Core Area Servicing Study (CASS): Wastewater

Final Report

Prepared by GM BluePlan for:

London
CANADA

Project No. 716013
December 8th 2017

GM BluePlan ENGINEERING

Version Updates

The following is a record of the changes/updates:

Version	Comment / Changes / Updates	Author	Reviewer	Date
Draft	First draft for review	Spenser Carey	James Jorgensen	May 9th 2017
Final Draft	Final Draft incorporating comments and changes following City review	Spenser Carey	James Jorgensen	May 30th 2017
Final	Final version following final City and Stakeholder review	Spenser Carey	James Jorgensen	December 8th 2017

Glossary of Terms and Acronyms

The following table provides a summary of terms and acronyms that are commonly used throughout the report.

Term or Acronym	Definition
CASS	Core Area Servicing Study
CSRF	City Servicing Reserve Fund
DC	Development Charge
DWF	Dry Weather Flow
GMIS	Growth Management Implementation Strategy
GWI	Groundwater Infiltration
HDR	High Density Residential
I/I	Inflow and Infiltration
IQR	Interquartile Range
LDR	Low Density Residential
LOS	Level of Service
MDR	Medium Density Residential
PPCP	Pollution Prevention Control Plan
RDII	Rainfall-derived inflow and infiltration

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Executive Summary

The City of London is undertaking the Core Area Servicing Studies (CASS) to determine the infrastructure servicing requirements that will support the City's vision and official plan objectives for the core area of the City. The CASS is the City's first servicing study to evaluate growth-related infrastructure needs associated with infill and intensification in the downtown core area.

The CASS comprises a family of servicing studies that includes water, wastewater and stormwater that will form a critical component to enable the City of London's growth aspirations. GM BluePlan was retained to undertake the wastewater component of the CASS, recognizing that coordination with water and stormwater consultants and several other ongoing/planned initiatives, including the SHIFT rapid transit project, would be required.

The primary aim of the Core Area Servicing Study (CASS – Wastewater) is to determine the necessary infrastructure to deliver sanitary servicing for the Core Area of the City, based on ultimate build-out population projections. Subsequently, using the City's growth allocation for the Core Area, establish the phased infrastructure costs for a 20 year period, to 2034.

Hydraulic modelling was used to support capacity analysis of the system to identify existing constraints. Growth projections were used in conjunction with City design criteria to load the models and identify future system constraints and intervention options.

Identified infrastructure needs were primarily based on a meeting a 1 in 5 year design rainfall event level of service trigger. Identified interventions were defined and costed using agreed unit rates, consistent with both the water and stormwater CASS studies. Similarly, a consistent approach was developed and employed to split costs as Development Charge (DC) eligible and Benefit to Existing (BTE) eligible.

City-wide growth projections, provided by the City and used to establish future servicing impacts, are summarized in Table ES 1. A summary of the projected growth in the Core Area and outside of it is provided in Table ES 2. Total estimated summary costs are as provided in Table ES 3.

The servicing analysis identified a total of 18 constraints for which solutions were identified. The location, individual cost estimates and required timing of the interventions are provided in Figure ES 1, Table ES 4, and Figure ES 2 respectively.

Table ES 1: Build-out Growth Projections

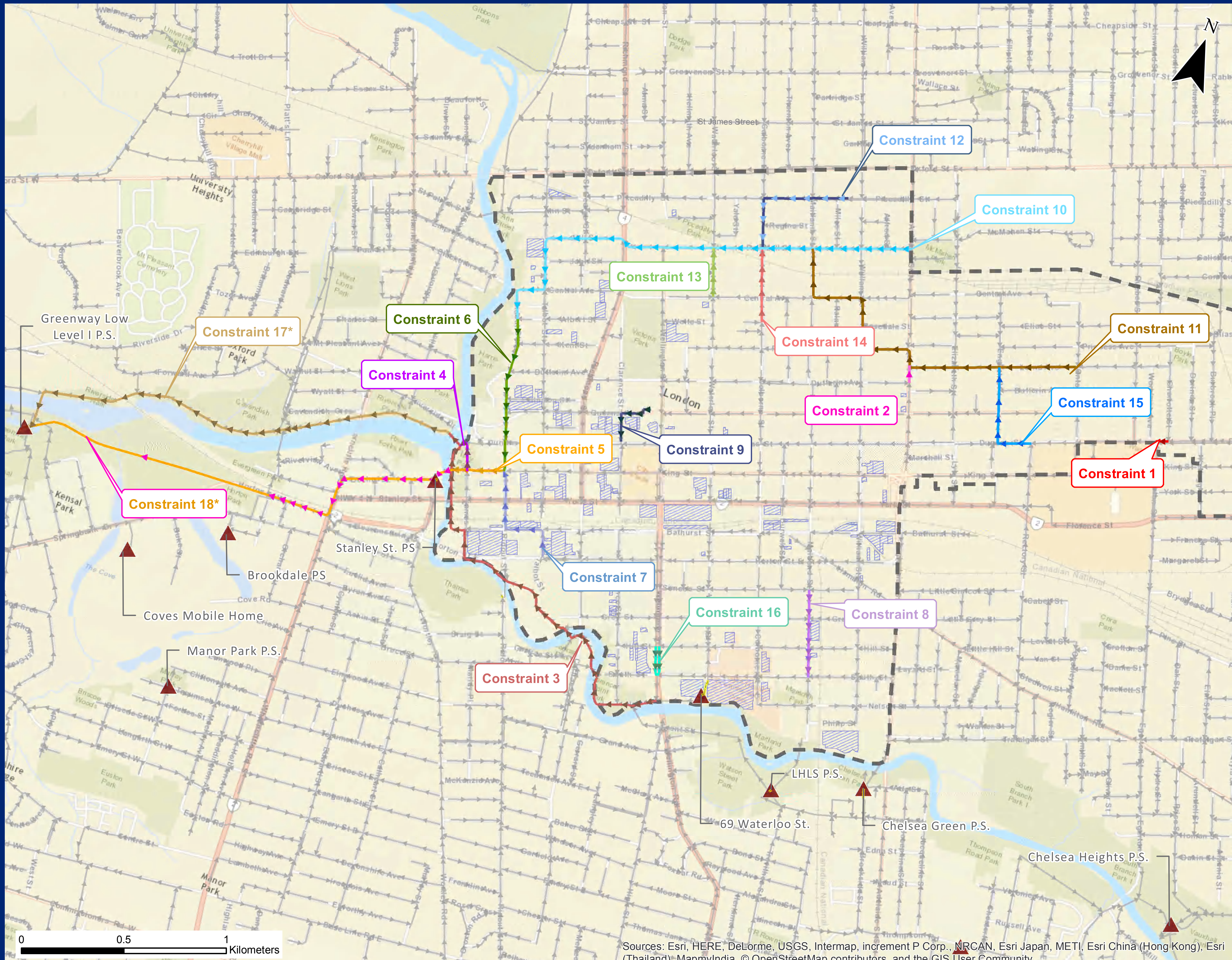
	Population	Employment	Units	ICI (m2)
2014 Total	377,529	194,067	174,360	-
Total Build-out Growth	**145,120**	**18,723**	**78,993**	**1,082,057**
Build-out Total	522,649	212,790	253,353	-

Table ES 2: Within and Outside Core Area Build-out Growth Projections

	Population	Employment	Units	ICI (m2)
Core Area Vacant Parcel Growth	42,301	3,958	24,850	162,969
Core Area TAZ Growth	13,250	650	7340	32,775
Sub-Total	**55,551**	**4,608**	**32,190**	**195,744**
Outside Core Area Growth	89,569	14,115	46,803	886,313
Total	**145,120**	**18,723**	**78,993**	**1,082,057**

Table ES 3: Total Estimated CASS Servicing Costs

	City Costs ($)	City Costs (%)	Growth Costs ($)	Growth Cost (%)	Total Costs
Required 2014 to 2034	$33,616,721	62%	$20,292,789	38%	$53,909,510
Required Build-out	$24,110,824	70%	$0,276,569	30%	$34,387,394
Total	**$57,727,545**	**65%**	**$30,569,359**	**35%**	**$88,296,904**



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City of London
Core Area Servicing Studies (CASS)
Wastewater System

All Core Area Servicing Constraints

Sewage Pumping Station

Study Area

Vacant Lands

Force Mains

Constraints

Constraint 1	Constraint 10
Constraint 2	Constraint 11
Constraint 3	Constraint 12
Constraint 4	Constraint 13
Constraint 5	Constraint 14
Constraint 6	Constraint 15
Constraint 7	Constraint 16
Constraint 8	Constraint 17*
Constraint 9	Constraint 18*

** Constraints 17 and 18 are beyond the boundaries of the study area.*

Figure ES 1 : Core Servicing Area - Wastewater Constraints

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716013 - WW - 18a
May 2017
Data Source: City of London
Scale: 1:18,554 | NAD 1983 UTM Zone 17N

Table ES 4: Summary of Estimated Cost for Wastewater Constraints

Constraint Number	Location	City Costs $	City Costs %	Growth Costs $	Growth Costs %	Total Costs	Phasing
1	Dundas and Egerton St	$ -	0%	$ 308,872	100%	$ 308,872	Commenced
2	Dufferin and Adelaide North	$ 63,303	20%	$ 257,017	80%	$ 320,319	Build-out
3-1	Thames Valley Pkwy (Between Riverside and Ridout)	$ 5,022,574	83%	$ 1,018,521	17%	$ 6,041,095	2024
3-2	Thames Valley Pkwy (Between Ridout St. N and Clarence St.)	$ 4,983,156	85%	$ 856,296	15%	$ 5,839,452	2024
3-3	Thames Valley Pkwy (Between Clarence and Wellington)	$ 256,212	40%	$ 386,675	60%	$ 642,887	2024
4	Thames St. (Between Dundas and King St.)	$ 472,092	61%	$ 298,454	39%	$ 770,546	Build-out
5	King St. (Between Thames St. and Ridout St. N)	$ 884,365	54%	$ 760,973	46%	$ 1,645,338	2019
6-1	Ridout Trunk (Between Dundas and King)	$ 520,937	42%	$ 706,110	58%	$ 1,227,047	2034
6-2	Ridout Trunk (Between Queens Av and Dundas)	$ 920,283	67%	$ 450,174	33%	$ 1,370,457	2034
6-3	Ridout St Nth between Fullarton and Albert	$ 2,137,052	56%	$ 1,662,915	44%	$ 3,799,967	2019
7-1	Ridout Trunk North (Between Bathurst and King)	$ 1,017,970	54%	$ 860,220	46%	$ 1,878,190	2034
7-2	Bathurst St. (between Simcoe and Ridout)	$ 744,061	71%	$ 310,314	29%	$ 1,054,375	2034
7-3	Talbot St. (between Bathurst and Horton)	$ 355,091	62%	$ 214,474	38%	$ 569,565	2034
8	Maitland St. between Simcoe St and South St	$ 758,726	47%	$ 863,247	53%	$ 1,621,972	2034
9	Clarence St and Queens Av	$ 393,179	35%	$ 726,175	65%	$ 1,119,354	2019
10-1	Pall Mall East and Talbot St	$ 6,522,578	61%	$ 4,234,469	39%	$ 10,757,048	2029
10-2	Pall Mall between Maitland and Adelaide	$ 893,490	49%	$ 920,636	51%	$ 1,814,126	Build-out
11-1	William St to Lorne Av	$ 4,005,288	65%	$ 2,175,143	35%	$ 6,180,432	2034
11-2	Lorne Av between Elizabeth and Ontario	$ 1,855,190	67%	$ 898,767	33%	$ 2,753,957	2034
12	Picadilly St. and Colborne	$ 1,285,200	51%	$ 1,253,386	49%	$ 2,538,585	2034
13	Waterloo St between Pall Mall and Central Av	$ 384,490	42%	$ 539,227	58%	$ 923,717	Build-out
14	Colborne St between Pall Mall and Hope St	$ 462,312	34%	$ 910,068	66%	$ 1,372,380	2019
15	English St	$ 1,091,457	53%	$ 978,146	47%	$ 2,069,603	2019
16	Wellington St between Hill St and Front St	$ 401,090	36%	$ 717,844	64%	$ 1,118,934	2024
17	Riverside Park	$ 12,568,010	77%	$ 3,814,625	23%	$ 16,382,635	Build-out
18	Becher St	$ 9,729,439	69%	$ 4,446,611	31%	$ 14,176,050	Build-out

Total	$ 57,727,545	65.4%	$ 30,569,359	34.6%	$ 88,296,904
Total (excluding Greenway trunk)	$ 35,430,095	61.4%	$ 22,308,123	38.6%	$ 57,738,218

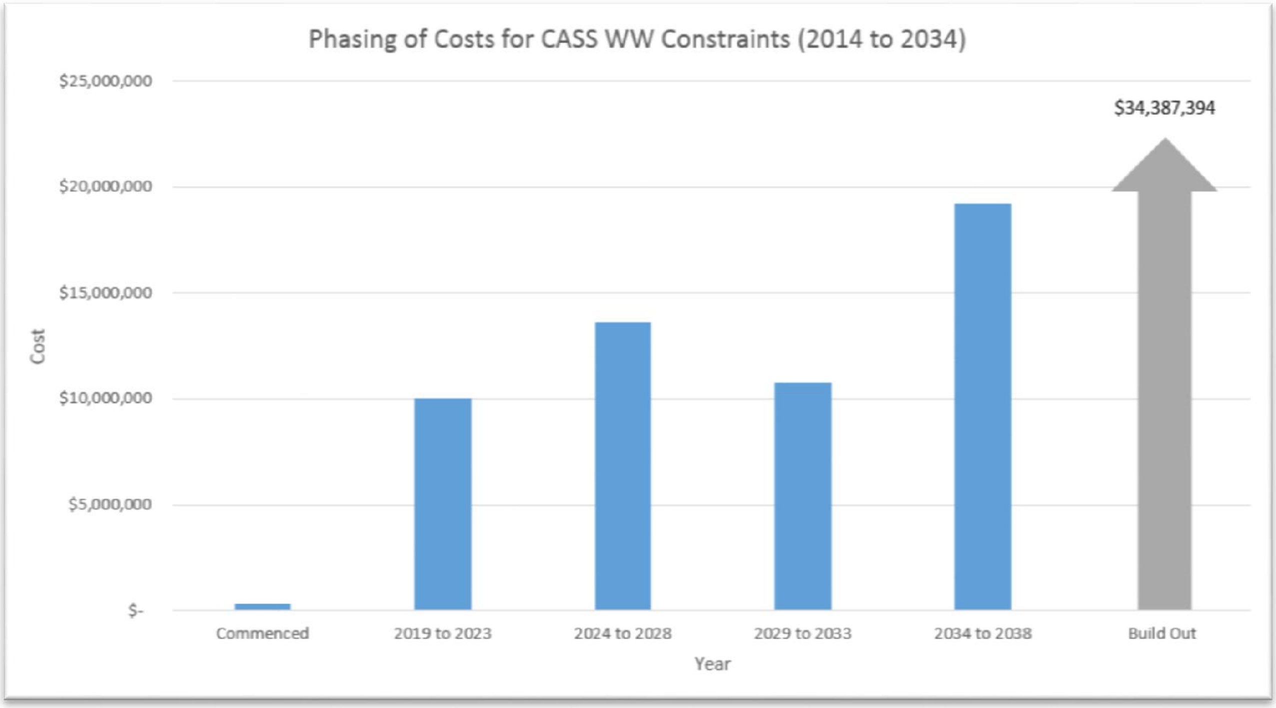


Figure ES 2: Phasing of Costs for Wastewater Constraints

1 Introduction

1.1 Introduction

The City of London is undertaking the Core Area Servicing Studies (CASS) to determine the infrastructure servicing requirements that will support the City's vision and official plan objectives for the core area of the City. The CASS is the City's first set of servicing studies to evaluate growth-related infrastructure needs associated with infill and intensification in the downtown core area.

The CASS comprises a family of servicing studies that includes water, wastewater and stormwater that will form a critical component to enable the City of London's growth aspirations. GM BluePlan was retained to undertake the wastewater component of the CASS, recognizing that coordination with water and stormwater consultants and several other ongoing/planned initiatives, including the SHIFT rapid transit project and the Pollution Prevention Control Program is required.

