October 3, 2019
TPB178051
Kate Hagerman, MCIP RPP
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Region of Waterloo
150 Frederick St., Kitchener N2G 4J3

RE: Upper Cedar Creek Scoped Subwatershed Study: Water Management Plan and Natural Heritage System Strategy, Regional Municipality of Waterloo

Dear Madam,

The Region’s Consulting Team of Matrix Solutions, Wood, and Natural Resource Solutions Inc. is pleased to submit the Upper Cedar Creek Water Management Plan and Natural Heritage System Strategy report. The analyses, conclusions, and recommendations presented herein have built upon the findings from the Scoped Subwatershed Study (Matrix Solutions et. al., October 2019), and provide further details for the management of potential future development within the Detailed Study Area (DSA) per the land use concept developed for the Scoped Subwatershed Study. As noted in this document, the physiography and environmental systems within, and proximate to, the potential development areas within the DSA present unique and specific challenges related to the need to maintain clean groundwater recharge to sustain municipal wellfields and environmental features, provide flood protection under seasonally-varying flood potential, provide stormwater quality management particularly for chloride and thermal enrichment, and protect drainage outlets with no defined drainage features from increased erosion potential resulting from future development. Managing these anticipated impacts from potential future development presents particular challenges, and will require innovative stormwater management and planning strategies. Notwithstanding, the findings and recommendations within this report include guidance for completing future studies, which would further build upon and refine the conclusions and recommendations advanced in the Scoped Subwatershed Study and the Water Management Plan and Natural Heritage System Strategy.

On behalf of the Study Team, we thank the Region for the opportunity to serve in completing this assignment, and sincerely appreciate the guidance and insight provided by the Region and GRCA over the course of this study.

Sincerely,

Wood Environment & Infrastructure Solutions
a Division of Wood Canada Limited

Per: Ron Scheckenberger, M.Eng., P.Eng.
Principal Consultant

Matrix Solutions Inc.

Per: Sam Bellamy, P.Eng.
Vice President, Eastern Operations
UPPER CEDAR CREEK SCOPED SUBWATERSHED STUDY
WATER MANAGEMENT PLAN AND NATURAL HERITAGE SYSTEM STRATEGY

Prepared for:
THE REGIONAL MUNICIPALITY OF WATERLOO AND GRAND RIVER CONSERVATION AUTHORITY

Prepared by:
MATRIX SOLUTIONS INC.
WOOD ENVIRONMENT AND INFRASTRUCTURE SOLUTIONS
NATURAL RESOURCE SOLUTIONS INC.
SGL PLANNING & DESIGN

Version 1.0
October 2019
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UPPER CEDAR CREEK Scoped Subwatershed Study

Water Management Plan and Natural Heritage System Strategy

Prepared for the Regional Municipality of Waterloo and the Grand River Conservation Authority

October 2019

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DISCLAIMER

Matrix Solutions Inc. certifies that this report is accurate and complete and accords with the information available during the project. Information obtained during the project or provided by third parties is believed to be accurate but is not guaranteed. Matrix Solutions Inc. has exercised reasonable skill, care, and diligence in assessing the information obtained during the preparation of this report.

This report was prepared for the Regional Municipality of Waterloo and Grand River Conservation Authority. The report may not be relied upon by any other person or entity without the written consent of Matrix Solutions Inc. and the Regional Municipality of Waterloo and Grand River Conservation Authority. Any uses of this report by a third party, or any reliance on decisions made based on it, are the responsibility of that party. Matrix Solutions Inc. is not responsible for damages or injuries incurred by any third party, as a result of decisions made or actions taken based on this report.
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<tr>
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1 Introduction

The Regional Municipality of Waterloo has partnered with the Grand River Conservation Authority (GRCA) to prepare the Upper Cedar Creek Scoped Subwatershed Study (Scoped SWS). A component of the Scoped SWS includes a more detailed and locally based assessment of potential future land uses and proposed management strategies in the identified locations in the subwatershed. This report is referred to as the Water Management Plan and Natural Heritage System Strategy (WMP&NHS Strategy).

Cedar Creek is a perennial cold-water stream, draining a 7,463 ha area within the City of Kitchener and Township of North Dumfries. The headwaters of the creek are located on the Waterloo Moraine, which supplies the Region of Waterloo with approximately 80% of its drinking water.

The Scoped SWS had two scales of study: the broader Project Study Area (PSA) included the whole of the subwatershed, whereas the Detailed Study Area (DSA) included the Cedar Creek subwatershed lands north of Cedar Creek Road and west of Dumfries Road within the City of Kitchener and the Township of North Dumfries. The DSA lands within the City of Kitchener are largely agricultural, while the DSA lands within the Township of North Dumfries are a mixture of agricultural, industrial, and aggregate extraction land uses. This report presents the outcome and recommendations for the detailed local-scale analysis of the DSA. The recommendations presented in this report have built upon the higher order conclusions and recommendations provided in the Scoped Subwatershed Study and provide a preliminary management plan for the area’s natural features, watercourses, groundwater, and stormwater.

The recommendations have been developed based upon the land use concept developed and assessed as part of the Scoped Subwatershed Study. While the recommendations advanced herein are considered to represent a basis for establishing and refining the management plan as part of future stages of planning and design, it is nevertheless recognized that this management plan is subject to verification and revision as part of future studies.

2 Management Plan

2.1 Introduction and Policy Context

Guidance on the scope and use of subwatershed planning (including scoped undertakings) is provided by the Ontario Provincial Policy Statement (PPS; MAH 2014) and Regional Official Plan (ROP; as approved, with modifications, by the Ontario Municipal Board on June 18, 2015) policies. The Scoped SWS outlines those policies of relevance to these objectives.
Furthermore, ROP Policies 7.F.4 and 7.F.5 identify the minimum terms of reference for watershed studies and outlines Regional interests to be addressed. This report, the Water Management Plan and Natural Heritage System Strategy, in conjunction with the Scoped Subwatershed Study, address these policies.

### 2.2 Preliminary Water Management Strategy

A higher order preliminary water management plan was established as part of the Scoped Subwatershed Study, for the Southwest Kitchener Policy Area (SKPA) and Prime Industrial Strategic Reserve (PISR) within the DSA. Based upon the results of the impact assessment and analyses completed for the Scoped Subwatershed Study, the Water Management Plan for potential development within the Cedar Creek subwatershed would be required to satisfy the following criteria:

1. Control post-development flows to pre-development levels at the outlets from potential development areas, to provide flood protection for downstream properties.

2. Reduce surface runoff volume from potential development areas to maintain pre-development water budget and mitigate erosion impacts to downstream watercourses, including areas with no defined drainage features.

3. Provide stormwater quality control to an Enhanced standard of treatment per current Provincial criteria.

4. Manage chloride loadings to runoff, particularly from snowpack during spring freshet.

5. Infiltrate clean groundwater to maintain the groundwater supply to municipal wellfields, the Roseville Swamp, and the Upper Cedar Creek West Tributary.

The management recommendations advanced in the Scoped Subwatershed Study built upon an integrated assessment of the DSA’s ecological features and systems, and the associated reliance of these features and systems on the local surface water and groundwater resources. In general terms, the DSA, as well as the balance of the Cedar Creek subwatershed, has a very low density of perennial watercourses, particularly so in the headwaters of the subwatershed. Perennial watercourses emerge in groundwater discharge areas, typically found in wetland areas associated with the Roseville Swamp. The perennial watercourses that are present have a strong baseflow component, and infrequently receive direct overland runoff. As a result of the strong baseflow component, Cedar Creek watercourses are typically characterized as cold or cool water and are host to cold-water species such as Brook Trout. Groundwater recharge
occurring within the DSA, and the resultant groundwater flow system, also supports other natural features such as the Roseville Swamp, watercourses in adjacent subwatersheds (i.e., Blair Creek), with a small portion of municipal withdrawals having been determined to be reliant on DSA-derived recharge. Consequently, protecting the quantity and quality of the groundwater system is critical to maintaining the ecological and human functions of those features.

Corresponding to the low density of watercourses and highly pervious surficial materials, there is also a lack of headwater drainage features that play a role, beyond limited and often seasonal conveyance. Neither the SKPA nor the western PISR lands have nearby watercourses that would receive associated stormwater discharge. As such, allowing frequent offsite discharge from these lands (post-development) would cause undesirable impacts to downslope lands in the form of frequent inundation, increased erosion, and potential adverse impacts to existing ecological features and functions.

Furthermore, as noted in the Scoped Subwatershed Study, surface flows have been observed over the study period during February 2018, coinciding with rain-on-snow events with frozen ground conditions. These observations indicate that the SKPA lands (and presumably the PISR lands) do have the potential to seasonally generate overland flow that may eventually reach a watercourse or drainage feature during certain hydrologic conditions. While the frequency of such events is neither known nor easily predicted, it is expected that these events play important roles in fluvial processes and should be maintained to the greatest degree possible under a potential urban land use scenario. Observations during the summer of 2017 indicated no runoff during storm events, consistent with expectations given the high permeability of the soils within the area. These observations were supported by anecdotal comments provided by area residents during the course of the Scoped Subwatershed Study and related public consultation.

As indicated by the foregoing, the physical, hydrologic, and environmental conditions within the Cedar Creek subwatershed present the following challenges to potential future development:

1. Lack of defined surface drainage outlets to receive and convey overland flow, which presents increased susceptibility for erosion and flooding impacts.
2. Seasonally-based overland flood potential.
3. Water quality considerations and issues (i.e., water temperature and chloride loadings), which are in addition to standard Provincial guidelines for TSS removal.
4. Size and complexity of the stormwater management facility.
Recognizing the unique characteristics, systems, and features within the Cedar Creek subwatershed, a preliminary water management plan has been developed which has been established to satisfy the foregoing requirements. The preliminary water management plan is presented in Drawing WR1 (Appendix A), and includes the following high-level management strategies:

1. Potential urban developments shall only discharge stormwater offsite at an approximately similar frequency as is occurring under baseline (existing) conditions.
   - As urbanized lands generate more surplus runoff than agricultural or natural lands, this would require infiltration (and subsequently groundwater recharge) being increased beyond baseline conditions in remaining permeable lands.

2. Infiltration of potentially contaminated urban runoff shall only be considered in areas where there is a lessor chance of the contaminated water reaching AFD1 (municipal supply aquifer).
   - The Phase 1 study identified those portions of the DSA that directly support the Strasburg, Roseville, and Ayr wellfields, as well as those land areas where recharge may interact with AFD1 (but not directly support municipal wellfields). In these areas only cleanwater (i.e., roofs and permeable surfaces) should be considered for infiltration.
   - By infiltrating clean water at source, the potential urban developments would be better able to replicate the existing spatial distribution of groundwater recharge, and subsequently, better mimic existing groundwater flow patterns.
   - Runoff from land uses that are more likely to be contaminated (e.g., roads, sidewalks, parking spaces) should be directed toward end-of-pipe facilities that are sited outside those lands that contribute groundwater recharge to AFD1.

