Project File Report

Humber Flats SWMF 1-4 Rehabilitation Municipal Class Environmental Assessment

February 2025 | TYLin Project 0010651

City of Richmond Hill

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1 Introduction and Background

1.1 Study Overview and Purpose

T.Y. Lin International Canada Inc. (TYLin) along with key team members Archaeological Services Inc. (ASI), Palmer, GHD, and Strybos Barron King Ltd. (SBK), were retained by the City of Richmond Hill to undertake a feasibility study for the rehabilitation of the Humber Flats stormwater management (SWM) facility. The primary goal of this assignment was to determine the current state of the SWM facility and to assess the feasibility of potential alternatives to rehabilitate the facility and all its associated components, such as the stormwater ponds and valleylands, to mitigate flooding and erosion, protect surface water quality and preserve the natural heritage system and public realm.

The project study area encompasses the Humber Flats Ecopark and the associated stormwater management infrastructure. It is generally bound by Bathurst Street to the west, Red Cardinal Trail to the north and east, and the East Humber River to the south (See **Figure 1-1**).

The stormwater management infrastructure within the study area includes small detention basins, referred to as filter pads, at nine (9) storm sewer outlets distributed through the study area. These filter pads discharge to an open channel system leading to a flow control structure on the upstream side of Humberland Drive, and there is a wet detention pond on the south side of Humberland Drive which provides water quality treatment and extended detention of storm runoff. The system of filter pads, open channels, flow control structures and wet pond are known collectively as SWMF 1-4.

There is also a trail system integrated into the open channel corridors, with 5 pedestrian bridge crossings over the channel, and a playground on the west side of the channel a short distance north of Humberland Drive.

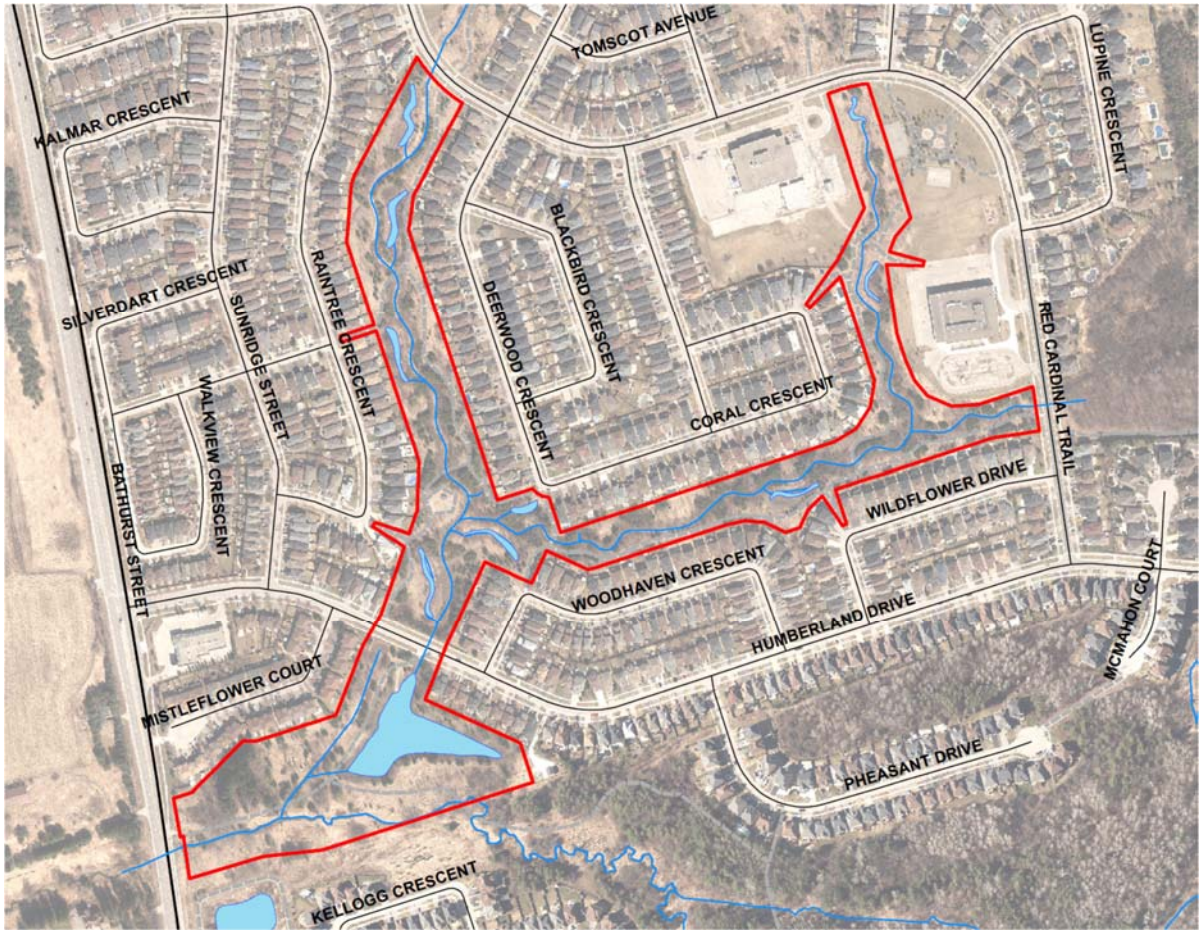
The Humber Flats stormwater management system was constructed more than 25 years ago and requires some maintenance. The water quality pond south of Humberland Drive is estimated to be approximately 15% full of sediment, which may be impairing its performance for water quality treatment. Many of the filter pads also appear to provide little to no attenuation of storm runoff, which could be due to excessive sediment accumulation, clogging of the granular materials in the berms forming the pads, erosion of the pad outlets, or a combination of the above.

In addition, a number of homes in the study area are potentially at risk of flooding. The Regulatory floodplain, as established by the Toronto and Region Conservation Authority (TRCA), extends well beyond the limits of the open space system associated with the channel corridors

and Ecopark. Previous studies have estimated that more than 100 properties are at risk of flooding if Hurricane Hazel were to reoccur over the study area. Finally, the existing playground located north of Humberland Drive needs to be replaced due to its age and condition, but there are potential liability concerns associated with the playground due to its location in the floodplain.

This feasibility study has been prepared to inventory the existing environments through the study area, and to develop and evaluate a range of alternatives to rehabilitate and enhance the stormwater management infrastructure, reduce flood risk, and preserve the recreational infrastructure through the study area in an integrated manner.

Figure 1-1 Study Area



1.2 Project Background

1.2.1 Humber Flats SWMF 1-4

The Humber Flats stormwater management system was designed and constructed in the mid-1990's when modern practices for stormwater quality treatment and erosion control were emerging and evolving. The design of the system is documented in the report 'Stormwater Management Design Brief, Humber Flats Subdivision, South Wet Extended Detention Pond, Quantity Control and Ecological Park Grading Study Area C' (Cosburn Patterson Mather Limited, 1996).

The following elements make up the SWMF 1-4 stormwater management system:

- Filter pads at 9 storm sewer outfalls distributed along the Ecopark system. These are small basins intended to hold and slowly release the runoff from small storm events. The water stored in the filter pads is intended to seep through granular layers in the berms forming the basins.
- A reconstructed channel corridor to convey runoff from external areas and the filter pads to Humberland Drive. The system of filter pads and open space corridors is also referred to as the 'Ecopark'.
- A French Drain under the low flow channel, which is intended to intercept base flows / low flows in the system and discharge directly to the East Humber River via a connection to the foundation drain collection system for the surrounding residential development. This system was included to mitigate thermal impacts to the coldwater fish habitat in the East Humber River, avoiding the risk of warming in the wet pond prior to discharge.
- Two culverts under Humberland Drive that provide quantity control. The culverts are intended to restrict peak flow rates and store water in the upstream Ecopark channel corridors during large storm events to meet the quantity control targets. A smaller culvert conveys the flows from more frequent events to the water quality pond, and a larger culvert set at a higher elevation conveys the controlled flows from larger storm events directly to the East Humber River.
- A wet detention pond south of Humberland Drive, which provides quality treatment and extended detention of the storm runoff. The pond receives controlled discharge from the smaller culvert under Humberland Drive, and discharges to the drainage channel from the Humberland Drive high flow culvert a short distance upstream of the outlet to the East Humber River.

The combination of filter pads, Ecopark channels, on-line flow control structures at Humberland Drive, and wet detention pond were designed to achieve Enhanced water quality protection

(80% TSS Removal), at least 24 hours detention of the runoff from a 25 mm storm event and achieve the peak flow targets established in the Functional Servicing Plan for a much larger study area that included the Humber Flats stormwater management system.

1.2.2 East Humber River Floodplain

Floodplain mapping for the East Humber River was established by the TRCA in 2014. The mapping shows the maximum extent of flooding associated with the Regional or Regulatory storm event. The Regional storm event is defined as the worst storm on record that could potentially re-occur over the watershed. Within the TRCA's jurisdiction, the Regional storm is Hurricane Hazel. The Regulatory storm event is the greater of the Regional storm or the 100 year return period storm. Through the Humber Flats study area, the Regional storm event (Hurricane Hazel) produces the largest flow rates and is the Regulatory storm.

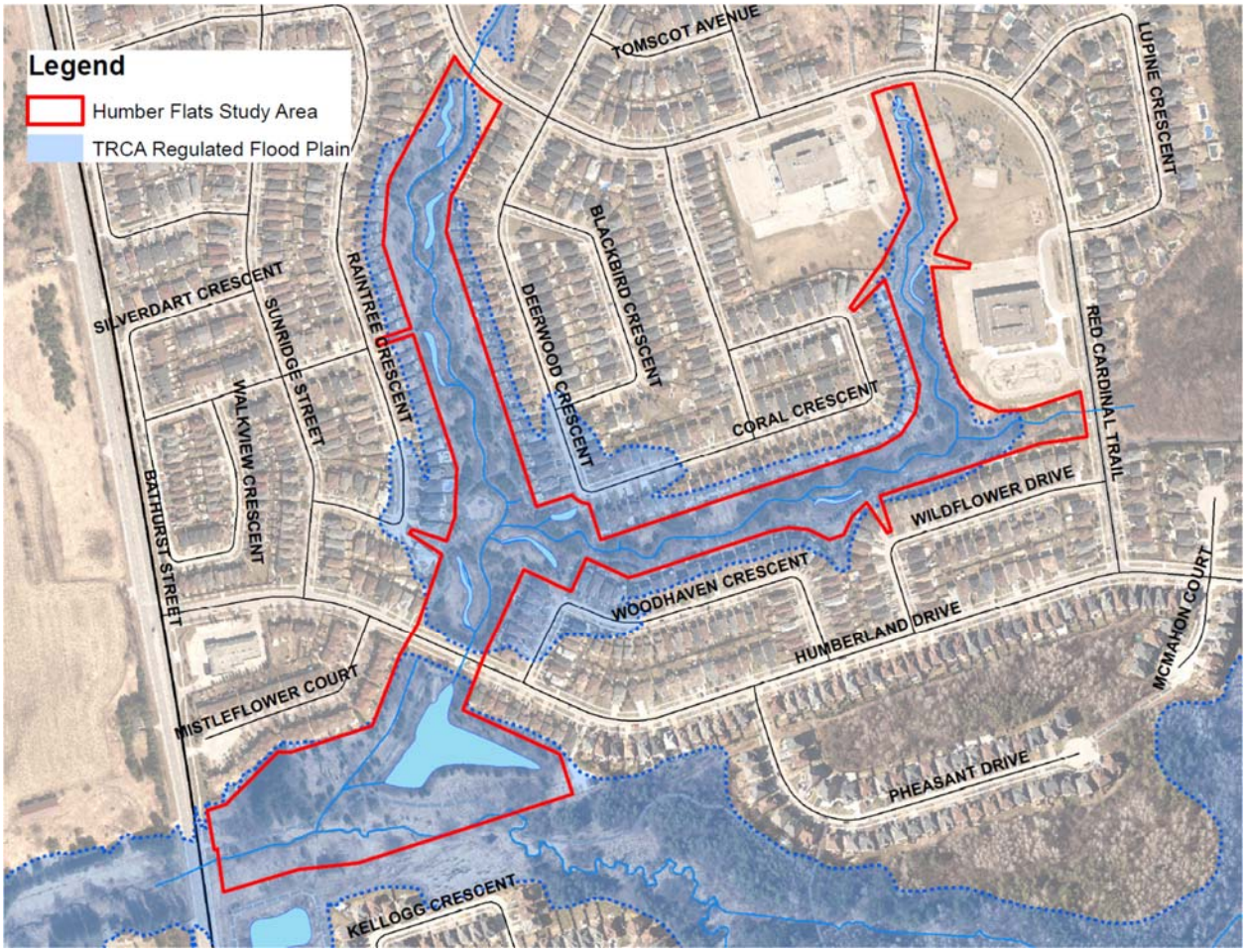
The extent of flooding associated with the Regulatory storm event was established using a HEC-RAS hydraulic model. The development of the model and resulting flood extents were documented in the report 'Summary Report for Digital Floodplain Mapping for the East Humber River within the Town of Richmond Hill' (RJ Burnside & Associates Limited, 2014). This initial floodplain mapping exercise indicated that a considerable number of properties and homes were potentially at risk of flooding in a Regulatory storm event.

In response to the findings from the East Humber River Floodplain Mapping study, the City and TRCA jointly undertook a study to explore flooding in the Humber Flats area in more detail and assess opportunities to mitigate flooding. The Humber Flats Flood Remediation Hydraulic Report (R.J. Burnside & Associates Limited, 2014) determined that 123 properties in the Humber Flats area were in the Regulatory floodplain, and 113 homes were at least partially in the floodplain. At roughly 50 of these homes, flood depths in the Regulatory flood event were high enough to pose a risk of floodwater entering the homes.

The study then developed a wide range of alternatives to reduce flood levels, including improvements to the Bathurst Street culvert, and the CN railway culvert west of Bathurst Street that causes a significant backwater in the Regulatory storm event. Replacement of the existing flow control culverts at Humberland Drive with a 15 m span bridge was selected as the preferred solution to mitigate flooding. With this solution in place, there would continue to be more than 100 properties within the floodplain, but the depth and extent of flooding on those lots would be significantly reduced, with minimal risk for floodwater to enter homes. The only solutions that could fully mitigate flooding involved replacement of the culverts under the CN railway and Bathurst Street. These were not selected as the preferred solution because the City has little to no ability to implement culvert replacements on transportation infrastructure owned by York Region and CN Rail.

Note that the TRCA completed an update to the Humber River Watershed Hydrology Model in 2018, and updated the floodplain mapping for the East Humber River as far upstream as Bathurst Street in 2019. The floodplain mapping for the East Humber River upstream of Bathurst Street continues to be based on older hydrologic modelling and requires updating.

Figure 1-2 TRCA Floodplain Mapping



1.3 Municipal Class Environmental Assessment Process

The planning of major municipal projects or activities is subject to the Ontario Environmental Assessment Act, R.S.O. 1990, and requires the proponent to complete an Environmental Assessment, including an inventory and description of the existing environment in the area affected by the proposed activity.

The Class EA process was developed by the Municipal Engineers Association, in consultation with the Ministry of Environment, Conservation and Parks (MECP), as an alternative method to Individual Environmental Assessments for recurring municipal projects that were similar in

nature, usually limited in scale and with predictable ranges of environmental effects which were responsive to mitigating measures. The latest Municipal Class EA document (Municipal Engineers Association, 2023) has been used for this study.

The Municipal Class EA provides for the following designations of projects depending upon potential impacts:

- **Exempt**: Projects are limited in scale, have minimal adverse environmental effects and include a number of municipal maintenance and operational activities. These projects, which were formerly classified as Schedule A and Schedule A+ projects, are exempt from the requirements of the Environmental Assessment Act.
- **Eligible for Screening to Exempt**: Projects may have the potential for some adverse environmental effects, depending on conditions in the study area. The screening process set out in the Municipal Class EA document can be completed to determine if the project is exempt from the requirements of the Environmental Assessment Act or should proceed as a Schedule B or Schedule C project.
- **Schedule B**: Projects have the potential for some adverse environmental effects. The proponent is required to undertake the first two phases of the assessment process, involving mandatory contact with directly affected public and relevant review agencies, to ensure they are aware of the project and that their concerns are addressed. If there are no outstanding concerns, then the proponent may proceed to implementation.
- **Schedule C**: Projects have the potential for significant environmental effects and must proceed under the full planning and documentation procedures specified in the Municipal Class EA document. Schedule C projects require that an Environmental Study Report be prepared and filed for review by the public and review agencies.

The Humber Flats SWMF 1-4 project has the potential for some adverse environmental impacts, and therefore follows the planning procedure for Schedule B activities. The following Class EA planning phases apply:

- **Phase 1**: Identify the problem (deficiency) or opportunity.
- **Phase 2**: Identify and evaluate alternative solutions to address the problem or opportunity by taking into consideration the existing environment, and establish the preferred solution taking into account public and review agency input.
- **Phase 5**: Complete contract drawings and documents, and proceed to construction and operation; monitor construction for adherence to environmental provisions and commitments. Where special conditions dictate, also monitor the operation of the completed facility.

The Class EA process also provides an appeal process to change the project status. Under the provisions of the Environmental Assessment Act, there is an opportunity under the Class EA planning process for the Minister to review the status of a project. Members of the public, interest groups and review agencies may request the Minister to require a proponent to comply with Section 16 of the EA Act, before proceeding with a proposed undertaking. This is known as a "Section 16 Order" (formerly called "Bump-Up Request" or 'Part II Order").

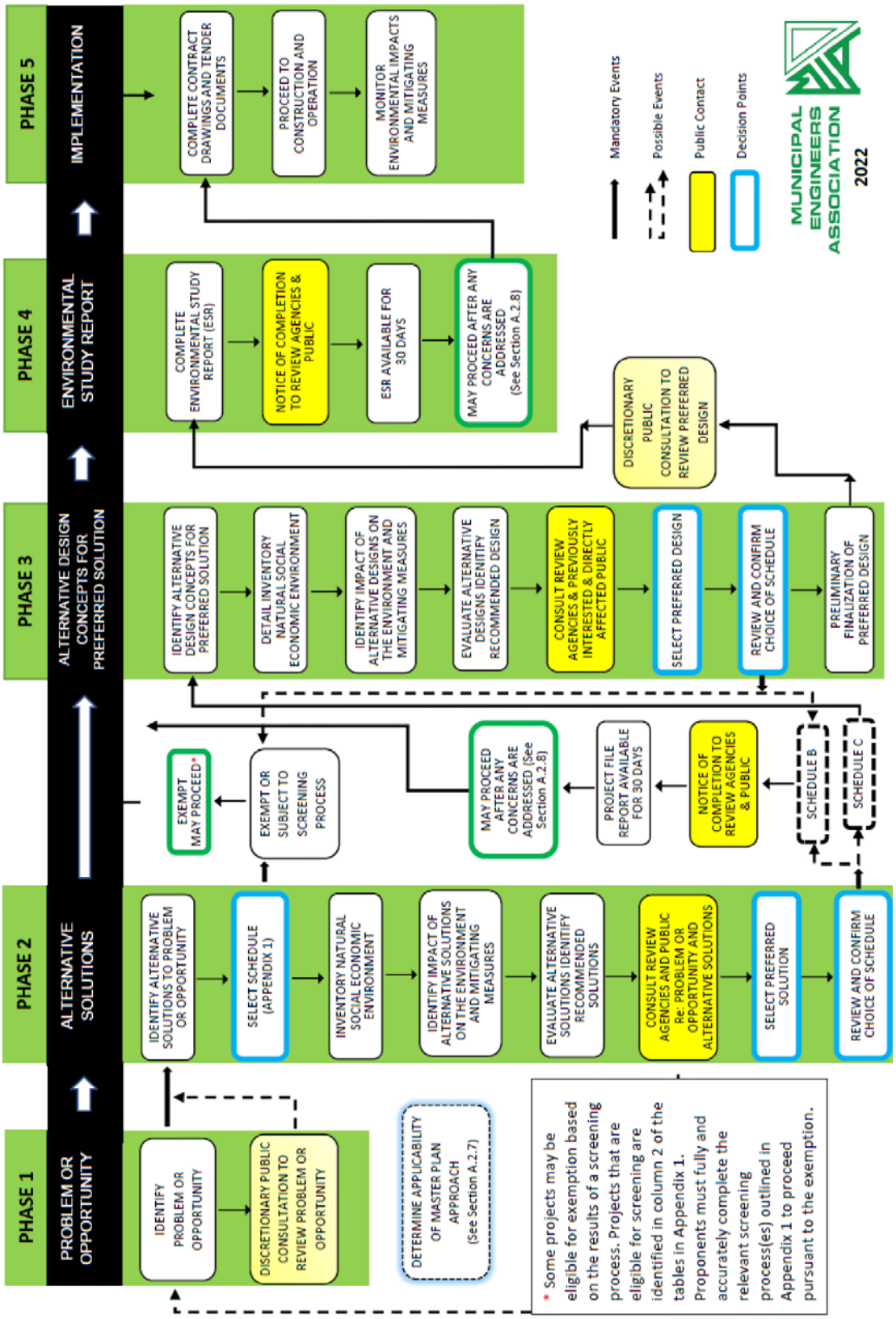
Any outstanding concerns are to be directed to the proponent for a response, and in the event there are outstanding concerns regarding potential adverse impacts to constitutionally protected Aboriginal and treaty rights, Section 16 Order requests on those matters may be addressed in writing to the Minister of the Environment, Conservation and Parks and the Director of the Environmental Assessment Branch. The Director will issue a Notice of Proposed Order to the proponent if the Minister is considering an order for the project within 30 days after the conclusion of the comment period on the Notice of Completion. At this time, the Director may request additional information from the proponent. Once the requested information has been received, the Minister will have 30 days within which to make a decision or impose conditions on the project.

The proponent cannot proceed with the project until at least 30 days after the end of the comment period provided for in the Notice of Completion. Further, the proponent may not proceed after this time if:

- A Section 16 Order request has been submitted to the Minister regarding potential adverse impacts to constitutionally protected Aboriginal and treaty rights, or;
- The Director has issued a Notice of Proposed Order regarding the project.

A flow chart describing the Class EA planning and design process is shown in **Figure 1-3**.

Figure 1-3 Municipal Class EA Planning Flow Chart



1.4 Project Team Organization

The project was completed by a multi-disciplinary team led by TYLin. Key staff involved in the Study are listed in **Table 1-1**. The project was completed under the direction of a technical working group comprised of City of Richmond Hill staff from various City departments.

Table 1-1 Project Team

Name	Organization	Role
Steve Hollingworth, P.Eng.	TYLin	Project Manager
Jeff Doucette, Ph.D, P.Geo.	GHD	Fluvial Geomorphology Lead
Austin Adams, M.Sc., EP	Palmer	Ecology Lead
Sarah Sipak, B.Sc., P.Geo (limited), QPESA	Palmer	Geoscience Lead
Joshua Beitz BLA, OALA, CSLA, ISA	SBK	Landscape Architect
Katrina Thach, BA	ASI	Archaeology Lead

1.5 Problem and Opportunity Statement

The filter pads at the storm sewer outfalls to SWMF 1-4 are in need of repair, and appear to be providing limited function for stormwater water management in their current condition, and a considerable amount of sediment has accumulated in the wet detention pond south of Humberland Drive. In addition, a large number of homes are potentially at risk of flooding if the Regional storm (Hurricane Hazel) were to reoccur over the study area.

The problem and opportunity statement is as follows:

> **To determine the preferred method(s) of rehabilitating the Humber Flats (SWMF 1-4) stormwater management facility to restore or improve stormwater quality, quantity, and erosion control, to reduce the potential for flooding and flood damages to private property and public infrastructure, while protecting or improving aquatic and terrestrial habitat and recreational infrastructure.**

2 Existing Environments

2.1 Planning Environment

The study area lies within the City of Richmond Hill in the Region of York. Additionally, the study area lies within the Oak Ridges Moraine, and there are a number of planning policies applicable to the site.

2.1.1 Provincial Policy Statement

The Provincial Policy Statement (PPS) (2020) provides broad land use planning and development policy direction, particularly as it relates to matters of provincial interest including but not limited to the natural environment and natural hazards. Section 2.1 of the PPS (Natural Heritage) includes policies for the long-term protection of natural heritage systems, restoration and enhancement of the diversity and connectivity of natural features. Similarly, Section 2.2 of the PPS (Water) directs planning authorities to protect, improve or restore water quality and quantity. It also emphasizes stormwater management practices to minimize runoff volumes and pollutant loadings and preparing for the impacts of climate change to water resources systems.

2.1.2 Growth Plan for the Greater Golden Horseshoe

The Growth Plan for the Greater Golden Horseshoe (GPGGH) (2020) is another provincial policy document intended to guide future growth in the area. The GPGGH is generally intended to direct future population and employment growth to existing urban areas. The study area is within an existing built-up area but is not within or near an Urban Growth Centre.

The potential rehabilitation of stormwater management infrastructure and natural heritage systems in the study area is not intended to facilitate new development and growth but is consistent with the guiding principles of the GPGGH which emphasize the protection and enhancement of natural heritage and hydrologic features and their functions. Under the heading of 'Protecting What is Valuable', there are a number of policies related to the protection and enhancement of water quality and quantity, and for the restoration and enhancement of natural heritage features.

2.1.3 York Region Official Plan

The 2022 York Region Official Plan (YROP) outlines strategies to guide growth and development in the Region, including the City of Richmond Hill (2023). York Region has recently updated it's Official Plan. The YROP has been adopted by Regional Council and is awaiting approval by the Province.

The study area is designated 'Urban' in the Region's Official Plan. The East Humber River is identified as a key hydrologic feature, and the East Humber River's valley corridor and Humber Flats Ecopark are designated as parts of the Region's Greenland system. The study area is located within a Wellhead Protection Area (WHPA – D) and portion of it are also considered both significant Groundwater Recharge Areas (SGRA) and Highly Vulnerable Aquifers (HVA) under the Source Protection Plan.

Section 3.3 of the YROP includes several policies applicable to the study area. There are policies related to protecting, improving, and restoring key hydrologic features, and policies restricting certain high-risk land uses and activities in SGRA, WHPA and HVAs. The YROP further encourages best management practices for the 'application, storage and/or handling of road salt on private roadways, parking lots and pedestrian walkways while recognizing that maintaining public safety is paramount'.

The complete York Region Official Plan document can be reviewed at www.york.ca/wps/portal/yorkhome/yorkregion/yr/regionalofficialplan.

2.1.4 City of Richmond Hill Official Plan

The City of Richmond Hill Official Plan was adopted by council in July 2010, but as with the York Region Official Plan, the City's Official Plan was appealed to the Ontario Municipal Board (OMB). The City of Richmond Hill Official Plan was partially approved by the OMB in 2012, bringing the policies into effect with the exception of those policies that remain under appeal. The Official Plan continues to be updated with Amending Orders as the remaining appeals are resolved. The most recent Amending Order was issued in February 2021, and the Official Plan was last consolidated to incorporate all Amending Orders and amendments in January 2023. The complete City of Richmond Hill Official Plan can be reviewed at https://www.richmondhill.ca/en/find-or-learn-about/Official-Plan.aspx.

The study area is denoted as being within the Oak Ridges Moraine Conservation Plan Area, and also includes areas designated as Natural Linkage, Natural Core, Wetland, Wellhead Protection Area and an area of high aquifer vulnerability under the City's Official Plan (**Figure 2-1**). Note that entire study area is designated as Settlement Area under the Oak Ridges Moraine Conservation Plan (ORMCP), and therefore only the City's Official Plan policies related to the Natural Linkage and Natural Core are applicable.

The Official Plan contains numerous policies related to stormwater management, many of which promote the use of low impact development practices to preserve groundwater recharge and minimize runoff volumes (3.1.9.2.6). The majority of the policies are related to stormwater management requirements for development, but there are policies for integration of stormwater management facilities into the Greenway system including trails and viewing opportunities

(3.1.9.2.11). Other policies encourage wetland creation as part of new and retrofit stormwater works (3.1.9.2.13), promote opportunities to implement quality and quantity treatment for existing untreated and undertreated areas (3.1.9.2.14), and encourage pilot and demonstration projects to test their effectiveness and increase public understanding of stormwater management (3.1.9.2.15).

2.1.4.1 Natural Linkage Policies

Small portions of the study area south of Humberland Boulevard and north of Red Cardinal Trail are designated as 'Natural Linkage' in the City's Official Plan (Schedule A2). Lands under this designation in the Official Plan are meant to maintain, improve or restore open space connections between Natural Core areas and stream corridors, and also to connect the City's Greenway systems. Relevant approved uses in Natural Linkage areas include:

- Conservation and flood and erosion control including stormwater management works (4.10.6.1 b)
- Essential public works may be permitted on lands within the Natural Linkage designation where the need for the project is demonstrated and there is no reasonable alternative, and where planning, design, construction and management practices are incorporated so that the proposed works:
    a. Do not adversely affect the ecological integrity or hydrological integrity of the Greenway System;
    b. Maximize the amount of natural vegetation cover restored within the right-of-way of the proposed infrastructure, transportation or utility use; and
    c. Maintain or, wherever possible, improve the ability of plant and animal species to move within and between the Greenway System and adjacent municipalities (4.10.6.1.2)
- Existing stormwater management works that abut or are located within Natural Linkage areas will continue to be used for the purpose they were designed for and will be evaluated and, where appropriate, may be modified to implement naturalization or restoration plans to enhance the ecological integrity or hydrological integrity of Natural Linkage areas and the larger Greenway System (4.10.6.1.3)

2.1.4.2 Natural Core Policies

The East Humber River valley corridor and the majority of the Ecopark are designated 'Natural Core' in the City's Official Plan (Schedule A2). Policies in the Official Plan are intended to provide long term protection to the Natural Core areas and where possible, "enhance the size, diversity, health, connectivity and resiliency of the Greenway System".

Flood and erosion control projects are permitted in the Natural Core, other than stormwater management works. The Official Plan Section 4.10.5.1 (3) states:

> Existing stormwater management works that abut or are located within Natural Core areas will continue to be used for the purpose they were designed for and will be evaluated and, where appropriate, may be modified to implement naturalization and/or restoration plans to enhance the ecological integrity or hydrological integrity of Natural Core areas and the larger Greenway System.

2.1.4.3 Key Natural Heritage Feature Policies

Key Natural Heritage Features (KNHF) include wetlands, fish habitat, significant woodlands, significant wildlife habitat and other ecological features. There are no KNHF identified within the study area in the City's Official Plan (Schedule A2), but wetlands are identified immediately south of Bloomington Road, in Cardinal Woods Park east of Red Cardinal Trail, and within the East Humber River valley corridor. The East Humber River valley corridor also includes areas designated as significant woodlands.

The Official Plan Section 3.2.1.1 (26) states the following with respect to Key Natural Heritage Features:

> All development and site alteration with respect to land within a key natural heritage feature or the related minimum vegetation protection zone as identified on Table 3 is prohibited, except the following:
>
> a. Fish, wildlife and forest management;
> b. Conservation and flood or erosion control projects, but only if they have been demonstrated to be necessary in the public interest after all alternatives have been considered;
> c. Transportation, infrastructure, and utilities as described in Section 41 of the ORMCP, but only if the need for the project has been demonstrated and there is no reasonable alternative; and
> d. Low-intensity recreational uses subject to Section 37 of the Oak Ridges Moraine Conservation Plan.

A Natural Heritage Evaluation, as defined in Section 5.24 of the City's Official Plan, is required for any works in or near a key natural heritage feature to confirm the designation, determine appropriate buffers or setbacks from the feature and demonstrate how the feature will be protected and enhanced during and following construction of any works in or near the feature.

