pond of approx. 800m² adjacent to the WWTP facility.

We are in agreement that this is an acceptable solution from a bird risk perspective provided the ongoing operation of the dugout and storm water collection ponds are managed appropriately to mitigate future bird activity on an ongoing basis as referenced by your report entitled Effluent & Stormwater Management Evaluation – RM of Comman Park, Saskatchewan dated June 14, 2016 (your File: 16-1889).

Sincerely,

[Signature]

Andrew Leeming  
Vice President Operational Excellence
Appendix H

Waste Service Removal Letter
October 15, 2015

Proteus Waters Inc.
Corman Park, Sask

Attn: Carlos Guzman

Please accept this letter stating that Loraas Disposal will offer waste service removal from the Waste Water Treatment Plant that will be located at NE 24-37-6-W3M on the condition that the TLCP test supplied to Loraas meets the criteria of the Landfill standards and they are able to accept the material.

Thank You,

Heather Button
Sales Representative
Loraas Disposal Services Ltd.
Appendix I

Database Searches
This map is a user-generated static output from an Internet mapping site and is for general reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable. THIS MAP IS NOT TO BE USED FOR NAVIGATION.

Map center: 52° 11' 54" N, 106° 43' 26" W

Legend
- Sask Outline
- Sask Mask
- Sections
- Rare and Endangered Species
- Acreage
- Communities
- Indian Reserves
- Other
- Rice
- Fish and Wildlife Development
- Flooded Lands
- Wildlife Habitat Protection
- Agricultural Crown Land
- SURN Roads
- Local/Street
- Reserve/Reservoir
- Collector
- Urban Municipalities
- SURN Highways
- Lakes 50s
- Interim Water
- Permanent Water
- Flooded Area
- Impoundment
- Rivers 50s
- PEST Community Pastures
- Ramsar Wetland
- Protected Areas
- Bird Sanctuary
- Wildlife Refuge
- Provincial Historic Sites
- National Wildlife Areas
- Ecological Reserves
- Canadian Heritage River
- Game Reserve
- Recreation Sites
- National Parks
- Provincial Parks
- Historic Park
- Wildlife Park
- Recreation Park
- Natural Environment Park
- Saskatchewan
- Watershed
This quarter-section is NOT heritage sensitive.

It is not necessary to submit the project to the Heritage Conservation Branch for screening. These results can be printed for submission to other regulatory bodies (e.g. Saskatchewan Environment, Saskatchewan Industry and Resources). Please email arms@gov.sk.ca if you have any questions.
Appendix J

Decommissioning Plan
DECOMMISSIONING PLAN REPORT
FOR
NW SASKATOON WASTEWATER
TREATMENT PLANT

September 28, 2016

Prepared by:
Russell McCrea, P.Eng.
PINTER & Associates Ltd.

Reviewed by:
Carlos Guzman, P.Eng.
Proteus Waters Inc.
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INTRODUCTION

The present Decommissioning Plan Report (the Report) has been prepared upon request by Saskatchewan Water Security Agency (WSA) to satisfy part of the requirements for an application for Permit to Construct Sewage Works, in accordance with Part II of The Waterworks and Sewage Works Regulations and Part V of The Environmental Management and Protection Act, 2010. This report provides a description of the activities that will be undertaken when the proposed facility will be decommissioned in order to attempt to restore the project site to pre-development conditions, as well as financial assurance available upfront for decommissioning and insurance requirements to address any potential environmental site liability.

In the Decommissioning Plan Report, restoration refers to the act of bringing a disturbed site back into, as nearly as possible, its original condition, whereas remediation refers to the act or process of removing pollution or contaminants for the protection of the environment and human health.

Specifically, the Decommission Plan Report will describe the following:

- Decommissioning activities after ceasing operations;
- Site Investigation to identify areas potentially affected by the facility;
- Plans to manage excess material and waste;
- Restoration of lands potentially affected by the facility.
- Financial assurance and environmental site liability insurance

1.1 Project Overview

101222478 Saskatchewan Ltd. is proposing to construct and operate a municipal wastewater treatment plant known as NW Saskatoon Wastewater Treatment Plant (NW Saskatoon WWTP). The proposed wastewater treatment plant will treat septic sewage from the City of Saskatoon and Rural Municipality of Corman Park (the RM). The treated effluent will be conveyed through an underground pipe off-Site to an effluent holding cell south west of the WWTP. This holding cell will provide storage for treated effluent during winter months (240 days) as recommended by WSA. Biosolids will be dewatered using a belt filter press, its pathogen content stabilized with lime and hauled off-site to a licensed landfill.

The location of the project site is legally described as NE ¼ 24-37-6-W3M within the RM Corman Park – Saskatoon District. The proposed WWTP will be located in the northeast corner of the quarter section that is currently pasture land and it will be separated from surrounding land by newly constructed berms. The existing lease agreement for the land grants rights for 2.5 acres (approx. 1 hectare). However, an area of 0.62 acres (0.25 hectares) will only be required for the development of proposed wastewater treatment plant.
The basic components of the NW Saskatoon WWTP project, as shown on the Site Plan (Figure 1), will include the following:

- Sewage receiving stations (3)
- Equalization tank
- Wastewater treatment plant
- Driveway

**Figure 1. Site Plan for Proposed Wastewater Plant**

### 1.2 Operations Period and Decommissioning Date

NW Saskatoon WWTP is expected to be in operation for at least seven (7) years. Current lease agreement with the land owner grants rights to use the land for a period of ten (10) years, terminating in 2026. Facility components will be maintained and replaced as needed which will allow the facility to operate beyond a seven (7)-year period either at the proposed site or to be removed to a new site, if relocation is later required.

Decommissioning activities are not expected to commence prior to the seven (7) years of operations. When NW Saskatoon WWTP will cease operations, adaptive reuse of the property and on-site components will be considered. Wastewater treatment equipment, enclosed in a building, will be dismantled and relocated to a new site for continued use. On-site components of the development that can be used for other purposes will remain on the site. In the event that no adaptive reuse is desired or found, components of development will be demolished and removed from the site via truck to an appropriate recycling facility or filled in using appropriate materials.

It is estimated that a time period of approximately one month is required to decommission the wastewater treatment plant, which will involve the removal of both above ground and underground components. Section 2 of this report provides a detailed plan for the activities involved in the decommissioning of the plant.
2 DECOMMISSIONING OF STRUCTURES AND EQUIPMENT

2.1 Aboveground Components
Aboveground structures, equipment and components include three (3) sewage receiving stations, a pre-fabricated building, wastewater treatment equipment, and an internal roadway (driveway). Except for the driveway, all other elements of the aboveground elements will be completely removed upon decommissioning.

2.1.1 Sewage Receiving Stations
There will be three (3) portable sewage receiving stations consisting of an insulated stainless steel enclosure, equipment and instrumentation (pneumatic gate valve, flowmeter, compressor, probes, and controller). The sewage receiving stations will be maintained throughout the operation of the WWTP. Pending the condition of the equipment, the sewage receiving stations will be either sold to third parties as complete units for continued use or as equipment components. Equipment components can be separated into scrap metal or waste products. Scrap metals will be hauled to a recycling facility and waste products will be disposed of at a licensed landfill.

2.1.2 Pre-fabricated Building
The building, to be used to enclose the wastewater treatment plant, will consist of a 1,280-square feet (119 square meters) pre-fabricated structure based on standard ISO HQ 40’ shipping containers. This modular structure will be manufactured for maximum strength, durability, and longevity. The pre-fabricated building will have 25 mm sandwich wall panels for insulation and galvanized steel top sheet as interior wall surface. The modular structure will be removed from the Site and relocated by individually transporting each of its seven (7) units of 40’ container modules.

The foundation of the building will consist of steel frame rig mats, which are designed to support large amount of weight. The rig mats will be also removed from the Site. Pending on the conditions on decommissioning, the rig mats will be resold or separated into scrap metal and waste wood. Scrap metal will be shipped to a recycling facility and waste products will be hauled to a licensed landfill.

2.1.3 Wastewater Treatment Plant Equipment
The wastewater treatment plant is based on membrane bioreactor (MBR) technology, which will treat septic sewage from the RM of Corman Park and City of Saskatoon. Under normal operations, all effluent in the MBR will be treated and pumped out to an effluent holding cell south west of the WWTP. Residual sludge (aka waste activated sludge, WAS) from the treatment process will be dewatered, stabilized (using lime), removed from the site by a waste hauler, and disposed of at a licensed landfill.

The wastewater treatment process consists of a sewage pretreatment unit and the MBR system. The sewage pretreatment unit comprises grit and grease removal device with screw conveyors all made of stainless steel. The MBR system is comprised of three structural stainless steel tanks.

The WAS treatment process consists of solids dewatering and mixing of dewatered solids with lime. The WAS treatment equipment includes a polymer mixing and dosing system, belt filter press, mixing and lime dosing device, and screw press conveyor.
The equipment for wastewater treatment and WAS treatment will be maintained and replaced as needed throughout the life cycle of the facility in order to maintain efficient operations. Therefore, the wastewater treatment and WAS treatment equipment is considered to have inherent value and can be sold to third parties for continued use. In the event that the equipment does not have a residual value at the time of decommissioning, it will be demolished and, where possible, all scrap metal will be sent to scrap metal recyclers and waste material will be shipped off-site for disposal as appropriate at the time of decommissioning.

The processing units of the wastewater treatment and WAS treatment will contain skid mounted equipment including electrical components, piping, HDPE tanks, and supporting instrumentation. Therefore, the equipment can be readily removed from the enclosing building and relocated to a new site for continued use.

2.1.4 Driveway
The driveway area consists of approx. 165 square meters (1,776 square feet) of soil aggregate and stabilizer (Permazyme). This internal road will be left on the site post-decommissioning activities. The driveway will match the surface elevation that drains surface runoff south for continued stormwater management on the site post-decommissioning activities.

2.1.5 Stormwater and Effluent Drainage
The topography of the Site is relatively flat along the northern and eastern borders with existing drainage ditches and along the western border with a slough. The WWTP will have berms all around the perimeter with a 1 foot deep ditch to collect and contain any surface runoff. Grading will direct surface runoff towards the WWTP perimeter ditch and via a channel towards a stormwater holding pond on-site.

Upon decommissioning, the berms surrounded the WWTP perimeter will be demolished and filled in. The grade of the Site post-decommissioning will be maintained the existing passive system for stormwater drainage.

2.2 Underground Components

2.2.1 Underground Piping
There will be three underground pipes between the underground tank and the wastewater treatment building. The pipelines will consist of PVC-U or stainless steel (304L) pipes. The pipelines will be removed after the building and supporting rig mat structure underneath have been removed. All steel piping will be removed and sent to a scrap metal recycling facility. Plastic piping will be removed and hauled off-site via truck for disposal.

There will also be a buried pipeline to convey the treated effluent between the wastewater treatment building and the evaporation pond located southwest of the WWTPs. This pipeline will consist of a buried HDPE pipe at a depth of approximately 2.7m below ground level. This pipeline will be removed at the time of decommissioning.
2.2.2 Sewage Equalization Tank
The underground equalization tank will remain on site and will not be reused. A sump pump and associated instrumentation in the tank will be removed from site and recycled as scrap. Scrap metal will be recycled and waste material will be disposed of at a licensed landfill.

The equalization tank is a 100-cubic meter concrete tank located immediately west of the wastewater treatment building. When the plant manager is aware of the decommission date, plans will be put in place to halt sewage delivery to the plant and keep the sewage level in the tank to a minimum. The remaining liquid contents of the equalization tank will pumped out by a vacuum truck and hauled to a licensed waste treatment facility. Subsequently, the tank will be disinfected by spreading hydrated lime over all exposed surfaces. The top and those parts of the walls above the ground will be demolished and collapsed into the tank and the tank filled with clean soil. The backfill material will be obtained from an on-site borrow pit.

2.2.3 Natural Gas Connection
A new natural gas pipeline will be constructed from the main gas line to the wastewater treatment building. This line will be removed during decommissioning. SaskEnergy will be notified of activities associated with the removal of this pipeline. The trench where the pipeline is placed will be dug out to allow for the pipeline removal. A licensed contractor will remove the carbon steel pipeline. The pipeline will be shipped off-site and recycled as scrap metal. The trench will be filled in using appropriate fill material and top soil that will be sodded post closure of the trench.
3 MANAGEMENT OF EXCESS MATERIAL AND WASTE

3.1 Excess Sewage
When the plant manager is aware of the decommission date, plans will be put in place to reduce and halt sewage delivery to the plant, which will allow for a gradual slow-down of the plant until all operations cease and the sewage level in the equalization tank is kept to a minimum. The remaining liquid contents of the equalization tank will pumped out by a vacuum truck and hauled to a licensed waste treatment facility.

3.2 Excess Chemicals
Excess chemicals used in membrane cleaning (sodium hypochlorite and citric acid) and sludge dewatering (flocculant) and stabilization (lime) are not expected to be remaining on the site at the time of decommissioning. These chemicals will be delivered regularly to the WWTP in 20 L pails, 15 lb or 50 lb bags. As the plant winds down, these chemicals will be used and, based on the experience of the plant operators, additional chemicals not needed will not be ordered or delivered to the site. Residual chemicals from storage tanks in the plant will be shipped off-site by a licensed waste hauler to an approved disposal facility.

3.3 Effluent and Biosolids from the Wastewater Treatment Facility
Treated effluent from the WWTP will be discharged to a holding cell south west of the facility as per normal operating procedures. Upon decommissioning, the wastewater treatment plant will be emptied of treated effluent. There may be waste activated sludge (WAS) present in the bottom of the wastewater treatment process tanks. This sludge will be pumped out to a sludge holding tank and subsequently dewatered by the belt filter press and stabilized by the lime mixing unit. The resulting biosolids will hauled to a licensed landfill as per the Permit to Operate.
4 SITE RESTORATION AND REMEDIATION OF LAND NEGATIVELY AFFECTED BY THE WWTP

This section provides a description of the existing environment, potential environmental impacts of the proposed development, proposed mitigation measures, proposed site restoration, and remediation of land negatively affected by the facility. In this Report, restoration is defined as the act of bringing a disturbed site back into, as nearly as possible, its original condition, whereas remediation refers to the act or process of removing pollution or contaminants for the protection of the environment and human health.

4.1 Description of Existing Environment
The proposed NW Saskatoon WWTP will require two point five (2.5) acres (approx. 1 hectare) of the NE 24-37-6-W3M quarter section to be subdivided and rezoned for waste management use as per the RM of Corman Park – Saskatoon Planning District Zoning Bylaw. However, an area of 0.62 acres (0.25 hectares) will only be developed for the project. The site is located north of the City of Saskatoon and west of Highway 16. The surrounding land uses of the site include country residential (to the northwest), light industrial (to the northeast) and agricultural.

The quarter section is currently zoned for agricultural use and consists of pasture land with sloughs. The vegetation of pasture consists mainly of grasses, which are grazed throughout the summer. The site does not include areas of ecological significance and is identified as not heritage sensitive.

The regional hydrogeological characteristics, obtained from the WSA groundwater mapping of the Saskatoon Map sheet 73B2, indicate Saskatoon is part of the prehistoric Lake Saskatchewan during the deglaciation era. The surficial geology at the site consists mainly of the Haultain Alloformation. The Alloformation consists (in descending order) of lacustrine silt and clay layer (Grasswood Allomember) followed by deltaic silt and sand (Furdale Allomember) layer. Generally, the Haultain Alloformation is a relatively coarse texture formation, which increases towards the surface due to increase of sand and silt contents.

The main surficial groundwater aquifer in the area is the Dalmeny Aquifer, which is protected by a thick aquitard clay and silt till layer (Grasswood Allomember) ranges in depth from approximately 25 – 75 m. The area is served by drinking water line, which explains the low number of groundwater wells (a total of five (5) groundwater wells) within 1.6 km of the site.

There are four (4) groundwater monitoring wells installed on the plant site. Three (3) wells are positioned north, south and east of the evaporation pond and one (1) well west of the evaporation pond area.

4.2 Potential Environmental Impacts
During operations and plant decommissioning, potential negative effects on the environment are limited to accidental spills and releases of on-site chemicals or catastrophic releases of the contents of sewage from the equalization and process tanks. Residual biosolids will be stabilized and hauled away from the
The Waste Water Treatment Plant is designed to remove suspended solids, organics and nutrients, such as nitrogen (ammonia and nitrates) and partly phosphorous through a nitrifying/denitrifying membrane bioreactor (MBR) process. The MBR process is a mature and proven technology that is able to produce high quality effluent. Typical water reuse applications for treated effluent from MBR-based facilities include land irrigation, flushing toilets, fire reservoir, and cooling towers. In addition, the WWTP will use UV radiation for effluent disinfection. Therefore, the risk of groundwater contamination due to treated effluent infiltration and migration to nearby aquifers is considered low.

In the effluent holding cell's quarter section, drinking water wells are not located. The WSA database indicates the presence of wells in quarter sections NW, NE and SW of the holding cell's quarter section. Exact well locations are unknown. Based on the well locations, local geology and intake screen depths, drinking water produced by these wells will not be at risk of being affected by effluent infiltration.

**4.3 Proposed Mitigation Measures**

The facility will be constructed and operated with mitigating measures in place to reduce, control and prevent accidental spills. Monitoring activities mandated as part of the project construction and operating approvals will ensure that the mitigation measures are functioning as designed. A contingency is in place in the event that mitigation measures fail and an accidental release occurs. Spills of the hazardous substances will be reported to Water Security Agency (WSA) and cleaned up when the spill occurs and the Site restored at that time to prevent the migration of any materials from entering the surrounding environment.

Since treated effluent will be release in the land adjacent to the proposed site, precautionary measures will be taken to monitor groundwater quality. A groundwater monitoring plan will serve as an assessment tool for effluent quality, in addition to the Permit to Operate. Four (4) groundwater monitoring wells will be installed near the effluent holding cell as per the “Protocols for the Installation and Sampling of Monitor Wells” (WQ 117, 1989) and ‘Guidelines for Groundwater Monitor wells at Wastewater Disposal Sites’ (WQ 100, 1987).

The baseline groundwater quality will be determined prior to operating the proposed WWTP and discharge of treated effluent by collecting and analyzing water samples from the four (4) monitoring wells. Water samples will be tested for the following parameters: Nitrate Nitrogen, Total Phosphorus, Biochemical Oxygen Demand, Fecal Coliform Bacteria, Conductivity, pH, Alkalinity, Calcium, Magnesium, Sodium, Bicarbonate, Carbonate, Chloride, and Sulphate. Time frames for the sampling of groundwater monitoring wells after construction and decommissioning will be once after two months, six months and a year, and each two years thereafter. Frequency of sampling and analysis of groundwater monitoring well are subject to the Permit to Operate.
4.4 Proposed Site Restoration
As described in Section 2, decommissioning of the WWTP involves a Phase two (2) Environmental Site Assessment (ESA) and then the removal of aboveground and underground components. All components of the aboveground elements, except for the driveway, will be completely removed upon commissioning. This includes the WWTP building and all wastewater treatment equipment.

Underground components include pipes and equalization tank. Underground pipes between the underground tank and the WWTP building will be removed. The effluent pipeline will be either filled with fillcrete or removed at the time of decommissioning. Once the equalization has been emptied, it will be disinfected by spreading hydrated lime over all exposed surfaces. The top and those parts of the walls above the ground will be demolished and collapsed into the tank and the tank filled with clean soil. The backfill material will be obtained from similar offsite soil deposits.

The berms surrounding the WWTP perimeter will be demolished and filled in upon decommissioning. The grade of the Site post-decommissioning will maintain the existing passive system for stormwater drainage.