3. Due to the reliance of sensitive ecological features (e.g., Cedar Creek, Roseville Swamp) on groundwater discharge, care should be taken to limit the introduction of potential contaminants to the infiltrated stormwater in the land base established to contribute to these receivers. This would include the implementation of:
   - Low Impact Development (LID) technologies such as bioswales/filters/curb cut-outs to reduce the concentration of contaminants (e.g., total suspended solids, nutrients, metals) at source.
Management strategies, such as salt management plans, to reduce the mass loading of chlorides into stormwater, and subsequently the groundwater system.

Specific details related to the application of the foregoing water management strategy are outlined for the PISR and SKPA in Sections 2.4 and 2.5, respectively.

### 2.3 Natural Heritage System Strategy

The **Greenlands Network** (Map E1) for the Cedar Creek subwatershed was established as part of the Scoped Subwatershed Study. The Greenlands Network comprises Landscape Level Systems, Core Environmental Features, Supporting Environmental Features, Fish Habitat, and Linkages. These include Provincially Significant Wetlands (PSW), Environmentally Sensitive Policy Areas (ESPA), and Significant Woodlands, among other features.

**Linkages** are connections between natural heritage features that provide movement opportunities for species between habitat patches that would otherwise be isolated. They enhance and maintain the viability of specific species populations by preserving genetic variability and allowing populations to recolonize areas where they are no longer found. Linkages also provide some foraging and breeding habitat, as well as a buffer function along watercourses and other features (Regional Municipality of Waterloo 2016). Linkage locations were identified as part of the Scoped Subwatershed Study and are included in the recommended Greenlands Network. Linkages are generally recommended to be 100 m wide, unless a narrower linkage is supported through an Environmental Impact Study (EIS). Where a linkage is to be less than 50 m wide, it should be located adjacent to land uses such as open space, passive recreational parkland, or naturalization and restoration areas. Its length should be minimized and it should incorporate any remnant natural heritage features and areas to the greatest extent possible. Where a linkage crosses a road, an appropriate wildlife crossing should be designed. It is recommended that newly proposed linkages be naturalized to provide wildlife habitat. It is noted that some of the proposed linkages in the DSA are currently unvegetated, and an ecological restoration plan would need to be developed for these linkages.

Recommended **buffers** (see Map E2) have been identified as 10 m from upland forests, 15 m from non-provincially significant wetlands, and 30 m from PSWs and features within the provincial NHS (in accordance with the Growth Plan 2019). The recommended buffers are minimums based on existing regulation and may be modified through further study.
**Restoration Areas** are primarily mapped/identified within the provincial NHS, outside the buffers. These lands are dominated by actively farmed agricultural fields, with some cultural woodlands east of Roseville Swamp. North of New Dundee Road, a wide hedgerow has been identified as a restoration area, allowing a connection between two deciduous woodlands. Linkages, buffers, and plantations are also restoration areas. Linkages identified within the Greenlands Network and buffers are generally ploughed fields and may be naturalized. Coniferous plantations within the DSA may be enhanced using active management techniques to help them transition into more naturalized forests.

### 2.3.1 Greenlands Management Plan

It is recommended that buffer areas, linkages, and restoration areas identified on the Greenlands Management plan be naturalized (see Map E2). Naturalization may occur through active restoration or enhancement of these areas by planting and seeding of native species. Through the development approval processes, it is recommended that detailed planting plans be established for these areas adjacent to the proposed development. It is recommended that the active agricultural areas identified for restoration be graded appropriately and amended with additional topsoil. A variety of habitats may be restored, depending on the adjacent natural areas, such as woodlands, wetlands, or watercourses, as well as providing some meadow and thicket habitats. Providing habitat for significant species should be considered. For instance, common milkweed should be included in most seeding plans to benefit Monarch Butterfly. Native seed mixes should be used along with plantings in a range of sizes (caliper stock, whips, plugs). The GRCA can recommend herbaceous companion plantings in this regard.

Existing plantations offer opportunities for restoration and enhancement as well. Plantations are not natural forests and offer a limited diversity of species and habitat. Plantations should be thinned and planted with a variety of native species over time. Especially suitable species for interplanting include Basswood (*Tilia americana*), Hickory (*Carya* sp.), Ironwood (*Ostrya virginiana*), Oak (*Quercus* sp.), and White Cedar (*Thuja occidentalis*). Plantation species should be assessed to ensure the interplanting species are applicable throughout the study area.

A trail network should be considered at the outset of development. Creating a network of trails within the Greenlands Network, especially within the buffer areas, would provide new residents with walking trails right away, which would discourage the random creation of footpaths. Trails would foster nature appreciation and allow for passive recreation opportunities, which is part of a sustainable community. As recommended in the Scoped Subwatershed Study, a comprehensive trail plan should be developed as an integrated part of the overall land use plan, prior to development occurring.
2.3.2  **Stewardship Strategy**

Should the DSA be considered for development, the Greenlands Network must be managed and maintained. That includes stewardship opportunities such as the following:

- controlling access to the Greenlands Network; rear yards backing on to the Greenlands Network shall be fenced so as to avoid buffers
- establishing a trail network through the Greenlands Network would provide for recreational opportunities and discourage footpaths and dumping
- removal of invasive species and control of invasive species in the future
- removal of trash and debris, including farm dump sites of vehicles, fencing, and farm implements
- nature interpretive signs for education purposes, especially along trails
- installing nest boxes for birds and bats
- naturalizing of plantations
- restoring of buffers, Linkages, and Restoration Areas
- naturalizing and stewardship of school yards, as these would likely be linked to the Greenlands Network in the future and would foster an appreciation of nature in children, as well as provide physical and psychological benefits

2.3.3  **Construction and Design Related Mitigation Recommendations**

Due to the preliminary nature of the potential land use scenarios, detailed mitigation measures associated with construction are not considered appropriate at this time. The following recommendations are general in nature but are standard mitigation measures for development and construction. The following recommendations are provided to ensure that any potential adverse impacts are minimized:

- Individual trees (e.g., hedgerows, surrounding residences) should be maintained and protected where possible. Where trees in fair to excellent condition have to be removed, these should be compensated for. Compensation plans are to be developed at the detailed design stage.

- No storage of equipment, materials, or fill is to occur within the natural areas or their buffers.

- Maintenance/refueling of machinery during construction should occur at a designated location, which should be setback a minimum of 30 m away from the proposed Greenlands Network.
• Sediment and erosion control measures must be installed before and monitored and maintained during construction. Measures must remain in place until the site is stable.

• During the installation of the construction limit fencing, any hazard trees should be identified by a Certified Arborist and removed or pruned as warranted. Cavity trees may have to be surveyed for species at risk (SAR) bats prior to any removal. This should be done in consultation with the Ministry of Environment, Conservation and Parks (MECP).

• Any areas of bare soil that arise should be graded and re-vegetated as soon as possible to avoid gullying and erosion (within 30 days of inactivity). A suitable native seed mix is to be applied to all exposed areas of soil that are immediately adjacent to the natural areas.

• Planting of native tree and shrub species on currently unvegetated portions of the DSA is recommended to enhance site conditions. Natural succession and plantings may be used to create native vegetation zones around retained natural heritage features. Landscaping plans should be developed for recommended buffer zones and linkages.

• Litter and debris should be removed from the construction areas on an ongoing basis.

### 2.4 Prime Industrial Strategic Reserve (North Dumfries)

#### 2.4.1 Water Management Plan

The PISR is located within the Township of North Dumfries. Analyses completed as part of the Scoped Subwatershed Study have determined that potential future development of the PISR would, without effective management, reduce the groundwater recharge in the area and increase the rate and volume of surface runoff to external lands, resulting in reduced baseflow along the Upper Cedar Creek and increased potential for flooding and erosion, particularly along receiving systems proximate to the PISR. Consequently, the preliminary water management strategy advanced in the Scoped Subwatershed Study incorporates recommendations for providing flood control, managing water budget and erosion, and providing stormwater quality control including chloride management. The following sections summarize the Water Management Plan for the PISR lands to satisfy these requirements advanced in the Scoped Subwatershed Study.

#### 2.4.1.1 Stormwater Quantity Control

As part of the Scoped Subwatershed Study, hydrologic analyses have been completed to establish unitary sizing criteria for stormwater management facilities within the PISR to mitigate the impacts of urbanization to address flooding, erosion, and local recharge requirements.
The unitary volumes have been adjusted by incremental multiples of 25 m³/imp. ha for this assessment, and the unitary discharge rates have been determined based upon the unitary peak flows for the 2 year through Regional Storm events. The resulting unitary storage and discharge criteria for flood control are presented in Table 1, and the locations of the PISR east and west areas are presented on Drawing WR1 (Appendix A).

Table 1  Unitary Storage and Discharge Criteria for Flood Control for the PISR

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</table>

2.4.1.2 Water Budget and Erosion Control

Infiltration facilities are proposed to be implemented within the PISR for the purpose of erosion control and maintaining groundwater recharge as part of the recommended management strategy. Infiltration facilities, sized to capture 12.5 mm of runoff per impervious hectare, have, through analysis, been determined to adequately maintain pre-development surface runoff volumes. It is anticipated that the infiltration facilities would be implemented in the form of LID infiltration best management practices (BMPs). It has been assumed that these infiltration facilities would be distributed throughout the development lands, although opportunities would also exist to provide infiltration within an end-of-pipe quantity control facility. Acceptable practices and final selection of LID infiltration BMPs are to be established as part of future studies, in consultation with the area municipality and agencies.
The PISR West development is sited on an existing quarry site. Details regarding the current onsite water management for the quarry have not been available for use and reference in this study. However, as expected the topographic mapping indicates that the quarry provides a significant topographic depression, and, potentially, significant abstraction of surface runoff during storm events. The hydrologic analyses completed for the Scoped Subwatershed Study, as well as for this detailed assessment, have assumed that a similar form of development, which would accommodate an internally draining site development and grading, would be implemented in this location. Hence the water management and resulting hydrologic regime of the quarry would need to be largely replicated post-development. The requirement to replicate the hydrologic response within potential future development of the quarry site is to be verified as part of future studies and the water management strategy to maintain water budget under future land use conditions, updated as appropriate.

