1 INTRODUCTION

In 2003, the City of Toronto (City) completed the development of a Wet Weather Flow Management Master Plan (WWFMMP). The WWFMMP was founded on the principle that precipitation is a resource that needs to be managed effectively. The overarching objective of the WWFMMP was to reduce and ultimately eliminate the adverse impacts of wet weather flow on public and private property, while simultaneously improving the ecological health of Toronto's varied ecosystems. The WWFMMP is a major planning document originally intended to allocate one billion dollars towards various projects over an initial 25-year implementation period. One major component of the WWFMMP is watercourse management for which $88.9 million was allocated from 2003-2016, with an additional $220.5 million of public spending planned for 2017-2026. This area of concern has recently received renewed interest and enhanced prioritization as a result of the severe damage caused to both public and private properties/infrastructure by channel erosion during the July 2013 flood.

The Watercourse Management Program is a collaborative endeavour between the City of Toronto and Toronto and Region Conservation Authority (TRCA) and is intended to address erosion related risks to public and private property. A major ongoing initiative of the Watercourse Management Program and WWFMMP is the development of Geomorphic Systems Master Plan studies for Toronto's major watercourses. Geomorphic Systems Master Plans are multi-phase, multi-disciplinary studies that assess active erosion processes at the watershed or subwatershed scale in order to ultimately identify, evaluate and prioritize erosion related risks to public and private assets at a more granular level.

The City of Toronto has commissioned Aquafor Beech Limited (Aquafor) to undertake the Geomorphic Systems Master Plan Study for Newtonbrook Creek and Blue Ridge Creek (NCGSMP), in North York. The emphasis of the NCGSMP is on systematically locating and prioritizing erosion related risks to Toronto Water (TW) infrastructure within the Newtonbrook Creek and Blue Ridge Creek corridors, including: sanitary sewers, storm sewers & outfalls, watermains and any associated erosion protection works. While risks to private property and non-municipal infrastructure will also be documented as part of the NCGSMP, these sites will not factor directly into the risk assessment process as the emphasis of the study is on protecting Toronto Water assets. However, when developing conceptual design solutions for each priority site, consideration will be given to adjusting project extents to simultaneously provide benefits to private property and non-municipal infrastructure where it is economically and technically feasible to do so.

Phase 1, 2, 3 & 4 of the NCGSMP have already been completed. **Phase 1** consisted of a comprehensive literature review and data gap analysis, which **Phase 2** leveraged to complete a detailed risk assessment of all Toronto water infrastructure within the Newtonbrook and Blue Ridge Creek valley corridors, culminating in the prioritization of twenty-four (x24) erosion risk sites. The development of restoration concepts to address erosion related risks to Toronto Water Infrastructure were introduced as part of the **Phase 3** works, which also included the evaluation of restoration concepts for all twenty-four (24) priority sites, using a multi-objective evaluation matrix consistent with City of Toronto standards. Given the spatial density of several priority sites, and the expansive nature of some of the proposed sub reach based solutions, multiple priority sites are often addressed through a single local or sub reach based works project. This bundling of priority sites ultimately resulted in a total of eleven (x11) capital works projects which will address not only the top twenty-four (x24) priority sites identified in the Risk Assessment Report, but will also address several other lower priority sites with medium to long-term erosion related risks to Toronto Water infrastructure. **Phase 4** included the prioritization of the eleven (x11) proposed capital works projects based on their associated failure risks to Toronto Water infrastructure, and developed refined cost estimates for each of the eleven (x11) projects. The submission of this Master Plan Report signifies the completion of **Phase 5**, and the completion of the environmental assessment study, and provides a summary of previous phases, along with an overview of the public and first nations consultation activities.

1.1 Goals and Objectives: Statement of Environmental Assessment

The NCGSMP is intended to satisfy all requirements of an Environmental Assessment including problem identification, development and assessment of alternatives, public and first nations consultation and creation of an implementation plan. This Master Plan Report is intended to fulfill all the components of the Environmental Assessment process, by using an approach that is consistent with environmental assessment standards.

2 PHASE 1: ISSUE ASSESSMENT AND PROBLEM CONFIRMATION

Phase 1 of the NCGSMP consisted of a comprehensive literature review for the study area, incorporating all pertinent information, such as easement information, utility information, inspection and maintenance records, and previously completed technical studies. Furthermore, gaps in the provided data were identified, and a strategy to resolve the missing information formulated. **Table 2-1** presents the background information that was reviewed as part of **Phase 1** of the NCGSMP.

