FCR (Park Lawn) LP and CPPIB
Park Lawn Canada Inc.

2150 Lake Shore

Stormwater Management Report

Issue 1 | May 13, 2020

Job number 264635-00

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Executive Summary

Background

In October 2019, FCR (Park Lawn) LP and CPPIB Park Lawn Canada Inc. ('the Owners') made an application for an Official Plan Amendment (OPA) in support of a proposed Master Plan for the redevelopment of the 27.7 acre / 11.2 hectare site located on the northeast corner of Park Lawn Road and Lake Shore Boulevard West, municipally known as 2150-2194 Lake Shore Boulevard West and 23 Park Lawn Road site ("the site" or "2150 Lake Shore"). The original Master Plan proposal envisioned a vibrant, mixed-use, transit-oriented redevelopment of the site. The Master Plan included a new Park Lawn GO Station, related TTC transit improvements, a fine-grained network of new streets and connections, a range of new open spaces including a new public park, and a diverse mix of residential, retail, service, entertainment and employment uses. At that time, the Master Plan contemplated a range of built form typologies including low, mid and high-rise buildings, fifteen towers ranging in height from 22 to 71 storeys.

This report presents the preliminary stormwater management design strategy and provides technical results for the proposed master plan.

Objectives

For the proposed masterplan, the key objectives related to management of stormwater are:

- Achieve an appropriate level of flood risk
- Maintain or preferably reduce the risk of flooding to adjacent sites
- Meet Toronto Green Standard Tier 3 for Water Balance (25mm onsite retention) and Tier 1 for Water Quality (80% of total suspended solids removed from total average annual rainfalls).
- Adhere to the City of Toronto Green Roof Bylaw and incorporate this into the stormwater retention strategy
- Maximise the use of Green Infrastructure (GI) to reduce amount of stormwater runoff, enhance the quality of stormwater runoff and also maximise infiltration
- Integrate with the existing City system; and
- Provide an appropriate level of resilience in the connections and collection system.
- To minimize Operation and Maintenance costs.

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1. Introduction

1.1 Project Description

In October 2019, FCR (Park Lawn) LP and CPPIB Park Lawn Canada Inc. ('the Owners') made an application for an Official Plan Amendment (OPA) in support of a proposed Master Plan for the redevelopment of the 27.7 acre / 11.2 hectare site located on the northeast corner of Park Lawn Road and Lake Shore Boulevard West, municipally known as 2150-2194 Lake Shore Boulevard West and 23 Park Lawn Road site ("the site" or "2150 Lake Shore"), as shown in Figure 1.

Figure 1 - Site Location

The original Master Plan proposal envisioned a vibrant, mixed-use, transit-oriented redevelopment of the site. The Master Plan included a new Park Lawn GO Station, related TTC transit improvements, a fine-grained network of new streets and connections, a range of new open spaces including a new public park, and a diverse mix of residential, retail, service, entertainment and employment uses. At that time, the Master Plan contemplated a range of built form typologies including low, mid and high-rise buildings, fifteen towers ranging in height from 22 to 71 storeys.

The Master Plan for the site has further evolved, both in response to comments and suggestions from stakeholders, including City staff, and as a result of a more detailed review to support this combined Zoning By-law Amendment application, Draft Plan of Subdivision application, and OPA resubmission (the Application). The fundamental vision and key elements of the Master Plan remain consistent.

1.2 Existing Site Conditions

The site is historically known as the Mr. Christie Cookie Factory, which was closed in 2013 and demolished in 2017/2018. It is currently empty land except for a Bank of Montreal building in the southwest corner.

1.3 Proposed Development

The proposed site contains several mix-use buildings (residential, employment and retail), two schools, a 1 ha park, several open spaces, a new train station on the Lake Shore GO line, a TTC streetcar loop, and a series of public and private roadways, as shown in Figure 2 - Proposed Development Layout.

Figure 2 - Proposed Development Layout

1.4 Phasing Overview

The proposed phasing for the site is displayed in Figure 3.

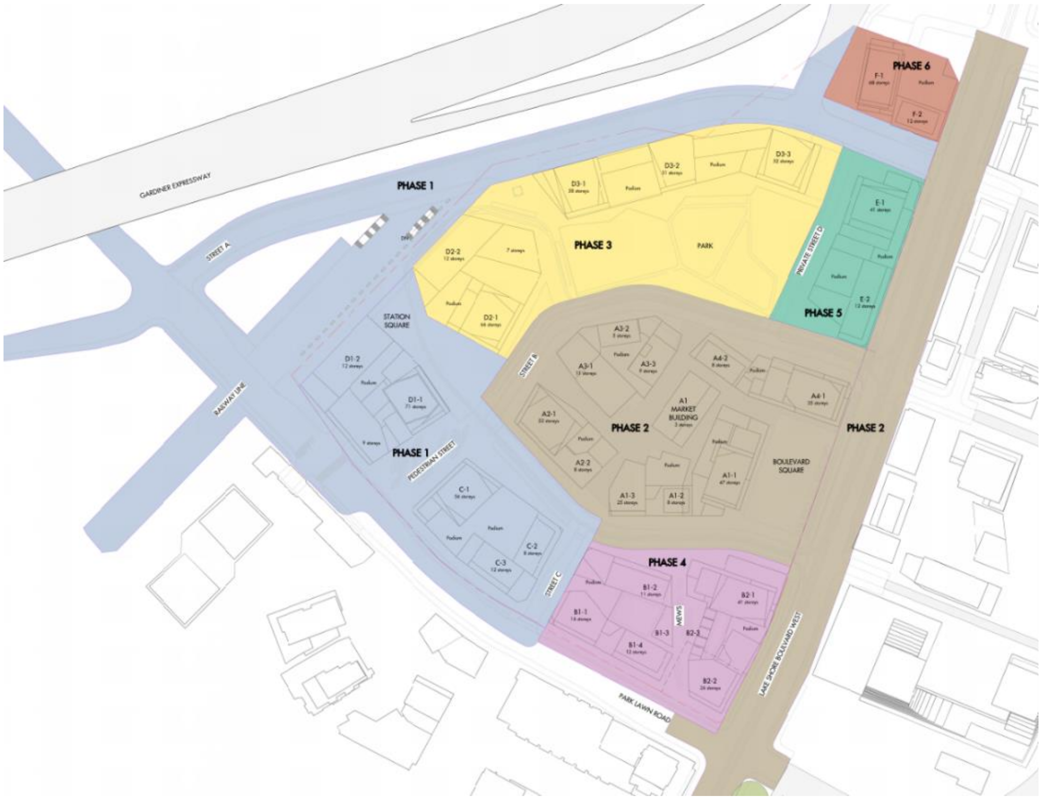


Figure 3 - Proposed Development Phasing

Phasing considerations for stormwater management are discussed further within the report.

1.5 Scope of Stormwater Management Report

The Stormwater Management Report examines the existing site drainage, proposed drainage conditions, and impacts to the surrounding existing infrastructure and overland flow routes.

This report has been prepared in support of the Zoning By-law Amendment (ZBA) application, to satisfy the City of Toronto and approval agencies by summarizing the stormwater management requirements of the site.

Information forming the basis of this report include:

- Record Drawings from City of Toronto
- Toronto Water Asset Group GIS files from City of Toronto
- Site Survey performed by EllisDon on 24 Feb 2020.

2 Existing Condition

2.1 Existing Stormwater Network

Existing utility asset information has been ascertained from the Toronto Water Asset Group (TWAG). The asset mapping indicates the presence of storm sewers along roads surrounding the site. These mains are present in the following locations:

- Park Lawn Road - a 300mm concrete storm sewer flows north along Park Lawn Road from south of the Metrolinx/GO corridor to an outfall to Mimico Creek. A 300mm concrete storm sewer flows south along Park Lawn Road from approximately 200m north of Lake Shore Boulevard towards the intersection where it is upsized to a 600 Vitrified Clay (VC) pipe and flows into the 900mm concrete pipe outfall to Mimico Creek.
- Marine Parade Drive – a 450mm concrete storm sewer collects flow from the bus loop at the intersection of Marine Parade Drive and Lake Shore Boulevard and connects to the 900mm concrete outfall to Mimico Creek. Other flow from Marine Parade Drive and side streets including The Marginal Boulevard, Brookers Lane and Palace Pier Court is directed towards Lake Ontario through outfalls.
- Lake Shore Boulevard – from west the intersection of the Marginal Boulevard and Lake Shore Boulevard, a 250mm VC pipe (transitioning to 375mm and 525mm) flows towards Park Lawn Road. It is joined by a 525mm concrete pipe from the 2150 Lake Shore property, where it crosses Lake Shore Boulevard in a 1200mm concrete sewer and turns to flow west on Lake Shore Boulevard as a 750mm concrete pipe (see CUMPA snip below). This pipe joins up with the 900mm outfall to Mimico Creek. The 525mm pipe appears to continue flowing west to meet up with the 600mm VC pipe at the intersection of Park Lawn Road and Lake Shore Boulevard (to be confirmed in the field)
- Within the Site – a 300mm concrete pipe with an abandoned connection to the system flowing towards the 900mm outfall to Mimico Creek (this connection will be confirmed to collect flow from no other lands and likely removed to facilitate installation of the development works). A 525mm concrete pipe connects to the system along Lake Shore Boulevard flowing west. There are several storm utilities under the Gardiner Expressway and Metrolinx/GO rail corridors, all of which drain towards Humber River or Mimico Creek through outfalls other than the 900mm outfall mentioned above.

The current hydraulic capacity of these pipes is unknown, the design team will conduct existing network analysis to understand if any mitigation measures are required to support proposed developments.

The known existing stormwater infrastructure near the site is shown in **Error! Reference source not found.** in green. The CUMAP and TWAG asset records do not show a complete extent of any network within much of the site. It is therefore assumed that there may be a series of private/un-adopted sewers servicing the bulk of the industrial area.

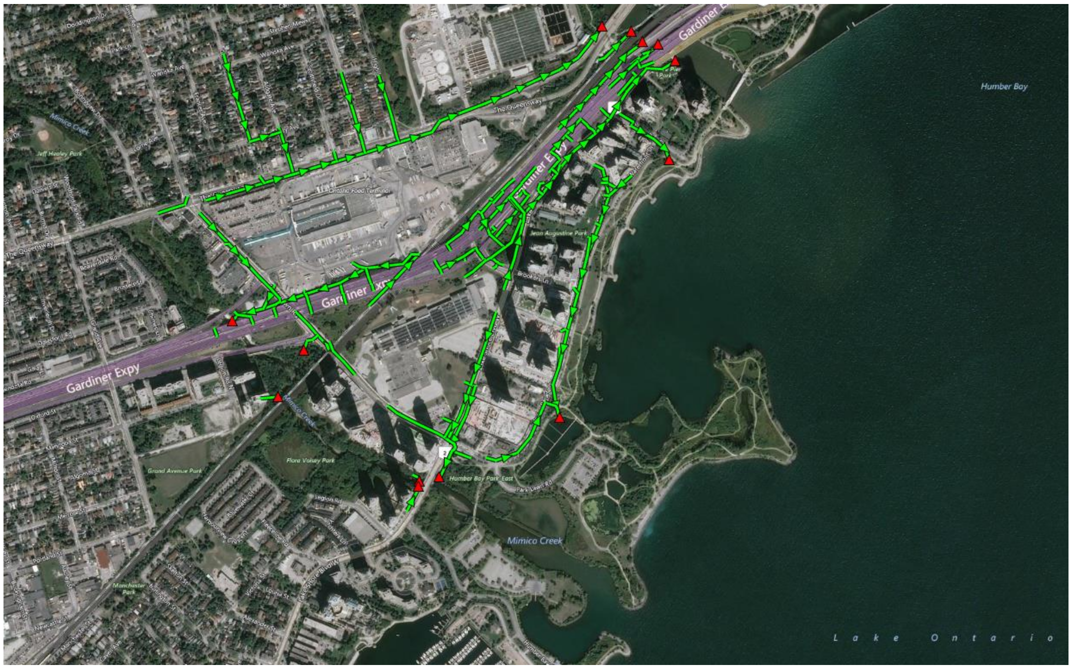


Figure 4 - Known existing storm sewer network (TWAG)

2.2 Pre-Development Site Condition

TWAG data was used to ascertain existing utility information, findings of which has been discussed in the Existing infrastructure section. Based on the available information, it is assumed that the surface runoff from the previous use i.e. Christie Cookie Factory, drained in to a 300mm diameter concrete pipe located south of the site, which eventually outfalls into the Mimico Creek.