4.5 Remediation of Land Negatively Affected by the WWTP
Accidental spills and releases of on-site chemicals or sewage from the equalization and process tanks will be reported to WSA and cleaned up when the spill occurs. Similarly, the Site will be remediated at that time to prevent the migration of any materials from entering the surrounding environment. Therefore, soil remediation of the Site is not anticipated at the time of decommissioning. However, during decommissioning activities, if any visual or olfactory evidence of a spill is observed, fill material on the Site showing staining or odour will be removed by a licensed waste hauler for appropriate disposal at an approved facility.

As a precautionary measure to protect groundwater, monitoring wells will be installed near the effluent holding cell. The baseline groundwater quality will be determined prior to operating the proposed WWTP and discharge of treated effluent by collecting and analyzing water samples from four (4) monitoring wells.

If groundwater contamination is detected, operations may be halted upon WSA or Saskatchewan Ministry of Environment recommendation. Since the source of wastewater is limited to residential origin, a Monitored Natural Attenuation (MNA) is recommended as an effective approach to bring the affected groundwater into compliance with remediation standards.
5 FINANCIAL ASSURANCE AND ENVIRONMENTAL SITE LIABILITY INSURANCE

5.1 Financial Assurance for Decommissioning Costs
The decommissioning costs of the proposed WWTP have been calculated based on the activities involved in the decommissioning of structures and equipment, management of excess material and waste, and site restoration and remediation. Monitoring costs for five (5) years of post-closure monitoring have been estimated to be $5,000. A 10-percent contingency cost has been added to the estimated decommissioning costs. Table 1 summarizes the decommissioning costs for based on present value costs.

Table 1. Estimated Decommissioning Costs

<table>
<thead>
<tr>
<th>Item</th>
<th>Estimated Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decommissioning of Structure &amp; Equipment</td>
<td>$10,000</td>
</tr>
<tr>
<td>Management of Excess Material &amp; Waste</td>
<td>5,000</td>
</tr>
<tr>
<td>Restoration/Remediation of Land</td>
<td>5,000</td>
</tr>
<tr>
<td>Post-closure monitoring</td>
<td>5,000</td>
</tr>
<tr>
<td>Contingency Costs (10%)</td>
<td>2,500</td>
</tr>
<tr>
<td><strong>Total Cost</strong></td>
<td><strong>$27,500</strong></td>
</tr>
</tbody>
</table>

101222478 Saskatchewan Ltd. will provide financial assurance. Accordingly, an upfront financial assurance will be provided, if requested by WSA.

Post-closure monitoring involves the periodic sample analysis of groundwater monitoring wells around the development and reporting to WSA.

5.2 Environmental Site Liability Insurance
101222478 Saskatchewan Ltd. will take all precautionary measures during design, construction, operation, and decommissioning to prevent soil or groundwater contamination. However, for protection against potential claims, the legal representative of 101222478 Saskatchewan Ltd. has arranged to provide the landlord with an Environmental Site Liability Insurance policy for the minimum amount of $2 million, as stated in the Land Lease Agreement (Appendix 1). This insurance policy will cover property damage, remediation costs, and related legal expenses for pollution conditions on, at under or migrating from the insured property. The insurance will be in place before operations and renewed on an annual basis during once the WWTP start operations. Based on the expected environmental impact assessed and remediation requirements in case of soil or groundwater contamination, the proposed $2 million amount is deemed to be appropriate and standard in industry.
6 SUMMARY
This Decommissioning Plant Report provides detailed explanation of the activities involved in the decommissioning of the proposed NW Saskatoon WWTP. In general, all equipment at the plant that has a residual value upon decommissioning will be sold to third parties. The remainder of materials on the site will be sorted into scrap metal and waste products. Metal components that can be recycled will be sold to a scrap metal recycler. All other materials that are not deemed fit for recycling or reuse will be removed from the site and disposed of at a licensed landfill as permitted at the time of decommissioning.

As part of the decommissioning plan, in the event that surface structures removal and demolition activities are conducted the site will be returned, as much as possible, to baseline conditions. Baseline conditions at the site consist of pasture land. The grade of the site will be maintained so that the existing passive stormwater draining system will be left intact, thus draining towards the centre of the quarter section.

This Decommissioning Plan Report also addresses potential negative impacts to the environment, a process to determine the mitigation measures to prevent impacts from occurring, proposed site restoration, and remediation of land negatively affected by the WWTP. The mitigation measures will be followed throughout the course of the entire life of the project including construction, operation, and decommissioning.

101222478 Saskatchewan Ltd. will provide a Financial Assurance to cover the WWTP decommissioning costs. For protection against potential claims, 101222478 Saskatchewan Ltd. will provide the landlord with an Environmental Site Liability Insurance policy for the minimum amount of $2 million, which will be in place before operations and renewed on an annual basis during the WWTP operations. Based on the proposed environmental impact assessed and remediation requirements in case of soil or groundwater contamination, the proposed $2 million amount is deemed to be appropriate.

Russell McCrea, P.Eng
Project Manager

PINTER Saskatoon Office: 710A - 48th Street East
Saskatoon, SK  S7K 5B4

Ph: 306 244-1710  Fx: 306 933-4986

www.pinter.ca
Appendix 1

Land Lease Agreement
LAND LEASE AGREEMENT
Regarding: NE Saskatoon Project

Version Date: Dec. 29, 2015

This Land Lease Agreement (the “Agreement”) is between:

Name: Nil-Ray Farms Ltd.
Attention: Brian Nilsson
Address: 303-13220 St. Albert Trail,
Edmonton, AB T5L 4W1
Phone: 780-477-2233
hereinafter called the “LANDLORD”

and

Name: NE Saskatoon Plant (#101222478 SK Ltd)
Attention: Jason Tratch
Address: 702-601 Spadina Cres.,
Saskatoon, SK S7K 5G8
Phone: 306-715-1589
hereinafter called the “TENANT”

Landlord and Tenant in consideration of the mutual covenants hereinafter set forth, agree as follows:

1. THE PREMISES

1.1 The “PREMISES” is a parcel of land owned by the Landlord and shall comprise an area of 2.5 acres. Such area is to be measured and determined in accordance with the plan as outlined on the attached Schedule, located on a portion of the lands described in clauses 1.2 and 1.3 and Appendix 1: Land Location. Such Land Location shall be approved by the Landlord at its sole discretion.

1.2 Municipal Address:
Nil-Ray Farms Ltd.
Attention: Brian Nilsson
Address: 303-13220 St. Albert Trail, Edmonton, AB T5L 4W1
Phone: 780-477-2233

1.3 Legal Description of the Premises:
- Legal Land Description is: NE 24-37-6-W3
- NE quarter of Section 24, Township 37, Range 6, West of 3rd Meridian
- NE square parcel (100 meters x 100 meters) as defined in Appendix 1

1.4 Irrigation Water Management Option: The Premises is located within a Quarter Section (NE Quarter) which forms part of Section 24, Township 37, Range 6, West of 3rd Meridian) which is also owned by the Landlord. The Tenant has the option to negotiate a contract which would include the following provisions: winter water storage within a stormwater retention pond, dugout or swamps plus summer water irrigation of vegetation or crops. The Tenant would require access to provide valuable irrigation to adjacent crops. The irrigation process requires an easement for a graded outflow channel and soil burms to ensure water discharge from the Premises flows in an engineered and controlled manner into the
slough located in the central area of the adjacent quarter. Such contractual arrangement shall be entered into by the Landlord at its sole and unfettered discretion and for clarity, the Landlord has the right to refuse such contractual arrangement.

1.5 Alternate Water Management: if water storage and/or irrigation is not available outside the Premises, the Tenant will store water within the boundaries of the Premises. Water release will be conducted as designed by engineers (e.g. sub surface drainage back to the aquifer or release into the stormwater flow plan of the municipality) and will comply with all legislation both enacted and proposed.

2. TERM
2.1 The Lease shall be for a term of 10 years, commencing May 1, 2016 and terminating on the day of April 30, 2026.
2.2 Possession of the land will commence at 12:00 pm on the dates listed above.

3. BASIC RENT
3.1 Basic Rent is the rental rate payable to the Landlord.
3.2 Basic Rent for the period of May 1, 2016 to April 30, 2019 shall be $5,000 per annum plus all applicable taxes including GST and PST, payable annually in advance (May 1st of each year).
3.3 Basic Rent for the period of May 1, 2019 to April 30, 2021 shall be $10,000 per annum plus all applicable taxes including GST and PST, payable annually in advance (May 1st of each year).
3.4 Basic Rent for the period of May 1, 2021 to April 30, 2026 shall be $20,000 per annum plus all applicable taxes including GST and PST, payable annually in advance (May 1st of each year).

4. ADDITIONAL RENT OR EXPENSES
4.1 Common expenses, shared costs or additional maintenance fees are not applicable to this agreement.

5. TAXES AND INSURANCE
5.1 The Tenant shall pay GST and all other applicable taxes on all Basic Rent and additional rent where applicable.
5.2 The Tenant shall be responsible for and pay in advance all land taxes, rezoning costs, application costs and other related costs for the development of the Premises as determined by the Landlord. Tax assessments will occur based on RM of Corman Park requirements/assessments. Any communication with the RM of Corman Park regarding taxes for the Premises must involve input, feedback and negotiation from both the Tenant and Landlord but the Landlord will have the ultimate decision making authority when communicating with the RM of Corman Park and any other legislative authority.
5.3 The Tenant shall arrange, pay for and provide the Landlord with insurance policies and certificates that include the Landlord as an insured and loss payee for both liability and environmental insurance in the minimum amounts of $2 Million.

5.4 All costs associated with the Premises shall be paid by the Tenant and the Landlord shall enjoy a care free lease of the Premises.

6. CONDITION OF PREMISES

6.1 The Tenant has visually inspected the Premises and agrees to accept the Premises in “as is” condition.

6.2 The Tenant is authorized to carry out the work necessary to complete the Premises, as set out in Appendix 2: Tenant’s Work Schedule. Any Tenant’s work shall be presented to the Landlord for approval and the Landlord shall inspect and approve the Tenant’s proposed work prior to its commencement.

6.3 The Tenant agrees to surrender the Premises at the end of the Term in substantially the same condition as the Premises were in at the commencement of the Term, unless otherwise agreed by the Landlord in writing. Any environmental liability, pollution liability or other liability associated with the Tenant’s use of the Premises shall be the full responsibility of the Tenant for complete clean up, return to original condition and compliance with all regulations, laws and other requirements.

6.4 The Tenant may enter into negotiations with the Landlord to leave aspects of the Premises as-is when required to vacate the site (e.g. leave gravel parking lot if beneficial to future development).

7. USE OF PREMISES

7.1 The Premises shall only be used for the operations of a Municipal Wastewater Treatment and Water Recovery Plant.

7.2 The Landlord grants the Tenant exclusivity with respect to treating Municipal Sewage to a maximum of 68,000 meters cubed per year utilizing an MBR Technology. For details on the MBR Technology to be utilized, refer to separate attachment called “Nil-Ray Farms Land Lease Addendum - MBR Technology”. Such exclusivity shall result in the Landlord not treating municipal waste on the Premises in a manner other than that which the Tenant has proposed; however, the exclusivity shall be terminated in the event the Tenant is unable to perform including for Force Majeure reasons.

7.3 The Landlord grants the Tenant exclusivity with respect to irrigating the quarter section which is owned by Nil-Ray Farms (Northwest Quarter of Section 24, Township 37, Range 6, West of 3rd Meridian). The irrigation will consist of treated effluent from the wastewater treatment plant mixed with storm/run-off water if applicable. The irrigation must meet regulatory conditions of the Permit to Construct/Operate.

8. CONDITIONS

8.1 The Tenant must ensure the land is not damaged due to flooding (as a result of excessive water irrigated onto the Section of land) of any other reason related to the irrigation by the Tenant. The Tenant shall provide the Landlord with an engineering report from a qualified engineer that explains and
documents the volumes and risks of operating the Wastewater Plant and conducting irrigation. Upon acceptance and approval of the Engineering Report by the Landlord. The Tenant shall provide annual reports or reports as often as the Landlord deems necessary, acting reasonably, to ensure that the irrigation is being conducted within proper business practices and that the lands on which the irrigation occurring have acceptable nutrients being applied as determined by the Landlord, acting reasonably.

8.2 If the Water Management Option is approved (as stated in section 1.4 above), the Landlord must allow access at any time (subject to the below) to the quarter section (Northwest Quarter of Section 24, Township 37, Range 6, West of 3rd Meridian) for any work related to irrigation of the land and the prevention/maintenance of the quarter section to prevent flooding/land degradation. The Tenant will have private, gated, locked access to the quarter section from this parcel and must take due diligence to ensure cattle gates are not changed or impacted.

8.3 The Tenant must communicate to the Pasture Manager in advance of any work that is required on the land that is not within the Premises unless the work to be performed is of an urgent nature to adhere to regulatory requirements.

9. THE LEASE

9.1 Within ten (30) days of unconditional acceptance of this Agreement, the Landlord will prepare and provide to the Tenant the Lease to conform to the provisions in this Agreement.

9.2 The Lease shall supersede all of the provisions of this Agreement. The Landlord and the Tenant acknowledge and agree that in the event of any conflict between the terms of this Agreement and the Lease the terms of the Lease shall govern.

10. ADDITIONAL TERMS

10.1 All time periods, deadlines and dates in this Agreement will be strictly followed and enforced. All times will be Central Time unless otherwise stated.

10.2 This Agreement is for the benefit of and will be binding upon the heirs, executors, administrators and permitted assigns of the individual parties and the successors and permitted assigns of corporate parties.

10.3 Capitalized words used in the headings, shall define the terms used in this Agreement.

10.4 This Agreement will be governed by the laws of the Province of Saskatchewan. The parties submit to the exclusive jurisdiction of the Courts in the Province of Saskatchewan regarding any dispute that may arise out of this transaction.

10.5 The Landlord shall have the ability to assign this Agreement, the Lease and any other collateral documents as referenced herein. The Tenant shall have similar rights except with the written approval of the Landlord, which may be arbitrarily withheld.

11. BINDING AGREEMENT

11.1 This offer, when accepted, shall constitute a binding Agreement to Lease.
11.2 The Landlord and the Tenant each acknowledge that, except as otherwise described in this Agreement, there are no other warranties, representations or collateral agreements made by or with the other party, any neighbouring lands, and this transaction, including any warranty, representation or collateral agreement relating to the size/measurements of the land and buildings or the existence or nonexistence of any environmental condition or problem.

12. ENVIRONMENTAL HAZARDS
12.1 The Landlord is responsible for pre-existing environmental hazards on the Premises, if any, at the time the Tenant takes possession.
12.2 The Tenant is responsible for environmental hazards that result from its subsequent use and occupancy of the Premises and indemnifies the Landlord with respect thereto.

13. TERMINATION OR ALTERATION OF LEASE
13.1 The Landlord must provide 3 years of advance written notice if the Lease is to be terminated.
13.2 The Landlord shall have the option to relocate the Tenant upon 1 year's written notice. Should the Landlord choose to relocate the Tenant, the Landlord shall provide the Tenant with a similar parcel of land in size and geography and such parcel shall have access to a municipal road.
13.3 If Landlord terminates the Lease or exercises its option to relocate the Tenant to another location, the Landlord must financially reimburse the Tenant for the cost of the civil improvements made to the site. The reimbursement must be at fair market value (independent estimate approved by both the Tenant and Landlord) and shall not exceed actual cost based on proof of payment. Estimated land improvements and estimated costs include and are limited to the following:

<table>
<thead>
<tr>
<th>Sample Land Improvement (not all-inclusive)</th>
<th>Estimated Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power (electric)</td>
<td>15,000-25,000</td>
</tr>
<tr>
<td>Heat (natural gas)</td>
<td>10,000-20,000</td>
</tr>
<tr>
<td>Approach</td>
<td>10,000-15,000</td>
</tr>
</tbody>
</table>

If the Landlord exercises its option to move the Tenant within 5 years of the commencement of the Lease the Landlord will reimburse the Tenant up to $25,000 for site work required on the new parcel of land.
14. AUTHORITY TO EXECUTE AND BIND

IN WITNESS WHEREOF the parties hereto have executed this Agreement effective as of the day and year first above written;

<table>
<thead>
<tr>
<th>Landlord, Per</th>
<th>Witness, Per</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name:</td>
<td>Name:</td>
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<td>Title:</td>
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<td>Date:</td>
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<tr>
<td>Signature:</td>
<td>Signature:</td>
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</tbody>
</table>

Mar 22/16

<table>
<thead>
<tr>
<th>Tenant, Per</th>
<th>Witness, Per</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name:</td>
<td>Name:</td>
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<tr>
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Mar 29/16
Appendix 1: Land Location and Maps

For additional maps, please refer to the following pages:

- A1-1 (First following page) – screen shot taken from a RM of Corman Park map. The map website is http://www.rmormonpark.ca/page/maps/. The title of the map is: 2014__RM_344__July RM of Corman Park Map. You can see the land parcel roughly in the center of this map, and the site is located in the top right corner of the top right quarter section of land, within Section # 24, plant site is marked with a Red X

- A1-2 (Second following page) – screen shot from google road maps view of the area that the plant is located (high level view showing how it is on the North West side of Saskatoon, South of Auction Mart Road), plant site is marked with a Red X

- A1-3 (Third following page) – screen shot and direct location of the plant, taken from google satellite maps (google earth) view, plant site is marked with a Red X

- A1-4 (Fourth following page) – site plan as it is geographically located in the upper most NE corner of the quarter section of land and is consisting of a larger and smaller square parcel – the Plant Work Site is the smaller, inner square approximately 50 meters long by 50 meters wide, larger square measures approximately 100 meters long by 100 meters wide and is the size of the parcel for this agreement (2.5 acres) Note: the 2.5 acres will be surveyed and clearly marked prior to any civil works

- A1-5 (Fifth following page) – example of the civil works and dimensions of the Plant Work Site and the tentative plans to connect to the Range Road 3060
Appendix 2: Tenant’s Work Schedule

A project schedule will be provided by the Tenant to the Landlord as soon as the Permit to Construct is received from the Ministry of Environment.

Note:
- Civil work on site is planned to begin in May, 2016
- Plant operation is planned to begin in July, 2016
ADDENDUM 1

Version Date: May 5, 2016

This document is in reference to a Land Lease Agreement dated Dec. 29, 2015 regarding: NE Saskatoon Project, between the parties

<table>
<thead>
<tr>
<th>Name: Nil-Ray Farms Ltd.</th>
<th>Name: NE Saskatoon Plant (#101222478 SK Ltd)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attention: Brian Nilsson</td>
<td>Attention: Jason Tratch</td>
</tr>
<tr>
<td>Address: 303-13220 St. Albert Trail, Edmonton, AB T5L 4W1</td>
<td>Address: 702-601 Spadina Cres., Saskatoon, SK S7K 3G8</td>
</tr>
<tr>
<td>Phone: 780-477-2233</td>
<td>Phone: 306-715-1589</td>
</tr>
</tbody>
</table>

hereinafter called the “LANDLORD”

hereinafter called the “TENANT”

May it be known that the undersigned parties do hereby agree to make the following changes that are outlined below. These changed clauses replace the previous clauses within the original contract and will be considered the most recent, active, up to date clauses for the original contract.

Stated contract clauses include clause 2.1 and 7.2 which now read as:

Updated Terms:

2. TERM
2.1 The Lease shall be for a term of 10 years, commencing the date of the month that the RM of Corman Park approves access to the land through their rezoning and Council Review process. This lease would terminate 10 calendar years following this start date. If this date surpasses November, 2016, the Landlord has the right to revisit the terms of this contract.