Table 2-1: List of Background Data Received as part of Phase 1

Data Received	Description of Data Set and Source
Orthophotos	Orthophotos of the area, from TRCA.
CADD specifications for MicroStation V8	Pdf describing the configuration preferred by the City of Toronto
CADD Specification Manual	Pdf from the City of Toronto, Third Edition (May 2019)
Watercourse Projects Requirements	From the City of Toronto, ECS, June 2020
General Work Requirements	From the City of Toronto, ECS Version 1.1, June 2017
Health and Safety Design Standards	From the City of Toronto, ECS Version 1.0, October 2016
Necessary Regulatory Approvals	From the City of Toronto, ECS Version 1.0, October 2016
Drawing Standards	From the City of Toronto, ECS Version 1.0, October 2016
Environmental Assessment Standards	From the City of Toronto, ECS Version 1.0, June 2017
Engineering Study Standards	From the City of Toronto, ECS Version 1.1, April 2017
Pre-Design Engineering Serves Definitions	From the City of Toronto, ECS Version 1.2, June 2017
Professional Services Performance Evaluation	From the City of Toronto, for Design, Contract Administration, Post Construction, Planning or Other (Version 1.0, March 22, 2017)
Capital Works Procedures Manual	Pdf from the City of Toronto, Rev. 1.1 (2011)
Wet Weather Flow Management Master Plan, Overview and Implementation Plan	Pdf from the City of Toronto (July 2003)
Wet Weather Flow Management Master Plan for Area 4: Don River	Additional details for Area 4: Don River Watershed, Sections 1 – 10, including Appendices, Figures, and Tables (July 2003)
Wet Weather Flow Management Policy	Pdf from the City of Toronto (August 2003)
Toronto Ravine Strategy	Pdf from the City of Toronto (October 2017)
Highland Creek Geomorphic Systems Concept Design Implementation Plan	Aquafor Beech Concept Design Report, (August 2011)
Taylor Massey Creek Geomorphic Systems Master Plan – MCEA	Municipal Class Environmental Assessment by Parish aquatic services, (March 2015)
Easement Agreements	Excel, .tif, and .pdf copies of Newtonbrook Creek Easement drawings
Engineering Drawings	As-Builts Drawings of all known sanitary sewers in both Newtonbrook Creek and Blue Ridge Creek, received from the City of Toronto in .tif format
Enbridge Concepts – oil and gas pipeline	One .pdf drawing of engineered designs to protect oil and gas pipeline from creek bed erosion, received from Enbridge
TRCA Inspections of Toronto Water Infrastructure	List of most recent inspection results for Toronto Water Infrastructure in the Study Area
Topography Data	LIDAR derived DEM of topography data (2018)
Property Data	From the City of Toronto, property data and parcels in shapefile format
TWAG Data	City of Toronto infrastructure mapping, including maintenance holes, stormwater outlets, and sanitary sewers
DCAD	Updated City of Toronto infrastructure mapping, including maintenance holes, stormwater outlets, and sanitary sewers
Newtonbrook Area GIS files	An assortment of shapefiles from TRCA, including Erosion Risk Sites, Erosion Structure Sites, ANSI, PSW, WSA, Floodplain mapping, Fisheries Data, and HEC-RAS Model and Associated Hydrological Modelling
Land use	Land use shapefile from TRCA
CCTV Data	CCTV data from sub-consultant on the conditions of sanitary sewer lines

Data Received	Description of Data Set and Source
Erosion Structures, Erosion Control Structures, TRCA Erosion Risk Monitoring Data	TRCA Erosion Structure and Erosion Risk monitoring data from most recent inspections
Wet Weather Flow Management Master Plan (WWFMMP) Models	Modelling completed for the City of Toronto WWFMMP, specifically the Don River Portion
Clarinda Drive Erosion Control and Slope Stabilization Design	Conceptual Design and Existing Conditions Survey, completed by TRCA for a Slope Stabilization Project along Blue Ridge Creek
TNPI Pipeline Engineering Drawing	Engineering Drawing of the TNPI Pipeline Crossing Newtonbrook Creek, now exposed
Don River HEC-RAS Model	TRCA generated HEC-RAS Model, to be used in Hydraulic Modelling
Meteorological Data	Ambient air temperature, precipitation, and other meteorological data available through Environment Canada

A categorized breakdown of the key information received based on the supplier of the information (i.e., TRCA, private utility owners, City of Toronto, etc.) is provided in the following sub-sections, followed by a data gap analysis.