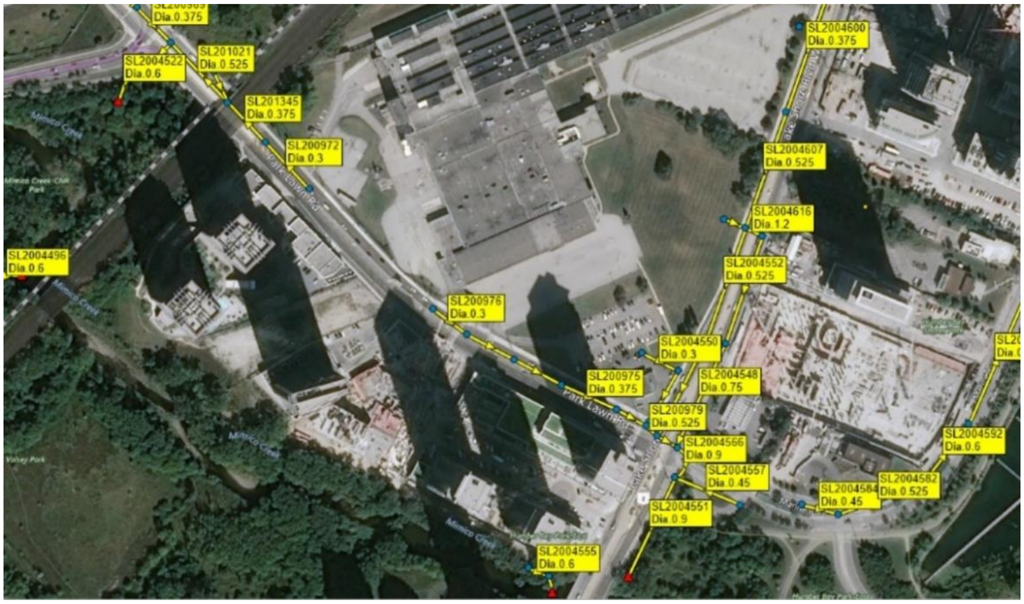


Figure 5 - Existing Site Connection

2.3 Proposed Site Condition

The site is situated approximately 250 m from Lake Ontario. The proposed development is described in section 1.3. The site plan consists of several mixed-use buildings with shared podium levels, an internal loop road for vehicles and a TTC streetcar and two connecting lateral roads. The buildings, podiums and streets are classified as impervious area (although permeable pavement could be considered, subject to approval from City of Toronto at a later stage). There are two hard landscaping areas called Boulevard Square and Station Square. The large Christie Park will be covered with grass and trees and therefore classified as a pervious area.

The blocks have large shared basements right up to the public right of way which limits the available areas for implementing sustainable urban drainage features, especially structures with underground storage and infiltration. The basement boundaries are shown in drawing LSB-ARP-XX-XX-DR-CD-60000 in Appendix C.

3 Design Criteria

The stormwater management approach for new development site is driven by the relevant federal, provincial and municipal legislation, by-laws and design guidelines and criteria. The governmentally mandated criteria include the following:

• City of Toronto’s Wet Weather Flow Management (WWFM) guidelines (2006)

• City of Toronto's Design Criteria for Sewer and Watermains (DCSW, 2019)

• Toronto Green Standard (TGS, version 3, 2019)

• Toronto and Region Conservation Authority (TRCA) Stormwater Management Criteria (2012)

• The Ministry of Environment (MOE) Stormwater Management Planning and Design Manual (2003)

As mentioned in section 1, the proposed site covers 11.2 ha area, classifying it as a large new development, per WWFM guideline. Table 1 outlines the relevant stormwater management requirements for applicable category.

Table 1 - Stormwater Management Design Criteria

Criteria	**Requirements**	**Governing Authority**
Water Quality Management	Enhanced level of protection is required by long-term 80% removal of Total Suspended Solids (TSS) on an annual loading basis from all run-off leaving the proposed development site.	WWFMG – Section 2.2.2.1 (a)
Water Balance Management	Retain runoff generated from a minimum of 25 mm depth of rainfall from all site surfaces through infiltration, evapotranspiration and water harvesting and reuse.	Toronto Green Standards – Tier 3
	Retain stormwater on-site, to the extent practicable, to achieve the same level of annual volume of overland runoff allowable from the development site under pre-development (i.e. presently existing site conditions before the new proposed development) conditions.	WWFMG – Section 2.2.1.1 (b)
	The maximum allowable annual runoff volume from any development site is 50% of the total average annual rainfall depth.	WWFMG – Section 2.2.1.1

Water Quantity – Flood Management	The City of Toronto has adopted the 100-year storm as the level of protection for properties, where feasible, against surface flooding from ponding on streets, particularly, in areas of the City experiencing chronic basement flooding and/or when a proper major overland flow stormwater drainage system does not exist. The required level of peak flow control from a development site contributing flow to a specific watercourse at the point of discharge, shall follow Toronto and Region Conservation Authority (TRCA) Flood Flow Criteria Map Control post-development peak flows to pre-development levels for all storms up to and including the 100-year storm (i.e., 2, 5, 10, 25, 50, and 100-year storms)	WWFMG – Section 2.2.3.1 TRCA – Table 3-1 (Mimico Creek Watershed)
Water Quantity - Erosion and Sediment Control	Regardless of size for all development sites, temporary erosion and sediment control for construction must be provided on-site.	WWFMG – Section 2.2.3.5 (a)
Water Quantity – Discharge criteria to municipal sewers	The allowable release rate to the municipal storm sewer system (minor system) from the development site during a 2-year design storm event must not exceed the peak runoff rate from the site under pre-development conditions during the same storm event, or existing capacity of the receiving storm sewer, whichever is less.	WWFMG – Section 2.2.3.7
	The City of Toronto has adopted the 100-year storm as the level of protection for properties, where feasible, against surface flooding from ponding on streets, particularly, in areas of the City experiencing chronic basement flooding and/or when a proper major (overland flow) stormwater drainage system does not exist	WWFMG – Section 2.2.3.4

3.1 Water Balance

The primary objective of the Water Balance criteria is to preserve the pre-development (prior to the existing) hydrology by capturing and managing the annual rainfall on the development site.

The project is targeting to meet TGS Tier 3 requirements for Water Balance, where at minimum., the first 25mm generated runoff from every storm event must be retained from all site surfaces through infiltration, evapotranspiration, water harvesting and water reuse.

Table 2 shows run off coefficients based on CoT guidelines, used to estimate the volume of retention required to satisfy this water balance target.

Table 2 - Runoff Coefficient

Land use	Runoff coefficient
Roof area (green)	0.25
Roof area (hard)	0.9
Green areas	0.25
Hardscape	0.9

Green Roofs, rainwater harvesting, Tree pits and Soil cells at block level and roadways will provide required retention volume. To design drainage structures, information about the existing ground water table elevation and soil parameters is essential. Based on MOE Stormwater Management Planning and Design Manual, bottom of the stormwater management structures should have a separation of more than 1meter from the seasonal maximum ground water level. In the absence of geotechnical investigation report for the proposed site, it is assumed that the groundwater table for the proposed site is deep and a sufficient separation between the two surfaces can be achieved.

Based on preliminary investigations, infiltration rates for the native soil are estimated be in the range of 12 -30 mm/hr. The development lots of the site will be built up from existing levels using granular permeable material and so greater infiltration rates are anticipated. All the infiltration measures and parameters will be verified at the detailed design stage and all the stormwater management facilities with infiltration components will be reassessed and re-designed based on the final geotechnical information.

3.2 Quality Control

WWFM guidelines in line with MOE SWM Planning and Design Manual, requires long term 80% removal of TSS on an average annual loading basis from all runoff leaving the proposed development site based on the post-development level of imperviousness, to reduce the chronic effect of suspended solids on the aquatic life in the receiving water bodies.

The design will meet quality control requirements by utilizing a combination of pervious surfaces; green infrastructure and low impact development facilities such as green roofs, tree pits and soil cells, permeable pavements, rain gardens and grassed swales as well as OGS or filter-based treatment system to promote settlement of suspended solids at the source and conveyance level.

3.3 Erosion and Sedimentation Control

As per WWFM guidelines section 2.2.3.5 (b), temporary erosion and sediment control measures shall be designed. All erosion and sediment control Best

Management Practices (BMPs) shall be designed, constructed and maintained in all development sites in accordance with the GTA CA's Erosion & Sediment Control Guidelines for Urban Construction (2006) and/or other City of Toronto requirements on a site-by site basis, where applicable.

Similar to the water quality approach, the erosion and sediment control requirement as laid out by WWFMG are met considering the 25mm onsite retention strategy and providing treatment through a series of GI and LID facilities.

3.4 Water Quantity Control

Water Quantity targets focus primarily on flood flow management and erosion control aimed to minimize the impacts on downstream flooding, stream bank erosion, and overflows of infrastructure. Typically, controls include peak flood control and both peak flow and runoff volume controls to mitigate erosion impacts.

3.4.1 Allowable Release Rates

For discharge into existing sewer according to the WWFM guidelines, the allowable release rate to the municipal storm sewer system during a 2-year design storm event must not exceed the peak runoff rate from the site under pre-development conditions during the same storm event, or existing capacity of the receiving storm sewer (whichever is less). The allowable release rate during a 2-year design storm was calculated for each block within the site, using the modified Rational Method, as shown in Table 4.

The capacity of the receiving sewer is unknown at this stage, however the allowable release rate based on the WWFM guidelines, when the percentage imperviousness of a development site under predevelopment condition is higher than 50% the maximum value of C (Runoff Coefficient) used in calculating the pre-development peak runoff rate is limited to 0.5. The rainfall intensity is calculated using the rainfall intensity curves for City of Toronto as illustrated in **Error! Reference source not found.**6.

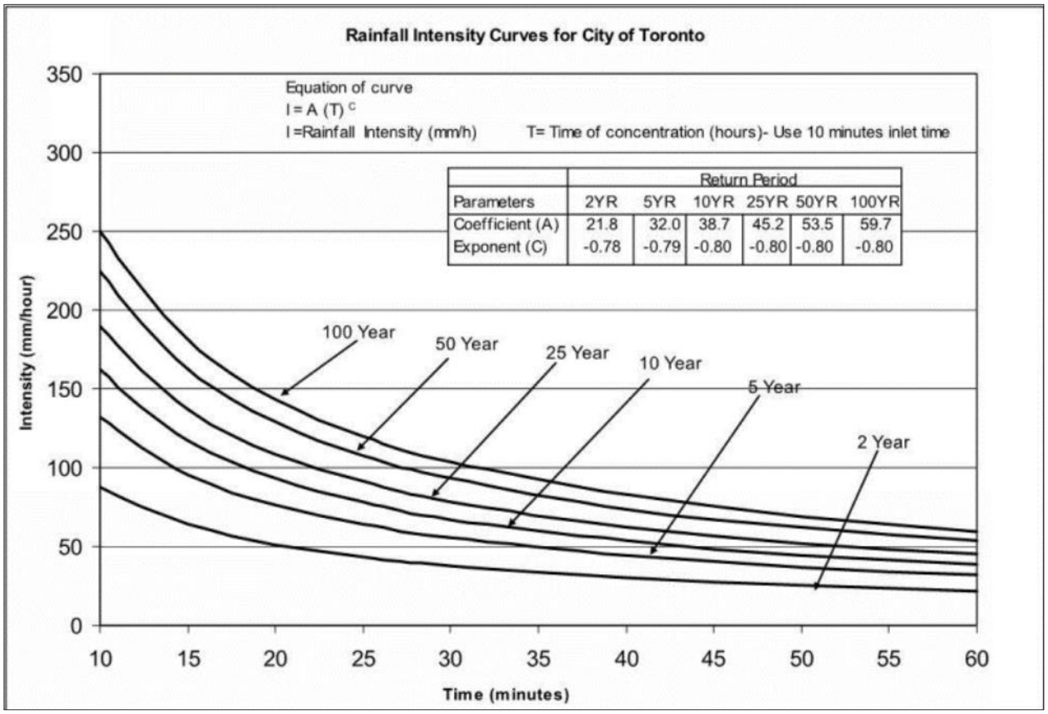


Figure 6 - Rainfall Intensity Curves for CIty of Toronto, (*WWFMG-Section 3.1*)

3.4.2 Context

Climate change as it is known as a long-term shift in weather conditions identified by changes in temperature, precipitation, winds and other indicators, has ability to reduce the ability of the engineered stormwater systems to operate as per its design capacities.