7. USE OF PREMISES
7.2 The Landlord grants the Tenant exclusivity with respect to treating Municipal Sewage to a maximum of 68,000 meters cubed per year utilizing an MBR Technology. For details on the MBR Technology to be utilized, refer to separate attachment called “Nil-Ray Farms Land Lease Addendum - MBR Technology”. Such exclusivity shall result in the Landlord not treating municipal waste on the Premises in a manner other than that which the Tenant has proposed; however, the exclusivity shall be terminated in the event the Tenant is unable to perform including for Force Majeure reasons.
7.3 The Landlord grants the Tenant exclusivity with respect to discharging into the quarter section which is owned by Nil-Ray Farms (Northwest Quarter of Section 24, Township 37, Range 6, West of 3rd Meridian). The discharge will consist of treated effluent from the wastewater treatment plant mixed with storm/run-off water if applicable. The discharge must meet regulatory conditions of the Permit to
Construct/Operate. Future irrigation plans will require additional permit approvals with applicable departments as required.

Addendum Signatures

IN WITNESS WHEREOF the parties hereto have executed this Agreement effective as of the day and year first above written;

Landlord, Per

Name: Brian Nilsson
(print)
Title: President
Date: May 9, 2016
Signature:

Witness, Per

Name: Chantelle Switzer
(print)
Title: Admin Assistant
Date: May 9, 2016
Signature:

Tenant, Per

Name: Jackon Trudel
(print)
Title: CEO
Date: May 9, 2016
Signature:

Witness, Per

Name: Jocelyn Trudel
(print)
Title:
Date: May 9, 2016
Signature:
Appendix K

Decommissioning Plan Approval - Water Security Agency
Subject: RE: CDR comments- Decommissioning and Remediation Plan
From: Jasmine Wang <jasmine.wang@wsask.ca>
Date: 2016-10-21 10:53 AM
To: Carlos Guzman <carlos.guzman@proteuswaters.com>

Hello Carlos

The Water Security Agency has reviewed the Decommissioning Plan Report for NW Saskatoon Wastewater Treatment Plant dated September 28, 2016 and Site Remediation Letter dated October 18, 2016 both prepared by PINTER. The activities and procedures specified in the decommissioning and remediation plan seems appropriate. The WSA does not have further questions or concerns.

Regards,

---

From: carlos.guzman@galexgroup.com [mailto:carlos.guzman@galexgroup.com] On Behalf Of Carlos Guzman
Sent: Thursday, October 20, 2016 1:27 PM
To: Jasmine Wang
Subject: Fwd: CDR comments

Carlos Guzman, P.Eng., M.Sc., PMP
Project Engineer
Proteus Waters Inc.
Ph: (306) 715-1589
www.proteuswaters.com

---------- Forwarded message ----------
From: Chad Watson <cwatson@rmcormanpark.ca>
Date: Fri, Oct 14, 2016 at 4:15 PM
Subject: CDR comments
To: Jason Tratch <jason.tratch@galexgroup.com>, "Russell McCrea P.Eng" <russell.mccrea@pinter.ca>, Hugo Beenke <hugo.beenke@pinter.ca>, Carlos Guzman <carlos.guzman@proteuswaters.com>

Hello all,

Attached is a document with comments from the RM and City based on the most recent draft of the CDR. Please review and contact me if you have any questions.

Take care,
Appendix L

Access Road Specifications
SUMMARY OF BASIC STANDARDS

Right-of-way width = 46 meters (purchased).

Full width of right-of-way to be cleared.

The standard basic finished top width for heavy haul roads is 10.0 meters for gravel surface and 9.0 meters for surfaced.

Sideslopes = 4:1
- fills 0 – 3 meters = 4:1
- fills 3 meters to 4 meters - toe of slope to be 12.0 meters from shoulder.
- fills over 4 meters = 3:1

Backslopes - 5:1, with maximum of 3:1
- 5:1 backslope is to be maintained until top of backslope reaches the edge of right-of-way. The backslope will remain at the edge of the right-of-way to a maximum of 3:1.

Snowclearance – When shoulder grade elevation is 0.3 meters or less above natural surface at 23.0 meters from center line then the backslope must be flattened using a variable slope of 5:1 to a maximum of 3:1.

Maximum gradient – 5%. In unusual circumstances – 6%.

Stopping sight distance – 200 meters minimum (for 100 km/h design).

Clear vision at road intersection – minimum of 85 meters from the point of intersection on municipal roads and grid intersections and to a maximum of 140 meters on primary grid roads using 80 km/h design speed and 200 meters for a highway on another heavy haul road using 100 km/hr design spread.
Heavy Haul Access Road Program

Subject: Heavy Haul Road - Gravel

<table>
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<tr>
<th>Required Construction Standards</th>
<th>Subject: Heavy Haul Road - Gravel</th>
</tr>
</thead>
</table>

Shall include the installation of all necessary drainage structures and construction of drainage ditches. Culverts should be designed for at least a Q15 flow, with a minimum culvert size of 500 mm diameter. Riprap only where necessary to avoid undue erosion. All culverts will be constructed of metal unless approved by the Municipality prior to construction.

Construction shall include all road connections and approaches. See attached plan – Standard Approach.

The average shoulder elevation of the road surface to be approximately 0.6 meters above the adjacent ground surface, except in cuts.

Objectionable organic material shall be subcut where the fill is less than 0.6 meters in depth.

The subgrade surface shall not be less than 1.5 meters above high water level on the ground water table. (ie: level to which free water would rise in a hole sunk in the ground).

Road surface, sideslopes, ditches and backslopes shall be bladed smooth to conform to the typical cross-section.

Where necessary provide a smooth, stable driving surface, the road top shall be capped with a minimum of 0.3 meters of clay material. If the subgrade is to be surfaced clay material should be avoided if possible and a granular subgrade constructed. Gravel shall be incorporated in the top 100 mm of the subgrade prior to traffic gravel being applied. Gravel incorporation shall be done according to the Municipal Specification attached. The gravel specification for incorporation is Type 103 or Type 104.

Gravel surfacing for the subgrade required at the rate of 250 m³/km for the first application, 250 m³/km for the year following construction and additional applications as required. The required gravel specification for traffic gravel is Type 106 or Type 108.

Alignment – curves must be constructed with the proper super-elevation as per the Ministry of Highways & Transportation Standards.

Asphalt surface for heavy haul roads – Soil testing is required to determine surface design. Along with the soil testing, traffic volume and vehicle configurations must be considered when selecting the surface structure.
SPECIFICATION FOR GRAVEL INCORPORATION

DESCRIPTION

The work will consist of traffic gravel uniformly mixed with the insitu material in the top of the subgrade.

MATERIALS

The gravel will be supplied, hauled and placed on the road by the developer.

The gravel will meet Type 103 or Type 104 specifications.

The gravel will be mixed with insitu material from the top of the subgrade.

A water source will be supplied by the developer.

CONSTRUCTION

The contractor may use any machine, combination of machines or equipment that will result in the gravel being uniformly mixed with the subgrade material in the top 100 millimetres of the finished road top. The mixture of gravel and subgrade material shall be packed enough to produce a smooth firm surface that will support normal road traffic without rutting or becoming unstable.

The amount of gravel to be blended into the subgrade may vary as directed by the Engineer but will normally be 190 cubic metres per kilometre (400 cubic yards per mile). The width and depth of subgrade material scarified or loosened up may also vary as designated by the Engineer, however, the width will normally be two metres less than the subgrade road top width and the depth will be between 75 to 100 millimetres.

Adding water to the mixture will be directed by the Engineer if there is insufficient moisture to produce a stable driving surface.

All surplus rock (80 millimetres and larger) shall be removed from the surface and disposed of as directed by the municipality. All small rocks from thirty millimetres (30 mm) to eighty millimetres (80 mm) shall be bladed off the road top into the ditch or onto the sideslope.
NOTE: SUBGRADE WIDTH FOR HEAVY HAUL–SURFACED ROADS TO BE DETERMINED AFTER COMPLETION OF SURFACING DESIGN.
Appendix M

Preliminary Hydrogeologic & Geotechnical Study
PROJECT: PRELIMINARY HYDROGEOLOGIC & GEOTECHNICAL STUDY FOR PROPOSED NW SASKATOON WWTP

LOCATION:

LSD NE 24-37-6-W3
RM OF CORMAN PARK, SK
18 September 2015

CONFIDENTIAL

To Whom It May Concern

Subject: PRELIMINARY HYDROGEOLOGIC & GEOTECHNICAL STUDY FOR PROPOSED NW SASKATOON WWTP
LSD NE 24-37-6-W3
IN THE RM OF CORMAN PARK, SASKATCHEWAN

Attached is a copy of our Preliminary Hydrogeological & Geotechnical Investigation for the proposed NW Saskatoon Waste Water Treatment Plant (WWTP) in the RM of Corman Park, Saskatchewan. PINTER has completed the preliminary hydrogeological investigation for a risk assessment for the proposed location of the NW Saskatoon WWTP at the proposed site located at NE 24-37-6-W3M (the Site).

The area south of the Site is affected by additional runoff but will be contained to a central slough area and is summarized and shown on the attached drawings. The run off area will require some earthworks to berm in-between the natural high points of the natural basin and a ditch will run from the Site to allow the effluent water to flow into the central slough area. These measures should adequately address the worst case scenario of a 1 in 100 year storm and still maintain separation from the other surface drainage on the Site.

PINTER has reviewed the site characteristics, conducted a geotechnical investigation, and performed hydrogeological testing on the site. The Hydrology and Surface water flow predictions are included on the attached Preliminary Hydrogeologic Study. The level of risk on this project has been determined to be low to minor. With a few changes to the site topography it will be possible to confine a drainage basin to store the effluent that is isolated from all other drainage patterns on site. The increased surface waste water has been estimated at 10,500m3 (or 20% of the maximum yearly volume) and combined with a severe rain storm (1 in 100 year storm). The resulting storage would be more than adequate to contain the water below the berm elevation with a factor of safety of three (3) times the required freeboard (elevation of water below the containment berm). The combined area of the existing three (3) sloughs within the drainage basin is 63,000 m2 or 15.5 acres. The contours and previous satellite imagery mapping shows these two sloughs were combined in previous years and will return to being a combined slough.
The closest and larger of the sloughs is “slough 2” which anticipated to increase in elevation by 0.35m, and a resulting increase in surface area of approximately 7,300 m².

The anticipated increase in surface area that is attributed to the maximum output by the NW Saskatoon WWTP is negligible as the overall area has a natural basin where the water is contained and the overall area is much larger than required by any typical storm water retention pond.

I would formally like to recommend this project to continue through the permitting phase and comprehensive design review (CDR) from the RM of Corman Park as the risk it poses is minimal and the project is suitable for consideration.

If you have any questions or concerns regarding our findings, please do not hesitate to contact the undersigned at: (306)-244-1710.

Yours Sincerely,

PINTER & Associates Ltd.

Russell McCrea, P.Eng.
Municipal Project Engineer
PRELIMINARY HYDROGEOLOGICAL REPORT

PROJECT RATIONAL

101222478 Saskatchewan Ltd. is planning to construct a Wastewater Treatment Plant (WWTP) (the Plant) at the Nil-Ray Farms Ltd. (the site) located at NE 24-37-6-W3M (the Site) outside the City of Saskatoon city limits, 800 m west of the junction of Highway 16 and Auction Mart Road, as shown in Figure 1 (Attachment A). Currently, the Site is used as a farmland pasture in the Biz Hub Industrial Park located north of the City of Saskatoon city limits.

Commercial properties in the area, currently, rely on holding tanks to hold their sewage. The stored untreated wastewater is hauled to the City of Saskatoon sewage treatment plant located at the far northeast corner of the city (approximately 10 km) for treatment and disposal.

A pre-requisite of the Saskatchewan Water Security Agency (WSA), in the preliminary stage of this project, is to assess the risks associated with the project and evaluate the likelihood of these risks on the existing hydrogeological conditions of the Site and surrounding areas. Potential risks include excessive runoff and flooding during a severe rainfall event, effects on physical and chemical properties of the soil, and impacts on the surficial aquifers (if any) in the area.

PROJECT BACKGROUND

The expected maximum annual discharge capacity of the Plant is estimated to be approximately 50,000 m$^3$/year of mechanically treated wastewater. The treated wastewater will be discharged to an evaporation pond, which will be constructed at the low lying area at the northeast corner of the Site, as shown in Figure 2 (Attachment A). The treated effluent quality of the Plant would meet (if not exceed) the typical effluent quality of advanced (mechanical) treatment process guidelines$^1$.

PINTER and Associates Ltd. (PINTER) carried out hydrogeological and geotechnical investigations at the site in the months of June and July in 2015. The details of these investigations are included in the corresponding reports (under development), which will be part of the Comprehensive Development Report of the Project (CDR) presented to the RM of Corman Park, SK. The following is a summary of the main outcomes of those investigations, which will be used as the basis for the Risk Assessment and Management process for the project.

The results of the hydrogeological and geotechnical investigations PINTER and Associates Ltd. (PINTER) carried out hydrogeological and geotechnical investigations at the site in the months of June and July 2015. The details of these investigations are included in the corresponding reports (under development), which will be part of the Comprehensive Development Report of the Project (CDR) presented to the RM of Corman Park, SK. The following is a summary of the

main outcomes of those investigations, which will be used as the basis for the Risk Assessment and Management process for the project.

REGIONAL HYDROLOGY AND GEOLOGY

The regional hydrogeological characteristics of the area are obtained from the WSA groundwater mapping of the Saskatoon Mapsheet 73B\(^2\). Saskatoon is part of the prehistoric Lake Saskatchewan during the deglaciation era. The surficial geology at the site consists mainly of the Haultain Alloformation. The Alloformation consists (in descending order) of lacustrine silt and clay layer (Grasswood Allomember) followed by deltaic silt and sand (Furdale Allomember) layer. Generally, the Haultain Alloformation is a relatively coarse texture formation, which increases towards the surface due to increase of sand and silt contents\(^3\).

The main surficial groundwater aquifer in the area is the Dalmeny Aquifer, which is protected by a thick aquitard clay and silt till layer (Grasswood Allomember) ranging in depth from approximately 25 – 75 m. The area is served by drinking water line, which explains the low number of groundwater wells (a total of five (5) groundwater wells\(^4\)) within 1.6 km of the site.

LOCAL HYDROLOGY AND GEOLOGY

LOCAL GEOLOGY

Figure 3 (Attachment A) shows the proposed project layout in addition to the location of the test holes drilled during the hydrogeological and geotechnical investigations. A Geological cross section of the northeast corner of the Site is shown in Figure 3. The lithological profile at the site supports the regional geological characteristics. A top silty sand layer is underlain by a silt till layer down to an approximate depth of 3.5 m below ground surface (bgs). The surficial layers are interbedded with thin intermittent sand layers. Increasing clay content (from silty sand to silt till layer) reflects the change from lacustrine to deltaic deposits.

Silty till layer, extending to the bottom of the drilled test holes, acts an aquitard (relatively low permeability) for any deep percolation of infiltrated surface water. Scattered shallow sand layers will facilitate the lateral movement of the infiltrated water. Discontinuity of those layers across the site reduces the risk of extensive lateral movement off site, considering the expected effluent discharge capacity.

Generally, Saskatoon soils at the Site have relatively good water-holding capacity, which reduces vertical downward movement through infiltration and deep percolation. The infiltrated water is


held in the root zone, due to the existence of grass, until withdrawn for transpiration, through the evapotranspiration process.

**INfiltration**

Two infiltration tests were carried out at the Site. The estimated infiltration rate is 36 mm/hr for the top surficial layer. Relatively low infiltration rate was observed at the bed of the dry slough area, which indicates the capability of the low lying areas to slow the infiltration of the stored treated effluent.

**Evaporation and Evapotranspiration**

Actual evaporation and evapotranspiration measurements were not carried out at the Site. Literature typical values for the prairies are used to carry out water balance calculations. Generally, evaporation consumes most rainfall on the prairies through direct wet surface evaporation from open water bodies. The Site is a grassland which increases the upward movement of moisture through evapotranspiration, reducing the amount of infiltration water. In general, precipitation in the prairie is relatively low, ranging from 300-400 mm per year. On average, seasonal evaporation and evapotranspiration losses are close to the seasonal rainfall in the Province, except in wet years.

**Rainfall**

Short duration rainfall Intensity-Duration-Frequency (PDF) curves for the City of Saskatoon at Diefenbaker International Airport are used to estimate the 100-year rainfall intensity. 15-min and 60-min duration rainfall events were used to estimate the 100-year storm intensities; 60 mm/hr and 120 mm/hr, respectively. These intensities were used to estimate the total annual volume of rainfall water to be considered in the design capacity of the evaporation ponds.

A maximum of 10,500 m$^3$ of additional storage is required in the evaporation ponds to account for 100-year storm, which is approximately 20% of the maximum effluent discharge capacity of the Plant.

**Site Topography**

Detailed site topography was carried out at the site as part of the fieldwork. Areal extension of the potential evaporation ponds and its holding capacity (volume) exceeds the required storage capacity for the effluent discharge. The areal extension of the evaporation pond provides a good means for increased surface area, which enhances the evaporation process and reduces the risk of excessive infiltration.

---


6 Environment Canada. (2012) Short Duration Rainfall Intensity-Duration-Frequency Data. Saskatoon Diefenbaker International Airport Station #4057120.
CONCLUSION

The risks associated with the construction of the evaporation pond are low and the provided risks mitigation measures will alleviate any future concerns.

If you require additional information please do not hesitate to contact the undersigned at 306-244-1710.

Sincerely yours,
PINTER & Associates Ltd.

Russell McCrea, P.Eng.
Project Manager
Municipal Services
Appendices

APPENDIX A

FIGURES

APPENDIX B

CROSS SECTIONS
Appendix B

Cross Sections
Cross Section: BH15-3 - BH15-6

Date: 16 June 2015

Drawn By: KM
Checked By: IE
Appendix N

Stormwater Plan Assurance and Comparison Specifications - Wet Ponds
To Whom It May Concern,

Re: **STORMWATER PLAN ASSURANCE AND COMPARISON OF SPECIFICATIONS – WET PONDS**

In regards to the City of Saskatoon concerns on the stormwater plan, this letter will illustrate the specifications followed in the design and how they relate to the *City of Saskatoon Stormwater Design Standards*.

The specifications followed in the design process where the WSA required specs that can be seen in the *Stormwater Guidelines EPB 322*. Section 3.4.1 “Wet Ponds” outlines the design guidelines that were considered in the design process. In comparison to *Section Six, Stormwater Drainage System* of the *City of Saskatoon New Neighbourhood Design and Development Standards Manual*, the Design guidelines remain in parallel with such similarities as; the same side slopes, the same maximum permanent water depth, etc. Both lists of design guidelines can be seen in the attached documents.

The design of the holding pond was made to withstand a 1-in-100-year storm, something both guidelines deem a necessity. To further increase the factor of safety, the holding pond will be constructed with four bermed walls, reaching a minimum height of 3 meters about existing ground level and a freeboard of 3.3 meters.

In the process of the Preliminary Hydrogeological & Geotechnical Study, the local geology and topography were analysed to ensure that all effluent and stormwater would remain onsite. The full report can be found in the Comprehensive Development Review (CDR) package.

Should there be questions, please do not hesitate to contact the undersigned.

Sincerely,

Russell McCrea, P.Eng.
Project Engineer

Encl.