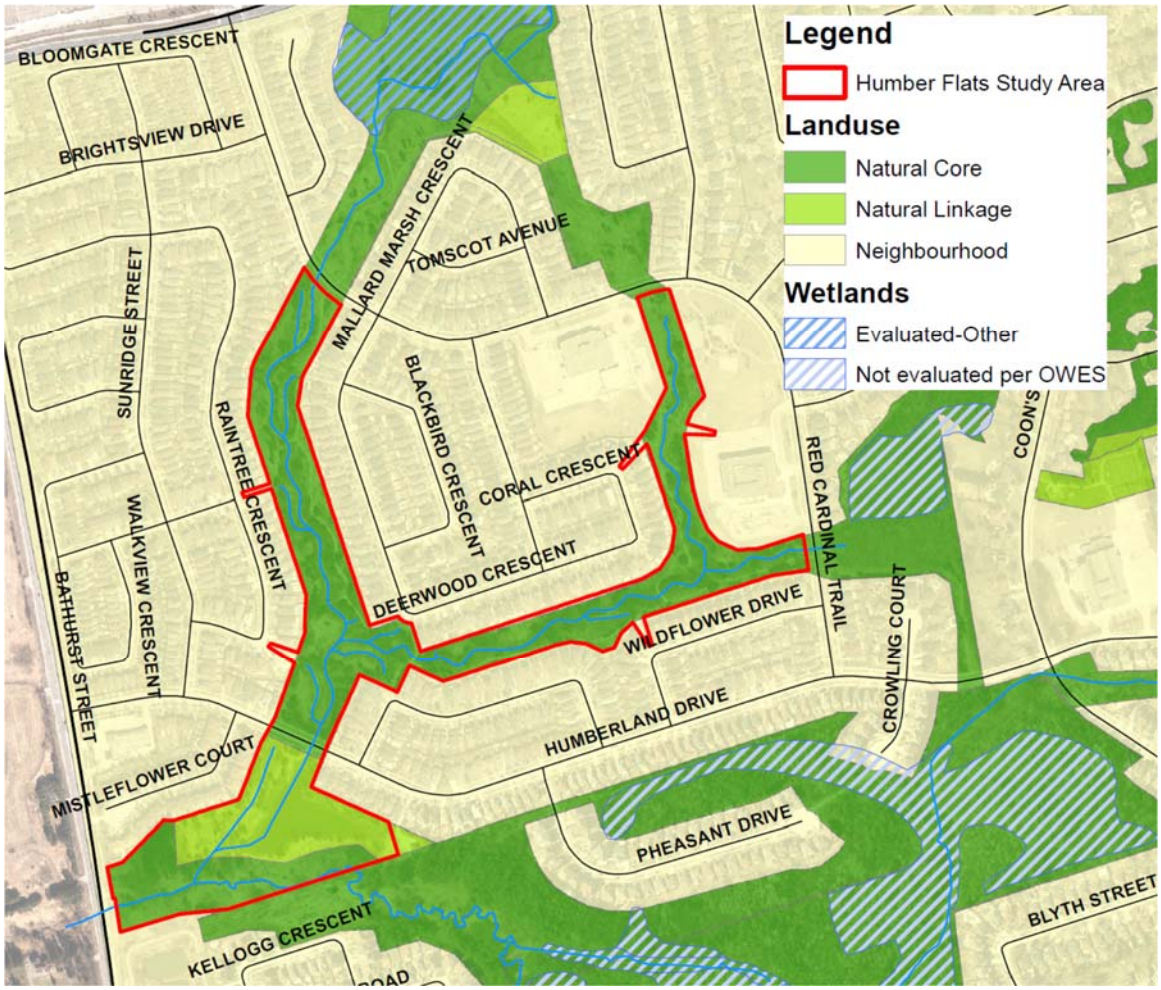
2.1.4.4 Source Water Protection Policies

Schedule A5 of the Official Plan show the majority of the study area being in an area of High Aquifer Vulnerability, and within or abutting a Wellhead Protection Area.

The Official Plan states in section 3.2.1.1 (37):

> The following uses, with the exception of existing uses permitted by policy 3.2.1.1.10 of this plan, shall be prohibited in areas of high aquifer vulnerability identified on Schedule A5 (ORM Areas of High Aquifer Vulnerability and Wellhead Protection Areas) to this Plan:
>
> a. Generation and storage of hazardous waste and liquid industrial waste.
> b. Waste disposal sites and facilities, organic soil conditioning sites and snow storage and disposal facilities
> c. Underground and above ground storage tanks that are now equipped with an approved secondary containment device.
> d. Storage of a contaminant listed in Schedule "3" (Severely Toxic Contaminants) to Regulation 347 of the Revised Regulations of Ontario, 1999.

Figure 2-1 Richmond Hill Official Plan

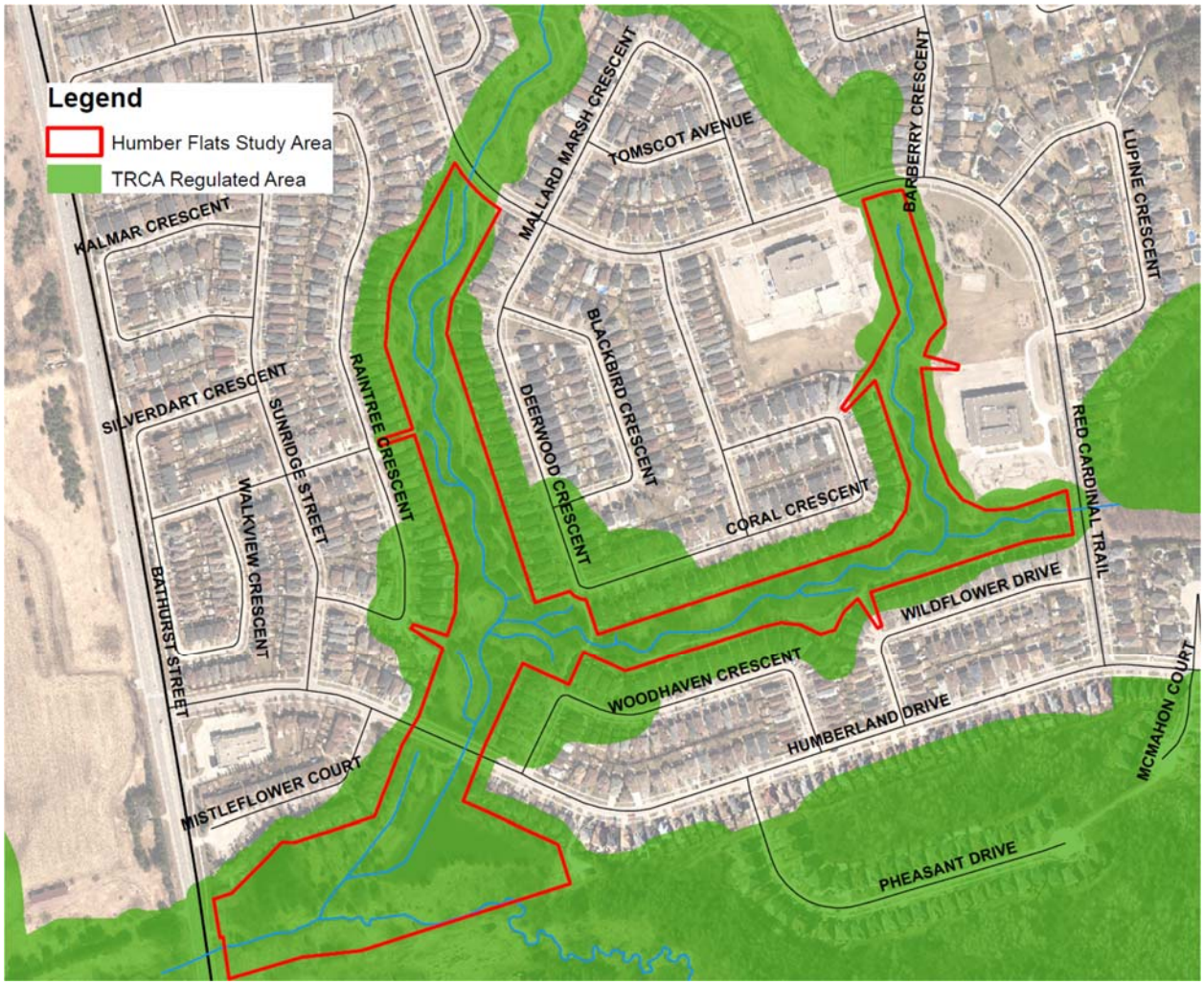


Recreated with information from Official Plan Schedules A2 and A4

2.1.5 Toronto and Region Conservation Authority

The Toronto and Region Conservation Authority (TRCA) prepared mapping to identify where works or development would require a permit under Ontario Regulation 166/06 (Development, Interference with Wetland and Alternations to Shorelines and Watercourses). An excerpt of the TRCA's Regulation limit mapping is presented in **Figure 2-2,** showing the area around the East Humber River, including the Ecopark, to be within the TRCA's regulation limit.

Figure 2-2 TRCA Regulation Limits



2.2 Natural Environment

2.2.1 Physiography and Topography

The project site is situated within the Oak Ridges Moraine physiographic region (Chapman & Putnam, 1984), which extends from the Niagara Escarpment to the Trent River and forms the drainage divide between Lake Ontario and the streams flowing into Lake Simcoe and Georgian Bay. The Oak Ridges Moraine is characterized by hilly or hummocky terrain, with sandy soils at surface in some areas and buried under till in others.

A review of available online surficial geology mapping was used to identify the overburden materials of the site. Overlying the majority of the study area are interbedded silt and clay textured glaciolacustrine deposits with minor sand and gravel.

2.2.2 Soils and Groundwater

A review of geotechnical reports prepared for previous developments in the study area generally confirm the general characterization of soils from the previous section. Soils encountered in borehole investigations include silt to sandy silt till soils, with silty clay tills observed closer to Bloomington Road.

Groundwater was measured at depths between 1 m to 2 m through much of the study area, and measured at depths in the order of 4 m below ground in the northern portions of the study area. Note that these groundwater measurements were collected prior to development. The grading and servicing for the developments in the Humber Flats area could have influenced groundwater levels in the area.

2.2.3 Source Water Protection

As noted in **Section 2.1.3**, the schedules included with the York Region Official Plan indicated that a small area at the north limit of the study area is within a Wellhead Protection Area (WHPA). Available on-line mapping is contradictory, as the Source Protection Information Atlas hosted by MECP suggest that almost the entire study area is within WHPA-D, while York Region online mapping shows the limit of the WHPA-D north of Bloomington Road and entirely outside of the study area.

In addition, portions of the study area are designated Significant Groundwater Recharge Area (SGRA), portions are designated Highly Vulnerable Aquifer (HVA), and the study area lies within a Wellhead Protection Area – Quantity (WHPA-Q).

However as noted in **Section 2.1.3**, the applicable source protection plan polices embedded in the York Region and Richmond Hill Official Plans do not pose significant constraints on potential rehabilitation or retrofit if the Humber Flats stormwater management systems.

2.2.4 Fisheries and Aquatic Habitat

An aquatic assessment was conducted for the tributaries and East Humber River within the Study Area. Observations included estimated channel size, substrate type, presence of bank undercuts and other observations that indicate the quality of the habitat such as bank condition, erosion, degradation, riparian cover and shading, as well as identification of in-stream barriers to fish passage. The findings are summarized in the following sections.

2.2.4.1 Ecopark Channels

At the time of the 2022 field investigations, the aquatic conditions in the Ecopark channels upstream of Humberland Drive were similar as they both shared the same riparian conditions and flows (standing water). In the lower reaches, and other tree covered areas, the channels

were characterized as confined tributaries with a wetted width of approximately 4 m, a bank height of approximately 1 m, and water depth of 20 cm-30 cm. Substrates generally consisted of gravel and cobbles. Riparian vegetation along these defined channels was associated with the Cultural Woodland (CUW1) community – including European Alder, Common Ninebark and Eastern White Cedar. In-water vegetation consisted of occasional cattails with scarce Spotted Jewelweed and water plantain.

In the upper reaches (closer to Red Cardinal Trail) and in other open areas, the channels were noted to be wider (>4 m width), less defined, with water depths of approximately 10 cm. Substrates were generally characterized as silty muddy bottom. Riparian vegetation along these reaches were associated with the Shallow Marsh (MAS2) community – including cattails, Common Reed, and occasional shrubs such as Red-osier Dogwood. In general, the tributaries were characterized as meandering, with little to no pools noted.

2.2.4.2 Wet Detention Pond Outlet Channel

At the time of the 2022 field investigations, water was observed flowing southward from the pond outlet to the channel leading south from Humberland Drive to the East Humber River. The clear water had a depth of approximately 10 cm, flowing through mostly rocks. The wetted width was noted to be approximately 2 m and no fish barriers were observed. Vegetation included occasional cattail and willow trees.

2.2.4.3 East Humber River

At the time of the 2022 field investigations, the clear water had a medium flow towards Bathurst Street, with an approximate depth of 80 cm. The meandering watercourse in this reach contained a small pool in which fish were observed. The channel had an approximate width of 2 m and a substrate containing silty mud and rocks. Riparian vegetation was dominated by Reed Canary Grass and abundant Red-osier Dogwood. Downstream of the confluence, near the Bathurst Street culvert crossing the clear water had a high flow and a depth of approximately 50 cm. In-water vegetation was dominated by cattails and contained scarce amounts of Watercress. Riparian vegetation was associated with a Meadow Marsh community containing abundant Purple Loosestrife, Spotted Joe-Pye-weed and occasional deciduous trees such as Silver Maple and White Oak.

2.2.5 Vegetation and Terrestrial Habitat

The Study Area is located within an urban setting and is largely comprised of anthropogenic lands. All of the natural areas are associated with the watercourses, including the East Humber River and the tributaries (Ecopark channels) through the study area. The riparian corridors of the watercourses were characterized as cultural woodland, shallow marsh, and / or cultural thicket.

Vegetation communities were mapped and described following the Ecological Land Classification (ELC) System for Southern Ontario protocols (Lee, et al., 1998). Field investigations identified 10 vegetation communities within the Study Area. These communities and anthropogenic areas are described in **Table 2-1**. Mapping showing the locations and limits of the different communities and additional information on the vegetation communities can be found in **Appendix B**.

Table 2-1 Vegetation Communities Identified in the Study Area

Vegetation ELC Community	Vegetation Community Description
CUW1 Mineral Cultural Woodland	This community was found throughout the Study Area and was associated with the riparian corridors of the tributaries of the East Humber River. The canopy provided 50-60% cover and was composed of a mix of deciduous and coniferous tree species. The canopy and subcanopy varied in species dominance but were mainly composed of Trembling Aspen, Willow, Eastern White Cedar, and European Black Alder. The understory (40% cover) was composed of abundant European Black Alder, frequent Eastern Ninebark, with occasional Green Ash, and White Oak. The groundcover (20-40%) included Goldenrod, Common Comfrey, and Field Horsetail.
CUM1 Mineral Cultural Meadow:	This community was located throughout the Study Area and was associated with open areas within the Ecopark corridors. Meadow species included Goldenrod, Wild Carrot, Cow Vetch, Canada Thistle and asters.
CUT1 Mineral Cultural Thicket	This community was located on the southwestern portion of the Study Area near Bathurst Street. The thicket was dominated by European Buckthorn, providing 40% cover.
FOD4 Dry – Fresh Deciduous Forest	This culturally-influenced community was located on the southwestern portion of the Study Area near Bathurst Street. The canopy and subcanopy provided about 60% cover and were composed of frequent Black Locust and White Spruce with occasional Norway Maple, Norway Spruce and Willow. The open understory (20% cover) contained frequent European Buckthorn, and occasional Eastern White Cedar, and White Pine. The groundcover (85% cover) was dominated by Goutweed with abundant Bracken Fern.

Vegetation ELC Community	Vegetation Community Description
FOD Deciduous Forest	This community was located east of the Study Area, on the east side of Red Cardinal Trail. The canopy and subcanopy provided more than 60% cover and included abundant Ironwood with frequent Largetooth Aspen, and occasional Sugar Maple and Basswood. The understory contained frequent Alternate-leaf Dogwood and Chokecherry with occasional European Buckthorn and Ironwood saplings. The groundcover included Broadleaved Enchanter's Nightshade, Virginia Waterleaf and Large False Solomon's Seal.
MAM2 Mineral Meadow Marsh	This community was located on the southern portion of the Study Area and was associated with the riparian vegetation of the East Humber River. The meadow marsh varied in species composition, though it contained abundant Reed Canarygrass, Purple Loosetrife, Spotted Joe Pye Weed and Spotted Jewelweed
MAS2 Mineral Shallow Marsh	This community was located throughout the Study Area and was associated with the in-water vegetation of the tributaries of the East Humber River. Portions of the shallow marsh were either dominated by cattails or Common Reed.
SWT2-2 Willow Mineral Thicket Swamp	This community was located in the southern portion of the Study Area and was associated with the riparian vegetation of the wet detention pond. The swamp thicket included frequent Sandbar Willow as well as occasional Red-osier Dogwood, Silky Dogwood and Rough-leaved Dogwood
SWT2 Mineral Swamp Thicket	This community was located on the north side of Humberland Drive and was associated with the riparian vegetation of the tributary. The swamp thicket was composed of frequent Heart-leaved Willow, Red-osier Dogwood, European Black Alder, and Eastern Ninebark.
OAO Open Aquatic	This community was identified as the wet detention pond located in the southern portion of the Study Area. At the time of the field investigations, the water was noted to be clear, with frequent Broad-leaved Arrowhead.

A total of 59 species of vascular plants were recorded within the Study Area during the 2022 field investigations. Based on these findings, 29% of the species identified are non-native to Ontario. The recorded presence of non-native species is indicative of past disturbance in the Study Area, typical of developed areas in the Greater Toronto Area (GTA).

No SAR plants were recorded during the 2022 field investigations. Furthermore, all native plants are identified as S5 or S4 ranking, indicating that they are common within Ontario (Ministry of

Natural Resources and Forestry, 2022). Several highly invasive species were recorded within the Study Area, including European Buckthorn and Common Reed.

Regionally, following the 2019 TRCA flora list for the Greater Toronto Area, most species were listed as common (L5, L4) or alternatively as exotic (L+) (Toronto and Region Conservation Authority, 2019). Five species were ranked as L3 or L2, including Silky Dogwood, Common Juniper, Eastern Ninebark, White Spruce, and White Oak. Of these species, Silky Dogwood, Eastern Ninebark, and White Oak are also considered regionally rare species by Varga et al. (2000), and Coyote Willow is considered regionally uncommon. All these species are considered "S5 – Secure" (Ministry of Natural Resources and Forestry, 2022).

2.2.6 Wildlife

2.2.6.1 Amphibian Breeding Surveys

Amphibian breeding surveys were conducted on May 5, May 31 and June 30, 2022. Breeding surveys were conducted in accordance with standard field protocols.

Two species of amphibians were recorded during the surveys: American Toad and Green Frog. Both species recorded are considered common, widespread, and abundant in Ontario. In general, relatively few calls were recorded throughout the Study Area.

2.2.6.2 Breeding Bird Surveys

Breeding bird surveys were conducted following the standard breeding bird survey methods of roving surveys that occurred during appropriate weather conditions on June 5 and July 1, 2022.

A total of 25 bird species were documented in the Study Area. Most of the birds recorded within the Study Area are considered common, widespread and abundant in the province of Ontario. The most frequently observed species found on site included birds characteristic of wooded ravines and suburban areas, such as Red-winged Blackbird, American Goldfinch, Song Sparrow and American Robin. One area-sensitive species was recorded at the site: White-breasted Nuthatch, which is a forest area-sensitive species. One White-breasted Nuthatch was observed on the second site visit in the naturalized area near the wet detention pond in the southwest portion of the site.

2.2.6.3 Turtle Surveys

Visual encounter surveys for turtles were completed during mornings and afternoons on June 14 and August 26, 2022. No turtles or other reptiles were observed in the Study Area during any site visit.

2.2.6.4 Bat Habitat Tree Screening

During the 2022 field investigations, trees with ideal bat roosting conditions were screened throughout the Study Area. Criteria for ideal roosting habitat included trees larger than 25 cm, peeling bark, cavities, cracks, or chimneys observed in trunk, and abundant leaf litter in the canopy. Based on this criteria, one tree was flagged as potential roosting habitat as it contained abundant peeling bark and potential cracks and cavities. The tree is located near the playground off of Raintree Crescent.

2.2.7 Species at Risk

Prior to field investigations, a background review was completed for potential Species at Risk (SAR) habitat opportunities. Based on available background information and the 2022 field investigations, the Study Area was screened for potential SAR habitat opportunities. The assessment was conducted by comparing habitat preferences of species deemed to have potential to occur against current site conditions.

The following five SAR were identified as having potential within the Study Area:

- Little Brown Myotis (Myotis lucifugus) – Endangered
- Northern Myotis (Myotis septentrionalis) – Endangered
- Eastern Small-footed Myotis (Myotis leibii) – Endangered
- Tri-colored Bat (Perimyotis subflavus) – Endangered
- Snapping Turtle (Chelydra serpentina) – Special Concern

Note that no SAR were observed during any of the field investigations.

2.2.8 Significant Wildlife Habitat

Significant Wildlife Habitat (SWH) is considered a significant feature in Provincial, Regional, and City of Richmond Hill OP policies. SWH is defined by and includes the following broad categories:

- Habitats of Seasonal Concentration of Animals;
- Rare Vegetation Communities or Specialized Habitats for Wildlife;
- Habitats of Species of Conservation Concern; and
- Animal Movement Corridors.

Based on a screening of the applicable criteria, no SWH were identified as having potential to occur within and adjacent to the Study Area.

2.3 Technical Environment

2.3.1 Topographic Survey

In June 2022, Hunt Surveys completed a topographic site survey of key site features including storm sewer outlets, filter pad details (base, top and bottom of berm), culvert crossing details, and details of the wet pond, including top and bottom of sediment, outlet storm sewer and outlet channel and foundation drain collector outlet. This site survey has been combined with contour information generated from LiDAR data, as well various City GIS layers, to create a base drawing that form the basis for the existing conditions inventories and analyses.

2.3.2 Stormwater Management System

2.3.2.1 Overview

The Humber Flats stormwater management system was designed and constructed in the mid-1990's, when requirements for water quality treatment and extended detention were being established in Ontario. It exemplified the 'treatment train' approach being advocated at the time, and consists of a number of different components. These components are briefly described below and illustrated on **Figure 2-3**.

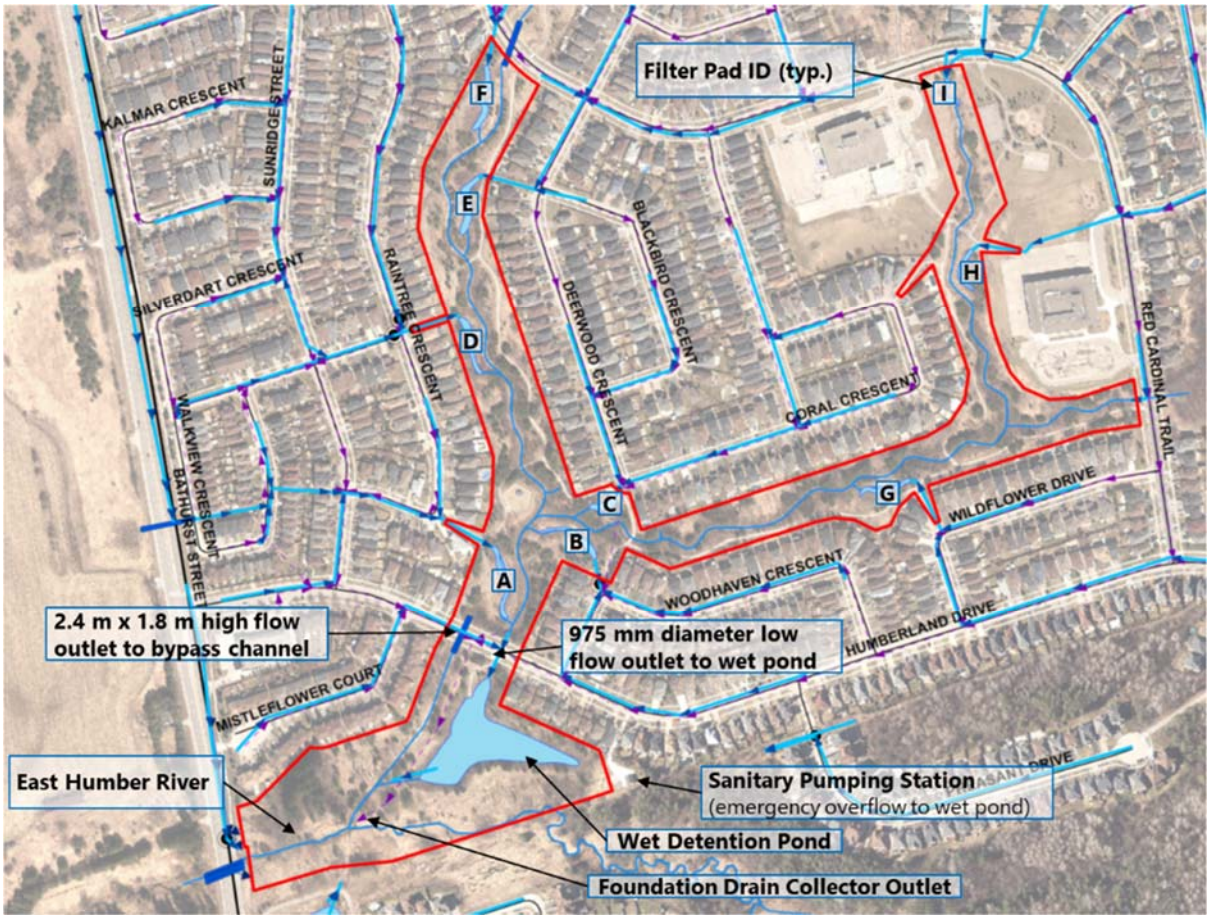
- To the extent feasible, roof drains in the surrounding residential areas are directed to grassed areas and side-yard swales before reaching the storm sewer system.
- Storm drainage is conveyed to the Ecopark via 9 different storm sewer outlets. The large number of outlets distributed through the Ecopark is intended to maximize the filtration of storm runoff through vegetation and increase travel times through the system.
- Granular Filter Pads are provided at each of the 9 storm sewer outlets to the Ecopark. The filter pads were designed with a 300 mm deep permanent pools, and additional storage to capture the runoff from a 13 mm storm event and release it over 48 hours, primarily for sediment removal. There are no formal flow control structures from the filter pads. Instead, the berms separating each filter pad from the Ecopark channel incorporate a 600 mm thick layer of coarse aggregate and the runoff detained in each filter pad is intended to seep through this layer to the Ecopark channel.
- The open space corridors that make up the Ecopark also function as a dry detention pond. Peak flow control is provided by 2 culverts under Humberland Drive. A 975 mm diameter culvert provides a direct connection to the SWMF 1-4 wet pond on the south side of Humberland Drive, and a 2400 mm wide x 1800 mm high concrete box culvert connects to a bypass channel leading directly to the East Humber River. The two culverts

restrict the flow in the system to a maximum of 9.5 m^3/s in a 100 year storm event, with runoff stored to a maximum depth of 3.1 m on the upstream side of Humberland Drive.

- A French Drain, consisting of a 1 m wide x 250 mm deep granular trench, underlies the low flow channel through the Ecopark. At Humberland Drive, a sub-drain connects the French drain to the Foundation Drain Collector (FDC) for the system, which outlets directly to the East Humber River. The French drain serves to bypass base flows in the system around the wet detention pond to avoid warming and thermal impacts on the coldwater habitat in the East Humber River. The granular materials also serve to stabilize and minimize erosion along the Ecopark low flow channel.
- Runoff from small to moderate storm events is directed via the 975 mm diameter culvert under Humberland Drive to the wet detention pond. The permanent pool was sized to provide Enhanced water quality treatment (80% TSS removal), and to provide at least 24 hours detention of the runoff from a 25 mm storm event. An overflow spillway is provided on the west side of the facility to the bypass channel leading from the concrete box culvert under Humberland Drive.

In addition to its stormwater management function, the Ecopark serves as a natural linkage, connecting Mallard Marsh (north of Red Cardinal Trail), the wetlands and woodlands in Cardinal Woods Park (east of Red Cardinal Trail) and the East Humber River valley corridor. It also serves as a public amenity, incorporating a trail system and a playground.

Figure 2-3 Stormwater Management System Components



2.3.2.2 Condition Assessment

TYLin staff completed a thorough inspection of the stormwater management infrastructure in the study area on June 21, 2022. There had been no rainfall recorded at the TRCA's Oak Ridges precipitation gauge for at least 72 hours preceding the inspection.

A second inspection was completed on November 30, 2022 to assess the function of the facilities during wet weather conditions. The inspection was completed in the afternoon of November 30, following 17 mm of rainfall that fell in the overnight and morning.

The conditions of each facility are summarized in the following sections. Additional notes and photographs of all facilities are included in **Appendix B**.

- **Filter Pad A** is a relatively long, narrow facility located immediately upstream of Humberland Drive. The majority of the pad was choked with reeds. A low flow channel was evident leading from the 900 mm diameter storm sewer outlet, with evidence of frequent flow (as opposed to evidence of extended standing water). The storm sewer outlet was slightly submerged, and a small pool of standing water was also observed

near the south end of the filter pad. A rip-rap lined spillway was evident at the south end of the filter pad, connecting to the main channel system in the Ecopark. The spillway appeared to be low relative to the berms forming the filter pad, and at an elevation comparable to the small pool of standing water near the spillway. There was some evidence of relatively frequent flow at the rip-rap spillway.

The filter pad did not appear to be storing any water during the wet weather inspection.

Overall, it appears that Filter Pad A is providing very little attenuation of storm runoff in its current condition. The low flow channel and spillway suggest that the filter pad is primarily functioning to convey storm runoff from the storm sewer outlet to the primary channel and culvert under Humberland Drive.

- **Filter Pad B** is a relatively long, narrow facility located off of Woodhaven Crescent. There was very little standing water in the facility, and a large area of damp soil near the 675 mm diameter storm sewer outlet. The downstream half of the filter pad was choked with reeds, with small areas of shallow ponded water. There was a rip-rap lined spillway at the outlet from the filter pad, which was elevated well above the base of the (dry) filter pad and appeared to experience very infrequent use. Relatively large rip-rap was observed at the outer toe of slope of the berm forming the filter pad, abutting the Ecopark channel.

  Very little water was observed in the filter pad during the wet weather inspection, although there was no evidence of flow at the outlet spillway and no evidence of recently elevated water levels in the filter pad.

  Overall, the filter pad is in good condition, but may not be performing as intended to capture storm runoff and slowly empty through infiltration and seepage through the berm. It is unlikely that runoff is infiltrating through the base of the filter pad at a rate that prevents a buildup of water in the filter pad as observed during the wet weather inspection, and more likely that water is discharged rapidly to the Ecopark channel through the voids in rip-rap at the base of the berm during storm events.

  A Stormceptor STC-6000 oil grit separator (OGS) is installed on the storm sewer leading from Woodhaven to the filter pad, but sediment depths in the OGS unit were not measured as part of the condition assessment.

- **Filter Pad C** is located off of Deerwood Crescent, and on the opposite side of the Ecopark channel from Filter Pad B. A considerable amount of standing water was observed in the filter pad, backing up slightly into the 825 mm diameter storm sewer outlet. The berm at the outlet from the filter pad appears to have eroded or been lowered in the past, and the water level in the filter pad was at the invert of the rip-rap

lined spillway leading towards the Ecopark channel. The rip-rap lined spillway showed signs of frequent use and/or being recently replaced, as there was no vegetation or sediment build up evident along the spillway. Also of note was a large number of mature (mostly coniferous) trees along the top of the berm separating the filter pad from the Ecopark channel.

The water level observed in the filter pad during the wet weather inspection did not appear noticeably higher than observed during the June 2022 inspection.