As part of the current study, the following documents were reviewed with respect to climate change and flood risk;

- Ontario Ministry of Environment Policy Review of Municipal Stormwater Management in the Light of Climate Change, 2019
- Toronto's First Resilience Strategy, 2019
- Summary of the Flood Resilient Toronto Project, 2019

Toronto's First Resilience Strategy sets out the City's vision of a resilient city. Urban resilience is the capacity of individuals, communities, institutions, and systems within a city to survive, adapt, and thrive in the face of the chronic stresses and acute shocks they experience. In the case of Toronto, the challenges of flooding and extreme heat pose the greatest and fastest growing risk to residents.

Within Toronto's First Resilience Strategy, Goal B1 specifically states that Toronto needs to become more resilient to the shocks and stresses of changing climate. The WWFM guidelines have been referred to and used in the storm water strategy, however, within Goal B1.3 of Toronto's First Resilience Strategy, it is acknowledged that "The Wet Weather Flow Master Plan will be 18 years old in 2021 and can be updated to integrate resilience".

To understand the impact of incorporating climate change adaptation strategies into stormwater management strategy, the design team also referred to the stormwater Design Criteria and Procedural Manual as published by Region of Peel (Region of Peel is located West of City of Toronto, about 7km from the site).

It is also noted that the City of Toronto is intending to review and update the WWFM guidelines, and consider climate change adaption, however the time line it is not known at this stage.

3.4.3 Climate Change Projections

As an available alternative, future weather patterns specific to the site location have been generated using Weathershift tool in order to determine site specific climate change allowances for design. Weathershift is a tool that uses data from global climate change modeling to produce EPW weather files adjusted for changing climate conditions in specific site locations.

WeatherShift-Rain data is delivered as a future-IDF curve (shifted from historic IDF) in any number of storm frequencies. There are four available data points for each IDF (intensity) and daily time series (depth). The data set is unique to the site location and has a data resolution of 1/16th degree (or approx. 100-km by 100-km)

The future-IDF curve provided in Figure 7 presents rainfall conditions under Relative Concentrations Pathway (RCP) scenario 4.5. RCP 4.5 was selected to be most appropriate as it represents a medium scenario in which there is moderately aggressive mitigation measures to reduce carbon emissions, compliant with the Paris agreement. RCP 4.5 assumes that carbon emissions peak around 2040, then decline. Under the projected rate of emission, the rainfall forecast for the years 2045 and 2099 are presented. Data within the 50^{th} percentile and 95^{th} percentile has been selected to show the potential range of percentage change.

For 4.5 RCP by 2045 average rainfall intensity is projected to increase between 3% and 32% from the historic baseline. By 2099 rainfall intensity is projected to increase between 6% and 31% from this historic baseline. Both scenarios as based on a 1 in 100-year storm event for a duration of 6 hours, in line with the Water Quantity control assessment criteria.

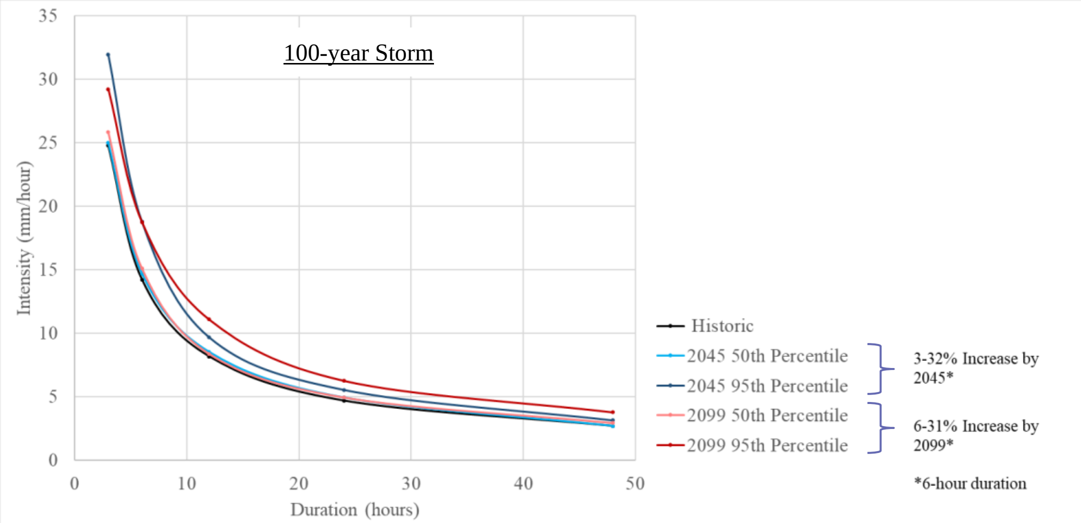


Figure 7 - Shifted Rainfall Intensity Curves for City of Toronto for 2045 and 2099, (Raw data from Weathershift)

3.4.4 Climate Change Resilience

For the drainage and flooding design of 2150 Lake Shore, currently there are no known mandatory requirements to account for climate change for drainage design. We request that the City advise if any specific requirement or guideline needs to be followed in the future in order to address Climate Change for next phases of the project.

The hydraulic model of the proposed stormwater system will be re-run iteratively to simulate performance under particular climate change scenarios. The objective will be to identify key vulnerabilities, risks as well as system strengths and overall flood risk resilience relative to climate change.

It is important to understand the potential for a climate change parameter to cause failure to meet the design objectives. The storm water design strategy will respond to ensure the masterplan is resilient against future risks.

3.5 Key Assumptions

Based on the available information and meeting with Toronto Water, following assumptions have been adopted:

• In absence of final geotechnical investigation results for the site, it is assumed that the infiltration rate and soil type as well as groundwater table will support current SWM design to achieve water balance and quality and quantity targets. These calculations will be revised, upon receiving the actual infiltration rate values and other relevant geotechnical information.

• From the preliminary study of site and considering its proximity to the Lake, it is assumed that the surface run-off from roads and landscape areas exceeding 2-year pre-development limits from the project site would follow approved overland flow route to each up to the existing outfall and ultimately discharge into the lake.

4 Proposed Stormwater Management Strategy

4.1 Key Drivers

City developments usually form an impermeable paved layer on top of green space, which affect habitats, can reduce biodiversity and has irreversible effects on the environment. Development can also prevent natural hydrological cycles and increases the volumes of polluted runoff entering stormwater infrastructure and therefore increasing the flood risk. With climate change set to increase the frequency and intensity of storms, the risk of flooding to and around the site could increase with time. Solutions to managing increasing volumes of rain include subsurface infiltration beds, green roofs and permeable paving.

The proposed storm water strategy aims to provide a resilient strategy which achieves an appropriate level of flood protection and maintains (or preferably reduces) the risk of flooding to adjacent sites. The strategy implements sustainable urban drainage principles to best mimic the natural processes which would've happened prior to any development and minimise both operational and capital carbon. Oversized infrastructure/pipe work have significant embodied carbon and so is a last resort within the Master Plan, where GI cannot meet the requirements.

The stormwater management and drainage strategy needs to consider; proposed site levels, infiltration rates, the capacity of existing's sewers, the proposed landscape strategy, the level of flood protection to be provided (1:100-year storm) and climate change considerations.

4.2 Outline Strategy

The stormwater management strategy aims to meet WWFMG criteria for water balance and water quality by retaining 25 mm of rainfall onsite and control the run-off from the development blocks to 2-year pre-development allowable release rates.

Overland flow from the retention features will be drained to minor system which will eventually join Lakeshore and Park Lawn Road sewer system, before draining into the Mimico Creek through the existing outfall.

The surface runoff exceeding 2-year pre-development allowable release rates where it is practical will flow through an approved existing overland flow route to the outfall. City to confirm availability of the approved overland flow routes downstream of the site.

To address conveyance requirements of the system, the capacity of the existing minor and major systems should be evaluated, and any required upgrades for the existing network and the outfall needs to be considered for this design approach.

Consultation with TRCA is also required in order to address quantity, quality and erosion control requirements for the existing Mimico Creek outfall.

The proposed storm water strategy is shown in drawing LSB-ARP-XX-XX-DR-CD-60000 in Appendix C. On the 2150 Lake Shore site the following measures are recommended for stormwater management:

- Green infrastructure will be used where possible to encourage infiltration.
- Tree pits/ Soil cells will be used to provide retention and allow the rainwater to be used for evapotranspiration.
- Large below ground geocellular storage beneath the Christie Park with infiltration provided at the bottom to capture runoff from park and adjacent areas.
- Proposed infiltration trenchs/soakaway pits within ROWs
- Proposed pipe beneath Street C, connecting to the existing 300mm pipe along Park Lawn Road.
- Proposed pipe beneath The Mews (area between B1 and B2 buildings) connecting to the existing manhole MH3003495 on Park Lawn Road.
- Proposed pipe from the Relief road and Block F to existing manhole MH3159006428 on Lakeshore Boulevard.
- Two pipe runs within the loop road, both reaching 525mm diameter, connecting to existing manhole MH3147506388 and existing 525mm pipes. It is recommended to make these connections at the same time as planned upgrades to these intersections.

4.3 Water Balance

The stormwater management strategy for 2150 Lake Shore is to retain minimum 25mm generated runoff from every storm event. The detailed design stage will exploit all areas within the Master Plan to achieve as much infiltration as possible considering constraints for subject site. As part of stormwater management plan, it is assumed that Green roofs cover 60% of the total roof area for each plot, however, the final percentage of area covered by green roof for each plot will be confirmed during the detailed design stage.

It is assumed that intensive green roofs will occupy 60% of the total roof area and will be so designed to capture 25mm of rainfall for the entire roof area. Rainfall retention of 25mm depth for rest of the site will be achieved through centralised rainwater harvesting tanks, soil cells and soakaway pits within the proposed ROWs.

Runoff from roofs over podium is considered to be clean and will be diverted to the rainwater storage tank. This collected rainwater could be re-used for irrigation of landscape area, mechanical cooling and can be diverted to partially satisfy grey water requirements. No roof storage has been proposed at this stage, however, roof control for the development plots can be also considered during the detailed design stage.

With basement area being planned extensively under the development plots, it limits the area available for providing underground stormwater management measures. To completely satisfy the water balance requirements, soil cells with infiltration capacity as well as deep soakaway pits within public and private Right of Way (ROW) will be provided.

The water balance requirements for the roads will also be met by retaining first 25mm of rainfall from all storm events through strategically placed soil cells, having infiltration capacity at the bottom and deep soakaway pits.

The site wide retention volumes have been calculated based on the land use and run off coefficients and are shown in Table 3. The areas apportioned for water retention are shown in drawing LSB-ARP-XX-XX-DR-CD-60000 in Appendix C.

As green roofs are considered as the proposed drainage solution to meet water balance requirements for roofs, area of roofs is calculated and not the building footprint. The total area mentioned in Table 3, double counts the area covered by roof overhangs and the surface underneath.

Table 3 Required Retention Volumes

Land Use	Area (ha)	Initial Abstraction (mm)	Volume Retained on Site (m^3)	Required Retention Volume 25mm Rainfall (m^3)	Additional Volume to Be Retained (m^3)
Roof Area – Green	1.37	5.0	68.5	342.5	
Roof Area – Hardscape	0.91	1.2	10.9	204.8	
Landscape	3.53	5.0	176.5	220.6	
Hardscape	5.56	1.2	66.7	1251.0	
Total	11.37		323	2019	1696

4.4 Water Quality and Erosion and Sediment Control

The enhanced water quality control requirement calls for long-term removal of 80% removal of TSS on annual loading from the runoff leaving the proposed development. Retaining 25mm of rainfall on site will satisfy not only water quality target of 80% TSS removal from 90% average annual rainfall but also erosion and sediment control requirements for the site. The design will meet quality control requirements in detail design stage by utilizing a combination of pervious surfaces; green infrastructure and low impact development facilities such as green roofs, tree pits and soil cells, permeable pavements, rain gardens and grassed swales as well as OGS or filter-based treatment system to achieve 80% TSS removal targets.