2.1 TRCA Background Information on Risks To Private Property & Toronto Water Infrastructure

In addition to impacting Toronto Water Infrastructure, erosion within Newtonbrook Creek and Blue Ridge Creek impacts private properties and non-municipal infrastructure. These erosion related risks to private property are predominately managed by Toronto Region Conservation Authority (TRCA) through their Erosion Control Structure (ECS) and Erosion Hazard Site (EHS) Monitoring programs. TRCA has provided information on the ECS and EHS they are managing in the Newtonbrook Creek and Blue Ridge Creek study areas. **Table 2-2** presents the ECS and EHS inspection records received from TRCA.

Table 2-2: Summary of Erosion Control and Erosion Hazard Data received from TRCA

Name	Number of Assets	Format	ID Series	Attributes
Erosion Control Assets	8	Shapefile	D-28-ESA0X and EMSXX	• Location coordinates • Inspection dates • Rankings • Scar Length • Stratigraphy • Riparian Vegetation • Mass movement type • Seepage • Distance to Structure
Water Erosion Risk Monitoring	177	Shapefile	DRR81-01 to DRR88-22	• Location coordinates • Infrastructure (Maintenance Hole, Outfall, Sewer, etc.) • Inspection dates • Risk Levels • Priority • Asset ID
Erosion Assets and Erosion Structure Monitoring Records	19	PDF Table	DR10X.XX and DRXX	• Inspection Dates • Owner • Builder • Structure Type • Structure Stability • Structure Condition • Maintenance Priority • Some Inspection Records

A full listing of data received by TRCA has been compiled, and is provided in **Appendix A**. These TRCA led monitoring programs evaluate the condition of various erosion control structures designed to mitigate erosion related risks to private properties. The program documents the condition of each structure and assesses attributes such as recent movement, gullying, slope instability, and future instability. Significant background information for eight (8) Erosion Control Assets have been delivered by TRCA. The Erosion Control Assets are summarized in **Table 2-3,** with a red-green color-coding system applied to highlight structures with high future instability.

Table 2-3: Erosion Control Structures in Newtonbrook Creek

TRCA Erosion Site ID	Watercourse	Score	Slope Height (m)	Scar Length (m)	Mass Movement	Future Instability	Flow Characteristic
EMS370	Newtonbrook Creek	47	0-10	26	Recent movement - minor to moderate	**Medium to high**	Major cutting at high flow only
D-28-ESA02	Newtonbrook Creek	46	0-10	~120	Recent movement - moderate	**High**	Minor cutting at high flow only
EMS752	Blue Ridge Creek	67	0-10	4.6	Recent movement - major	**Medium to high**	Moderate cutting at high flow only
D-28-ESA01	Newtonbrook Creek	43	0-10	37	Recent movement - minor	**Low to medium**	Moderate cutting at high flow only
D-28-ESA02	Newtonbrook Creek	74	0-10	38	Recent movement - minor	**Medium to high**	Moderate cutting at high flow only
EMS073	Newtonbrook Creek	66	21+	N/A	Recent movement - minor	**Low**	Not applicable
EMS183	Newtonbrook Creek	74	0-10	22	Recent movement - moderate	**High**	Major cutting at high flow only
EMS857	Newtonbrook Creek	68	N/A	N/A	Recent movement - minor	**Low to medium**	Not applicable

Maps of the locations of these erosion control structures and water risk monitoring sites can be found in **Appendix B.** TRCA also implements an EHS monitoring program for a number of erosion hazard sites. These sites may be flagged by TRCA staff during general inspections or by private property owners. Many of these sites threaten private or municipal property but to varying degrees of severity and urgency. Similar to the Erosion Control Asset program, these sites are inspected annually to evaluate any changes to the hazard site, especially for changes affecting or possibly affecting nearby private structures. For the erosion hazard sites in Newtonbrook Creek, the correlated Toronto Water infrastructure was included. **Table 2-4** shows sites which correlate directly with Toronto Water infrastructure crossings. It is notable that all the crossings show a risk level of visible risk or are marked as exposed.

Table 2-4: Selected Water Erosion Risk Monitoring sites, with Correlated Sanitary Sewer Crossings