**2.4.1.3 Stormwater Quality Control and Chloride Management**

The stormwater management plan (SWMP) is required to include stormwater quality controls, sized to current Provincial standards for an Enhanced level of treatment. In addition, all infiltrated runoff is required to receive some form of pre-treatment to remove pollutants to the extent feasible from the runoff to comply with emerging guidance from MECP related to the application of a treatment train approach (MOECC 2017). Where possible, direct recharge of clean runoff (i.e., from rooftops and permeable areas) is encouraged through infiltrative practices.

Although the PISR lands do not contribute directly to municipal wellfields, it is nevertheless recognized that infiltrated storm runoff contributes toward the baseflow within the Cedar Creek. Consequently, the SWMP is also required to manage chloride from infiltrated runoff. For public rights-of-way, chloride concentrations would be anticipated to be higher due to the use of road salts for winter maintenance, hence, efforts should be made to minimize the use of road salt for winter maintenance. In order to further mitigate the potential for chloride to infiltrate into the groundwater, it is recommended that all runoff from the public rights-of-way be directed toward centralized facilities for the capture of chloride-laden runoff prior to infiltration. The use of dual cells in end-of-pipe facilities with seasonal adjustments may limit chloride reaching the groundwater.
2.4.1.4 Functional Grading and Stormwater Management Plan

A functional grading and SWMP has been developed for the east and west PISR developments areas. The functional grading plan (Appendix A; Drawing WR2) is premised upon the following criteria:

- road grades established at 0.5% minimum and 4% maximum
- roadways required to match existing road grades within the surrounding area, where future roads are proposed to connect with existing roads

The functional SWMP is premised upon providing stormwater quality and infiltration practices at source within potential future development areas. Although quantity controls primarily for flood control may be implemented at source, the functional SWMP is premised upon providing the requisite quantity control (flood) within dry end-of-pipe facilities. The storage-discharge relationships for the end-of-pipe facilities for the functional grading and SWMP are presented in Table 2.3.2.

### Table 2 Storage-Discharge Relationships for End-of-Pipe Quantity Control Facilities Within PISR Lands Per Functional Stormwater Management Plan

<table>
<thead>
<tr>
<th>Operating Level</th>
<th>Storage (m³)</th>
<th>Discharge (m³/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PISR West</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 year</td>
<td>6500</td>
<td>0.17</td>
</tr>
<tr>
<td>5 year</td>
<td>8000</td>
<td>0.27</td>
</tr>
<tr>
<td>10 year</td>
<td>9800</td>
<td>0.35</td>
</tr>
<tr>
<td>25 year</td>
<td>11000</td>
<td>0.44</td>
</tr>
<tr>
<td>50 year</td>
<td>11800</td>
<td>0.51</td>
</tr>
<tr>
<td>100 year</td>
<td>12800</td>
<td>0.59</td>
</tr>
<tr>
<td>Regional</td>
<td>28,000</td>
<td>1.9</td>
</tr>
<tr>
<td><strong>PISR East</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 year</td>
<td>21000</td>
<td>0.03</td>
</tr>
<tr>
<td>5 year</td>
<td>26100</td>
<td>0.1</td>
</tr>
<tr>
<td>10 year</td>
<td>29600</td>
<td>0.15</td>
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<tr>
<td>25 year</td>
<td>33500</td>
<td>0.21</td>
</tr>
<tr>
<td>50 year</td>
<td>36500</td>
<td>0.26</td>
</tr>
<tr>
<td>100 year</td>
<td>39400</td>
<td>0.32</td>
</tr>
<tr>
<td>Regional</td>
<td>115,300</td>
<td>1.48</td>
</tr>
</tbody>
</table>
The concept plans for the end-of-pipe facilities are based upon the following assumed design requirements:

- facilities to be designed as dry facilities with granular base for infiltration
- 5:1 side slopes
- maximum permissible depth of 2 m up to 100-year water level per current Provincial Guidelines
- total permissible depth of 5 m to regional storm control elevation
- maintenance access and decanting zones represent 20% of the facility footprint

As noted, the PISR West development area is located within an existing quarry site. Based upon the Light Detection and Ranging (LiDAR) mapping provided for use in this study, the existing grades within the PISR West development are up to 9 m below adjacent grades, hence it is anticipated that significant fill would be required within the PISR West development to achieve functional drainage and stormwater management design with continuous positive grade toward the site outlet. The PISR West development is located adjacent to an existing development with a dry infiltration facility. At detailed design, opportunities to expand the existing facility to service the PISR West development should be investigated, along with consideration for a stand-alone facility. Determination of the preferred approach would be dependent on the condition of the existing system, land ownership, and final grading strategy.

The PISR East development is located within an existing agricultural area. Based upon the LiDAR mapping provided for use in this study, the site currently drains westward toward the Cedar Creek. The dry end-of-pipe facility and functional grading plan have been developed with the goal of providing a stormwater quantity control facility upstream of the existing drainage outlet for the site. The site also conveys runoff from external lands toward the east. As such, the drainage plan for the PISR East development has included a trunk sewer to convey runoff from the external lands through the site, bypassing the end-of-pipe facility.

The stormwater management facilities for the PISR development (East and West) are recommended to incorporate a designated impermeable detention storage zone for winter operation. As noted previously, under winter operating conditions, runoff from snowmelt would be conveyed to the detention storage zone, to capture the salt laden runoff and reduce chloride contamination from infiltration. During summer operating conditions, runoff would be conveyed directly to the dry facility with an infiltration base. A flow splitter would be required at the inlet to the facility, with gate valves operated according to the winter and summer operating conditions of the facility. Furthermore, the detention storage zone for winter operation requires a liner to ensure that captured snowmelt is retained within the facility and
would not infiltrate into the groundwater system. Management alternatives for the chloride-laden water would need to be reviewed at detailed design, including pumping, evaporation, and physical cleanout and/or conveyance to the sanitary system during off-peak periods.

As noted in the Scoped Subwatershed Study, stormwater quality management for chloride should also include a winter maintenance plan for the area roads, which would reduce reliance on road salt for winter maintenance. This management plan should be developed as part of future planning studies, in consultation with the area municipality and agencies. Developing this plan should include a review of practices in other areas of the Province, as well as in other cold climate jurisdictions to manage roads for winter operation reducing reliance on the use of road salts.

2.4.2 Watercourse Management

As part of the Scoped Subwatershed Study, the impact assessment for streams has applied a qualitative assessment of anticipated impacts. The majority of identified headwater drainage features within the PISR Development Area provide a local conveyance function only. These headwater drainage features are typically found in agricultural fields that are actively cultivated and lack defined bed and banks. While these features have been classified as “No Management” as per the Headwater Drainage Protocol, additional management considerations may need to be considered at detailed design (e.g., wetlands, floodplains). Management of all reaches, including those recommended for “no management” under the headwater drainage feature (HDF) protocol, must follow GRCA’s Consolidated Policies for the Administration of Ontario Regulation 150/06 (GRCA 2015).

As noted in the Scoped Subwatershed Study, the unmitigated release of stormwater discharge to Cedar Creek would be expected to significantly increase the duration of erosive flows, as well as erosion volumes within Upper Cedar Creek. Due to a current lack of well-defined watercourse features adjacent to the potentially urbanized lands in the PISR, it is apparent that Upper Cedar Creek and its tributaries do not receive significant surface flows, but rather water largely infiltrates along the overland flow route, greatly reducing the volume of flow, before entering Cedar Creek. Notwithstanding, under future conditions, erosion impacts would be expected to occur locally and proximate to potential future development within the PISR. As noted previously, these impacts may be mitigated through the implementation of LID infiltration BMPs, sized per the unitary criteria outlined in the foregoing (12.5 mm capture).
The Eastern PISR is noted to receive flows from external lands, which are conveyed through the proposed development area toward the Cedar Creek, primarily during the spring freshet when the ground would be frozen, as well as during severe storm events during which the ground would be highly saturated. The intermittent conveyance function afforded by the existing drainage features and systems within the Eastern PISR would need to be incorporated into the drainage plan for potential future development areas, through the detailed planning and design of subsurface (piped) and/or surface drainage systems. It is noteworthy, however, that the conveyance function is considered to be able to be addressed through the design of municipal drainage infrastructure (i.e., storm sewers, ditches, swales, major system right-of-way), and would not be expected to require the planning and design of a regulated open watercourse.

2.4.3 Greenlands Network

The PISR borders onto the Greenlands Network (Map E1). The western PISR portion borders onto a deciduous forest that is a Core Environmental Feature (Maps E1, E4.2). The Scoped Subwatershed Study recommended a 10 m buffer from woodlands, which is to be confirmed through an EIS. The eastern PISR area borders deciduous and coniferous swamps (Map E4.3), that are Core Environmental Features, as they are part of the Roseville Swamp Cedar Creek PSW Complex, as well as the Cedar Creek Spillway ESPA and significant woodland (Map E3). A 30 m no-touch buffer from these wetlands has been recommended. GRCA regulated floodplain is also found in the area, which is to be considered during development planning. A Supporting Environmental Feature, which is part of the Greenlands Network, is located near Dumfries Road. This Sugar Maple Forest has been recommended for a buffer of 10 m, which is to be confirmed through an EIS. The eastern PISR area borders the Dumfries Carolinian Environmentally Sensitive Landscape on its east side.

2.5 Southwest Kitchener Policy Area

2.5.1 Water Management Plan

The SKPA is located within the City of Kitchener, in the headwaters of the Upper Cedar Creek subwatershed. Analyses completed as part of the Scoped Subwatershed Study have determined that the potential development of the SKPA would, without effective management, reduce the groundwater recharge in the area and increase the rate and volume of surface runoff, resulting in reduced baseflow along the Upper Cedar Creek and increase potential for flooding and erosion, particularly along those receiving systems proximate to the SKPA. Consequently, the preliminary water management strategy advanced in the Scoped Subwatershed Study incorporates recommendations for providing flood control, managing water budget and
erosion, and providing stormwater quality control, including chloride management. The following sections summarize the Water Management Plan for the SKPA lands to satisfy these requirements, advanced in the Scoped Subwatershed Study.

### 2.5.1.1 Stormwater Quantity Control
As part of the Scoped Subwatershed Study, hydrologic analyses have been completed to establish unitary sizing criteria for stormwater management facilities within the SKPA to mitigate the impacts of urbanization to address flooding, erosion, and local recharge requirements. The unitary volumes have been adjusted by incremental multiples of 25 m³/imp. ha for this assessment, and the unitary discharge rates have been determined based upon the unitary peak flows for the 2 year through Regional Storm events. The resulting unitary storage and discharge criteria for flood control are presented in Table 2.4.1.