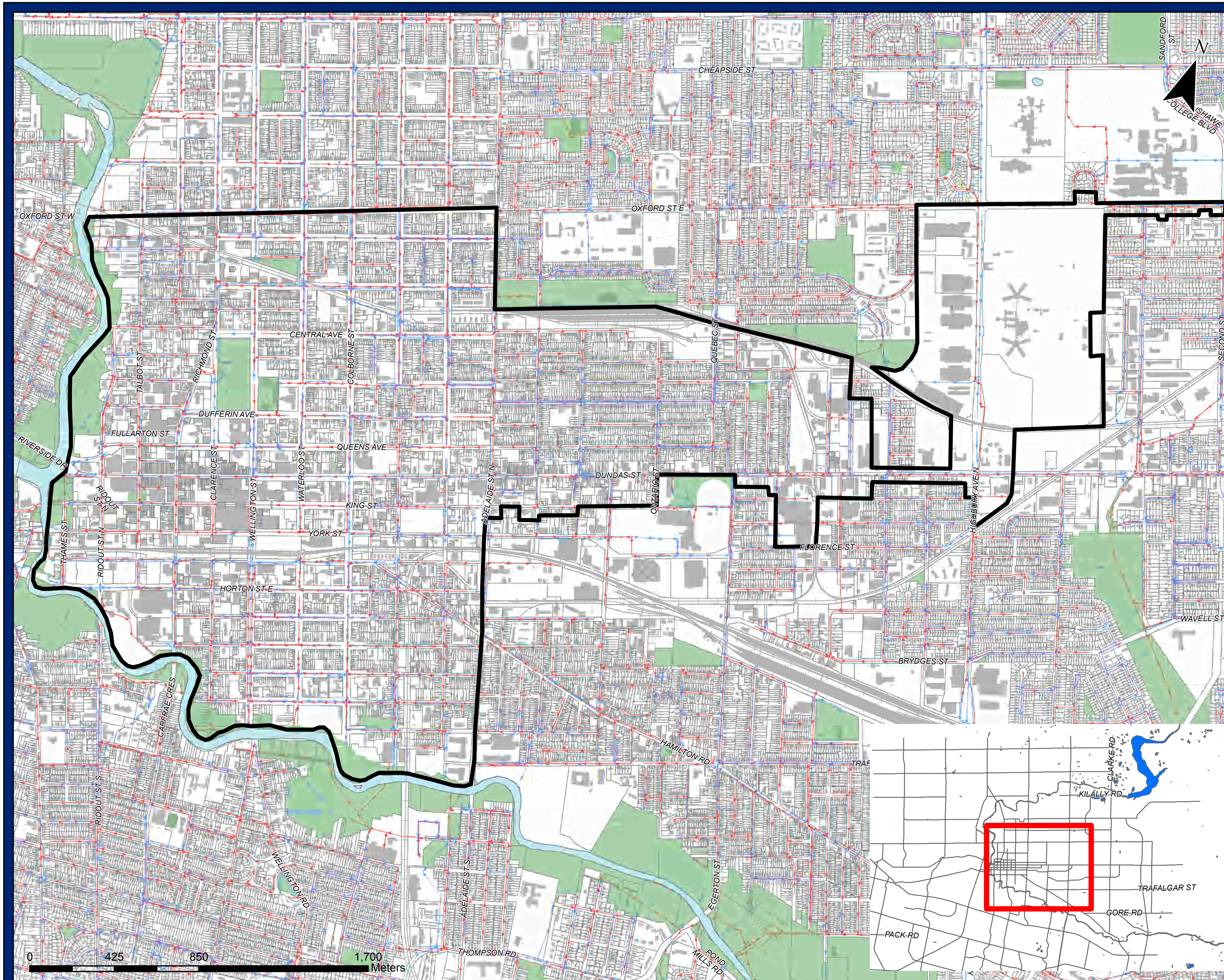
The study is being undertaken in support of the Development Charge (DC) Background Study process to determine system improvements that will accommodate future growth projected to 2034, and ultimate build-out scenarios. Existing and future wastewater servicing requirements for the core area have been identified.

The study leveraged the recently completed hydraulic model build and calibration projects covering the downtown core. A unified all-pipe model was created to assist with the study analysis using the older available hydraulic models.

The CASS wastewater project focuses on growth in a downtown core context which brings existing infrastructure and existing constraints into consideration with the new requirements to service growth. A review of DC policy best practice within the industry provided alternative methods of determining DC eligible works and recommendations on suggested changes to the existing Local Service Policy relevant to the City of London.

A Design Criteria, Level of Service (LOS) and Policy review was undertaken to provide a baseline assessment for determining the trigger points for intervention and the approach to identify DC eligible infrastructure costs. For the CASS, a typical trigger for linear infrastructure improvements were based on meeting a 1 in 5 year event, further described in Section 6.2. The level of service of overflows and cross-connections between sanitary and combined or sanitary and storm sewers throughout the City followed MOECC's F-5-5 regulations.

The Study area for the wastewater CASS is shown in Figure 1.



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716013 - City of London
Core Area Servicing Studies (CASS)
Wastewater Component

Study Area Map

Legend

Study Area

SewerPipes

Sanitary

Storm

Figure 1:
CASS Wastewater Study Area

GM BluePlan ENGINEERING

716013-23-Study Area
May 2017
Data Source: City of London
Scale: 1:217,632 | NAD 1983 UTM Zone 17N

1.2 Aim and Objectives

1.2.1 Aim

The primary aim of the Core Area Servicing Studies (CASS – Wastewater) is:

- To determine what infrastructure is required to deliver sanitary servicing to the Core Area of the City, based on agreed level of service and ultimate build-out population projections. Subsequently, using the City's growth allocation for the Core Area, establish the phased infrastructure delivery timing and costs for a 20 year period, to 2034.

1.2.2 Objectives

To meet these aims the completion of the following project objectives are required:

- Review, understand and use the City's growth projections to forecast the future sanitary flow.
- Create a holistic hydraulic model of the Core Area, using the City's recently calibrated component model
- Identify the spatial location and load the growth projections to the model. Use the model to help identify infrastructure needs.
- Review the City's current relevant processes and policies and update and develop them to enable a consistent, transparent and traceable approach to identifying infrastructure needs and costs based on a defined design criteria and Level of Service.
- Cost all required infrastructure needs to service the core area using agreed unit rates and a defined cost splitting process.
- Summarize all infrastructure constraints and needs in a DC consumable format.
- Coordinate the needs of Water Servicing, Sanitary servicing, Storm Servicing, and the Rapid Transit Project to ensure that the output is integrated and viable. The staging plan should also be consistent with the London Plan in terms of development of growth areas;

2 Planning and Population Growth Projection Data

Significant effort was undertaken by City's Planning Services Area (PSA) with assistance from Development Finance to develop growth projections for the 2014 DC Background Study. These projections were provided to CASS consultants as part of the RFP process and were identified as the preferred approach to complete the CASS studies. No new projections were developed for specifically for this study.

Additional work was completed by PSA to provide more refined spatial allocation of growth within the core area. This enabled a more granular allocation of intensification growth to vacant parcels leading to a more defined review of impacts to the existing and future system.

The planning data provided was comprehensive and robust. The data was provided in GIS format which enabled the efficient use of the data.

2.1 Planning Data Review and Summary

A summary of the growth projection data, which was used to load the model to assess future growth needs, is shown in Table 1.

Table 1: Datasets provided

Name of Shapefile	Data contained	Number of Records
'TZ_alloc_ICI_M5_13'	Employment change between 2011 and 2014, 2014 and 2019, 2019 and 2024, 2024 and 2029, 2029 and 2034.	(532 records)
'TZ_CASS_buildout_F_16'	Population for 2014, Max Build out Population, Max Build out Employment	(532 records)
'TZ_alloc_res_FINAL'	Population and population growth for 2014, 2019, 2024, 2029, and 2034	(532 records)
'TZ_allocations_VLIparcels'	Corresponding TAZ link vacant parcels, Max Build out Population, Max Build out Employment.	(129 records)
'TZ_generalized'	Population for 2014, Max Build out Population, Max Build out Employment	(23 records)

A preliminary analysis was performed on the datasets provided in order to isolate any trends or anomalies. The growth of population and employment was spatially allocated based on Traffic Analysis Zones (TAZs) and covered the entire City of London's municipal boundary. A positive growth was observed for all TAZs with the exception of a negative population growth for TAZ# 513.

Following review and consultation, the City completed additional analysis and allocated the majority of the TAZ growth within the Core Area to any vacant land parcels present. This provided a more accurate spatial allocation of growth within the core area and direction when loading the growth population equivalents to the hydraulic model. A small proportion remained as TAZ generalized growth, where no vacant parcels were present.

For the purposes of the CASS, only TAZs with a projected growth allocation were of interest.

Figure 2 shows the extents of the planning data provided including:

- The complete TAZ extents provided;
- The TAZ's with positive future growth allocation;
- The core area TAZ's that do not contain vacant parcels, and;
- The core area vacant parcel to which TAZ population projections were assigned.

A summary of projected build-out growth for the City of London is provided in Table 2.

Table 2: Summary of Growth Data

	Population	Employment	Units	ICI (m2)
2014 Total	377,529	194,067	174,360	-
Total Build-out Growth	145,120	18,723	78,993	1,082,057
Build-out Total	522,649	212,790	253,353	-

The focus of the Study is the Core Area. Growth was allocated to the vacant parcels to the TAZs in the core area. If a TAZ in the core area did not contain any vacant parcels then the growth was allocated based on the TAZ spatial area. A summary of the projected growth in the Core Area and outside of it is provided in Table 3.

Table 3: Within and Outside Core Area Build-out Growth Projections

	Population	Employment	Units	ICI (m2)
Core Area Vacant Parcel Growth	42,301	3,958	24,850	162,969
Core Area TAZ Growth	13,250	650	7340	32,775
Sub-Total	**55,551**	**4,608**	**32,190**	**195,744**
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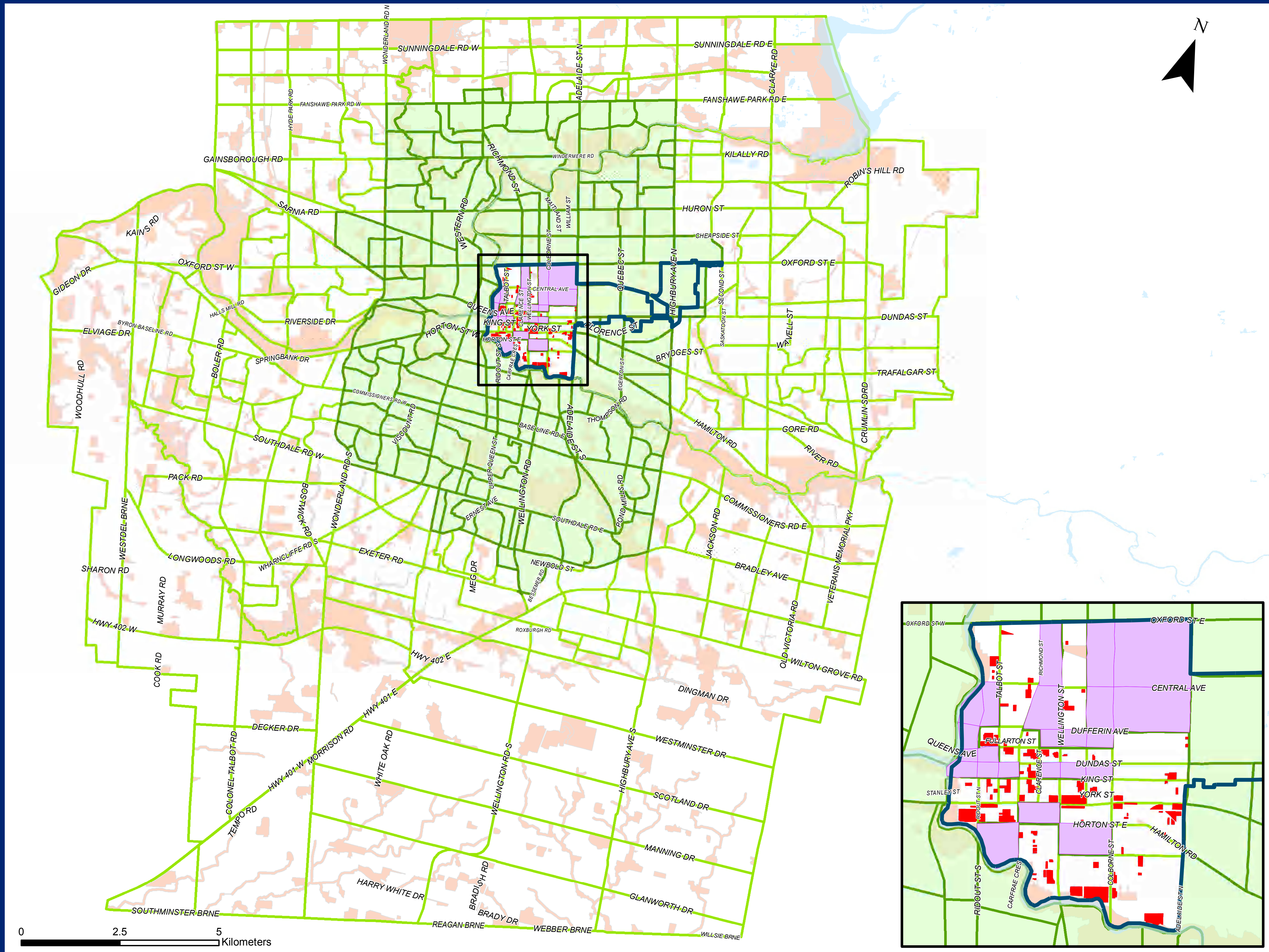

London
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City of London Planning Data

- Study Area
- Core Area Vacant Parcels
- Core Area TAZ growth
- All TAZs with growth
- All TAZs
- Open Space

Figure 2: City of London Planning Data Extents

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716013-WW- Planning Data Map for Report with open space
December, 2017
Data Source: City of London
Scale: 1:35,211 | NAD 1983 UTM Zone 17N

3 Design Criteria, Level of Service and Policy Review

The foundation for the future servicing strategies for the CASS area is based on understanding existing conditions and service requirements, applying a design criteria to new growth to estimate future increase in flows, the trigger or Level of Service used to define an intervention need and the policy to consistently identify Benefit to Existing (BTE) and DC eligible costs.

A thorough and comprehensive review was completed for each of these components. The following sections provide a summary of work completed and key findings. The complete technical memorandum is provided in Appendix A.

3.1 Design Criteria

The purpose of this review and analysis was to assess and comment on the suitability of using the City's design criteria and approach of applying it to growth projections and hydraulic modelling to assess servicing impacts for the CASS.

The scope of this project included a review of the City's current design criteria with a comparative review of industry best practice and the criteria used by other similar municipalities. GM BluePlan is currently assisting the City complete hydraulic modelling assignments. As added value we have leveraged this experience to provide an analysis of the City's latest flow monitoring data, used for modelling purposes, in comparison to the current design criteria used by the City.

3.2 Best Practice Review

A review of other municipal design criteria was undertaken in order to compare industry standards against the existing City of London's criteria. The dry weather flow per capita criteria, extraneous flow criteria used to calculate peak wet weather flow, peaking factor methodology, and sewer design flow basis were used in this review. On conducting an assessment of existing design criteria, it was determined that the City of London's current design flow basis for estimation of future flows is generally consistent with the methodologies that other municipalities currently practice. It is noted that whilst the approach is similar, the values used are comparatively low.

A review and analysis was completed to assess and comment on the City's design criteria and approach of applying it to growth projections and hydraulic modelling to assess servicing impact for the CASS. This review included an assessment of existing land use classification densities, an assessment of existing design criteria, and a comparison of the City's design criteria to the design criteria of 12 other municipalities. The City's criteria are the lowest of all surveyed.

Statistical analyses of the flow monitoring data included a dry weather flow analysis and an extraneous wet weather flow analysis, which outputted the dry weather per capita sanitary flow (DWF) and the peak unit RDII. These two outputs were compared to the City's design criteria to assess the accuracy /appropriateness of the City's design criteria for use in infrastructure planning.

The City have an agreed design criteria that was not subject to change for this study. The City's design criteria for DWF is 230L/cap/d. The average DWF from flow monitoring analysis undertaken on a relatively small number of monitors is 275L/cap/d. The flow monitor data would indicate that actual DWF in the areas that were monitored exceeds the City's design criteria. Although the data shows that the existing DWF exceeds the City's design criteria, policy on water efficiency and data trends show that per capita water consumption (and in turn wastewater generation rate) is being reduced. For the CASS study the design criteria with the uncertain development factor was used, resulting in a per capita rate of 257l/cap/d.

The design criteria that will be used for the purposes of the CASS are consistent with the existing City of London design standards:

- Average dry weather flow (DWF) of 230 L/cap/d
- Harmon peaking factor applied to computer peak sanitary flow
- Infiltration allowance of 8,640 L/ha/d or 0.10 L/s/ha is not applicable to the CASS as intensification growth will not increase existing levels of extraneous flow*
- Uncertain development factor of 1.1
- Peak Flow = (Population * DWF * Peaking Factor * Uncertain Development Factor) + Infiltration

*The CASS hydraulic model area is calibrated to flow data where the actual I/I is accounted for. The contributing area or extent/length of pipe network is generally not increasing as the area is already built up and serviced by sewers. There could be a change in the % of impermeable area but this wouldn't necessarily mean that more I/I is entering the system than is already modelled. It is common practice not to include additional I/I allowance when assessing intensification growth.

3.3 Levels of Service

A LOS review was undertaken as a baseline assessment to mitigate servicing impacts by determining the trigger for intervention strategies. In particular, for the context of the CASS, the LOS trigger is important to distinguish between existing and growth driven servicing constraints.

In accordance with the DC Act, it is important "to ensure that municipalities do not improve their existing levels of service through capital improvements funded by developer contributions, the Act provides protection under (s.5 (1) 4.)".

Collection system LOS are often based on modelled flows under a specified design event. For a given event, thresholds such as percentage pipe full can be selected to initiate action. These thresholds can vary for pipe types and size, most commonly for trunk and locally defined sewers. Most important for the CASS study is the need to define LOS thresholds that can be used to identify when an infrastructure project is required.

For the purposes of the CASS, it is recommended that a typical trigger for linear infrastructure improvements be based on a 1 in 5 year design event. It is recommended that a flow threshold for a 1 in 5 year event of 85% d/D^{max} be used to initiate mitigating measures. The rationale behind selecting this design storm was to create a response in the system that revealed regular occurring constraints for which a feasible plan could be developed and implemented.

The occurrence of combined sewers in the City of London complicates the definition of LOS. Collection system flows and capacities are regulated and relieved by Collection System Overflows (CSOs). In some cases this means that a virtually unlimited amount of growth flows could be accommodated within the pipe system without reaching a threshold, because a CSO relieves the system. However, the growth flow would be discharging from the CSO and as such must be subject to a LOS. In this case it is important to ensure that CSO discharges are not increased in frequency or volume as a result of growth and that CSO achieve F-5-5 compliance, ensuring that at least 90% of all wet weather flows are contained in the system.

3.4 Policy

The purpose of DC policy is to ensure that growth pays for growth in an equitable manner. The CASS wastewater project focusses on growth in a downtown core context which brings existing infrastructure and existing constraints into consideration with the new requirements to service growth. This presents challenges around the funding of intensification projects which need to be balanced with benefit to existing customers, concurrent roads and transit improvements and level of service. The DC Act has been in place since 1997 and specifies the ways in which funding is collected.