Structure	Watercourse	Infrastructure	Risk Level	Priority	TW Asset ID	Crossing #
DRR83-14	Newtonbrook	Sanitary Sewer	Exposed	N/A	SL4033032	1
DRR83-12	Newtonbrook	Sanitary Sewer	Visible Risk	N/A	SL4033582	2
DRR83-09	Newtonbrook	Sanitary Sewer	Visible Risk	N/A	SL4032406	3
DRR83-07	Newtonbrook	Sanitary Sewer	Visible Risk	1 (To Be Monitored)	SL4032404	4
DRR85-20	Newtonbrook	Sanitary Sewer	Exposed	N/A	SL4031857	5
DRR85-18	Newtonbrook	Sanitary Sewer	Visible Risk	N/A	SL4031887	6
DRR85-25	Newtonbrook	Sanitary Sewer	Visible Risk	N/A	SL4031887	7
DRR85-03	Newtonbrook	Sanitary Sewer	Visible Risk	N/A	SL4033483	8
DRR86-21	Newtonbrook	Sanitary Sewer	Visible Risk	N/A	SL4031889	9
DRR86-26	Newtonbrook	Watermain	Visible Risk	N/A	LN24062	10
DRR86-15	Newtonbrook	Sanitary Sewer	Visible Risk	N/A	SL4031891	11
DRR86-12	Newtonbrook	Sanitary Sewer	Visible Risk	N/A	SL4034029	12
DRR86-11	Newtonbrook	Sanitary Sewer	Visible Risk	N/A	SL4032523	13
DRR86-04	Newtonbrook	Sanitary Sewer	Visible Risk	N/A	SL4032971	14
DRR87-28	Newtonbrook	Sanitary Sewer	Visible Risk	N/A	SL4034103	15
N/A	N/A	N/A	N/A	N/A	N/A	16
DRR87-29	Newtonbrook	Sanitary Sewer	Visible Risk	N/A	SL4031698	17
DRR82-28	Blue Ridge	Sanitary Sewer	Visible Risk	N/A	SL4030369	18
DRR82-05	Blue Ridge	Sanitary Sewer	Visible Risk	N/A	SL4029711	19

2.2 Background Information Provided by Private Utility Owners

Located within a highly urbanized watershed, the study area contains several types of utilities besides City-owned linear infrastructure including, but not limited to, telephone and communication cables, natural gas pipelines, oil pipelines, and overhead and underground electrical cables. As part of the background compilation and review process, Aquafor submitted an Ontario One Call request and also corresponded directly with a series of private utility owners. The following subsections provide a detailed description of each utility type present within the study area.

2.2.1 Telephone and Communication Cables

The following telephone and communication utilities are located within the study area:

- **Bell:** Some existing conduits cross Newtonbrook Creek at major road crossings such as Maxome Avenue and Bayview Avenue. Buried lines cross Blue Ridge Creek where Burbank Drive crosses Newtonbrook Creek.
- **Rogers:** Some existing conduits and buried infrastructure cross Newtonbrook Creek at Bayview Avenue and Finch Avenue. In addition, an existing conduit runs approximately parallel to the creek at that location. Telecommunication cables run parallel to Blue Ridge Creek from Bayberry Crescent to Burbank Drive, and this area is entirely private property.

Overall, there are minimal conflicts with telecommunications infrastructure in the NCGSMP study area.

2.2.2 Oil and Gas Pipelines

The following oil and gas pipeline infrastructure is present within the study area:

- **Enbridge Gas Inc.:** A natural gas pipeline runs parallel to the hydro corridor along Finch Avenue, and crosses Newtonbrook Creek downstream of Maxome Avenue. The pipeline crossing is locally protected by engineered erosion control works.
- **Trans-Northern:** A natural gas pipeline runs parallel to Finch Avenue, and crosses Newtonbrook Creek downstream of Maxome Avenue. Based on field investigations and correspondence with Trans-Northern,

this pipeline is exposed in the creek bed. An engineering drawing of this pipeline at the crossing was received as part of the background data request process.

- **Sun-Canadian:** An oil pipeline crosses Newtonbrook Creek downstream of Maxome Avenue. This pipeline is also exposed laterally in the bank.
- **Imperial Oil:** The imperial oil pipeline crosses Newtonbrook Creek downstream of Maxome Avenue, parallel to the Trans-Northern Pipeline.

As noted above, the Trans-Northern Pipeline **(Figure 2-1)** is exposed in the bed of Newtonbrook Creek and the Sun Canadian Pipeline **(Figure 2-2)** is exposed laterally in the bank of Newtonbrook Creek.

Figure 2-1: Photo of Trans-Northern Pipeline Exposure in Channel Bed of Newtonbrook Creek

Figure 2-2: Photo of Sun-Canadian Pipeline Exposure in Bank of Newtonbrook Creek

2.3 Toronto Water Infrastructure - Existing Conditions

In support of the NCGSMP the City of Toronto provided Aquafor with access to the City's DCAD 2.0 database. Based on the mapping available in DCAD, sites where Toronto Water infrastructure crossed Newtonbrook Creek were identified. A total of nineteen (19) crossings were identified, with seventeen (17) on Newtonbrook Creek and two (2) on Blue Ridge Creek. A topographic survey of all (nineteen) Toronto Water infrastructure crossings was later completed. Using DCAD, Aquafor identified the City's Asset ID for each infrastructure crossing in addition to the sewer/watermain diameter, year of construction, material, and upstream & downstream invert depths. The sewer/watermain profiles based on City records (DCAD and As-Built) were overlain onto each cross-section to evaluate discrepancies, which can be viewed in **Appendix C**.