#### Table 3 Unitary Storage and Discharge Criteria for Potential Future Development Within the SKPA

<table>
<thead>
<tr>
<th>Operating Stage</th>
<th>Unitary Storage (m³/imp. ha)</th>
<th>Unitary Discharge (m³/s/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2yr</td>
<td>325</td>
<td>0.001</td>
</tr>
<tr>
<td>5yr</td>
<td>475</td>
<td>0.002</td>
</tr>
<tr>
<td>10yr</td>
<td>550</td>
<td>0.003</td>
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<td>0.004</td>
</tr>
<tr>
<td>100yr</td>
<td>825</td>
<td>0.006</td>
</tr>
<tr>
<td>Regional</td>
<td>2,950</td>
<td>0.017</td>
</tr>
</tbody>
</table>

### 2.5.1.2 Water Budget and Erosion Control
Infiltration facilities are proposed to be implemented within the SKPA for the purpose of erosion control and maintaining groundwater recharge as part of the recommended management strategy. Infiltration facilities, sized to capture 12.5 mm of runoff per impervious hectare, would adequately maintain pre-development surface runoff volumes; this value is also consistent with the interim target per the City of Kitchener Development Guidelines (The City of Kitchener 2017). For the purpose of the Scoped Subwatershed Study and the detailed analyses, it has been assumed that these infiltration facilities would be distributed throughout the development, although opportunities would also exist to provide infiltration within an end-of-pipe quantity control facility. Acceptable practices and final selection of LID infiltration BMPs are to be established as part of future studies, in consultation with the City of Kitchener and agencies.
Of particular importance, the potential development of the SKPA, assessed as part of this study, includes development of lands that generate groundwater recharge which contributes to both AFDI (municipal supply aquifer), and Roseville Swamp (Appendix A; Drawing WR1). The water management strategy for development in these areas is specifically recommended to include onsite infiltration practices which promote direct recharge of clean runoff (i.e., from rooftops and non-urbanized areas). The runoff from road rights-of-way is recommended to be separately conveyed toward the centralized end-of-pipe facility, to better manage chloride-laden runoff during winter operating conditions.

2.5.1.3 Stormwater Quality Control and Chloride Management

The SWMP is required to include stormwater quality controls, sized to current Provincial standards for an Enhanced level of treatment. In addition, all infiltrated runoff is required to receive some form of pre-treatment, to remove pollutants to the extent feasible from the runoff. Where possible, direct recharge of clean runoff (i.e., from rooftops) is encouraged through infiltrative practices.

The SWMP is also required to manage chloride from infiltrated runoff. As noted, this is of particular significance within the potential residential development within the SKPA north of New Dundee Road, where a portion of the area contributes recharge to the municipal supply aquifer (AFD1), and another area contributes toward the Roseville Swamp. In these areas, the direct infiltration of clean runoff from private rooftops and non-urban areas is strongly encouraged, in order to maintain high quality groundwater recharge at source in these locations. For public rights-of-way, chloride concentrations would be anticipated to be higher due to the use of road salts for winter maintenance, hence efforts should be made to minimize the use of road salt for winter maintenance and also continue to advocate for alternatives. In order to further mitigate the potential for chloride to infiltrate into the groundwater, it is recommended that all runoff from the public rights-of-way be directed toward centralized facilities for seasonally-based management of chloride-laden runoff prior to infiltration. These centralized facilities should be located outside the area that contributes recharge to the municipal supply aquifer or the Roseville Swamp.

The SKPA is anticipated to afford the opportunity to implement centralized stormwater management systems to provide the requisite stormwater quality and quantity control for multiple landownership, in combination with distributed LID infiltration BMPs. Recognizing that LID infiltration BMPs are required to also manage impacts to offsite erosion, as well as maintaining groundwater recharge, and the associated requirement to provide pre-treatment prior to infiltration, wet end-of-pipe facilities for water quality are not recommended, as
separate facilities for infiltration would be required downstream of the facility outlet. In this regard, it is recommended that vegetated technologies, combined with infiltration facilities, be incorporated into the drainage system for potential future development within the SKPA. A centralized facility providing quantity control may also be designed to incorporate an infiltration component for drainage from the public rights-of-way, provided that runoff from the public rights-of-way is pre-treated prior to infiltrating. The final selection of appropriate stormwater quality management alternatives would necessarily need to consider site-specific conditions and constraints (i.e., depth to groundwater, soil permeability, bedrock, etc.) as part of future studies (i.e., Master Environmental Servicing Plans [MESPs]), and would need to be established in consultation with the City of Kitchener. The following alternatives are to be considered, per the City’s Site Grading, Erosion Control, Servicing & Stormwater Management Guidelines (The City of Kitchener 2017):

- rainwater harvesting
- green roofs
- soakaways, infiltration trenches and chambers
- bioretention
- permeable pavement
- perforated pipe system

2.5.1.4 Functional Grading and Stormwater Management Plan

A functional grading and SWMP (Appendix A; Drawing WR3) for the SKPA is premised upon the following criteria:

- road grades established at 0.5% minimum and 4% maximum
- roadways required to match existing road grades within the surrounding area, where future roads are proposed to connect with existing roads

The functional SWMP is premised upon providing stormwater quality and infiltration practices at source within the potential future development area. Although quantity controls primarily for flood control may be implemented at source, the functional SWMP has been premised upon providing the requisite quantity control within a dry end-of-pipe facility. The storage-discharge relationship for the end-of-pipe facility is presented in Table 4.
Table 4  Storage-Discharge Relationships for End-of-Pipe Quantity Control Facilities
Within SKPA Lands Per Functional Stormwater Management Plan

<table>
<thead>
<tr>
<th>Operating Level</th>
<th>Storage (m$^3$)</th>
<th>Discharge (m$^3$/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 year</td>
<td>34,800</td>
<td>0.18</td>
</tr>
<tr>
<td>5 year</td>
<td>50,500</td>
<td>0.45</td>
</tr>
<tr>
<td>10 year</td>
<td>60,000</td>
<td>0.61</td>
</tr>
<tr>
<td>25 year</td>
<td>72,200</td>
<td>0.76</td>
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<tr>
<td>50 year</td>
<td>84,000</td>
<td>0.82</td>
</tr>
<tr>
<td>100 year</td>
<td>91,800</td>
<td>1.21</td>
</tr>
<tr>
<td>Regional</td>
<td>327,000</td>
<td>3.66</td>
</tr>
</tbody>
</table>

The concept plan for the end-of-pipe facility has been developed based upon the following assumed design requirements:

- facilities to be designed as dry facilities with granular base for infiltration
- 5:1 side slopes
- maximum permissible depth of 2 m up to 100-year water level per current Provincial Guidelines
- total permissible depth of 5 m to regional storm control elevation
- maintenance access and decanting zones represent 20% of the facility footprint

The SKPA lands lie within the headwaters of the Cedar Creek. The end-of-pipe facility for the SKPA lands has been sited proximate to the existing outlet at New Dundee Road. Based upon the LiDAR mapping provided for use in this study, it is anticipated that potential future development of the SKPA lands may be implemented without requiring substantial changes to the grading (i.e., cutting and/or filling) compared to existing grades. Furthermore, it is anticipated that a stormwater management facility may be implemented at or near the existing outlet at New Dundee Road which would be compatible with the criteria noted above and the existing grades in the area. The final planning for this facility would necessarily need to be integrated with the planning for the NHS though this area.

Of particular note, the field monitoring completed for the Scoped Subwatershed Study provided incidental observations of surface runoff during the course of the 2018 monitoring program. Although the contributing factors (meteorology, antecedent conditions) for this runoff have not been conclusively determined, it has been hypothesized that these conditions occurred as a result of rainfall and snowmelt conditions, during which the underlying soils were frozen and/or saturated, thus preventing infiltration which would otherwise occur in the area. Additional analyses have therefore been completed to verify the performance of the
recommended SWMP under hydrologic conditions representative of the February 2018 snowmelt event (Appendix B). Nevertheless, recognizing that the hydrologic conditions which would generate surface runoff likely vary according to season, the monitoring program and future studies should include provision for collecting additional data to confirm the influence of seasonal variation on the potential for producing surface runoff to receiving systems. Furthermore, it is recommended that the information collected under these studies be used to further calibrate the hydrologic model to account for snow accumulation and melt, and that the modelling apply long-term continuous simulation to assess the seasonally varying flood potential to downstream properties under existing and potential future land use conditions.

As noted previously, the SWMP for the SKPA requires implementing LID infiltration BMPs to maintain groundwater recharge and flows toward the municipal wellfield and the Roseville Swamp. The infiltration of clean runoff is critical within these zones. Hence it is recommended that only rooftop runoff and runoff from pervious surfaces be infiltrated in these areas (i.e., no infiltration of runoff from road rights-of-way). The LID infiltration BMPs would be constructed at source within potential future development areas. General guidance for siting LID infiltration BMPs would be established as part of future Secondary Planning Studies in accordance with Kitchener’s design guidelines. The final selection, siting, and sizing of LID infiltration BMPs would be completed at the detailed design stage.

With the foregoing in place, all runoff from the municipal rights-of-way would be conveyed toward the proposed end-of-pipe facility. The stormwater management facility for the SKPA includes a designated impermeable detention storage zone for winter operation. As noted previously, under winter operating conditions, runoff from snowmelt would be conveyed to the detention storage zone, to capture the salt laden runoff and reduce chloride contamination from infiltration. During summer operating conditions, runoff would be conveyed directly to the dry facility with an infiltration base. A flow splitter would be required at the inlet to the facility, with gate valves operated according to the winter and summer operating conditions of the facility. Furthermore, the detention storage zone for winter operation requires a liner to ensure that captured snowmelt is retained within the facility and would not infiltrate into the groundwater system. Management alternatives for the chloride-laden water would need to be reviewed at detailed design, including pumping, evaporation, and physical cleanout and/or conveyance to the sanitary system.

As noted in the Scoped Subwatershed Study, stormwater quality management for chloride should include a winter maintenance plan for the area roads, which would reduce reliance on road salt for winter maintenance. This management plan should be developed as part of future
planning studies, in consultation with the area municipality and agencies. Developing this plan should include a review of practices in other areas of the province as well as in other cold climate jurisdictions to manage roads for winter operation reducing reliance on the use of road salts.

2.5.2 Watercourse Management

The existing drainage outlet proximate to the SKPA currently has no defined drainage feature. Under current baseline conditions most of the precipitation infiltrates into the ground and hence recharges the groundwater system, with little direct surface runoff occurring during storm events. As noted previously, the increased rate and frequency of offsite discharge under urbanized conditions, directed toward downslope lands that have no defined drainage feature, would increase both the erosion potential and flooding risk along the overland flow path that the discharged water would travel. Although it is recognized that infiltration of the increased runoff may occur further downstream of the outlet, offsite flooding and erosion impacts would be anticipated to occur across multiple land parcels within North Dumfries Township.