3.4.1 Area Rating

A 2015 amendment to the *Development Charges Act* introduced new policies. One of these new requirements is that municipalities must now consider areas-specific charges for all services as part of their background studies. However, the Province has not provided details describing how municipalities would go about meeting this requirement.

As such, it is important to consider the following in future DC Background Studies:

- Options for area delineation (e.g. built boundary vs greenfield)
- Types of services suitable for an area-specific DC
- Financial and administrative implications of adopting area-specific DCs
- Alternative methods for structure of DC rates to achieve the policy objectives and priorities (e.g. allocation of costs to intensification areas)

The City has identified area rating as a strategic priority for the upcoming 2019 DC Study. Development industry feedback into the policy will help shape the plan, but area rates are not being recommended for the CASS projects through this study for 2019. Once a greater understanding of the impact of RT and Pollution Prevention Control Plan (PPCP) projects can be incorporated into a core area program, it may be beneficial to establish and area rate for the core area.

3.4.2 3.4.2 Local Service Policy Review

The industry DC policy review that was completed provided insight into alternative methods of determining DC-eligible works for intensification and infill (i.e. non-greenfield areas) and recommendations on any suggested changes to the existing Local Service Policy that are appropriate for the City of London. It is understood that the costs for linear infrastructure works identified as part of the CASS will need to address non-growth costs, growth costs, and the Res/ICI allocations for the City's wastewater system.

The City of London's DC By-law and Local Service Policy for Wastewater infrastructure (2014 DC Study, Appendix N) was reviewed and compared against those used by other comparator municipalities.

Using the review as a basis, GM BluePlan worked with the City and AECOM (water and stormwater CASS consultant) to define a consistent approach for use in the CASS studies. Section 6.4 provides details of the approach and how it was applied to the wastewater CASS.

4 Unit Cost Review

The purpose of the unit cost review was to help the City of London formalize and document project cost estimation to provide a consistent, transparent, and auditable approach to costing growth related projects. The City wants to understand industry best practices of cost estimation and develop and adopt a methodology that best fits its needs.

The primary aim of this analysis was to provide decision support information to agree on a consistent cost estimation methodology and unit cost rates for use in the CASS that complemented the 2014 DC background study.

In order to achieve this, a review of cost estimation methodologies used in the 2014 WWSMP, DC background study, and the City of London's project tender costs were undertaken.

4.1 Unit Cost Review

Unit cost estimates are used to create short, medium, or long-term budgets, and to determine funding requirements, customer charges, and developer charges. The City's current cost estimation practices and long-term infrastructure planning studies were reviewed to develop the project cost estimates to ensure a consistent and transparent approach was adopted.

A review of recent tender information was to be completed to provide information on other industry approaches and put forth appropriate recommendations to the City. The review of recent tender information included analysis of six tenders for various projects undertaken in the City of London by other contractors in order to arrive at an average unit cost for installation of sewers and manholes.

Ultimately, it was decided that a similar approach used for the 2014 DC Background Study would be used, with the unit rates updated based on the review of tenders and inflation index information.

The key unit rates used to identify infrastructure costs are provided in Section 4.2.

Detailed breakdown of the methodology, reasoning and components used in the analysis of unit cost is provided in the full technical memorandum provided in Appendix B.

4.2 Unit Rates Tables

PIPE COSTS

Based on 2014 Concast reinforced circular concrete pipe price list, includes pipe and gaskets.

200mm and 250 mm pipe cost was extrapolated based on other 2014 pipe prices

All pipe prices inflated to 2017 using Statistics Canada Infrastructure Construction Price Index. As it only provides data to 2015 Quantity Survey estimating resource (BTY) was used for 2016-2017 At 2.5% per annum.

	Diameter																									
Depth	**200**	**250**	**300**	**375**	**450**	**525**	**600**	**675**	**750**	**825**	**900**	**975**	**1050**	**1200**	**1350**	**1500**	**1650**	**1800**	**1950**	**2100**	**2250**	**2400**	**2550**	**2700**	**3000**
2.5	71	77	89	100	104	114	153	234	305	354	425	469	540	676	823	1,008	1,210	1,461	1,695	1,940	2,207	2,583	2,910	3,232	3,957
5.0	71	77	89	100	104	114	153	234	305	354	425	561	649	812	992	1,057	1,270	1,537	1,782	2,038	2,322	2,709	3,052	3,390	4,153
7.5	71	77	89	100	104	131	174	267	349	452	491	561	649	812	992	1,210	1,450	1,755	2,033	2,333	2,649	3,101	3,493	3,875	4,747
10.0	71	77	89	100	104	131	174	267	349	452	491	659	752	943	1,155	1,412	1,690	2,044	2,371	2,720	3,090	3,613	4,071	4,524	5,543
12.5	71	77	89	100	131	131	207	267	349	452	491	659	752	943	1,155	1,412	1,690	2,044	2,371	2,720	3,090	3,613	4,071	4,524	5,543
15.0	71	77	89	100	131	158	207	311	409	474	572	659	752	943	1,155	1,412	1,690	2,044	2,371	2,720	3,090	3,613	4,071	4,524	5,543

CONSTRUCTION COSTS - Open Cut - Pipe Cost NOT Included

Based on tender costs as provided by the City over the past 5 years and indexed to 2017.

Includes trenching labor and equipment, bedding, backfill, compaction, dewatering, and maintenance holes.

	Diameter																								
Depth	**200**	**250**	**300**	**375**	**450**	**525**	**600**	**675**	**750**	**825**	**900**	**975**	**1050**	**1200**	**1350**	**1500**	**1650**	**1800**	**1950**	**2100**	**2250**	**2400**	**2550**	**2700**	**3000**
2.5	431	441	458	469	496	523	567	583	627	665	698	736	763	801	839	872	910	937	986	1,019	1,221	1,428	1,630	1,935	2,344
5.0	649	659	676	692	730	790	839	877	927	1,014	1,019	1,019	1,019	1,057	1,095	1,281	1,341	1,417	1,482	1,591	1,913	2,294	2,605	3,216	3,897
7.5	763	774	790	801	867	899	992	1,030	1,090	1,090	1,177	1,226	1,264	1,368	1,477	1,591	1,695	1,815	1,946	2,060	2,523	3,057	3,564	4,333	5,346
10.0	1,090	1,101	1,172	1,237	1,412	1,564	1,728	1,875	2,044	2,115	2,240	2,273	2,300	2,414	2,523	2,638	2,774	2,916	3,036	3,139	3,793	4,518	5,112	6,071	7,390
12.5	2,267	2,278	2,289	2,300	2,344	2,403	2,425	2,491	2,556	2,551	2,572	2,594	2,632	2,665	2,709	2,785	2,916	3,134	3,363	3,619	4,355	5,303	6,180	7,646	9,270

RESTORATION COSTS

Taken from 20-year (LSSSS) plan and updated as per 2016 tender and transportation costs for rural and urban restoration.

Open - no restoration; Landscape- minor/boulevard (no roadway restoration); Rural - cross section as per transportation cost table; Urban - cross section as per transportation cost table; Ecosystem - applies to areas adjacent to or within environmentally significant areas.

Condition Depth	Open	Landscape	Rural	Urban	Ecosystem
2.5	0	436	1,744	1,929	916
5.0	0	556	2,224	2,409	1,166
7.5	0	654	2,671	2,845	1,384
10.0	0	774	3,183	3,357	1,613
12.5	0	883	3,706	3,859	1,831

CASS Cost Factors

It is recognized that an increased cost may be encountered and applied to total cost of project due to location of works and to account for extra efforts for shoring, traffic control, additional utilities, slower construction progress, etc.

Project specific cost in CASS to include 20% Engineering Fees and 30% Contingencies

5 Water Efficiency/ I/I reduction / Sewer separation

This section summarizes the water efficiency, I/I reduction and sewer separation initiatives undertaken by the City of London.

The water usage trend experienced over the years in the City of London and the programs and initiatives taken by the City to curb unnecessary water consumption has been outlined below.

5.1 Water Efficiency/ I/I Reduction / Sewer Separation Review

5.1.1 Water Usage

The City of London consumes approximately 126,000,000 liters of water per day (126MLD) (based on a 5 year average). As seen in Figure 3, the average water usage for City of London has been on a steady decline since 2002. Despite the increase in population by 116,000 between 1980 and 2016, the average daily water consumption levels for 2016 were comparable to those of 1980.

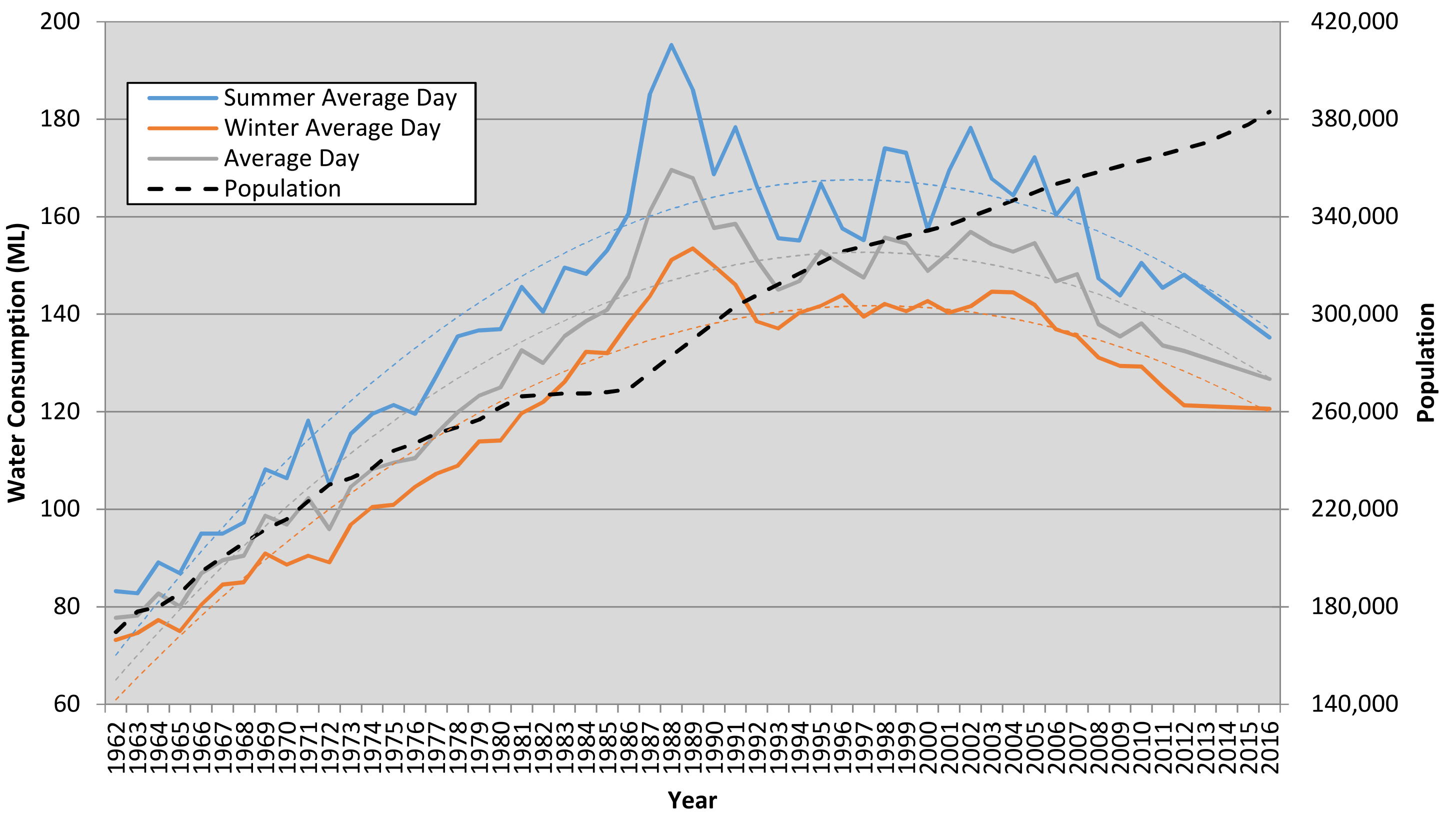

Figure 3: Average Daily Trends from 1962 to 2016 (as per City of London)

5.1.2 Programs and Studies

The steady declining water usage levels are attributed to the efforts put forth by the City with regard to public education, appropriate policies and by-laws, and management of infrastructure.

5.1.2.1 Public Education Policy

The City of London has invested in public education regarding careful consumption of water through the creation of teacher resources. Presentation materials, guidance documents, and stewardship projects are available for various age groups. On occasion, in-class presentations are arranged with City of London staff to speak of more complex and in-depth topics. Strategic partnerships with the Ontario Clean Water Agency makes available their “One Water” program, which includes a visit by a drinking water plant operator and activity booklet to classes throughout the City.

5.1.2.2 Policy/ By-Law on Outdoor Water Use

The City has also introduced an Outdoor Water Use By-Law which aids towards the goal of efficient water usage, in effect every year from June 1 to August 31. As per the By-Law, even numbered houses use water outdoors on even numbered calendar days, and odd numbered address on odd numbered calendar days only. There are no restrictions on weekends or statutory holidays. In this way, the City was able to significantly reduce unnecessary water consumption.

5.1.2.3 Leak Detection within the Distributed System and Reduction of Non-Revenue Water

At present, the ratio of billed water to purchased water rests at 89%. Although 89% is favourable, the City of London has been noticing an increase in non-revenue water in recent years. Therefore, the City is considering opportunities that help to improve the efficiency of the system in terms of leak reduction, billing meter accuracy, reduction of breaks and early response to breaks, and improve water quality to minimize flushing requirements.

A proven method to proactively find leaks in the system before they appear on the surface is through the use of District Meter Areas (DMAs). Hence, the City of London introduced EW1630 District Meter Areas, a new project to develop a City-wide leak detection program that incorporates elements of water modelling, fire hydrant management, and billing audit confirmation to enhance the cost effectiveness of water service delivery.

As part of the Water Efficiency program, the City of London also initiated two pilot projects in 2012 that utilizes “acoustic listening devices” and “real water consumption data analysis” in isolated parts of the water distribution system for the identification of undetected water leakage in the system. In a pilot DMA program in 2012, DMAs were set up in 5 areas of the city. In 2013 as the City Council approved the continuation of the DMA program, it was confirmed that 55 more DMAs are to be placed throughout the City by 2017.

Additionally, in an effort to reduce non-revenue water, the City has also undertaken numerous construction projects every year to replace aged or failing infrastructure, and to separate flows from one combined system into two independent systems.

5.1.2.4 Weeping Tile/Downspout Disconnection

In an effort to minimize inflow/infiltration (I/I) that places excessive demand on sanitary sewer systems, the City has managed to eliminate the majority of downspout connections over the years and strongly encourages the residents to take the initiative to do so, especially if they are connected into the sanitary system.

A weeping tile disconnection program was started in addition to the downspout disconnection program. This proved more effective than the downspout disconnection program in terms of I/I reduction.

The use of flow monitoring helped determine the amount of storm water infiltration reduction to be almost complete, with very little wet weather response appearing on disconnected areas. It is estimated that addressing the issue on the private side is more cost effective, at 20% of the cost of a public side alternative.

5.1.2.5 Basement Flooding Grant Programs

In order to encourage residents to take preventive measures to reduce the likelihood of basement flooding, the City of London has implemented a grant program that will help the residents pay for the costs of installing sump pumps, sewage ejectors, storm drain connections, and port-type backwater valves.

Since 2009, the Sump Pump Grant Program has been in place where 75% of the cost is covered by the City and 25% by the homeowner. This has been increased in 2017 to the City covering 90% of the cost, 10% by the homeowner, and with higher maximum limits.

Many of these initiatives can re-capture system capacity and allow for growth. Therefore, a proportion of the associated costs can be defined as DC eligible. This work may actually occur outside of the CASS study area but relive capacity constraints within it. For the purposes of the CASS, this should be considered and included in the final output as a line item expenditure with an agreed proportion allocated to growth.

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6 Analysis Methodology

6.1 Hydraulic Modelling: Tools and Approach

6.1.1 CASS Model Development

Preceding the CASS, numerous hydraulic models were developed for the City's PPCP. The models developed for the PPCP were combined to create a suitable hydraulic model that could be analyzed to measure the impact of growth on the sanitary sewers covering the majority of the CASS study area. The extent of the PPCP models and the study area boundary are shown in Figure 3. The only area that did not have modelled pipe network is in the northeast portion of the study area. Catchment areas draining into the study area, particularly to the east of the Pall Mall North and Pall Mall (PM) catchments, were not modelled in detail despite good pipe network coverage in the CASS area. In these cases, the catchment areas were assigned to the next downstream node but some detail, in terms of storage in the pipe network and attenuation in the sewer system, was lost. However, this method was considered appropriately accurate for a study of this nature.

The source of models, relative to the CASS study area, derived from individual hydraulic modeling assignment numbers and the PM model is highlighted in Figure 3.

There were challenges when merging the models because the models were built at different times, used different calibration data or were developed using different modelling settings.

The older models were validated using more recent boundary meter data to mitigate the potential variations in calibration and ensure that flows generated were still valid.

Additional data that was useful for the costing of the CASS projects was added to the model after the models were combined. The data included the age of the asset and the asset rating, provided by the City's Asset Management department.

The full electronic hydraulic modelling database was provided to the City's Wastewater and Drainage Department: Contact Kyle Chambers.

6.1.2 CASS Model Growth Loading

The model loading was either allocated to vacant land parcels or was considered to be 'generalized intensification'. All of the growth was assigned to a neighbouring maintenance hole if there was one or more vacant land parcels within a TAZ. The full TAZ was loaded to a trunk sewer if there were no vacant land parcel within a TAZ. The dry weather flow value assigned to the growth population 253 L/pc/d. This was the City's design criteria value of 230 L/pc/d plus and uncertain development factor of 1.1.