Similar to Filter Pad A, it appears that Filter Pad C is primarily conveying runoff from the storm sewer outlet to the Ecopark channel with little to no attenuation.

- **Filter Pad D** is located off of Raintree Crescent, generally opposite Amaryllis Avenue. The facility was choked with reeds, but little standing water was observed at and downstream of the 975 mm diameter storm sewer outlet. The crest of the rip-rap lined spillway at the end of the filter pad was elevated well above the base of the facility and appeared to experience very infrequent use.

  The water level appeared slightly higher during the wet weather inspection, but remained below the spillway crest. It was not possible to visually determine if the filter pad had filled to the level of the spillway during the storm event.

  Overall, the filter pad is in fair condition and appears to be providing some function for retention of storm runoff. The degree of performance cannot be easily determined, but the observations suggest that the volume retained and detention time in the filter pad are less than the original design condition.

  Two OGS units are installed on the storm sewer system upstream of the outlet to Filter Pad D. A Stormceptor STC-6000 is installed on the 900 mm diameter storm sewer on Amaryllis Avenue, and a Stormceptor STC-4000 is installed on the 600 mm diameter storm sewer on Raintree Crescent.

- **Filter Pad E** is located off of Deerwood Crescent, opposite Blackbird Crescent. There was some evidence of erosion at the 825 mm diameter storm sewer outlet headwall, with a small drop from the edge of the concrete apron to the base of the filter pad. Below the storm sewer outlet, the filter pad was completely choked with reeds to the rip-rap lined spillway to the Ecopark channel. The crest of the spillway was slightly above the base of the filter pad, which had a very small depth of standing water near the outlet.

  The filter pad did not appear to be storing any water during the wet weather inspection.

  Similar to Filter Pads A and C, it appears that Filter Pad E is primarily conveying runoff from the storm sewer outlet to the Ecopark channel with little to no attenuation.

- **Filter Pad F** is located on the opposite side of the Ecopark channel from Filter Pad E, immediately south of Red Cardinal Trail. The facility is choked with reeds, but is in otherwise good condition with little standing water, but some evidence of a low flow channel leading from the 975 mm storm sewer outlet. The rip-rap lined spillway at the outlet of the pond shows little evidence of frequent use, and the crest of the spillway was well above the base of the (dry) filter pad. However, there was some evidence of frequent flow along a channel connecting the spillway to the Ecopark channel.

  During the wet weather inspection, the filter pad appeared similar to the dry weather observations, with little standing water.

  It is possible that storm runoff is flowing through the voids in the rip-rap at the spillway rather than overtop of it. This would result in the filter pad being drained down faster than intended, as the filter pads were designed to empty through relatively slow seepage through granular soils in the berms adjacent the Ecopark channel. Given these observations, it is difficult to determine if or how well the filter pad is functioning, but it appears that the volume retained and detention time in the filter pad are less than the original design condition.

  Also of note was the lack of vegetation on the side slope leading up from the filter pad to the residential lots to the west. The majority of the side slope was exposed soil with sparse grass. City staff have confirmed that the side slope has been in this condition since the Ecopark was assumed by the City.

- **Filter Pad G** is located off of Wildflower Drive. A small amount of vegetation and debris (potentially dumped yard waste) was observed immediately downstream of the 675 mm diameter storm sewer outlet. There was negligible backwater above the storm sewer outlet at the time of the inspection, but it has the potential to obstruct flow from the storm sewer during storm events. Downstream of this obstruction, the majority of the filter pad was choked with reeds.

  Similar to many of the other filter pads, the base of the rip-rap lined spillway at the end of the pad was slightly above the base of the facility, with evidence of frequent flow to the main channel system in the Ecopark. It appears that the filter pad is primarily conveying runoff from the storm sewer outlet to the Ecopark channel with little to no attenuation.

  During the wet weather inspection, the water level in the filter pad appeared similar to the dry weather inspection. The small debris jam was still present at the storm sewer outlet, but not as significant as it appeared in the dry weather inspection and did not appear to have been backing water up significantly into the upstream storm sewer.

Also of note was the lack of vegetation on the side slope leading up from the filter pad to the pedestrian pathway to the south. The majority of the side slope was exposed soil with sparse grass. City staff have confirmed that the side slope has been in this condition since the Ecopark was assumed by the City.

- **Filter Pad H** is located immediately west of the Windham Ridge Public School, on the west side of Red Cardinal Trail. Some baseflow was observed at the 975 mm diameter storm sewer outlet, and baseflow was similarly observed at the rip-rap spillway from the filter pad. A pool of water was also observed within the filter pad, which was largely choked with reeds.

  Negligible discharge was observed from the storm sewer outlet during the wet weather inspection, but the water level in the filter pad appeared similar to that observed during the dry weather inspection.

  Overall, it appears that the filter pad is primarily conveying runoff from the storm sewer outlet to the Ecopark channel with little attenuation, although the shallow pool just upstream of the outlet spillway may be providing some function for pollutant removal. It is suspected that the baseflow observed during the June 2022 inspection may be associated with interception of seasonally high groundwater levels into the storm sewer system.

- **Filter Pad I** is located immediately south of Red Cardinal Trail, and west of Our Lady of Hope Catholic Elementary School, and forms the upstream limit of the east branch of the Ecopark channel. Local runoff from Barberry Crescent and Red Cardinal Trail discharges to the filter pad via a 675 mm diameter storm sewer, and a 1500 mm diameter storm sewer conveys runoff from a large external area to the east to the filter pad, with some attenuation provided upstream in SWMF 1-8.

  The outlet of the 1500 mm diameter storm sewer is perched above the invert of the filter pad and headwall apron, but no erosion was evident at the outlet. The safety grating on the outlet of the 1500 mm diameter storm sewer was partially dislodged, potentially allowing public access into the sewer. The 675 mm diameter storm sewer outlet was submerged to approximately ½ of its depth.

  The design drawings for Filter Pad I show a berm separating the filter pad from the start of the Ecopark channel, but neither a berm nor any impoundment of water was observed during any of the inspections. A low flow channel was evident leading from the storm sewer outlet headwall, and was continuous through the location of the filter pad to the downstream Ecopark channel.

As such, the filter pad does not provide any attenuation of storm flows and the Ecopark channel effectively originates at the storm sewer outlet headwall.

It should be noted that the current condition and limited function of the majority of the filter pads is not due to a lack of routine maintenance by the City. City staff continue to carry out routine inspection and maintenance of the filter pads, including restoration of areas impacted by scour and erosion. However, as will be described in **Section 3.1**, restoration of the filter pads to their as-designed condition would be a significant capital project, well beyond what would be considered typical maintenance works for stormwater management facilities.

- The two culverts under **Humberland Drive** that function as part of the stormwater management system appear in generally good condition. A negligible amount of flow was observed in the 975 mm diameter pipe culvert that connects the Ecopark channel to the wet detention pond, and there was no evidence of scouring or erosion at the inlet. The pipe inlet and safety grating were generally clear of vegetation and debris, which was unexpected given the dense vegetation along the Ecopark channel corridors.

  The 2400 mm wide x 1800 mm high concrete box culvert that conveys high flows to the bypass channel and East Humber River appears to be used very infrequently. There were no defined flow paths leading to the culvert inlet and there was no debris built up on the safety grating over the inlet. Similarly, the channel leading from the concrete box culvert to the East Humber River showed no evidence of erosion and little evidence of use for flow conveyance.

  During the wet weather inspection, water levels upstream of the 975 mm diameter low flow culvert were slightly elevated, but there was no evidence of any significantly elevated water levels and storage volumes during the storm event, and the high flow concrete box culvert remained dry.

- The **Wet Detention Pond** is located south of Humberland Drive, and is intended to provide final water quality treatment and extended detention of the runoff conveyed through the Ecopark. The facility also serves as an emergency overflow from a City of Richmond Hill sanitary pumping station (SPS) located immediately east of the facility, on the south side of Humberland Drive.

  At the time of the dry weather inspection, negligible inflows were observed at the inlet to the facility, and minimal discharge was observed at the outlet from the facility. This was expected, given the several days of dry weather preceding the inspection.

  During the wet weather flow inspection, water levels in the facility appeared to be approximately 0.5 m to 0.6 m above the permanent pool elevation. Both the elevated

water level and discharge from the facility appeared reasonable given the amount of rainfall preceding the inspection, and given the negligible storage and attenuation observed in the upstream filter pads.

The facility is in overall good condition, with a few minor issues. The maintenance access road into the facility has deteriorated where it approaches and enters the water. It appears to have been repaired with concrete at some point in the past but continues to be impacted by erosion and/or material degradation. While in poor condition, it remains functional to allow maintenance equipment to enter the facility.

There also appears to be poor water circulation through the facility, as a significant portion of the pond was covered with algae and other floating vegetation, and the City has received complaints from residents regarding the appearance and odour of the pond surface.

The rip-rap lined channel connecting the facility outfall to the East Humber River appeared stable with no evidence of erosion, and the overflow spillway appeared stable and well vegetated, indicating that it is rarely used.

While not directly related to SWMF 1-4, a Foundation Drain Collector (FDC) servicing the subdivision to the north is aligned under the berm along the west side of the wet detention pond and discharges to the East Humber River. The outlet headwall appeared in good condition, but the water level in the East Humber River was observed at the obvert of the FDC outlet pipe. The FDC system should have been originally designed based on high flood levels in the East Humber River, and there have been no reports of basement flooding due to surcharging of the FDC system. Regardless, the City should consider completing a hydraulic grade line analysis of the FDC system to verify that the elevated normal water level at the system outlet will not adversely affect the performance of the FDC system.

Finally, the berm along the west side of the facility appears to function as an informal trail, and a desire line was observed extending eastward along the south side of the facility. The desire line terminates a short distance away from the City's SPS. The fencing around the SPS has recently been replaced. A resident on Humberland Drive informed the inspection team that prior to the fencing replacement, it was common for people to be walking adjacent and even into the rear yards abutting the north edge of the SWM facility.

2.3.2.3 Sediment Survey

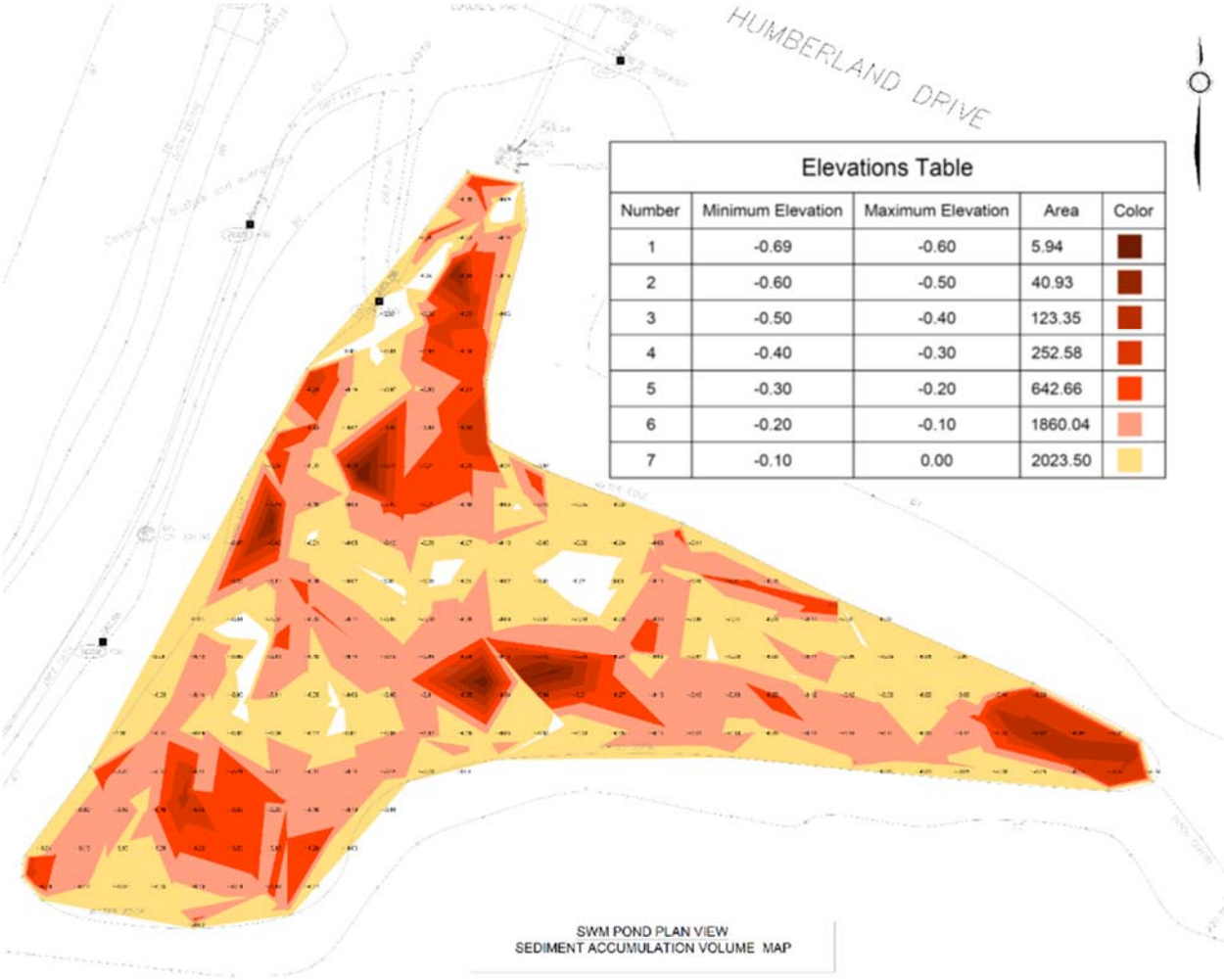
City of Richmond Hill staff complete regular but limited sediment surveys of all of their SWM facilities to inform their maintenance programs. The most recent survey for the SWMF 1-4 wet detention pond was completed in October 2021.

Sediment depths of up to 43 cm were measured by City staff, with an average depth of approximately 24 cm across the facility. By comparing the measured permanent pool depths and calculated volume against the original design information, The City's survey estimated that a sediment volume of approximately 900 m^3 had accumulated in the facility.

A detailed bathymetric survey was completed for wet detention pond in June 2022. This survey included measurements of the top and bottom of sediment in the facility. The survey recorded slightly lower sediment depths and volumes relative to the City's surveys. Sediment depths were typically less than 20 cm through much of the wet pond, with isolated areas where sediment depths were up to 60 cm. Analyses of the survey data indicate that a sediment volume of approximately 700 m^3 has accumulated in the facility. This represents approximately 12% of the design permanent pool volume. According to the survey, the remaining permanent pool volume in the wet pond is approximately 6,643 m^3. A separate survey of SWMF 1-4 completed by the Lake Simcoe Region Conservation Authority in 2022 using sonar technology, and estimated that the pond was providing a permanent pool volume of 5,771 m^3 in its current condition.

A plan indicating the sediment depths through the facility is included as **Figure 2-4**.

Figure 2-4 Sediment Depths



2.3.2.4 Sediment and Water Quality Analyses

Representative water and sediment samples were collected on August 16, 2022, following six days of dry weather conditions. Five sediment samples and 3 water quality samples were collected from the wet detention pond, and 1 sediment sample was collected from Filter Pad A.

The corresponding documentation and results and have been provided in **Appendix E** and are briefly summarized below.

Sediment samples collected for laboratory analysis were compared to Ontario Regulation 153/04 Table 1 Full Depth Background Site Condition Standards for all types of property uses. Three samples from the wet detention pond met Table 1 SCS, but the sample from the filter pad and two samples from the wet detention pond exceeded Table 1 parameters for some metals (Copper, Chromium, Nickel and/or Zinc).

The sediment samples were also compared against the Excess Soil Quality Standards for residential/parkland/institutional/industrial/commercial/community property uses (Ontario Regulation 406/19 Table 1). Only one sample, collected from the wet detention pond, met the ESQS. The remainder of the samples exceeded the ESQS for a range of parameters including Electrical Conductivity and hydrocarbons.

The three water quality samples were tested against the Provincial Water Quality Objectives (PWQO). All three samples tested above the PWQO for metals (Aluminum, Copper and/or Iron) and for Total Phosphorus.

Overall, the results from the sediment and water samples are typical for stormwater management facilities in Richmond Hill.

2.3.2.5 Facility Performance

As noted in **Section 2.3.2.1**, the SWMF 1-4 stormwater management system was designed to achieve Enhanced water quality protection (80% TSS Removal), control post-development peak flows to pre-development levels, and provide extended detention of the runoff from a 25 mm storm event for at least 48 hours.

While the practice of stormwater management has evolved over the more than 20 years since the facilities were constructed, these criteria remain generally applicable. The only exception is for peak flow control, where new, greenfield developments in the Humber River watershed are expected to comply with the TRCA's Humber River Watershed Unit Rate criterion.

Water balance criteria also apply to new greenfield developments, typically requiring measures distributed throughout the development area to achieve water balance criteria to minimize runoff volumes and preserve groundwater recharge where applicable.

The storage volumes and discharge rates needed to comply with the above applicable stormwater management criteria are a function of the total drainage area contributing to a stormwater management facility and the fraction of impervious cover in the contributing area.

Note that the Humber Flats stormwater management system receives drainage from external areas that receive limited treatment prior to discharging to the Ecopark channels. The areas contributing to SWMF 1-4 are summarized in **Table 2-2** and illustrated in **Figure 2-5**. A larger scale catchment area drawing can be found in **Appendix G.**

Note that in the description of the contributing drainage areas in **Table 2-2** and the following discussion, 'Internal Areas' refer to the development areas for which SWMF 1-4 was designed to treat.

Table 2-2 SWMF 1-4 Drainage Areas

Description (Hydrology Model Sub-Catchments)	Drainage Area (ha)	Average Imperviousness
External Area to West Ecopark Channel [1] (14.07_01, 14.07_02, 14.07_03, 14.07_04, 14.07_05)	47.96	37%
Internal Area to West and Main Ecopark Channel (Filter Pads A, B, C, D, E and F) [2,3] (14.07_06, 14.07_07, 14.07_08, 14.07_20, 14.07_21, 14.07_22)	49.17	57%
External Area to East Ecopark Channel [4] (Filter Pad I) (14.07_10, 14.07_11, 14.07_12)	48.81	35%
Internal Area to Filter Pad I (14.07_13)	5.19	50%
Total Area to East Ecopark Channel at Red Cardinal Trail [3] (14.07_10, 14.07_11, 14.07_12, 14.07_13)	54.00	39%
Internal Area to East Ecopark Channel (Filter Pads G, H and I) [3] (14.07_13, 14.07_14, 14.07_15, 14.07_18)	18.36	53%
Total Internal Area at Humberland Drive [3] (Sum of areas/subcatchments for 'Internal Area to West and Main Ecopark Channel' and 'Internal Areas to East Ecopark Channel')	67.53	55%
Total Area at Humberland Drive (14.07_01 through 14.07_15, 14.07_17 through 14.07_22)	178.78	43%
Internal Area to SWMF 1-4 South of Humberland Drive (14.07_23)	3.09	56%
Total Internal Area to Wet Detention Pond [3] (Sum of areas/subcatchments for 'Total Internal Area at Humberland Drive' and 14.07_23)	70.61	55%
Total Area to Wet Detention Pond (Sum of areas/subcatchments for 'Total Area at Humberland Drive' and 14.07_23)	181.87	44%

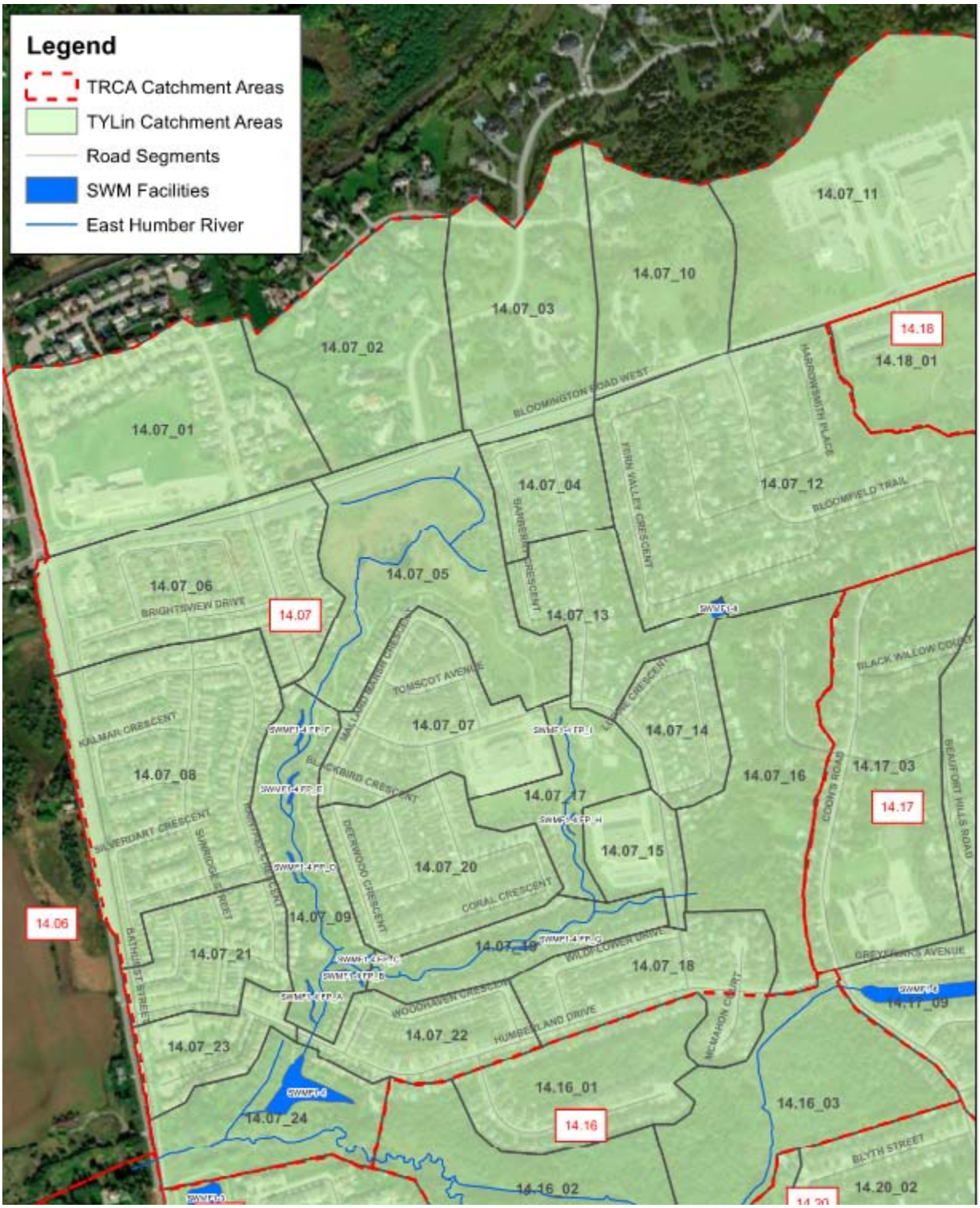
[1] Approximately 13.5 ha is treated by a SWM Facility in the Town of Aurora, and 3.6 ha is treated by an OGS and then flows through a created wetland at the outlet from Barberry Crescent to Mallard Marsh.

[2] Of this area, 4.4 ha is treated by an OGS unit upstream of the outlet to Filter Pad B, and 13.8 ha is treated by OGS units upstream of the outlet to Filter Pad D.

[3] Excluding the area of the Ecopark natural channel corridors.

[4] Peak flows from this area are attenuated in the dry pond SWMF 1-8 with controlled flows discharging to Filter Pad I at Red Cardinal Trail. Of this area, approximately 19.0 ha receives water quality and quantity control in a constructed wetland in the Town of Aurora.

Figure 2-5 SWMF 1-4 Drainage Areas



Water Quality Control

Table 2-3 summarizes the permanent pool storage volumes that would be required in the wet detention pond to achieve Enhanced water quality protection under different scenarios, depending on how the external development areas are considered. Recall from **Table 2-2** that the original design of SWMF 1-4 only considered the internal development areas, and did not account for the pre-existing development areas north of Bloomington Road and those draining through SWMF 1-8 to the north-east.

Table 2-3 Water Quality Storage Volume Requirements

Scenario	Drainage Area (ha)	Impervious Fraction	Unit Volume Required (m^3/ha)	Total Volume Required (m^3)
Internal Development Areas Only	70.61	55%	150.6	10,634
Internal Development Area and Untreated External Areas [1]	119.67	49%	134.8	16,128
Total Internal and Total External Areas	181.87	44%	121.5	22,106

[1] Total internal drainage plus only the untreated external drainage area, ie. of the 111.26 ha of total external drainage area, 62.20 ha is treated by other sources (OGS, SWMF 1-8, etc.) prior to discharge to the wet pond facility. See notes on Table 2-2 for further reference.

In its current condition, considering the accumulated sediment in the facility, the wet detention pond provides a permanent pool volume of **6,643 m^3**. With the sediment removed, the permanent pool volume would increase to **7,330 m^3**.

The permanent pool volume in the facility is not sufficient to achieve Enhanced water quality protection (80% TSS Removal), even when only considering the internal drainage areas for which the facility was designed, which would require a permanent pool volume of 10,634 m^3. The current permanent pool volume equates to a TSS removal efficiency of 73%, and would increase to 74% with the sediment removed.

According to the design brief, the facility was sized to provide Enhanced water quality protection for a drainage area of 67.3 ha at 41% impervious. The required storage was calculated to be 5,515 m^3 (82 m^3/ha), and the design brief indicated that a permanent pool volume of 5,720 m^3 was provided. However, according to the Stormwater Management Planning and Design Manual (MECP, March 2003), a permanent pool volume of 7,740 m^3 (115 m^3/ha) would be required to

treat 67.3 ha at 41% impervious. This is larger than the calculated storage volume from the design brief, and larger than the storage volume currently provided in the facility. Unfortunately, calculations were not provided in the design brief to support the reported required storage volume. It is not clear if there was an error in the calculation of the required permanent pool volume or if the conveyance of runoff through the Filter Pads and Ecopark channels was used to justify lower storage requirements. Finally, note that the design brief was based on treating the runoff from a 67.3 ha drainage area. This area calculation closely corresponds to the internal drainage area of 67.5 ha at Humberland Drive from the current drainage area delineation, and may not have accounted for the small residential area on the south side of Humberland Drive, between Bathurst Street and the SWMF 1-4 outlet channel.

Extended Detention Criteria and Performance

According to the design brief, the wet detention pond was sized to capture the runoff from a 25 mm storm event and release it over a duration of 24 hours. This remains a typical, valid criterion for extended detention to mitigate downstream erosion, unless a detailed erosion assessment is warranted or requested by approval agencies.

The design of the wet pond was based on a runoff depth of 7.64 mm for the 67.3 ha internal area, resulting in a storage requirement of 5,142 m^3 and a peak release rate of 89 L/s. The design brief indicates that pond was sized to provide a total active storage volume of 5,825 m^3, and a peak release rate of 84 L/s regulated by a 200 mm diameter orifice. Based on the model output and calculations included in the design brief, it appears that the 25 mm storm runoff volume and extended detention storage requirement conservatively did not account for the effect of the filter pads upstream of Humberland Drive for runoff retention.

As with the quality control component, the extended detention storage requirements only considered the internal drainage areas associated with the Humber Flats development, and did not consider the runoff from the external development areas that flow through SWMF 1-4 in a 25 mm storm event.

The extended detention storage volume and release rate requirements are summarized in the following tables, considering both the internal and total drainage areas to the wet detention pond. **Table 2-4** presents the calculated and modelled values ignoring the effect of the upstream filter pads, and **Table 2-5** presents the calculated and modelled values considering the upstream filter pads in their as-constructed condition. Hydrologic modelling is discussed later in this section under the heading of **Peak Flow Control Criteria and Performance**.

In assessing extended detention storage requirements at the wet detention pond for the second scenario, the cumulative storage volume provided in the filter pads was subtracted from the 25 mm storm runoff volume to calculate the runoff volume delivered to the wet detention pond.

Table 2-4 Extended Detention Storage Volume Requirements – Ignoring Filter Pads

Scenario	Drainage Area (ha)	25 mm Storm Runoff Depth (mm)	Extended Detention Storage Volume Requirement (m^3)	Average Release Rate (L/s)
Internal Development Areas Only	70.61	10.42	7,358	85
Total Internal and External Areas	181.87	8.20	14,920	173
VO Model Output[1]	175.16	8.20	9,889	103

[1] This refers to the maximum storage used in the wet detention pond and the maximum flow rate from the wet detention pond from the VO hydrologic model, which also includes the peak flow controls at Humberland Drive. The smaller drainage area reflects the small portion of flow that will bypass the pond via the box culvert under Humberland Drive.

Table 2-5 Extended Detention Storage Volume Requirements – Including Filter Pads

Scenario	Drainage Area (ha)	25 mm Storm Runoff Depth (mm)	Extended Detention Storage Volume Requirement (m^3)	Average Release Rate (L/s)
Internal Development Areas Only	70.61	7.78	5,490	64
Total Internal and External Areas	181.87	7.17	13,052	151
VO Model Output[1]	178.44	7.17	8,488	96

[1] This refers to the maximum storage used in the wet detention pond and the maximum flow rate from the wet detention pond from the VO hydrologic model, which also includes the peak flow controls at Humberland Drive. The smaller drainage area reflects the small portion of flow that will bypass the pond via the box culvert under Humberland Drive.

When considering the filter pads in their original design condition, SWMF 1-4 appears to be achieving the original design targets. The runoff volume from a 25 mm storm event from internal areas of 5,490 m^3 is slightly below the provided storage volume of 5,825 m^3

documented in the design brief, and the peak discharge of 96 L/s slightly exceeds the original target maximum release rate of 89 L/s.

In the design brief, the extended detention storage volume of 5,825 m^3 was achieved at an elevation of 290.05 m. However, the pond was designed with an overflow spillway at an elevation of 290.75 m, and a maximum water level of 291.0 m. The topographic survey completed for this study agrees with the design information, with an active storage volume of 5,957 m^3 achieved at an elevation of 290.05 m. The topographic survey noted a low point on the overflow spillway at an elevation of 290.7 m, and the pond provides an active storage volume of **10,860 m^3** at this elevation. The controlled discharge from the pond would be **107 L/s** at the spillway crest elevation of 290.7 m.

Under both current conditions and with the filter pads in their original design condition, the water level in the wet detention pond would remain below the overflow spillway crest, with a slightly smaller storage volume and discharge rate from the pond when considering the filter pads. The maximum release rates from the pond would be comparable but slightly above the original design target of 89 L/s for both scenarios. In the 2 year and larger storm events, water would exit the pond via the overflow spillway but remain below the top of the pond under both current conditions and with the filter pads restored to their original condition.

The model results are generally consistent with water level monitoring data from the wet pond, which shows that water levels in the pond exceed the crest of the overflow spillway once or twice a year, on average.

Peak Flow Control Criteria and Performance

The design brief indicates that the SWMF 1-4 system was designed to control post-development peak flow rates to pre-development levels. The pre-development peak flow rate targets were established through a prior study for Official Plan Amendment 129, covering a significant portion of the Oak Ridges community in the City of Richmond Hill.

New development in the Humber River watershed is now required to control peak flows to targets established using the Humber River unit rate equations (Toronto and Region Conservation Authority, 2012). For the Humber Flats study area, the unit rate equation for Sub-Basin 15 (Equation D) would apply. The resulting target release rates from the system are presented in **Table 2-6** and compared against the peak flow criteria and actual flow rates reported in the design brief.