1. EPB 322 Stormwater Guidelines
2. City of Saskatoon New Neighbourhood Design and Development Standards Manual, Section Six, Stormwater Drainage System
Stormwater Guidelines

EPB 322

April 2006
Preface

Under The Environmental Management and Protection Act, 2002 (EMPA) and The Water Regulations, 2002; stormwater quality and most aspects of its management at present is not specifically regulated. The purpose of this guideline is to provide a high-level technical guidance to municipal authorities, individuals and consultants who plan to develop and implement drainage systems for stormwater in urban/built-up municipal areas, commercial and industrial areas in Saskatchewan. Although the guidelines provide technical and practical guidance, users must exercise judgment in planning, designing and implementing stormwater management works.

Stormwater management solutions are site specific, which must be recognized when using the guidance provided in this document. The designer has to determine if a single practice or a combination of practices are needed to meet the stormwater objectives and goals for any given site and is responsible for the design and decisions made with respect to stormwater management.

Saskatchewan Environment encourages the development and use of novel designs and best available technologies in developing stormwater management solutions. Saskatchewan Environment believes that the guidelines, when employed as a “Code of Practice” will aid minimizing the impacts on receiving waters due to stormwater discharges and may serve as a “diligent” approach to improved stormwater management in the province.
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1. Rationale and Background for Stormwater Management Guidelines

Stormwater is rainfall and snowmelt that runs off the land into storm sewers, streams and nearby lakes or rivers. The degradation of water quality has received increasing attention over the past several decades. The cause of degradation may be attributed to point sources of pollution such as wastewater treatment plants or industrial waste discharges. Although a great deal of progress has been made to minimize or eliminate point sources of pollution, water quality degradation of some watercourses may occur due to non-point pollution such as stormwater runoff.

It is recognized that urbanization increases the quantity of localized stormwater runoff and affects the quality of water in receiving water bodies, thereby resulting in significant environmental impacts, which affect aquatic habitats of receiving waters. Environment Canada has estimated that urbanization of a natural drainage basin can result in increases in stormwater runoff of 400 per cent or more.

Where urbanization occurs, undisturbed pervious surfaces become impervious with the construction activities. Impervious surfaces produce an increase in stormwater runoff, both quantitatively and qualitatively. It is anticipated that these changes may cause pollution in receiving waters, affect the aquatic habitats and their functions, disrupt the natural balance of physical, chemical and biological processes, result in soil erosion that creates damage downstream, reduces infiltration of water into the ground and in extreme cases may also causes flooding.

Municipal stormwater collection systems discharge many substances in addition to water. As stormwater collects and flows over pavement, lawns, driveways and other urban surfaces; it collects considerable quantities of pollutants such as oil and grease, fertilizers, pesticides and metals. Sediment from active construction sites often discharges into storm drainage systems. Private citizens may also contribute to stormwater pollution by improper disposal of lawn clippings, used oil or household chemicals. Industrial and commercial facilities may discharge pollutants into stormwater collection systems through cross-connection of storm drains and sanitary sewers.

Under The Environmental Management and Protection Act (EMPA) and The Water Regulations stormwater quality and most aspects of its management at present is not specifically regulated. Neither EMPA nor The Water Regulations presently require a permit for the construction or operation of a dedicated stormwater works. However, EMPA does provide authority for the creation of regulations governing stormwater by virtue of:

81(1)(bbb) respecting storm water and storm water works, including prohibiting any matter or action related to storm water works and protecting the environment as it is affected by storm water and requiring the holding of a permit to do any matter or undertake any action related to storm water works and protecting the environment as it is affected by storm water;

The Water Regulations define stormwater as:

2(1)(gg) “storm sewer” means a system of conduits, drains, mains, manholes, basins and pipes intended to convey storm water exclusively or principally.

The Water Regulations only prohibit the permittee of a sanitary sewage works from interconnecting a sanitary sewers and storm sewers by means of Section 14 as follows:

14 No permittee shall cause any sanitary sewers and storm sewers to be interconnected in a manner that permits sewage in the sanitary sewer to be discharged through the storm sewer.

Prior to the revisions to water related legislation in 2002, the management of stormwater was specifically exempted from permitting by clause 6(1)(d) of The Water Pollution Control and Waterworks Regulations which state:

6(1) The following discharge of contaminants are exempted from Clause 17(a) of the Act:
(d) any storm water discharge other than storm water discharge at any industrial operation that has a permit pursuant to clause 17(a) or 17(c) of the Act.

Interconnection of stormwater and sanitary sewers was also prohibited under the former Water Pollution Control and Waterworks Regulations that was in effect from 1987 to 2002.

Although management aspects of stormwater management are presently limited as outlined above, section 4(2) of EMPA prohibits discharges that may cause or is causing an adverse effect as follows:

4(2) No person shall discharge or allow the discharge of a substance into the environment in an amount, concentration or level or at a rate of release that may cause or is causing an adverse effect unless otherwise expressly authorized pursuant to:

(a) this Act or the regulations;
(b) any other Act, Act of the Parliament of Canada or the regulations made pursuant to any other Act or Act of the Parliament of Canada; or
(c) any approval, permit, licence or order issued or made pursuant to:
   (i) this Act or the regulations; or
   (ii) any other Act, Act of the Parliament of Canada or the regulations made pursuant to any other Act or Act of the Parliament of Canada.

Pollution resulting from stormwater runoff carries the potential to affect the quality of water and environment in natural receiving systems. Saskatchewan Environment believes it is essential to develop and implement ‘Stormwater Management Guidelines’ as a “Code of Practice” for municipal authorities, individuals and consultants who plan to develop and implement drainage systems for stormwater in urban areas, commercial and industrial areas. Voluntary observance of these guidelines will then serve as a “diligent” approach to improved stormwater management in the province and thereby avoid the potential consequences of adverse impacts to aquatic ecosystems.

2. Stormwater Quantity and Quality

2.1 General
Stormwater quantity is variable in duration, frequency and location. The amount of stormwater runoff reaching a receiving water body will also depend upon the surface over which it travels. An increase in stormwater runoff in urban areas results in increased peak flows, which must be determined in order to design and implement any stormwater works. The quality of stormwater runoff is often a function of several mechanisms and the type and amount of pollutants in runoff are associated with a given land use or activity. As the case with the design of any wastewater treatment works, the incoming quality of stormwater runoff must be known prior to designing any stormwater works.

2.2 Stormwater Quantity
The hydraulic sizing of drainage and conveyance structures in urban areas always requires estimation of peak flow rates. Peak flow is the maximum rate of flow passing a given point during or after a rainfall event. Historically, the Rational Method is the most widely used method of estimating the peak runoff rates for the design of urban drainage systems. The Rational Method is based on an empirical formula relating the peak flow rate to the drainage area, the rainfall intensity and a runoff coefficient. The Rational formula is:

\[ Q = 0.0028 \, C \, I \, A \] [Metric units], or
\[ Q = C \, I \, A \] [British units]

Where
- \( Q = \) peak runoff rate
- \( C = \) dimensionless runoff coefficient
- \( I = \) rainfall intensity for a duration that equals time of concentration (\( t_c \)) of the basin (mm/hr and in/hr in metric and British units, respectively)
- \( A = \) basin area (hectares and acres in metric and British units, respectively), and
- \( t_c = \) time of concentration for the basin for the particular event (min).
The fundamental assumptions underlying the Rational Method are: 
- The rainfall intensity is constant over a period that equals the time of concentration of the basin;
- The rainfall intensity is constant throughout the basin;
- The frequency distribution of the event rainfall and the peak runoff rate are identical (this assumption is true for all event-based computations);
- The time of concentration of a basin is constant and is easily determined; and
- The runoff coefficient is invariant, regardless of season of the year or depth or intensity of rainfall.

Typically, rainfall intensities are determined from Intensity-Duration-Frequency curves (IDF curves) or Depth-Duration-Frequency curves (DDF curves). These are plots of rainfall intensity (or depth) verses duration of event rainfall. The runoff coefficient $C$ that is commonly used in estimating peak runoff rate is shown in Table 1.

There are a number of computer programs (models) that are available to perform hydrologic and hydraulic computations for large watersheds. However, only a few programs are designed as general application models that can be applied to a wide variety of problems in different locations. There are two types of models for doing hydrologic and hydraulic computations for a system: continuous simulation models and event-based models. These models can be used as long as the designer can demonstrate that the model is appropriate and accurate.

<table>
<thead>
<tr>
<th>Type of drainage area</th>
<th>Runoff coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business:</td>
<td></td>
</tr>
<tr>
<td>Downtown areas</td>
<td>0.70-0.95</td>
</tr>
<tr>
<td>Neighborhood areas</td>
<td>0.50-0.70</td>
</tr>
<tr>
<td>Residential:</td>
<td></td>
</tr>
<tr>
<td>Single-family areas</td>
<td>0.30-0.50</td>
</tr>
<tr>
<td>Multi-units, detached</td>
<td>0.40-0.60</td>
</tr>
<tr>
<td>Multi-units, attached</td>
<td>0.60-0.75</td>
</tr>
<tr>
<td>Suburban</td>
<td>0.25-0.40</td>
</tr>
<tr>
<td>Apartment dwelling areas</td>
<td>0.50-0.70</td>
</tr>
<tr>
<td>Industrial:</td>
<td></td>
</tr>
<tr>
<td>Light areas</td>
<td>0.50-0.80</td>
</tr>
<tr>
<td>Heavy areas</td>
<td>0.60-0.90</td>
</tr>
<tr>
<td>Parks, Cemeteries</td>
<td>0.10-0.25</td>
</tr>
<tr>
<td>Playgrounds</td>
<td>0.20-0.40</td>
</tr>
<tr>
<td>Railroad yard areas</td>
<td>0.20-0.40</td>
</tr>
<tr>
<td>Unimproved areas</td>
<td>0.10-0.30</td>
</tr>
<tr>
<td>Lawns:</td>
<td></td>
</tr>
<tr>
<td>Sandy soil, flat, 2%</td>
<td>0.05-0.10</td>
</tr>
<tr>
<td>Sandy soil, average, 2 to 7%</td>
<td>0.10-0.15</td>
</tr>
<tr>
<td>Sandy soil, steep, 7%</td>
<td>0.15-0.20</td>
</tr>
<tr>
<td>Heavy soil, flat, 2%</td>
<td>0.13-0.17</td>
</tr>
<tr>
<td>Heavy soil, average, 2 to 7%</td>
<td>0.18-0.25</td>
</tr>
<tr>
<td>Heavy soil, steep, 7%</td>
<td>0.25-0.35</td>
</tr>
<tr>
<td>Streets:</td>
<td></td>
</tr>
<tr>
<td>Asphalitic</td>
<td>0.70-0.95</td>
</tr>
<tr>
<td>Concrete</td>
<td>0.80-0.95</td>
</tr>
<tr>
<td>Brick</td>
<td>0.70-0.85</td>
</tr>
<tr>
<td>Drives and walks</td>
<td>0.75-0.85</td>
</tr>
<tr>
<td>Roofs:</td>
<td>0.75-0.95</td>
</tr>
</tbody>
</table>
2.3 Stormwater Quality
Numerous studies have indicated that there can be significant pollution in receiving waters due to stormwater runoff. The pollutant loading from urban/rural runoff may be similar to that of wastewater effluent and industrial discharges and have significant impacts on potable water supply, aquatic habitat, recreation, agriculture and aesthetics. Stormwater runoff is usually high in suspended solids and organic matter that exert oxygen demand in the receiving waters. Other pollutants or physical conditions associated with urban/rural runoff that are harmful to receiving waters include nitrogen/phosphorus, temperature, pathogens, metals, hydrocarbons, organics and salt.

Significant impacts on receiving waters associated with stormwater discharges include:

- water quality changes (short-term) during and after storm events including temporary increases in the concentration of one or more pollutants, toxins or bacteria levels;
- long-term water quality impacts caused by the cumulative effects associated with repeated stormwater discharges from a number of sources; and
- physical impacts due to erosion, scour and deposition associated with the increased frequency and volume of runoff that alters aquatic habitat.

Pollutants frequently found in stormwater runoff, their source and the impact on receiving waters are summarized in Table 2. Stormwater samples were collected by Saskatchewan Environment during spring 2005 (immediately after snowmelt) from selected storm sewer outfalls located in a Saskatchewan community and the results of selected parameters are shown in Table A-1 of Appendix A. The results of stormwater samples collected during summer 2003 from selected stormwater outfalls located in another Saskatchewan community are shown in Table A-2 of Appendix A. Table A-3 in Appendix A provides compilation of selected parameters from a study on urban runoff conducted by the USEPA. Table A-4 in Appendix A shows the concentration of certain parameters in stormwater collected from two storm outfalls located in the City of Edmonton.

Table 2. Summary of main Stormwater Pollutants, Sources, Effects, and Related Impacts.

<table>
<thead>
<tr>
<th>Stormwater Pollutant</th>
<th>Sources</th>
<th>Effects</th>
<th>Related Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen/Phosphorus (Nutrients)</td>
<td>Urban landscape runoff (fertilizers, detergents, plant debris, sediments, dust, gasoline, tires); agricultural runoff (fertilizers, animal waste); failing septic systems.</td>
<td>Phosphorus is the limiting nutrient in most freshwater systems. Nitrogen is the limiting nutrient in most saltwater systems, but can be a concern in streams as well.</td>
<td>Algal growth; reduced clarity; lower dissolved oxygen (DO); release of other pollutants. Nutrients can limit recreational values (swimming, boating, fishing and other uses), reduce animal habitats and contaminate water supplies.</td>
</tr>
<tr>
<td>Suspended solids</td>
<td>Construction sites; other disturbed and non-vegetated lands; eroding banks; road sanding; urban runoff.</td>
<td>Increased turbidity and deposition of sediment.</td>
<td>Increased turbidity; lower DO; deposition of sediments; smothered aquatic habitat.</td>
</tr>
<tr>
<td>Pathogens (bacteria/viruses)</td>
<td>Animal waste; urban runoff; failing septic systems.</td>
<td>Presence of bacteria and viral strains. Bacteria levels are usually high in summer when warm temperatures are beneficial to reproduction.</td>
<td>Human health risks via drinking water supplies; contaminated shellfish-growing areas and swimming beaches.</td>
</tr>
<tr>
<td>Metals</td>
<td>Industrial processes; normal wear of automobile brake lines and tires; automobile emissions and fluid leaks; metal roofs.</td>
<td>Increased toxicity of runoff and accumulation in the food chain.</td>
<td>Toxicity of water column and sediment; bioaccumulation in aquatic species and through the food chain.</td>
</tr>
<tr>
<td>---</td>
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</tr>
<tr>
<td>Hydrocarbons (oil and grease, Polycyclic Aromatic Hydrocarbons (PAHs))</td>
<td>Industrial processes; automobile wear; automobile emissions and fluid leaks; waste oil.</td>
<td>Degraded appearance of water surfaces; limiting water and air interactions (lower DO). Hydrocarbons have a strong affinity for sediment.</td>
<td>Toxicity of water column and sediment; bioaccumulation in aquatic species and through the food chain.</td>
</tr>
<tr>
<td>Organics (pesticides, polychlorinated biphenyl/PCBs, synthetic chemicals)</td>
<td>Pesticides (herbicides, insecticides, fungicides, etc.); industrial processes.</td>
<td>Increased toxicity to sensitive animal species and fishery resources and accumulation in the food chain.</td>
<td>Toxicity of water column and sediment; bioaccumulation in aquatic species and through the food chain.</td>
</tr>
<tr>
<td>Salt (sodium, chlorides)</td>
<td>Salting of roads and uncovered salt storage</td>
<td>Toxicity to organisms, reduction of fishery resources and increased levels of sodium and chloride in surface and groundwater. Could stress plant species respiration processes through their effect on soil structure.</td>
<td>Toxicity of water column and sediment. Salt can cause the loss of sensitive animal species, plant species, and fishery resources and contaminate surface and groundwater.</td>
</tr>
</tbody>
</table>

In Saskatchewan, the General Surface Water Quality Objectives (Table 4.1 of Surface Water Quality Objectives, MB 110, 1997) are applicable to all receiving waters except that portion designated by Saskatchewan Environment as an effluent mixing zone. However, within the mixing zone, the General Objectives for Effluent Discharges (section 3 of Surface Water Quality Objectives, MB 110, 1997) apply. Further, specific water quality objectives (section 4.2 of Surface Water Quality Objectives, MB 110, 1997) are applicable to receiving waters based on the type of use such as recreational use, agricultural use and protection of aquatic life and wildlife. Hence, the owners and designers of stormwater management systems in Saskatchewan who plan to discharge the treated stormwater into receiving waters should consider these objectives during planning, designing and implementation of stormwater drainage systems. At present, Saskatchewan Environment’s Surface Water Quality Objectives are being revised and are applicable as and when revised.


3.1 General
Stormwater Management Practices are a series of practices or treatment methods that reduce the effects of stormwater pollution and meet stormwater management objectives for a given area. Effective stormwater management is often achieved from a management systems approach rather than focusing on individual practices. That is, the pollutant control achievable from any management system is viewed as the sum of parts, taking into account the range of effectiveness associated with each single practice, the cost of each practice, and the resulting overall cost and effectiveness. Some individual practices may not be very effective alone but, in combination with others, may provide a key function in highly effective systems.
The selection and design of management practices must incorporate water quantity and water quality concerns. Stormwater management practices that are considered for the control of urban stormwater runoff are as follows: \(^3,^4,^6,^7\)

- source controls;
- on-site (lot-level) and conveyance system controls; and
- end-of-pipe controls

The minor and major (piped) systems should be designed for 1:5 and 1:100 year events, respectively. The minor systems consist of drainage works that transport flows from a catchment during minor rainstorms. The major systems consist of drainage routes that transport flow during major storm events. All of the municipalities should give considerations regarding mosquito control programs near any open stormwater systems, such as wet ponds. Regarding interconnection, as per Section 14 of *The Water Regulations* no interconnection is permitted between sanitary and storm sewers and the discharge of sewage from sanitary sewers into storm sewers is not permitted in Saskatchewan.

First flush is a common phenomenon encountered during first runoff from a storm and often it is contaminated. It is caused by the rapid mobilization of contaminants attached to fine sediments on impervious surfaces and by the flushing of catchbasins and manholes. Sufficient storage requirements are recommended to reduce the effect of “first flush” in detention systems such as wet ponds, dry ponds and constructed wetlands.

### 3.2 Source Controls

Adoption of pollution prevention and source control practices minimize the level of pollutants entering the stormwater systems. Source control is a simple concept, which can be cost effective and requires public participation. Source control measures include:

- pet waste collection;
- street cleaning;
- storm drain system cleaning;
- catchbasin cleaning;
- pesticide control; and
- eliminating non-stormwater discharges.

Pet waste collection, as a source control involves using a combination of education programs and compliance to encourage residents to clean up after their pets. The presence of pet waste in storm water runoff has a number of implications for urban stream water quality, with perhaps the greatest impact from fecal bacteria. According to a recent research study \(^8\), nonhuman waste represents a significant source of bacterial contamination in urban watersheds. These bacteria can pose health risks to humans and other animals and result in the spread of disease. Pet waste may also be a factor in the eutrophication of lakes. The release of nutrients from the decay of pet waste promotes weed and algae growth, limiting light penetration and the growth of aquatic vegetation. This situation, in turn, can reduce oxygen levels in the water, affecting fish and other aquatic organisms. Pet waste collection programs use pet awareness and education, signs and pet waste control ordinances to alert residents to the proper disposal techniques for pet droppings.