Areas that contributed flow to the CASS study area but were not calibrated as part of the PPCP study had a design inflow and infiltration rate of 0.1 L/s/ha.

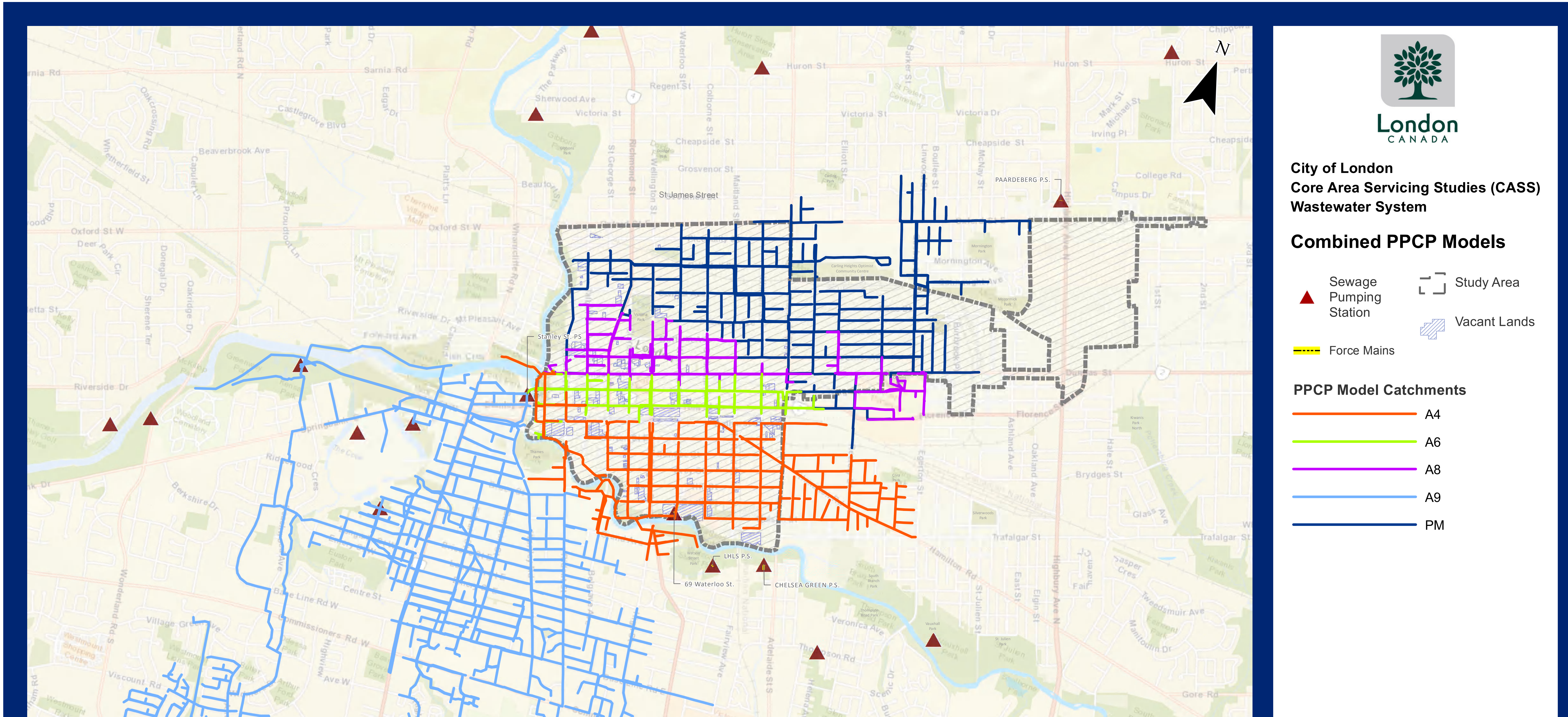


Figure 3: Combined PPCP Models for CASS Analysis

716013 - WW - 16
March, 2017
Data Source: City of London
Scale: 1:33,306 | NAD 1983 UTM Zone 17N

6.2 Existing and Future Capacity Assessment

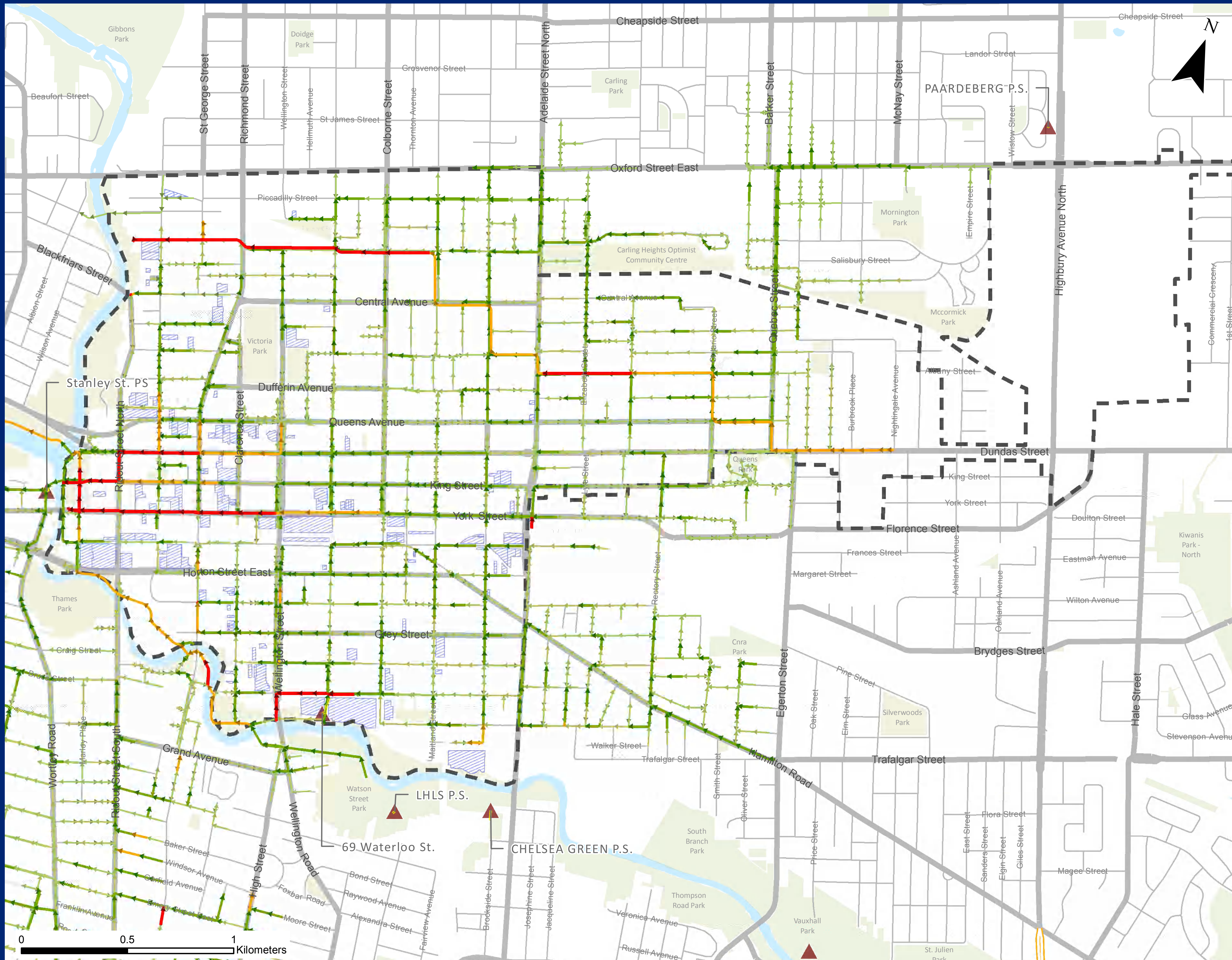
The following scenarios were created for analysis once the model was finalized:

- Existing base model
- Growth model without interventions
- Growth model with interventions

The growth model without interventions is simply the base model with the full growth allocation applied. This highlights constraints in the linear system and also enables the impact on overflows to be understood. In some cases the system overflows 'hide' a linear system constraint. E.g. if the flow stayed in the system then a pipe's capacity issues would be evident. This creates a need to model the system with interventions in place. An important aspect for the interventions is to ensure that overflow frequencies or volumes do not increase as a result of growth and that the linear system maintains the target LOS.

Analysis of the capacity of the system was performed using a 1 in 5 year return period 'Chicago' design storm. Criteria for a constraint in the system was for d/D of 85% to be exceeded for the design storm scenario.

The impact of growth on the Core Area where growth flows cause the largest increase in flows, based on a 1 in 5 year design event, is highlighted in Figure 4. The existing system and growth scenario surcharge is shown in Figure 5. Any increase in flow as a result of growth will lead to elevated levels of surcharge where there is existing surcharge.



City of London
Core Area Servicing Studies (CASS)
Wastewater System

Growth Capacity Impacts - 5 Year

Sewage Pumping Station
Study Area
Vacant Lands
Force Mains

Growth Impact on Flow

None
Low Increase in Flow
Medium Increase in Flow
High Increase in Flow

Figure 4 : Impact of Growth on Watewater Flows

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716013 - WW - 14
January 2017
Data Source: City of London
Scale: 1:17,909 | NAD 1983 UTM Zone 17N

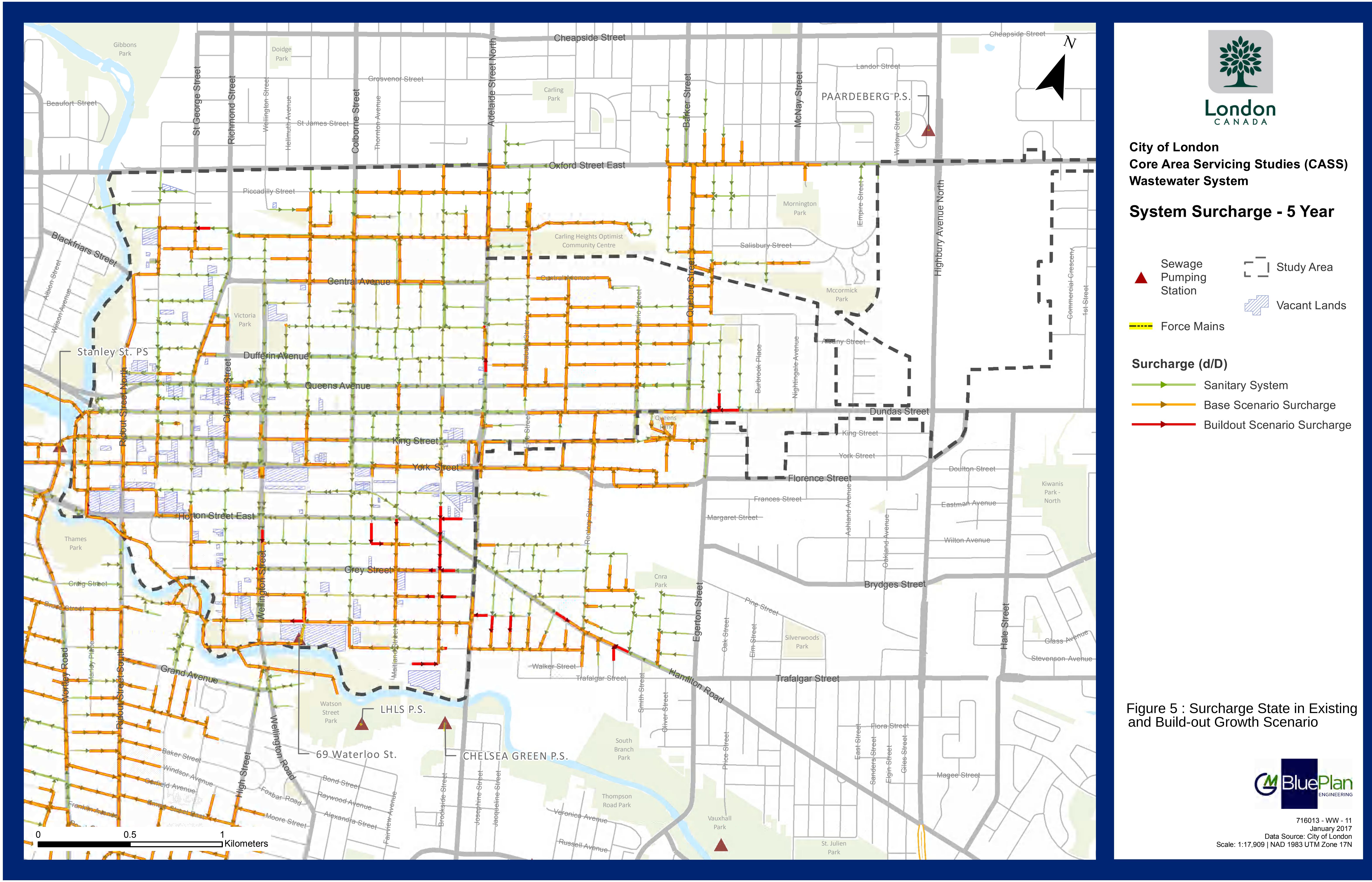

Figure 5 : Surcharge State in Existing and Build-out Growth Scenario

6.3 Evaluation of Alternatives

Numerous options were reviewed in order to address the constraints in the existing sewer system. These included:

- Sizing the sewer to accommodate depth of flow below 85% d/D
- Sewer separation, if the constraint was downstream of combined sewers
- Options for diverting flow or reallocating development

The benefits of sewer separation were difficult to assess because the way in which the model has been built. Contributing area had been applied uniformly upstream of flow monitor locations, not taking into account the increased percentage of RDII that would enter a combined sewer network. In addition, there is no firm answer to how much RDII can be removed from the system, even with full sewer separation (flow could still enter the separated sewer network).

In order to identify the proportion of wet weather flow contributing to the combined and separate systems, a flow monitor would be required for each system at the boundary of where one system joined with the other (separate into combined or combined into separate). In the case of the models used for the CASS analysis, the flow monitors were downstream of both separate and combined systems so it was not possible to identify the proportion of wet weather flow entering each system. An assumption can be made that if a constraint has combined sewers upstream, some sewer separation can be undertaken to reduce the amount of wet weather flow entering the system. However, even a separate system contains wet weather flow so the percentage of wet weather flow that can be removed as a result of sewer separation will always be an estimate. As a result, GMBP took an approach to show what percentage of WWF would have to be removed from the system to improve the system performance, rather than saying that a certain percentage could be removed from the system. It may also be possible to have an effective I/I reduction program in separate sewer systems, but further investigation would need to be undertaken to understand the source of the I/I and the ability and effectiveness to remove it.

Different scenarios were simulated to reflect different percentages of RDII being removed from the sanitary sewer network to try and replicate sewer separation/inflow and infiltration reduction programs. The scenarios run were:

- 50% removal of RDII
- 80% removal of RDII

These scenarios showed what would happen in the network if you could remove a range of percentages of RDII from the sanitary sewer network, with 80% removal replicating a successful sewer separation program. These were “what if scenarios” because it would be difficult to assess the success of a sewer separation/I and I removal program until completion of the program. It may be possible to benchmark the typical removal of RDII based on existing results from I and I reduction programs in the City of London and other municipalities.

6.4 Constraint Costing Methodology

Costing of the constraints was only undertaken for sewer upgrades because, at this stage, it would not be possible to cost a sewer separation or I and I reduction program without further study.

A methodology to cost splitting was developed with the City and the other CASS consultants. The approach is complimentary to that used for the 2014 DC Background Study and embracing the new direction in the DC Act to consider spatially varying rates and embrace the ethos of asset management based asset information to inform BTE calculation.

Details of how the costing for wastewater constraints are classified as a BTE or to facilitate growth is summarized as follows:

1. If the constraint is caused by growth, and there is no existing LOS issue then:
   a. The developed BTE split between the City and growth is assigned to the total cost of the project and based on condition assessment. For example, if the asset rating is 'very poor' then 90% of the total cost will be attributed as a BTE; if the asset rating is 'very good' then 10% of the total cost will be attributed as a BTE.
2. If there is an existing level of service issue as well as growth upstream, but no oversizing is required because of growth.
   a. Cost of replacing existing sewer is attributed the City. The difference between the cost of replacing the existing pipe and the cost to size the sewer to meet the LOS and growth requirements is to be split using the asset rating method.
3. If there is an existing LOS issue as well as growth upstream and oversizing is required to accommodate growth
   a. As point number 2, except the oversizing cost is attributed entirely to growth

A methodology based on the asset rating of the sewer was applied to allocate costs to the City or to growth where growth instigated or benefited from work to resolve constraints in the system. The splits based on the asset rating are shown in Table 4:

Table 4: Cost Split Based on Condition Rating

Asset Rating	Growth (%)	Benefit to Existing (%)
1 (Very Good)	90	10
2 (Good)	75	25
3 (Fair)	50	50
4 (Poor)	25	75
5 (Very Poor)	10	90

Costing was undertaken for each sewer length because each pipe had a unique asset rating and also a replacement cost needed to be calculated for each sewer.

6.5 Constraint Phasing Methodology

A phasing plan to resolve the constraints was developed once the constraints were identified. This was initially based on the future growth projections provided by the City. An upstream trace from each constraint was undertaken and the growth population for each project growth interval was calculated.

The phasing was timed to coincide with the growth, rather than being flagged as an immediate phasing requirement if the constraint was an existing LOS issue.

In some cases, for the purposes of coordinating projects, the initial phasing was amended so that efficiencies could be made. These cases have been commented on in section 7.1, where applicable.

If growth was scheduled after 2034 (full build-out), then this constraint is excluded from the final costing.

7 Analysis Results

7.1 Constraint Costing Details

Individual constraints were initially identified from the growth model with the 1 in 5 year return period design storm applied. A unique constraint was identified where the LOS was continuously exceeded for a length of sewer. In some cases, once the initial constraint had been removed, it created a LOS issue downstream which could then merge with a separate constraint. In these cases, the constraints remained separate in terms of the review of the issue and the costing of the constraint. Sub-projects for constraints were developed where there was a change in pipe size for the upsize or oversize costing. It should be noted that if the projected growth allocation changes in the future, this will change the results in terms of constraints and costs.