As noted previously, the unmitigated release of stormwater discharge to Cedar Creek could significantly increase the duration of erosive flows, as well as erosion volumes within Upper Cedar Creek. Due to a current lack of a well-defined watercourse features adjacent to the potentially urbanized lands, it is apparent that Upper Cedar Creek and its tributaries do not receive significant flows. Rather, water largely infiltrates along the overland flow route, greatly reducing the volume of flow, before entering Cedar Creek. Notwithstanding, under future conditions the erosion potential of unmitigated stormwater discharges on Cedar Creek would be expected to occur locally and proximate to potential future development within the SKPA. Given the nature of the upper reaches of Cedar Creek and the limited overland flow they currently receive, it can be concluded that these watercourses should only receive occasional stormwater/overland flow inputs in order to maintain existing geomorphic form and function. Hence these impacts may be mitigated through the implementation of LID infiltration BMPs, sized per the unitary criteria outlined in the foregoing (12.5 mm capture).

The majority of identified headwater drainage features in the SKPA provide conveyance function only. These headwater drainage features are typically found in agricultural fields that are actively cultivated and lack defined bed and banks. While these features have been classified as “No Management” as per the Headwater Drainage Protocol, additional management considerations may apply (e.g., wetlands, floodplains). Management of all reaches, including those recommended for “no management” under the HDF protocol, must
follow GRCA’s Consolidated Policies for the Administration of Ontario Regulation 150-06 (GRCA 2015).

Three headwater drainage features were identified as conservation, protection, or recharge function. None of these features are located within areas that the land use scenarios identified as potentially urbanizing. As such, there is not expected to be direct impacts from the land use scenarios to the identified features. One HDF is found within the Cedar Creek Regulatory floodplain as delineated in the Scoped Subwatershed Study, while the two other HDFs are within the area identified as requiring the protection of hydrologic function (i.e., conveyance), and subject to GRCA regulation and policies.

### 2.5.3 Greenlands Network

The SKPA contains portions of the Greenlands Network (Map E1). Core Environmental Features found in the north of the SKPA in the form of deciduous woodlands and small swamp communities (Map E4.1). These woodlands are considered significant in the Region. 10 to 15 m buffers have been recommended from the woodland and non-PSW in this area, which is to be confirmed through an EIS. The Scoped Subwatershed Study recommended that monitoring for Jefferson Salamander (Ambystoma jeffersonianum) occur in these woodlands due to suitable habitat and the presence of this endangered species in the greater area. Should this species be found within these woodlands, Regulated Habitat for Jefferson Salamander would have to be identified in consultation with the MECP. A Linkage has been identified in the southwest corner of the SKPA that aligns with an overland flow path (Map E3). A Landscape Level Connection (Map E1) is identified from the northern woodlands to the northeast, outside the DSA, to Core Environmental Features associated with Blair Creek. A specific width for this connection is not identified, nor an exact alignment at the present stage of land use planning. Secondary Plans and MESPs should ensure an ecological connection is maintained in this area between the Core Environmental Features. Mapping of the Greenlands Network is attached.

### 3 Implementation Plan

#### 3.1 Introduction

The management recommendations provided in the Scoped Subwatershed Study are to be verified and refined as appropriate as part of locally specific future planning and supporting engineering and environmental studies. It is anticipated that the future Secondary Plans would be initiated by the local municipalities, to further refine the land use plans for the respective development areas. Further, it is anticipated that MESPs or equivalent would be completed in support of the Secondary Plans, and prior to consideration of Draft Plan Approvals. The MESPs
should include supporting technical analyses including hydrology, hydraulics, hydrogeology, geotechnical investigations, and fluvial geomorphology. MESP should also integrate and consider details associated with the evaluation of aquatic habitat and terrestrial features as part of an EIS.

Subsequent to the completion of the MESP, Functional Servicing Plans and Engineering Submissions in support of Subdivision Plans would be required to address Draft Plan Applications. These studies would demonstrate the manner in which the stormwater and environment management system for the specific developments has complied with the criteria and recommendations provided in the higher level studies (i.e., the Scoped Subwatershed Study and the applicable MESP and related Secondary Plan policies). Supporting analyses would be completed as part of these submissions, to verify the performance of the stormwater and environmental management system against the refined analyses completed per the MESP and EIS.

3.2 Future Study Requirements

3.2.1 Master Environmental Servicing Plans

MESP are generally completed in support of Secondary Plans, to update and refine the environmental and stormwater management strategy established at the Scoped Subwatershed Study level and requirements for the Secondary Plan Area. The MESP build upon the guidance and recommendations from higher level studies (i.e., Watershed Studies, Scoped Subwatershed Studies), and refine the analyses and update the recommendations based upon the more detailed field investigations and monitoring, as well as the future land use per the Secondary Plans. In this regard, monitoring program for MESP would include provision for collecting additional data to confirm the influence of seasonal variation on the potential for producing surface runoff to receiving systems. The following provides additional guidance regarding MESP requirements for each study discipline.

3.2.1.1 Hydrogeology

It is expected that additional data would be collected at MESP stage to support local-scale characterization of the hydrogeologic system with specifics documented in the individual MESP. Where substantive differences in current conditions are identified in soil type (e.g., sand vs. till), subsurface geology, groundwater depth, groundwater flow direction, groundwater discharge locations, the local characterization should be refined and include a discussion of how these local refinements may influence or change the hydrogeological characterization presented in the Scoped Subwatershed Study. Where the refinements in the
local characterization are interpreted to have potential to substantively change estimated infiltration, recharge, groundwater flow direction, gradients, or groundwater discharge, it is recommended that the analytical tools developed for the Scoped Subwatershed Study be updated in the area local to the MESP and calibrated to available data. Any modifications to the current conditions model would necessitate refinement of the future conditions model, and the proposed source capture scenario would need to be evaluated for its ability to maintain pre-development groundwater discharge, depth to groundwater, and water budget.

The assumptions regarding future land use may be different from those used in the Scoped Subwatershed Study and may likewise necessitate local model refinements and additional simulations as part of future MESPs if:

- site grading changes the average slopes, modifies areas contributing runoff to depressions in pervious areas and natural features, or by adding fill
- surface and subsurface soil properties are modified to the degree that hydraulic conductivity changes by more than one-order of magnitude
- assumptions about imperviousness, vegetative cover are modified

In addition, it is recommended that future modelling for groundwater systems incorporate specifics related to the siting and sizing of LID infiltration BMPs. A simplified approach may be applied for representing LID infiltration BMPs within potential future development areas as part of MESPs, with further refinement and detailed analyses completed as part of subsequent studies (i.e., functional studies).

### 3.2.1.2 Stormwater Management and Hydraulics

The Scoped Subwatershed Study provides the following details for the stormwater management system:

- Stormwater management facility locations and preliminary contributing drainage area limits, sizes, and land uses.

- Flood Control Volumetric Requirements and Flow Release Rates based on post to pre-development control at key locations.

- Regional Storm (Regulatory) Volumetric requirements based on post- to pre-development control at key downstream locations.
• Hydraulic analyses to verify that residual increases to peak flows would not increase the risk of flooding to private property.

• LID BMP capture rates for land uses based on the objective of managing groundwater recharge and baseflow to support sensitive aquatic habitat, maintain contributions toward municipal wellfields, and sustain significant terrestrial features.

• Stormwater quality control requirements as per Provincial Level One (Enhanced), and alternatives for managing chloride from snowmelt.

• Floodline mapping for the regulated watercourses under the existing 100-year return period and Regional Storm event.

To enhance the level of detail from the Scoped Subwatershed Study, the MESPs should provide the following stormwater management and hydraulic information:

• Refined drainage areas and impervious coverages draining to each proposed stormwater management facility based on updated land uses.

• Preliminary stormwater management facility layout, grading, and outlet control details.

• Regulatory Flood control volumes based on the Scoped Subwatershed Study volumetric and flow release requirements, including Regional Storm control details. Verification of post to pre-development flow at target flow nodes using the Scoped Subwatershed hydrologic modelling.

• Feasibility screening of structural LID BMPs (based on groundwater levels, bedrock, soil permeability, etc.), and structural details such as type, sizing, design calculations, location, constructability, and maintenance requirements.

• Verification of critical flow durations, critical shear exceedance, and stream power exceedance meeting acceptable levels at target flow nodes would be required using the Scoped Subwatershed hydrologic modelling.

• Stormwater quality control volumes based on Provincial Level One / Enhanced control requirements.

• Expanded details regarding Chloride management measures to be implemented.
• Watercourse grading, crossing details, hydraulic modelling and flood elevations, and riparian flood storage calculations. Riparian flood storages to match existing land use storage for the subject creek reaches.

• Preliminary design for trunk storm sewers, foundation drains, and roof drainage collection systems including details of systems draining to existing natural features and associated buffers. Water budgets to existing natural features should be provided, describing how water contributions to natural features would be managed.

• Verification of post-development water budget using Scoped Subwatershed Study GAWSER, MIKE SHE, and FEFLOW modelling.

It is recommended that future MESPs build upon the analyses completed as part of the Scoped Subwatershed Study. In this regard, it is recommended that the GAWSER, MIKE SHE, FEFLOW, and HEC-RAS modelling developed for the Scoped Subwatershed Study be updated and refined based upon the detailed characterization and land use plans established at the MESP and Secondary Plan stage. The modelling should be further verified using hydrometeorologic data collected as part of the MESP and calibrated as appropriate depending upon data availability. The performance of the analytical tools should be further verified at the MESP stage, using additional field data collected from the MESP monitoring program.

3.2.1.3 Terrestrial Ecology and Greenlands Network

The management practices established as part of the Scoped Subwatershed Study provide direction for many initiatives and implementation details to be considered or addressed in the MESP process related to potential refinements of the Greenlands Network and terrestrial ecology. Future MESPs would require additional information related to:

• existing vegetation communities and species, including ecosystem context and community description
• flora and fauna inventories (including fisheries)
• identification of significant areas, communities, and species (both flora and fauna)
• buffers/development setbacks, linkages, and restoration

The information collected as part of the Scoped Subwatershed Study should be used to characterize the features, functions, and sensitivities of the terrestrial features and Greenlands Network within the MESP area. The scope of work for future MESPs or EISs should also consider requirements as outlined in the Region of Waterloo Greenlands Network Implementation
Guideline (Regional Municipality of Waterloo 2016), as well as the GRCA EIS Guidelines and Submission Standards for Wetlands (GRCA 2005).