2.4 Review of Engineering Drawings Provided by City of Toronto

In support of the NCGSMP, a review of the available engineering drawings for the NCGSMP Study area was completed, for the drawings outlined in **Table 2-5.**

Table 2-5: Summary of Received Engineering Drawings

Drawing Name (s)	Description
157M-2, -3, -4	Watermain crossing Newtonbrook Creek (Asset ID: LN24062).
G-135-03	Sanitary Trunk Sewer underneath Gustav Crescent
H-11-5	Storm sewers, sanitary sewers, and watermain along Maxome Avenue, but not Newtonbrook Creek
A-100-01, -02	Storm sewer and sanitary sewer plan and profile along Alamosa Drive and the East Don River, upstream of the confluence with Newtonbrook Creek.
ST-36-R-01, -02	Storm sewer and sanitary sewer profiles coming off Forest Grove Drive into the East Don River.
1213-R-1, -3	East Don River sanitary trunk sewer from Sheppard Avenue E to Highway 401, south of study area
C-128-01, -02, -03	Sanitary trunk sewer along Citation Drive, adjacent to but not in the valley corridor of Blue Ridge Creek
SA-2-R-01, -02	Sanitary Trunk Sewer crossing Blue Ridge Creek (previously known as Mill Gate Creek)

After completing a comprehensive review of the engineering drawings made available, it was determined that of the nineteen (19) infrastructure crossing sites, only seven (7) have available engineering drawing records. Without engineering drawings for the remaining Toronto Water Infrastructure, it is unknown what the exact depth of cover is at time of construction. In addition, it is unknown whether the infrastructure is a straight or siphon system, which affects the modern depth of cover. In the absence of evidence to the contrary, for the purposes of this study, the infrastructure crossing the creek is conservatively assumed to be straight. This approach is considered conservative, as a siphon system would have a lower profile, and as a result more cover, than a straight sewer. The modern-day depth of cover was estimated using information from the City of Toronto's online infrastructure mapping software, supplemented with in-person field investigations where required.

2.5 Data Gap Analysis

Aquafor reviewed in detail all background information received from the City of Toronto, TRCA, and other sources. Field investigations to understand existing site conditions have been completed, including topographic surveys and geomorphic field walks of both Newtonbrook and Blue Ridge Creek. Upon completion of the data collection phase, a number of discrepancies and data gaps were uncovered, which were subsequently addressed through a combination of follow-up data requests, targeted technical assessments and application of conservative, defensible assumptions. Further details are provided in **Section 3**.

Of particular relevance to the NCGSMP study was the lack of available as-built drawing records. As noted above, as-built engineering drawings are not available for twelve (12) of the nineteen (19) infrastructure crossing sites. To inform the geomorphic risk analysis at these locations pipe inverts were sourced either from information available in DCAD or measured directly in field through a topographic survey investigation. In the event discrepancies were noted between the information provided in the DCAD database and in-field measurements, in-field measurements were assumed to be correct unless otherwise noted. Inclusion of the nineteen (19) infrastructure crossing sites, a summary of the information available in DCAD, any discrepancies with field measurements, and availability of associated engineering drawings is provided in **Appendix D**.

2.6 Issues Assessment and Problem Confirmation

The background information provided by TRCA, private utility owners and the City of Toronto demonstrates that Newtonbrook Creek and Blue Ridge Creek are actively eroding, and thereby creating risks to local infrastructure and property. Mitigation of these risks requires engineering intervention and the planning of capital works projects. This in turn, justifies the completion of the Newtonbrook Creek Geomorphic Systems Master Plan study, which developed a robust strategy for the protection of at-risk Toronto Water infrastructure within the Newtonbrook and Blue Ridge creek channel corridors.

To achieve this objective, the scope of the NCGSMP included undertaking a suite of technical assessments to:

- define existing site conditions;
- systematically identify and prioritize risks to Toronto Water Infrastructure;
- develop and evaluate design solutions to address erosion risks;
- select a preferred solution to be carried forward to detailed design and construction; and
- prioritize the implementation of the various proposed projects through the development of a comprehensive implementation plan.