The location of the identified constraints are shown in the map in Figure 6. The detailed costing of constraints and how the costs are split between the City and growth are shown in Table 5. The phasing of the costs to address the constraints are shown in Figure 7.

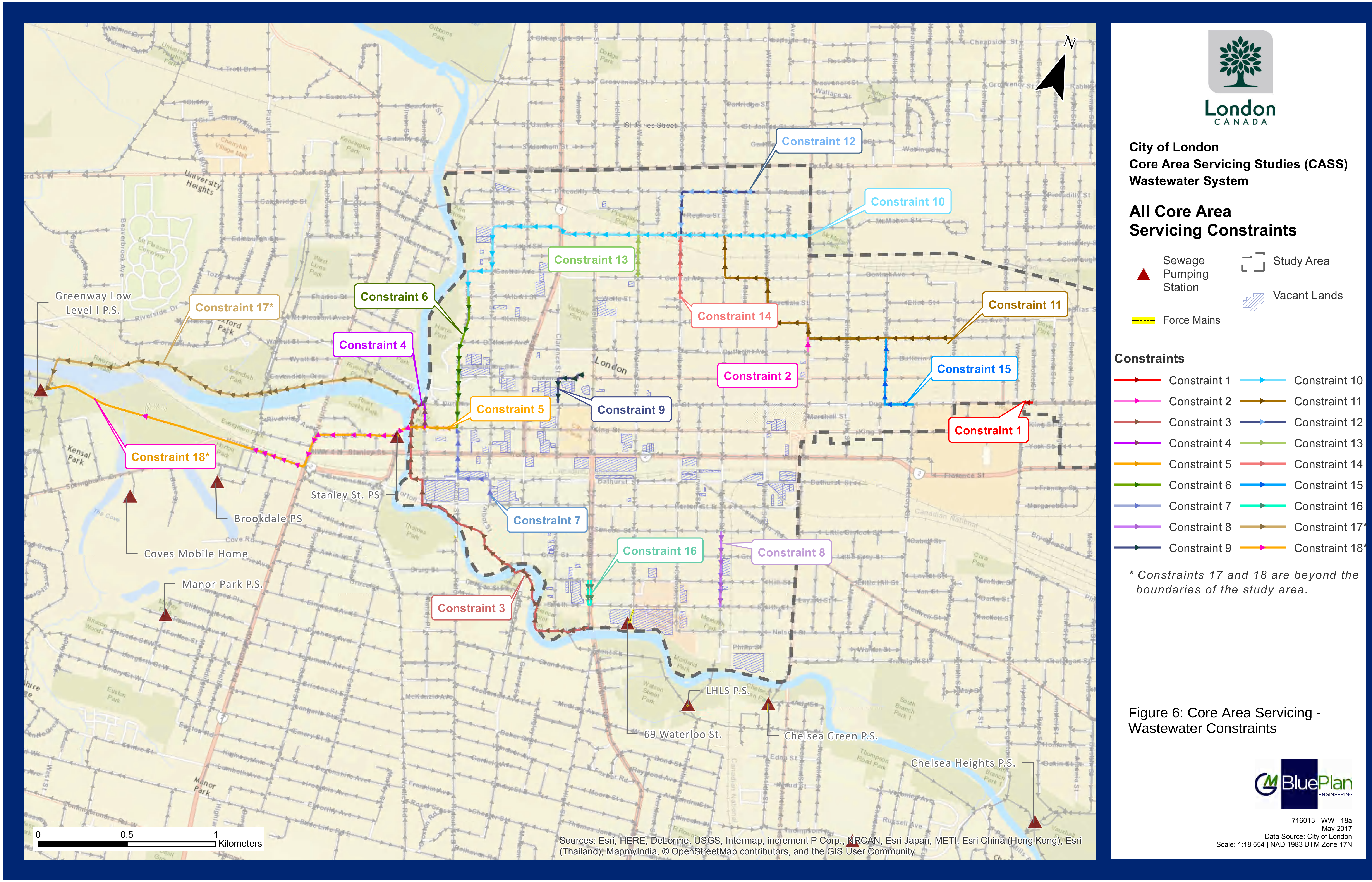

Figure 6: Core Area Servicing - Wastewater Constraints

Table 5: Detailed Estimated Cost for Wastewater Constraints

Constraint #	Location Detail: StreetArea	Street From	Street To	Pipe Attribute Data: US Node ID	Length (m)	Ground Level (m AD)	Depth (m)	Diameter (mm)	Condition Description	Asset Age	Unit Rates: Pipe Cost	Construction Costs	Pipe Size Requirements: New Pipe Diameter (No Growth) (mm)	New Pipe Diameter (Growth) (mm)	Total Costs: Pipe Costs	Construction Costs	Restoration Costs	Total Cost ($)
1	Dundas St	Charlotte St	Egerton St	BB336	63.5	250	6	300	2	116	$ 89	$ 676	450	450	$ 6,575	$ 46,374	$ 152,965	$ 308,872
2	Adelaide St. N	Dufferin Avenue	Lorne Avenue	DN0244	86.2	248.8	3.8	250	2	100	$ 77	$ 441	300	300	$ 7,707	$ 39,476	$ 166,363	$ 320,319
3.1	Thames Valley Parkway	Ridout Street South	Riverside Drive	DS1546	59.4	232.4	2.4	900	5	81	$ 425	$ 698	1500	1650	$ 71,868	$ 54,063	$ 114,600	$ 360,797
				DS1547	59.5	232.7	2.8	900	4	81	$ 469	$ 736	1500	1650	$ 71,989	$ 54,154	$ 114,793	$ 361,404
				CV0173	82.0	232.8	3.1	900	5	81	$ 425	$ 698	1500	1650	$ 99,212	$ 74,632	$ 158,203	$ 498,070
				DS0615	88.1	233.1	3.2	900	5	81	$ 425	$ 698	1500	1650	$ 106,592	$ 80,184	$ 169,971	$ 535,122
				DS1542	155.2	233.9	3.3	900	5	81	$ 425	$ 698	1500	1650	$ 187,776	$ 141,255	$ 299,427	$ 942,689
				DS1661	56.0	233.5	3.3	900	4	81	$ 425	$ 698	1500	1650	$ 67,754	$ 50,968	$ 108,041	$ 340,145
				DS0015	16.8	233.9	3.8	900	5	81	$ 425	$ 698	1500	1650	$ 20,326	$ 15,291	$ 32,412	$ 102,044
				DS0016	68.6	233.9	3.9	900	5	81	$ 425	$ 698	1500	1650	$ 82,999	$ 62,436	$ 132,350	$ 416,678
				DS0010	96.9	234.4	3.9	900	5	81	$ 425	$ 698	1500	1650	$ 117,239	$ 88,194	$ 186,949	$ 588,573
				DS0013	77.8	234.2	4.0	900	4	81	$ 305	$ 627	1500	1650	$ 94,130	$ 70,810	$ 150,100	$ 472,559
				DS0011	118.9	235.9	5.5	900	4	81	$ 425	$ 1,019	1500	1650	$ 150,985	$ 159,409	$ 286,418	$ 895,219
				DS0012	24.4	236.0	5.8	900	4	81	$ 425	$ 1,019	1500	1650	$ 30,984	$ 32,713	$ 58,777	$ 183,712
				DS0641	45.7	236.1	5.8	900	4	81	$ 425	$ 1,019	1500	1650	$ 58,032	$ 61,270	$ 110,087	$ 344,083
				Total	949.3										$ 1,159,889	$ 945,379	$ 1,922,129	$ 6,041,095
3.2	Thames Valley Parkway	Clarence Street	Ridout Street South	OS1305	118.9	233.8	2.6	900	4	81	$ 425	$ 698	1200	1200	$ 80,353	$ 95,257	$ 229,394	$ 607,505
				OS1540	29.9	234.1	3.0	975	3	26	$ 469	$ 736	1200	1200	$ 20,206	$ 23,954	$ 57,686	$ 152,770
				DS0518	82.3	234.7	3.9	900	5	81	$ 425	$ 698	1200	1200	$ 55,618	$ 65,935	$ 158,781	$ 420,502
				DS0009	20.2	234.7	4.0	900	5	81	$ 425	$ 698	1200	1200	$ 13,651	$ 16,183	$ 38,972	$ 103,209
				DS7024	46.0	235.0	4.1	900	5	81	$ 425	$ 698	1200	1200	$ 31,087	$ 36,853	$ 88,748	$ 235,031
				OS1306	45.7	235.6	4.5	900	4	81	$ 425	$ 698	1200	1200	$ 30,884	$ 36,613	$ 88,169	$ 233,498
				DS0630	147.5	236.1	4.7	900	4	81	$ 425	$ 698	1200	1200	$ 99,681	$ 118,170	$ 284,572	$ 753,633
				DS0429	84.7	236.5	5.0	900	4	81	$ 425	$ 698	1200	1200	$ 57,240	$ 67,857	$ 163,412	$ 432,764
				OS1303	57.0	236.3	5.0	900	4	81	$ 425	$ 698	1200	1200	$ 38,521	$ 45,666	$ 109,970	$ 291,234
				DS0428	82.9	236.9	5.1	750	3	81	$ 305	$ 927	1200	1200	$ 67,319	$ 87,650	$ 199,698	$ 532,000
				OS1029	63.4	236.4	5.3	900	4	0	$ 425	$ 1,019	1200	1200	$ 51,484	$ 67,033	$ 152,724	$ 406,862
				OS1541	19.8	236.4	5.3	900	5	81	$ 425	$ 1,019	1200	1200	$ 16,079	$ 20,935	$ 47,696	$ 127,064
				DS0008	94.5	236.2	5.5	900	5	81	$ 425	$ 1,019	1200	1200	$ 76,739	$ 99,915	$ 227,641	$ 606,442
				OS1030	87.0	237.1	6.2	900	5	81	$ 425	$ 1,019	1200	1200	$ 70,648	$ 91,985	$ 209,574	$ 558,312
				OS2022	52.0	237.4	6.5	900	5	81	$ 425	$ 1,019	1200	1200	$ 42,227	$ 54,980	$ 125,263	$ 333,704
				OS7029	7.0	237.8	6.8	900	5	81	$ 425	$ 1,019	1200	1200	$ 5,684	$ 7,401	$ 16,862	$ 44,922
				Total	1038.8										$ 757,420	$ 936,385	$ 2,199,162	$ 5,839,452
3.3	Thames Valley Parkway	Wellington Street	Clarence Street	DS1634	58.0	237.1	4.6	375	2	56	$ 100	$ 469	750	825	$ 20,547	$ 38,564	$ 111,899	$ 256,515
				DS1485	60.0	239.0	6.2	375	2	56	$ 100	$ 692	750	825	$ 21,255	$ 60,822	$ 144,534	$ 339,917
				DS0414	8.2	239.7	6.4	675	2	44	$ 234	$ 877	750	825	$ 2,905	$ 8,312	$ 19,753	$ 46,455
				Total	126.2										$ 44,706	$ 107,699	$ 276,186	$ 642,887
4	Ivey Park	King Street	Riverside Drive	CV0175	30.5	233.0	1.7	300	3	51	$ 89	$ 458	525	600	$ 4,654	$ 17,287	$ 58,844	$ 121,178
				CV0172	20.1	234.7	3.3	300	4	95	$ 89	$ 458	525	600	$ 3,067	$ 11,393	$ 38,779	$ 79,858
				DS0614	60.4	236.0	4.4	300	3	95	$ 89	$ 458	525	600	$ 9,217	$ 34,235	$ 116,530	$ 239,972
				DS0613	64.6	237.3	5.5	300	3	95	$ 89	$ 676	525	600	$ 9,858	$ 54,219	$ 155,615	$ 329,538
				Total	175.6										$ 26,797	$ 117,134	$ 369,767	$ 770,546
5	King Street	Ridout Street North	Becher Street	DS0486	58.3	238.3	1.4	900	2	0	$ 425	$ 698	1650	1650	$ 70,537	$ 53,062	$ 112,478	$ 354,116
				DS1700	31.6	238.3	1.4	900	4	0	$ 425	$ 698	1650	1650	$ 38,233	$ 28,761	$ 60,966	$ 191,939
				DS0484	9.8	238.8	1.9	900	2	0	$ 425	$ 698	1650	1650	$ 11,857	$ 8,919	$ 18,907	$ 59,525
				DS1560	9.0	239.4	2.5	900	2	0	$ 425	$ 698	1650	1650	$ 10,889	$ 8,191	$ 17,364	$ 54,666
				DS0483	50.0	241.8	4.8	900	3	0	$ 425	$ 698	1650	1650	$ 60,495	$ 45,508	$ 96,465	$ 303,701
				DS1526	5.2	243.5	6.4	1050	2	17	$ 649	$ 1,019	1650	1650	$ 6,603	$ 6,972	$ 12,526	$ 39,152
				DS672	85.3	243.4	6.4	900	2	0	$ 425	$ 1,019	1650	1650	$ 108,318	$ 114,362	$ 205,479	$ 642,239
				Total	249.2										$ 306,933	$ 265,774	$ 524,185	$ 1,645,338
6.1	Ridout Street North	Dundas Street	King Street	DS1528	10.1	243.4	6.1	1050	1	14	$ 649	$ 1,019	1350	1350	$ 10,018	$ 11,064	$ 24,330	$ 68,118
				DN758	4.5	245.5	8.1	1050	1	14	$ 649	$ 1,264	1350	1350	$ 4,464	$ 6,646	$ 12,802	$ 35,868
				DN757	140.9	245.5	8.1	1050	1	14	$ 649	$ 1,264	1350	1350	$ 139,759	$ 208,102	$ 400,846	$ 1,123,061
				Total	155.5										$ 154,240	$ 225,813	$ 437,978	$ 1,227,047
6.2	Ridout Street North	Fullarton Street	Dundas Street	DN0466	64.8	245.5	8.1	825	3	0	$ 452	$ 1,090	1350	1350	$ 64,275	$ 70,985	$ 156,097	$ 437,036
				DN0460	69.2	246.4	9.0	825	3	0	$ 452	$ 1,090	1350	1350	$ 68,639	$ 75,805	$ 166,696	$ 466,711
				DN0457	69.2	246.8	9.2	825	3	0	$ 452	$ 1,090	1350	1350	$ 68,639	$ 75,805	$ 166,696	$ 466,711
				Total	203.2										$ 201,554	$ 222,595	$ 489,488	$ 1,370,457
6.3	Ridout Street North	Albert Street	Fullarton Street	DN0454	79.9	245.9	8.1	825	3	0	$ 452	$ 1,090	1050	1200	$ 64,883	$ 109,299	$ 227,308	$ 602,234
				DN0447	119.8	248.3	10.0	825	2	0	$ 452	$ 2,115	1050	1200	$ 112,953	$ 289,239	$ 402,193	$ 1,206,578
				DN0450	142.5	249.2	11.0	825	2	0	$ 452	$ 2,115	1050	1200	$ 134,356	$ 344,045	$ 478,401	$ 1,435,203
				DN0453	55.2	249.2	11.2	825	3	0	$ 452	$ 2,115	1050	1200	$ 52,045	$ 133,272	$ 185,317	$ 555,952
				Total	397.4										$ 364,238	$ 875,855	$ 1,293,219	$ 3,799,967
7.1	Ridout Street North	Bathurst Street	King Street	DS0456	23.9	242.1	4.8	675	3	0	$ 234	$ 583	1350	1350	$ 19,669	$ 20,059	$ 46,110	$ 128,757
				DS0457	73.1	242.3	5.0	675	3	0	$ 234	$ 583	1350	1350	$ 60,158	$ 61,353	$ 141,032	$ 393,813
				DS0462	6.1	242.7	5.4	750	3	0	$ 305	$ 927	1350	1350	$ 6,051	$ 6,682	$ 14,694	$ 41,141
				DS0479	109.8	242.7	5.4	900	2	14	$ 425	$ 1,019	1350	1350	$ 108,911	$ 120,280	$ 264,497	$ 740,532
				DS1701	53.2	242.9	5.5	675	3	0	$ 234	$ 877	1350	1350	$ 52,769	$ 58,278	$ 128,153	$ 358,801
				DS1527	31.9	243.2	6.0	900	1	14	$ 425	$ 1,019	1350	1350	$ 31,642	$ 34,945	$ 76,844	$ 215,146
				Total	298.0										$ 279,198	$ 301,598	$ 671,331	$ 1,878,190
7.2	Bathurst Street	Talbot Street	Ridout Street North	DS0455	76.8	242.6	5.1	600	3	0	$ 153	$ 839	1200	1200	$ 62,365	$ 81,201	$ 185,004	$ 492,854
				DS0454	76.8	243.1	5.4	600	4	0	$ 153	$ 839	1200	1200	$ 62,365	$ 81,201	$ 185,004	$ 492,854
				DS7008	10.7	243.3	5.5	600	3	0	$ 153	$ 839	1200	1200	$ 8,689	$ 11,313	$ 25,775	$ 68,666
				Total	164.3										$ 133,420	$ 173,714	$ 395,782	$ 1,054,375
7.3	Talbot Street	Horton Street East	Bathurst Street	DS0452	108.8	242.5	4.4	600	3	0	$ 153	$ 567	825	825	$ 38,542	$ 72,341	$ 209,908	$ 481,187
				DS0453	15.6	243.1	5.3	600	3	0	$ 153	$ 839	825	825	$ 5,526	$ 15,814	$ 37,579	$ 88,378
				Total	124.4										$ 44,069	$ 88,155	$ 247,487	$ 569,565
8	Maitland Street	South Street	Simcoe Street	DS0286	70.7	247.4	3.5	250	3	36	$ 77	$ 441	375	375	$ 7,321	$ 35,064	$ 136,402	$ 268,179
				DS0285	70.7	247.7	3.6	250	1	36	$ 77	$ 441	375	375	$ 7,321	$ 35,064	$ 136,402	$ 268,179
				DS0292	73.8	247.3	3.8	300	3	105	$ 89	$ 458	375	375	$ 7,642	$ 36,601	$ 142,382	$ 279,938
				DS0295	32.0	247.0	3.9	300	3	105	$ 89	$ 458	375	375	$ 3,314	$ 15,870	$ 61,738	$ 121,382
				DS0291	69.2	247.6	3.9	300	3	105	$ 89	$ 458	375	375	$ 7,166	$ 34,320	$ 133,508	$ 262,489
				DS0296	71.6	246.5	4.0	300	3	105	$ 89	$ 458	375	375	$ 7,414	$ 35,510	$ 138,138	$ 271,593
				DS7012	39.6	247.0	4.2	300	2	26	$ 89	$ 458	375	375	$ 4,101	$ 19,640	$ 76,400	$ 150,211
				Total	427.6										$ 44,278	$ 212,068	$ 824,969	$ 1,621,972
9	Clarence Street	Queens Avenue	Dundas Street	DN753	35.7	248.8	1.9	200	4	52	$ 71	$ 431	375	375	$ 3,580	$ 16,733	$ 68,876	$ 133,783
				DN752	20.0	248.7	2.3	250	2	52	$ 77	$ 441	375	375	$ 2,006	$ 9,374	$ 38,586	$ 74,948
				DN0599	71.7	248.1	2.5	300	1	27	$ 89	$ 458	375	375	$ 7,190	$ 33,606	$ 138,331	$ 268,690
				DN0598	33.5	248.4	2.7	300	1	27	$ 89	$ 458	375	375	$ 3,359	$ 15,701	$ 64,632	$ 125,539
				DN0600	62.8	248.1	2.8	300	2	27	$ 89	$ 458	375	375	$ 6,298	$ 29,434	$ 121,160	$ 235,338
				DN0586	75.0	247.9	3.0	300	1	27	$ 89	$ 458	375	375	$ 7,521	$ 35,153	$ 144,698	$ 281,057
				Total	298.7										$ 29,954	$ 140,001	$ 576,282	$ 1,119,354