As part of future MESPs, the Greenlands Network established as part of the Scoped Subwatershed Study would need to be confirmed through additional site investigations and the preparation of Secondary Plans. The Greenlands Network also provides opportunities for enhancement and restoration of vegetation communities and wildlife habitat. In some instances, restoration plans and implementation would require coordination among multiple landowners, agency stakeholders, and the local municipality. As many aspects of restoration planning and implementation would be dependent on details and timing of development, outlined in the associated MESP, it is recommended that a Restoration Master Plan be prepared for each area. This could complement the various development strategies that are required within the MESP, such as those that address fill management, site development phasing, erosion and sediment control, stormwater management, and top soil management. Specific content of the Restoration Master Plan may be developed as part of the MESP process, but key elements would include:

- target plants and wildlife species that are anticipated to utilize restored habitat types
- composition and structure of vegetation communities using ecological land classification community targets
- integration with other disciplines to identify functional characteristics that support or complement restoration objectives (e.g., aquatic habitat management targets, head water feature management, erosion management, groundwater recharge, stormwater management, green infrastructure, LID BMPs)
- habitat management, where required (e.g., to maintain early successional habitat)
- buffer treatment and management
- integration of trails
- phasing of restoration activities

3.2.1.4 Stream Morphology

The Scoped Subwatershed Study provides a high-level characterization of the existing watercourses and should be treated as a starting point for further studies at the next stages of planning and design. The meander belt widths and erosion thresholds established as part of the Scoped Subwatershed Study should be further refined at the MESP stage, through additional rapid and detailed geomorphic assessments, as required. Similarly, the erosion thresholds should be reviewed and further field-verified, to ensure that the critical discharge being applied is appropriate for establishing stormwater management criteria.
Where applicable, the MESP should also establish appropriate natural channel design principles to any realignment, restoration, and/or channel enhancement opportunities for open watercourses.

Additionally, if assumptions made during the Scoped Subwatershed Study stage, particularly with respect to the stormwater management facilities (e.g., locations, peak flows and durations, etc.) change, these must be re-evaluated at the MESP stage, to ensure that there are no impacts to the downstream watercourses.

3.2.1.5 Headwater Drainage Features

The location, classification, and function of headwater drainage features identified by the Scoped Subwatershed Study should be confirmed in the field. If observations indicate that the classification or function differs from what was identified by the Scoped Subwatershed Study, then supporting information should be submitted to GRCA, so that the class and function may be re-evaluated.

3.2.2 Functional Servicing Reports

Functional Servicing Reports are typically prepared as part of the detailed site design process, to support plans of subdivision or site plans, in order to identify the manner in which water, sanitary, and storm servicing is to be provided for the site. The information provided within these documents generally includes, but is not limited to:

- location and preliminary sizing of sanitary sewers
- location and preliminary sizing of storm sewers
- location and preliminary sizing of watermains
- preliminary site grading plan
- location and preliminary sizing of stormwater management facilities
- location and preliminary sizing of hydraulic structures (i.e. bridges and culverts)
- preliminary channel grading plans and supporting analyses
- assessment of riparian storage for existing channel and preliminary channel designs

Current practice also requires that these studies include an assessment of the impacts of the proposed servicing for the site, specifically related to potential impacts to groundwater systems and recommended mitigation strategies.
3.2.3 Stormwater Management Design Briefs

Requirements for SWMPs are outlined within the Stormwater Management Best Management Practices Guidelines (MOE 2003). SWMPs are prepared in support of individual development applications and build upon guidance from higher level studies such as the Scoped SWS and MESPs. The SWMP complement the planning process associated with Draft Plans of Subdivision or individual Site Plans. Stormwater management reporting associated with this planning stage would be the “Functional Design” plan. Subsequently, in support of final subdivision design, a “Detailed Design” plan is prepared. Stormwater management designs and supporting documentation are required to address local standards. For the SKPA, the SWMP are required to address the recommendations advanced in the City of Kitchener Integrated Stormwater Management Master Plan (Aquafor Beech 2016) regarding the market-based approach for implementing source controls within residential areas. Furthermore, SWMPs for the SKPA are required to provide the following guidance regarding operation and maintenance per the City’s 2017 Guidelines:

- inspection of all structures and how often (minimum of once annually)
- immediate repair or replacement of all worn, missing, and damaged structures
- removal of sediments and how often
- method of restabilization of all disturbed areas
- sediment disposal to be in accordance with MECP standards

3.2.3.1 Functional Design

This level of design typically involves demonstrating the feasibility of providing stormwater management for a particular development. In areas where no Scoped Subwatershed Plan or MESP has been completed, the SWMP would be required to address additional issues such as environmental baseline conditions and screening of various stormwater management strategies and techniques. For the SKPA and PSIR lands, the intent of the Functional Design SWMP would focus on demonstrating compatibility and compliance with principles and requirements prescribed in the Scoped Subwatershed Study and follow-on MESP and EIS, per the Secondary Plan process. This includes identifying specific stormwater management infrastructure which is to be implemented for the proposed development (type of LID BMPs, end-of-pipe facilities, groundwater management techniques, chloride management plan, etc.).

3.2.3.2 Detailed Design

The detailed design submission is required to demonstrate how the required information, outlined in the Functional Design report, has been integrated, providing further details on the
proposed stormwater management system (i.e., details related to minor system design details, landscaping, safety, and maintenance aspects of Stormwater Management Facility design), as well as outlining subsequent specific monitoring requirements.

3.2.4  Natural Channel Design Briefs

Natural Channel Design Briefs are prepared in support of any proposed realignment, alteration, or enhancement to a regulated open watercourse. These reports would provide the following information, specifically related to the preliminary and detailed design:

- details related to the natural channel design principles applied to the detailed design of the watercourse
- fluvial geomorphological analysis of the proposed watercourse design
- rationale for selection of plantings within the riparian zone and floodplain
- details regarding any enhancements proposed within the adjacent watercourse
- detailed hydrologic and hydraulic analyses of proposed watercourse and hydraulic structures to demonstrate impacts to floodplains, and freeboard under proposed conditions, maintenance of riparian storage post-development
- detailed assessment of impacts of proposed watercourse to aquatic habitat and fish species
- detailed design drainage for proposed watercourse and corridor

3.2.4.1  Headwater Drainage Features

Headwater drainage features classed as Protection and their appropriate buffers should be fully within the Greenland Network. Natural channel design, including appropriate buffers, would be required for those headwater drainage features that are classed as Conservation and proposed to be moved. New alignments, or existing alignments for those that are not proposed to be moved, and appropriate buffers should be fully within the NHS.

The features that receive water from headwater drainage features that are classed Mitigation should be assessed to determine if they are dependent upon site-specific flow from the individual feature. If this is the case, then flow should continue to be provided to that specific location via LID BMPs or other drainage infrastructure. If the flow does not serve a site-specific function but supports a valley and/or floodplain community in general, the replication of function does not need to occur at the existing location and should occur where the greatest benefit to the stream network and overall NHS is achieved.
3.2.5 Cumulative Effects Study Associated with Aggregate Production

For many years the GRCA, Region of Waterloo, and Township of North Dumfries have had an interest in the potential cumulative effects of aggregate extraction below the water table on critical ground water and surface water resources. As a next step toward further understanding these impacts, a proposed set of considerations for a potential future Cumulative Effects study addressing below water table aggregate extraction in the Cedar Creek Subwatershed has been included in this report.

These considerations build on the work that was undertaken by the GRCA, Ministry of Natural Resources (MNR), and the Ontario Stone Sand & Gravel Association (OSSGA) to draft a set of principles to guide future discussions and commitments to action in this regard (GRCA Resolution No. 149-07), and the subsequent best practices paper that was developed collaboratively in 2010 in accordance with the agreed-to principles: "Cumulative Effects Assessment (Water Quality and Quantity) Best Practices Paper for Below-Water Sand and Gravel Extraction Operations in Priority Subwatersheds in the Grand River Watershed (September 2010)".

Aggregate production is a significant activity within the subwatershed of Cedar Creek. While local effects are typically estimated at the license application stage, there has not been a cumulative effect study on the impact of aggregate production activities on the water resources of Cedar Creek.

GRCA guidance (GRCA 2010) found that potential impacts on water quantity can arise from a combination of:

- dredging, where groundwater and precipitation replace the sand and gravel that is extracted from the pit pond
- evaporation from the pit pond and other processing operations (e.g., wash plants)
- levelling of the groundwater table across the pit pond

Potential impacts to water quality could result in changes to:

- temperature
- biological (nutrients) parameters
- general chemistry
To assess the cumulative effects of multiple aggregate operations, GRCA guidance (GRCA 2010) has indicated two broad scales for consideration. They are:

- local scale
- watershed/subwatershed

Local scale cumulative effect studies are typically completed by individual proponents of new or amended license applications. Effects from the proposed site are superimposed on predicted or known effects from existing sites, while recognizing the spatial and temporal variability of such impacts as each aggregate operation proceeds through its life cycle. The spatial scope of such an investigation is often determined by the extent and proximity of aggregate producers to the proposed site; however, is generally limited to the potential direct impacts (e.g., lowering of water table beneath a sensitive feature) associated with the proposed site.

Watershed/subwatershed scale cumulative effect studies are typically completed at a broader scale and are recommended to be done at a quaternary-level watershed scale. This scale is approximately equal to the Cedar Creek subwatershed. Rather than investigating potential impacts to a specific receptor, (sub)watershed-scale cumulative effect studies aim to understand the cumulative effect from all operations on the broader water resources and hydrologic regime of the watershed. Specifically, this includes understanding potential changes in water budget (e.g., evapotranspiration, groundwater recharge, baseflow, groundwater in/out flows), as well as water quality conditions (including temperature).

Currently, there are approximately 40 licensed aggregate producers within the Cedar Creek watershed, as well as extensive additional sand and gravel resources that may be developed in the future. These operations are at differing points in their life cycle, ranging from project initiation to project closure. Given the high density of aggregate producers within the subwatershed, and the likelihood of future aggregate development applications, it is likely prudent to understand the cumulative effects of current and future aggregate production activities on the hydrology and water quality of the Cedar Creek subwatershed. Potential impacts may also extend beyond the boundaries of the Cedar Creek subwatershed, possibly including discharge areas of the Grand and Nith Rivers, or potentially adjacent water supplies.

GRCA guidance (GRCA 2010) has stated that a subwatershed scale cumulative effects study should include the following tasks:

- compare pre-extraction, operational, and post-rehabilitation for the site
• include estimates for precipitation, evapotranspiration/evaporation, run-off, and infiltration/recharge
• identify the nature and extent of anticipated changes to water quality

With these three main components in mind, the following sections outline a potential scope for a cumulative effects study for Cedar Creek.

Such a study is anticipated to be a significant level of effort, particularly associated with the data gathering phase. It is recommended that a phased approach be implemented, whereby each successive phase builds from the previous phase. Each of the identified phases are described in the following sections.