Table 2-6 Peak Flow Control Criteria

Storm Event	Unit Release Rate (L/s/ha)	Target Flow Rate (m^3/s)[1]	Original Design Criteria (m^3/s)	Original Design Flow (m^3/s)
2 Year	2.4	0.429	3.7	2.8
5 Year	4.1	0.750	4.9	4.4
10 Year	5.4	0.990	n/a	n/a
25 Year	7.3	1.329	10.1	6.8
50 Year	8.8	1.609	n/a	n/a
100 Year	10.5	1.911	12.8	9.5

[1] Based on the total drainage area to SWMF 1-4 of 181.87 ha

A hydrology model is needed to determine the storage volumes needed to control flows to the targets established by the Humber River unit rate equations. The TRCA's latest hydrologic model of the Humber River watershed was obtained and used as the starting point for this study. The development and calibration of the Visual OTTHYMO (VO) model and the model outputs are documented in the Humber River Hydrology Update – Final Report (Civica, 2018).

The TRCA's VO model was set up to establish flows through the entire watershed, and isn't intended to model specific areas of the watershed in great detail. For example, the entire catchment area contributing to SWMF 1-4 was represented by a single, 197 ha catchment area, controlled by a single stormwater management facility. It did not consider the two stormwater management facilities controlling the developments in the Town of Aurora, nor did it consider SWMF 1-8 which controls the flows from the Bloomington Heights development to the north-east (discharging to Filter Pad I). As a result, significant refinements to the TRCA's model were needed to better represent the flow rates through the study area.

This included subdividing the TRCA catchments into smaller sub-catchments. The model was discretized to represent the catchment areas to each of the management facilities for the external areas. In addition, the drainage area to each filter pad was represented by discrete catchment areas in the model. The resulting sub-catchments are shown on **Figure 2-5**.

All existing stormwater management facilities were represented in the hydrology model. This includes the two (2) SWM ponds on the north side of Bloomington Road and SWMF 1-8 for the Bloomington Heights area. The rating curves used to represent these facilities in the model were

taken from the design reports and / or re-created based on as-built drawings. Details for each SWM facility are included in **Appendix G.**

The peak flow control provided at Humberland Drive was represented in the model. The discharge rates at different elevations were established using the TRCA's HEC-RAS model, refined to accurately represent the Humberland Drive culverts (See **Section 2.3.3**). Storage volumes in the Ecopark corridors upstream of the culverts were calculated using the LiDAR topographic mapping provided by the City, combined with the detailed topographic survey described in **Section 2.3.1**.

The wet detention pond south of Humberland Drive was represented as a separate facility in the VO model, with the rating curve based on the topographic mapping and the discharge characteristics of the 200 mm diameter orifice installed on the pond outlet.

Two scenarios were created for the filter pads. The first ignored the effect of the filter pads, and the second represented the filter pads in their original as-constructed condition. Given the very small discharge rates from these facilities (via seepage through the filter pad berms) reported in the design brief, rating curves were not developed for each filter pad. Instead, the initial abstraction depth in each catchment was adjusted to account for the volume of water that would be trapped below the design overflow elevation in each filter pad.

Additional refinements to the model were completed to better represent all areas in the City of Richmond Hill discharging to the East Humber River between Bathurst Street and Yonge Street. The TRCA's model was generally preserved for the areas draining into the East Humber River west of Bathurst and East of Yonge Street, including the representation of all stormwater management facilities and Lake Wilcox. More details, including the calculation of input parameters for all modified catchments, are included in **Appendix G.**

The model was used to simulate the peak flows through the study area and along the East Humber River. For the 2 year through 100 year design storms, the AES storm distribution was applied. According to the Humber River Hydrology Update – Final Report (Civica, 2018), the governing peak flow is to be the greater of the 6 hour and 12 hour AES storms. Based on the model outputs from the hydrology model, the 6 hour AES storm generates the higher peak flows through the study area. The output from the model is presented in **Table 2-7** through **Table 2-12.**

Note that the hydrologic modelling completed for this study yields maximum storage volumes, ponding elevations and peak discharge rates from the controls at Humberland Drive that are significantly less than those presented in the original design brief. There are a number of potential reasons for this. The original modelling appeared to be based on a 4 hour Chicago storm distribution, which is expected to generate higher peak flow rates compared to the 6 hour

AES storm that the TRCA now applies to this portion of the East Humber River subwatershed. The original modelling also did not appear to account for all upstream external stormwater management facilities.

Table 2-7 Hydrology Model Output – Humberland Drive (Current Conditions)

Storm Event	Peak Inflow Rate (m^3/s)	Total Discharge (m^3/s) [1]	Maximum Storage Used (m^3)	Maximum Water Level (m) [2]
25 mm	3.19	1.87	1,409	290.505
2 Year	3.27	2.29	2,212	290.617
5 Year	4.99	3.41	4,425	290.925
10 Year	6.40	4.23	6,651	291.111
25 Year	8.55	5.37	10,121	291.340
50 Year	10.45	6.24	12,820	291.511
100 Year	12.31	6.95	15,752	291.627

[1] Total Discharge refers to the combined flow through both the low flow and high flow culverts under Humberland Drive

[2] Rear yards backing onto the Ecopark would be flooded once water levels reach an elevation of 292.5 m

Table 2-8 Hydrology Model Output – Humberland Drive (Original Conditions)

Storm Event	Peak Inflow Rate (m^3/s)	Total Discharge (m^3/s) [1]	Maximum Storage Used (m^3)	Maximum Water Level (m) [2]
25 mm	1.83	1.35	748	290.234
2 Year	3.15	2.15	1,933	290.578
5 Year	4.92	3.32	4,270	290.903
10 Year	6.35	4.17	6,463	291.099
25 Year	8.52	5.31	9,393	291.292
50 Year	10.42	6.20	12,644	291.504
100 Year	12.29	6.91	15,576	291.620

[1] Total Discharge refers to the combined flow through both the low flow and high flow culverts under Humberland Drive

[2] Rear yards backing onto the Ecopark would be flooded once water levels reach an elevation of 292.5 m

Table 2-9 Hydrology Model Output – Wet Detention Pond (Current Conditions)

Storm Event	Peak Inflow Rate (m^3/s)	Maximum Release Rate (m^3/s)	Maximum Storage Used (m^3)	Maximum Water Level (m)[1]
25 mm	1.71	0.103	9,889	290.574
2 Year	1.85	1.15	11,382	290.752
5 Year	2.17	1.85	11,733	290.794
10 Year	2.33	2.15	11,883	290.812
25 Year	2.51	2.33	11,974	290.822
50 Year	2.62	2.47	12,042	290.831
100 Year	2.74	2.57	12,093	290.837

[1] The overflow spillway from the wet detention pond is at an elevation of 290.70 m

Table 2-10 Hydrology Model Output – Wet Detention Pond (Original Conditions)

Storm Event	Peak Inflow Rate (m^3/s)	Maximum Release Rate (m^3/s)	Maximum Storage Used (m^3)	Maximum Water Level (m)[1]
25 mm	1.29	0.096	8,488	290.395
2 Year	1.79	0.95	11,284	290.740
5 Year	2.14	1.77	11,690	290.789
10 Year	2.32	2.06	11,839	290.806
25 Year	2.50	2.29	11,950	290.820
50 Year	2.62	2.42	12,015	290.827
100 Year	2.72	2.54	12,077	290.835

[1] The overflow spillway from the wet detention pond is at an elevation of 290.70 m

Table 2-11 Peak Flow Comparison – Outlet to East Humber River (Current Conditions)

Storm Event	Modelled Peak Flow Rate (m^3/s)	Original Target Peak Flow rate (m^3/s) [1]	Original Design Peak Flow Rate (m^3/s) [1]	Humber River Unit Rate Targets (m^3/s)
25 mm	0.262	n/a	n/a	n/a
2 Year	1.211	3.6	2.8	0.429
5 Year	2.595	5.1	4.4	0.750
10 Year	3.668	n/a	n/a	0.990
25 Year	4.892	10.2	6.8	1.329
50 Year	5.875	n/a	n/a	1.609
100 Year	6.733	12.8	9.5	1.911

[1] The flows reported in the original design brief are for the quantity control facility at Humberland Drive

Table 2-12 Peak Flow Comparison – Outlet to East Humber River (Original Conditions)

Storm Event	Modelled Peak Flow Rate (m^3/s)	Original Target Peak Flow rate (m^3/s) [1]	Original Design Peak Flow Rate (m^3/s) [1]	Humber River Unit Rate Targets (m^3/s)
25 mm	0.142	n/a	n/a	n/a
2 Year	0.958	3.6	2.8	0.429
5 Year	2.289	5.1	4.4	0.750
10 Year	3.379	n/a	n/a	0.990
25 Year	4.605	10.2	6.8	1.329
50 Year	5.573	n/a	n/a	1.609
100 Year	6.513	12.8	9.5	1.911

[1] The flows reported in the original design brief are for the quantity control facility at Humberland Drive

2.3.2.6 Summary

The majority of the Filter Pads provide little to no capture or attenuation of storm runoff in their current condition. While originally designed to capture and slowly release the runoff from up to a 13 mm storm, field observations during dry and wet weather conditions suggest that only 3 of the 9 Filter Pads appear to provide any attenuation of storm flows in their current conditions.

It is interesting to note that OGS units are installed on the storm sewer systems upstream of Filter Pads B and D, and these were 2 of the 3 Filter Pads that appeared to still be functioning for stormwater treatment.

The culverts under Humberland Drive that regulate peak flow rates from the Humber Flats study area appear in good condition and continue to control the peak flow rates delivered to the East Humber River to or below the original design criteria, though still significantly higher than the targets that would be applied to new, greenfield development.

The wet detention pond downstream of Humberland Drive is in fair condition. The pond appears prone to some 'short-circuiting', with little flow circulation in the eastern portion of the facility, leading to stagnant water conditions and excessive algae growth. The permanent pool volume is also much less than the volume needed to achieve Enhanced water quality protection, even when only considering the local development areas for which the facility was originally designed and approved (not considering the upstream external areas that also flow through the pond). There is also approximately 700 m^3 of sediment that has accumulated in the pond, which is equivalent to approximately 12% of the originally designed permanent pool volume, and approximately 9% of the as-built permanent pool volume. The filter pads and Ecopark channel corridors may be providing some additional water quality benefits, but their performance cannot be easily quantified and conservatively has not been considered in the water quality performance evaluation.

The wet detention pond is performing reasonably well for erosion mitigation, as the discharge from the wet pond would be regulated entirely by the extended detention orifice control outlet for storms up to and including the 25 mm storm event. This agrees with the fluvial geomorphology investigation (**Section 2.3.4**), which did not find any evidence of excessive erosion in the outfall channel downstream of the wet pond outlet.

2.3.3 Flooding

Recall from **Section 1.2.2** that the TRCA's current floodplain mapping shows that a significant number of properties and several homes would be at risk of flooding in a Regional storm event. The Regional storm is the largest rainfall event on record that could potentially re-occur over the watershed. Within the TRCA's jurisdiction, the Regional storm event is Hurricane Hazel.

However, the TRCA's current hydraulic modelling and floodplain mapping for the Humber Flats area is out of date. The current hydraulic modelling and floodplain mapping for the study area was completed in 2014. The watershed hydrology model for the Humber River watershed, which generates the flow rates for the Regional storm event for input to the hydraulic model, was updated in 2018. The TRCA completed an update to the floodplain mapping for the East Humber River in 2019, but only as far upstream as Bathurst Street.

An update to the HEC-RAS hydraulic modelling and floodplain mapping was completed as part of this study to more accurately characterize flood risk through the study area. The update included the following:

- A combined, georeferenced HEC-RAS hydraulic model was created, using the information from the 2019 model for Bathurst Street and all areas downstream of Bathurst Street, and using the 2013 model for all areas upstream of Bathurst Street
- Flows from the updated VO hydrology model were used as input to the HEC-RAS hydraulic model. The updates and refinements to the VO model specific to the Humber Flats study area were discussed in **Section 2.3.2.5**, and the refinements for the areas between Yonge Street and Bathurst Street are described in the Schomberg Road Culverts Municipal Class Environmental Assessment (TY Lin International Canada Inc., 2023).
- The Humberland Drive and Schomberg Road culverts were updated in the model based on detailed topographic surveys carried out for this study and the Schomberg Road Municipal Class EA study.
- The CN rail crossing, located downstream (west) of Bathurst Street, is significantly undersized and causes a severe backwater condition during large storm events. Metrolinx is currently constructing a second track along this corridor, and work is nearing completion on the culvert extensions to accommodate the widened rail embankment. Design drawings were obtained from Metrolinx, and the model was updated to reflect the proposed culvert extensions, linings and additional barrels installed at the East Humber River crossing. The design drawings were also used to update the top-of-rail profile in the hydraulic model. The low point along the top of rail profile from the design drawings was approximately 0.4 m higher than the low point in the 2019 hydraulic model received from the TRCA.
- The flood depth of more than 6 m above the CN rail culvert invert in a Regional storm event inundates a significant area between the railway and Bathurst Street, even with the additional barrels installed by Metrolinx. In such situations, it is reasonable to use a routed water level to establish a more reasonable flood level on the upstream side of the CN rail culvert. For the routing analysis, the discharge rates through the rail culverts at different elevations were obtained from the updated HEC-RAS hydraulic model, and the

storage volumes upstream of the CN rail crossing at different elevations were obtained from available LiDAR topographic mapping. These were combined to represent the storage upstream of the crossing in the VO hydrology model. The maximum storage volume from the VO model was translated to a ponding elevation, which was added to the HEC-RAS model as a fixed flood level immediately upstream of the CN rail crossing. Note that, consistent with provincial guidelines, the flows downstream of the CN rail crossing were not reduced.

The routing analysis resulted in decreases in upstream flood levels of 0.7 m and 1.6 m for the 50 year and 100 year storm events, respectively, but a reduction of only 18 cm for the Regional storm event.

Note that the slight reduction in the routing analysis for the Regional storm event was essentially offset by the corrections to the rail deck profile in the hydraulic model noted above, resulting in a 3 cm increase in the elevation of the Regional floodplain upstream of the CNR crossing relative to the TRCA's current modelling and floodplain mapping.

The development of the HEC-RAS hydraulic model, including the routing analysis at the CN rail crossing, are documented in **Appendix H**.

The refinements to the hydrologic and hydraulic models resulted in a negligible change in the depth and extent of flooding relative to the TRCA's 2019 modeling at and upstream of Bathurst Street for the Regional storm event. However, the Regional storm flood levels from the refined modelling are higher than those from the TRCA's 2013 modelling, upon which the TRCA's current regulatory floodplain mapping through the study area is based.

There are two primary reasons for the increase in flood levels relative to the 2013 model.

- The 2018 hydrologic model and the refined hydrology model developed through this study yield larger peak flow rates along the main East Humber River for the Regional storm event relative to the 2013 model. This results in higher flood levels at the Bathurst Street culvert (which is overtopped), and this higher flood level extends up into the Humber Flats study area.
- The top of road profile along Humberland Drive in the 2013 model did not accurately represent the hydraulic conditions at this crossing. The 2013 model assumed that weir flow over Humberland Drive would occur once upstream water levels reached an elevation of 293.66 m, corresponding to the low point along the Humberland Drive road profile. However, the low point on Humberland Drive is located at the intersection with Woodhaven Crescent, and at this location the homes on the south side of the street are at a higher elevation than Humberland Drive. When considering the grading through the residential lots on the north and south sides of Humberland Drive, it is clear that the

upstream water level would have to build to an elevation of approximately 293.87 m before the roadway is overtopped. As the existing culverts do not have sufficient capacity to convey the full Regional storm flow without overtopping, upstream flood levels are governed by the depth of flow over Humberland Drive. The correction to the model for weir flow over Humberland Drive resulted in an increase in Regional storm flood levels at and upstream of Humberland Drive relative to the 2013 model.

The flows and flood levels from the 2013, 2019 and current models are compared in **Table 2-13**.

Table 2-13 Regional Storm Flood Level Comparison

Location	Parameter	2013 TRCA Model	2019 TRCA Model	2022 TYLin Model
Upstream of CNR Tracks	Flow (m^3/s)	109.01	146.82	145.39
Upstream of CNR Tracks	Water Level (m)	291.64	291.51	291.54
Downstream of Bathurst Street	Flow (m^3/s)	109.01	137.16	128.35
Downstream of Bathurst Street	Water Level (m)	291.83	291.79	291.77
Upstream of Bathurst Street	Flow (m^3/s)	101.24	125.25	118.18
Upstream of Bathurst Street	Water Level (m)	292.60	292.75	292.71
Upstream of Humberland Drive	Flow (m^3/s)	24.80	n/a	24.28
Upstream of Humberland Drive	Water Level (m)	293.64	n/a	293.90

The extent of flooding for the 100 year return period storm event (1% chance of occurring in any year) and Regional storm events is presented in **Figure 2-6**. For the 100 year return period storm event, the extent of flooding is fully contained within the public open space associated the East Humber River and Ecopark tributaries.

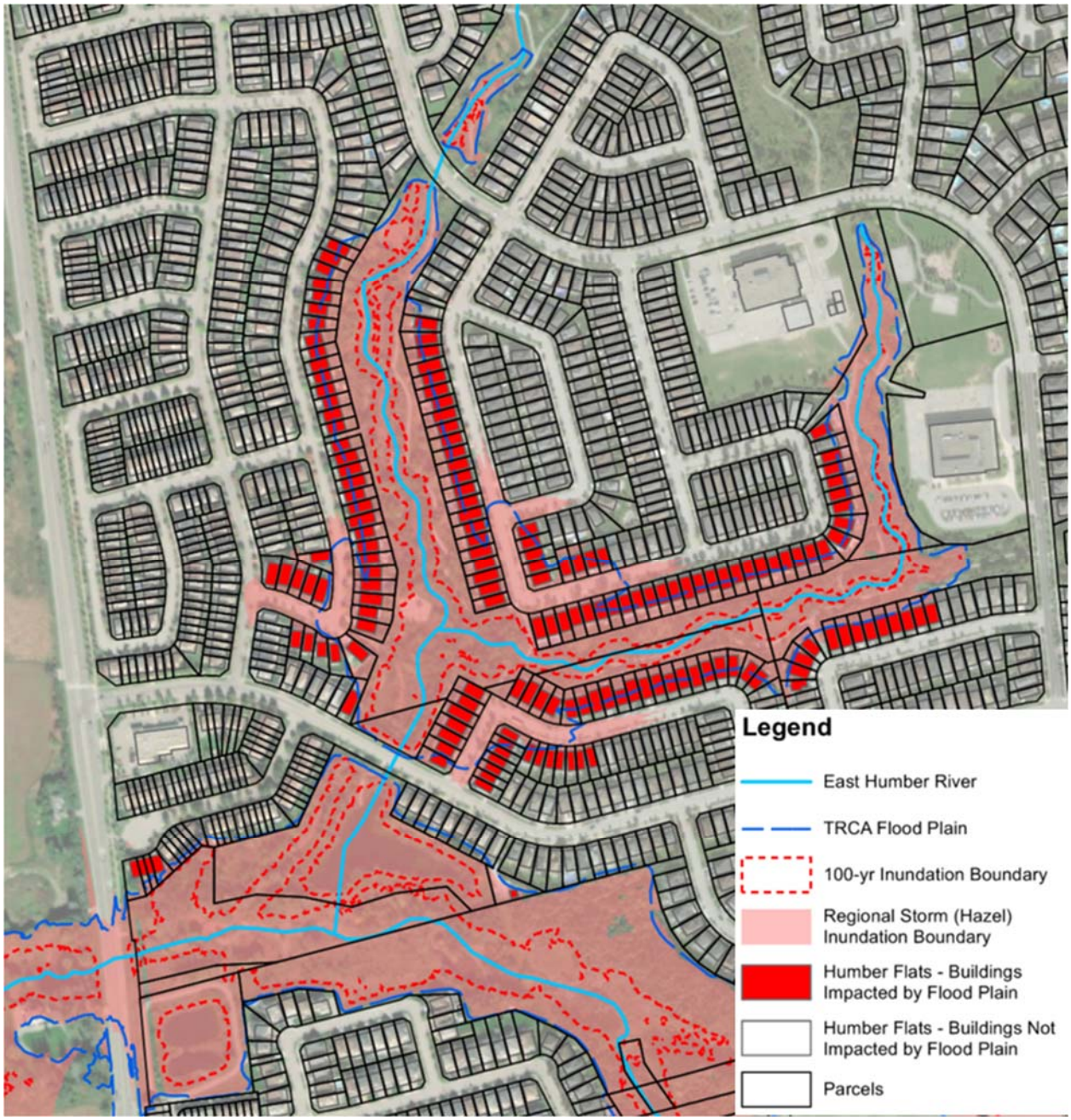
However, the extent of flooding associated with the **Regional storm event extends into 203 private properties**, the majority of which are located upstream of Humberland Drive. The modelling also predicts that up to **165 homes are partially to entirely in the Regional storm**

floodplain. However, some of these homes may not be at risk of flooding. It is possible that doors, windows and other openings into some of the homes are above the Regional floodplain elevation and floodwater would not enter the building. A detailed survey to record the minimum opening elevations into all potentially impacted homes is beyond the scope of this study.

This is an increase in flood risk relative to the Humber Flats Flood Remediation Hydraulic Report (RJ Burnside & Associates Limited, 2014), which determined that 123 properties and 113 homes were partially to entirely within the Regional storm floodplain. This increase in the number of properties and homes potentially at risk of flooding is directly related to the 26 cm increase in Regional flood elevations at and upstream of Humberland Drive relative to the 2014 modelling. The reasons for the increase were discussed earlier in this section.

While the probability of private properties and homes in the study area being impacted is very low, the number of homes that would be potentially impacted if Hurricane Hazel were to re-occur over the watershed is significant. The study area's ranking in the top 10 of all of the TRCA's flood damage centres is justified.

Figure 2-6 Floodplain Mapping



The culverts at Humberland Drive function as part of the SWMF 1-4 stormwater management system to restrict peak flow rates, but also contribute to flooding upstream of Humberland Drive during events larger than the system was designed to manage.

According to the Highway Drainage Design Standards (Ontario Ministry of Transportation, 2008), Humberland Drive would be considered a Collector Road. For culverts with spans of less than 6 m, the design event would be the 25 year storm.

For the design storm event, the freeboard should be at least 1 m, where freeboard is measured from the lowest point on the road centerline profile to the upstream water level. In addition, the headwater to depth ratio on the upstream side of the culvert should be less than 1.5. The headwater depth is measured from the upstream water level to the upstream culvert invert.

The flood levels upstream of the Humberland Drive culvert for the 25 year design storm and larger events is summarized in **Table 2-14**. Note that the depths are based on the concrete box culvert, which conveys the majority of the flow under Humberland Drive during large storm events.

The analysis demonstrates that the culverts under Humberland Drive have more than sufficient capacity for the 100 year storm event, and exceed the minimum standards established in the Highway Drainage Design Standards. However, Humberland Drive would be overtopped in a Regional storm event, resulting in the significant extent of flooding through the study area.

Table 2-14 Flood Depths at Humberland Drive

Storm Event	Upstream Flood Level (m)	Freeboard (m)	Headwater to Depth Ratio
25 Year	291.45	2.29	0.57
50 Year	291.68	2.06	0.70
100 Year	291.80	1.94	0.76
Regional	293.90	Submerged, with flood depth of 0.16 m at Woodhaven Cres.	1.91

Flooding at the existing playground north of Humberland Drive was also examined. The depth of flooding over the playground for different storm events is summarized in **Table 2-15**. According to the model, the playground would remain above the depth of flooding in the Ecopark channel for up to the 5 year storm event, with a depth of approximately 0.6 m in a 100 year storm and a depths of approximately 2.7 m for the Regional storm event.

There is therefore a real risk of flooding at the playground, though it is recognized that no one would be expected to be using the playground during such large storm events.

Given that the playground is above the predicted 5 year flood depth, it appears that the reports of chronic wet conditions and frequent standing water in the playground are more related to poor drainage conditions at the playground rather than floodwater backing up into the playground from the Ecopark channel. The playground is located in a relatively flat area at the base of the slope leading down from the rear lots along Raintree Crescent. It is suspected that

runoff from the rear yards and other areas collects at the playground and cannot easily drain from the playground to the channel, and it is also possible that groundwater is close to the ground surface in the vicinity of the playground, further contributing to the observed chronic wet conditions.

Table 2-15 Flood Depths at the Playground

Storm Event	Flood Depth (m)
2 Year	0.22 m below playground
5 Year	0.06 m below playground
10 Year	0.07
25 Year	0.25
50 Year	0.48
100 Year	0.60
Regional	2.70

2.3.4 Fluvial Geomorphology

A geomorphic assessment of the East Humber River tributaries within the Humber Flats Ecopark has been completed. The study area for the geomorphic assessment included the Ecopark tributaries upstream of Humberland Drive, the outfall channel south of Humberland Drive and the East Humber River between the outlet channel and Bathurst Street. The full fluvial geomorphology report is included as **Appendix F,** and the key findings are summarized below.

The geomorphic assessment study area has been delineated into 7 distinct reaches (**Figure 2-7**) and their respective characteristics are summarized in **Table 2-16**.

There were no fluvial geomorphic erosion issues identified within the study area due to a lack of defined watercourse aside from the downstream reach along the East Humber River. The watercourses through the Ecopark were in constructed trapezoidal valleys with no defined bed and banks. The tributaries had low gradients and were heavily vegetated. Plane bed morphology was dominant through the study area and there was no pool and riffle sequence. Bed material consisted primarily of clay, silt, and sand, with scattered cobble sized rip rap near the filter pads.

Figure 2-7 Geomorphic Assessment Study Area

Table 2-16 Reach Characteristics

Reach	Bankfull Width (m)	Bankfull Depth (m)	Substrate	Riparian Vegetation	Notes
1	5.5 – 8.5	0.7 – 0.8	Clay/Silt and Sand	Established trees, shrubs, and grasses (5-30 years)	Unconfined, well-defined channel through meadow/wetland area; low sinuosity, gradient, and entrenchment; left bank more defined with leaning trees and exposed roots; undercutting up to 0.25 m; rooted emergent aquatic vegetation; low density of woody debris in channel and cutbank; vegetated bars; submerged outlet from French Drain at confluence.
2	7.2 – 10.4	0.2 – 0.4	Clay/Silt and Sand	Established trees, shrubs, and grasses (5 – 30 years)	Watercourse adjacent to stormwater pond; appears to be a bypass channel for overflow from upstream of Humberland Drive; culvert outlet at Humberland Drive elevated with no defined channel downstream and dry with heavy vegetation encroachment; stormwater pond outlets into the reach towards the downstream end; standing water downstream of the pond outlet; cattails and rooted emergent aquatic vegetation; plane bed morphology.

Reach	Bankfull Width (m)	Bankfull Depth (m)	Substrate	Riparian Vegetation	Notes
3	N/A	N/A	Clay/Silt and Sand	Established trees, shrubs, and grasses (5-30 years)	Narrow, poorly defined channel through wetland area; low gradient; wide floodplain; dense rooted emergent aquatic vegetation; no signs of erosion.
4	5.0 – 7.0 [1]	0.1 – 0.3 [2]	Clay/Silt and Sand	Established trees, shrubs, and grasses (5-30 years)	Partially confined, poorly defined channel; upstream portion of reach densely vegetated with cattails and no defined channel; more defined sections of channel through the downstream portion of the reach in treed areas; leaning fence along path behind FP-E; plane bed morphology; rip rap in channel from filter pads.
5	2.0 – 5.0 [1]	0.1 – 0.4 [2]	Clay/Silt and Sand	Established trees, shrubs, and grasses (5-30 years)	Partially confined, poorly defined channel; dense cattails at FP-G near upstream limit of reach; bare soil along trail embankment at FP-G; more defined channel through treed areas downstream; rooted emergent aquatic vegetation; predominantly plane bed morphology.

Reach	Bankfull Width (m)	Bankfull Depth (m)	Substrate	Riparian Vegetation	Notes
6	N/A	N/A	Clay/Silt and Sand	Established trees, shrubs, and grasses (5-30 years)	Standing water at upstream stormwater outlet; most of reach dry with no defined channel; heavy vegetation encroachment and rooted emergent aquatic vegetation; exposed filter fabric observed along bed; armourstones around upstream outlet slumping slightly.
7	4.0 – 4.5 [1]	0.5 – 0.6 [2]	Sand and Gravel Clay/Silt	Established (5-30 years) trees, shrubs, and grasses	Partially confined, poorly defined channel; pool at upstream culvert outlet then narrow channel through wetland area; more defined channel in treed areas; heavy vegetation encroachment and aquatic vegetation; no signs of erosion.

[1] denotes depth / width of trapezoid shaped corridor lacking defined watercourse bed and banks

[2] denotes evidence of water depth within the trapezoidal corridor. Not a bankfull depth

2.3.4.1 Rapid Geomorphic Assessments

Rapid assessments were only completed for the East Humber River downstream of the confluence with the SWMF 1-4 outlet (Reach 1). Assessments could not be completed for the Ecopark reaches due to the lack of a well-defined channel, and no evidence of erosion was noted in these reaches.

Reach 1 was characterized as 'in transition/stress' with aggradation as the dominant form of adjustment throughout the reach. This was indicated by siltation in pools and the presences of medial and lobate bars. The signs of widening included leaning trees and exposed roots. Basal scouring was also observed on inner meander bends where the banks were well defined.

The reach was characterized as being in 'fair' ecological health, with the primary limiting factor being instream and riparian habitat conditions due to the lack of riffle features and low canopy coverage.

2.3.4.2 Rapid and Detailed Geomorphic Assessments

Detailed geomorphic assessments were carried out on the Ecopark channels where evident. The detailed geomorphic assessments consisted of a topographic survey, pebble counts, and observations of bank material, bank angle, and root density and depth.

The results of the detailed assessment are summarized in **Table 2-17**. Note that reported bankfull flows are provided as estimates of potential flows through the corridor. Due to the lack of defined channels through the study area, the bankfull discharge and velocity may not be indicative of channel forming flows and should not be used for the design of bankfull channels in the study area.

Table 2-17 Detailed Geomorphic Assessment Summary

Channel Parameter	Reach 2	Reach 3	Reach 4	Reach 5
Average bankfull width (m)	8.7	N/A	6.4	3.2
Average bankfull depth (m)	0.3	N/A	0.2	0.2
Channel bed gradient (%)	0.72	0.36	0.36	0.31
D_{50} (mm)	0.1	N/A	0.1	0.1
D_{84} (mm)	0.1	N/A	0.1	0.1
Manning's 'n'-value	0.04	N/A	0.04	0.04
Bankfull Discharge (m^3/s)	1.86	N/A	0.66	0.25
Bankfull Velocity (m/s)	0.66	N/A	0.51	0.44
Tractive force at Bankfull (N/m^2)	9.9	N/A	7.1	5.4
Flow competency for D_{50} (m/s)	0.1	N/A	0.1	0.1
Flow competency for D_{84} (m/s)	0.1	N/A	1.6	0.9

2.3.5 Utilities

All relevant private utility owners that could potentially have existing or planned infrastructure in the study area were circulated information on the project. In general, all utilities present are located within the existing road right-of-ways through the study area. The most relevant responses from utility providers are summarized below, and all correspondence with utility providers is included in **Appendix J**.

- Rogers Communication: There is a buried coaxial cable and a buried fibre cable on the south side of Humberland Drive at the culvert crossing
- Alectra: There are several different buried power cables in the Humberland Drive right-of-way.
- Enbridge: There is a 4" (100 mm) buried gas line on the south side of Humberland Drive at the culvert crossing.

The City also has infrastructure in the Humberland Drive right-of-way. A 250 mm diameter sanitary, a 300 mm diameter watermain, and a 600 mm diameter storm sewer are aligned under Humberland Drive. The watermain makes a 45° vertical bend to pass under the existing culvert crossing, while the other services run at a continuous slope below the culvert. A 300 mm foundation drain collector runs west to east through Humberland Drive under the existing culvert where it joins with a 450 mm diameter FDC from the west and a 150mm diameter FDC from the north where they discharge to a 525 mm diameter FDC that runs south under the wet pond access road and discharges to the wet pond.