Constraint #	US Node ID	Cost of Replacing Existing Sewer - Existing Project Costs: Pipe Costs	Construction Costs	Restoration Costs	Total Cost ($)	Upsize to Accommodate LOS: Pipe Costs	Construction Costs	Restoration Costs	Total Cost ($)	Growth Project Costs: Pipe Costs	Construction Costs	Restoration Costs	Total Cost ($)	Local Servicing Costs (<300mm): Total Cost ($)	BTE Split Based on Asset Rating: Growth	BTE	BTE Cost Split Based on Asset Rating: Growth	BTE	Total Cost Split ($): City	Growth	Total Cost Split (%): City	Growth	Year Scheduled Commenced
1	BB336									$ 6,575	$ 46,374	$ 152,965	$ 308,872										
2	DN0244	N/A	N/A	N/A	N/A	$ 1,034	$ 1,410	$ 166,363	$ 253,210	$ -	$ -	$ -	$ -	$ 67,109.13	75	25	$ 189,908	$ 63,303	$ 63,303	$ 257,017	20%	80%	Build-out
3.1	DS1546	$ 25,251	$ 41,437	$ -	$ 100,033	$ 34,639	$ 10,359	$ 114,600	$ 239,398	$ 11,978	$ 2,266	$ -	$ 21,366	$ -	10	90	$ 23,940	$ 215,459	$ 315,491	$ 45,306	87%	13%	2024
	DS1547	$ 25,293	$ 41,507	$ -	$ 100,201	$ 34,697	$ 10,377	$ 114,793	$ 239,801	$ 11,998	$ 2,270	$ -	$ 21,402	$ -	25	75	$ 59,950	$ 179,851	$ 280,052	$ 81,352	77%	23%	2024
	CV0173	$ 34,858	$ 57,203	$ -	$ 138,092	$ 47,818	$ 14,301	$ 158,203	$ 330,483	$ 16,535	$ 3,128	$ -	$ 29,495	$ -	10	90	$ 33,048	$ 297,434	$ 435,526	$ 62,544	87%	13%	2024
	DS0615	$ 37,451	$ 61,459	$ -	$ 148,365	$ 51,376	$ 15,365	$ 169,971	$ 355,067	$ 17,765	$ 3,361	$ -	$ 31,690	$ -	10	90	$ 35,507	$ 319,561	$ 467,925	$ 67,196	87%	13%	2024
	DS1542	$ 65,976	$ 108,268	$ -	$ 261,365	$ 90,505	$ 27,067	$ 299,427	$ 625,499	$ 31,296	$ 5,921	$ -	$ 55,825	$ -	10	90	$ 62,550	$ 562,949	$ 824,313	$ 118,375	87%	13%	2024
	DS1661	$ 23,806	$ 39,066	$ -	$ 94,307	$ 32,656	$ 9,766	$ 108,041	$ 225,695	$ 11,292	$ 2,136	$ -	$ 20,143	$ -	25	75	$ 56,424	$ 169,272	$ 263,578	$ 76,567	77%	23%	2024
	DS0015	$ 7,142	$ 11,720	$ -	$ 28,292	$ 9,797	$ 2,930	$ 32,412	$ 67,709	$ 3,388	$ 641	$ -	$ 6,043	$ -	10	90	$ 6,771	$ 60,938	$ 89,230	$ 12,814	87%	13%	2024
	DS0016	$ 29,162	$ 47,855	$ -	$ 115,526	$ 40,004	$ 11,964	$ 132,350	$ 276,477	$ 13,833	$ 2,617	$ -	$ 24,675	$ -	10	90	$ 27,648	$ 248,829	$ 364,355	$ 52,323	87%	13%	2024
	DS0010	$ 41,192	$ 67,597	$ -	$ 163,184	$ 56,507	$ 16,899	$ 186,949	$ 390,534	$ 19,540	$ 3,697	$ -	$ 34,855	$ -	10	90	$ 39,053	$ 351,480	$ 514,665	$ 73,908	87%	13%	2024
	DS0013	$ 33,073	$ 54,273	$ -	$ 131,019	$ 45,369	$ 13,568	$ 150,100	$ 313,555	$ 15,688	$ 2,968	$ -	$ 27,985	$ -	25	75	$ 78,389	$ 235,167	$ 366,186	$ 106,374	77%	23%	2024
	DS0011	$ 50,544	$ 121,177	$ -	$ 257,582	$ 69,337	$ 31,104	$ 286,418	$ 580,288	$ 31,104	$ 7,128	$ -	$ 57,348	$ -	25	75	$ 145,072	$ 435,216	$ 692,798	$ 202,421	77%	23%	2024
	DS0012	$ 10,372	$ 24,867	$ -	$ 52,860	$ 14,229	$ 6,383	$ 58,777	$ 119,084	$ 6,383	$ 1,463	$ -	$ 11,769	$ -	25	75	$ 29,771	$ 89,313	$ 142,172	$ 41,540	77%	23%	2024
	DS0641	$ 19,427	$ 46,575	$ -	$ 99,003	$ 26,650	$ 11,955	$ 110,087	$ 223,038	$ 11,955	$ 2,740	$ -	$ 22,042	$ -	25	75	$ 55,759	$ 167,278	$ 266,282	$ 77,802	77%	23%	2024
	Total	$ 403,547	$ 723,005	$ -	$ 1,689,828	$ 553,584	$ 182,039	$ 1,922,129	$ 3,986,628	$ 202,757	$ 40,336	$ -	$ 364,639	$ -			$ 653,882	$ 3,332,746	$ 5,022,574	$ 1,018,521	83%	17%	
3.2	OS1305	$ 50,544	$ 82,945	$ -	$ 200,234	$ 29,808	$ 12,312	$ 229,394	$ 407,271	$ -	$ -	$ -	$ -	$ -	25	75	$ 101,818	$ 305,453	$ 505,687	$ 101,818	83%	17%	2024
	OS1540	$ 14,014	$ 21,999	$ -	$ 54,020	$ 6,192	$ 1,955	$ 57,686	$ 98,751	$ -	$ -	$ -	$ -	$ -	50	50	$ 49,375	$ 49,375	$ 103,395	$ 49,375	68%	32%	2024
	DS0518	$ 34,986	$ 57,412	$ -	$ 138,597	$ 20,633	$ 8,522	$ 158,781	$ 281,904	$ -	$ -	$ -	$ -	$ -	10	90	$ 28,190	$ 253,714	$ 392,311	$ 28,190	93%	7%	2024
	DS0009	$ 8,587	$ 14,092	$ -	$ 34,018	$ 5,064	$ 2,092	$ 38,972	$ 69,192	$ -	$ -	$ -	$ -	$ -	10	90	$ 6,919	$ 62,272	$ 96,290	$ 6,919	93%	7%	2024
	DS7024	$ 19,555	$ 32,090	$ -	$ 77,466	$ 11,532	$ 4,763	$ 88,748	$ 157,565	$ -	$ -	$ -	$ -	$ -	10	90	$ 15,756	$ 141,808	$ 219,275	$ 15,756	93%	7%	2024
	OS1306	$ 19,427	$ 31,880	$ -	$ 76,961	$ 11,457	$ 4,732	$ 88,169	$ 156,537	$ -	$ -	$ -	$ -	$ -	25	75	$ 39,134	$ 117,403	$ 194,364	$ 39,134	83%	17%	2024
	DS0630	$ 62,702	$ 102,896	$ -	$ 248,397	$ 36,978	$ 15,274	$ 284,572	$ 505,235	$ -	$ -	$ -	$ -	$ -	25	75	$ 126,309	$ 378,927	$ 627,324	$ 126,309	83%	17%	2024
	DS0429	$ 36,006	$ 59,087	$ -	$ 142,639	$ 21,234	$ 8,771	$ 163,412	$ 290,125	$ -	$ -	$ -	$ -	$ -	25	75	$ 72,531	$ 217,594	$ 360,233	$ 72,531	83%	17%	2024
	OS1303	$ 24,231	$ 39,763	$ -	$ 95,991	$ 14,290	$ 5,902	$ 109,970	$ 195,244	$ -	$ -	$ -	$ -	$ -	25	75	$ 48,811	$ 146,433	$ 242,423	$ 48,811	83%	17%	2024
	DS0428	$ 25,301	$ 76,807	$ -	$ 153,162	$ 42,018	$ 10,843	$ 199,698	$ 378,838	$ -	$ -	$ -	$ -	$ -	50	50	$ 189,419	$ 189,419	$ 342,581	$ 189,419	64%	36%	2024
	OS1029	$ 26,951	$ 64,614	$ -	$ 137,348	$ 24,533	$ 2,419	$ 152,724	$ 269,513	$ -	$ -	$ -	$ -	$ -	25	75	$ 67,378	$ 202,135	$ 339,483	$ 67,378	83%	17%	2024
	OS1541	$ 8,417	$ 20,179	$ -	$ 42,894	$ 7,662	$ 755	$ 47,696	$ 84,170	$ -	$ -	$ -	$ -	$ -	10	90	$ 8,417	$ 75,753	$ 118,647	$ 8,417	93%	7%	2024
	DS0008	$ 40,172	$ 96,310	$ -	$ 204,722	$ 36,567	$ 3,605	$ 227,641	$ 401,720	$ -	$ -	$ -	$ -	$ -	10	90	$ 40,172	$ 361,548	$ 566,270	$ 40,172	93%	7%	2024
	OS1030	$ 36,984	$ 88,666	$ -	$ 188,475	$ 33,665	$ 3,319	$ 209,574	$ 369,837	$ -	$ -	$ -	$ -	$ -	10	90	$ 36,984	$ 332,853	$ 521,328	$ 36,984	93%	7%	2024
	OS2022	$ 22,105	$ 52,996	$ -	$ 112,652	$ 20,121	$ 1,984	$ 125,263	$ 221,052	$ -	$ -	$ -	$ -	$ -	10	90	$ 22,105	$ 198,947	$ 311,598	$ 22,105	93%	7%	2024
	OS7029	$ 2,976	$ 7,134	$ -	$ 15,165	$ 2,709	$ 267	$ 16,862	$ 29,757	$ -	$ -	$ -	$ -	$ -	10	90	$ 2,976	$ 26,781	$ 41,946	$ 2,976	93%	7%	2024
	Total	$ 432,958	$ 848,869	$ -	$ 1,922,740	$ 324,462	$ 87,516	$ 2,199,162	$ 3,916,711	$ -	$ -	$ -	$ -	$ -			$ 856,296	$ 3,060,415	$ 4,983,156	$ 856,296	86%	14%	
3.3	DS1634	$ 5,816	$ 27,185	$ -	$ 49,501	$ 11,885	$ 9,167	$ 111,899	$ 199,427	$ 2,845	$ 2,213	$ -	$ 7,586	$ -	75	25	$ 149,571	$ 49,857	$ 99,358	$ 157,157	39%	61%	2024
	DS1485	$ 6,017	$ 41,529	$ -	$ 71,319	$ 12,295	$ 14,061	$ 144,534	$ 256,335	$ 2,943	$ 5,232	$ -	$ 12,263	$ -	75	25	$ 192,251	$ 64,084	$ 135,403	$ 204,514	40%	60%	2024
	DS0414	$ 1,922	$ 7,195	$ -	$ 13,675	$ 581	$ 402	$ 19,753	$ 31,104	$ 402	$ 715	$ -	$ 1,676	$ -	75	25	$ 23,328	$ 7,776	$ 21,451	$ 25,004	46%	54%	2024
	Total	$ 13,755	$ 75,909	$ -	$ 134,495	$ 24,762	$ 23,630	$ 276,186	$ 486,867	$ 6,190	$ 8,160	$ -	$ 21,525	$ -			$ 365,150	$ 121,717	$ 256,212	$ 386,675	0%	0%	0
4	CV0175	$ 2,726	$ 13,963	$ -	$ 25,033	$ 765	$ 1,995	$ 58,844	$ 92,404	$ 1,164	$ 1,330	$ -	$ 3,740	$ -	50	50	$ 46,202	$ 46,202	$ 71,236	$ 49,942	59%	41%	Build-out
	CV0172	$ 1,797	$ 9,202	$ -	$ 16,497	$ 504	$ 1,315	$ 38,779	$ 60,896	$ 767	$ 876	$ -	$ 2,465	$ -	25	75	$ 15,224	$ 45,672	$ 62,170	$ 17,689	78%	22%	Build-out
	DS0614	$ 5,399	$ 27,651	$ -	$ 49,575	$ 1,514	$ 3,950	$ 116,530	$ 182,991	$ 2,304	$ 2,633	$ -	$ 7,407	$ -	50	50	$ 91,496	$ 91,496	$ 141,070	$ 98,902	59%	41%	Build-out
	DS0613	$ 5,774	$ 43,657	$ -	$ 74,146	$ 1,620	$ 7,393	$ 155,615	$ 246,942	$ 2,464	$ 3,169	$ -	$ 8,450	$ -	50	50	$ 123,471	$ 123,471	$ 197,617	$ 131,921	60%	40%	Build-out
	Total	$ 15,695	$ 94,472	$ -	$ 165,251	$ 4,402	$ 14,653	$ 369,767	$ 583,234	$ 6,699	$ 8,008	$ -	$ 22,061	$ -			$ 276,393	$ 306,841	$ 472,092	$ 298,454	64%	36%	
5	DS0486	$ 24,783	$ 40,670	$ -	$ 98,180	$ 45,754	$ 12,392	$ 112,478	$ 255,936	$ -	$ -	$ -	$ -	$ -	75	25	$ 191,952	$ 63,984	$ 162,164	$ 191,952	46%	54%	2019
	DS1700	$ 13,433	$ 22,044	$ -	$ 53,216	$ 24,800	$ 6,717	$ 60,966	$ 138,723	$ -	$ -	$ -	$ -	$ -	25	75	$ 34,681	$ 104,042	$ 157,258	$ 34,681	82%	18%	2019