4.5 Water Quantity

City of Toronto criteria requires that the post development storm runoff from the development plots for all events up to and including 1 in 100-year storm be controlled to the existing 1 in 2-year flow rate where proper downstream major overland flow route does not exist, and quantity control requirements strictly apply to the proposed project.

However, 2150 Lake Shore development is located at the end of the sewer system close to the existing Mimico Creek outfall and Lake Ontario. Thus, the quantity control of the project beyond the two-year storm event will be based on the downstream system capacity and TRCA requirements at existing Mimico Creek outfall.

The proposed site is divided into 2 main categories, development plots and public right of way. There are 6 proposed development plots, consisting of buildings, internal walkways, private street, a park and a site for future Go Station.

In the following section, baseline scenario for the stormwater management strategy of the development plots and public right of way is discussed.

4.5.1 Development Plots

The existing site has extensive impervious areas, the target allowable runoff rate is calculated for all the proposed development plots, as shown in **Error! Reference source not found.**4.

Table 4 Allowable release rate for the development plots

Location	**Area (ha)**	**Allowable Release rate (L/s)**
A	2.16	264.6
B	0.92	112.7
C	0.49	60.6
D	1.65	201.7
E	0.54	66.1
F	0.47	57.1
Boulevard Square	0.30	36.9
Station Square	0.33	40.9
Christie Park	1.01	123.8

The collection of total run-off from the development plots is managed by controlling the flows to the allowable 2-year pre-development rate as presented in

Table 4. For runoff generated by storm events greater than this, flow will be limited via inlet control devices and allowing the excess runoff to be conveyed to the outfall following an approved overland flow route. During severe storm events, the street would act as an open channel and will be designed accordingly.

It is assumed that the available overland flow routes are approved by the city, however, this solution for storm water management strategy for water quantity control will be developed further upon receiving feedback from the city. In absence of an approved overland flow route for major system flow, the alternative solution would be to design storage areas to detain water and while allowing it to flow through the minor system at a required discharge rate. Any required mitigation for the downstream system including existing Mimico Creek outfall will be proposed to provide adequate conveyance capacity and protection in the system.

Development plot covering D3 buildings located North of the park area and being at a higher elevation than the park, it is designed to discharge runoff in excess of 2-year pre-development flow rate, to the park. Storm water management requirements for D3 development plot and public park (Phase 3 of the project) will be satisfied by proposing the underground stormwater storage facility. Infiltration will be promoted through the bottom of the tank and any required detention will be achieved using control structure at the outlet of the facility. This approach will help to satisfy overall water balance target of the project.

The final control solution for the development plots will be confirmed at the detailed design stage. Additional quantity control can be achieved within the plots using the underground storage tank and orifice control located upstream of the control manhole.

The stormwater management strategy of the project is to holistically meet the standards site-wide; however, each block might not necessarily fully meet the city requirements, rather would meet the imposed discharge limits based on the integrated site wide stormwater management plan.

4.5.2 Municipal Roads

As part of the project, a future road named Relief road to North of the site is proposed. Relief road starts from Park Lawn road, south of Gardiner expressway runs along the north edge of the proposed development, turns south within the site and ties to Lakeshore Boulevard West. This road is categorised as an arterial road. According to CoT guidelines, the minor system of the road will be sized based on 10year storm and any larger storm event will be conveyed using the ROW as an open channel. The grade of Relief road dips along halfway of its length. It is assumed that all the flows at this point will be captured and pumped back to another existing storm system, at Park Lawn road, south of Gardiner expressway. The detailed design of the relief road will be finalized at a later stage.

Different blocks within the proposed development are connected through a 23m wide internal loop road which is also a proposed route for TTC streetcar loop and two other lateral road, private and public street. These roads are anticipated to be categorised as collector roads.

The drainage and stormwater design of these collector roads will be based on the dual system approach such that the minor system will be sized based on 5-year storm event. Any runoff from the storm exceeding 5-year shall be conveyed as an overland flow via major system. The allowable flow rates for the local roads are shown in **Error! Reference source not found.**, it is calculated using modified r ational method. According to the City of Toronto guideline, if the downstream receiving system has capacity limitation, in order to eliminate the adverse impact on the downstream system, the new system must be controlled to the available capacity of the existing sewer system. Required modification to the vertical alignments of the proposed roads as well as changes to the grading design needs to be considered based on the drainage design requirements of the project.

The depth of ponding and the velocity of the overland flow within proposed public ROW, shall meet the criteria as in dictated by Table 5. These depth/ velocity parameters are in accordance with Design Criteria for City of Toronto Sewers and Watermains Design and WWFMG, to reduce risk to the public having access to these overland flow routes.

Table 5 **-** Design criteria for overland flow velocity and depth

Water Velocity (m/s)	Permissible Depth (m)
0.5	0.80
1.0	0.32
2.0	0.21
3.0	0.09

A landscape design is proposed along Park Lawn Road and Lakeshore Boulevard to plant more trees in these areas. It is anticipated to introduce soil cells with infiltration at the bottom, under the proposed planting as many as possible subject to site constraints identified at detailed design stage.

It is assumed that existing overland flow route to the outfall are approved by the city. If no approved overland flow route exists, alternative solution for stormwater strategy is to fully capture the 100-year flows and discharging at the existing Mimico creek outfalls using existing municipal storm network. This will be achieved by providing cross-falls and longitudinal grading of the roads towards catch basins located at low points. The existing downstream system will be assessed, and any required mitigation/upgrade will be proposed. TRCA requirements needs to be followed at the existing Mimico Creek outfall.

5 Downstream Capacity Analysis

The proposed storm sewer network from the site connects to 525mm diameter storm sewer on Lakeshore Boulevard west and turns west to continue flowing west on Lake Shore Boulevard as a 750mm concrete pipe. This pipe joins up with the 900mm outfall to Mimico Creek. The 525mm pipe appears to continue flowing west to meet up with the 600mm VC pipe at the intersection of Park Lawn Road and Lake Shore Boulevard, however, this needs to be confirmed.

On Park Lawn road, a 300mm concrete storm sewer flows north along Park Lawn Road from south of the Metrolinx/GO corridor to an outfall to Mimico Creek. A 300mm concrete storm sewer flows south along Park Lawn Road from approximately 200m north of Lake Shore Boulevard towards the intersection where it is upsized to a 600 Vitrified Clay (VC) pipe and flows into the 900mm concrete pipe outfall to Mimico Creek.

Based on the best available data to date, the high point on Lakeshore boulevard, west of Brookers Lane, marks the boundary for the overland flow in the major system. The surface elevation of Lakeshore Boulevard drops while moving towards the intersection with Park Lawn road. Park Lawn road has a high point south of the under pass, which marks the beginning of the overland flow route on Park Lawn road. From this high point, Park Lawn road slopes down and intersects with Lakeshore boulevard West. The overland flow from Park Lawn road and Lakeshore boulevard intersection, flows south up to Mimico Creek. These information needs to be confirmed with field data.

According to the City of Toronto guideline, if the downstream receiving system has capacity limitation, in order to eliminate the adverse impact on the downstream system, the new system must be controlled to the available capacity of the existing sewer system or any required mitigation to the existing system should be considered.

It should be noted that all the information/data required for complete downstream capacity assessment were not available at this time. However, preliminary assessment of the existing downstream minor system discharging to the Mimico Creek existing outfall has been done under post development conditions. Mitigations and sewer upgrades are expected along both Lake Shore Blvd and Park Lawn Rd. to service proposed development at 2150 Lake Shore Blvd while addressing City of Toronto requirements. All the analysis will refine based on the required field data and information. Please refer to Appendix D for preliminary 100-Year storm sewer profiles.

6 Hydraulic Modelling

A stormwater model is set up in by simulating the hydrologic and hydraulic parameters of the site based on the available information and proposed site layout. PCSWMM software is selected as the modelling software.

The objective of modelling is to:

- Update the proposed stormwater management design based on these results to achieve water balance, water quantity and water quality criteria for the site.
- Estimate the hydraulic capacity of the existing stormwater network surrounding the proposed development site
- Simulate rainfall- runoff and get the results for different storms events 25mm 2-year to 100-year storm events. And estimate the impact of the proposed development on the downstream stormwater network

6.1 Modelling Parameters

Hydrologic and hydraulic parameters of the site are essential components for setting up the stormwater management model.

The basic steps to create hydrology model include:

- Delineate the proposed drainage area into smaller subcatchments,
- Assigning hydrological runoff parameters to each subcatchments based on available data and characteristics of proposed developments,
- Preliminary design of the internal storm sewer network. Assigning appropriate outlets to the subcatchments using hydraulic elements, and
- Simulate the model using design storm events to generate runoff from all the subcatchments.

6.1.1 Drainage Area

The proposed site was divided in to 29 subcatchments, consisting of 6 plots and each plot further divided based on buildings, internal walkways between the buildings within plot area, the public park, station square area, boulevard square and collector roads.

The land use map for the model consists of roof area including green roof and hard roof, landscape and hardscape including roads, walkway and other impervious area. Runoff coefficient from the subcatchments is calculated as the weighted average of the runoff coefficient of different surfaces.

6.1.2 Hydrologic Parameters

The runoff parameters are set based on City of Toronto guidelines for run-off coefficient. The run-off coefficient value considered for pervious as 0.25 and for impervious area as 0.5. A weighted average value for each plot was assigned based on land use. Refer to Appendix D for the hydrologic parameter details.

The design storm analysis is carried out based on the 6-hour Chicago distribution with 10-minute time step and a ratio to peak r=0.38. The analysis is carried out based on the design storm rainfall files as provided by the City guideline, refer to Appendix A for 6-hour Chicago design storm details. The design rainfall events considered for modelling purpose are Chicago 6h – 2-year, 5- year, 10- year, 25-year, 50-year and 100-year for water quantity results. Rainfall of Chicago 4h-25mm is considered to get runoff results for water balance requirements. The storm water runoff results for 25mm storm event and 100-year storm are presented in Appendix D.

6.1.3 Stormwater Network

The TWAG data received from the City of Toronto was imported into the PCSWMM model to create existing stormwater network. The data contained sewer alignments, sewer diameter, length and connecting manhole information.

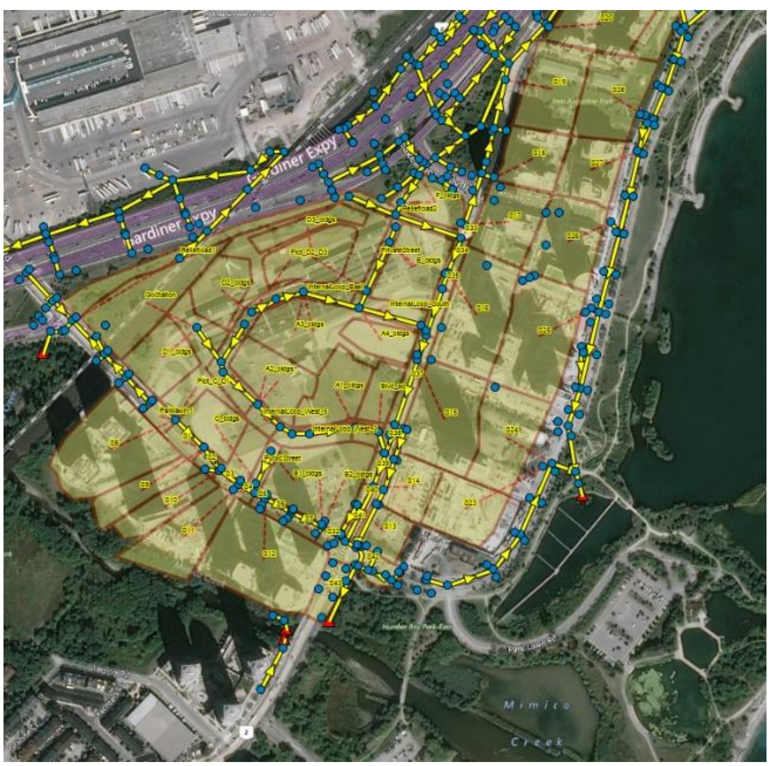


Figure 8 - SWM Site Model

Figure 8 shows the catchment area delineation, existing and proposed subcatchments and stormwater network.