A sanitary pumping station is located just west of the existing wet pond, and overflow pipe from the pumping station discharges to the pond.

2.4 Social and Cultural Environment

2.4.1 Recreation and Public Amenities

2.4.1.1 General

The study area contains a network of recreational trails, located primarily along the alignment of the stormwater features. A well-defined arterial trail network runs the entire length of the facility between Humberland Drive and Red Cardinal Trail. Secondary trail branches feed into the surrounding subdivision streets by way of catwalks. These include connections to: Deerwood Crescent, Raintree Crescent, Woodhaven Crescent, Wildflower Drive and Coral Crescent. Several informal pathways were noted throughout the subject lands, mostly around the wet detention pond south of Humberland Drive, and predominantly in the form of intermittent desire lines

from the main trail to the adjacent storm feature. Based on observations conducted during the initial site review, the trails within the study area experience a moderate level of recreational use.

2.4.1.2 Trees

The existing planted and naturalized tree canopy adjacent to the trail network consists of a variety of species, but predominant species to note are White Cedar, White Spruce, White Pine, Red Pine, Tamarack, Red Oak, Bur Oak, Sugar Maple, Manitoba Maple, Basswood, Willow spp., Poplar spp., Black Locust and scattered dead Ash. With the exception of the trees retained at the time of the original storm feature works, and the naturalized immature trees, established from various seed sources over the course of the past several years, the trees within the study area are generally described as semi-mature.

2.4.1.3 Amenities

The study area is utilized predominantly as an active amenity feature by way of trail network; however, limited passive recreation opportunities were noted throughout the site, adjacent to the main trail. These include informal bench seating, spaced intermittently along the trail, several armourstone retaining features located immediately adjacent to the trail and viewpoints from the pedestrian bridges that traverse the feature. The most significant amenity is in the southwest portion of the study area, just north of Humberland Drive and accessed from Raintree Crescent. It contains a large, curbed playground area including a play structure, swing sets and independent play features. The parkette is enveloped by unit paving and several bench seating opportunities. Finally, while it is not technically within the Humber Flats SWMF study area, the previously noted Oak Ridges Lions Club Park abuts the northeast limit of the study area and is directly connected to the trail system. It contains several amenities such as a splash pad, playgrounds, sports courts, open lawn areas and seating.

2.4.1.4 Trails

The majority of the formal trails within the facility are limestone screens, varying in width and condition, but are predominantly approximately 2m wide and well maintained. Sections of asphalt trail were noted in the southwest portion of the subject lands; from the play area to Humberland drive, and in the northeast portion of the site, from the Coral Crescent catwalk to each of the school properties and Oak Ridges Lions Club Park.

Generally, the main granular trail and asphalt sections are in fair condition. In some areas, the width has narrowed, likely as a result of organic matter migration followed by herbaceous growth. In limited locations, the asphalt is uneven, heaving and/or cracked as a result of either root growth along and underneath the asphalt or freeze-thaw cycles in the wetter areas. Erosion was noted at some of the granular trail connections to the surrounding subdivision streets,

wherever gradients exceed the standard accessible range. A mow strip of approximately 1m width was noted along each side of the formal trails, with wider bump outs of maintained lawn occurring intermittently throughout the trail corridor.

2.4.1.5 Signage/Demarcation

Trail and feature signage is in some cases dated and weathered, but overall it is in fair to good condition and was noted at all connections to the study area. Metal P-Gates were noted at trail access points from the surrounding subdivision streets, including limestone rockery defining these entry points. Based on condition and style of the gates, they were likely installed more recently.

2.4.1.6 Furniture

The most common form of seating is wooden and/or steel benches, the majority of which are in fair condition. The wooden / steel benches are described as well used and weathered. Based on style and condition, the metal benches appear to have been installed more recently, either as supplemental seating, or replacements for original wooden / steel benches. A combination of wooden / steel and steel waste receptacles was noted throughout the main trail alignment. Similar to the benches, the steel bins appear to have been installed more recently, either as supplemental receptacles or as replacements for the weathered originals.

2.4.1.7 Pedestrian Bridges

The study area contains several wooden bridges over the channel corridor. They are all the same design and based on the weathering observed, are likely all the originally installed structures. Each bridge contains a pair of demarcating wooden bollards, one on each end, at the trail's approach to each bridge. The bollards were all noted to be weathered and decaying and at least one has been removed / knocked over. The overall bridge structures appear to be in fair condition. Replacement pieces were noted on several of the end boards, planks and other high-use / high exposure bridge components.

These findings agree with the Parks Crossing Assessment Study (GHD, 2021), which found the pedestrian bridges to be in fair to good condition with localized, minor deterioration of some of the timber curbs, railings and deck planks.

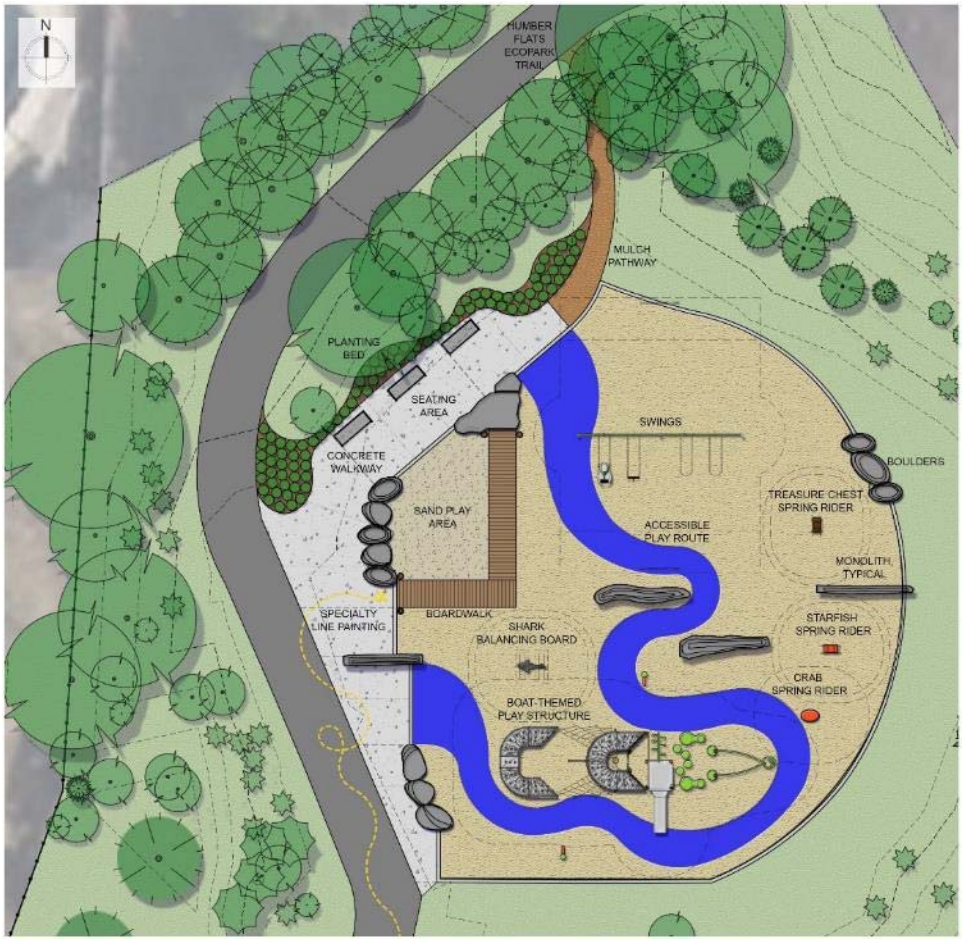
2.4.1.8 Planned Playground Upgrades

The existing playground off of Raintree Crescent suffers from poor drainage. The playground surface is occasionally wet or flooded for extended periods in the spring, and sometimes ice covered in winter. These conditions resulted in complaints from residents and may also be leading to premature aging of the concrete, timber and unit paver surfaces that contain the

playground. As evident from **Table 2-15**, this condition is due to poor drainage conditions in and around the playground. It is not due to frequent flooding from the Ecopark channel located east of the playground.

Plans to replace the playground were advanced in 2017, and a permit application was made to the TRCA. In their response, the TRCA raised issues related to flood risk and liability. These issues have not been resolved, and planning for replacement of the playground has been on hold while options to mitigate the flood risk are explored. **Figure 2-8** presents the concept plan for the playground from 2017.

Figure 2-8 Raintree Crescent Playground Concept Plan (2017)



2.4.2 Archaeology and Cultural Heritage

A Stage 1 Archaeological Assessment was carried out for the study area. The study report, included as **Appendix C,** concluded that the study area does not retain any archaeological potential. The majority of the study area was previously assessed and documented in previous reports on record with the Ministry of Tourism, Culture and Sport (MTCS). Previous assessments are not available for a small portion of the Ecopark, but it has been cleared of any potential due to the deep and extensive disturbance that occurred during construction of the Ecopark and filter pads.

The potential for cultural heritage resources in the study area was screened using the Ontario Ministry of Citizenship and Multiculturalism (MCM) 'Criteria for Evaluating Potential for Built Heritage Resources and Cultural Heritage Landscapes' checklist. A copy of the checklist is included in **Appendix C**. The City's Inventory of Cultural Heritage Resources (City of Richmond Hill, 2023) does not indicate any listed or designated heritage properties in or near the study area, and there are no other features in the area that warrant further investigation. The study area lies within the Humber River watershed, and the Humber River is a Canadian Heritage River. However, this study does not contemplate any alterations to the East Humber River, and the TRCA, who are responsible for the management of the Humber River Watershed, have not identified any cultural heritage constraints associated with the Humber River within the study area.

3 Description of Alternative Solutions

The background review, field investigations and analyses described in **Section 2** revealed a number of issues in the study area. The filter pads at the storm sewer outfalls north of Humberland Drive appear to be providing little treatment or attenuation of storm runoff in their current condition. This is due, in part, to the difficulties for City staff to access the filter pads for routine maintenance such as sediment removal, and due to erosion of the filter pad outlets, whose repair would be a major capital project and not a routine maintenance item. Despite the limited attenuation provided by the filter pads in their current condition, no erosion issues were identified along the Ecopark channels in the study area, and the low gradients along the channels have resulted in the lack of a defined low flow channel through much of the Ecopark and heavily vegetated conditions across the full width of the channel corridor. The vegetation in the majority of the Ecopark corridors is dominated by the invasive Common Reed.

The culverts at Humberland Drive continue to control peak flow rates to or below the original design criteria, and the wet detention pond provides an acceptable level of extended detention storage to mitigate erosion. However, the permanent pool volume provided in the wet detention pond is not sufficient to achieve Enhanced water quality protection, even if the accumulated sediment in the pond were to be removed.

Finally, a significant portion of the study area upstream of Humberland Drive is predicted to be within the Regulatory floodplain, with up to 165 homes potentially at risk of flooding.

A range of alternatives have been developed to rehabilitate and enhance the stormwater management infrastructure through the study area. The solutions have been developed comprehensively for the entire study area, but there are unique opportunities and constraints associated with the different components of the system. The following sections describe the alternative solutions that have been developed for the filter pads and Ecopark channels upstream of Humberland Drive, the wet detention pond downstream of Humberland Drive, and to reduce flood risk throughout the study area.

3.1 Systems North of Humberland Drive

3.1.1 Do Nothing

The first alternative would be to leave the filter pads and Ecopark in their current condition. Storm runoff would continue to be conveyed through the filter pads with little attenuation, and no alterations would be carried out to manage invasive species or establish defined watercourses through the Ecopark corridors.

3.1.2 Decommission the Filter Pads

Decommissioning the filter pads is similar to the Do Nothing alternative, but includes an administrative change to no longer consider the filter pads as stormwater management infrastructure in the City's asset management system. The filter pads would remain and continue to provide informal benefits for stormwater management, but their function would not formally be a part ofthe City's water quality treatment system, instead relying on the downstream storm pond cell. Under this scenario, the City would no longer be required to restore and maintain the filter pads in their original as-constructed condition within the City's overall stormwater management facility maintenance program.

Limited works may be required at some filter pads to minimize the long-term potential for stormwater and sediment to back up into the storm sewer system during and following rainfall events. Note, however, that none of the storm sewer outlets appeared to be impacted by water levels in the filter pads during the wet weather inspection carried out in November 2022. Once decommissioned, the storm sewer outlets would continue to require occasional inspection, consistent with all other storm outfalls in the City not associated with stormwater management facilities.

3.1.3 Rehabilitate the Filter Pads

As noted throughout this report, the existing filter pads have filled with sediment and/or the outlet spillways have been lowered such that the pads provide little function for stormwater quality and quantity control in their current condition. For this alternative, all of the filter pads would be rehabilitated to restore their function. The work would include:

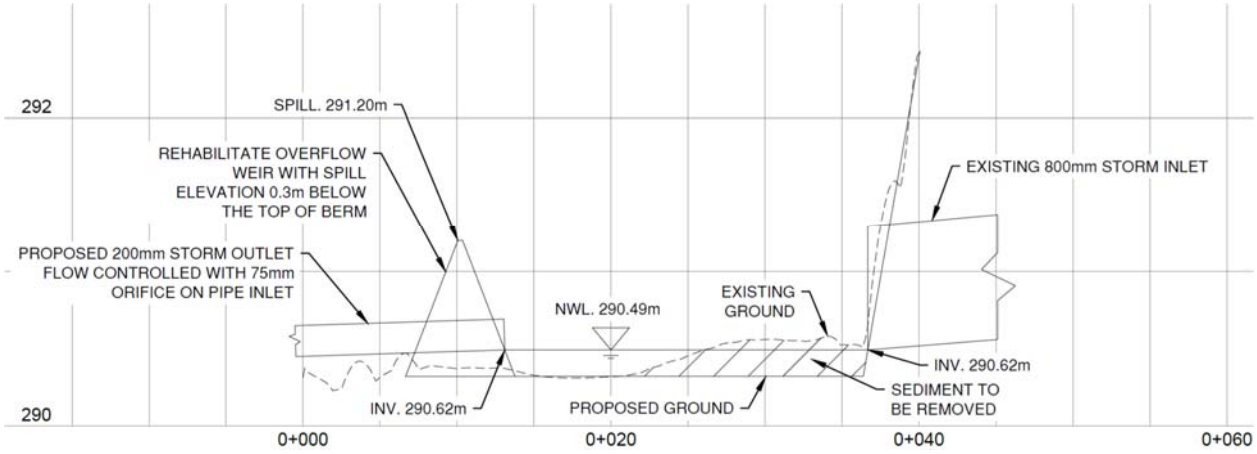
- Removing the sediment accumulated within the filter pads. Sediment depths in the filter pads were not measured during the topographic survey. Instead, sediment volumes have been estimated based on comparing the ground elevations from the topographic survey against the elevations of bases of the filter pads from the original design drawings. The cumulative volume of sediment to be removed from all filter pads is estimated to be approximately 300 m^3.
- The berms at each of the filter pad outlets, with the exception of Filter Pad I, would be rebuilt to their original design elevations, and a new spillway would be provided with a crest approximately 0.3 m below the top of the berm. No works are recommended at Filter Pad I, as a large external drainage area of approximately 49 ha discharges from the outlet headwall at Red Cardinal Drive, and any filter pad or similar small detention basin would be overwhelmed by the flows from the large drainage area during even small storm events.

A Hickenbottom outlet would be installed in each restored filter pad, equipped with a 75 mm diameter orifice to regulate the discharge from the pad. The original design relied on seepage through a granular layer in the berms forming the filter pads to regulate discharge, which is considered unreliable and likely contributes to the number of filter pads that appear to not currently function as intended. The Hickenbottom outlets would better regulate the discharge from each filter pad and achieve the desired extended detention time. The outlets would be designed to create a shallow permanent pool at the same elevation as the invert of the storm sewer outlet into each filter pad. The remainder of the filter pad volume above the storm sewer invert would be used for extended detention and slowly drawn down by Hickenbottom outlet and orifice control.

- Impermeable liners would also be needed on the filter pad side slopes abutting the Ecopark channels to prevent any seepage that may still be occurring through the berms. This solution assumes that the liners would be installed at all filter pads, although the inspections indicate that seepage may only be a concern for Filter Pad B.

A cross section illustrating how a typical filter pad would be rehabilitated is provided as **Figure 3-1**.

Figure 3-1 Concept Design for Filter Pad Rehabilitation



3.1.4 Reconstruct the Ecopark System with On-line Quantity and Quality Facilities

The final alternative for the area north of Humberland Drive would be to completely transform the Ecopark, moving all of the water quality, erosion mitigation and peak flow control to a reconstructed stormwater management system upstream of Humberland Drive. This would involve the following works:

- Construction of a new on-line flow control structure immediately upstream of Humberland Drive. The structure would control flows to or below existing levels for the 2 year through 100 year storm events. This would also allow the existing culverts under

Humberland Drive to be replaced by a structure sized to convey the Regional storm flow, significantly reducing the extent of the Regional storm floodplain upstream of Humberland Drive.

This solution would also require reconstruction of the Ecopark channel between the new control structure and Humberland Drive, and reconstructing the channel from Humberland Drive to the East Humber River. The proposed single new crossing under Humberland Drive will be at a lower elevation relative to the existing concrete box high flow culvert, requiring the channel to be reconstructed on a different alignment and flatter slope to match the location and elevation of the replacement culvert at Humberland Drive.

- Regrading the west Ecopark corridor to create an on-line wet detention pond. The pond would have a permanent pool and would provide extended detention of the runoff from a 25 mm storm event. The reconstruction of the Ecopark corridor would require the existing playground to be removed and the trail system reconfigured to also provide maintenance access to the wet detention pond. The existing pedestrian bridges would need to be removed and replaced with new bridges or boardwalks across the reconstructed west corridor.
- With all stormwater management function moved to north of Humberland Drive, the existing wet detention facility could be decommissioned. Some or all of the wet detention facility could be filled and be used for a new playground and other active recreation facilities.

A concept design for the reconstructed west Ecopark corridor is illustrated in **Figure 3-2**. A similar concept was explored for reconstruction of the east branch of the Ecopark. However, the eastern corridor is narrower than the west branch (approximately 43 m vs approximately 60 m for the west branch), and its reconstruction would achieve limited gains in overall storage volume for water quality treatment, extended detention and peak flow control. As such, only the reconstruction of the west branch has been considered in this alternative.

The wet detention pond would have a permanent pool volume of approximately 22,800 m^3, which would be adequate to provide Enhanced water quality treatment for the entire 179 ha contributing drainage area, including the external areas. However, the majority of the runoff would enter the facility near the south end of the system at the confluence of the east and west Ecopark branches, with limited options to increase the flow path through the system and make better use of the northern portion of the permanent pool. As a result, the overall effectiveness of the facility for water quality treatment may be diminished.

The pond would provide an extended detention storage volume of approximately 19,000 m^3, which is comparable to the runoff volume from a 25 mm storm event, including all upstream

and external areas. The extended detention storage would be controlled by a 200 mm diameter orifice to draw the storage down from full over a duration of at least 72 hours.

Finally, the reconstructed facility would provide a total active storage volume of approximately 50,000 m^3, including the available storage in the east branch of the Ecopark which would remain in its current condition. With the additional storage created by this alternative, peak flows would be controlled to the Don River unit rate targets, and the maximum water levels in the Ecopark would remain well below the rear yards abutting the Ecopark for the 100 year storm event. The significant reduction in peak flow rates from the SWMF 1-4 system would also achieve nearly a 20% reduction in peak flow rates in the East Humber River at Bathurst Street for up to the 100 year storm event. The performance of this alternative for peak flow control is summarized in **Table 3-1** and **Table 3-2.**

Note that under current conditions, a small area on the south side of Humberland Drive, west of the tributary, drains directly to the wet detention pond for quality treatment and extended detention. It will not be possible to direct the runoff from this 3.1 ha area to the wet detention pond in the reconstructed Ecopark corridor. Instead, this area will discharge uncontrolled to the tributary downstream of Humberland Drive, and should be retrofitted with an oil-grit separator for water quality treatment. The uncontrolled flows from this area are reflected in the total peak flow rates presented in **Table 3-1** and **Table 3-2**.

Table 3-1 Peak Flow Comparison – Outlet to East Humber River

Storm Event	Peak Rate, Current Conditions(m^3/s)	Peak Flow Rate with Reconstructed Corridor (m^3/s)	Original Design Peak Flow Rate (m^3/s) [1]
2 Year	1.211	0.165	2.8
5 Year	2.595	0.315	4.4
10 Year	3.668	0.521	n/a
25 Year	4.892	0.889	6.8
50 Year	5.875	1.314	n/a
100 Year	6.733	1.742	9.5

[1] The flows reported in the original design brief are for the quantity control facility at Humberland Drive

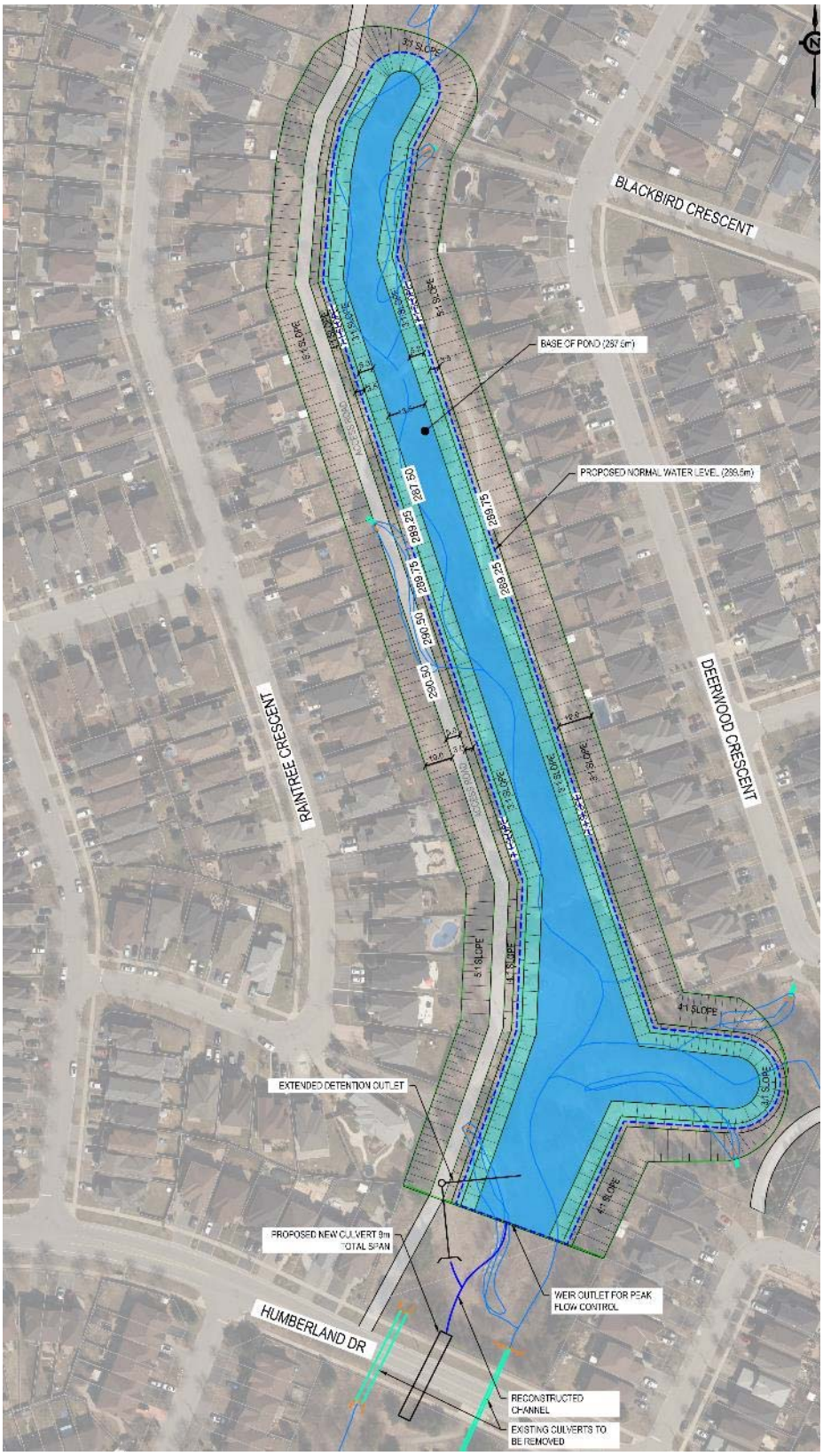
Table 3-2 Peak Flow Comparison at Bathurst Street

Storm Event	Peak Rate, Current Conditions(m^3/s)	Peak Flow Rate with Reconstructed Corridor (m^3/s)
2 Year	6.103	5.726
5 Year	11.283	9.259
10 Year	15.153	12.127
25 Year	20.265	16.241
50 Year	24.545	19.666
100 Year	28.725	23.199

Finally, moving all the flow controls to the facility north of Humberland Drive allows for the existing culverts to be removed and replaced with a larger structure. The existing culverts were designed to restrict the discharge from the Ecopark system to target levels for up to a 100 year storm, and Humberland Drive is predicted to be overtopped in a Regional storm event (refer to **Section 2.3.3**). With the flow controls moved to upstream of Humberland Drive, the existing culverts can be replaced with a larger culvert sized to convey the Regional storm flow. A structure consisting of 3 – 3.0 m wide x 2.1 m high concrete boxes can convey the Regional storm flow and significantly reduce flooding upstream of Humberland Drive.

The performance of this solution for flood reduction for the Regional storm event is essentially the same as the alternative of only replacing the Humberland Drive culvert, which is described in **Section 3.3.2**. With the proposed improvements, the number of homes potentially impacted by flooding in a Regional storm event will be reduced from 165 to 7 and the flood elevation should be reduced such that it will remain below the lowest openings into those few remaining vulnerable homes.

Figure 3-2 Reconstruction of the Ecopark Corridor



3.2 Wet Detention Pond South of Humberland Drive

3.2.1 Do Nothing

Recall from **Section 2.3.2** that the wet detention pond generally achieves the required level of extended detention storage to mitigate downstream erosion, but does not have sufficient permanent pool storage to achieve Enhanced water quality treatment, suffers from poor circulation resulting in excessive algae growth and odor complaints, and the maintenance access road into the sediment forebay is in poor condition.

For this alternative, the wet detention pond would remain in its current condition, with no modifications to address the observed deficiencies.

3.2.2 Clean and Restore the Wet Detention Pond to its As-constructed Condition

This alternative would restore the wet detention pond to its original design condition. This would include the following.

- Removing the accumulated sediment in the facility, which is estimated to be approximately 700 m^3
- Reconstructing the maintenance access road into the sediment forebay.

No other works would be completed to increase the permanent pool volume or address the poor water circulation in the facility.

3.2.3 Clean, Deepen and Expand the Wet Pond

As noted in **Section 2.3.2.5**, the permanent pool volume in the wet pond would not be sufficient to achieve the current standard of Enhanced water quality treatment (80% TSS removal), even if all of the accumulated sediment were removed.

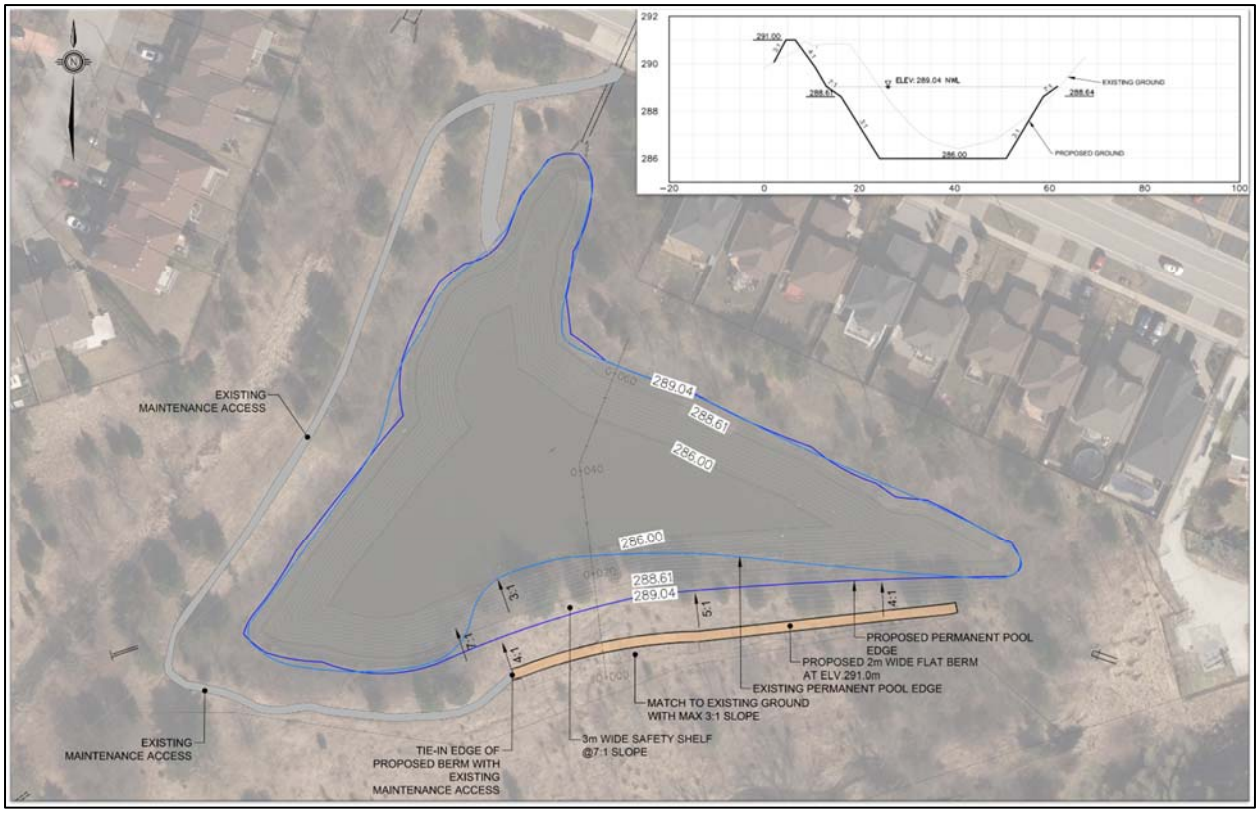
This alternative would include removing all of the accumulated sediment in the facility, expanding the pond southward, and excavating the base of the pond to create a uniform 3 m deep permanent pool throughout the facility. The existing reverse slope pipe outlet from the facility would need to be removed and replaced with a new reverse slope pipe into the deeper permanent pool.

To alleviate safety concerns related to the increased permanent pool depth, a flat safety shelf would be created, centered on the normal water level in the pond. The maintenance access road into the pond would be reconstructed, and the maintenance access around the west side of the pond would be upgraded to support construction equipment.

The deepened and expanded wet pond would provide a permanent pool volume of 10,640 m^3. This volume would be sufficient to provide Enhanced water quality treatment (80% TSS removal) for the entire 70.6 ha drainage area for which the wet pond was designed (refer to **Section 2.3.2.5**).

A concept design for the facility is shown in **Figure 3-3**, and a larger size drawing is included in **Appendix I**.

Figure 3-3 Deepened and Expanded Wet Detention Pond



3.3 Flood Mitigation

3.3.1 Do Nothing

With this alternative, no flood mitigation works would take place. Up to 203 properties would continue to be potentially at risk of flooding in a Regional storm event.