Street cleaning practices such as street sweeping on a regular basis minimizes pollutant level in stormwater runoff and receiving waters. These cleaning practices are designed to remove from road and parking lot surfaces sediment debris and other pollutants that are a potential source of pollution impacting urban waterways \(^8\). Street sweeping practice removes sediment buildup and large debris from curb gutters. The effectiveness of street sweeping in regard to reduction of pollutant level depends on factors such as frequency, time of year, type of sweeping equipment, rainfall intensity, length of time between rainfall events and type of road surface. In colder climates, street sweeping is recommended immediately after the spring snowmelt to reduce pollutant loads from road salt and to reduce sand export to receiving waters. Seventy per cent of cold climate storm water experts recommend street sweeping during the spring snowmelt as a pollution prevention measure\(^10\).
Storm drain systems need to be cleaned regularly. Routine cleaning reduces the amount of pollutants, trash and debris both in the storm drain system and in receiving waters. Clogged drains and storm drain inlets can cause the drains to overflow, leading to increased erosion. Benefits of cleaning include increased dissolved oxygen, reduced levels of bacteria and support of in-stream habitat. Areas with relatively flat grades or low flows should be given special attention because they rarely achieve high enough flows to flush themselves.

Catchbasin cleaning is an efficient and cost effective method for preventing the transport of sediment and pollutant to receiving water bodies. Catchbasins are chambers or sumps, usually built at the curb line, which allow the surface water runoff to enter the stormwater conveyance system. Many catchbasins have a low area below the invert of the outlet pipe intended to retain coarse sediment. By trapping sediment, catchbasins prevent solids from clogging the storm sewer and being washed into receiving waters. Catchbasins must be cleaned periodically to maintain their ability to trap sediment and consequently their ability to prevent flooding.

Pesticide management measures involve limiting the impact of pesticides on water quality by educating residents and businesses on alternatives to pesticide use, proper storage and on application techniques. The presence of pesticides in storm water runoff has a direct impact on the health of aquatic organisms and can present a threat to humans through contamination of drinking water supplies. The major source of pesticides to urban streams is home application of products designed to kill insects and weeds in the lawn and garden. Pesticide pollution prevention programs try to limit adverse impacts of insecticides and herbicides by providing information on alternative pest control techniques other than chemicals or explaining how to determine the correct dosages needed to manage pests.

One of the important source control measures is identifying and eliminating non-stormwater discharges to storm sewers, which is cost-effective and improves the water quality of runoff. Non-stormwater discharges can include discharge of process water, air conditioner condensate, non-contact cooling water, vehicle wash water or sanitary wastes, and are typically the result of unauthorized connections of sanitary or process wastewater drains to storm sewers.

Environmental impact evaluations have shown that the elimination of non-stormwater discharges is an effective management practice because such discharges may contain significant loading of pollutants.

3.3 On-site (Lot-level) and Conveyance System Controls

3.3.1 On-site (Lot-level) Controls
On-site (Lot-level) controls are practices that reduce the quantity of stormwater runoff and improve the water quality before the runoff reaches the conveyance system. These practices are applied at a single lot level or multiple lots in a small area.

3.3.1.1 Reduced Lot Grading
The development standards require a minimum lot grade of two per cent to ensure adequate drainage of stormwater away from the buildings. In order to avoid foundation drainage problems, grading within two to four metres of buildings should be maintained at two per cent or higher. In areas outside this envelope, grading can be flattened to 0.5 per cent. A reduction in the lot grading should be evaluated if the land is flat. In hilly areas, alterations to natural topography should be minimized. Areas outside this envelope should be graded at less than two per cent (Figure 1).

Reduced lot grading can be implemented where soils have an infiltration rate of \( \geq 15 \text{ mm/h} \) and it is applicable to all soils coarser than loam; clay soils are usually not suitable. In areas where reduced lot grading is implemented, roof leaders should extend two metres away from the building to discharge to the surface.
3.3.1.2 Roof Leader to Ponding Areas and Rooftop Storage

Roof leaders discharge water to the surface and water is directed to the ponding area. Water is retained in the ponding area and surface ponding reduces the potential for downstream flooding and erosion and helps maintain pre-development end-of-pipe discharge rates. The same benefits can result from the use of rooftop storage that are likely suitable for commercial, industrial and institutional buildings.

Surface ponding may be used for parking lots or parking areas and for any new developments. The area for ponding should be a shallow depression and pond depth can be up to a maximum of 300 millimetres. The roof leader should discharge into the ponding area via a splash pad and flow paths should be provided to direct overland flow to the pond. The area of ponding should be at least four metres away from any building foundations to ensure the ponded water does not increase the amount of foundation drainage. Ponding areas can be created along the rear lot lines by raising rear yard catchbasins such that they are used as an overflow system. Infiltration in the ponding areas can be enhanced by providing an on-lot infiltration system.

3.3.1.3 On-lot Infiltration System

On-lot infiltration systems or soakway pits are used for detention of stormwater from small drainage areas, mainly single family dwellings. They provide some reduction in overflows and enhance the quality of stormwater. They also can be used in areas without adequate minor system conveyance. On-lot infiltration systems are pits with a filter liner and rock drain material or more complex systems with catchbasin sumps and inspection wells. Example of on-lot infiltration systems is shown in Figure 2.

General design considerations for on-lot infiltration systems are as follows:

- There should be a significant distance from the bottom of the pit to the high groundwater table. This may vary from ≥0.8 to ≥1.2 metres, depending on local conditions and constraints. Local authorities should be consulted or test holes should be drilled to ensure proper distances are provided;
- The distance between the bottom of the pit and bedrock should be ≥1.2 metres;
- The trench should be located at least four metres away from the foundation of the nearest building;
- The trench should comprise clean (properly washed) 50 millimetres diameter stone and be lined with suitable geotextile;
- The total void volume of the trench should be based on the storage required for the appropriate design storm, based on the effective porosity of the trench media (usually assumed to be 35 to 40 per cent). The required infiltration surface area (bottom surface area) to drain the system within 48 hours is calculated from the 24-hour sustained percolation rate;
- The trench should be located close to the ground surface but factors such as the depth of trench storage, frost heave potential and surrounding soil stratification should be considered;
A filter should be incorporated into the soakway pit design or the sump to limit solids and debris entering the system. An overflow pipe should be included where possible;

On-lot infiltration systems should generally not be constructed on fill material, under parking lots or under multi-use areas; and

For infiltration systems draining parking lots, one or two pretreatment devices in series should be used before the infiltration system to extend its useful life without clogging.

3.3.1.4 Sump Pumping of Foundation Drains

Development standards may permit foundation drains to be connected to the storm sewer in some municipalities. Instead of connecting to the storm sewer, an alternative can be made by pumping foundation drainage to surface ponding/infiltration trench systems. Since foundation drainage is relatively clear water, keeping it separate from storm and sanitary sewers may reduce the cost of stormwater management and sewage treatment. Local municipalities should be contacted for consent before commencing this type of work. Sump pump foundation drainage to surface ponding/infiltration system is shown in Figure 3.

Sump pump discharges should be at least 2.0 metres away from foundations and be discharged to rear yards away from sidewalks. There should be sufficient grading away from the foundation wall when the sump pump is discharging the foundation drainage to the surface of the ground. The outlet for sump pumps that discharge to the ground surface should be at least 0.5 metres above the ground to prevent blockage from ice and snow during the winter.
3.3.2 Conveyance System Controls
Stormwater conveyance systems transport drainage from developed areas. Stormwater conveyance controls are part of the stormwater conveyance system and can be classified into following categories:

- pervious pipe systems;
- pervious catchbasins;
- grassed swales; and
- vegetated filter strips.

3.3.2.1 Pervious Pipe Systems
Pervious pipe systems are designed to convey the road drainage. These systems have not been commonly used because of some problems and are still experimental in nature. Pervious pipe systems are perforated along their length, thereby allowing exfiltration of water through the pipe wall as it is conveyed downstream. Pervious pipe systems are components of roadway drainage systems.

Since roadway drainage carries a high level of suspended sediments, pretreatment components are essential to remove the sediments. The runoff from the roadway is directed toward grassed areas that filters sediment prior to flowing into the stormwater catchbasin. The stormwater catchbasin is connected to the pervious pipe and is raised to allow some ponding and further sediment removal.

Pervious pipes can be used where soils have a percolation rate of ≥ 15 millimetres/hour. The minimum storage volume should be equal to the runoff from a four-hour five millimetres storm over the contributing drainage area and the maximum storage should be equal to the runoff from a four-hour 25-millimetres storm over the contributing drainage area. The exfiltration storage bedding depth should be between 75 and 150 millimetres deep above the pervious pipe. The bedding should drain within 24 hours and the minimum diameter for the pervious pipe should be 200 millimetres.

3.3.2.2 Pervious Catchbasins
Pervious catchbasins are designed to convey the road drainage and these systems have large sumps that are physically connected to an exfiltration storage medium. The storage medium is located below or beside the catchbasin. Pervious catchbasin details for road drainage are shown in Figure 4.

![Figure 4. Pervious Catchbasin](image.png)

Figure 4. Pervious Catchbasin
Pretreatment of road drainage is necessary prior to catchbasins so as to prevent frequent clogging. It is recommended that pervious catchbasins be constructed at least one metre above the groundwater table. The exfiltration storage depth is dependent on the native soil type/characteristics. Clear stone (50 millimetres) should be used as the exfiltration storage medium to promote filtration with a low clogging frequency. The criteria for storage volume are similar to that of pervious pipes.

3.3.2.3 Grassed Swales

Swales can be natural or manmade and are designed to trap particulate pollutants (suspended solids and trace metals), promote infiltration, and reduce the flow velocity of storm water runoff. In the past, grassed swales were constructed for stormwater conveyance. However, stormwater objectives have changed and now grassed swales are being used to store, infiltrate and convey road and on-lot stormwater runoff. As storm water runoff flows through the channels, it is treated through filtering by the vegetation in the channel, filtering through a subsoil matrix and/or infiltration into the underlying soils. Variations of the grassed swale include the grassed channel, dry swale and wet swale. The specific design features and methods of treatment differ in each of these designs. These designs incorporate modified geometry and other features for use of the swale as a treatment and conveyance practice.

In rural areas and in urban applications, grassed swales have been shown to effectively infiltrate runoff and remove pollutants. They are also very well suited for treating highway runoff because they are linear practices. Grassed swales infiltrate stormwater and reduce the end-of-pipe discharge volumes normally associated with curb and gutter controls. Figure 5 shows grassed swale systems.

Grassed swales are generally used for small drainage areas of less than two hectares and should be used on sites with relatively flat slopes of less than four per cent slope; one to two per cent slope is recommended. Runoff velocities within the channel become too high on steeper slopes. This can cause erosion and does not allow for infiltration or filtering in the swale. Grass in the channel should be allowed to grow higher than 75 millimetres but less than 300 millimetres to enhance the filtration of suspended solids.

Figure 5. Grassed Swale Systems
The dense vegetation also helps to reduce velocities and protect the channel from erosion. Deep narrow swales are less effective for pollutant removal than shallow wide swales. Typical urban swale dimensions are 0.75 metres bottom width, 2.5:1 side slopes, and a depth of 0.5 metres. The maximum velocity in the swale should be 0.5 metres per second and if velocities are greater than 0.5 metres per second, check dams to be used to promote infiltration and settling of pollutants.

### 3.3.2.4 Vegetated Filter Strips

Vegetated filter strips (grassed filter strips, filter strips and grassed filters) are vegetated surfaces that are designed to remove pollutants from overland runoff. Typically, filter strips treat small drainage areas (<2 hectares). Filter strips function by slowing runoff velocities, filtering out sediment and other pollutants, and by providing some infiltration into underlying soils. With proper design and maintenance, filter strips can provide relatively high pollutant removal.

Vegetated filter strips should be located in flat areas (<10 per cent slope) to promote sheet flow and maximize the filtration potential. Filter strips should be designed on slopes between one and five per cent. Greater slopes than this would encourage the formation of concentrated flow. The width of the vegetated filter strip should be 10 to 20 metres in the direction of flow to provide sufficient stormwater quality enhancement.

### 3.4 End-of-pipe Controls

End-of-pipe controls are the final treatment methods that are intended to reduce the pollutants and enhance the quality of stormwater runoff before discharging into receiving waters. Although a number of end-of-pipe controls are available for treating stormwater runoff, selection of a suitable treatment depends on the site conditions, upstream runoff characteristics and requirements for treated water quality. End-of-pipe controls are as follows:

- wet ponds;
- dry ponds;
- constructed wetlands;
- infiltration trench;
- infiltration basin;
- sand filters; and
- oil/grit separators.

End-of-pipe controls, such as wet ponds or dry ponds should be designed for 1:100 year event with a safe overflow route so as to avoid flooding for large events.

#### 3.4.1 Wet Ponds

Wet detention ponds are stormwater control structures designed to retain and treat the contaminated stormwater runoff. Although there are several different versions of the wet pond design, the most common design is the extended detention wet pond where adequate storage is provided above the permanent pool in order to detain storm water runoff and provide settling. Wet ponds are among the most cost-effective and widely used stormwater practices.

The pond consists of a permanent pool of water into which storm water runoff is directed. Runoff from each rain event is detained and treated in the pond until it is displaced by runoff from the next storm. Sedimentation processes remove particulates, organic matter and metals, while nutrients are removed through biological uptake. Wet detention ponds require periodic sediment removal and proper measures should be taken to control blue green algae, if any. In general, a higher level of nutrient removal and better storm water quantity control can be achieved in wet ponds than can be achieved with other practices, such as dry ponds, infiltration trenches or sand filters. A typical wet pond is shown in Figure 6.
Several modifications can be made to the ponds so as to increase their pollutant removal efficiency. The first modification is increasing the settling area for sediments by adding a sediment forebay (Figure 7) near the inlet. Heavier sediments will settle as runoff passes through the sediment forebay, while lighter sediments will settle out as the runoff is retained in the permanent pool. A second modification is constructing shallow ledges along the edge of the permanent pool. These shallow peripheral ledges can be used to establish aquatic plants that can impede flow and trap pollutants as they enter the pond. The plants also increase biological uptake of nutrients. Finally, perimeter wetland areas can also be created around the pond to aid in pollutant removal.

The minimum drainage area required for wet ponds is five hectares and the preferred one is $\geq 10$ hectares. Design guidelines for wet ponds are summarized in Table 3.
Table 3. Design Guidelines for Wet Ponds

<table>
<thead>
<tr>
<th>Design component</th>
<th>Minimum criteria</th>
<th>Preferred criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drainage area</td>
<td>5 hectares</td>
<td>≥ 10 hectares</td>
</tr>
<tr>
<td>Detention time</td>
<td>24 hours</td>
<td>24 hours</td>
</tr>
<tr>
<td>Side slopes</td>
<td>Side slopes above permanent pool are 4:1 to 5:1. Side slopes in permanent pool 5:1 to 7:1</td>
<td>Side slopes above permanent pool are 4:1 to 5:1. Side slopes in permanent pool 5:1 to 7:1</td>
</tr>
<tr>
<td>Length to width ratio</td>
<td>From 4:1 to 5:1</td>
<td>From 4:1 to 5:1</td>
</tr>
<tr>
<td>Permanent pool depth</td>
<td>Maximum depth: 3 m</td>
<td>Maximum depth: 2.5 m</td>
</tr>
<tr>
<td></td>
<td>Mean depth: 1 to 2 m</td>
<td>Mean depth: 1 to 2 m</td>
</tr>
<tr>
<td>Forebay</td>
<td>Minimum depth: 1 m</td>
<td>Minimum depth: 1.5 m</td>
</tr>
<tr>
<td></td>
<td>Length to width ratio of 2:1 or greater</td>
<td>Length to width ratio of 2:1 or greater</td>
</tr>
<tr>
<td></td>
<td>Surface area not to exceed one-third of the permanent pool surface area.</td>
<td>Surface area not to exceed one-third of the permanent pool surface area.</td>
</tr>
<tr>
<td>Active storage depth</td>
<td>Water quality and erosion control: maximum 1.5 m</td>
<td>Water quality and erosion control: maximum 1 m</td>
</tr>
<tr>
<td></td>
<td>Total (including quality control): 2 m</td>
<td>Total (including quality control): 2 m</td>
</tr>
</tbody>
</table>

Forebay length can be calculated using the following equation:

\[ L_{FB} = \left[ r Q_p / V_s \right]^{0.5} \]

where:
- \( L_{FB} \) = forebay length (m)
- \( r \) = length to width ratio of forebay
- \( Q_p \) = peak flow rate from the pond during design quality storm (m³/s)
- \( V_s \) = Settling velocity (dependent on desired particle size to settle), (m/s)

The dispersion length refers to the length of fluid required to slow a jet discharge (i.e. pipe flow). It is recommended the fluid jet will disperse to a velocity of less than or equal to 0.5 m/s at the forebay berm. The forebay should be separated from the rest of the pond by an earthen berm. The berm can be submerged slightly below the permanent pool or it can extend into the extended detention portion of the pond. The length of dispersion required to dissipate flows from the inlet pipe can be calculated using the following equation.

\[ L_{dis} = (8Q)/(dV_f) \]

where:
- \( L_{dis} \) = length of dispersion (m)
- \( Q \) = flow rate from the inlet pipe (m³/s)
- \( d \) = depth of the permanent pool in the forebay (m)
- \( V_f \) = desired velocity in the forebay (m/s)

Forebay bottom width can be calculated using the following equation

Width, \( W = L_{dis}/8 \)

3.4.2 Dry Ponds

Dry ponds are basins whose outlets have been designed to detain the storm water runoff for some minimum time (i.e. 24 hours) to allow particles and associated pollutants to settle. Unlike wet ponds, these facilities do not have a large permanent pool. Dry ponds have only moderate pollutant removal when compared to other treatment methods. Although dry ponds can be effective at removing some pollutants through settling, they are less effective at removing soluble pollutants because of the absence of a permanent pool. Dry ponds operating in a continuous or batch mode have been reported to be less effective at pollutant removal compared to wet ponds. Generally, dry ponds should be implemented if wet ponds cannot be implemented due to site or planning constraints. The design guidelines for dry ponds are presented in Table 4 and some of the design guidelines are similar to that of wet ponds.
Table 4. Design Guidelines for Dry Ponds

<table>
<thead>
<tr>
<th>Design component</th>
<th>Minimum criteria</th>
<th>Preferred criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drainage area</td>
<td>5 hectares</td>
<td>10 hectares</td>
</tr>
<tr>
<td>Detention time</td>
<td>24 hours</td>
<td>48 hours</td>
</tr>
<tr>
<td>Side slopes</td>
<td>Side slope: 4:1 to 5:1</td>
<td></td>
</tr>
<tr>
<td>Length to width ratio</td>
<td>3:1</td>
<td>From 4:1 to 5:1</td>
</tr>
<tr>
<td>Depth</td>
<td>Maximum depth: 3m</td>
<td>Maximum depth: 2m</td>
</tr>
<tr>
<td></td>
<td>Mean depth: 1 to 2m</td>
<td>Mean depth: 1 to 2m</td>
</tr>
<tr>
<td>Forebay</td>
<td>Minimum depth: 1m</td>
<td>Minimum depth: 1.5m</td>
</tr>
</tbody>
</table>

3.4.3 Constructed Wetlands

Construct wetland is a suitable treatment method for stormwater quality enhancement where a large area of land is available for construction. They require a large area of land because of their shallower depth (both in the permanent pool and active storage depth). Pollutant removal effectiveness and water quality enhancement in wetland systems are achieved through physical, chemical and biological processes. The design guidelines for constructed wetlands are shown in Table 5 and some of the design guidelines are similar to that of wet ponds.