	DS0484	$ 4,166	$ 6,836	$ -	$ 16,504	$ 7,691	$ 2,083	$ 18,907	$ 43,022	$ -	$ -	$ -	$ -	$ -	75	25	$ 32,266	$ 10,755	$ 27,259	$ 32,266	46%	54%	2019
	DS1560	$ 3,826	$ 6,278	$ -	$ 15,156	$ 7,063	$ 1,913	$ 17,364	$ 39,510	$ -	$ -	$ -	$ -	$ -	75	25	$ 29,632	$ 9,877	$ 25,034	$ 29,632	46%	54%	2019
	DS0483	$ 21,255	$ 34,880	$ -	$ 84,203	$ 39,240	$ 10,628	$ 96,465	$ 219,499	$ -	$ -	$ -	$ -	$ -	50	50	$ 109,749	$ 109,749	$ 193,952	$ 109,749	64%	36%	2019
	DS1526	$ 3,372	$ 5,300	$ -	$ 13,008	$ 3,231	$ 1,672	$ 12,526	$ 26,144	$ -	$ -	$ -	$ -	$ -	75	25	$ 19,608	$ 6,536	$ 19,544	$ 19,608	50%	50%	2019
	DS672	$ 36,261	$ 86,933	$ -	$ 184,792	$ 72,057	$ 27,428	$ 205,479	$ 457,447	$ -	$ -	$ -	$ -	$ -	75	25	$ 343,085	$ 114,362	$ 299,153	$ 343,085	47%	53%	2019
	Total	$ 107,097	$ 202,942	$ -	$ 465,059	$ 199,836	$ 62,832	$ 524,185	$ 1,180,280	$ -	$ -	$ -	$ -	$ -			$ 760,973	$ 419,306	$ 884,365	$ 760,973	54%	46%	
6.1	DS1528	$ 6,550	$ 10,293	$ -	$ 25,266	$ 3,468	$ 771	$ 24,330	$ 42,853	$ -	$ -	$ -	$ -	$ -	90	10	$ 38,567	$ 4,285	$ 29,551	$ 38,567	43%	57%	2034
	DN758	$ 2,918	$ 5,690	$ -	$ 12,912	$ 1,545	$ 956	$ 12,802	$ 22,955	$ -	$ -	$ -	$ -	$ -	90	10	$ 20,660	$ 2,296	$ 15,208	$ 20,660	42%	58%	2034
	DN757	$ 91,381	$ 178,154	$ -	$ 404,302	$ 48,378	$ 29,948	$ 400,846	$ 718,759	$ -	$ -	$ -	$ -	$ -	90	10	$ 646,883	$ 71,876	$ 476,178	$ 646,883	42%	58%	2034
	Total	$ 100,850	$ 194,137	$ -	$ 442,480	$ 53,391	$ 31,675	$ 437,978	$ 784,567	$ -	$ -	$ -	$ -	$ -			$ 706,110	$ 78,457	$ 520,937	$ 706,110	43%	57%	
6.2	DN0466	$ 29,312	$ 70,632	$ -	$ 149,916	$ 34,963	$ 353	$ 156,097	$ 287,119	$ -	$ -	$ -	$ -	$ -	50	50	$ 143,560	$ 143,560	$ 293,476	$ 143,560	67%	33%	2034
	DN0460	$ 31,303	$ 75,428	$ -	$ 160,096	$ 37,337	$ 377	$ 166,696	$ 306,615	$ -	$ -	$ -	$ -	$ -	50	50	$ 153,307	$ 153,307	$ 313,403	$ 153,307	67%	33%	2034
	DN0457	$ 31,303	$ 75,428	$ -	$ 160,096	$ 37,337	$ 377	$ 166,696	$ 306,615	$ -	$ -	$ -	$ -	$ -	50	50	$ 153,307	$ 153,307	$ 313,403	$ 153,307	67%	33%	2034
	Total	$ 91,918	$ 221,488	$ -	$ 470,108	$ 109,637	$ 1,107	$ 489,488	$ 900,349	$ -	$ -	$ -	$ -	$ -			$ 450,174	$ 450,174	$ 920,283	$ 450,174	67%	33%	
6.3	DN0454	$ 36,143	$ 87,091	$ -	$ 184,851	$ 15,676	$ 13,935	$ 227,308	$ 385,378	$ 13,064	$ 8,274	$ -	$ 32,006	$ -	50	50	$ 192,689	$ 192,689	$ 377,539	$ 224,695	63%	37%	2019
	DN0447	$ 54,192	$ 253,329	$ -	$ 461,281	$ 35,910	$ 22,199	$ 402,193	$ 690,452	$ 22,852	$ 13,711	$ -	$ 54,844	$ -	75	25	$ 517,839	$ 172,613	$ 633,894	$ 572,684	53%	47%	2019
	DN0450	$ 64,460	$ 301,331	$ -	$ 548,686	$ 42,714	$ 26,405	$ 478,401	$ 821,281	$ 27,182	$ 16,309	$ -	$ 65,237	$ -	75	25	$ 615,961	$ 205,320	$ 754,006	$ 681,197	53%	47%	2019
	DN0453	$ 24,970	$ 116,726	$ -	$ 212,543	$ 16,546	$ 10,229	$ 185,317	$ 318,138	$ 10,529	$ 6,318	$ -	$ 25,271	$ -	50	50	$ 159,069	$ 159,069	$ 371,613	$ 184,340	67%	33%	2019
	Total	$ 179,764	$ 758,477	$ -	$ 1,407,361	$ 110,847	$ 72,767	$ 1,293,219	$ 2,215,249	$ 73,627	$ 44,612	$ -	$ 177,357	$ -			$ 1,485,558	$ 729,691	$ 2,137,052	$ 1,662,915	59%	41%	
7.1	DS0456	$ 5,601	$ 13,937	$ -	$ 29,307	$ 14,068	$ 6,122	$ 46,110	$ 99,450	$ -	$ -	$ -	$ -	$ -	50	50	$ 49,725	$ 49,725	$ 79,032	$ 49,725	61%	39%	2034
	DS0457	$ 17,131	$ 42,628	$ -	$ 89,639	$ 43,027	$ 18,725	$ 141,032	$ 304,175	$ -	$ -	$ -	$ -	$ -	50	50	$ 152,087	$ 152,087	$ 241,726	$ 152,087	61%	39%	2034
	DS0462	$ 1,862	$ 5,652	$ -	$ 11,270	$ 4,189	$ 1,031	$ 14,694	$ 29,871	$ -	$ -	$ -	$ -	$ -	50	50	$ 14,935	$ 14,935	$ 26,205	$ 14,935	64%	36%	2034
	DS0479	$ 46,676	$ 111,903	$ -	$ 237,868	$ 62,235	$ 8,378	$ 264,497	$ 502,664	$ -	$ -	$ -	$ -	$ -	75	25	$ 376,998	$ 125,666	$ 363,534	$ 376,998	49%	51%	2034
	DS1701	$ 12,467	$ 46,680	$ -	$ 88,722	$ 40,302	$ 11,598	$ 128,153	$ 270,079	$ -	$ -	$ -	$ -	$ -	50	50	$ 135,040	$ 135,040	$ 223,761	$ 135,040	62%	38%	2034
	DS1527	$ 13,561	$ 32,511	$ -	$ 69,107	$ 18,081	$ 2,434	$ 76,844	$ 146,038	$ -	$ -	$ -	$ -	$ -	90	10	$ 131,434	$ 14,604	$ 83,711	$ 131,434	39%	61%	2034
	Total	$ 97,298	$ 253,311	$ -	$ 525,913	$ 181,900	$ 48,286	$ 671,331	$ 1,352,277	$ -	$ -	$ -	$ -	$ -			$ 860,220	$ 492,057	$ 1,017,970	$ 860,220	56%	44%	
7.2	DS0455	$ 11,720	$ 64,458	$ -	$ 114,267	$ 50,646	$ 16,742	$ 185,004	$ 378,588	$ -	$ -	$ -	$ -	$ -	50	50	$ 189,294	$ 189,294	$ 303,561	$ 189,294	62%	38%	2034
	DS0454	$ 11,720	$ 64,458	$ -	$ 114,267	$ 50,646	$ 16,742	$ 185,004	$ 378,588	$ -	$ -	$ -	$ -	$ -	25	75	$ 94,647	$ 283,941	$ 398,208	$ 94,647	81%	19%	2034
	DS7008	$ 1,633	$ 8,981	$ -	$ 15,920	$ 7,056	$ 2,333	$ 25,775	$ 52,746	$ -	$ -	$ -	$ -	$ -	50	50	$ 26,373	$ 26,373	$ 42,293	$ 26,373	62%	38%	2034
	Total	$ 25,072	$ 137,897	$ -	$ 244,454	$ 108,348	$ 35,817	$ 395,782	$ 809,921	$ -	$ -	$ -	$ -	$ -			$ 310,314	$ 499,607	$ 744,061	$ 310,314	68%	32%	
7.3	DS0452	$ 16,603	$ 61,668	$ -	$ 117,406	$ 21,940	$ 10,673	$ 209,908	$ 363,781	$ -	$ -	$ -	$ -	$ -	50	50	$ 181,890	$ 181,890	$ 299,297	$ 181,890	62%	38%	2034
	DS0453	$ 2,381	$ 13,093	$ -	$ 23,210	$ 3,146	$ 2,721	$ 37,579	$ 65,168	$ -	$ -	$ -	$ -	$ -	50	50	$ 32,584	$ 32,584	$ 55,794	$ 32,584	63%	37%	2034
	Total	$ 18,983	$ 74,761	$ -	$ 140,617	$ 25,085	$ 13,394	$ 247,487	$ 428,949	$ -	$ -	$ -	$ -	$ -			$ 214,474	$ 214,474	$ 355,091	$ 214,474	63%	37%	
8	DS0286	$ -	$ -	$ -	$ -	$ 1,850	$ 3,853	$ 136,402	$ 213,156	$ -	$ -	$ -	$ -	$ 55,023	50	50	$ 106,578	$ 106,578	$ 106,578	$ 161,601	40%	60%	2034
	DS0285	$ -	$ -	$ -	$ -	$ 1,850	$ 3,853	$ 136,402	$ 213,156	$ -	$ -	$ -	$ -	$ 55,023	90	10	$ 191,841	$ 21,316	$ 21,316	$ 246,864	8%	92%	2034
	DS0292	$ 6,596	$ 33,786	$ -	$ 60,573	$ 1,046	$ 2,815	$ 142,382	$ 219,365	$ -	$ -	$ -	$ -	$ -	50	50	$ 109,683	$ 109,683	$ 170,255	$ 109,683	61%	39%	2034
	DS0295	$ 2,860	$ 14,650	$ -	$ 26,265	$ 453	$ 1,221	$ 61,738	$ 95,118	$ -	$ -	$ -	$ -	$ -	50	50	$ 47,559	$ 47,559	$ 73,824	$ 47,559	61%	39%	2034
	DS0291	$ 6,185	$ 31,680	$ -	$ 56,797	$ 981	$ 2,640	$ 133,508	$ 205,692	$ -	$ -	$ -	$ -	$ -	50	50	$ 102,846	$ 102,846	$ 159,643	$ 102,846	61%	39%	2034
	DS0296	$ 6,400	$ 32,778	$ -	$ 58,767	$ 1,015	$ 2,732	$ 138,138	$ 212,826	$ -	$ -	$ -	$ -	$ -	50	50	$ 106,413	$ 106,413	$ 165,180	$ 106,413	61%	39%	2034
	DS7012	$ 3,539	$ 18,129	$ -	$ 32,502	$ 561	$ 1,511	$ 76,400	$ 117,708	$ -	$ -	$ -	$ -	$ -	75	25	$ 88,281	$ 29,427	$ 61,930	$ 88,281	41%	59%	2034
	Total	$ 25,581	$ 131,022	$ -	$ 234,904	$ 7,754	$ 18,625	$ 824,969	$ 1,277,022	$ -	$ -	$ -	$ -	$ 110,046			$ 753,201	$ 523,821	$ 758,726	$ 863,247	47%	53%	
9	DN753	$ 2,529	$ 15,371	$ -	$ 26,850	$ -	$ -	$ -	$ -	$ 1,051	$ 1,362	$ 68,876	$ 106,933	$ -	25	75	$ 26,733	$ 80,200	$ 80,200	$ 53,583	60%	40%	2019
	DN752	$ 1,548	$ 8,829	$ -	$ 15,565	$ -	$ -	$ -	$ -	$ 458	$ 545	$ 38,586	$ 59,383	$ -	75	25	$ 44,537	$ 14,846	$ 14,846	$ 60,103	20%	80%	2019
	DN0599	$ -	$ -	$ -	$ -	$ 6,409	$ 32,824	$ -	$ 58,849	$ 782	$ 782	$ 138,331	$ 209,841	$ -	90	10	$ 188,857	$ 20,984	$ 79,833	$ 188,857	30%	70%	2019
	DN0598	$ -	$ -	$ -	$ -	$ 2,994	$ 15,336	$ -	$ 27,496	$ 365	$ 365	$ 64,632	$ 98,043	$ -	90	10	$ 88,238	$ 9,804	$ 37,300	$ 88,238	30%	70%	2019
	DN0600	$ -	$ -	$ -	$ -	$ 5,613	$ 28,750	$ -	$ 51,544	$ 685	$ 685	$ 121,160	$ 183,794	$ -	75	25	$ 137,845	$ 45,948	$ 97,493	$ 137,845	41%	59%	2019
	DN0586	$ -	$ -	$ -	$ -	$ 6,704	$ 34,335	$ -	$ 61,558	$ 817	$ 818	$ 144,698	$ 219,499	$ -	90	10	$ 197,549	$ 21,950	$ 83,508	$ 197,549	30%	70%	2019
	Total	$ 4,077	$ 24,200	$ -	$ 42,415	$ 21,719	$ 111,245	$ -	$ 199,447	$ 4,157	$ 4,556	$ 576,282	$ 877,492	$ -			$ 683,760	$ 193,732	$ 393,179	$ 726,175	35%	65%	