3.3.2 Humberland Drive Culvert Improvements

For this alternative, the existing concrete box culvert under Humberland Drive would be replaced with 3 – 3.0 m wide x 2.1 m high concrete box culverts, with no other improvements to

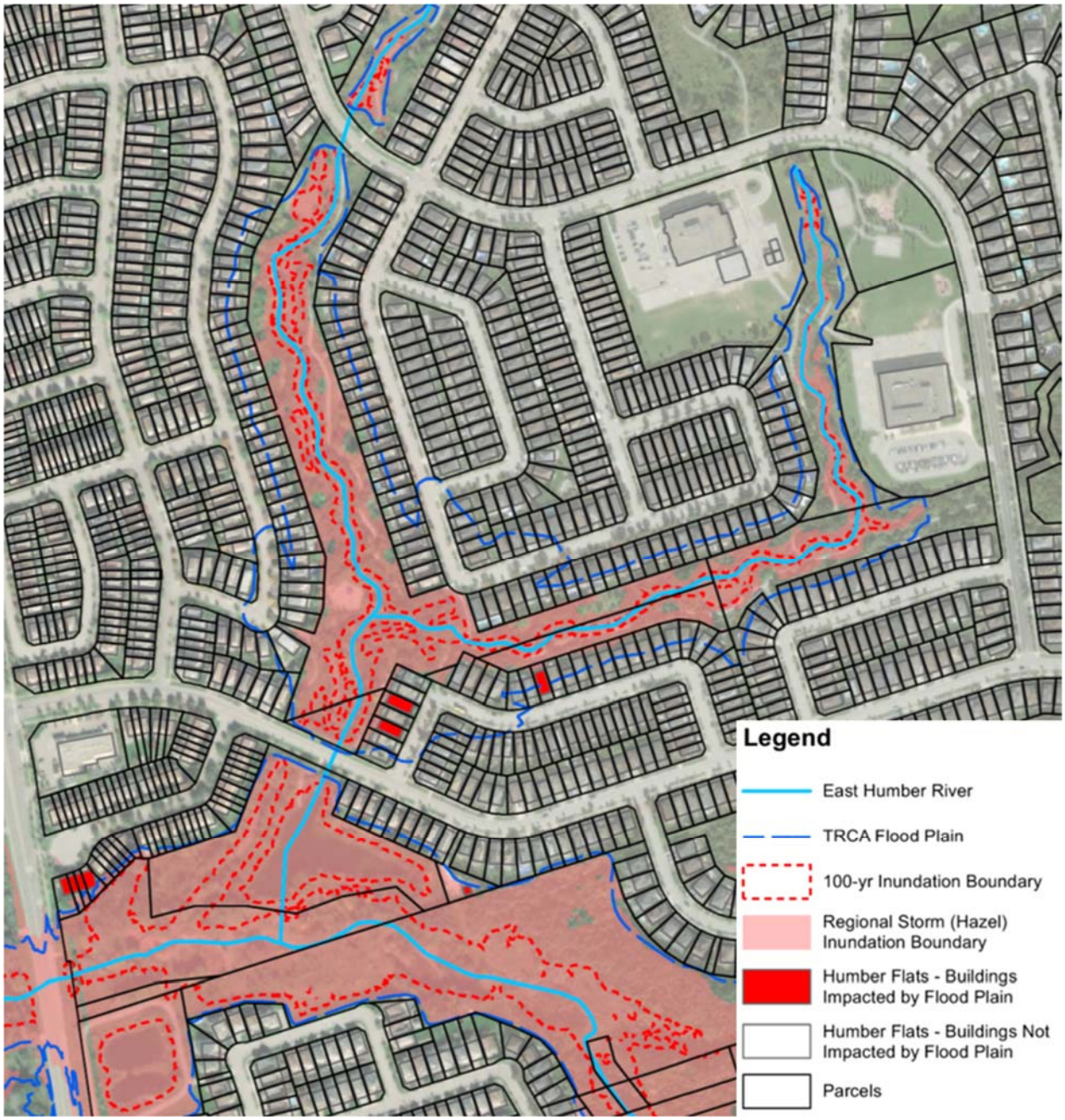
the system upstream or downstream. Low flows would continue to be conveyed through the 975 mm diameter concrete pipe under Humberland Drive and continue to be treated in the wet detention pond.

As described in **Section 2.3.2.5**, the existing concrete box culvert forms part of the flow control system for SWMF 1-4, limiting the discharge to the East Humber River and storing stormwater in the Ecopark channel corridors during large storm events. Replacing the existing culvert with a much larger concrete box culvert would significantly improve flooding conditions upstream of Humberland Drive, but would also increase the peak flow rates delivered to the East Humber River during severe storm events.

The extent of flooding from a Regional storm event following implementation of the culvert improvements is illustrated in **Figure 3-4**. The number of properties impacted by flooding would be reduced from 203 to 129. Additionally, as can be seen from **Figure 3-4**, the Regional storm floodplain would be largely contained within the Ecopark corridors, barely encroaching into the remaining affected properties. The number of homes potentially impacted by flooding in a Regional storm event would be reduced from 165 to only 7. The depth of flooding upstream of Humberland Drive in a Regional storm event would be reduced by more than 1 m, and the flood elevation should be reduced such that it does not exceed the elevation of the lowest openings into these few remaining homes in the floodplain.

Flood depths and the frequency of flooding would also be reduced at the playground. The playground would remain safe from flooding in a 100 year storm event, and the depth of flooding in a Regional storm event would be reduced from approximately 2.7 m to 1.7 m.

Figure 3-4 Flood Extents with Humberland Drive Culvert Improvements



The decrease in flooding is achieved by conveying more runoff through the culverts under Humberland Drive. As the existing single concrete box culvert functions as part of the SWMF 1-4 peak flow control system, the larger culvert will reduce the amount of peak flow control provided by the system. The resulting flows at the system outlet to the East Humber River are compared against existing conditions in **Table 3-3**. The slight decreases in peak flow rates for the smaller storm events are due to the flow splits between the existing low flow and new high

flow culverts and subsequent routing through the wet detention pond south of Humberland Drive. During the 100 year storm event, the peak discharge from the system will increase by approximately 1.3 m^3/s, but will remain below the original design and target peak flow rates. Where the flows join the East Humber River at Bathurst Street, the peak flow rate in a 100 year storm event will increase by less than 3% relative to current conditions.

Table 3-3 Peak Flow Comparison – Outlet to East Humber River

Storm Event	Peak Rate, Current Conditions (m^3/s)	Peak Flow Rate with Culvert Upgrades (m^3/s)[1]	Original Design Peak Flow Rate (m^3/s)[1]	Original Target Peak Flow Rate (m^3/s)
25mm	0.262	0.342	n/a	n/a
2 Year	1.211	1.079	2.8	3.6
5 Year	2.595	2.336	4.4	5.1
10 Year	3.668	3.588	n/a	n/a
25 Year	4.892	5.477	6.8	10.2
50 Year	5.875	6.742	n/a	n/a
100 Year	6.733	8.106	9.5	12.8

[1] The flows reported in the original design brief are for the quantity control facility at Humberland Drive

Table 3-4 Peak Flow Comparison at Bathurst Street

Storm Event	Peak Rate, Current Conditions(m^3/s)	Peak Flow Rate with Culvert Upgrades (m^3/s)
25 mm	3.427	3.419
2 Year	6.103	6.015
5 Year	11.283	10.871
10 Year	15.153	14.740
25 Year	20.265	20.374
50 Year	24.545	24.957
100 Year	28.725	29.498

3.3.3 Humberland Drive Culvert Improvements with Upstream Flow Control

Section 3.3.2 determined that replacing the Humberland Drive relief culvert with a larger structure would significantly reduce flooding, but would result in a moderate increase in peak flows from the SWMF 1-4 and a very small increase in return period peak flow rates in the East Humber River at Bathurst Street.

The increases in peak flow rates could be fully mitigated if an on-line flow control structure was added immediately north of Humberland Drive to replicate the function provided by the existing culvert for peak flow control. This alternative solution considers adding a structure that would likely take the form of a concrete weir across the width of the Ecopark channel with openings to regulate flows in addition to the culvert replacement described in Section 3.3.2. A photo of a typical flow control weir is included as **Figure 3-5**, though the openings in the weir at SWMF 1-4 would be smaller. A concept design has been prepared for an on-line weir consisting of a 0.9 m wide x 0.9 m high lower notch, and a 2.0 m wide x 1.8 m high upper notch.

There would be no alterations to the Ecopark upstream of the flow control weir, and the existing 975 mm diameter low flow pipe under Humberland Drive would remain. Flows would continue to be routed through the wet detention pond south of Humberland Drive for water quality treatment and extended detention.

Table 3-5 and **Table 3-6** demonstrate that the improved Humberland Drive culvert combined with an upstream flow control structure would generally maintain existing peak flow rates, resulting in a 4% to 5% reduction in peak flow rates in the East Humber River for most storm

events. A small increase is predicted for the 2 year storm event, likely due to timing effects related to the upstream control structure and routing through the wet detention pond.

The maximum water levels behind the on-line flow control structure would be only 2 cm to 3 cm higher than existing for the return period storm events, and therefore would have a negligible impact on the frequency and depth of flooding at the existing playground north of Humberland Drive.

Figure 3-5 Typical On-Line Flow Control Weir (SWMF 24-2)

Table 3-5 Peak Flow Comparison – Outlet to East Humber River

Storm Event	Peak Rate, Current Conditions (m^3/s)	Peak Flow Rate with Culvert Upgrades and Upstream Flow Control (m^3/s)
25 mm	0.262	0.296
2 Year	1.211	1.169
5 Year	2.595	2.321
10 Year	3.668	3.422
25 Year	4.892	4.537
50 Year	5.875	5.463
100 Year	6.733	6.303

Table 3-6 Peak Flow Comparison at Bathurst Street

Storm Event	Peak Rate, Current Conditions(m^3/s)	Peak Flow Rate with Culvert Upgrades and Upstream Flow Control (m^3/s)
25 mm	3.427	3.432
2 Year	6.103	6.091
5 Year	11.283	10.762
10 Year	15.153	14.472
25 Year	20.265	19.375
50 Year	24.545	23.478
100 Year	28.725	27.601

3.3.4 Non-Structural Measures to Reduce Flood Risk

This alternative would not involve any physical works to reduce the depth or extent of flooding, but would instead focus on minimizing risks to public safety and property damage during future potential flood events.

As noted in **Section 2.3.3**, the existing playground located off of Raintree Crescent is predicted to be inundated in a 10 year storm event, and could be flooded to a depth of more than 2.7 m in a Regional storm event. While it is unlikely that residents would be using the playground during a severe storm event, there remains some risk to public safety associated with the playground in such a flood prone area.

Public safety could be improved with signage alerting playground users and their caregivers about flood risk at the playground and instructing them to leave the playground and move to higher ground when a significant rainfall event is predicted or occurring. As a further enhancement, a visual and/or audible warning device could be installed at the park and connected to City operated flood warning system. This would require City staff to actively monitor weather forecasts and real-time rainfall and streamflow gauges and activate the alarm when severe rainfall is imminent. The warning device would alert park users of impending flooding conditions and direct them to exit the Ecopark system and return to their homes.

Section 2.3.3 also determined that more than 200 private properties and up to 165 homes could potentially be impacted by flooding in a Regional storm event. However, flooding is fully contained in the Ecopark corridor and outside of any private property for the 100 year return period storm event (1% chance of occurring in any year). Given this relatively low risk of flooding, a Flood Emergency Response Plan (FERP) tailored to this area is not recommended. A site specific FERP would typically consist of a team at the City tasked with monitoring weather forecasts and real-time rainfall and streamflow gauges, a protocol for alerting residents in flood prone areas to the potential for flooding and actions to take to reduce flood damages, and a practiced and coordinated plan (typically involving police and emergency services) to evacuate vulnerable residents in advance of flooding. Instead, it is recommended that the potential for flooding in the study area be specifically considered in future updates to the City's Emergency Plan (City of Richmond Hill, 2023) and other Emergency Preparedness resources (https://www.richmondhill.ca/en/our-services/Fire-and-Emergency-Services-Emergency-Preparedness.aspx).

4 Evaluation of Alternative Solutions

Section 3 described a number of alternative solutions to address the issues that were identified through the analyses and assessments of existing conditions. This section of the report describes the process of evaluating those alternative solutions to determine the preferred option.

4.1 Evaluation Criteria

The alternative solutions developed were comparatively and qualitatively evaluated based on criteria developed within the following main categories, which represent the broad definition of the environment from the Municipal Class Environmental Assessment (EA) guidelines.

- **Natural Environment**, which relates to potential impacts to the natural and physical components of the environment (i.e., air, land, water and biota) including natural and/or environmentally sensitive areas.
- **Social Environment**, which relates to potential impacts to residents, neighbourhoods, businesses, community character, social cohesion, and community features.
- **Cultural Environment**, which relates to potential impacts to historical/archaeological remains, and heritage features.
- **Technical Environment**, which relates to the technical feasibility, constructability, operation and maintenance, and other engineering aspects of the alternative solutions.
- **Financial Environment**, which relates to the capital and maintenance costs of the alternative solutions. Full breakdowns of cost estimates for each of the options under consideration are provided in **Appendix I**. Note that cost estimates include all key construction elements that are anticipated to be required to deliver the alternative under consideration, with costs estimated either on a lump sum per item basis, or using industry standard unit rates, as appropriate – and a 40% allowance is included to cover soft costs and contingencies.

Within each main category, project-specific evaluation criteria were developed based on the existing conditions of the study area and the alternative solutions being considered.

Table 4-1 Evaluation Criteria

Category	Evaluation Criteria
Natural Environment	Potential effects on fish habitat and aquatic ecosystems Potential effects on terrestrial wildlife and ecosystems Potential effects on known habitat for Species at Risk Potential effects on groundwater
Social/Cultural Environment	Potential impact on public safety Potential for requiring private property Potential impacts to the community during construction (noise, dust, traffic restrictions) Potential impact to archaeological resources Potential enhancement to the public realm (aesthetics, trails, recreational amenities)
Technical Environment	Potential to achieve technical objectives Potential constructability of proposed infrastructure Potential challenges to secure approvals and permits Potential future maintenance requirements Potential conflicts with existing municipal and utility services. Resiliency to future climate conditions
Financial Environment	Potential costs of implementation Potential operations and maintenance (O&M) costs

4.2 Evaluation of Alternatives for Systems North of Humberland Drive

4.2.1 Do Nothing

For this alternative, no works would take place within the Ecopark corridors north of Humberland Drive. The filter pads would remain in their current condition, providing limited function for water quality treatment or erosion mitigation. However, as noted in **Section 2.3.2.5**, the wet pond south of Humberland Drive provides adequate extended detention of storm runoff without considering the effect of the filter pads. .

There would be no impacts to social or cultural resources, as no work would take place. Similarly, there are no technical challenges with this alternative, and no direct costs. However,

the City would continue to be responsible for long term maintenance of the filter pads and Ecopark corridors.

4.2.2 Decommission the Filter Pads

This alternative is largely administrative. The filter pads would no longer be formally relied upon to provide stormwater treatment, and would no longer be considered a component of this stormwater management facility in the City's asset management system. As such, the City would no longer be required to carry out routine maintenance of the filter pads. Limited works would take place at some of the filter pads in the Ecopark corridors north of Humberland Drive to minimize the potential for stormwater and sediment to back up into the incoming storm sewer systems. It is expected that these limited decommissioning works could be completed using small equipment and with access via the existing trail system. As such, there would be negligible direct impacts to the natural environment.

There would be no impacts to social or cultural resources, although with no work taking place, there would be no incentive to upgrade the existing trail system to better resist erosion and washouts. The filter pads, while decommissioned, would continue to occupy space with the Ecopark system and would function to convey runoff from the storm sewer outlets to the Ecopark channels.

There are no technical challenges with this alternative, and limited costs are anticipated to decommission the filter pads to ensure that they would not obstruct flow and back water up into the storm sewer systems.

With no repairs, the existing filter pads would continue to provide little quantifiable benefit for water quality treatment or erosion mitigation. However, as noted in **Section 2.3.2.5**, the wet pond south of Humberland Drive provides adequate extended detention of storm runoff without considering the effect of the filter pads, and the quantifiable water quality treatment provided by the filter pads in their original as-constructed condition is not significant relative to the wet pond.

With the filter pads formally decommissioned, the City's long-term operations and maintenance obligations associated with the SWMF 1-4 stormwater management system would be reduced. It is estimated that the capital costs of this alternative would be **$0.1 Million** to implement minor works at some of the filter pads to prevent long term impacts to the upstream storm sewer systems.

4.2.3 Rehabilitate the Filter Pads

This alternative, described in **Section 3.1.3**, would seem the filter pads north of Humberland Drive restored and improved. The accumulated sediments in each filter pad would be removed,

the embankments reconstructed to their original design elevations, and perforated pipe outlets installed to better regulate the discharge from the filter pads.

Natural Environment: Some vegetation removals would be required for construction access to each filter pad, both along the access routes from the surrounding roadways and for access to the filter pad outlets to restore and line the berms and install the perforated pipe outlet. There would also be temporary impacts to the Ecopark channel during construction of the pipe outlets and small channels between the outlet headwalls and main Ecopark channel, and works to replace the filter pad berms, if warranted, would be in very close proximity to the channel. Temporary crossings of the Ecopark channels could also be needed for construction access to the filter pads.

The work needed to access and rehabilitate the filter pads would provide an opportunity to implement a plan to better manage the invasive species (particularly common reed) that are dominating portions of the Ecopark.

Social/Cultural Environment: Local residents could experience short term impacts associated with noise, dust, vibration and traffic during construction. There would also be a need to close portions of the trail system in the Ecopark during construction.

It is expected that some of the trails would be used for construction access to the filter pads. These trails would be expected to be damaged and replaced during construction, providing an opportunity to upgrade the granular surfaced trails to standard asphalt trails and alleviating the concerns regarding erosion and repairs to the existing granular trails.

Technical Environment: Construction access to each filter pad would be a significant challenge. Most of the existing access points to the trail system in the Ecopark are via relatively narrow blocks between residential properties which are not adequate to get heavy construction equipment into and out of the work areas of the filter pads. Furthermore, the existing pedestrian bridges could not support heavy construction equipment. Construction access would need to be from Humberland Boulevard and Red Cardinal Trail, with temporary or permanent crossings of the channel to access several of the filter pads. Once complete, there would continue to be a need to provide suitable access to each of the filter pads to facilitate routine inspections and carry out sediment removal and other repairs when warranted.

There are few challenges anticipated to secure permits and approvals to construct this alternative, but it would require a robust and comprehensive erosion and sediment control plan to protect the Ecopark channels and East Humber River during construction.

Once completed, there would be a small improvement in extended detention at the wet detention pond, corresponding to a negligible reduction in downstream erosion potential. Recall from **Section 2.3.2** that even if there were no discharge from the filter pads, the peak discharge

from the wet detention pond would be 96 L/s in a 25 mm storm event, compared to a peak discharge rate of 103 L/s when ignoring the effects of the filter pads.

This alternative could result in improvements in water quality. The permanent and extended detention storage volumes that could be provided in the rehabilitated filter pads remain small relative to the contributing drainage associated with their respective storm sewer outlet, making it difficult to quantify the potential benefit.

Financial Environment

The capital cost to remove the accumulated sediment from the filter pads, restore and/or line the berms and install the Hickenbottom outlets is estimated to be approximately **$2.4 Million**. This includes costs to restore and pave the trails that are likely to be used for construction access.

Once complete, the filter pads would require routine inspections, and relatively frequent sediment removal from the shallow permanent pools provided in each filter pad. Given that there would be eight separate filter pads to be maintained, the costs for the ongoing sediment removal and other repairs to preserve the restored function would be significant.

4.2.4 Reconstruct the Ecopark with On-Line Quality and Quantity Control Facilities

This alternative, described in **Section 3.1.4**, would comprehensively transform the Ecopark. The filter pads would be removed, and the western Ecopark corridor would be reconstructed to function as an on-line wet detention pond. All extended detention and peak flow control functions would be relocated to upstream of Humberland Drive, and the Humberland Drive culverts would be replaced with a single larger culvert. With all stormwater functions moved to upstream of Humberland Drive, the existing wet detention pond south of Humberland Drive could be decommissioned.

Natural Environment: This alternative would have significant impacts to the natural environment. A significant amount of vegetation in the Ecopark, including a considerable number of trees, would need to be cleared, and there would be limited opportunities to replace these trees in the reconstructed corridor, which will include permanent pools. The aquatic systems in the Ecopark is limited given the continuous vegetation and lack of defined channels through the majority of the study area, but the existing channels would be removed and replaced with the wet ponds. However, it is recognized that the existing Ecopark functions as a stormwater management facility and should therefore be treated differently from a natural stream corridor from a natural heritage perspective.

The decommissioning of the wet detention pond south of Humberland Drive would provide an opportunity for restoration, which could improve the quality and quantity of habitat along the East Humber River corridor.

Social/Cultural Environment: The existing trail system and playground in the Ecopark would be closed and removed during a relatively long construction duration. Once complete, the maintenance access routes for the SWM facilities in the Ecopark corridor could also function as a trail system. A portion of the decommissioned wet detention pond south of Humberland Drive could be filled and raised to create a suitable dry area for a replacement playground and additional active recreational facilities. This area would likely remain within the Regional storm floodplain, but above the 100 year return period floodplain.

Local residents could experience short term impacts associated with noise, dust, vibration and traffic during the relatively long construction period. There may also be long term noise concerns for the residents on the south side of Humberland Drive if the playground and other recreation facilities were relocated to be adjacent these properties.

Finally, with all peak flow controls relocated to upstream of Humberland Drive and the Humberland Drive culverts replaced, the amount of properties potentially impacted by flooding would be significantly reduced. Humberland Drive would no longer be at risk of overtopping in a Regional storm event, further improving public safety in the study area.

Technical Environment: There would be significant technical and regulatory challenges to overcome for implementation of this alternative. Securing permits and approvals for the works would be difficult, as it is unclear how environmental approval agencies would define the existing natural features located within the Ecopark corridors. As noted above, the Ecopark system north of Humberland Drive essentially acts as a stormwater management facility, but does provide natural habitat. There is a risk that environmental agencies would view the system as protected habitat, which would significantly complicate the approvals process.

The work to reconstruct the Ecopark corridors would be extensive, but not complicated construction. It would require a robust erosion and sediment control plan and water management plan to protect work areas from wet weather flows, and could require extensive dewatering as it is possible that the bases of the wet detention facilities would be below the seasonally high groundwater table in the study area.

There are challenges associated with the replacement of the culverts under Humberland Drive with a single larger structure. It would require relocation of the existing watermain, storm sewers and foundation drain collectors within Humberland Drive, and relocation of numerous other utilities such as gas mains, hydro ducts and telecommunications lines.

Few challenges are anticipated with the decommissioning of the existing wet detention pond south of Humberland Drive, but it would be necessary to preserve a flow path for the emergency overflow from the SPS immediately east of the pond.

Once implemented, the permanent pool volume provided would achieve Enhanced water quality protection, and the facility would provide extended detention of the runoff from a 25 mm event from the full upstream drainage area and would control peak flow rates to the targets established by the Don River unit rates. However, as noted in **Section 3.1.4**, the majority of the flows from the east branch of the Ecopark would enter the facility very close to the outlet control structure, and water quality treatment could be compromised due to short-circuiting of flows.

The solution would also reduce the potential for flooding and flood damages in the study area. The Regional storm floodplain would be largely contained within the Ecopark channel corridors, reducing the number of potentially impacted properties from 203 to 129 and reducing the number of homes in the floodplain from 165 to only 7. Flood depths in a Regional storm would also be significantly reduced such that it would be extremely unlikely that floodwater would enter the few homes remaining partially in the floodplain.

Financial Environment

The capital cost for this alternative is **$10.2 Million**, and includes decommissioning the existing filter pads and wet detention pond, regrading the Ecopark corridors, constructing the extended detention and peak flow control structures, and replacing the culverts under Humberland Drive.

Once complete, the City's long term operations and maintenance obligations would be reduced relative to current conditions. This solution would eliminate the existing filter pads and their associated maintenance requirements, and maintenance access to the relocated wet detention pond north of Humberland Drive will facilitate future inspection and maintenance.

4.3 Evaluation of Alternatives for the Wet Detention Pond

4.3.1 Do Nothing

For this alternative, no works would take place at the wet detention pond. The accumulated sediment would remain, and water quality treatment would continue to be impaired. The maintenance access road into the facility would continue to degrade, and the pond would continue to suffer from poor water circulation, contributing to algae growth and potential odor complaints.

There would be no impacts to social or cultural resources, as no work would take place. Similarly, there are no technical challenges with this alternative, and no direct costs. However, it

is important to note that in both existing and original design conditions, the wet pond does not provide sufficient permanent pool volume to meet the MECP requirements for enhanced TSS removal (80%). Furthermore, the sediment accumulation in the facility will soon reach the threshold that triggers the need for sediment removal under the City's Environmental Compliance Approval (5% reduction in existing TSS removal efficiency).

4.3.2 Clean and Repair the Wet Detention Pond

This alternative, described in **Section 3.2.2**, would involve limited works to clean the accumulated sediment from the wet detention pond, and to replace the existing degraded maintenance access road leading into the facility.

Natural Environment: There would be negligible impacts to the natural environment, as no trees or other vegetation would need to be removed. However, a robust erosion and sediment control plan would need to be implemented to prevent sediment from escaping the pond and reaching the East Humber River during the cleanout. Following sediment removal, water quality from the facility will be slightly improved, benefitting aquatic habitat in the East Humber River.

Social/Cultural Environment: Local residents could experience short term impacts associated with noise, dust, vibration and traffic during construction. The trail along the west side of the wet pond would also be closed during the relatively short construction period.

Technical Environment: There are few technical challenges associated with this alternative, as sediment removal from stormwater ponds is a common construction activity, and no risks are associated with reconstruction of the maintenance access road.

Once completed, the performance of the wet pond for sediment removal will be slightly improved (74% TSS removal, an increase of 1% over current conditions), but will not comply with the current standard of Enhanced water quality treatment (80% TSS removal). The pond would continue to be prone to poor circulation and stagnant water conditions, contributing to algae growth and potential odor complaints.

Financial Environment: It is estimated that it would cost approximately **$0.6 Million** to remove the accumulated sediment and repair the maintenance access road. There would be no reduction in the City's long term operations and maintenance obligations associated with the wet detention pond, although the reconstructed maintenance access may facilitate future maintenance activities.

4.3.3 Clean, Deepen and Expand the Wet Detention Pond

This alternative, described in **Section 3.2.3**, includes sediment removal and replacement of the maintenance access road from the previous alternative, and also includes expanding the pond to

the south, deepening the permanent pool to a uniform depth of 3 m, and installing a flat safety shelf at the normal water level to improve public safety. The reverse slope outlet pipe from the wet pond would also be replaced as a result of the pond deepening.

Natural Environment: There would be minor impacts to the natural environment, as some vegetation would have to be removed to enable the expansion to the south. However, as noted in **Section 2.2.5** and **Appendix B**, the area that would be impacted by the wet pond expansion is a sparsely vegetated cultural meadow. Very few tree removals would be required for the wet pond expansion. As with the previous alternative, a robust erosion and sediment control plan would need to be implemented to prevent sediment from escaping the pond and expansion work area and reaching the East Humber River during the cleanout, deepening and expansion.

The replacement reverse slope outlet pipe would draw cooler water from near the base of the 3 m deep permanent pool, mitigating thermal impacts from the wet pond and benefiting downstream cold and cool water fish habitat.

Social/Cultural Environment: Local residents could experience short term impacts associated with noise, dust, vibration and traffic during construction. The trail along the west side of the wet pond would also be closed during the construction period.

Once implemented, local residents would benefit from the extension of the informal pathway along the top of the berm forming the edge of the expanded wet pond. Public safety at the wet pond would also be improved with the addition of the safety shelf at the normal water level in the wet pond.

Technical Environment: There are no significant technical challenges associated with this alternative. The initial sediment removal work is a common construction activity, but the expansion of the pond and regrading of the side slopes to create a safety shelf will require the pond to be dewatered for a longer period of time relative to the Clean and Repair alternative.

There may also be some challenges for permits and approvals, as the wet pond expansion area is located within the Regulatory floodplain associated with the East Humber River. However, as expansion will result in a net increase in the amount of flood storage in the East Humber River floodplain, there should be no concerns from a flooding perspective.

Once completed, the permanent pool volume in the expanded wet pond would be sufficient to achieve Enhanced water quality treatment in accordance with current standards. The deeper permanent pool and safety shelf may also promote better mixing and turnover of water in the pond between storm events, potentially mitigating some of the concerns regarding stagnant water and algae growth in the wet pond. Finally, the expansion will also increase the extended detention storage volume in the wet pond, which would benefit any potential erosion sites along the East Humber River downstream of the study area.

Financial Environment: It is estimated that it would cost approximately **$1.3 Million** to remove the accumulated sediment, repair the maintenance access road and excavate and expand the pond. There would be no reduction in the City's long term operations and maintenance obligations associated with the wet detention pond, although the reconstructed maintenance access may facilitate future maintenance activities.

4.4 Evaluation of Alternatives for Flood Mitigation

4.4.1 Do Nothing

With no mitigation, up to 203 properties and up to 165 homes will continue to be at risk of flooding in a Regional storm event. Humberland Drive would also be overtopped to a depth of approximately 17 cm in a Regional storm event, complicating access to and from the area in a flood.

The playground located off of Raintree Crescent would also be at risk of flooding in a 10 year storm event, posing a risk to public safety and complicating permits and approvals for replacement of the playground.

There would be no impacts to the natural environment, social or cultural resources, as no work would take place.

4.4.2 Humberland Drive Culvert Improvements

This alternative, described in **Section 3.3.2**, would replace the existing 2.4 m wide x 1.8 m high concrete box culvert under Humberland Drive with 3 – 3.0 m wide x 2.1 m high concrete box culverts. The existing 975 mm low flow pipe connecting to the wet detention pond south of Humberland Drive would remain, and no other alterations would be made to the Ecopark upstream of Humberland Drive nor the conveyance channel south of Humberland Drive.

Natural Environment: The works would largely take place within the existing Humberland Drive right-of-way. Minor impacts to vegetation may be required to facilitate construction access to the upstream and downstream ends of the culvert crossing.

The works would also take place away from the low flow channel, but a robust erosion and sediment control program would be required to protect the Ecopark channel and East Humber River from sediment during construction.

Social/Cultural Environment: Public safety in a severe flood event would be significantly improved, as noted in the technical evaluation.

Local residents could experience impacts associated with noise, dust, vibration and traffic during construction. Humberland Drive would also need to be closed during construction, which would negatively impact traffic in the area.

Technical Environment: Implementation of this alternative would be complicated by the number of utilities potentially impacted during construction. An existing watermain and valve chamber would need to be relocated, and measures such as partial concrete encasement may be needed to protect the existing sanitary sewer, storm sewer and foundation drain collector where they would cross under the larger structure.

The replacement culvert would significantly reduce the potential for flooding and flood damages in the study area. The Regional storm floodplain would be largely contained within the Ecopark channel corridors, reducing the number of potentially impacted properties from 203 to 129 and reducing the number of homes in the floodplain from 165 to only 7. Flood depths in a Regional storm would also be significantly reduced such that it would be extremely unlikely that floodwater would enter the few homes remaining partially in the floodplain. The existing playground north of Humberland Drive would be safe from flooding in a 100 year storm event, and the maximum depth of flooding in a Regional storm event would be reduced from 2.7 m to 1.7 m.

The larger culvert under Humberland Drive would allow more water to pass under the roadway during large storm events, leading to an increase of up to 3% in the 100 year flow rates in the East Humber River at Bathurst Street. However, the peak flow rates from the SWMF 1-4 system would remain below the predicted flow rates from the original design brief, and well below the target peak flow rates referenced in the design brief. For the 100 year storm event, the original target discharge rate was 12.8 m^3/s, and the SWMF 1-4 system was designed to control the peak flow to 9.5 m^3/s. The modelling carried out for this study predicts that the larger culvert would increase peak flow rates from 6.7 m^3/s under existing conditions to 8.1 m^3/s in a 100 year storm event.

Financial Environment: It is estimated that it would cost approximately **$3.6 Million** to replace the existing culvert under Humberland Drive with the larger structure. The larger structure should not have a measurable impact on the City's long term operations and maintenance costs. While not quantified, the larger culverts would significantly reduce flood damages in a Regional storm event.