Table 5. Design Guidelines for Constructed Wetlands

<table>
<thead>
<tr>
<th>Design component</th>
<th>Minimum criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drainage area</td>
<td>5 hectares</td>
</tr>
<tr>
<td></td>
<td>10 hectares preferable</td>
</tr>
<tr>
<td>Detention time</td>
<td>24 hours</td>
</tr>
<tr>
<td>Side slopes</td>
<td>Side slope of 5:1 for 3 m above and below permanent pool.</td>
</tr>
<tr>
<td></td>
<td>Maximum 3:1 elsewhere</td>
</tr>
<tr>
<td>Length to width ratio</td>
<td>Overall: minimum 3:1</td>
</tr>
<tr>
<td></td>
<td>Forebay: minimum 2:1</td>
</tr>
<tr>
<td>Permanent pool depth</td>
<td>Average permanent pool depth should range between 150 mm and 300 mm.</td>
</tr>
<tr>
<td>Forebay</td>
<td>Minimum depth: 1 m</td>
</tr>
<tr>
<td></td>
<td>Surface area not to exceed 20 per cent of the permanent pool surface area.</td>
</tr>
<tr>
<td>Active storage depth</td>
<td>Maximum 1 m</td>
</tr>
</tbody>
</table>

3.4.4 Infiltration Trench

Infiltration trench in this guideline refer to infiltration systems designed to collect, store and treat the stormwater runoff from several lots as opposed to on-lot infiltration systems that are used for single lot application. An infiltration trench can be constructed at the ground surface to intercept overland flows or below ground as a component of a storm sewer system. These systems are suitable where limited land is available. However, the application of infiltration trench is limited because they provide marginal water quality control, but may be used as a secondary facility where the maintenance of groundwater recharge is a concern. They also can be used in conjunction with other practices, such as wet ponds, to provide water quality control and peak flow control.

Infiltration trenches can be implemented for residential uses where soils should have an infiltration rate of ≥ 15 millimetres per hour. Infiltration trenches with details are shown in Figures 8 and 9. The design guidelines are shown in Table 6.
Table 6. Design Guidelines for Infiltration Trench

<table>
<thead>
<tr>
<th>Design component</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drainage area</td>
<td>&lt; 2 hectares</td>
</tr>
<tr>
<td>Depth to water table</td>
<td>&gt; 1 m</td>
</tr>
<tr>
<td>Depth to bed rock</td>
<td>&gt; 1 m</td>
</tr>
<tr>
<td>Storage</td>
<td>A maximum storage volume equal to the runoff from a 4-hour 15 mm storm should be provided. The storage media should hold the stormwater until it infiltrates into the surrounding material. Clear stone of 50 mm is recommended as a storage medium. Gravel also can be used as a medium.</td>
</tr>
</tbody>
</table>
3.4.5 Infiltration Basin
Infiltration basins are above ground pond systems designed to collect, store and treat the stormwater runoff. Water infiltrates through the basin and either recharges the groundwater or is collected by an underground perforated pipe system and discharges to a downstream outlet. The appearance of an infiltration basin is similar to that of wet ponds.

Infiltration basins are suitable for residential land uses and not recommended for industrial/commercial areas where there is a high potential for groundwater contamination due to chemical spills and maintenance activities. Infiltration basin have a high rate of failure and the factors that contribute to the failure are poor site selection, poor design, large drainage area, inadequate pretreatment facilities and lack of maintenance. The design guidelines for infiltration basin are summarized in Table 7.

<table>
<thead>
<tr>
<th>Design component</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drainage area</td>
<td>&lt; 5 hectares</td>
</tr>
<tr>
<td>Depth to water table</td>
<td>&gt; 1 m</td>
</tr>
<tr>
<td>Depth to bed rock</td>
<td>&gt; 1 m</td>
</tr>
<tr>
<td>Storage depth</td>
<td>&lt; 0.6 m</td>
</tr>
<tr>
<td>Length to width ratio</td>
<td>3:1 preferred</td>
</tr>
<tr>
<td>Percolation rate</td>
<td>≥ 60 mm/hr</td>
</tr>
</tbody>
</table>

3.4.6 Sand Filters
Sand filters used in many parts of the United States have proven to be effective in removing several common pollutants from stormwater runoff. Sand filters are not widely used in Canada and it is not yet known about their performance in winter conditions. Sand filters generally control stormwater quality, providing very limited flow rate control. There are many forms of sand filters, among these surface and underground filters are the most commonly used. Sand filters are suitable for small drainage areas (less than or equal to five hectares).

In general, sand filters are preferred over infiltration practices, such as infiltration trenches, when contamination of groundwater with conventional pollutants (Biochemical Oxygen Demand, suspended solids and fecal coliform) is of concern. Sand filters generally require less land than other practices such as ponds or wetlands. Sand filters can be effective stormwater management practices and can achieve high removal rates for sediment, BOD and fecal coliform bacteria. However, silt/sediment deposited on the surface of the filter medium should be removed periodically so as to avoid clogging and to remove trapped contaminants.

The cross-section details and design guidelines of sand filter are shown in Figure 10 and Table 8, respectively.

Figure 10. Cross-section of a Sand Filter
Table 8. Design Guidelines for Sand filter

<table>
<thead>
<tr>
<th>Design component</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drainage area</td>
<td>&lt; 5 hectares</td>
</tr>
<tr>
<td>Pretreatment</td>
<td>Pretreatment to be provided by sedimentation chamber or forebay, filter strip, swale</td>
</tr>
<tr>
<td>Filter media depth</td>
<td>Sand: 0.5 m</td>
</tr>
<tr>
<td>Underdrain</td>
<td>Minimum 100 mm perforated pipes.</td>
</tr>
</tbody>
</table>

3.4.7 Oil/grit separators

Oil/grit separators consist a series of chambers to trap and retain oil and grit and/or sediment in the chambers. They are usually located below ground and often are used as spill controls, pretreatment devices or end-of-pipe controls as part of multi-component management practices for water quality control.

Oil/grit separators are used for small drainage areas (< 2 hectares). They can be used for industrial and commercial areas, parking lots, automobile service station parking areas and airports that generate high hydrocarbon concentrations and where there is a high risk of spills.

There are two types of oil/grit separators available and these are shown in Figure 11. Oil/grit separators from automobile service stations should not discharge into storm sewer or surface water because of high oil/grit loading of the wastewater.

![Diagram of Oil/grit Separator](image)

**a) Three-chamber Oil/grit Separator**

**b) By-pass Oil/grit Separator**

**Figure 11. Oil/grit Separator**
### Appendix A

#### Table A-1. Selected Pollutant Concentration in Stormwater (Saskatchewan community)*

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Storm sewer outfall 1</th>
<th>Storm sewer outfall 2</th>
<th>Storm sewer outfall 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOD (mg/L)</td>
<td>12</td>
<td>18</td>
<td>16.5</td>
</tr>
<tr>
<td>COD (mg/L)</td>
<td>78.5</td>
<td>103</td>
<td>121</td>
</tr>
<tr>
<td>TSS (mg/L)</td>
<td>129</td>
<td>350</td>
<td>324</td>
</tr>
<tr>
<td>Nitrate –N (mg/L)</td>
<td>0.64</td>
<td>0.42</td>
<td>1.48</td>
</tr>
<tr>
<td>TKN (mg/L)</td>
<td>2.3</td>
<td>3.1</td>
<td>4.1</td>
</tr>
<tr>
<td>Total P (mg/L)</td>
<td>0.95</td>
<td>1.08</td>
<td>1.06</td>
</tr>
<tr>
<td>Total Alkalinity (mg/L CaCO₃)</td>
<td>82</td>
<td>92</td>
<td>94</td>
</tr>
<tr>
<td>Bicarbonate (mg/L)</td>
<td>100</td>
<td>112</td>
<td>115</td>
</tr>
<tr>
<td>Sodium (mg/L)</td>
<td>81</td>
<td>72</td>
<td>113</td>
</tr>
<tr>
<td>Magnesium (mg/L)</td>
<td>6</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Calcium (mg/L)</td>
<td>24</td>
<td>21</td>
<td>24</td>
</tr>
<tr>
<td>Total Hardness (mg/L CaCO₃)</td>
<td>85</td>
<td>73</td>
<td>81</td>
</tr>
<tr>
<td>Chloride (mg/L)</td>
<td>113.4</td>
<td>105.6</td>
<td>159.5</td>
</tr>
<tr>
<td>Potassium (mg/L)</td>
<td>11</td>
<td>10</td>
<td>13</td>
</tr>
<tr>
<td>Zinc (mg/L)</td>
<td>0.077</td>
<td>0.19</td>
<td>0.19</td>
</tr>
<tr>
<td>Cadmium (mg/L)</td>
<td>&lt; 0.001</td>
<td>&lt; 0.001</td>
<td>0.001</td>
</tr>
<tr>
<td>Copper (mg/L)</td>
<td>0.015</td>
<td>0.038</td>
<td>0.028</td>
</tr>
<tr>
<td>Iron (mg/L)</td>
<td>5.09</td>
<td>14.5</td>
<td>10.2</td>
</tr>
<tr>
<td>Lead (mg/L)</td>
<td>0.022</td>
<td>0.053</td>
<td>0.052</td>
</tr>
<tr>
<td>Nickel (mg/L)</td>
<td>0.01</td>
<td>0.02</td>
<td>0.021</td>
</tr>
<tr>
<td>Coliforms, org/100mL</td>
<td>10900</td>
<td>98800</td>
<td>10900</td>
</tr>
<tr>
<td>E.coli, org/100mL</td>
<td>727</td>
<td>13400</td>
<td>959</td>
</tr>
</tbody>
</table>

* Samples collected during 2005

#### Table A-2. Selected Pollutant Concentration in Stormwater (Saskatchewan community)*

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Site 1</th>
<th>Site 2</th>
<th>Site 3</th>
<th>Site 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOD (mg/L)</td>
<td>8.4</td>
<td>4.5</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>TSS (mg/L)</td>
<td>102</td>
<td>139</td>
<td>52</td>
<td>58</td>
</tr>
<tr>
<td>Nitrate –N (mg/L)</td>
<td>1.16</td>
<td>2.07</td>
<td>&lt; 0.02</td>
<td>0.09</td>
</tr>
<tr>
<td>TKN (mg/L)</td>
<td>2.2</td>
<td>1.5</td>
<td>0.8</td>
<td>4</td>
</tr>
<tr>
<td>Total P (mg/L)</td>
<td>0.36</td>
<td>0.41</td>
<td>0.18</td>
<td>0.49</td>
</tr>
<tr>
<td>Coliforms, org/100mL</td>
<td>&gt;2400000</td>
<td>150000</td>
<td>360</td>
<td>460000</td>
</tr>
<tr>
<td>Fecal coliforms, org/100mL</td>
<td>930000</td>
<td>43000</td>
<td>90</td>
<td>930</td>
</tr>
</tbody>
</table>

* Samples collected during 2003
Table A-3. Selected pollutant Median Event Mean Concentrations and Associated Coefficient of Variation (CV) in Stormwater runoff as a function of land use (USEPA, 1983).

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Units</th>
<th>Residential</th>
<th>Mixed</th>
<th>Commercial</th>
<th>Open/Non-urban</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Median</td>
<td>COV</td>
<td>Median</td>
<td>COV</td>
</tr>
<tr>
<td>BOD mg/L</td>
<td>10</td>
<td>0.41</td>
<td>7.8</td>
<td>0.52</td>
<td>9.3</td>
</tr>
<tr>
<td>COD mg/L</td>
<td>73</td>
<td>0.55</td>
<td>65</td>
<td>0.52</td>
<td>57</td>
</tr>
<tr>
<td>TSS mg/L</td>
<td>101</td>
<td>0.96</td>
<td>67</td>
<td>1.14</td>
<td>69</td>
</tr>
<tr>
<td>NO₂+NO₃ mg/L</td>
<td>736</td>
<td>0.83</td>
<td>558</td>
<td>0.67</td>
<td>572</td>
</tr>
<tr>
<td>Total P mg/L</td>
<td>383</td>
<td>0.69</td>
<td>263</td>
<td>0.75</td>
<td>201</td>
</tr>
<tr>
<td>Total Cu mg/L</td>
<td>33</td>
<td>0.99</td>
<td>27</td>
<td>1.32</td>
<td>29</td>
</tr>
<tr>
<td>Total Pb mg/L</td>
<td>144</td>
<td>0.75</td>
<td>114</td>
<td>1.35</td>
<td>104</td>
</tr>
<tr>
<td>Total Zn mg/L</td>
<td>135</td>
<td>0.84</td>
<td>154</td>
<td>0.78</td>
<td>226</td>
</tr>
<tr>
<td>TKN mg/L</td>
<td>1900</td>
<td>0.73</td>
<td>1288</td>
<td>0.50</td>
<td>1179</td>
</tr>
</tbody>
</table>

Table A-4. Selected Pollutant Concentration in Stormwater (City of Edmonton)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Groat Rd Storm</th>
<th>30th Ave Storm</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Spring</td>
<td>Summer</td>
</tr>
<tr>
<td>BOD (mg/L)</td>
<td>28</td>
<td>19</td>
</tr>
<tr>
<td>COD (mg/L)</td>
<td>145</td>
<td>-</td>
</tr>
<tr>
<td>TSS (mg/L)</td>
<td>290</td>
<td>227</td>
</tr>
<tr>
<td>NH₃-N (mg/L)</td>
<td>1.6</td>
<td>0.67</td>
</tr>
<tr>
<td>TKN (mg/L)</td>
<td>5.2</td>
<td>0.9</td>
</tr>
<tr>
<td>Total N (mg/L)</td>
<td>6.2</td>
<td>4.2</td>
</tr>
<tr>
<td>Total P (mg/L)</td>
<td>1.08</td>
<td>0.69</td>
</tr>
<tr>
<td>Total Dissolved P (mg/L)</td>
<td>0.4</td>
<td>-</td>
</tr>
<tr>
<td>Chloride (mg/L)</td>
<td>157</td>
<td>40</td>
</tr>
<tr>
<td>Phenol (mg/L)</td>
<td>0.06</td>
<td>0.01</td>
</tr>
<tr>
<td>Zinc (mg/L)</td>
<td>0.961</td>
<td>0.101</td>
</tr>
<tr>
<td>Cadmium (mg/L)</td>
<td>0.005</td>
<td>0.0006</td>
</tr>
<tr>
<td>Copper (mg/L)</td>
<td>0.17</td>
<td>0.019</td>
</tr>
<tr>
<td>Iron (mg/L)</td>
<td>73.4</td>
<td>7.1</td>
</tr>
<tr>
<td>Lead (mg/L)</td>
<td>0.21</td>
<td>0.024</td>
</tr>
<tr>
<td>Fecal coliforms, org/100mL</td>
<td>58,000</td>
<td>91,000</td>
</tr>
</tbody>
</table>

(Source: City of Edmonton; Infraguide, 2003)
References:


2. California Department of Transportation Highway Design Manual, Chapter 810 (July 1, 1995)


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SECTION SIX – STORM WATER DRAINAGE SYSTEM

1 Objective

Storm runoff generated within new developments shall be routed through a conveyance, storage, and/or treatment system to regulate the rate of outflow and the quality of the water that is released into the South Saskatchewan River.

The storm drainage system shall be designed to be completely separate from the sanitary sewer collection system. Interconnectivity with sanitary sewer mains is not acceptable.

2 Submissions and Approvals

The Proponent is responsible for being aware of the regulatory requirements governing the development of the storm drainage system, and for compliance with these requirements.

Regulatory and supporting documents that shall be referenced for the design and installation of the storm drainage system include:

- **Sewer Use Bylaw**, COS;
- **Drainage Bylaw**, COS;
- **Park Development Guidelines Policy**, COS;
- **Landscape Guidelines**, COS;
- **Standard Construction Specifications and Drawings: Roadways, Water, and Sewer**, Transportation & Utilities Department, COS;
- **Standard Construction Specifications and Drawings: Parks**, Transportation & Utilities Department, COS;
- **Hydraulic Structures**, Smith, C.D., University of Saskatchewan, Printing Services;
- **Stormwater Guidelines EPB 322**, Saskatchewan Environment;
- **Wetland Design Guidelines**, CH2MILL;
- **The Environmental Management and Protection Act**, Province of Saskatchewan;
- **The Water Regulations**, Province of Saskatchewan;
- **The Occupational Health and Safety Act**, Province of Saskatchewan;
- **The Plumbing and Drainage Regulations**, Province of Saskatchewan;
• National Building Code, Canadian Commission on Building and Fire Codes, National Research Council of Canada;
• The Fisheries Act, Department of Fisheries and Oceans;
• The Navigable Waters Protection Act, Transport Canada;
• The Canadian Environmental Protection Act, Environment Canada;
• Canadian Water Quality Guidelines, Environment Canada;
• PVC Pipe: Design and Installation, (M23), American Water Works Association (AWWA); and
• PE Pipe: Design and Installation, (M55), AWWA.

2.1 City of Saskatoon

The TU Department requires the submission of a Storm Water Drainage Plan based on modelling of the proposed storm water drainage system and a Storm Water Storage Basin Design Report.

2.1.1 Storm Water Drainage Plan

At the neighbourhood concept stage, an analysis of the major and minor systems shall be carried out. The model shall be submitted to the COS for verification. The conceptual Storm Water Drainage Plan shall contain the following elements:
• A general description and site plan of the proposed development.
• A description of, and figures showing, the pre-development hydrology of the site.
• A description of, and figures showing, the proposed post-development topography and hydrology.
• A description of, and figures showing, the proposed staging of development and the storm water drainage infrastructure to be constructed during each major stage.
  ➢ This shall include identification of potential locations for oil/grit separators.
• A description of, and figures showing, the proposed storm water retention facilities to be constructed during each major stage of development.
• Identification of the impacts that the proposed development will have on the drainage of the local watershed.
• Justification for the proposed storm water management practices.
- A description of the erosion control methods that are to be used during construction and during the life of the storm water drainage system.
- A description of flow rates, boundary conditions, and any other assumptions used for modelling, together with calculations and/or the rationale for their use.
- A description of any simulation results. Actual model run data shall be appended to the Storm Water Drainage Plan.

For detailed design, modelling of the major and minor system shall be carried out for each stage of development. The staged Storm Water Drainage Plans shall include the same elements as the conceptual plan, but shall be specific to each stage of development. Models shall be submitted to the COS for verification.

The TU Department reserves the right to require resubmission of the Storm Water Drainage Plan if there are any changes to the proposed development that significantly affect the storm water drainage system and/or hydraulic analysis. Resubmissions shall be required at the discretion of the TU Department and shall typically relate to changes in the configuration of the system and/or changes to proposed land uses.

### 2.1.2 Storm Water Storage Basin Design Report

Proponents shall submit the following information, at the neighbourhood concept stage, to the TU Department for each proposed storm water storage basin (SWSB):

- A site plan showing the area served by the SWSB.
- Justification of the need for the SWSB.
- A description of each proposed basin, including drainage area, normal water level, and intended function.
- The results of the soil investigation for each SWSB.
- A design summary and present worth life cycle cost estimate for each SWSB.
- A comparison of technically viable options, if applicable. The technical or economic rationale for the preferred option shall be clearly outlined.
- Estimated inflows and outflows at the initial stage of construction, by phase, and at full buildout.
The COS shall be responsible for coordinating the design of each SWSB including:

- Design drawings and stage/storage/discharge rating curves.
- Modelling of basin performance under various operating conditions.
- Development of an erosion control program during construction and over the life of the SWSB.
- Development of a monitoring and maintenance program to complement the intended function of the SWSB.
- Development of an operation and maintenance manual for each facility.

2.2 Other Authorities

The Proponent shall be responsible for obtaining approvals from the appropriate authorities in a timely manner.

3 Design Flows

The storm drainage system for new developments shall consist of both major and minor components.

The **minor system** consists of piping, manholes, catch basins, and outfall structures that are able to convey runoff from more frequent, lower intensity storm events to the receiving water.

The **major system** consists of overland street drainage, detention facilities, park land, and any other land that is required to convey runoff from less frequent, higher intensity storms that produce runoff in excess of what the minor system typically handles.