Proposed internal storm sewer network is preliminary and defined in the model to assess the impact of the proposed development on the existing network. Major system is not included in the current model and only preliminary sizing has been done to estimate the conveyance capacity of the minor system.

Current hydraulic model is not calibrated at this stage and needs to be evaluated and calibrated using appropriate flow monitoring data. The final alignment and size of the storm sewers will be designed and confirmed at detailed design stage.

7 Conclusion and Summary

This report presents the proposed stormwater management strategy and design of the proposed development at 2150 Lake Shore Blvd. Technical requirements including Quantity, Quality, Water Balance and Erosion control also have been outlined and addressed as outlined in the City of Toronto Sewer and Watermain Design and Wet Weather Flow Management Guidelines

Proposed public roads will be designed considering dual drainage methodology. The minor system is sized based on 10 and 5-Year storm events, considering the category of the proposed road. Any runoff exceeding minor system design storm capacity shall be carried by proposed ROWs, Lakeshore boulevard west and Park lawn road. It is assumed that approved overland flow route to the outfall are available.

In the absence of the approved overland routes, a piped drainage network will fully capture the 100-year flows and discharge at the existing Mimico creek outfalls using existing municipal storm network. The existing downstream storm system will be assessed, and any required upgrades will be considered. TRCA requirements for quantity, quality and erosion control also needs to be followed at the existing Mimico Creek outfall.

The water balance requirements for the municipal roads will be met by retaining first 25mm of rainfall from all storm events through strategically placed soil cells, having infiltration capacity at the bottom and deep soakaway pits.

For development plots it is assumed that green roofs will occupy 60% of the total roof area and will be so designed to capture 25mm of rainfall for the entire roof area. Rainfall retention of 25mm depth for rest of the site is planned to be achieved through centralised rainwater harvesting tanks, soil cells and soakaway pits within the proposed roads.

The collection of surface run-off from the development plots is managed by controlling the flow in the pipes to storm event with 2-year return period. For runoff generated by storm events greater than this, flow will be limited via inlet control devices and allowing the excess runoff to be conveyed to the outfall following an approved overland flow route.

The enhanced water quality control targets required 80% removal of TSS on annual loading from the annual average runoff. Retaining 25mm of rainfall on site will satisfy not only water quality target of 80% TSS removal from 90% average annual rainfall but also erosion and sediment control requirements for the site.

8 References

Design Criteria for Sewers and Watermains. (2019)Retrieved from Standards for Designing and Constructing City Infrastructure:

MOE. (2003). Stormwater Managment Planning and Design Guidelines.

Standard, Toronto Green. (2017). *Toronto Green Standard.* City of Toronto.

Wet Weather Flow Management Guidelines.

TRCA. (Aug 2012). *Stormwater Management Criteria.*

APPENDICES

Appendix -A Hydrology information

Based on available rainfall data for the City of Toronto, Chicago 6hr rainfall from 2-year to 100-year, IDF curves were developed to measure rainfall intensity.

Table A1: Rainfall Intensity Data

Figure A1: Rainfall Intensity Curve

Table A2: Landuse Runoff Coefficients

Table A3: Manning' 'n' value for different pipe materials

Table A1: Rainfall Intensity Data

Time Step (min)	Intensity (mm/hr)					
	2- Year	5- Year	10-Year	25-Year	50-Year	100-Year
10	88.2	131.8	162.3	189.5	224.3	250.3
11	81.9	122.2	150.4	175.6	207.9	231.9
12	76.5	114.1	140.2	163.8	193.9	216.3
13	71.9	107.1	131.5	153.6	181.9	202.9
14	67.8	101	124	144.8	171.4	191.2
15	64.3	95.7	117.3	137	162.2	181
16	61.1	90.9	111.4	130.1	154	171.9
17	58.3	86.7	106.1	124	146.7	163.7
18	55.8	82.8	101.4	118.4	140.2	156.4
19	53.5	79.4	97.1	113.4	134.2	149.8
20	51.4	76.2	93.2	108.9	128.8	143.8
21	49.4	73.3	89.6	104.7	123.9	138.3
22	47.7	70.7	86.4	100.9	119.4	133.2
23	46.1	68.3	83.3	97.3	115.2	128.6
24	44.6	66	80.5	94.1	111.4	124.3
25	43.2	63.9	78	91.1	107.8	120.3
26	41.9	62	75.6	88.2	104.4	116.6
27	40.6	60.1	73.3	85.6	101.3	113.1
28	39.5	58.4	71.2	83.2	98.4	109.8
29	38.4	56.8	69.2	80.9	95.7	106.8
30	37.4	55.3	67.4	78.7	93.1	103.9
31	36.5	53.9	65.6	76.7	90.7	101.3
32	35.6	52.6	64	74.7	88.5	98.7
33	34.8	51.3	62.4	72.9	86.3	96.3
34	34	50.1	61	71.2	84.3	94
35	33.2	49	59.6	69.6	82.3	91.9
36	32.5	47.9	58.2	68	80.5	89.8
37	31.8	46.9	57	66.5	78.8	87.9
38	31.1	45.9	55.8	65.1	77.1	86
39	30.5	45	54.6	63.8	75.5	84.3
40	29.9	44.1	53.5	62.5	74	82.6
41	29.3	43.2	52.5	61.3	72.6	81
42	28.8	42.4	51.5	60.1	71.2	79.4
43	28.3	41.6	50.5	59	69.8	77.9
44	27.8	40.9	49.6	57.9	68.6	76.5
45	27.3	40.2	48.7	56.9	67.3	75.1
46	26.8	39.5	47.9	55.9	66.2	73.8
47	26.4	38.8	47	55	65	72.6
48	25.9	38.2	46.3	54	64	71.4
49	25.5	37.6	45.5	53.1	62.9	70.2
50	25.1	37	44.8	52.3	61.9	69.1

Time Step (min)	Intensity (mm/hr)					
	2- Year	5- Year	10-Year	25-Year	50-Year	100-Year
51	24.7	36.4	44.1	51.5	60.9	68
52	24.4	35.8	43.4	50.7	60	66.9
53	24	35.3	42.7	49.9	59.1	65.9
54	23.7	34.8	42.1	49.2	58.2	65
55	23.3	34.3	41.5	48.5	57.4	64
56	23	33.8	40.9	47.8	56.5	63.1
57	22.7	33.3	40.3	47.1	55.7	62.2
58	22.4	32.9	39.8	46.4	55	61.3
59	22.1	32.4	39.2	45.8	54.2	60.5
60	21.8	32	38.7	45.2	53.5	59.7

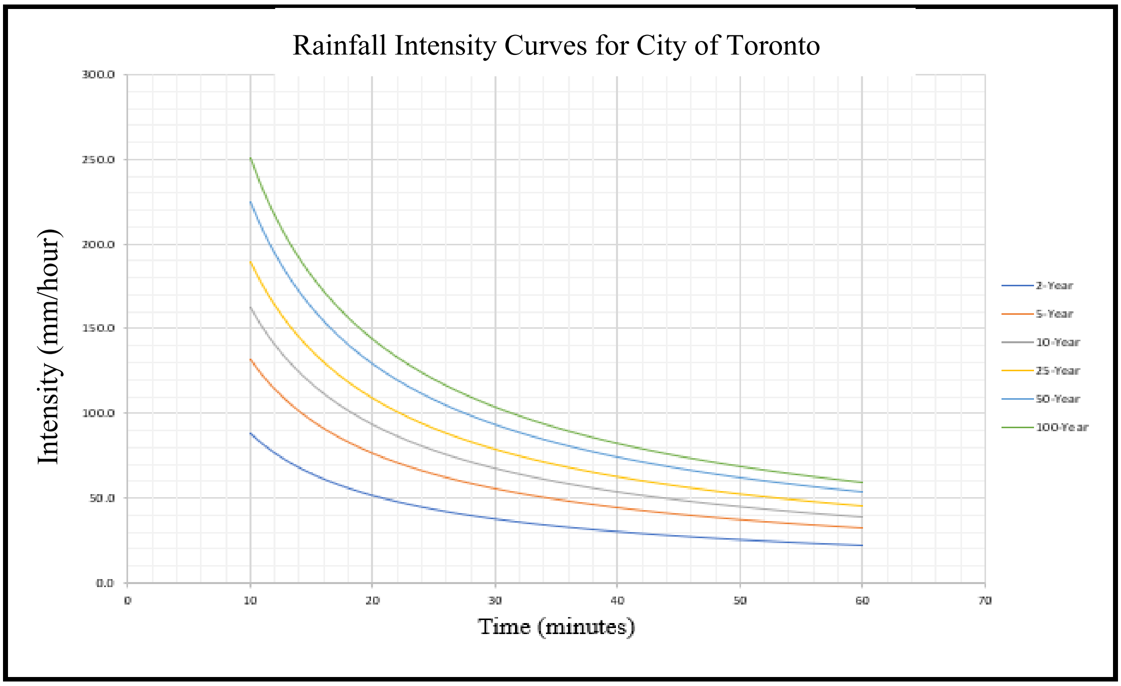


Figure A1 Rainfall Intensity Curves

Table A2 : Land Use Runoff Coefficients
(Design Criteria for Sewers and Watermains)

Land use	Runoff coefficient
forest and dense wooded areas	0.10 - 0.25
parks, open space and palygrounds	0.25
single family residential	0.65
semi-detached residential	0.7
townhouse or rowhousw	0.75
apartments or hi-rise residential	0.75 - 0.85
industrial	0.85
commercial	0.9
institutional	0.75
densely built, paved	0.9
asphalt, concrete, roof areas - without green roofs	0.9

Table A3: Manning' 'n' value for Different Pipe Materials

If pipe material is…	Then value of 'n' is…
concrete (CONC)	0.013
polyvinyl chloride (PVC)	0.013
high density polyethylene (HDPE)	0.013
corrugated steel pipe (CSP)	0.024

Appendix B - SWM Calculations

Table B1 represents plot area as divided based on Landuse.

Table B2 shows the Allowable release rate from each subcatchments based on pre-development 2-year storm event.

Table B1: Subcatchement Area Calculation

Plot	Hardscape (ha)	Landscape (ha)	Total Roof Area (ha)	Green Roof Area (ha)	Hard Roof Area (ha)
Total area for plot A, including Boulevard sq.	1.29	0.44	0.73	0.47	0.26
Total area for plot B	0.65	0.23	0.23	0.14	0.09
Total area for plot C	0.27	0.07	0.16	0.09	0.06
Total area for plot D	1.16	0.56	0.87	0.52	0.35
Total area for plot E	0.29	0.07	0.17	0.10	0.07
Total area for plot F	0.28	0.07	0.12	0.07	0.05
Park Area	0.00	1.01	0.00	0.00	0.00
Street C	0.07	0.02	0.00	0.00	0.00
Private Street D	0.14	0.05	0.00	0.00	0.00
Street B (Internal Loop)	0.94	0.31	0.00	0.00	0.00
Go Station Area	0.47	0.70	0.00	0.00	0.00
Total Area	**5.56**	**3.53**	**2.28**	**1.40**	**0.88**

Assumptions and Considerations:

1. Podium area is assumed to be 80% impervious, considering there may be option to install planters.
2. Station square to be 80% hardscape area
3. Pedestrian Street to be 50% hardscape area
4. Other Streets and internal loop, assumed to be 75% hardscape
5. Green roofs assumed to be 60% of the total roof area
6. Total hardscape area is calculated as the difference of the total plot area and the roof area.