4.4.3 Humberland Drive Culvert Improvements with Upstream Flow Control

This alternative, described in **Section 3.3.3**, is the same as the above alternative for replacement of the Humberland Drive culvert, but also includes an on-line flow control structure upstream of

Humberland Drive to mitigate the potential impacts on downstream peak flow rates and flooding.

Natural Environment: In addition to the works in the Humberland Drive right-of-way, there would be impacts to trees and vegetation for access and construction of the on-line flow control structure. The additional structure would also involve in-water works during construction. Once completed, the on-line control structure would impede wildlife movement through the corridor.

Social/Cultural Environment: Public safety in a severe flood event would be significantly improved, as described in the previous section. Local residents could experience impacts associated with noise, dust, vibration and traffic during construction. Humberland Drive would also need to be closed during construction, which would negatively impact traffic in the area. Once installed, residents and trail users may be negatively impacted due to the aesthetics of the on-line control structure.

Technical Environment: Implementation of this alternative would include all the challenges associated with construction of the Humberland Drive culverts described in the previous section. There are additional challenges associated with the on-line control structure, including securing approvals from environmental agencies who don't typically accept on-line flow control structures, and challenges to manage wet weather flows in the Ecopark during construction. The on-line control structure would need to have a relatively narrow weir opening, which may be prone to debris jams during large storm events.

This alternative would provide the same degree of flood protection as described in the previous section. Flood depths would be significantly reduced, the number of properties potentially impacted by flooding in a Regional storm event would be reduced from 203 to 129 and the number of homes partially or entirely in the floodplain would be reduced from 165 to only 7.

The on-line control structure would mitigate the impacts of the culvert replacement on downstream peak flow rates, resulting in up to a 5% decrease in peak flow rates in the East Humber River at Bathurst Street.

Financial Environment: It is estimated that it would cost approximately **$3.9 Million** to replace the existing culvert under Humberland Drive with the larger structure and install the on-line flow control structure north of Humberland Drive.

There would be additional long term operation and maintenance costs to inspect the on-line control structure, remove any debris jams and carry out any other warranted repairs.

4.4.4 Non-Structural Measures to Reduce Flood Risk

This alternative, described in **Section 3.3.4**, could range from simple signage at the playground to inform users of the risk of flooding to an active flood warning system tied into a flood forecasting and warning program administered by the City.

Natural Environment: No impacts to the natural environment are anticipated, as little to no physical works would take place in the study area. Similarly, no impacts to the social or cultural environments are anticipated, but the alternative would result in an improvement in public safety.

Social/Cultural Environment: There would be no challenges and minimal costs to install signage at the playground alerting users to the risk of flooding.

Technical Environment: There would be more challenges to implement an active warning system at the park, as it would require a wired or wireless communication link to a visual and/or audible warning system installed at the playground. To be effective, it would also require installation of a remotely accessed gauge on the Ecopark channel to send real-time water level data to City staff. There would be costs and challenges to staff a flood warning centre at the City to monitor weather forecasts, and rainfall and streamflow data, and to activate the warning system when flooding was predicted.

Financial Environment: The cost to establish such a system is expected to cost approximately **$0.1 Million**, including installation and maintenance of the remotely accessible warning system and development of a Flood Emergency Response Plan specific to the playground. This estimate does not account for the cost of City staff to operate and maintain the flood warning system.

4.5 Evaluation Summary

The evaluation of the alternative solutions discussed in the preceding sections are summarized in **Table 4-2** through **Table 4-6**.

For the systems upstream of Humberland Drive, the preferred solution is to **Decommission the Filter Pads**. The filter pads provided limited quantifiable benefits for water quality and erosion mitigation in their original as-constructed condition. Decommissioning the filter pads will significantly reduce the City's long term maintenance obligations with a negligible impact on water quality and erosion in and downstream of the study area. Spending more than $2 Million to restore them to their original as-built condition would provide little quantifiable benefit to water quality or erosion relative to the cost, especially considering that the wet detention pond south of Humberland Drive can provide all required extended detention storage and permanent pool storage to adhere to current stormwater management criteria and adequately protect the

East Humber River. Furthermore, if rehabilitated, the City would continue to be responsible for long term maintenance of the filter pads. Reconstructing the west branch of the Ecopark to provide full water quality treatment, extended detention and peak flow control would benefit the East Humber River, but the costs to implement this solution would be considerable, and the relocated facility would have a significant impact on the natural and recreational environment within the Ecopark.

The preferred solution for the wet detention pond is to **Clean, Deepen, and Expand the Wet Pond**. This is the only feasible option to upgrade the performance of the system to comply with current, established standards for water quality treatment, and can be implemented with minimal impacts to the natural environment due to the sparse vegetation in the wet pond expansion footprint. Simply removing the accumulated sediment would result in only a slight increase in water quality treatment performance, which would remain below current standards. Constructing a new water quality treatment facility in the western Ecopark channel corridor could achieve Enhanced water quality treatment for the area, but is not recommended due to the prohibitive costs and impacts to the existing natural and recreational environments in the Ecopark.

The preferred solution to mitigate flooding is **Humberland Drive Culvert Improvements** (without upstream flow controls). This solution will remove nearly all the homes in the study area from the Regional storm floodplain and significantly improve public safety. The addition of an upstream flow control structure is not recommended due to the additional costs and impacts to the natural environment, and because the increased flows resulting from the larger culvert will remain significantly below the peak flow targets established during the original design and analysis of the stormwater management system. **Signage** is also recommended at the playground north of Humberland Drive to inform playground users of the flood risk. An active flood warning system is not recommended, given the significant cost and effort needed to administer such a system, and given the relatively low probability that residents will be using the playground during a storm event large enough to flood the area.

Table 4-2 Natural Environment Evaluation

Facility Component/ Area	Alternative	Natural Environment Impacts	Natural Environment Benefits
North of Humberland Drive	Do Nothing	No impacts, as no works are proposed	No benefits, as no works are proposed
North of Humberland Drive	Do Nothing / Decommission the Filter Pads	Negligible impacts to vegetation for works to modify outlet spillways	No benefits anticipated
North of Humberland Drive	Rehabilitate the Filter Pads	Potential impacts to vegetation for construction access to filter pad outlets and berms	No direct benefits anticipated, but works would provide an opportunity to implement an invasive species management program for the Ecopark
North of Humberland Drive	Reconstruct the Ecopark System with an On Line SWM Facility	Extensive vegetation removals and transformation of the west branch of the Ecopark to a wet pond.	Removal and restoration of the wet detention pond south of Humberland Drive would expand and enhance the East Humber River valley corridor
Wet Detention Pond	Do Nothing at the Wet Pond	No impacts, as no works are proposed	No benefits, as no works are proposed
Wet Detention Pond	Clean and Repair the Wet Pond	Negligible impacts to vegetation for construction access	Improved aquatic habitat due to the slight improvement in water quality
Wet Detention Pond	Clean, Deepen and Expand the Wet Pond	Minor impacts to vegetation for construction access and wet pond expansion	Improved aquatic habitat due to the moderate improvement in water quality

Facility Component/ Area	Alternative	Natural Environment Impacts	Natural Environment Benefits
Flood Mitigation	Do Nothing for Flood Mitigation	No impacts, as no works are proposed	No benefits, as no works are proposed
Flood Mitigation	Replace the Humberland Drive Culvert	Minor impacts to vegetation for construction access to culvert inlet and outlet locations	No benefits anticipated
Flood Mitigation	Replace the Humberland Drive Culvert with Upstream Flow Controls	Moderate impacts to vegetation for construction access to culvert and on-line control structure, control structure could impede wildlife passage	No benefits anticipated
Flood Mitigation	Non-Structural Measures to Reduce Flood Risk	Negligible impacts to vegetation for installation of telecommunications line, if required	No benefits anticipated

Table 4-3 Social/Cultural Environment Evaluation

Facility Component/ Area	Alternative	Social/Cultural Environment Impacts	Social/Cultural Environment Benefits
North of Humberland Drive	Do Nothing	No impacts, as no works are proposed	No benefits, as no works are proposed
North of Humberland Drive	Decommission the Filter Pads	Negligible impacts due to short term trail closures	No benefits anticipated
North of Humberland Drive	Rehabilitate the Filter Pads	Short-term trail closure during construction	Trails impacted by construction access would be reconstructed and paved
North of Humberland Drive	Reconstruct the Ecopark System with an On Line SWM Facility	Longer-term trail closure during construction, playground relocated further away from residential areas	Improved public safety due to reduced flooding and relocation of the playground to higher ground
Wet Detention Pond	Do Nothing at the Wet Pond	No impacts, as no works are proposed	No benefits, as no works are proposed
Wet Detention Pond	Clean and Repair the Wet Pond	Short-term trail closure during construction	No benefits anticipated
Wet Detention Pond	Clean, Deepen and Expand the Wet Pond	Short-term trail closure during construction	Construction access to wet pond expansion area could remain as an extension to the trail around the wet pond, safety shelf at normal water level will improve public safety

Facility Component/ Area	Alternative	Social/Cultural Environment Impacts	Social/Cultural Environment Benefits
Flood Mitigation	Do Nothing for Flood Mitigation	No impacts, as no works are proposed	No benefits and no mitigation of flood risk to public safety, as no works are proposed
Flood Mitigation	Replace the Humberland Drive Culvert	Short-term trail closure during construction	Improved public safety due to reduced flooding
Flood Mitigation	Replace the Humberland Drive Culvert with Upstream Flow Controls	Short-term trail closure during construction, potential aesthetic concerns with on-line flow control weir	Improved public safety due to reduced flooding
Flood Mitigation	Non-Structural Measures to Reduce Flood Risk	No impacts, as little to no physical works are proposed	Improved public safety for playground users

Table 4-4 Technical Environment Evaluation

Facility Component/ Area	Alternative	Technical Environment Challenges	Technical Environment Performance
North of Humberland Drive	Do Nothing	No challenges, as no works are proposed	No improvement in water quality or quantity treatment provided by the filter pads
North of Humberland Drive	Decommission the Filter Pads	Limited challenges to modify spillways to prevent backups into the storm sewer systems	No improvement in water quality or quantity treatment provided by the filter pads
North of Humberland Drive	Rehabilitate the Filter Pads	Challenges for construction access and future maintenance access to all filter pads	Slight improvement in water quality and erosion mitigation
North of Humberland Drive	Reconstruct the Ecopark System with an On-Line SWM Facility	Significant challenges to secure permits and approvals, poor water circulation in the new wet pond, utility conflicts with the Humberland Drive culvert replacement	Water quality treatment, erosion mitigation and peak flow control improved to meet current standards, 158 homes removed from the floodplain

Facility Component/ Area	Alternative	Technical Environment Challenges	Technical Environment Performance
Wet Detention Pond	Do Nothing at the Wet Pond	No challenges, as no works are proposed	No improvements to water quality or quantity control, performance would remain below current standards
Wet Detention Pond	Clean and Repair the Wet Pond	Few challenges related to permitting, approvals and construction access	Slight improvement in water quality treatment, but performance would remain below current standards
Wet Detention Pond	Clean, Deepen and Expand the Wet Pond	Minor challenges related to permitting and water management during construction	Water quality treatment would be improved to meet or exceed current standards. The increased extended detention storage would further improve water quality treatment and better mitigate potential downstream erosion

Facility Component/ Area	Alternative	Technical Environment Challenges	Technical Environment Performance
Flood Mitigation	Do Nothing for Flood Mitigation	No challenges, as no works are proposed	No reduction in the frequency or depth of flooding
Flood Mitigation	Replace the Humberland Drive Culvert	Challenges to move and/or protect utilities in Humberland Drive	Significant reduction in frequency and depth of flooding, 158 homes removed from the floodplain, slight increase in return period peak flows in the East Humber River
Flood Mitigation	Replace the Humberland Drive Culvert with Upstream Flow Controls	Challenges to move and/or protect utilities in Humberland Drive, challenges to secure approvals for on-line control structure, risk of debris jams at control structure	Significant reduction in frequency and depth of flooding, 158 homes removed from the floodplain, slight reduction in return period peak flows in the East Humber River
Flood Mitigation	Non-Structural Measures to Reduce Flood Risk	Challenges to operate, staff and maintain an active flood warning system	Slight mitigation of flood risk to playground users

Table 4-5 Financial Environment Evaluation

Facility Component/ Area	Alternative	Financial Environment Evaluation
North of Humberland Drive	Do Nothing	No initial capital costs as no works are proposed. No reduction in future long term operation and maintenance costs
North of Humberland Drive	Decommission the Filter Pads	Capital costs of $0.1 Million to implement minor works to prevent backups into the storm sewer systems. Reduced long term maintenance costs with filter pads decommissioned
North of Humberland Drive	Rehabilitate the Filter Pads	Capital costs of $2.4 Million to remove sediment, reconstruct berms and install new flow controls at the filter pads. No reduction in future long term operation and maintenance costs
North of Humberland Drive	Reconstruct the Ecopark System with an On-Line SWM Facility	Capital costs of $10.2 Million to move all stormwater functions to north of Humberland Drive and replace the Humberland Drive culvert. Reduced long term maintenance costs with all functions provided in a single facility
Wet Detention Pond	Do Nothing at the Wet Pond	No initial capital costs as no works are proposed. Sediment removal will be required in the future to ensure compliance with provincial requirements
Wet Detention Pond	Clean and Repair the Wet Pond	Capital costs of $0.6 Million to remove sediment and reconstruct the maintenance access. No reduction in future long term operation and maintenance costs
Wet Detention Pond	Clean, Deepen and Expand the Wet Pond	Capital costs of $1.3 Million to remove sediment, expand and deepen the wet pond and reconstruct the maintenance access. No reduction in future long term operation and maintenance costs

Facility Component/ Area	Alternative	Financial Environment Evaluation
Flood Mitigation	Do Nothing for Flood Mitigation	No costs, as no works are proposed
Flood Mitigation	Replace the Humberland Drive Culvert	Capital costs of $3.6 Million to replace the existing box culvert with a larger structure, including utility relocations. No reduction in future long term operation and maintenance costs.
Flood Mitigation	Replace the Humberland Drive Culvert with Upstream Flow Controls	Capital costs of $3.9 Million to install the on-line flow control structure and replace the existing box culvert with a larger structure, including utility relocations. Increased future long term operation and maintenance costs associated with the new on-line flow control structure.
Flood Mitigation	Non-Structural Measures to Reduce Flood Risk	Initial costs of $0.1 Million to develop a flood emergency response plan and install an active warning system. Significant long term operating costs for City staff to administer the flood warning program.

Table 4-6 Overall Evaluation Summary

Facility Component/ Area	Alternative	Evaluation Summary
North of Humberland Drive	Do Nothing	**Not Recommended** There would be no improvement in water quality or erosion mitigation, and the City would continue to be responsible to carry out long term maintenance of the filter pads
North of Humberland Drive	Decommission the Filter Pads	**Recommended** Leaving the filter pads in their current condition, with minor works at some filter pads to ensure positive drainage, would have a negligible impact on water quality and erosion mitigation, and would reduce the City's long term maintenance costs for the Ecopark.
North of Humberland Drive	Rehabilitate the Filter Pads	**Not Recommended** There would be significant costs to rehabilitate the filter pads, and it would result in a negligible quantifiable improvement in water quality treatment and erosion mitigation. The City would continue to be responsible for the significant maintenance obligations associated with the eight separate filter pads.
North of Humberland Drive	Reconstruct the Ecopark System with an On-Line SWM Facility	**Not Recommended** There are significant costs, a significant loss of potential wildlife habitat and significant approvals challenges for implementation of this alternative.

Facility Component/ Area	Alternative	Evaluation Summary
Wet Detention Pond	Do Nothing at the Wet Pond	**Not Recommended** With no improvements, water quality treatment will remain below current standards. Sediment removal must be carried out at some point in the future to comply with provincial requirements for pond maintenance.
Wet Detention Pond	Clean and Repair the Wet Detention Pond	**Not Recommended** Removing the accumulated sediment will result in a slight improvement in water quality treatment, but performance will remain below current standards
Wet Detention Pond	Clean, Deepen and Expand the Wet Pond	**Recommended** This alternative achieves provincial standards for water quality treatment and can be implemented with minimal impacts to the natural environment

Facility Component/ Area	Alternative	Evaluation Summary
Flood Mitigation	Do Nothing for Flood Mitigation	**Not Recommended** Up to 203 properties and up to 165 homes would continue to be at risk of flooding in a Regional storm event
Flood Mitigation	Replace the Humberland Drive Culvert	**Recommended** The solution would remove 158 homes from the floodplain, and works would be contained in the Humberland Drive right-of-way. The increased peak flow rates resulting from the larger culvert would remain below original target levels
Flood Mitigation	Replace the Humberland Drive Culvert with Upstream Flow Controls	**Not Recommended** There would be additional costs, impacts to the natural environment and approvals challenges associated with the on-line flow control structure to mitigate the relatively small predicted increase in peak flow rates resulting from the larger culvert
Flood Mitigation	Non-Structural Measures to Reduce Flood Risk	**Partially Recommended** There would be long term costs and challenges to maintain a flood warning system at the playground, and it is very unlikely that residents would be using the playground during a flood event. However, signage alerting playground users to the risk of flooding is recommended.

5 Design Considerations for the Preferred Alternative

The preferred alternative for rehabilitation and improvements to the Humber Flats SWMF 1-4 stormwater management system includes the following works.

- **Decommission the Filter Pads**: This is largely an administrative process to no longer include the filter pads as stormwater management infrastructure in the City's asset management system, and for the City to no longer maintain them as stormwater management infrastructure. Minor works may be needed at some filter pads to ensure positive drainage.
- **Clean, Deepen and Expand the Wet Pond**: This involves removing the accumulated sediment, expanding the wet pond to the south, and excavating the pond to create a uniform 3 m deep permanent pool with a flat safety shelf at the normal water level. The maintenance access road into the wet pond will also be rehabilitated, and the maintenance access may also be upgraded and extended around the south side of the pond as part of the expansion works.
- **Humberland Drive Culvert Improvements**: The existing 2.4 m wide x 1.8 m high concrete box culvert under Humberland Drive will be removed and replaced with 3 – 3.0 m wide x 2.1 m high concrete box culverts to convey the flow from the Regional storm event. This will remove nearly all the homes upstream of Humberland Drive from the Regional storm floodplain.
- **Non-Structural Measures to Reduce Flood Risk**: Signage will be installed at the playground off of Raintree Crescent to inform park users of the flood risk and direct them to leave the park and move to higher ground during and following a storm.

5.1 Filter Pad Decommissioning

The filter pads were screened to determine what works, if any, would be warranted to ensure safe, maintenance free drainage from the storm sewer outfalls to the Ecopark channel.

For some of the filter pads the topographic survey indicates that the crests of the spillways from the filter pads are approximately up to 12 cm higher than the storm sewer inverts, which could lead to standing water and sediment deposition in the storm sewers.

At several of the filter pads, the topographic survey indicates that the crests of the spillways are up to 0.65 m above the base of the filter pads. While only shallow depths of standing water were

observed in some of these filter pads, over time, the depth and duration of standing water conditions may increase, creating favourable conditions for mosquito breeding and potentially causing foul odours.

The recommended works at each filter pad are summarized below.

- **Filter Pad A**: The topographic survey and field observations indicate that there are no concerns for standing water in the filter pad, and no concerns for water to back up behind the spillway crest and affect the storm sewer outlet. No works are warranted at Filter Pad A.
- **Filter Pad B**: The spillway crest is only slightly above the storm sewer invert, but the base of the filter pad is up to 65 cm below the spillway crest. While only shallow depths of standing water were observed in the downstream end of the filter pad, it is recommended that the spillway be reconstructed at a lower elevation to eliminate the potential for future significant ponding depths.
- **Filter Pad C**: The topographic survey indicates that the spillway crest is only 5 cm above the storm sewer outlet invert, and the depth of ponding in the filter pad is less than 20 cm. However, standing water was observed in the filter pad during the dry weather inspection, and the water level was above the storm sewer outlet invert during the wet weather inspection. It is recommended that the spillway be reconstructed at a lower elevation to eliminate or reduce ponding depths to below the storm sewer outlet invert.
- **Filter Pad D**: Similar to Filter Pad B, the spillway crest at this filter pad is slightly higher than the storm sewer invert and the base of the filter pad is in the order of 50 cm below the spillway crest, but only shallow depths of ponding were observed during the dry and wet weather inspections. It is recommended that the spillway be reconstructed at a lower elevation to eliminate the potential for future significant ponding depths.
- **Filter Pad E**: There are no concerns for backwater or standing water at this filter pad. A small drop was noted at the end of the concrete apron at the storm sewer outlet headwall, but there are no concerns for erosion impacts to the headwall and no works are recommended.
- **Filter Pad F**: The outlet spillway crest is safely below the storm sewer outlet invert, but is approximately 60 cm above the base of the filter pad. Little to no standing water was observed in the filter pad during either inspection, but it is recommended that the spillway be reconstructed at a lower elevation to eliminate the potential for future significant ponding depths. Consideration should also be given to placing additional topsoil and seed on the west side slope of the filter pad, which is generally bare of vegetation.

- **Filter Pad G**: The spillway crest is safely below the storm sewer outlet invert, and only very shallow ponding depths can develop in the filter pad behind the spillway. While no standing water was observed in the filter pad, a buildup of vegetation and debris was noted immediately below the storm sewer outlet, and has the potential to obstruct the discharge from the storm sewer. It is recommended that the vegetation and debris be cleared from in front of the storm sewer outlet. Consideration should also be given to placing additional topsoil and seed on the south side slope of the filter pad, which is generally bare of vegetation.
- **Filter Pad H**: The spillway crest at this filter pad is approximately 10 cm higher than the storm sewer outlet invert, and a shallow water depth was observed in the storm sewer during the inspections. Standing water was also observed throughout the filter pad during the inspections, and the topographic survey indicates that water depths could be more than 50 cm. It is recommended that the spillway be reconstructed at a lower elevation to reduce the depth and duration of ponding in the filter pad.
- **Filter Pad I**: There was no evidence of a filter pad below the storm sewer outfalls at Red Cardinal Way, and no obstructions to the flow through the Ecopark channel in this area. No works are warranted at Filter Pad I. However, the City should ensure that the safety grating over the outlet of the 1500 mm diameter storm sewer is repaired.

There are no immediate maintenance concerns at any of the filter pads, and there is no need to undertake any of the above recommended works before formally no longer recognizing the filter pads as stormwater management infrastructure.

The recommended works can be completed using small construction equipment, which can access the work areas via the existing pathways in the Ecopark.

5.2 Wet Detention Pond Expansion

The cleanout, deepening and expansion of the wet pond is recommended in order to increase the permanent pool volume sufficient to achieve the current standard of Enhanced water quality treatment. However, the southward expansion of the wet pond will also increase the volume of storage available above the normal water level for extended detention. It is recommended that, during detailed design, additional modelling be carried out to determine if any modifications to the orifice control are warranted to improve the performance of the pond for extended detention and peak flow control. The orifice control should be configured to provide at least 48 hours drawdown of the extended detention storage volume, and the maximum water level in the pond during a 25 mm, 4 hour storm event should approach but remain below the elevation of the overflow spillway from the wet pond (290.7 m).

Consideration should be given to installing a formal trail along the west and south sides of the expanded wet pond. Recall from **Section 2.3.2.2** that an informal trail was evident along the berm on the west side of the wet pond, and footpaths were observed along the south side of the facility. Consideration should also be given to the integration of any trail around the perimeter of the pond into the City's planned extension of the East Humber River trail system to Bathurst Street.

5.3 Humberland Drive Culvert Improvements

5.3.1 Downstream Flood Assessment

As described in **Section 3.3.2**, the larger culverts under Humberland Drive will result in an increase in peak flow rates delivered to the East Humber River relative to existing conditions. Peak flow rates will remain below the targets established during the original planning and design of the SWMF 1-4 system, but will result in up to a 3% increase in peak flow rates in the East Humber River upstream of Bathurst relative to current conditions.

In response to feedback from the TRCA (See **Section 7.6**), the potential impact of the increased flow rates on downstream flood levels for the 2 year through 100 year return period storm events was assessed. Provincial guidelines stipulate that stormwater management systems and other human-made flow control structures should not be included in hydrologic models for the Regional storm event, and therefore the peak flow reduction achieved by the Humberland Drive culverts was not considered in Regional storm hydrologic models for all scenarios. The recommended culvert replacements will therefore have no impact on peak flow rates for the Regional storm event, used to generate the Regulatory floodplain mapping for the East Humber River.

The increase in peak flow rates will result in up to a 3 cm increase in the 100 year return period flood levels in the East Humber River upstream of Bathurst Street. This very small increase in flood levels will result in a very slight increase in the extent of flooding in a 100 year storm event, but the area impacted will be fully contained within lands owned by the City of Richmond Hill and TRCA. Downstream of Bathurst Street, flood levels for up to the 100 year storm event are predicted to increase by a maximum of 1 cm. This is insignificant relative to the accuracy of the model, and will not have a measurable impact on the extent of flooding along the East Humber River.

There are therefore no concerns regarding flooding impacts to private property or public infrastructure resulting from the proposed culvert replacements.

5.3.2 Raintree Crescent Playground

As noted in **Section 2.4.1.8**, the City has advanced plans for replacement of the playground located off of Raintree Crescent, but concerns over flood risk and liability have prevented the City from implementing the new playground.

The recommended Humberland Drive culvert replacements will significantly reduce upstream flooding, such that the existing playground area would be safe from flooding in a 100 year storm event. Flood levels at the playground would be reduced by approximately 1 m in a Regional storm event, but the flood depth would be approximately 1.7 m.

At a meeting held on May 19, 2023, TRCA staff indicated that, based on the Regional storm flood depths, the playground would likely be considered to lie within the hydraulic floodway, and the TRCA would continue to have concerns with the replacement of the playground in the same location from a flood risk perspective.

Further consultation is recommended with the TRCA to fully assess the flood risks associated with replacement of the playground, considering both the reduction in frequency and severity of flooding following replacement of the Humberland Drive culvert and installation of signage around the reconstructed playground alerting playground users to the risk of flooding during and following storm events.

Recall also from **Section 2.4.1.8** that the existing playground suffers from poor drainage, resulting in standing water on the playground and premature deterioration of the timber elements of the playground. If the playground is replaced at the same location, it is recommended that the elevation of the playground be raised slightly, and that appropriate drainage infrastructure be installed to direct both surface runoff and groundwater around the reconstructed playground to alleviate the current poor drainage conditions at the site.

5.3.3 Humber Flats Baseflow Bypass System Rehabilitation

As noted in **Section 2.3.2.1**, the SWMF 1-4 system includes a granular trench under the Ecopark low flow channel, with a sub-drain installed within the granular trench at Humberland Drive and connected to the FDC system. This system is intended to capture baseflows in the Ecopark channel and route it directly to the East Humber River via the FDC outlet, bypassing the Wet Pond and associated warming of runoff in the Wet Pond. During the dry weather inspection, a small amount of discharge was observed from the Wet Pond. There was no evidence of significant discharge from the FDC, but it's submergence below the water level in the East Humber River made it difficult to determine if there was any discharge from the FDC.

It is recommended that the design of the Humberland Drive culvert replacement also include works to restore or improve baseflow capture and bypass via the FDC system. This could include

exposing the sub-drain upstream of Humberland Drive, flushing any debris from the sub-drain and FDC pipes leading to the East Humber River, and replacing the granular materials covering the sub-drain. Consideration could also be given to extending the length of the sub-drain upstream of Humberland Drive and/or implementing other measures to prevent long-term clogging of the sub-drain and connection to the FDC system.

5.4 Construction Schedule and Phasing

There are few restrictions for phasing the recommended works for SWMF 1-4. The works associated with decommissioning the filter pads, expanding the wet pond and replacing the Humberland Drive culvert can proceed independently and in any order, with no negative impacts upstream or downstream. However, it is generally recommended that works proceed from upstream to downstream. While not critical, it would be preferable if the works to decommission the filter pads were carried out in advance of the Humberland Drive culvert replacements and wet pond expansion.

There may be some cost savings if the expansion of the wet pond was constructed at the same time as the Humberland Drive culvert replacement. Due to their close proximity, completing these works under a single contract could allow for construction efficiencies relating to construction access and staging, as well as traffic control and road closures.

5.5 Monitoring

Post-construction monitoring may be considered to verify the effectiveness of the proposed improvements to the SWMF 1-4. This could include monitoring the water levels in the Ecopark upstream of Humberland Drive to assess the effectiveness of the culvert replacement with regards to flood mitigation, as well as continuous monitoring of water levels and/or flow rates and water temperature from the wet pond.

Any post-construction monitoring program will be developed during detailed design and will be based on the requirements of the City's Consolidated Linear Infrastructure Environmental Compliance Approval (CLI-ECA).

5.6 Recommendations for Future Study

5.6.1 Utility Investigation for Humberland Drive

As noted in **Section 2.3.5**, there is an existing watermain, storm sewer, foundation drain collector and sanitary sewer that run along Humberland Drive. There are also a number of private utilities including gas mains, power lines and telecommunication cables.

Depending on the final design of the culvert, it is possible that culvert could conflict with existing infrastructure, or that existing infrastructure would make it challenging to complete the installation of the culvert. A detailed utility investigation is recommended to confirm the horizontal and vertical position of all private and public utilities at the location of the proposed culvert replacement. Depending on their location, it may be necessary to realign some of the existing services to accommodate the larger culvert size.

5.6.2 Geotechnical and Hydrogeological Investigation

A geotechnical and hydrogeological investigation is recommended to support the detailed design of the proposed works. A borehole investigation is recommended for the expansion of the SWMF 1-4 wet pond to confirm sub-surface soil conditions, establish stabilized groundwater levels at the facility and inform the design of the berm, side slopes and maintenance access.

The geotechnical report included with the original design brief for the facility (Cosburn Patterson Mather Limited, 1996) noted that the base of the wet pond would be below the seasonal high ground water table, but did not propose a liner to minimize groundwater interaction. The report recommended local dewatering during excavation, and noted that the wet soil conditions would make it difficult for heavy construction equipment to travel along the base of the wet pond.

The recommended hydrogeological investigation should specifically examine soil and groundwater conditions at the proposed lowered base of the wet pond and reassess the need for a clay or geosynthetic liner to prevent groundwater interaction with the deepened permanent pool.

A geotechnical and hydrogeological investigation is also recommended for the proposed roadworks and expansion of Humberland Drive. The geotechnical investigation should provide recommendations for the bedding or foundations of the replacement culverts, protection of the sanitary sewer and FDC located below the proposed replacement culverts, and general recommendations for backfill and pavement design.

6 Potential Construction Impacts and Mitigation

The potential construction impacts of the preferred solutions and recommended mitigation measures are described in the following sections.

6.1 Terrestrial Features

The proposed improvements to the Humber Flats SWMF 1-4 wet pond may require some vegetation removals for the southward expansion of the pond, and some vegetation removals may also be required for construction access for the Humberland Drive culvert replacement. Limited vegetation removals are anticipated for the decommissioning of the Filter Pads as described in **Section 5.1**.

A detailed tree inventory and preservation plan will be prepared for the entire area potentially impacted by construction of the replacement culvert and the expansion of wet pond. A comprehensive restoration plan will also be completed during detailed design that will comply with the Provincial Policy Statement, the City's Official Plan and Tree Preservation By-Law, required tree replacement/ compensation policies and will achieve a net environmental benefit to the East Humber River natural heritage system. Native pollinator seed mixes should be considered where conditions allow.

Where appropriate and feasible, certified weed-free topsoil and materials should be used and a protocol should be adopted to ensure that construction equipment does not further spread invasive species in the study area. Additional recommendations for invasive species management are included in **Appendix B**.

6.2 Breeding Birds

During detailed design, the need for vegetation removals will be refined, and assessments will be carried out on any vegetation that may be removed. It is possible that some of the vegetation may provide habitat for breeding birds.