3.1 Minor System

The minor system shall be designed to accommodate the 1-in-2 year event. The COS is investigating the possibility of changing the requirement for minor system design to the 1 in 5 year event.

- The Rational Method shall be used to determine design flows.
- Computer modelling shall be used to confirm design.
The minor system shall be evaluated to confirm that runoff during design events will be conveyed to adequate receiving waters without surcharging the pipe system.

The release rate from a new neighbourhood shall not exceed the capacity of the downstream system, or as set by the TU Department.

### 3.2 Major System

The major system shall be designed to accommodate the 1-in-100 year, 24-hour, design event.

- Systems containing SWSBs shall also accommodate the current maximum rainfall event of June 24, 1983.
- Computer modelling shall be used to confirm design.

The major system shall be evaluated to confirm that any flooding during design events shall be restricted to public areas.

The grading of streets and the layout of the major drainage system shall be assessed relative to the following guidelines during the design event:

- The maximum depth of ponding on the road shall be 0.40 m for all roadways.
  - A depth of 0.45 m shall be considered if adequate justification can be provided. In this case, the approval of the TU Department must be obtained.
- Continuity of the overland flow routes between adjacent developments shall be maintained.

### 3.3 Rational Method

The formula for the design peak runoff rate shall be:

\[ Q = 2.78 \times C \times I \times A \]

Where
- \( Q \) = Design peak flow rate (L/s)
- \( C \) = Runoff coefficient
- \( I \) = Rainfall intensity that corresponds to the time of concentration (mm/hr)
- \( A \) = Area of contributing runoff surface (ha)
3.3.1 Rainfall Intensity, Duration, and Frequency Data

Rainfall intensity, duration, and frequency (IDF) data and curves for Saskatoon can be found in Table B-1 and Figure B-1 of Appendix B. A record of the current maximum rainfall event for June 24, 1983 can be found in Table B-2 of Appendix B.

3.3.2 Time of Concentration

The duration of rainfall used to determine intensity is equal to the time of concentration. The time of concentration equals the time of overland flow to the storm drainage system inlet plus the time of travel in the upstream conduits.

- The overland flow time to curb side in residential and commercial areas shall not exceed 10 minutes in duration.
- Specific overland flow times shall be computed separately for industrial and undeveloped areas.
- Gutter flow time shall not exceed 5 minutes.
- The maximum time of concentration to an upstream inlet for a residential development shall be 15 minutes.
- The time of travel in the conduit shall be based on full flow velocity.

3.3.3 Coefficient of Runoff

The value of runoff coefficients shall be estimated from the following equation:

\[
C = \frac{(C_n A_n) + (C_{n-1} A_{n-1}) + ... + (C_1 A_1)}{A_n + A_{n-1} + ... + A_1}
\]

Where:
- \( C \) = Runoff coefficient, see Table B-3 in Appendix B
- \( A \) = Area, gross
- \( N \) = Denotes sub-areas, distinguished by land use
3.4 Modelling

A hydraulic analysis shall be required for every new development and for every change that significantly impacts a previous hydraulic analysis. The results of the modelling shall be summarized in the Storm Water Drainage Plan and submitted to the TU Department for approval.

The selection of an appropriate computer model shall be based on an understanding of the principles, assumptions and limitations of the system being designed. The preferred software model is the current release of XP-SWMM by XP Software. Submissions for approval using alternate modeling software shall be pre-approved by the TU Department.

- The TU Department shall provide information for existing nodes that will be connection points for the proposed network.
- The TU Department shall provide the datum for node elevations.
- Table B-4 in Appendix B contains information for the design storm hyetographs.

Modelling of the major and minor system shall include:

- Pre- and post-development hydrology with identification and quantification of all major points of drainage entry into and exit from the proposed development.
- The proposed staging of development and implementation of storm water management practices for each major stage.
- Simulation of 1-in-2 year, 1 hour design storm for the minor system.
- Simulation of 1-in-5 year, 1 hour design storm for the minor system.
- Simulations of the 1:100 year, 1 hour design storm for portions of the major system that do not include storage.

Modelling of SWSBs shall include:

- Performance during the 1:100 year design storm.
  - The duration of the design rainfall event for systems with storage shall be at least 24 hours.
- Performance during the current maximum rainfall event for June 24, 1983.
- The time taken to drain back to normal water level (NWL) in all cases.

3.4.1 Water Levels

In systems with an SWSB, the effects of the high water level (HWL) shall be considered in the design of the minor system and property drainage.
For major system design:
- The HWL of the 1-in-100 year event shall be restricted to public lands in all cases.
- Basement floor slabs shall be constructed above the HWL.
  - Walkout basements shall be constructed with a minimum freeboard of 1.0 m above the HWL.

For SWSB design:
- A dry pond’s outlet capacity shall be such that the facility shall drain and reach NWL within 24 hours of reaching HWL during the design event.
- A wet pond’s outlet capacity shall be such that the facility shall drain and reach NWL within 48 hours of reaching HWL during the design event unless otherwise approved by the TU Department.
- The SWSB’s shall be designed with a minimum of 1.0 m free board between pond HWL and property line. An XPSWMM model shall be used to analyze the SWSB under 100% clogged outlet conditions. The analysis will show that with zero outlet flow, the pond HWL during 24-hour 100-year storm will remain below the property line elevations. If the analysis shows that HWL is higher than the property line elevations, the SWSB shall be redesigned to keep the HWL below property line elevations.

### 3.5 Gravity Flow: Minor System

The piped system shall convey the design flow when flowing full with the HGL at the pipe crown. The Manning Equation shall be used for the design and modelling of gravity flows in storm drainage pipes.

\[
Q = \frac{(A*R^{2/3}*S^{1/2})}{n}
\]

Where:
- \(Q\) = Flow (m³/s)
- \(A\) = Cross sectional area of pipe (m²)
- \(R\) = Hydraulic radius (area/wetted perimeter) (m)
- \(S\) = Slope of hydraulic grade line (m/m)
- \(n\) = Manning coefficient = 0.013 for all approved materials in straight alignment (s/m¹/³)
3.5.1 Velocity

Flow velocities shall not be less than 0.90 m/s at full flow.
- When the flow velocity exceeds 3.0 m/s, special consideration shall be given to invert erosion in the piping.

3.5.2 Size

The minimum size of storm drainage piping shall be 300 mm diameter.

3.5.3 Slope

Minimum slopes, based on full flow, which shall be permitted for various pipe sizes are provided in the table below.
- Maximum slopes shall be based upon limiting the maximum flow velocity.

Table 3-1a
Minimum Permitted Pipe Slope at Full Flow
For Straight Sewers

<table>
<thead>
<tr>
<th>Pipe Size (mm)</th>
<th>Minimum Slope (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>300</td>
<td>0.44</td>
</tr>
<tr>
<td>375</td>
<td>0.32</td>
</tr>
<tr>
<td>450</td>
<td>0.26</td>
</tr>
<tr>
<td>525</td>
<td>0.22</td>
</tr>
<tr>
<td>600</td>
<td>0.18</td>
</tr>
<tr>
<td>675</td>
<td>0.15</td>
</tr>
<tr>
<td>750</td>
<td>0.13</td>
</tr>
<tr>
<td>900 and larger</td>
<td>0.1</td>
</tr>
</tbody>
</table>

3.5.4 Curved Pipes

If storm drainage pipes are curved, the coefficient of roughness and minimum acceptable slopes shall be subject to the approval of the ME Branch.
### Table 3-1b
Minimum Permitted Pipe Slope at Full Flow
For Curved Sewers

<table>
<thead>
<tr>
<th>Pipe Size (mm)</th>
<th>Minimum Slope (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>300</td>
<td>.50</td>
</tr>
<tr>
<td>375</td>
<td>0.37</td>
</tr>
<tr>
<td>450</td>
<td>0.29</td>
</tr>
<tr>
<td>525</td>
<td>0.24</td>
</tr>
<tr>
<td>600</td>
<td>0.20</td>
</tr>
<tr>
<td>675</td>
<td>0.17</td>
</tr>
<tr>
<td>750</td>
<td>0.15</td>
</tr>
<tr>
<td>900</td>
<td>0.12</td>
</tr>
<tr>
<td>1050 and larger</td>
<td>0.10</td>
</tr>
</tbody>
</table>

#### 3.6 Gravity Flow: Major System

On streets, the maximum acceptable storm water velocity shall be 0.45 m/s. In other areas, the combination of velocity and depth of overland flow shall not exceed the values outlined in the following table:

### Table 3-2
Permissible Depths for Submerged Objects

<table>
<thead>
<tr>
<th>Water Velocity (m/s)</th>
<th>Permissible Depth (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>0.80</td>
</tr>
<tr>
<td>1.0</td>
<td>0.32</td>
</tr>
<tr>
<td>2.0</td>
<td>0.21</td>
</tr>
<tr>
<td>3.0</td>
<td>0.09</td>
</tr>
</tbody>
</table>


In areas where the permissible depth and velocity values specified in Table 3-2 are difficult to satisfy, such as in close proximity of culverts in linear parks, appropriate safety measures shall be included in the design for consideration of approval by the TU Department.
4 Property Drainage

Standard drawings that should be referenced for site and lot drainage are listed in Appendix A.

4.1 General Drainage

An allowable range of 2% to 4% slope shall be used for general property drainage.

4.2 Drainage Easements

Where stormwater drainage for a grouping of lots is directed along one or more property lines, the Proponent shall provide a drainage easement.

4.2.1 Slope

The minimum slope for drainage channels at common residential property lines is:

- 1.0% for grassed channels.
  - This may be reduced to zero if all lots along the common property line drain from back to front.
- 0.5% for concrete-lined channels.

The minimum slope for drainage channels at common commercial or institutional property lines is 0.5% for grassed or concrete-lined channels.

- If a commercial or institutional property line is common with a residential property line, then the minimum slopes for the residential property shall govern.

Where back lot drainage is common to flankage and more than 2,000 m² is drained along a side yard:

- The side yard shall be configured with a catch basin in the back.
- A concrete channel with a minimum slope of 0.5% shall be placed along the side yard.

4.2.2 Length and Configuration

- The length of a channel from high point to discharge point shall not exceed 200 m.
• Bends between the high point and the discharge point shall not exceed 40°.

4.2.3 Discharge Points

Discharge points shall be at the intersection of the drainage easement with a street, walkway, concrete swale, or catch basin.
• When a walkway or concrete swale is used as a discharge point:
  ➢ The minimum slope of the walkway or concrete swale shall be 0.5%.
  ➢ The length of the sidewalk shall be included as part of the total easement length.
• When a catch basin is used as a discharge point, a concrete pad shall surround the basin and extend at least 1.0 m from the edge of the basin.

4.3 Approaches and Culverts

Approaches and culverts are discouraged. Their use shall be pre-approved and design shall be carried out under the direction of the TU Department.

5 Design of Minor System Components

Standards for the design of catch basins, pipes, manholes, and outfalls are presented in this section. Standard drawings that should be referenced for the design of minor system components are listed in Appendix A.

5.1 Catch Basins

Catch basins shall be installed to intercept all overland flows, including flows in back lanes and gutters/swales.

5.1.1 Drainage Length

• The first catch basin (furthest upstream) in any portion of the storm drainage system shall be located a maximum distance of 200 m from the nearest high point.
• Catch basins within the storm drainage system shall have a typical maximum spacing of 120 m.
5.1.2 Capacity

- Surface water shall be intercepted with a number of catch basins such that the inlet capacity is sufficient to receive the design storm water flow.
- Catch basin capacity shall be considered for both sump conditions and on inlet grate type.

5.1.3 Barrels

All catch basin barrels shall be 600 mm or 900 mm precast, sulphate resistant concrete sections. A sump shall be provided.

5.1.4 Leads

All catch basin leads shall discharge directly into the storm drainage system at a manhole.
- The maximum lead length shall be 30 m.
- The minimum lead size shall be 250 mm with a minimum slope of 2%.
- A 300 mm diameter lead may be used with a minimum slope of 1%.

Two catch basins may be connected to one lead. In this case:
- The minimum lead size shall be 300 mm.
- The minimum slope shall be 2%.

5.2 Pipes

The sewage collection system shall consist of two types of pipes, as outlined in the following table:

<table>
<thead>
<tr>
<th>Type</th>
<th>Storm Water Path</th>
<th>Diameter (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local Storm Pipe</td>
<td>From service connections and catch basin manholes to trunk</td>
<td>Minimum 300</td>
</tr>
<tr>
<td>Trunk Storm Pipe</td>
<td>From neighbourhoods to receiving water</td>
<td>Minimum 1350</td>
</tr>
</tbody>
</table>
5.2.1 **Sizing**

Storm water pipes shall be sized to accommodate the design flows for the proposed contributing area and if applicable, to reasonably accommodate extensions to adjacent future development areas as described in the sector plan for each development area.

5.2.2 **Depth of Cover**

The depth of the minor storm water drainage system shall be sufficient to meet the following requirements:

- Frontage piping shall be of adequate depth to receive connections from adjacent properties.
- Minimum depth of cover of 1.85 m to the crown of the pipe.

5.2.3 **Clearance**

- The minimum vertical clearance from the bottom of one pipe to the top of the next lowest pipe shall be 150 mm.
- Where pipes are laid on undisturbed soil, the minimum horizontal clearance between the outer walls of the adjacent pipes shall be 300 mm.
- If pipes are installed in a common trench with other pipes, clearances must be approved by the TU Department.

5.2.4 **Pipe Strength**

The strength of the pipe shall be calculated on the basis of transition width trench conditions.

- Pipe strength and wall thickness shall be determined in accordance with AWWA standard design manuals for various pipe materials.
- Pipe bedding shall be determined as per the City of Saskatoon *Standard Construction Specifications and Drawings*.
- Minimum backfill weight shall be 2162 kg/m³ unless a detailed geotechnical investigation indicates that a lesser value can be used.
5.2.5 Curved Storm Drainage Pipes

Curved storm drainage pipes may be built with radius pipe or bends.
- The minimum radius of curvature allowed shall be in accordance with manufacturer’s specifications for the material.
- Curbs shall not be undercut to accommodate the curvature.

5.3 Manholes

Manholes shall be located at the upstream end of each line, at changes in size or alignment, at all junctions, and at all catch basin connections.

5.3.1 Locked Manholes

Manholes shall be locked when:
- Not located on a roadway.
- Located in crosswalks or along a public pathway.
- Located in proximity to an area that will be generally accessible to the public.

5.3.2 Spacing

The maximum spacing between manholes shall be 120 m for maintenance considerations.
- Greater spacing may be considered for pipes larger than 750 mm in diameter at the discretion of the TU Department. In no case shall spacing be greater than 250 m.
- Maximum spacing for curved pipes shall be 100 m unless otherwise approved by the TU Department.

5.3.3 Diameter

The minimum manhole diameter shall be 1.2 m.
- For pipes at depths greater than 6.0 m special manholes are required with safety platforms at intermediate levels.
  - The lowest platform should typically be above the incoming flow.
  - The maximum spacing of safety platforms is 6.0 m.
5.3.4 Hydraulic Losses

- Allowance shall be made for hydraulic losses through manholes by:
  - Maintaining grades of sewers and matching crowns for straight run manholes types.
  - Dropping the invert by 0.03 m at deflections of 45° to 90°.
  - Providing benching.

5.4 Oil and Grit Separators

Oil and grit separators are underground detention structures that are designed to capture hydrocarbons and sediments on the principles of gravity based sedimentation and phase separation for oil. They take the place of a conventional manhole in the storm water drainage system and are typically used in areas that are highly impervious with potential for discharge of hydrocarbons and/or polluted sediments. Installation of oil and grit separators results in extension of operational life of storm water management facilities and protection of environment from sediment and oil contamination.

Oil and grit separators are typically installed for small sites (< 2 ha) where a pond/wetland is not feasible for quality control. For larger sites (> 2 ha) oil and grit separators are usually allowed in a treatment train approach in conjunction with other approved storm water management options.

The minimum flow captured by an oil and grit separator shall not be less than the 1 hour 2-year post development flow. A design brief storm water management report shall be submitted to the City of Saskatoon along with site approval application. Approved oil and grit separators shall be installed as per the following criteria:

- At interface of COS storm water management system and industrial, commercial, and government sites.
- At all interface between private drainage systems for parking lots over 1500 m².
- At the interface between the drainage system for newly developed residential sites and the existing COS storm water drainage system.
- On inlets to SWSBs from small sites described above.
5.4.1 General Design Considerations

Sizing calculations shall use the following guidelines:

- Total suspended solids (TSS) removal efficiency equivalent to enhanced level of treatment (80% TSS removal). For example, in order to get 80% TSS removal, a separator could be sized to capture 94% of the 2-year storm runoff volume with 85% removal efficiency.
- A bypass shall be provided for high storm water flow conditions to avoid re-suspension of settled solids.
- Calculations shall be based on City of Saskatoon IDF data with time of concentration of 15 minutes.
- Particle size distribution shall be determined for each site and shall be used in sizing calculations to ensure that enhanced level of treatment is achieved.

5.4.2 Maintenance and Repairs

The owner shall be responsible for maintenance and repairs of oil and grit separators installed on their property. Operation and maintenance requirements shall be noted in the design brief storm water management report for site development and shall be implemented by the owner to ensure that the required performance is achieved as per City’s approval. Separators shall be maintained appropriately to reduce the sediment/hydrocarbon load entering the COS storm water drainage system. Monitoring shall be required during the maintenance period and throughout the operating life of the separator at the discretion of the TU Department.

5.5 Outfalls

The purpose of an outfall structure is to reduce flow velocity and prevent erosion.

- Outfall structures shall be placed at the end of all non-submersed storm drainage pipes that discharge to an open channel, watercourse, river or other receiving water body.
- The structure shall be a chute, spillway, stilling basin, plunge pool with headwall, or other appropriate structure.
- The structure shall be designed in accordance with C.D. Smith’s *Hydraulic Structures*.
5.5.1 General Design Considerations

- Outfalls to a receiving stream or open channel shall be a minimum of 1.0 m above the NWL.
- Outfalls shall be located to avoid damage from moving ice during break up.
- Design shall prevent collection of debris on the apron.
- A cutoff wall is required at the end of the outfall apron to prevent undermining of the structure.
- Riprap and a filter layer, complete with geotextile, shall be placed downstream of the outfall structure where required to prevent erosion.
- Weeping tile shall be placed under the structure to reduce any water pressure behind the head wall.
- Grills shall be placed over all storm drainage outlets to prevent access.
- Railings shall be placed along the head wall and wing walls of the outfall structure.

6 Design of Major System Components

Standards for the design of grassed swales, wet ponds, dry ponds, and constructed wetlands are presented in this section. Standard drawings that should be referenced for the design of the storm drainage system are listed in Appendix A.

6.1 Grassed Swales

Swales can be natural or manmade and can be constructed only for conveyance or to temporarily store water and remove materials by infiltration and/or settling. Flow is typically conveyed toward a catch basin. The use of grassed swales must be approved and design shall be carried out under the direction of the TU Department.