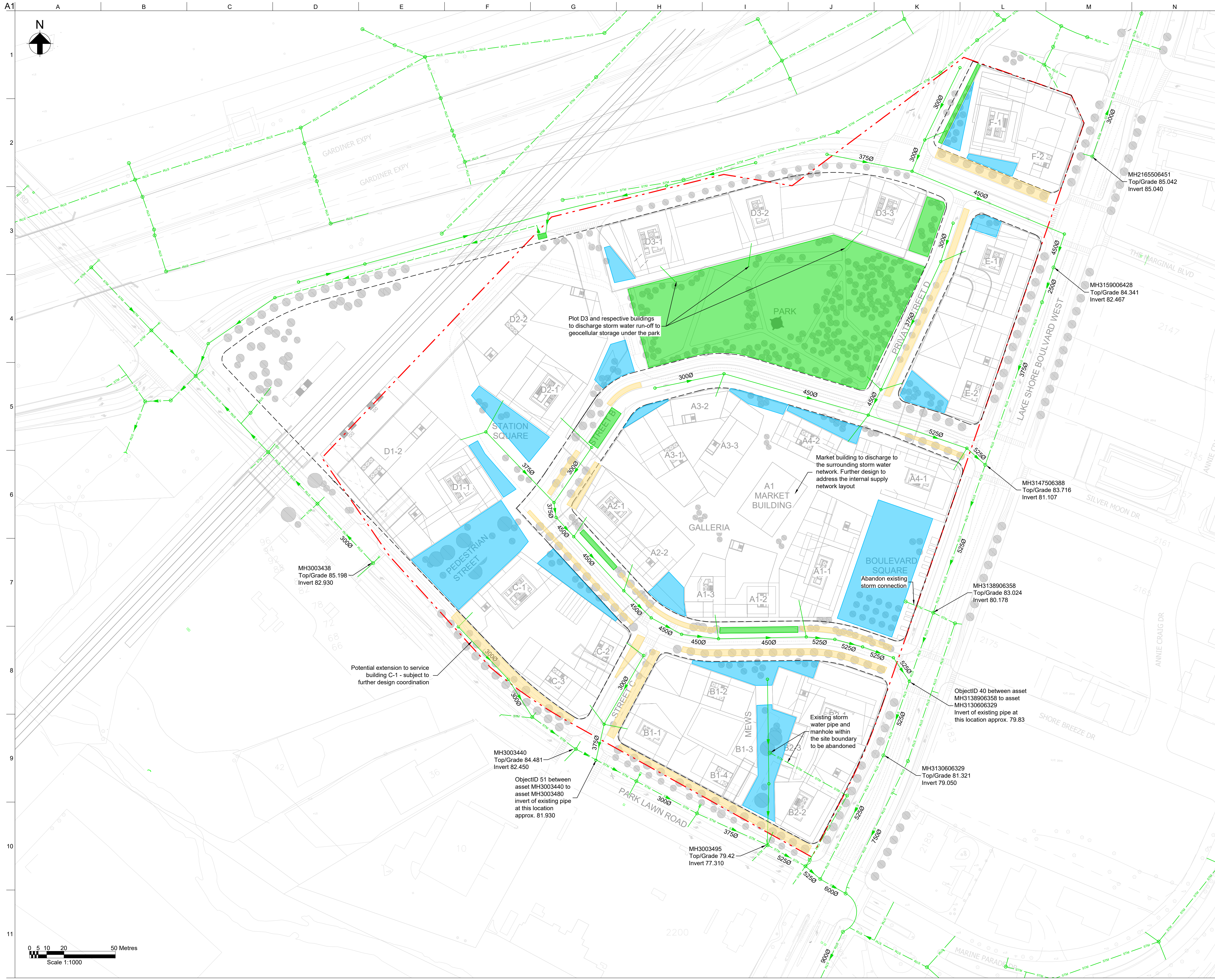
Table B2: Allowable Release Rate

Location	Area (ha)	Allowable Release rate (l/s)
A	2.16	264.62
B	0.92	112.78
C	0.49	60.6
D	1.65	201.74
E	0.54	66.19
F	0.47	57.16
Boulevard Square	0.3	36.93
Station S	0.33	40.98
Internal Loop	1.25	153.23
Pedestrian Walk	0.8	98.07
Public Street – Street C	0.1	12
Private Street – Street D	0.18	22.16
Park	1.01	123.81
Go Station	1.17	143.42

Appendix C – Drawings

Figure C1 Proposed storm water drainage layout

Figure C2 Proposed drainage catchment plan



Notes

1. All coordinates are in metres and referenced to Zone 10 of the Ontario Coordinate System, NAD (North American Datum) 1927, 1968 adjustment, 3 degree MTM (NAD 27 MTM 3 degrees Zone 10)
2. All dimensions are in metres unless noted otherwise.
3. The design of the storm water network should comply with Design Criteria for Sewers and Watermains, 1st edition, March 2014 and Wet Weather Flow Management Guidelines, November 2016.
4. Existing services are based in the topographical survey issued by EllisDon on 24 February 2020 and information provided by Toronto Water on 04 February 2020.
5. All manholes in the carriageway should be suitable to vehicle loading and finished to same skid resistance as adjacent carriageway.
6. Connection to existing storm water network is subject to agreement with Toronto Water.
7. Location and extent of existing services is indicative only and is intended to identify approximate location of main service corridors. For full details refer to utility providers record drawings or topographical survey.
8. Off-site reinforcement and temporary construction services are excluded from this drawing.
9. Proposed network design, plot connections and details are indicative only and are subject to approval by existing and proposed network operators as well as building designer.
10. Extent of proposed geocellular storage. soil cells and permeable pavement is indicative only and subject to further detailed modeling.
11. For typical street sections and cover depths refer to drawings LSB-ARP-XX-XX-DR-CU-72001 and LSB-ARP-XX-XX-DR-CU-72002
12. All proposed storm water mains within the road corridor to be 300mm pipes with a minimum gradient of 1:200, unless otherwise stated.

Legend

- Site Boundary
- Basement/Tunnel Extent
- Extent of Private Land

Existing Utilities

- Storm Water Network

Proposed Utilities

- Storm Water Sewer and Manhole
- Storm Water Force Main
- Pumping Station
- Geocellular Storage with Infiltration
- Soil Cells with Infiltration
- Landscape / SWM Zone at Grade

Rev	Date	By	Chkd	Appd
01	15/05/20	AF	FF	HJ
For planning submission				

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PROVINCE OF ONTARIO

Client
FCR (Park Lawn) LP and CPPIB Park Lawn Canada Inc.

Project Title
2150 Lake Shore

Drawing Title
Proposed Storm Water Drainage Layout

Scale at A1: 1:1000

Role: Civil

Suitability: Detailed Masterplan

Arup Job No: 264635

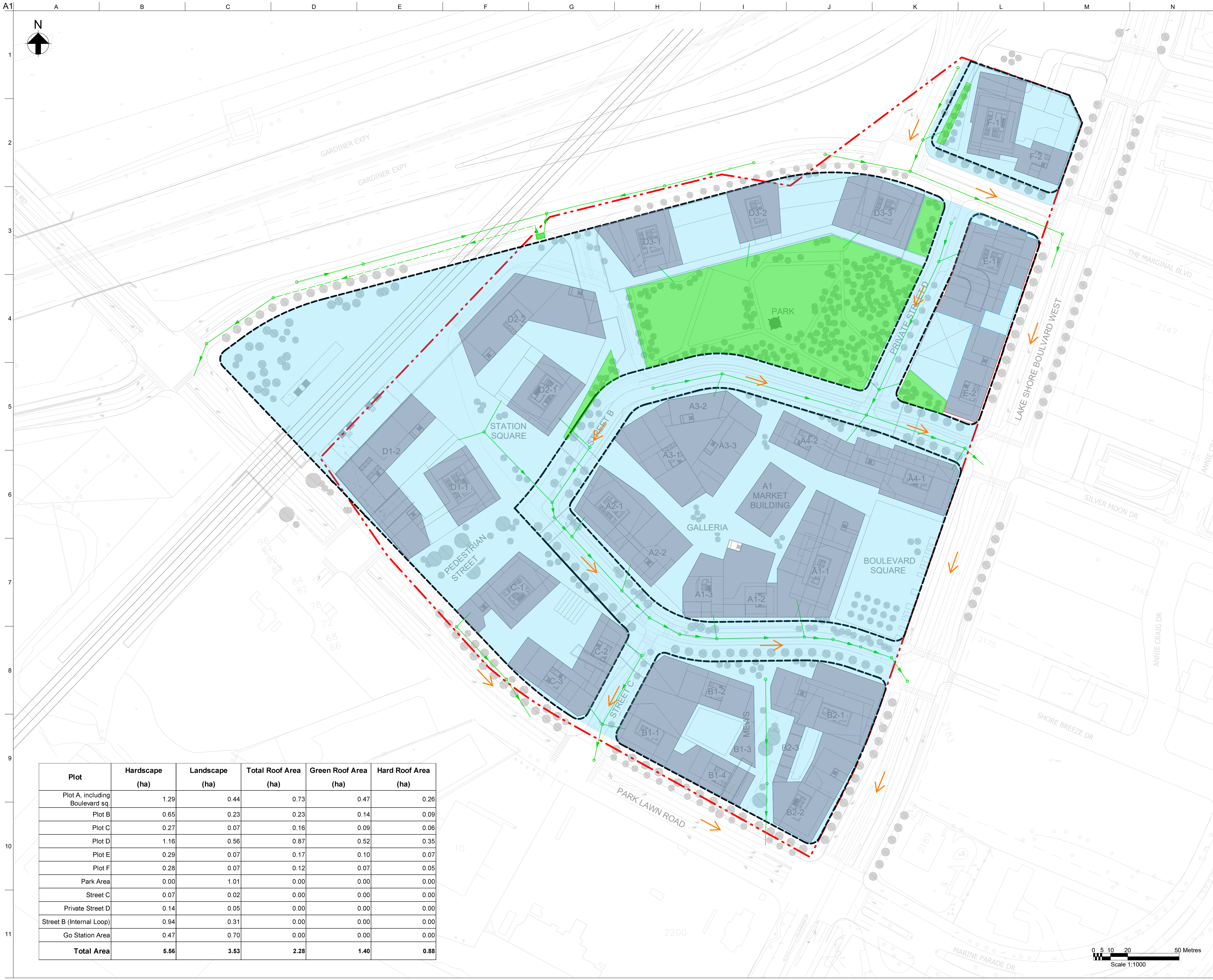
Rev: 01

Name: LSB-ARP-XX-XX-DR-CD-60000

Do not scale

Notes

1. All coordinates are in metres and referenced to Zone 10 of the Ontario Coordinate System, NAD (North American Datum) 1927, 1968 adjustment, 3 degree MTM (NAD 27 MTM 3 degrees Zone 10)
2. All dimensions are in metres unless noted otherwise.



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Street C	0.07	0.02	0.00	0.00	0.00
Private Street D	0.14	0.05	0.00	0.00	0.00
Street B (Internal Loop)	0.94	0.31	0.00	0.00	0.00
Go Station Area	0.47	0.70	0.00	0.00	0.00
Total Area	**5.56**	**3.53**	**2.28**	**1.40**	**0.88**

Legend

- Extent of the Drainage Catchment
- Plots boundaries, capacity of the pipes restricted to 2-year return period, unless otherwise stated
- Storm Water Sewer and Manhole
- Storm Water Force Main
- Pumping Station
- Indicative Roof areas and podium (60% green roof coverage to retain 25mm from entire roof area)
- Hardscape assumed 20% pervious area
- Landscape
- Overland flow route (any rainfall event over the 2 year return period)

Rev	Date	By	Chkd	Appd
01	15/05/20	AF	FF	HJ

For planning submission

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PROVINCE OF ONTARIO

Client
FCR (Park Lawn) LP and CPPIB Park Lawn Canada Inc.