3.2.5.1 Phase 1 - Data Gathering

Phase 1 consists of three main data gathering tasks. They are as follows:

• Aggregate Operations - To understand potential impacts of aggregate operations, one must have a solid understanding of the operations themselves. This includes; the spatial extent and depth of extraction; phasing of operations; rate of extraction; rehabilitation plans; etc.

• Baseline data – as many of the aggregate producers within Cedar Creek have been active for >30 years, it may be a challenge to understand the Baseline conditions (hydrologic and water quality conditions prior to aggregate production). Baseline conditions are a key component in a cumulative effect study as they are the comparator to which the current (or future) conditions are compared against. By gathering and reviewing monitoring data that preceded aggregate producing operations or was collected by aggregate operators prior to producing (as part of the license application), the study team may be able to better understand the baseline conditions of Cedar Creek.

• Monitoring data – throughout the life of the aggregate operation, the producer will be required to monitor for local effects. While the extent of required monitoring will vary with the vintage of the approval, producers are generally required to monitor parameters such as pond surface water levels, groundwater levels, discharge volumes (if applicable), and water takings for aggregate wash operations, or dust suppression. In recent years, monitoring may also be required for sensitive ecological receptors. By gathering, consolidating, and reviewing monitoring data from each aggregate producer, the study team can identify trends or inflection points that may indicate an unforeseen impact (either locally, or regionally). This collection of monitoring data should also include other potential sources of data (e.g., municipal monitoring wells, GRCA/WSC streamgauges, PGMN
monitoring wells). Collecting streamflow data within Cedar Creek has proven to be challenging (due to beaver activity). For tributaries in the eastern portion of the subwatershed, this may be particularly difficult as eastern watercourse can be poorly defined and difficult to gauge accurately.

Each of the three components of Phase 1 would require extensive review and data mining from both MNRF’s records as well as aggregate producers records. To expedite gathering of this information, it is recommended that a steering committee be struck, including representatives from the Township of North Dumfries, the Grand River Conservation Authority, MNRF, and local aggregate producers.

3.2.5.2 Phase 2 – Model Development

To understand and quantify the cumulative effects of a large number of aggregate producers on a subwatershed’s water resources, it is felt that a modeling approach is required. Hydrologic models have the ability to integrate a large amount of information and estimate how changes in that information may affect key predictors (e.g., water budget). In the case of aggregate operations within Cedar Creek, many are producing aggregate from beneath the water table. This can result in large ponds being created, that are closely linked to the groundwater flow system. Due to the integrated nature of aggregate ponds (and resulting precipitation and evapotranspiration inputs/outputs), the groundwater flow system, and streamflow within Cedar Creek, it is recommended that an integrated SW/GW model be developed and applied.

As part of the Model Development phase, three tasks have been identified, and are as follows:

- Hydrostratigraphic Update

  - The hydrostratigraphy of most of Cedar Creek has previously been developed and documented by OGS (Bajc et al. 2014) and provides an excellent starting point in understanding the regional hydrostratigraphy and flow system. However, use of this hydrostratigraphic model as part of the RMOW Tier 3 (Matrix 2014) required extensive updating to reflect localized conditions. It is expected this would also be the case within the Cedar Creek subwatershed.

  - To undertake this update, it is recommended that the existing Waterloo Moraine hydrostratigraphic layer structure be maintained, but elevations of specific layers (or the presence/absence) of layers be confirmed via geologic interpretation.
The domain of this hydrostratigraphic update should include the entirety of the Cedar Creek subwatershed and extend to major discharge features (e.g., middle Grand River and Nith River).

Boreholes and other geologic information that has been acquired since the OGS interpretation should be consolidated and included in the interpretation. These datasets should include, but not be limited to, the following:

- Boreholes and other geologic information gathered to support aggregate activities.
- Boreholes and other geologic information gathered to support land development activities. While urban development is generally limited to the north (Kitchener), the east (Cambridge), and the south (Ayr), information from these areas may be key to understand how the subwatershed flow system interacts with major discharge zones of the middle Grand River and Lower Nith River.

During the hydrostratigraphic update, specific knowledge gaps may be identified. Depending on the significance of those gaps and the available project resources, it may be appropriate to complete a targeted drilling program to address said gaps.

**Model Development**

The aim of the integrated model would be to simulate the water budget and flow processes throughout the watershed, and how external factors (e.g., aggregate operations) may affect those processes. As such, the model must include all hydrologically significant features and processes found within the subwatershed. This includes:

- All aggregate producing operations
- All significant water withdrawals, including the temporary loss of water from the natural flow system as sand/gravel is removed from below the water table
- Urban areas and processes
- The interactions of surface and groundwater, specifically as they relate to aggregate ponds, and how groundwater can sustain evapotranspiration from the ponds
- The ability of closed depressions to trap and infiltrate overland runoff

The model should be developed for a specific point in time (e.g., 2019), for which observed conditions are available for calibration purposes. Land use, water withdrawal rates, and the extent of aggregate production should be from an approximately similar point in time.
• The model should utilize climate data from a 10 to 20 year period that also corresponds with the modeling time period. This will allow the study team to understand not only average annual conditions, but also monthly and year-to-year variability.

• It is expected that the model platform used for this assessment would be one of the following model softwares: HydroGeoSphere, GSFLOW, or MIKE SHE.

• Model Calibration

• Model calibration is the process of modifying model parameters to minimize differences between simulated and observed conditions. Model calibration (and validation) is completed to increase the level of confidence that the model is replicating real world conditions.

• An integrated model should be calibrated to both groundwater levels and streamflow conditions. By calibrating a model to two independent datasets, the level of confidence associated with model predictions is increased.

• Ideally, calibration would occur to baseline conditions without aggregate production. Given the length of time aggregate production has been active, this is not likely feasible. Rather, calibration should take place in the period for which there is the highest density of observations (e.g., streamflow and water level) available.

3.2.5.3 Phase 3 - Model Application

The final phase seeks to quantify the degree of change between a series of scenarios that reflect differing levels of aggregate development within the Cedar Creek subwatershed. The model that was developed and calibrated in the preceding phase is the primary assessment tool for this and would be modified to represent differing aggregate production scenarios. Four scenarios are envisaged for this assessment, and are as follows:

• Baseline – Baseline conditions are meant to represent the hydrologic conditions that would be present within Cedar Creek should there be no aggregate extraction. This scenario is not meant to represent “ultimate baseline” conditions (a.k.a. pre-European settlement), but to isolate potential cumulative effects from aggregate production only. The Baseline scenario is critical to establish the benchmark for other scenarios to be compared against and to understand the magnitude of impacts.

• Existing – Current extent and rate of aggregate production.
• Future Maximum – From the information gathered in Phase 1, the study team will be able to identify the year at which total subwatershed aggregate production would occur. Peak aggregate production should align with maximum impact and would be therefore useful to understand the maximum cumulative effect expected from current permitted operations. Within the model, the representation of each aggregate operation would need to be modified to match their expected state in the identified peak year. Aggregate operations which are currently near the end of their operation may no longer be producing aggregate in this future scenario.

• Future Ultimate – A fourth, and potentially optional, scenario involves the prediction of future aggregate operations beyond what is currently permitted. This would require assuming which of the remaining sand/gravel resources would be developed in the future, the depth of extraction, as well as the production rate. While this would be a hypothetical scenario, it may nonetheless be useful to understand potential future impacts.

To communicate differences between each of the scenarios, the project team should identify key indicators that can be used to quantify the differences between scenarios. These indicators could be Cedar Creek streamflow, groundwater flux to adjacent subwatersheds/discharge receptors, or critical stream reaches within Cedar Creek. The comparison should quantify the degree of difference both in average annual conditions, but also monthly conditions, and drought/wet years. By looking at the impact over a range of climatic conditions, the study team will be better placed to understand the significance of identified impacts.

3.3 Phasing

It is recommended that MESPs for future Secondary Plans include a Staging and Sequencing Strategy, to integrate and coordinate the timing for implementing development and communal infrastructure in an orderly and efficient manner. The Strategy and plan should provide a preliminary overview of the potential development phasing and associated considerations and principles with respect to the implementation of the transportation system, development lands, community uses and parks, stormwater management and erosion and sediment controls, and the creation of the NHS. The phasing of development should avoid out-of-phase works whereby the developers in consultation with the regulators and approval agencies develop a detailed plan which considers temporary works and the prioritization of NHS elements and infrastructure, as well as potential out-of-phase construction management.
3.4 Operation and Maintenance

Monitoring, regular (monthly/seasonal) inspection, and maintenance of stormwater management facilities and systems is critical to maintain water quality and stormwater management performance. Active maintenance may also reduce the time interval at which major maintenance activities, such as sediment clean out, are required in order to sustain water quality and quantity (flooding and erosion) performance.

The operation and maintenance of stormwater management infrastructure is to be completed in accordance with the recommendations outlined in the applicable Stormwater Management Design Brief, as well as municipal requirements per the applicable municipal standards and guidelines. The following provides general recommendations for the operations and maintenance activities of stormwater management infrastructure:

- All stormwater facilities should be regularly inspected and maintained by the landowner/developer until municipal assumption and thereafter by the municipality in a manner that ensures annual performance is maintained according to original design parameters for pollutant removal and quantity control.

- Stormwater management facility maintenance should incorporate as a minimum the 2003 Ministry of Environment (MOE 2003) guidelines, including but not limited to:
  - hydraulic function and adaptation
  - five-year seasonal and annual water quality monitoring and adaptation to results
  - annual sediment accumulation and quality monitoring
  - clean out planning and funding
  - five-year vegetative success monitoring and adaptive planting

4 Monitoring and Adaptative Management Plan

General requirements for future monitoring programs are provided in Section 8.0 of the Scoped Subwatershed Study. As noted in that report, future monitoring programs are recommended to be implemented, and would generally fall under the following two categories:

- Subwatershed-Scale – Monitoring activities that would inform potential impacts to specific receptors (e.g., Cedar Creek, Roseville Swamp), or pathways that would eventually result in impacts to those receptors. Except for Roseville Swamp, these features are generally south of Roseville Road. This monitoring would likely be agency led (Region, GRCA, City of Kitchener). Some aspects of the existing monitoring program could be continued, while
others could be re-instated prior to any potential future land use change to update pre-development conditions.

- Local Monitoring – Specific monitoring of post-development environmental and stormwater management systems that are specific to potential urban land uses. The objective of this monitoring component would be to evaluate management system performance. This monitoring would likely be developer led and would occur pre-, during, and after construction.

The following sections provide further guidance regarding the implementation of monitoring programs as part of future studies, specifically relating to potential future development of the PISR and SKPA lands.