6.2 Storm Water Storage Basins: General

For the purposes of these standards, storm water storage basins (SWSBs) shall include wet ponds, dry ponds, and constructed wetlands. The use of a SWSB shall require the submission of a Storm Water Storage Basin Design Report and the approval of the TU Department.
• In assessing the need for SWSB, the Proponent shall consider the impacts of uncontrolled drainage as well as the capital and operating costs of providing control.
• Where a SWSB is to have multiple functions, its design shall consider the aesthetic implications of shape, grading and landscape features.
• Where possible, design shall incorporate measures for water quality improvement.
• The storm water retention area, up to and including the HWL, shall become public property.
• The storm water retention area above the 1 in 5 year storm elevation may be part of the required municipal reserve.
• Where possible, an emergency overflow system shall drain to a receiving stream for storms greater than the design event.
• Monitoring shall be required during the maintenance period to ensure that the storage basin is operating in accordance with its intended design flow, storage volume, and water quality improvement objectives (if applicable).
• The Proponent shall remove sediment from SWSBs and ensure that vegetation is adequately established by the end of the maintenance period.
• SWSBs located within four km of the Saskatoon Airport may be subject to Airport Zoning Regulations (AZRs). The AZRs may require special design features not covered in these standards. The TU Department will determine if the SWSB is subject to the AZRs and inform the Proponent of the determination.
• SWSB’s shall have appropriate signage including safety precautions and other general public information.

6.2.1 Soil Investigations

Hydrologic and geotechnical investigations specific to the SWSB shall be undertaken to determine appropriate design factors.
• Constructed storage basins shall not act as either a recharge or a discharge area for groundwater.
• Where the basin is sited above a shallow aquifer the potential for groundwater contamination shall be minimized.
• Wet pond detention facilities shall be constructed in impervious soils to minimize water losses during dry weather periods.
• Intruding silt or sand seams shall be sealed off.
6.3 Wet Ponds

Wet ponds are designed to retain and treat storm water runoff. They are typically located at local low points or adjacent to or part of an existing watercourse. Public access and safety issues are to be addressed in the design of the basin. Whenever possible, a constructed wetland should be located immediately upstream of the wet pond.

6.3.1 Configuration

- The preferred length:width ratio shall be from 4:1 to 5:1.
- The bottom of the pond shall be graded so that the facility can be completely pumped dry.
- Side slopes shall be no steeper than 3:1 from the bottom of the pond to 0.5 m below the NWL.
  ➢ From this point to 5 horizontal meters beyond the design event flood level, the side slopes shall be no steeper than 5:1.
- At NWL, the minimum depth shall be 2.5 m and the maximum depth shall be 3.0 m.
- Maximum active storage depth shall be 1.8 m.

6.3.2 Inlets and Outlets

Inlets and outlets shall be located to maximize detention time and circulation within the wet pond.

- Narrow and/or dead bay areas where floating debris may accumulate shall be avoided.
- Inlets shall be, where possible, a minimum of 1.0 m below the NWL. Otherwise, inverts of inlet pipes shall be above the water ice level.
  ➢ Provision shall be made for sediment accumulation at points of inflow and for the periodic removal of sediment by maintenance crews.
- Outlet pipe crowns shall be at least 1.0 m below NWL, below ice level, and above the level of anticipated sediment accumulation.
  ➢ Outlets shall operate by gravity.
  ➢ Drainage control shall be located in the outlet control structure.
6.3.3 Edge Treatment

- Naturalized shorelines are preferred over inorganic shorelines. Inorganic shoreline treatments shall be provided for 1.5 horizontal meters below and 3.0 horizontal meters above the NWL. Inorganic shorelines shall make up no more than 30% of the total shoreline.
- Edge treatments shall be compatible with adjacent land use and consider safety, maintenance and access.
- The area around the wet pond, up to the design event flood level, shall be sodded or grassed, or protected with a silt fence, during the construction phase to prevent erosion and sedimentation.

6.4 Dry Ponds

Dry ponds are designed to act as a temporary holding facility for storm water runoff and to delay the release of runoff into the storm drainage system. Dry ponds are not considered to be a treatment facility for water quality improvement, although some removal of settleable solids may occur. Public access and safety issues are of concern, especially when the pond is in operation, and shall be addressed in the design of the basin. Dry ponds shall not be used to hold runoff from storms with a frequency of 1 in 2 years or less.

6.4.1 Configuration

The dry pond shall have dimensions that are acceptable to the Transportation & Utilities Department and, where appropriate, to the Community Services Department.
- The preferred length: width ratio shall be from 4:1 to 5:1.
- Side slopes shall be no steeper than 5:1.
- The bottom of the pond shall be graded with minimum longitudinal and lateral slopes of 100:1.
- The bottom and sides shall be sodded or grassed.
- Maximum depth shall be 2.0 m at full operating level.

6.4.2 Inlets and Outlets

- A low flow bypass is required for flows from minor events.
- Grills shall be placed over all inlets and outlets to prevent access.
6.5 Constructed Wetlands

Constructed wetlands are preferred over wet ponds. Constructed wetlands consist of a forebay and a shallow environment suitable for the growth of aquatic and semi-aquatic plants. They may be used to provide an enhanced level of water treatment via sedimentation, filtration, and biological uptake. Constructed wetlands may be built in conjunction with downstream wet ponds.

In 2013-14 City of Saskatoon retained CH2MHILL to prepare standard wetland design guidelines to provide a basic set of guidelines to developers and designers to aid them in understanding the design requirements for constructed wetland design. The full report can be accessed by a link found on the City of Saskatoon website page - Design and Development Standards Manual. Link to “Wetland Design Guidelines”.

6.5.1 Overall Configuration

- Where possible, wetland should be limited to 1 inlet, and 1 outlet.
- Minimum side slope is 5:1.
- Active storage fluctuation depth should be limited to 1.85m.
- Minimum 1m of freeboard is required.

6.5.2 Inlet Pipe Configuration

- Inlets should be located with the longest flow path possible between inlet and outlet to minimize short circuiting.
- Submerged inlets are preferable, where the crown of the inlet pipe requires a minimum of 0.8m below NWL, and the invert a minimum of 100mm from the wetland floor.
- Unsubmerged inlets can be used provided the pipe invert is set at the HWL, and the inlet has a grating.
- If pre-treatment of flow through a forebay, vortex separator is not possible, a skimming type manhole on the first manhole upstream of the inlet is recommended to prevent floatable from entering the wetlands.
- Inlet velocities should be limited to 1.5m/s where possible to minimize erosion or scour.
- Erosion control measures must be provided at the bottom of the inlet structure to control erosion and scour.
6.5.3 Sediment Forebay

- Sediment forebay should be designed to settle 0.150mm sediment with a settling velocity of 0.0003m/s, in a 1:2 year storm event.
- Forebay area is typically between 10-20% of the volume of the permanent pool or at least 10% of the wetland volume.
- Forebays are typically separated from the wetland by gabions, riprapped berm, or by an earthen berm with a controlled overflow with erosion protection. The height of the gabions or berm can be from NWL to 0.3m above NWL.
- Length to width ratio of the forebay minimum 2:1.
- Forebay depth range from 1-3m.
- Side slopes below NWL minimum 5:1.

6.5.4 Permanent Pool Configuration

- Slopes below NWL minimum 5:1.
- Permanent Pool depths typically range from 150mm – 300mm.
- Deep zones with a minimum depth of 1m should be introduced to redistribute flow across the wetland to encourage sheet flow.
- Any interior berms used for flow attenuation will have a minimum side slope of 5:1 below NWL, and 3.5:1 above. Width of the top of the berm will be a minimum of 1m for foot traffic, and 3m for vehicle traffic.

6.5.5 Wetland Outlet Configuration

- There are two main outlet flow structure configurations. Reverse sloped outlet pipe, and a perforated riser outlet pipe.
- It is preferable that all outlet pipes be fully submerged with the crown of the pipe a minimum of 0.8m below discharging wetland NWL, and a minimum of 100mm above wetland floor.
- Outlet control structures should be designed so that water level depth can be controlled in the wetland, including complete draining of the wetland.
6.5.6 Vegetation Establishment

- After excavation, grading, and 75mm to 150mm of top soil placement, if manually planting emergent vegetation as bare root, plugs, or potted material, the wetland should be kept flooded (saturated) until planting. At least 48 hours prior to planting, the wetland should be drained. After planting the soil must be kept saturated with minimal standing water of 100-200mm until the plants are well established and have a growth to more than 0.5m height. After which the wetlands can return to normal functionality.
- Maximum drain time after a rain event should be kept to 48 hours to protect the viability of young plants.
- Experience suggests that from the time of germination to the time when the wetland can be brought up to the NWL is about 6-8 weeks.
- Maintaining saturated conditions can be done by pumping water into the wetland if dry conditions are present. This is particularly important if using wetland soils containing viable rhizomes/roots. If the wetland is being constructed with non-wetland soils, the wetland can remain dry until about one week before planting.
- When establishing or restoring vegetation, inspection every 2 weeks of vegetation health, density, and diversity should be performed.
- If the earthworks can be completed in the summer/fall period, the wetland can be seeded in the fall.
- If the wetland bottom elevation will not change and the existing soils are tight enough that the hydraulic conductivity is similar to that of clay compacted to 95-98% proctor, consideration can be given to retaining the wetland soil undisturbed in the areas that are at the correct bottom elevation.
- Seeds and plant supplied must come from the same climatic zone as Saskatoon and preferably from within 100km radius.

6.6 Other Storage Facilities

- Underground storage tanks shall be considered only if no other economical alternative means of storage is feasible.
- Parking lot and rooftop storage shall be considered only for developments where the facilities are part of the project.
Infiltration and evaporation facilities shall require detailed engineering studies, which shall involve site-specific measurements of infiltration, knowledge of the groundwater regime, and an evaluation of the water balance for the system.

7 Water Quality

Water quality objectives have been established for Saskatchewan and are outlined in the SE Surface Water Quality Objectives. These objectives are guidelines used to issue permits and to support/maintain designated water uses.

7.1 Sediment and Erosion Control

Controls shall be provided to minimize sediment discharge to the storm drainage system.

- This shall include properly graded and surfaced streets and lanes, landscaping, sediment control structures at pond and lake inlets, and other means where appropriate.
- Measures shall be incorporated in new developments to prevent any increase in the amount of downstream erosion.
  - If a development causes downstream erosion despite the use of on-site peak runoff rate controls, appropriate measures shall be constructed in the downstream areas.
- Preservation of watercourse aesthetics and wildlife habitat shall be considered in erosion and bank stability work.

7.2 Monitoring Requirements

Proponents shall be required to monitor the water level, flow, storage volume, and water quality (if applicable) impacts of SWSBs and oil/grit separators during the maintenance period to demonstrate that the infrastructure is operating in accordance with the intended design.

- Specific monitoring requirements for individual facilities shall be determined by the TU Department.
- A summary of monitoring results shall be submitted at the end of each year of the maintenance period.
7.2.1 Wet Ponds and Constructed Wetlands

Samples shall be taken at both the inlet(s) and the outlet(s) of wet ponds and constructed wetlands during each monitoring event.

During the maintenance period:
- Routine monitoring shall occur on a monthly basis to create a baseline database.
  - This will include pond based sampling when there is no inflow.
- Annual monitoring shall take place during spring melt and immediately following three or more storm events.
- Monitoring shall typically include, but not be limited to, the following parameters:
  - Turbidity.
  - Total Suspended Solids.
  - Nitrogen.
  - Total Phosphorous.
- Additional monitoring requirements shall be based on proposed land uses in the surrounding watershed, as determined by the TU Department.
- Monitoring records shall include:
  - A description of the weather conditions prior to and during monitoring, including precipitation amounts.
  - Velocity and water level measurements.

After the maintenance period:
- Annual monitoring shall take place in accordance with the monitoring and maintenance program developed by the TU Department.

7.2.2 Dry Ponds

Samples shall be taken at both the inlet and the outlet of dry ponds during each monitoring event.

During the maintenance period:
- Monitoring shall occur immediately following three or more storm events and shall continue at a minimum of once daily until the facility has emptied, or as directly by the TU Department.
• Monitoring records shall include:
  ➢ A description of the weather conditions prior to and during monitoring, including precipitation amounts.
  ➢ Velocity and water level measurements.

After the maintenance period:
• Annual monitoring shall take place in accordance with the monitoring and maintenance program developed by the TU Department.

7.2.3 Oil and Grit Separators

Oil and grit separators shall be monitored at least once every six months during and after the maintenance period.
• Potential upstream erosion and/or hydrocarbon loading issues shall be reported immediately to the TU Department.

8 Future Developments

In the event that storm water pipe stubs are provided for future developments, they shall be installed at as great a depth as possible to maximize flexibility when the pipes are extended.
• Stubs shall be capped.
• Storm system stubs shall be staggered, by a minimum of 2.5 m, in relation to any other stubs to facilitate access in the future.
APPENDIX A – STANDARD DRAWINGS

Proponents shall be responsible for referencing standard drawings that are applicable to their development. Drawings are available from the City website (see link at the end of this Appendix).

Drawings are subject to revision, addition, or deletion. Revised drawings shall be renamed using the date of latest revision. Proponents are responsible for ensuring that they are referencing the latest version of any standard drawing.

Drawings that are applicable to the Storm Water Drainage System include:

<table>
<thead>
<tr>
<th>Drawing Number</th>
<th>Title</th>
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<tr>
<td><strong>Lot Drainage</strong></td>
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<tr>
<td>102-0022-003</td>
<td>Easement Grading Back Yard</td>
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<tr>
<td>102-0022-004</td>
<td>Easement Grading Side Yard Grading</td>
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<tr>
<td>102-0022-005</td>
<td>Drainage Swale Back of Lot, 1 of 2</td>
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<tr>
<td>102-0022-007</td>
<td>Drainage Swale Back of Lot, 2 of 2</td>
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<tr>
<td>102-0022-006</td>
<td>Grade Markers Electrical Kiosk</td>
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<tr>
<td>102-0022-008</td>
<td>Grade Markers Electrical Kiosk</td>
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<td>102-0022-009</td>
<td>C.O.S. Lot Grade Markers Construction and Placement</td>
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<td>102-0022-010</td>
<td>Drainage Improvement</td>
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<td>102-0022-012</td>
<td>Side Yard Drainage Swale</td>
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<td>102-0022-013</td>
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<td>Lot Grading Transition Lot Type D/C &amp; C/D</td>
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<td>Lot Grading Transition Lot Type D/E &amp; E/D</td>
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<td>Lot Grading Type E</td>
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<td>Side Yard Typical Concrete Drainage Swale</td>
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<td><strong>Curbs and Walks</strong></td>
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### Storm Drainage System

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<tr>
<td>102-0018-001</td>
<td>Grating for Concrete Endwall Pipe Dia. Up to 1200 mm</td>
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<td>102-0018-002</td>
<td>Grating for Concrete Endwall Pipe Dia. 1350 mm to 1800 mm</td>
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<tr>
<td>102-0018-003</td>
<td>Standard Handrail</td>
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<td>102-0018-004</td>
<td>Standard Riprap Detail</td>
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<tr>
<td>102-0018-005</td>
<td>Storm Sewer Outfall</td>
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<td>102-0018-006</td>
<td>Storm Sewer Outfall Reinforcement Details</td>
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<td>102-0018-007</td>
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<td>102-0018-009</td>
<td>Standard Ditch Crossing Culvert Requirements</td>
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<td>Stormwater Storage Basin Cross Sections</td>
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### Manholes

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<td>Manhole Safety Platform</td>
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<td>Standard 1050 mm Manhole for 200 mm to 525 mm Sewers-For Rehabilitation Work Only</td>
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<td>Standard 1200 mm Manhole for 200 mm to 600 mm Sewers</td>
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<td>102-0011-006</td>
<td>Standard 1200 mm Manhole for 675 mm to 900 mm Sewers</td>
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<td>Circular Pipe Beddings</td>
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<td>Drop Structure Manhole for Connection to Trunk Storm Sewers</td>
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<td>Standard 1200mm Manhole for 200 mm to 600 mm Sewers</td>
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<td>Concrete Manhole Collars</td>
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<td>Lifter Ring Details</td>
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<td>102-0011-014</td>
<td>Rubber Manhole Adjustment Riser</td>
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<td>102-0011-016</td>
<td>Manhole Rehabilitation Where Thickness of Concrete Below Invert Exceeds 125mm</td>
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<td>Manhole Rehabilitation Where Thickness of Concrete Below Invert Does Not Exceed 125 mm</td>
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<td>102-0011-018</td>
<td>Sewer Force Main Inspection Manhole</td>
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<td>102-0011-019</td>
<td>Standard Lockable COS Manhole Frame &amp; Cover for Public Properties</td>
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<td>102-0011-020</td>
<td>Lock Wing &amp; Spacers for Standard COS Manhole Covers</td>
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<tr>
<td>102-0011-021</td>
<td>Standard Lockable COS Manhole Frame &amp; Cover for Private Properties</td>
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<td>102-0011-028</td>
<td>Standard Manhole Types for Large Sewers – Notes and Schedules</td>
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<tr>
<td>102-0011-031</td>
<td>Standard Storm Sewer Subdrain Detail – Crown Depth up to 2.3m</td>
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<tr>
<td>102-0011-032</td>
<td>Standard Storm Sewer Subdrain Detail – Crown Deeper than 2.3m</td>
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<td><strong>Catch Basins</strong></td>
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<td>Sump Pump Retrofit #2 With Pumped Discharge to Surface</td>
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## APPENDIX B – TABLES AND FIGURES

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<td>Intensity-Duration-Frequency (IDF) Data</td>
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<td>Interpolation Equation</td>
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<td>Table B-2</td>
<td>Rainfall Amounts for the Event of June 24, 1983</td>
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<td>Table B-3</td>
<td>Runoff Coefficients for Urban Areas</td>
</tr>
<tr>
<td>Table B-4</td>
<td>Design Storm Hyetographs</td>
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### Table B-1

**Intensity-Duration-Frequency (IDF) Data**

**University of Saskatchewan and Saskatoon Airport**

1926 to 1986 (61 years)

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<tr>
<th>Time (Minutes)</th>
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<td>60</td>
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<td>120</td>
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Source: Meteorological Service of Canada (formerly Atmospheric Environment Services), Environment Canada and the University of Saskatchewan.

### Table B-1.1

**Interpolation Equation**

(for 10 min to 2 hr durations)

**University of Saskatchewan and Saskatoon Airport**

1926 to 1986 (61 years)

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<th>Intensity = A / (t + C)^B</th>
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<td>B</td>
<td>0.694</td>
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<td>C (min)</td>
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Source: Meteorological Service of Canada (formerly Atmospheric Environment Services), Environment Canada and the University of Saskatchewan.
### Table B-2

**Rainfall Amounts for the Event of June 24, 1983\(^1,\!^2\)**

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<th>Rainfall During Period (mm)</th>
<th>Period End (hr:min)</th>
<th>Rainfall During Period (mm)</th>
<th>Period End (hr:min)</th>
<th>Rainfall During Period (mm)</th>
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Source: Meteorological Service of Canada (formerly Atmospheric Environment Services), Environment Canada.

**Table B-2 Notes:**
1: Time 0:00 of this hyetograph corresponds to 5:00 p.m. of the actual storm.
2: A total of 96.5 mm fell on June 24; 14.6 mm before 7:00 a.m. and 81.9 mm after 5:00 p.m.
### Table B-3
Runoff Coefficients for Urban Areas

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<th>Land Use</th>
<th>Runoff Coefficients (SE)$^1$</th>
<th>City of Saskatoon $^{2,3,4}$</th>
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<th>5 year</th>
<th>25 year</th>
<th>100 year</th>
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<td>0.05</td>
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<td>0.95</td>
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</table>
Table B-3 Notes:
2: Values are recommended minimums for use with the Rational Method.
3: Where specific land surfaces are known for apartment and commercial areas, the runoff coefficient may be determined based on the surface characteristics for the ultimate development conditions.
4: Runoff coefficients for industrial land use must be estimated based on ultimate land use condition.

Table B-4
Design Storm Hyetographs

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Table B-4 Notes:
1: Time of peak/duration of storm, r = 0.38.
2: Peak intensity reduced by averaging over 10 minutes.