The Migratory Bird Convention Act restricts vegetation removal or any other activity that could be construed as impacting nesting or breeding of a range of bird species from April 1st to August 31st. The nesting window should be confirmed during detailed design, and if vegetation removals cannot occur outside of this window, a qualified biologist will be required to complete a survey to determine the presence of any nesting activity prior to any removals.

6.3 Species at Risk

During the 2022 field investigations, a single tree was flagged as potential bat maternity roosting habitat for endangered bats as it contained abundant peeling bark, potential cracks, and cavities, and is adjacent to a water source. The tree is located near the playground off of Raintree Crescent. No construction activities are planned near this tree.

Regardless, it is recommended that the findings from the surveys be shared with the MECP in the form of a memo or Information Gathering Form (IGF) during the detailed design stage. The MECP would then confirm that the work areas have been cleared for SAR or provide instructions for any additional work and timing windows for tree impacts or removals based on the information provided.

6.4 Surface Water and Aquatic Habitat Protection

The recommended solution involves works within the Humber Flats SWMF 1-4 wet pond, as well as the Humberland Drive culvert that conveys high flows to the East Humber River, and there is therefore the potential for short-term negative impacts to the system during construction. Any in-water works could be subject to the modified warmwater fisheries timing window, which would only permit construction activity in or near the water between July 15th and March 31st. All fisheries timing windows should be confirmed with TRCA and MNRF during the detailed design. The recommended works at the SWMF 1-4 wet pond are not subject to the fisheries timing window, but it is recommended that work at the wet pond is not initiated after October 15th in order to protect wildlife such as turtles and amphibians that may be hibernating in the pond.

To prevent accidental introduction of debris into the water, the establishment and use of specific construction access routes is recommended, as well as the use of mitigation techniques that contain sediment, debris and other contaminants within the work site.

Best Management Practices (BMPs) for the protection of aquatic habitat and source water protection will be reviewed at the detailed design stage and incorporated into the detailed design package. The use of erosion and sediment control devices and techniques should adhere to the principles limiting soil mobilization and trapping sediment as close to the source as possible. The Erosion and Sediment Control Guideline for Urban Construction (TRCA, 2019) will be followed for the development and implementation of the comprehensive Erosion and Sediment Control (ESC) plan. BMPs to prevent contaminants from entering surface water and groundwater will also be in place, such as appropriate fuel storage and refueling methods during construction.

6.5 Groundwater Management

As noted in **Section 5.6.2**, the soils investigation carried out during the original design of the wet pond indicated that the seasonal high groundwater table may be above the base of the existing wet pond. Some dewatering is expected to permit the deepening of wet pond to create a uniform 3 m deep permanent pool.

The geotechnical and hydrogeological studies recommended in **Section 5.6.2** will determine the groundwater levels at the facility and requirements for dewatering. However, any groundwater impacts during construction are likely to be localized and temporary.

During detailed design, it will be necessary to develop appropriate strategies to minimize, treat and dispose of any dewatering discharge water. Should construction site dewatering requirements be greater than 50,000 L/day, permitting with the MECP will be required. Construction site dewatering of more than 50,000 L/day but less than 400,000 L/day (under normal site conditions) will require registration on the MECP Environmental Activity and Sector Registry (EASR) and fulfillment of EASR regulation monitoring and mitigation requirements. A Permit to Take Water (PTTW) will be required if any of the construction requires dewatering of over 400,000 L/day.

6.6 Soils Management

The proposed improvements will involve topsoil stripping, sediment removal, excavation, and filling. All excess and unsuitable materials generated during construction will be managed appropriately. The materials may be reused as a construction material or transported from the site. Materials may also be temporarily stockpiled in preparation for these uses or temporarily removed from the site if required. A construction staging plan will detail the locations and mitigation requirements for stockpiles. Any soil stockpiles will be stabilized in accordance with the Erosion and Sediment Control Guideline for Urban Construction (TRCA, 2019).

All excess fill and any contaminated waste encountered naturally (e.g., culvert sediment) or through the Contractor's efforts (e.g., diesel spill) should be managed in accordance with the 'On-Site and Excess Soil Management' (Ministry of the Environment, Conservation and Parks, 2019) and Ontario Regulation 406/19. As noted in **Section 2.3.2.4**, the sediment that has accumulated in the wet pond culverts exceeds several of the parameters from the applicable excess soils regulations and is not deemed suitable for reuse.

6.7 Air Quality, Noise and Vibration

The Contractor's activities, specifically the operation of construction equipment, could result in a temporary increase in noise, vibration and dust in the project area during the construction period. It is anticipated that these effects will be short in duration and limited to periods of construction machinery operation, and can be effectively mitigated by providing advance notice of construction to the adjacent homeowners, by limiting construction activities to normal working hours, and applying best management practices. If warranted, only non-chloride dust suppressants are to be applied during construction. A comprehensive list of dust prevention and control measures can be found in Environment Canada's "Best Practices for the Reduction of Air Emissions from Construction and Demolition Activities" (Cheminfo Services Inc., 2005).

6.8 Archaeology

As previously discussed in **Section 2.4.2**, a Stage 1 Archaeological Assessment was carried out for the study area. The assessment concluded that the study area does not retain any archaeological potential. Therefore, there is no need for a Stage 2 assessment for the recommended works.

In the unlikely event that the work will extend beyond the areas cleared by the Stage 1 AA, a Stage 2 AA would be required for those areas, consisting of test pits at 5 m intervals.

Should previously undocumented archaeological resources be discovered during future field investigations or during construction, they may indicate a new archaeological site and therefore subject to Section 48 (1) of the Ontario Heritage Act. The proponent or person discovering the archaeological resources must cease alteration of the site immediately and engage a licensed consultant archaeologist to carry out archaeological assessment, in compliance with Section 48 (1) of the Ontario Heritage Act.

The Funeral, Burial and Cremation Services Act, 2002, S.O. 2002, c.33 requires that any person discovering human remains must cease all activities immediately and notify the police or coroner. If the coroner does not suspect foul play in the disposition of the remains, in accordance with Ontario Regulation 30/11, the coroner shall notify the Registrar, Ontario Ministry of Public and Business Service Delivery, which administers provisions of that Act related to burial sites. In situations where human remains are associated with archaeological resources, the Ministry of Citizenship and Multiculturalism (MCM) should also be notified (at archaeology@ontario.ca) to ensure that the archaeological site is not subject to unlicensed alterations which would be a contravention of the Ontario Heritage Act.

6.9 Traffic and Transportation

Construction access to the wet pond is anticipated to be from the existing access road off of Humberland Drive. Construction access to the Humberland Drive culvert will also be via Humberland Drive. Construction access for any works to decommission the filter pads will be from the existing trail system, using small construction equipment.

A full road closure is recommended for removal of the existing concrete box culvert under Humberland Drive and installation of the proposed 3 concrete box culverts. Closure of the road would not prevent access to any properties, but it is recognized that Humberland Drive is a key east-west connection to Bathurst Street. Traffic on Humberland Drive and connecting roadways may be temporarily impacted as equipment and materials are transported to and from the work areas. A traffic management plan will be developed in accordance with Ontario Health and Safety Book 7 to ensure the least possible impact, and standard traffic control measures will be implemented to safely co-ordinate traffic flow. Signage and traffic control personnel will be posted, if necessary, during these events.

6.10 Recreation Facilities

The recommended works may require short term closures of the existing trails leading north and south from Humberland Drive. Appropriate signage and barriers should be installed to prevent the public from entering any active construction areas, and advanced notice should be provided to area residents alerting them to the timing and duration of any temporary trail closures.

6.11 Post-Construction Impacts and Mitigation

Few impacts are anticipated following the improvements to the SWMF 1-4 wet pond facility, the replacement of the Humberland Drive culvert, or the decommissioning of the Ecopark filter pads. As mentioned in **Section 5.5**, monitoring may be considered to verify the effectiveness of the proposed improvements to the wet pond, and the impacts on the upstream flood levels due to the Humberland Drive culvert replacement.

6.12 Permits and Approvals

The complete list of required permits and approvals will be established during detailed design. However, it is expected that the following permits and approvals will be required for construction of the recommended works.

- **Toronto and Region Conservation Authority**: A permit will be required for Development, Interference with Wetlands and Alterations to Shorelines and Watercourses (Ontario Regulation 166/06).
- **City of Richmond Hill**:
  - Formal approvals from the City are not required, as the City is the proponent and owns the Ecopark, Humberland Drive right-of-way and SWMF 1-4 wet pond. However, the detailed design must consider input and be coordinated with or reviewed by a number of City departments, and it should be confirmed that the project continues to comply with all applicable City policies and by-laws at the time of construction.
  - An amendment to the City's CLI-ECA will be required for the proposed modifications to the SWMF 1-4 wet pond.
  - The City and design engineer will be required to sign off on the alterations to the existing watermain on Humberland Drive through the City's Drinking Water Works Permit with MECP.
- **Ministry of the Environment, Conservation and Parks**:
  - Depending on construction requirements, registration on the Environmental Activity and Sector Registry or a Permit to Take Water may be required for construction site dewatering.
  - As described in **Section 6.3**, a Request for Review memo or Information Gathering Form should be submitted to MECP with the results of the Species at Risk screening. This should take place during detailed design, when the extent of work and potential impacts can be clearly understood and communicated to MECP.
- **Ministry of Natural Resources:** A fish and wildlife collection permit may be needed to rescue and fish and animals trapped in the SWMF 1-4 wet pond when it is emptied prior to sediment removal, deepening and expansion.
- **Fisheries and Oceans Canada**: A Request for Review should be submitted to the DFO to screen for potential requirements under the Fisheries Act.
- **Utilities**: Approvals will be required for utility owners for protection and/or relocation of existing above and below ground utilities.

7 Public Consultation

7.1 Consultation Approach

The Municipal Class Environmental Assessment (EA) requires contact with the public at certain points during the EA study. The study involves 'works undertaken in a watercourse for the purposes of flood and erosion control,' and therefore the study was completed as a Schedule 'B' project under the Municipal Class EA. Schedule 'B' generally include a single Public Open House to present the preliminary preferred solution to the public. The points of public contact for this project are summarized in **Table 7-1**.

Table 7-1 Schedule of Class EA Milestones

Milestone	Date
Notice of Commencement	March 8, 2023
Public Open House	May 31, 2023
Notice of Completion	March 2024

7.2 Notice of Commencement

A Notice of Commencement was prepared and circulated on March 8, 2023. A copy of the Notice is provided in **Appendix J** for reference. The Notice was mailed to all residents in and near the study area, and a copy was sent via e-mail to relevant agencies, indigenous communities, utilities, and other stakeholders.

The Notice summarized the purpose and scope of the study, and invited interested parties to provide comments. All feedback received from the public and agencies in response to the Notice of Commencement is included in **Appendix J**.

7.3 Public Open House

The Public Open House (POH) was held at the Oak Ridges Library, 34 Regatta Avenue, Richmond Hill, in Meeting Rooms 1 and 2 on the evening of May 31, 2023. The Notice for POH was advertised on the City of Richmond Hill website, and was mailed to surrounding property owners, residents in adjacent communities and all other stakeholders who indicated in interest

in the study in their response to the Notice of Commencement. A copy of the Notice of POH is included in **Appendix J.**

The purpose of the POH was to inform the public of the existing conditions in the study area, present alternative solutions and the preliminary preferred solutions to address the filter pads north of Humberland Drive, wet pond and flooding due to the Humberland Drive culverts. The POH followed an informal open house format with display boards presenting the project information, and provided participants with an opportunity to review and comment on the project information and correspond directly with the project team. A copy of the display boards is included in **Appendix J.**

The presentation materials from the POH were also posted on the City's website. An online survey was developed to obtain comments from the public regarding the information and recommendations presented at the POH.

Seventeen (17) individuals registered on the sign-in sheet for POH. Attendees were encouraged to provide written comments on comment sheets provided. Seven (7) comment sheets were completed and submitted at the POH, and an additional thirteen (13) on-line comment forms were submitted following the POH. All comment forms are included in **Appendix J.**

The key issues raised at and following the POH are as follows:

- A resident expressed a desire to see the wet pond decommissioned, and instead rely exclusively on the Ecopark itself to provide all stormwater quality and quantity control. This has been examined but not carried forward as it would not meet current provincial standards for stormwater management.
- Several residents expressed concerns regarding the extent of the existing Regional storm floodplain. Explanations have been provided to these residents clarifying how and when the TRCA established the Regulatory flood plain for the Ecopark tributaries.
- A resident raised concerns regarding the conditions of the existing filter pads and questioned the City's past maintenance of the filter pads. Additional information regarding the City's ongoing maintenance program for the stormwater management infrastructure is included in the condition assessment (**Section 2.3.2.2**).
- Two residents raised concerns regarding poor drainage conditions within the Ecopark and rear yards abutting the Ecopark, and a potential link to mosquitos. These concerns are related to local drainage issues, and not the broader stormwater management and flooding issues documented in this Project File Report. Appropriate City staff have been alerted to investigate these local drainage issues and determine whether any work needs to be done to prevent these flooding concerns.

Responses to the residents indicating how their concerns have been addressed in the final Project File Report are included in **Appendix J**.

7.4 Notice of Completion

The Project File Report (PFR) was made available to the public, other interested parties and external agencies for a 30-day review period as required under the Ontario Environmental Assessment Act. A Notice of Study Completion was posted on the City's website at RichmondHill.ca/HumberFlatsEA and a copy of the notice was issued to government agencies, Indigenous communities, stakeholders, external agencies, adjacent residents and other members of the public on the project mailing list.

A copy of the Notice of Completion as it appeared on the City's website is included in **Appendix J**. The Notice includes information on how to access the PFR, instructions to direct any comments or concerns to the City's project manager, and instructions on completing a Section 16 request if there remain outstanding concerns regarding potential adverse impacts on constitutionally protected Aboriginal and treaty rights.

7.4.1 Section 16 Request

A member of the public submitted a letter to the Minister requesting a higher level of study (through a Section 16 Order) on April 24, 2024. The letter generally requested that the filter pads and Ecopark channel corridors be restored to their original condition and formally recognized as providing full water quality and quantity treatment of storm runoff. The letter further requested that the flow from the Ecopark channels should bypass the wet detention pond and be discharged directly to the East Humber River.

The City provided MECP with additional information on the study and stakeholder engagement process, and met with the member of the public on December 11, 2024 to attempt to resolve their concerns. The member of the public was not fully satisfied with the outcome of the meeting, and subsequently made a delegation to Richmond Hill City Council on February 12, 2025. Following the presentation, Council did not direct staff to carry out any further study or revisit the recommended solutions for rehabilitation of the Humber Flats stormwater management facility.

A copy of the materials submitted to MECP and minutes from the meeting with the member of the public is included in Appendix J.

7.5 Consultation with Indigenous Communities

Staff at MECP indicated that the Mississaugas of the Credit First Nation (MCFN) may have an interest in the study, and the Huron-Wendat First Nation may also have interest in the study if there is any potential for impacts to archaeological resources.

As the anticipated area of disturbance for the culvert replacements have been cleared of archaeological potential, the Huron-Wendat First Nation was not engaged for this Municipal Class EA.

The MCFN was informed of the study on May 23, 2023 and provided an opportunity to provide input to the study, but no response was received at that time.

Further attempts were made to contact MCFN in November and December 2024, and a response was received on December 17, 2024 with some questions related to biodiversity, climate change, monitoring, and opportunities for First Nation field staff to participate construction or post-construction inspections. The City responded to the questions from MCFN on December 20, 2024, and committed to keeping the MCFN informed of the project as it proceeds to detailed design and construction. The MCFN indicated they were satisfied with the responses in an e-mail dated January 23, 2025.

A copy of the correspondence with the MCFN, including the City's responses to the questions received in December 2024, is included in **Appendix J**.

7.6 Other Agency Consultation

A meeting was held with the TRCA on May 19, 2023. Staff from the TRCA were in general agreement with the recommendations to decommission the filter pads and expand the wet detention pond, but were concerned with the potential increase in downstream peak flow rates resulting from the Humberland Drive culvert replacement.

TYLin undertook additional analyses to assess the impact of the increased flow rates on flood levels in the East Humber River. The analyses, documented in **Section 5.3.1**, determined that any impacts on flooding would be negligible and/or contained within publicly-owned lands.

TRCA subsequently reviewed and provided comments on a draft final version of this Project File Report. A copy of the meeting minutes, a letter responding to the initial concerns raised by the TRCA and a letter describing how the TRCA's comments have been addressed in this final Project File Report are included in **Appendix J**.

8 Summary

The Humber Flats SWMF 1-4 stormwater management system is generally located east of Bathurst Street and south of Bloomington Road in the City of Richmond Hill. The study area is bound by Bathurst Street to the west, Red Cardinal Trail to the north and east, and the East Humber River to the south.

The following elements make up the SWMF 1-4 stormwater management system:

- Small detention basins, referred to as filter pads, at 9 storm sewer outfalls distributed along the Ecopark system that are intended to hold and slowly release the runoff from small storm events through granular layers in the berms forming the basins.
- The Ecopark, which is a combination of the filter pads and open space corridors. Runoff from external areas and the filter pads are conveyed to Humberland Drive via open channels in the Ecopark.
- A French Drain under the low flow channel, which is intended to intercept base flows / low flows in the system and discharge directly to the East Humber River via a connection to the foundation drain collection system for the surrounding residential development. This system was included to help mitigate thermal impacts to the coldwater fish habitat in the East Humber River.
- Two culverts under Humberland Drive, which are intended to store and attenuate peak flows in the Ecopark corridors during large storm events to meet the quantity control targets.
- A wet detention pond south of Humberland Drive, which provides quality treatment and extended detention of the storm runoff.

Controlled flows from the Humberland Drive culverts and wet detention pond discharge to the East Humber River via an open channel leading from Humberland Drive.

The stormwater management infrastructure in the study area was constructed over 25 years ago and requires some maintenance.

- The majority of the filter pads appear to provide little attenuation of storm runoff in their current condition. This is due in part to excessive sediment accumulation, clogging of the granular materials in the berms forming the pads, and/or erosion of the outlet spillways from the filter pads. Note, however, that the benefits of the filter pads for water quality and erosion mitigation are difficult to quantity, and they were not relied upon to achieve the criteria for quality and quantity control in the original design of the facility.

- The wet detention pond located south of Humberland Drive is approximately 10% full of sediment, impairing its performance for water quality treatment. Even if all the accumulated sediment were removed, the wet detention pond would not meet current standards for water quality treatment. In addition, the maintenance access road leading into the wet detention pond is in poor condition.
- The culverts under Humberland Drive, intended to control peak flow rates from the system to the targets established during the design of the facility, contribute to significant flooding along the Ecopark upstream of Humberland Drive during a Regional (Hurricane Hazel) storm event. More than 200 properties and up to 165 homes are at risk of flooding in a Regional storm event.

This study was carried out to more accurately characterize the planning, natural, social, cultural and engineering environments through the study area, and to develop and evaluate alternatives to rehabilitate and enhance the SWM infrastructure, reduce the potential for flooding and flood damages, and protect or improve natural habitat and recreational infrastructure through the study area.

The study area is located on the Oak Ridges Moraine and is designated Natural Core and Natural Linkage in the City of Richmond Hill Official Plan. It contains mineral cultural woodland and meadow vegetation communities, and a mineral shallow marsh community along the East Humber River itself. No rare, threatened or endangered vegetation species were observed and several highly invasive species like the European Buckthorn and Common Reed are present in the study area.

A single tree located near the playground off of Raintree Crescent was flagged as potential roosting habitat for endangered bat species due to abundant peeling bark and cracks. No Species at Risk were observed in the field investigations, and it was concluded that the study area does not contain Significant Wildlife Habitat.

No erosion issues were identified in the study area. The majority of the Ecopark lacks a defined low flow channel, and storm runoff instead flows along the wide, vegetated base of the Ecopark.

Updates to the hydrologic and hydraulic modelling for the East Humber River subwatershed were completed to better represent areas discharging to the East Humber River between Bathurst Street and Yonge Street. The model was used to assess the performance of the SWMF 1-4 system for water quality treatment, erosion mitigation and peak flow control, and to predict the depth and extent of flooding through the study area for a range of storm events.

The filter pads were intended to capture and slowly release the runoff resulting from a 13 mm rainfall event. In their current condition, the filter pads appear to provide little attenuation of storm runoff. The hydrologic modelling indicates that, even if restored to their original design

condition, the filter pads would result in negligible improvements that could be quantified for water quality treatment, erosion mitigation and peak flow control.

Approximately 700 m^3 of sediment has accumulated in the wet detention pond south of Humberland Drive, reducing its water quality treatment performance to 73% TSS removal. Even if all of the sediment were removed, the TSS removal efficiency would only increase to 74%, whereas current standards require 80% TSS removal.

Even without considering the filter pads, the wet detention pond appears to be meeting current criteria for erosion mitigation (extended detention of the runoff from a 25 mm storm event), and the combination of the wet detention pond and Humberland Drive culverts are controlling peak flow rates well below the targets established during the original design of SWMF 1-4 for all storm events up to and including the 100 year storm.

The updated hydrologic modelling, hydraulic modeling and floodplain mapping determined that the extent of flooding in a 100 year storm event is fully contained within the Ecopark corridors. However, the Regional (Hurricane Hazel) floodplain extends into 203 properties within the study area, and 165 homes in the study area are partially to entirely within the Regional storm floodplain. The culverts at Humberland Drive are a bottleneck in the system, leading to the significant depth and extent of flooding upstream of Humberland Drive during a Regional storm event.

A range of alternative solutions were considered for the rehabilitation of each component of the Humber Flats SWMF 1-4 stormwater management system.

Systems North of Humberland Drive

- **Do Nothing**: Stormwater runoff would continue to be conveyed through the filter pads with no attenuation.
- **Decommission the Filter Pads:** The filter pads would also no longer be relied upon as part of the SWM system and would be decommissioned and removed from the City's stormwater management facility inspection and maintenance program. Limited works would be needed at some filter pads to ensure positive drainage from the storm sewer outlets to the Ecopark channels.
- **Rehabilitate the Filter Pads**: Sediment accumulated in the filter pads would be removed and the berms and spillways at each filter pad outlet would be reconstructed. Additionally, a Hickenbottom outlet would be installed in each restored filter pad to better regulate the discharge from each filter pad and achieve the desired extended detention time.
- **Reconstruct the Ecopark System with On-line Quantity and Quality Facilities:** This would help control flows up to current standards for the 2 to 100 year storm events, and

also allow for the replacement of the culverts under Humberland Drive to reduce the extent of the Regional storm floodplain upstream of Humberland Drive. This would also require modification of the Ecopark channel between the new control structure and Humberland Drive and reconstructing the channel from Humberland Drive to the East Humber River. The existing wet detention pond south of Humberland Drive could also be decommissioned with all stormwater management function moved to north of Humberland Drive.

Wet Detention Pond South of Humberland Drive

- **Do Nothing**: The wet detention pond would remain in its current condition, with no modifications to address the observed deficiencies.
- **Clean and Restore the Wet Detention Pond:** The accumulated sediment would be removed, and the maintenance access road leading into the pond would be reconstructed. Following cleanout, the permanent pool volume in the wet pond would not be sufficient to meet current standards for Enhanced water quality treatment.
- **Clean, Deepen and Expand the Wet Pond**: This would include removing all of the accumulated sediment in the facility, expanding the pond southward, and excavating the base of the pond to create a uniform 3 m deep permanent pool throughout the facility. The resulting permanent pool volume would be sufficient to achieve the current standard of Enhanced water quality treatment. A safety shelf would also be constructed at the normal water level in the pond to alleviate safety concerns related to the increased water depth.

Flood Mitigation

- **Do Nothing**: No flood mitigation would take place and approximately 203 properties and 165 homes would continue to be at risk of flooding during a regional storm event.
- **Humberland Drive Culvert Improvements**: The existing concrete box culvert under Humberland Drive would be replaced with 3 – 3.0 m wide x 2.1 m high concrete box culverts. The number of properties impacted by flooding would be reduced from 203 to 129. The number of homes potentially impacted by flooding in a Regional storm event would be reduced from 165 to only 7. The larger culverts under Humberland Drive would increase peak flow rates to the East Humber River relative to current conditions for up to the 100 year storm event, but the peak flow rates would remain well below the targets established during the original design of the system. Relative to current conditions, the increased peak flow rates would have a negligible impact on flood levels and flood extents downstream of Bathurst Street, and the very small increase in the depth and

extent of flooding upstream of Bathurst Street would be contained within the open space lands owned by the City and TRCA.

- **Humberland Drive Culvert Improvements with Upstream Flow Control:** This alternative includes the same with 3 – 3.0 m wide x 2.1 m high concrete box culverts as the previous alternative, but also includes a flow control structure upstream of Humberland Drive to prevent the increase in peak flow rates associated with the larger culverts under Humberland Drive. The flow control structure would likely take the form of a concrete weir across the width of the Ecopark channel a short distance upstream of Humberland Drive.
- **Non-Structural Measures to Reduce Flood Risk**: This alternative would not involve any physical works to reduce the depth or extent of flooding, but would instead focus on minimizing risks to public safety and property damage during future potential flood events. At a minimum, this would include signage at the playground located off of Raintree Crescent to alert playground users of the risk of flooding and direct them to avoid the playground during and following storm events. It could also include an audible and visual warning system at the playground, connected to City operated flood warning system.

The above alternatives for each facility were evaluated comprehensively against criteria related to the natural, social, cultural, technical and financial environments. The results of the evaluation and preferred solutions are summarized in **Table 8-1.**

Table 8-1 Preferred Solutions

Facility Component/Area	Alternative	Estimated Cost
North of Humberland Drive	**Decommission the Filter Pads** Leaving the filter pads in their current condition, with minor works at some filter pads to ensure positive drainage, would have a negligible impact on water quality and erosion mitigation, and would reduce the City's long term maintenance costs for the Ecopark.	**$0.1 Million**
Wet Detention Pond	**Clean, Deepen and Expand the Wet Pond** This alternative achieves provincial standards for water quality treatment and can be implemented with minimal impacts to the natural environment.	**$1.3 Million**
Flood Mitigation	**Humberland Drive Culvert Improvements** The solution would remove 158 homes from the floodplain, and works would be contained to the Humberland Drive right-of-way. The increased peak flow rates resulting from the larger culvert would remain below original target levels.	**$3.6 Million**
Flood Mitigation	**Non-Structural Measures to Reduce Flood Risk (Partially Recommended)** Signage alerting playground users to the risk of flooding is recommended. Signage can be installed at a relatively small cost and will improve public safety at the playground	**$0.02 Million**

The Humber Flats SWMF 1-4 Rehabilitation Study has been carried out in accordance with the Municipal Class Environmental Assessment Process (Schedule B), which is required for the planning of all major municipal projects and activities. Consultation with the public, agencies and other stakeholders has taken place throughout the project, including a Public Open House to provide an opportunity for the public to provide input to the project and preferred solutions.

All concerns raised by the public and agency staff, including Indigenous Communities, have been considered in the development and evaluation of alternative solutions and have been addressed in the final Project File Report.

9 References

A Place to Grow: Growth Plan for the Greater Golden Horseshoe. (2020, August). Ontario, Canada. Retrieved 2023, from https://files.ontario.ca/mmah-place-to-grow-office-consolidation-en-2020-08-28.pdf

Aquafor Beech Limited. (2019). *Humber River in York Region Floodplain Mapping Update*. Prepared for the Toronto and Region Conservation Authority.

Chapman, L., & Putnam, F. (1984). *The Physiography of Southern Ontario* (Vol. 2). Ontario Ministry of Natural Resources.

Cheminfo Services Inc. (2005, March). Best Practices for the Reduction of Air Emissions from Construction and Demolition Activities. Prepared for Environment Canada Transboundary Issues Branch. Retrieved from http://www.bv.transports.gouv.qc.ca/mono/1173259.pdf

City of Richmond Hill. (2023). *City of Richmond Hill Emergency Plan.* Retrieved 2023, from Richmond Hill: https://www.richmondhill.ca/en/our-services/Richmond-Hill-Emergency-Plan.aspx

Civica. (2018). *Final Report: Humber River Hydrology Update.* Prepared for the Toronto and Region Conservation Authority.

Cosburn Patterson Mather Limited. (1996). *Stormwater Management Design Brief, Humber Flats Subdivision, South Wet Extended Detention Pond, Quantity Control and Ecological Park Grading Study Area C.* Town of Richmond Hill.

GHD. (2021, November 26). Parks Crossing Assessment Study 2021. Prepared for the City of Richmond Hill.

Government of Ontario. (2017, May). Oak Ridges Moraine Conservation Plan (2017). Retrieved 2023, from https://files.ontario.ca/oak-ridges-moraine-conservation-plan-2017.pdf

Hatch. (2017). *Barrie Corridor Expansion Project Transit Project Assessment Process Environmental Project Report.* Prepared for Metrolinx. Retrieved from https://www.metrolinx.com/en/projects-and-programs/barrie-line-go-expansion/studies/barrie-rail-corridor-expansion-tpap

Lee, H. T., Bakowsky, W., Riley, J., Bowles, J., Puddister, M., Uhlig, P., & Mcmurray, S. (1998). *Ecological Land Classification for Southern Ontario: First Approximation and its Application.* Ontario Ministry of Natural Resources, Southcentral Science Section, Science Development and Transfer Branch.

Ministry of Natural Resources and Forestry. (2022). *Natural Heritage Information Centre Species Lists*. Retrieved from Ministry of Natural Resources and Forestry: https://www.ontario.ca/page/get-natural-heritage-information

Ministry of the Environment, Conservation and Parks. (2019, December). *Handling Excess Soil*. Retrieved from Government of Ontario: https://www.ontario.ca/page/handling-excess-soil

Municipal Engineers Association. (2023). *Municipal Class Environmental Assessment*. Retrieved from https://prod-environmental-registry.s3.amazonaws.com/2023-03/2023%20Amended%20Municipal%20Class%20Environmental%20Assessment.pdf

Ontario Ministry of Transportation. (2008, January). Highway Drainage Design Standards. Retrieved from Ontario Ministry of Transportation: https://www.library.mto.gov.on.ca/SydneyPLUS/Sydney/Portal/default.aspx?component=AAAAIY&record=51bb97c8-3a86-41b6-9bbf-cc0c2e7a45fa

Provincial Policy Statement, 2020: Under the Planning Act. (2020, May 1). Ontario, Canada. Retrieved 2023, from https://files.ontario.ca/mmah-provincial-policy-statement-2020-accessible-final-en-2020-02-14.pdf

R.J. Burnside & Associates Limited. (2014, July). *Summary Report for Digital Floodplain Mapping for the East Humber River within the Town of Richmond Hill*. Prepared for the Toronto and Region Conservation Authority.

Richmond Hill Official Plan. (2023, January). Ontario, Canada. Retrieved 2023, from https://www.richmondhill.ca/en/find-or-learn-about/Official-Plan.aspx

RJ Burnside & Associates Limited. (2014). *Humber Flats Flood Remediation Hydraulic Report*. Prepared for the Toronto and Region Conservation Authority and Town of Richmond Hill.

Toronto and Region Conservation Authority. (2012, August). Stormwater Management Criteria. Retrieved from https://trca.ca/app/uploads/2016/04/SWM-Criteria-2012.pdf

Toronto and Region Conservation Authority. (2019). *Flora Ranks and Scores*. Retrieved from Toronto and Region Conservation Authority: https://s3-ca-central-1.amazonaws.com/trcaca/app/uploads/2019/07/08142613/2019_Flora_Ranks__Scores.pdf

TY Lin International Canada Inc. (2023). *Schomberg Road Culverts Project File Report Addendum*. Prepared for the City of Richmond Hill.

York Region. (2023, June). 2022 York Region Official Plan. Ontario, Canada. Retrieved 2023, from York Region: https://www.york.ca/york-region/regional-official-plan