4.1 Subwatershed-Scale

As noted in the Scoped Subwatershed Study, subwatershed-scale monitoring is recommended as part of future works to support future planning studies and ongoing baseline data collection. The monitoring programs would build upon the existing monitoring network, as well as implementing additional monitoring stations proximate to and within the planning study area. The information collected under these programs would serve to refine the characterization and understanding of the planning study area both locally and in the context of the broader subwatershed system.

Future monitoring at the subwatershed-scale is recommended to be undertaken as part of future secondary planning studies and MESPs. The monitoring stations implemented for the Scoped Subwatershed Study should be reinstated for these programs, and additional locations should be identified within and proximate to the planning study area. The monitoring completed for these future studies should encompass the suite of discipline-specific studies undertaken for the Scoped Subwatershed Study (i.e., groundwater, surface water, terrestrial and aquatic ecology, and fluvial geomorphology). The monitoring program for MESPs should also include provision for collecting additional data to confirm the influence of seasonal variation on the potential for producing surface runoff to receiving systems. Although general guidance regarding the components of these monitoring programs is presented in the Scoped Subwatershed Study, the full scope and locations for monitoring should be established in consultation with the local municipality and agencies participating on the planning study and MESP.
4.2 Local Monitoring Programs

As noted in theScoped Subwatershed Study, local monitoring programs are to be developed as part of future studies, to assess the performance of environmental and stormwater management systems post-development, as well as to inform the management of erosion and sediment controls during construction. The information collected should coincide with the pre-developed condition to establish baseline conditions, during construction conditions, as well as post-construction to assess the ultimate performance of the management system. Local monitoring programs for the DSA are recommended to build upon the monitoring program established under the MESPs. The post-construction monitoring program should include monitoring within and proximate to key stormwater management infrastructure (i.e., end-of-pipe facilities, selected LID BMPs), watercourses, and terrestrial features and linkages within the study area to verify the performance of the management strategy locally within the study area. The local monitoring programs to verify performance during and post-construction should be developed as part of functional design submissions, and monitoring programs to verify performance of key stormwater management infrastructure, watercourses, and terrestrial features and systems should be developed as part of detailed design applications.

5 Summary

Potential development within the Cedar Creek subwatershed would be required to satisfy the following criteria related to water management:

1. Control post-development flows to pre-development levels at the outlets from potential development areas, to provide flood protection for downstream properties.

2. Reduce surface runoff volume from potential development areas to maintain pre-development water budget and mitigate erosion impacts to downstream watercourses, including areas with no defined drainage features.

3. Provide stormwater quality control to an Enhanced standard of treatment per current Provincial criteria.

4. Manage chloride loadings to runoff, particularly from snowpack during spring freshet.

5. Infiltrate clean groundwater to maintain the groundwater supply to municipal wellfields, the Roseville Swamp, and the Upper Cedar Creek West Tributary.
The physical, hydrologic, and environmental conditions within the Cedar Creek subwatershed present the following challenges to potential future development:

1. Lack of defined surface drainage outlets to receive and convey overland flow, which presents increased susceptibility for erosion and flooding impacts.

2. Seasonally-based overland flood potential.

3. Water quality considerations and issues (i.e., water temperature and chloride loadings), which are in addition to standard Provincial guidelines for TSS removal.

4. Size and complexity of the stormwater management facility.

The water management plan presented herein has been developed based upon the development concepts prepared as part of the Upper Cedar Creek Scoped Subwatershed Study for potential future development within the PISR and the SKPA. The water management plans for each area include end-of-pipe facilities, sized per the unitary sizing criteria presented herein, to provide stormwater quantity controls to control post-development flows to pre-development levels for all events up to and including the Regional Storm event. Infiltration of clean runoff, through the incorporation of LID infiltration BMPs sized to capture 12.5 mm/impervious hectare, is recommended in order to provide erosion protection at existing drainage outlets and along downstream drainage paths and watercourses, as well as to maintain groundwater contributions to municipal wellfields and key natural features and to maintain the supply of baseflow to watercourses. Water quality management for potential future development must include measures to mitigate loadings of chloride and thermal enrichment of runoff, in addition to satisfying current Provincial standards to provide stormwater quality control to an Enhanced standard of treatment.

The intermittent conveyance function afforded by the existing drainage features and systems within the Eastern PISR would need to be incorporated into the drainage plan for potential future development areas, through the detailed planning and design of subsurface (piped) and/or surface drainage systems; however, would not be expected to require the planning and design of a regulated open watercourse. Three headwater drainage features were identified as conservation, protection, or recharge function proximate to the SKPA. None of these features are located within the limits of the conceptual land use scenarios assessed as part of the WMP/NHSS. As such, there is not expected to be direct impacts from the conceptual land use scenarios to the identified features. Notwithstanding, the HDFs are to be managed in accordance with the CVC/TRCA Guidelines, and features within the Cedar Creek Regulatory
floodplain and/or requiring the protection of hydrologic function (i.e., conveyance) are subject to GRCA regulation and policies.

Per the recommendations of the Scoped Subwatershed Study, a 10 m buffer is to be applied from woodlands, which is to be confirmed through an EIS. The eastern PISR area borders deciduous and coniferous swamps that are Core Environmental Features, as they are part of the Roseville Swamp Cedar Creek PSW Complex, as well as the Cedar Creek Spillway ESPA and significant woodland. A 30 m “no-touch” buffer from the wetlands has been recommended. A Sugar Maple Forest near Dumfries Road, identified as a Supporting Environmental Feature, is part of the Greenlands Network and has been recommended for a buffer of 10 m, which is to be confirmed through an EIS.

Core Environmental Features found in the north of the SKPA, in the form of deciduous woodlands and small swamp communities, are considered significant in the Region. 10 to 15 m buffers have been recommended from the woodland and non-PSW in this area, which is to be confirmed through an EIS. Per the recommendations outlined in the Scoped Subwatershed Study, monitoring for Jefferson Salamander (Ambystoma jeffersonianum) should occur in these woodlands due to suitable habitat and the presence of this endangered species in the greater area. Should this species be found within these woodlands, Regulated Habitat for Jefferson Salamander would have to be identified in consultation with MECP. A Linkage has been identified in the southwest corner of the SKPA that aligns with an overland flow path, as well as a Landscape Level Connection from the northern woodlands to the northeast, outside the DSA, to Core Environmental Features associated with Blair Creek. A specific width for this connection is not identified, nor an exact alignment at the present stage of land use planning. Secondary Plans and MESPs should ensure an ecological connection is maintained in this area between the Core Environmental Features.

Additional study is required as part of any potential future development, coinciding with additional levels of planning for any potential future development. The additional study requirements, discussed further in this document, include MESPs, Functional Studies, and Detailed Design Studies and Reports. As part of these future studies, additional monitoring within the Upper Cedar Creek is recommended, in order to further verify and refine the baseline condition and characterization as part of pre-development monitoring, as well as to verify the performance of management strategies and inform adaptive management as part of post-development monitoring programs.
6 References


Upper Cedar Creek Subwatershed Study
Ecological Land Classification

Legend
- Project Study Area
- Detailed Study Area
- Ecological Land Classification (ELC)
- (CUM) Cultural Meadow
- (CUM1) Mineral Cultural Meadow Ecotope
- (CVC) Business Sector
- (CVR) Residential
- (FOD) Deciduous Forest
- (FOD5) Dry-Fresh Sugar Maple Deciduous Forest Ecotope
- (MAW2) Mineral Marsh Wetland Ecotope
- (MAW3) Marsh Wetland Ecotope
- (OAM1) Annual Row Crops
- (SA) Shallow Water
- (SWM3-2) Green Ash Mineral Deciduous Swamp Type
Upper Cedar Creek Subwatershed Study
Ecological Land Classification

Legend
- Project Study Area
- Detailed Study Area
- Ecological Land Classification (ELC)
  - (CUM1) Mineral Cultural Meadow EcoSite
  - (CUP3) Coniferous Plantations
  - (CUP3-1) Red Pine Coniferous Plantation Type
  - (CUT1) Mineral Cultural Thicket EcoSite
  - (CUT1-1) Mineral Cultural Woodland EcoSite
  - (CVC) Commercial and Institutional
  - (CVR) Residential
  - (FOD) Deciduous Forest
  - (FOD3) Dry - Fresh Sugar Maple Deciduous Forest EcoSite
  - (MAS2) Mineral Shallow Marsh EcoSite
  - (OA) Open Aquatic
  - (OAG2M1) Annual Row Crops
  - (OAG2M2) Perennial Cover Crops
  - (SWT) Thicket Swamp

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Map E4.2

Path: X:\1896_CedarCreek\SWD\Data\1896_McG4_ELC\EMC_1896_20190821_2348_8600.mxd
Project: 1896
Date: August 21, 2019
NAD83 - UTM Zone 17
Scale 1:10,000
0 100 200 300 400 Metres

Upper Cedar Creek
Subwatershed Study
Ecological Land Classification
Upper Cedar Creek Subwatershed Study
Ecological Land Classification

Legend
- Project Study Area
- Detailed Study Area
- Railway
- Ecological Land Classification (ELC)

(CGL_4) Recreational
(CUM1) Mineral Cultural Meadow Ecosite
(CUP1) Coniferous Plantations
(CUP2) Red Pine Coniferous Plantation Type
(CUP3) White Pine Coniferous Plantation Type
(CVC1) Mineral Cultural Woodland Ecosite
(CVC) Commercial and Institutional
(CVC_4) Extraction
(CVR) Transportation
(CVR) Residential
(FOOD) Dry - Fresh Sugar Maple Deciduous Forest Ecosite
(MAM2) Mineral Marsh Ecosite
(MAM2-1) Cultal Mineral Shallow Marsh Type
(NA) Open Aquatic
(OAGM1) Annual Row Crops
(OAGM2) Perennial Cover Crops
(OAGM4) Open Pasture
(SAS3) Shallow Submerged Shallow Aquatic Type
(SWC2) White Cedar Organic Deciduous Swamp Type
(SW22) Black Ash Mineral Deciduous Swamp Type
(SWD4) Mineral Deciduous Swamp Ecosite
(SWD1) White Birch - Poplar Organic Deciduous Swamp Type
(SWM1) White Cedar-Hardwood Mineral Mixed Swamp Type
(SWM2) White Cedar-Hardwood Organic Mixed Swamp Type
(SWN5) Red Maple - Conifer Organic Mixed Swamp Type
(SWN6) Birch - Conifer Organic Mixed Swamp Type
(SWT2) Willow Mineral Thicket Swamp Type
(SWT2-5) Red-osier Dogwood Mineral Thicket Swamp Type

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- Project: 1896
- Date: August 21, 2019
- NAD83 - UTM Zone 17
- Scale: 1:6,000
- Size: 11 x 17"