Project Title
2150 Lake Shore

Drawing Title
Drainage Catchment Plan

Scale at A1: 1:1000

Role: Civil

Suitability: Detailed Masterplan

Arup Job No: 264635

Rev: 01

Name: LSB-ARP-XX-XX-DR-CD-60001

Do not scale

Appendix – D Hydraulic modelling

Figure D1 shows the proposed site as modelled in PCSWMM

Table D1: Hydrologic Parameters

Table D2: Catchment Parameters

Table D3: Run-off Results for 25mm Storm

Table D4 - Run-off Results for 6hr 100- year Storm

Figure D2 Storm Sewer Profile -1 along Lake Shore Blvd - 100Year Storm

Figure D3 Storm Sewer Profile -2 along Lake Shore Blvd - 100Year Storm

Figure D4 Storm Sewer Profile along Park Lawn Road - 100Year Storm

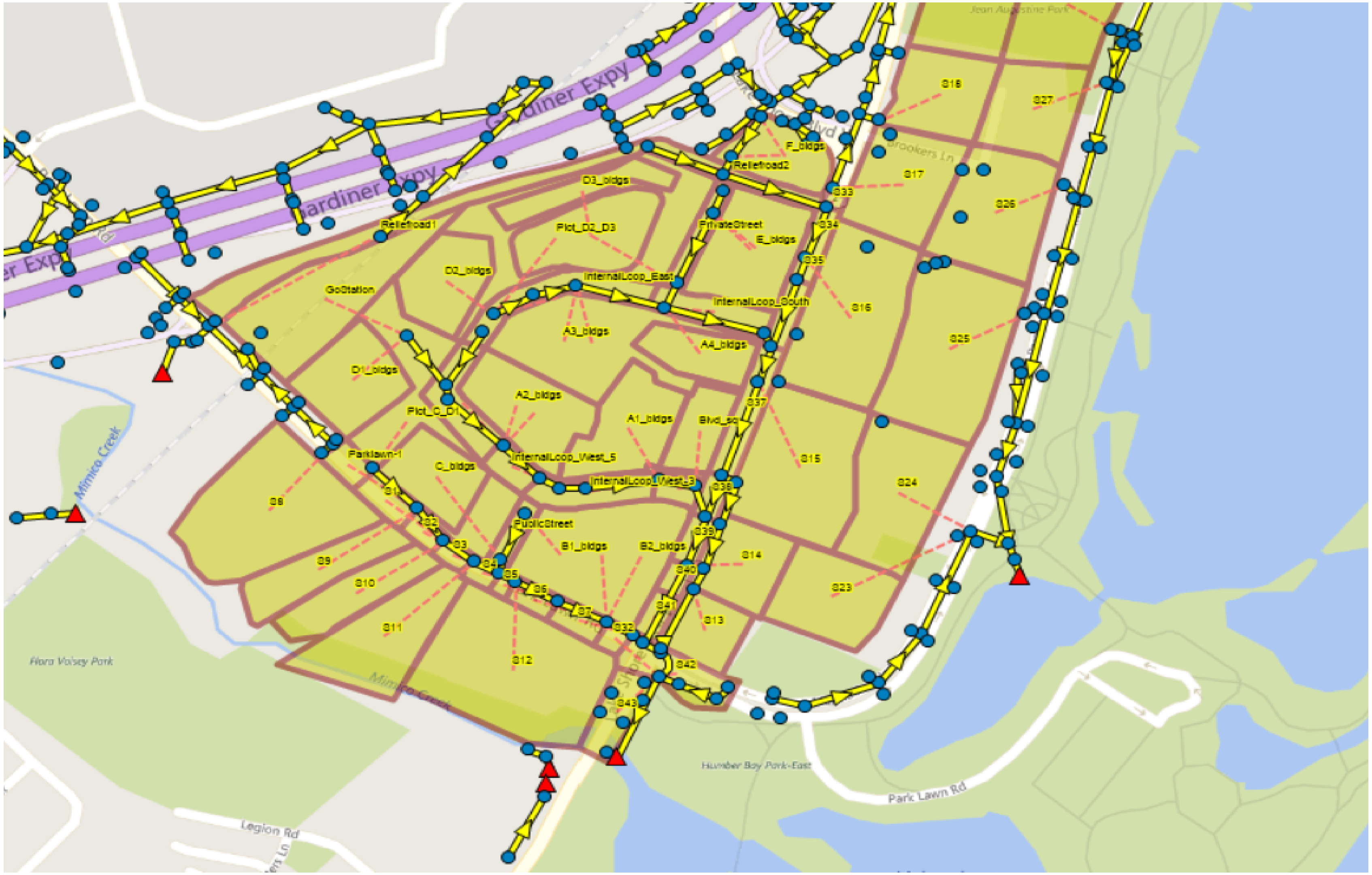

Figure D1 Proposed Site Model

Table D1: Hydrology Parameters for Proposed Subcatchments

Name	N Imperv	N Perv	Dstore Imperv (mm)	Dstore Perv (mm)	Zero Imperv (%)	Subarea Routing
GoStation	0.013	0.15	1.2	5	0	OUTLET
A4_bldgs	0.013	0.15	1.2	5	0	OUTLET
InternalLoop_East	0.013	0.15	1.2	5	0	OUTLET
InternalLoop_West	0.013	0.15	1.2	5	0	OUTLET
InternalLoop_South	0.013	0.15	1.2	5	0	OUTLET
Plot_D2_D3	0.013	0.15	1.2	5	0	OUTLET
Plot_C_D1	0.013	0.15	1.2	5	0	OUTLET
E_bldgs	0.013	0.15	1.2	5	0	OUTLET
D1_bldgs	0.013	0.15	1.2	5	0	OUTLET
B1_bldgs	0.013	0.15	1.2	5	0	OUTLET
B2_bldgs	0.013	0.15	1.2	5	0	OUTLET
Plot_B	0.013	0.15	1.2	5	0	OUTLET
Plot_E	0.013	0.15	1.2	5	0	OUTLET
C_bldgs	0.013	0.15	1.2	5	0	OUTLET
F_bldgs	0.013	0.15	1.2	5	0	OUTLET
Plot_F	0.013	0.15	1.2	5	0	OUTLET
A3_bldgs	0.013	0.15	1.2	5	0	OUTLET
A2_bldgs	0.013	0.15	1.2	5	0	OUTLET
A1_bldgs	0.013	0.15	1.2	5	0	OUTLET
Blvd_sq	0.013	0.15	1.2	5	0	OUTLET
D2_bldgs	0.013	0.15	1.2	5	0	OUTLET
Park	0.013	0.15	1.2	5	0	OUTLET
D3_bldgs	0.013	0.15	1.2	5	0	OUTLET
PublicStreet	0.013	0.15	1.2	5	0	OUTLET
PrivateStreet	0.013	0.15	1.2	5	0	OUTLET
Reliefroad2	0.013	0.15	1.2	5	0	OUTLET
Reliefroad1	0.013	0.15	1.2	5	0	OUTLET
PloA-West	0.013	0.15	1.2	5	0	OUTLET
PlotA-East	0.013	0.15	1.2	5	0	OUTLET

Notes:
1.N Values = Manning's value
2.Dstore = Initial Abstraction
3.%Zero impervious = % of area with zero depression storage

Table D2: Proposed Catchment Parameters

Name	Outlet	Area (ha)	Slope (%)	Imperv. (%)
GoStation	J19	1.17	0.5	60
A4_bldgs	J9	0.36	0.5	63
InternalLoop_East	J1	0.38	2	75
InternalLoop_West	J25	0.66	2	75
InternalLoop_South	J9	0.18	2	75
Plot_D2_D3	J1	0.46	0.5	65
Plot_C_D1	J6	0.65	0.5	65
E_bldgs	J11	0.46	0.5	63
D1_bldgs	J19	0.53	0.5	63
B1_bldgs	J24	0.46	0.5	63
B2_bldgs	MH300349	0.46	0.5	63
Plot_B	MH300349	0.19	0.5	65
Plot_E	J11	0.07	0.5	65
C_bldgs	J23	0.49	0.5	63
F_bldgs	J30	0.28	0.5	65
Plot_F	J29	0.19	0.5	65
A3_bldgs	J3	0.35	0.5	60
A2_bldgs	J16	0.22	0.5	63
A1_bldgs	J7	0.63	0.5	60
Blvd_sq	J25	0.3	0.5	50
D2_bldgs	J1	0.5384	0.5	63
Park	J10	1.01	1.2	20
D3_bldgs	Park	0.6	0.5	65
PublicStreet	J23	0.098	1.5	65
PrivateStreet	J12	0.18	2	65
Reliefroad2	J28	0.3	1.3	75
Reliefroad1	MH300343	0.79	3.5	75
PloA-West	J16	0.29	0.5	80
PlotA-East	J3	0.29	0.5	80

Table D3 - Run-off Results - 100 Year Storm

Name	Area (ha)	Precipitation (mm)	Runoff Volume (ML)	Peak Runoff (m^3/s)
A1_bldgs	0.63	85.43	0.38	0.73
A2_bldgs	0.22	85.43	0.13	0.44
A3_bldgs	0.35	85.43	0.19	0.26
A4_bldgs	0.36	85.43	0.25	0.19
B1_bldgs	0.46	85.43	0.28	0.62
B2_bldgs	0.46	85.43	0.29	1.09
Blvd_sq	0.30	85.43	0.19	0.14
C_bldgs	0.49	85.43	0.30	0.65
D1_bldgs	0.53	85.43	0.30	0.36
D2_bldgs	0.54	85.43	0.30	0.36
D3_bldgs	0.60	85.43	0.36	0.45
E_bldgs	0.46	85.43	0.28	0.61
F_bldgs	0.28	85.43	0.17	0.49
GoStation	1.17	85.43	0.78	0.60
InternalLoop_East	0.38	85.43	0.28	0.24
InternalLoop_South	0.18	85.43	0.13	0.11
InternalLoop_West_1	0.10	85.43	0.08	0.07
InternalLoop_West_2	0.25	85.43	0.18	0.16
InternalLoop_West_3	0.21	85.43	0.15	0.13
InternalLoop_West_5	0.14	85.43	0.10	0.09
Park	1.01	85.43	0.78	0.61
Parklawn-1	0.11	85.43	0.09	0.07
PloA-West	0.29	85.43	0.22	0.18
Plot_B	0.19	85.43	0.13	0.10
Plot_C_D1	0.65	85.43	0.46	0.37
Plot_D2_D3	0.46	85.43	0.32	0.25
Plot_E	0.07	85.43	0.05	0.04
Plot_F	0.19	85.43	0.13	0.10
PlotA-East	0.29	85.43	0.22	0.18
PrivateStreet	0.18	85.43	0.13	0.11
PublicStreet	0.10	85.43	0.06	0.06
Reliefroad1	0.79	85.43	0.58	0.51
Reliefroad2	0.30	85.43	0.22	0.19
S1	0.13	85.43	0.10	0.08
S10	0.47	32.54	0.04	0.03
S11	0.83	32.54	0.07	0.05
S12	1.63	32.54	0.13	0.10
S13	0.39	32.54	0.03	0.02
S14	0.53	32.54	0.04	0.03
S15	1.27	32.54	0.10	0.08
S16	1.30	32.54	0.10	0.08

Table D3 - Run-off Results - 100 Year Storm

Name	Area (ha)	Precipitation (mm)	Runoff Volume (ML)	Peak Runoff (m^3/s)
S17	0.79	32.54	0.06	0.05
S18	0.62	32.54	0.05	0.04
S19	0.90	32.54	0.07	0.06
S2	0.08	85.43	0.06	0.05
S20	0.81	32.54	0.06	0.05
S21	1.11	32.54	0.09	0.07
S22	0.49	32.54	0.04	0.03
S23	0.73	32.54	0.06	0.04
S24	0.99	32.54	0.08	0.06
S25	1.44	32.54	0.11	0.09
S26	0.95	32.54	0.07	0.06
S27	0.64	32.54	0.05	0.04
S28	0.92	32.54	0.07	0.06
S29	1.87	32.54	0.15	0.11
S3	0.06	85.43	0.05	0.04
S30	1.14	32.54	0.09	0.07
S31	3.08	32.54	0.24	0.19
S32	0.06	85.43	0.05	0.04
S33	0.03	85.43	0.02	0.02
S34	0.10	85.43	0.08	0.06
S35	0.04	85.43	0.03	0.03
S36	0.13	85.43	0.10	0.09
S37	0.28	85.43	0.22	0.18
S38	0.09	85.43	0.07	0.06
S39	0.10	85.43	0.08	0.07
S4	0.06	85.43	0.05	0.04
S40	0.07	85.43	0.05	0.04
S41	0.10	85.43	0.08	0.07
S42	0.33	85.43	0.26	0.22
S43	0.27	85.43	0.21	0.17
S5	0.03	85.43	0.03	0.02
S6	0.09	85.43	0.07	0.06
S7	0.12	85.43	0.09	0.08
S8	1.44	32.54	0.11	0.09
S9	0.50	32.54	0.04	0.03

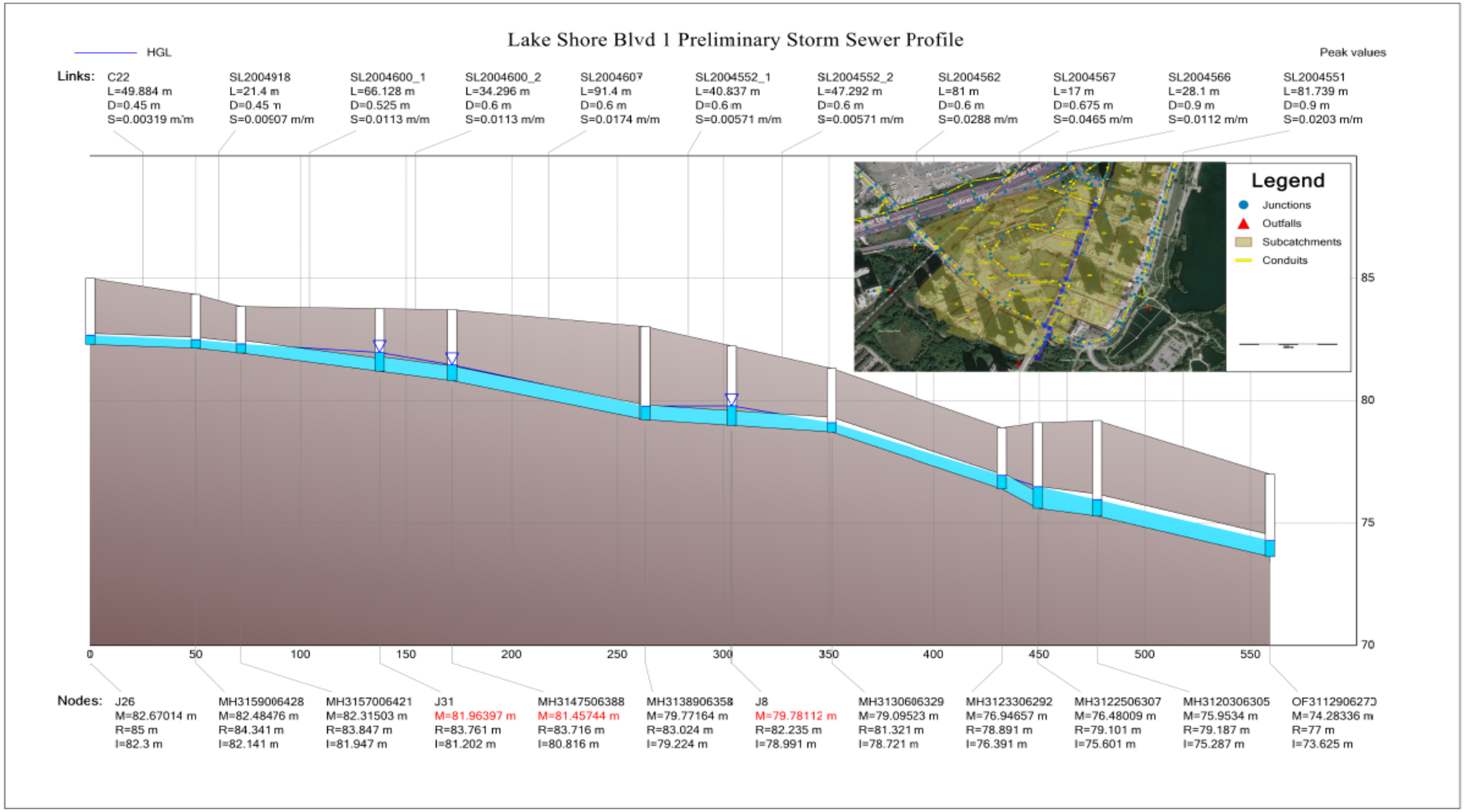

Figure D2 Storm Sewer Profile - 1 along Lakeshore Blvd - 100Year Storm

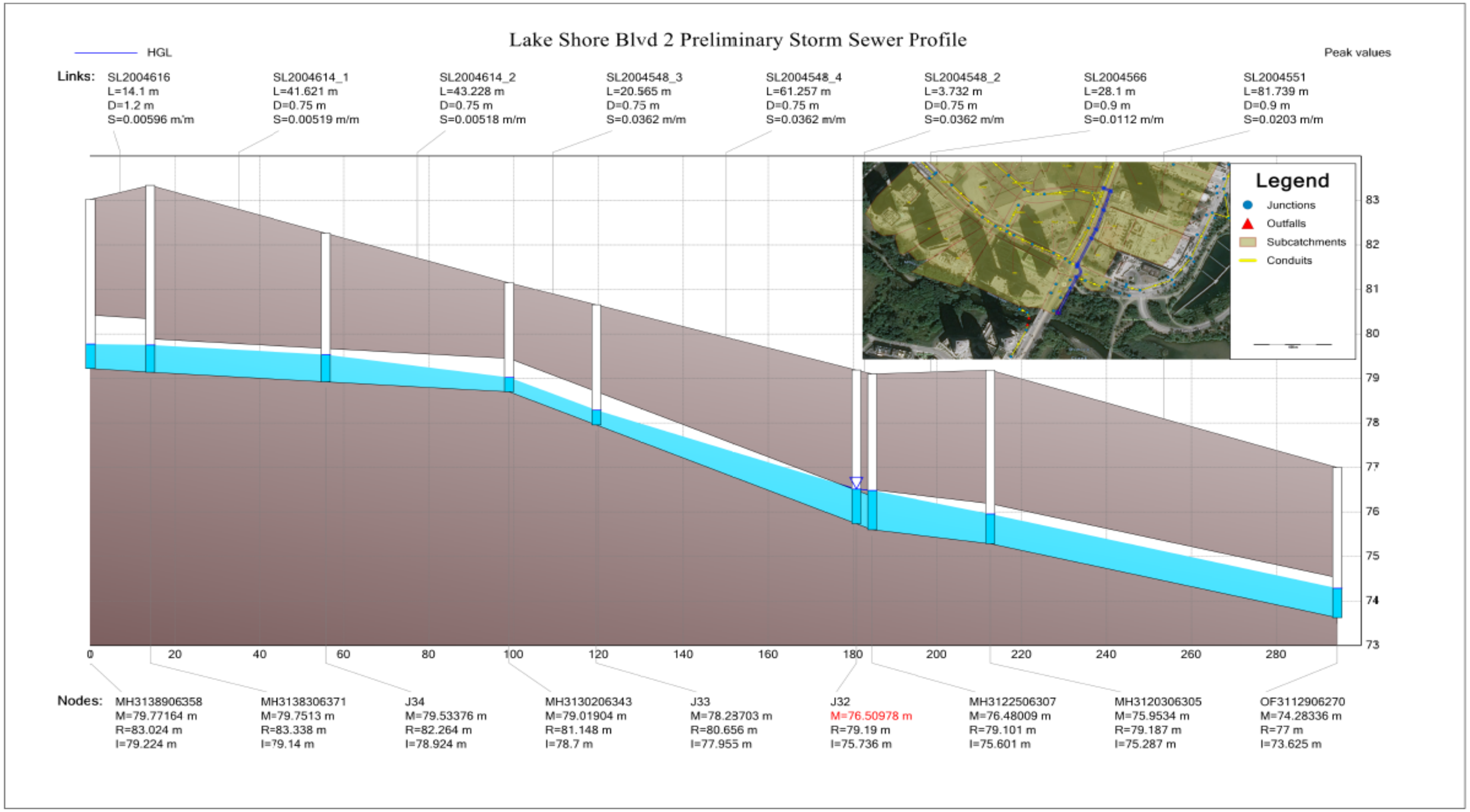

Figure D3 Storm Sewer Profile - 2 along Lakeshore Blvd - 100Year Storm

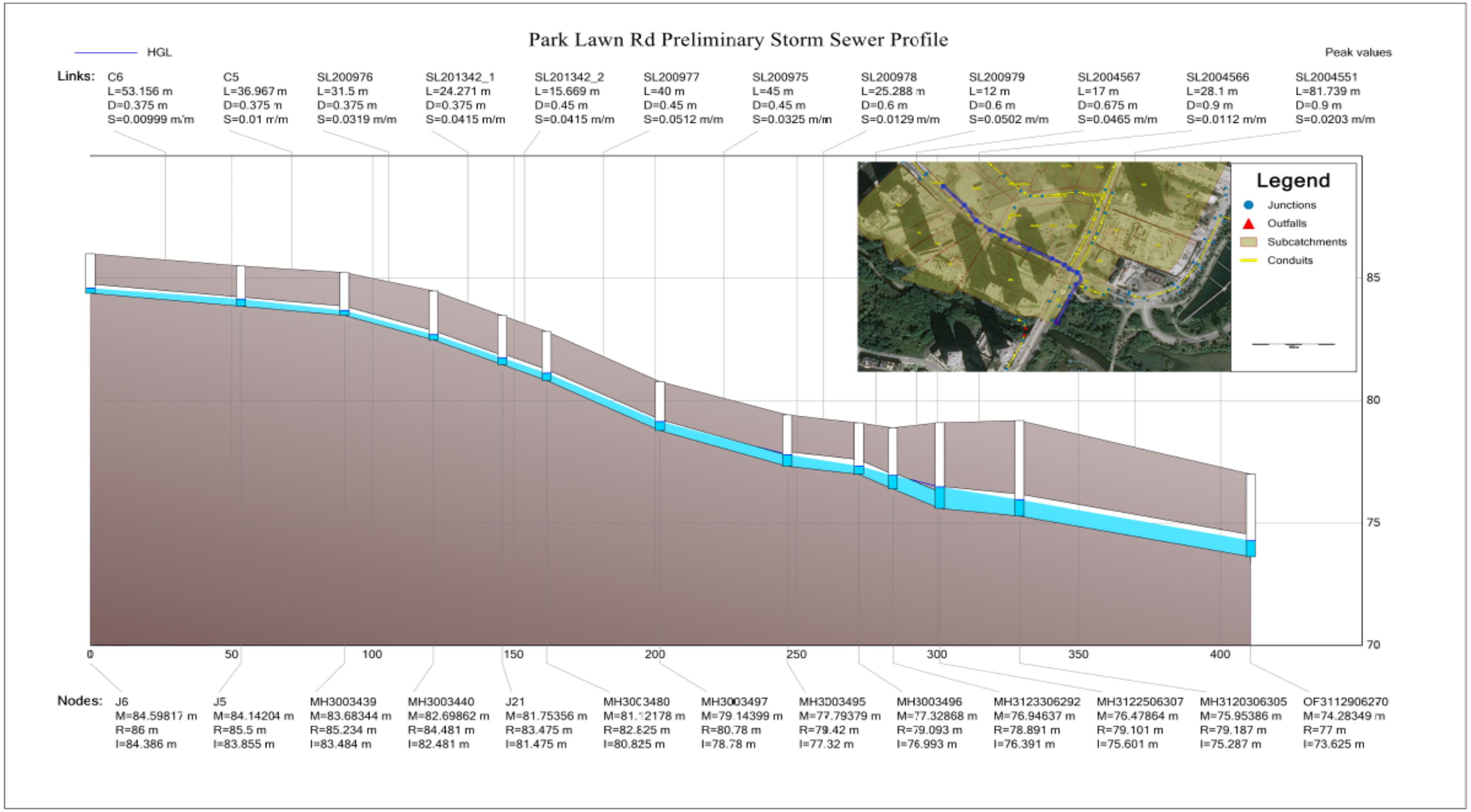

Figure D4 Storm Sewer Profile along Park Lawn Road - 100Year Storm