	Ridout Street North/Talbot Street/Mill Street/Pall Mall Street	Maitland Street	Albert Street	DN805	15.8	240.8	2.2	825	2	0	$ 354	$ 665	1050	1050	$ 8,525	$ 12,055	$ 30,483	$ 76,595	$ 5,597	$ 10,505	$ -	$ 24,154	$ 2,928	$ 1,550	$ 30,483	$ 52,441	$ -	$ -	$ -	$ -	$ -	75	25	$ 39,331	$ 13,110	$ 37,264	$ 39,331	49%	51%	2029
				DN0517	137.2	240.8	2.3	825	3	0	$ 354	$ 665	1050	1050	$ 74,026	$ 104,684	$ 264,700	$ 665,115	$ 48,603	$ 91,224	$ -	$ 209,741	$ 25,423	$ 13,459	$ 264,700	$ 455,374	$ -	$ -	$ -	$ -	$ -	75	25	$ 341,530	$ 113,843	$ 323,584	$ 341,530	49%	51%	2029
				DN0356	88.4	244.0	3.4	825	3	0	$ 354	$ 665	1050	1050	$ 47,696	$ 67,449	$ 170,550	$ 428,543	$ 31,316	$ 58,777	$ -	$ 135,139	$ 16,381	$ 8,672	$ 170,550	$ 293,404	$ -	$ -	$ -	$ -	$ -	50	50	$ 146,702	$ 146,702	$ 281,841	$ 146,702	66%	34%	2029
				DN0393	128.5	244.0	3.4	825	3	0	$ 354	$ 665	1050	1050	$ 69,332	$ 98,046	$ 247,915	$ 622,939	$ 45,521	$ 85,440	$ -	$ 196,441	$ 23,811	$ 12,606	$ 247,915	$ 426,498	$ -	$ -	$ -	$ -	$ -	50	50	$ 213,249	$ 213,249	$ 409,690	$ 213,249	66%	34%	2029
				DN0355	76.2	244.6	3.9	825	4	0	$ 354	$ 665	1050	1050	$ 41,114	$ 58,141	$ 147,013	$ 369,400	$ 26,994	$ 50,665	$ -	$ 116,489	$ 14,120	$ 7,475	$ 147,013	$ 252,912	$ -	$ -	$ -	$ -	$ -	25	75	$ 63,228	$ 189,684	$ 306,173	$ 63,228	83%	17%	2029
				DN0394	118.0	244.7	4.3	825	3	0	$ 354	$ 665	1050	1050	$ 63,667	$ 90,034	$ 227,657	$ 572,037	$ 41,802	$ 78,458	$ -	$ 180,390	$ 21,865	$ 11,576	$ 227,657	$ 391,648	$ -	$ -	$ -	$ -	$ -	50	50	$ 195,824	$ 195,824	$ 376,214	$ 195,824	66%	34%	2029
				DN0354	72.6	245.1	4.4	825	3	0	$ 354	$ 665	1050	1050	$ 39,171	$ 55,394	$ 140,067	$ 351,948	$ 25,719	$ 48,272	$ -	$ 110,985	$ 13,453	$ 7,122	$ 140,067	$ 240,963	$ -	$ -	$ -	$ -	$ -	50	50	$ 120,482	$ 120,482	$ 231,467	$ 120,482	66%	34%	2029
				DN777	7.5	245.3	4.5	825	1	7	$ 354	$ 665	1050	1050	$ 4,047	$ 5,723	$ 14,470	$ 36,358	$ 2,657	$ 4,987	$ -	$ 11,465	$ 1,390	$ 736	$ 14,470	$ 24,893	$ -	$ -	$ -	$ -	$ -	90	10	$ 22,404	$ 2,489	$ 13,955	$ 22,404	38%	62%	2029
				DN0420	22.8	243.7	4.6	825	3	0	$ 354	$ 665	1050	1050	$ 12,302	$ 17,396	$ 43,988	$ 110,529	$ 8,077	$ 15,160	$ -	$ 34,855	$ 4,225	$ 2,237	$ 43,988	$ 75,674	$ -	$ -	$ -	$ -	$ -	50	50	$ 37,837	$ 37,837	$ 72,692	$ 37,837	66%	34%	2029
				DN0419	87.8	244.0	4.8	825	4	0	$ 354	$ 665	1050	1050	$ 47,372	$ 66,991	$ 169,393	$ 425,635	$ 31,103	$ 58,378	$ -	$ 134,222	$ 16,269	$ 8,613	$ 169,393	$ 291,413	$ -	$ -	$ -	$ -	$ -	25	75	$ 72,853	$ 218,559	$ 352,781	$ 72,853	83%	17%	2029
				DN0402	78.0	245.0	5.0	825	3	0	$ 354	$ 1,014	1050	1050	$ 50,587	$ 79,494	$ 187,894	$ 476,962	$ 27,632	$ 79,069	$ -	$ 160,050	$ 22,955	$ 425	$ 187,894	$ 316,912	$ -	$ -	$ -	$ -	$ -	50	50	$ 158,456	$ 158,456	$ 318,506	$ 158,456	67%	33%	2029
				DN778	75.4	246.0	5.1	825	1	7	$ 354	$ 1,014	1050	1050	$ 48,901	$ 76,844	$ 181,631	$ 461,063	$ 26,710	$ 76,433	$ -	$ 154,715	$ 22,190	$ 411	$ 181,631	$ 306,348	$ -	$ -	$ -	$ -	$ -	90	10	$ 275,713	$ 30,635	$ 185,350	$ 275,713	40%	60%	2029
				DN0403	78.0	245.0	5.1	825	4	0	$ 354	$ 1,014	1050	1050	$ 50,587	$ 79,494	$ 187,894	$ 476,962	$ 27,632	$ 79,069	$ -	$ 160,050	$ 22,955	$ 425	$ 187,894	$ 316,912	$ -	$ -	$ -	$ -	$ -	25	75	$ 79,228	$ 237,684	$ 397,734	$ 79,228	83%	17%	2029
				DN0417_2	1.9	244.5	5.1	825	4	0	$ 354	$ 1,014	1050	1050	$ 1,232	$ 1,936	$ 4,577	$ 11,618	$ 673	$ 1,926	$ -	$ 3,899	$ 559	$ 10	$ 4,577	$ 7,720	$ -	$ -	$ -	$ -	$ -	25	75	$ 1,930	$ 5,790	$ 9,688	$ 1,930	83%	17%	2029
				DN0417	87.0	244.5	5.1	825	4	0	$ 354	$ 1,014	1050	1050	$ 56,424	$ 88,666	$ 209,574	$ 531,996	$ 30,820	$ 88,192	$ -	$ 178,517	$ 25,604	$ 474	$ 209,574	$ 353,479	$ -	$ -	$ -	$ -	$ -	25	75	$ 88,370	$ 265,109	$ 443,627	$ 88,370	83%	17%	2029
				DN779	80.3	246.3	5.3	825	1	7	$ 354	$ 1,014	1050	1050	$ 52,079	$ 81,838	$ 193,435	$ 491,026	$ 28,446	$ 81,400	$ -	$ 164,770	$ 23,632	$ 438	$ 193,435	$ 326,257	$ -	$ -	$ -	$ -	$ -	90	10	$ 293,631	$ 32,626	$ 197,395	$ 293,631	40%	60%	2029
				DN0414	81.4	245.0	5.4	825	3	0	$ 354	$ 1,014	1050	1050	$ 52,792	$ 82,959	$ 196,084	$ 497,753	$ 28,836	$ 82,515	$ -	$ 167,027	$ 23,956	$ 444	$ 196,084	$ 330,726	$ -	$ -	$ -	$ -	$ -	50	50	$ 165,363	$ 165,363	$ 332,390	$ 165,363	67%	33%	2029
				DN0415	81.0	245.0	5.5	825	3	0	$ 354	$ 1,014	1050	1050	$ 52,533	$ 82,551	$ 195,121	$ 495,307	$ 28,694	$ 82,110	$ -	$ 166,206	$ 23,838	$ 441	$ 195,121	$ 329,101	$ -	$ -	$ -	$ -	$ -	50	50	$ 164,550	$ 164,550	$ 330,756	$ 164,550	67%	33%	2029
				DN0413	21.7	245.3	5.6	825	3	0	$ 354	$ 1,014	1050	1050	$ 14,074	$ 22,116	$ 52,273	$ 132,693	$ 7,687	$ 21,997	$ -	$ 44,527	$ 6,386	$ 118	$ 52,273	$ 88,167	$ -	$ -	$ -	$ -	$ -	50	50	$ 44,083	$ 44,083	$ 88,610	$ 44,083	67%	33%	2029
				DN0420_2	7.0	244.7	5.6	825	2	0	$ 354	$ 1,014	1050	1050	$ 4,540	$ 7,134	$ 16,862	$ 42,804	$ 2,480	$ 7,096	$ -	$ 14,363	$ 2,060	$ 38	$ 16,862	$ 28,441	$ -	$ -	$ -	$ -	$ -	75	25	$ 21,331	$ 7,110	$ 21,474	$ 21,331	50%	50%	2029
				DN780	63.0	246.8	5.6	825	1	7	$ 354	$ 1,014	1050	1050	$ 40,859	$ 64,206	$ 151,761	$ 385,239	$ 22,318	$ 63,863	$ -	$ 129,271	$ 18,541	$ 343	$ 151,761	$ 255,967	$ -	$ -	$ -	$ -	$ -	90	10	$ 230,371	$ 25,597	$ 154,868	$ 230,371	40%	60%	2029
				DN781	17.6	246.8	5.7	825	1	7	$ 354	$ 1,014	1050	1050	$ 11,414	$ 17,937	$ 42,397	$ 107,622	$ 6,235	$ 17,841	$ -	$ 36,114	$ 5,180	$ 96	$ 42,397	$ 71,508	$ -	$ -	$ -	$ -	$ -	90	10	$ 64,358	$ 7,151	$ 43,265	$ 64,358	40%	60%	2029
				DN0423	92.6	244.9	5.8	825	2	0	$ 354	$ 1,014	1050	1050	$ 60,056	$ 94,373	$ 223,064	$ 566,240	$ 32,804	$ 93,869	$ -	$ 190,008	$ 27,252	$ 505	$ 223,064	$ 376,231	$ -	$ -	$ -	$ -	$ -	75	25	$ 282,174	$ 94,058	$ 284,066	$ 282,174	50%	50%	2029
				DN0405	37.5	245.8	6.1	825	3	0	$ 354	$ 1,014	1050	1050	$ 24,321	$ 38,218	$ 90,334	$ 229,309	$ 13,284	$ 38,014	$ -	$ 76,947	$ 11,036	$ 204	$ 90,334	$ 152,362	$ -	$ -	$ -	$ -	$ -	50	50	$ 76,181	$ 76,181	$ 153,128	$ 76,181	67%	33%	2029
				DN0404	15.7	245.8	6.1	825	3	0	$ 354	$ 1,014	1050	1050	$ 10,182	$ 16,001	$ 37,820	$ 96,004	$ 5,562	$ 15,915	$ -	$ 32,215	$ 4,621	$ 86	$ 37,820	$ 63,789	$ -	$ -	$ -	$ -	$ -	50	50	$ 31,894	$ 31,894	$ 64,110	$ 31,894	67%	33%	2029
				DN831	85.6	246.8	7.8	825	2	0	$ 452	$ 1,090	1050	1050	$ 55,516	$ 108,233	$ 243,523	$ 610,908	$ 38,721	$ 93,304	$ -	$ 198,038	$ 16,795	$ 14,929	$ 243,523	$ 412,870	$ -	$ -	$ -	$ -	$ -	75	25	$ 309,653	$ 103,218	$ 301,255	$ 309,653	49%	51%	2029
				DN828	40.6	247.8	9.0	825	2	0	$ 452	$ 1,090	1050	1050	$ 26,331	$ 51,335	$ 115,503	$ 289,753	$ 18,365	$ 44,254	$ -	$ 93,929	$ 7,966	$ 7,081	$ 115,503	$ 195,824	$ -	$ -	$ -	$ -	$ -	75	25	$ 146,868	$ 48,956	$ 142,885	$ 146,868	49%	51%	2029
				DN827	23.8	248.2	9.5	825	2	0	$ 452	$ 1,090	1050	1050	$ 15,435	$ 30,093	$ 67,709	$ 169,855	$ 10,766	$ 25,942	$ -	$ 55,062	$ 4,670	$ 4,151	$ 67,709	$ 114,793	$ -	$ -	$ -	$ -	$ -	75	25	$ 86,095	$ 28,698	$ 83,760	$ 86,095	49%	51%	2029
				DN0444	106.6	249.1	10.4	825	2	0	$ 452	$ 2,115	1050	1050	$ 80,174	$ 245,169	$ 357,878	$ 1,024,831	$ 48,221	$ 225,416	$ -	$ 410,455	$ 31,953	$ 19,753	$ 357,878	$ 614,376	$ -	$ -	$ -	$ -	$ -	75	25	$ 460,782	$ 153,594	$ 564,049	$ 460,782	55%	45%	2029
10.1				Total	1829.5										$ 1,115,287	$ 1,844,508	$ 4,211,569	$ 10,757,048	$ 673,273	$ 1,720,091	$ -	$ 3,590,046	$ 442,015	$ 124,418	$ 4,211,569	$ 7,167,002	$ -	$ -	$ -	$ -	$ -			$ 4,234,469	$ 2,932,533	$ 6,522,578	$ 4,234,469	60%	40%	
	Pall Mall Street	Adelaide Street North	Maitland Street	DN0292	58.1	248.2	3.2	300	3	0	$ 89	$ 458	375	375	$ 5,826	$ 27,231	$ 112,092	$ 217,725	$ 5,193	$ 26,598	$ -	$ 47,687	$ 633	$ 633	$ 112,092	$ 170,038	$ -	$ -	$ -	$ -	$ -	50	50	$ 85,019	$ 85,019	$ 132,706	$ 85,019	61%	39%	Build-out
				DN0293	63.1	248.0	3.4	300	3	0	$ 89	$ 458	375	375	$ 6,328	$ 29,575	$ 121,739	$ 236,462	$ 5,640	$ 28,887	$ -	$ 51,791	$ 688	$ 688	$ 121,739	$ 184,672	$ -	$ -	$ -	$ -	$ -	50	50	$ 92,336	$ 92,336	$ 144,126	$ 92,336	61%	39%	Build-out
				DN0286	59.5	249.5	3.5	300	3	107	$ 89	$ 458	375	375	$ 5,967	$ 27,888	$ 114,793	$ 222,971	$ 5,318	$ 27,239	$ -	$ 48,836	$ 649	$ 649	$ 114,793	$ 174,136	$ -	$ -	$ -	$ -	$ -	50	50	$ 87,068	$ 87,068	$ 135,904	$ 87,068	61%	39%	Build-out
				DN783	66.5	247.4	3.6	300	1	7	$ 89	$ 458	375	375	$ 6,669	$ 31,169	$ 128,298	$ 249,203	$ 5,944	$ 30,444	$ -	$ 54,581	$ 725	$ 725	$ 128,298	$ 194,622	$ -	$ -	$ -	$ -	$ -	90	10	$ 175,160	$ 19,462	$ 74,043	$ 175,160	30%	70%	Build-out
				DN0291	59.4	249.0	3.7	300	3	107	$ 89	$ 458	375	375	$ 5,957	$ 27,841	$ 114,600	$ 222,597	$ 5,309	$ 27,193	$ -	$ 48,754	$ 647	$ 647	$ 114,600	$ 173,843	$ -	$ -	$ -	$ -	$ -	50	50	$ 86,922	$ 86,922	$ 135,675	$ 86,922	61%	39%	Build-out
				DN784	61.2	248.0	3.9	300	1	7	$ 89	$ 458	375	375	$ 6,137	$ 28,684	$ 118,073	$ 229,342	$ 5,470	$ 28,017	$ -	$ 50,231	$ 667	$ 667	$ 118,073	$ 179,111	$ -	$ -	$ -	$ -	$ -	90	10	$ 161,200	$ 17,911	$ 68,142	$ 161,200	30%	70%	Build-out
				DN782	53.6	247.0	4.1	300	1	7	$ 89	$ 458	375	375	$ 5,375	$ 25,122	$ 103,410	$ 200,862	$ 4,791	$ 24,538	$ -	$ 43,993	$ 584	$ 584	$ 103,410	$ 156,868	$ -	$ -	$ -	$ -	$ -	90	10	$ 141,182	$ 15,687	$ 59,680	$ 141,182	30%	70%	Build-out
				DN0287	62.7	249.8	4.1	300	3	107	$ 89	$ 458	375	375	$ 6,288	$ 29,387	$ 120,967	$ 234,963	$ 5,604	$ 28,704	$ -	$ 51,462	$ 683	$ 683	$ 120,967	$ 183,501	$ -	$ -	$ -	$ -	$ -	50	50	$ 91,750	$ 91,750	$ 143,213	$ 91,750	61%	39%	Build-out
10.2				Total	484.1										$ 48,546	$ 226,898	$ 933,974	$ 1,814,126	$ 43,269	$ 221,621	$ -	$ 397,335	$ 5,277	$ 5,277	$ 933,974	$ 1,416,791	$ -	$ -	$ -	$ -	$ -			$ 920,636	$ 496,155	$ 893,490	$ 920,636	49%	51%	
	Maitland Street/Central Avenue	William Street	Pall Mall Street	DN771	101.4	245.0	3.4	675	3	0	$ 234	$ 583	900	900	$ 43,105	$ 70,737	$ 195,631	$ 464,209	$ 23,763	$ 59,131	$ -	$ 124,342	$ 19,342	$ 11,605	$ 195,631	$ 339,867	$ -	$ -	$ -	$ -	$ -	50	50	$ 169,934	$ 169,934	$ 294,275	$ 169,934	63%	37%	2034
				DN0313	16.1	245.0	3.6	675	4	0	$ 234	$ 583	900	900	$ 6,844	$ 11,231	$ 31,062	$ 73,706	$ 3,773	$ 9,389	$ -	$ 19,743	$ 3,071	$ 1,843	$ 31,062	$ 53,963	$ -	$ -	$ -	$ -	$ -	25	75	$ 13,491	$ 40,472	$ 60,215	$ 13,491	82%	18%	2034
				DN0325	118.0	245.0	3.6	675	4	0	$ 234	$ 583	900	900	$ 50,162	$ 82,317	$ 227,657	$ 540,204	$ 27,653	$ 68,812	$ -	$ 144,698	$ 22,509	$ 13,505	$ 227,657	$ 395,507	$ -	$ -	$ -	$ -	$ -	25	75	$ 98,877	$ 296,630	$ 441,327	$ 98,877	82%	18%	2034
				DN765	89.7	245.9	4.0	675	2	0	$ 234	$ 583	900	900	$ 38,131	$ 62,575	$ 173,058	$ 410,647	$ 21,021	$ 52,309	$ -	$ 109,995	$ 17,110	$ 10,266	$ 173,058	$ 300,652	$ -	$ -	$ -	$ -	$ -	75	25	$ 225,489	$ 75,163	$ 185,158	$ 225,489	45%	55%	2034
				DN0274	26.0	246.0	4.0	675	3	0	$ 234	$ 583	900	900	$ 11,053	$ 18,138	$ 50,162	$ 119,028	$ 6,093	$ 15,162	$ -	$ 31,883	$ 4,960	$ 2,976	$ 50,162	$ 87,146	$ -	$ -	$ -	$ -	$ -	50	50	$ 43,573	$ 43,573	$ 75,455	$ 43,573	63%	37%	2034
				DN0309	107.9	246.2	4.4	675	3	0	$ 234	$ 583	900	900	$ 45,868	$ 75,271	$ 208,171	$ 493,966	$ 25,286	$ 62,922	$ -	$ 132,312	$ 20,582	$ 12,349	$ 208,171	$ 361,654	$ -	$ -	$ -	$ -	$ -	50	50	$ 180,827	$ 180,827	$ 313,139	$ 180,827	63%	37%	2034
				DN762	17.3	247.0	4.6	675	3	0	$ 234	$ 583	900	900	$ 7,354	$ 12,068	$ 33,377	$ 79,199	$ 4,054	$ 10,088	$ -	$ 21,214	$ 3,300	$ 1,980	$ 33,377	$ 57,985	$ -	$ -	$ -	$ -	$ -	50	50	$ 28,993	$ 28,993	$ 50,207	$ 28,993	63%	37%	2034
				DN7010	10.4	247.0	4.6	675	3	0	$ 234	$ 583	900	900	$ 4,421	$ 7,255	$ 20,065	$ 47,611	$ 2,437	$ 6,065	$ -	$ 12,753	$ 1,984	$ 1,190	$ 20,065	$ 34,858	$ -	$ -	$ -	$ -	$ -	50	50	$ 17,429	$ 17,429	$ 30,182	$ 17,429	63%	37%	2034
				DN0256	104.8	247.0	4.6	675	3	0	$ 234	$ 583	900	900	$ 44,550	$ 73,108	$ 202,191	$ 479,774	$ 24,560	$ 61,114	$ -	$ 128,511	$ 19,991	$ 11,994	$ 202,191	$ 351,263	$ -	$ -	$ -	$ -	$ -	50	50	$ 175,632	$ 175,632	$ 304,143	$ 175,632	63%	37%	2034
				DN0328	91.7	246.0	4.8	675	3	0	$ 234	$ 583	900	900	$ 38,982	$ 63,970	$ 176,917	$ 419,803	$ 21,490	$ 53,475	$ -	$ 112,447	$ 17,492	$ 10,495	$ 176,917	$ 307,355	$ -	$ -	$ -	$ -	$ -	50	50	$ 153,678	$ 153,678	$ 266,125	$ 153,678	63%	37%	2034
				DN0275	32.1	246.6	4.8	675	3	0	$ 234	$ 583	900	900	$ 13,646	$ 22,393	$ 61,931	$ 146,954	$ 7,523	$ 18,719	$ -	$ 39,363	$ 6,123	$ 3,674	$ 61,931	$ 107,591	$ -	$ -	$ -	$ -	$ -	50	50	$ 53,796	$ 53,796	$ 93,158	$ 53,796	63%	37%	2034
				DN0257	93.9	247.1	4.9	675	3	0	$ 234	$ 583	900	900	$ 39,917	$ 65,505	$ 181,161	$ 429,874	$ 22,005	$ 54,758	$ -	$ 115,145	$ 17,911	$ 10,747	$ 181,161	$ 314,729	$ -	$ -	$ -	$ -	$ -	50	50	$ 157,365	$ 157,365	$ 272,510	$ 157,365	63%	37%	2034
				DN0245	60.5	247.5	5.0	675	4	0	$ 234	$ 877	900	900	$ 25,719	$ 61,659	$ 145,738	$ 349,673	$ 14,178	$ 53,086	$ -	$ 100,896	$ 11,540	$ 8,573	$ 145,738	$ 248,778	$ -	$ -	$ -	$ -	$ -	25	75	$ 62,194	$ 186,583	$ 287,479	$ 62,194	82%	18%	2034
				DN0233	4.5	248.0	5.1	675	3	0	$ 234	$ 877	900	900	$ 1,913	$ 4,586	$ 10,840	$ 26,009	$ 1,055	$ 3,949	$ -	$ 7,505	$ 858	$ 638	$ 10,840	$ 18,504	$ -	$ -	$ -	$ -	$ -	50	50	$ 9,252	$ 9,252	$ 16,757	$ 9,252	64%	36%	2034
				DN0583	104.5	248.0	5.1	675	3	0	$ 234	$ 877	900	900	$ 44,423	$ 106,501	$ 251,730	$ 603,981	$ 24,490	$ 91,694	$ -	$ 174,275	$ 19,933	$ 14,808	$ 251,730	$ 429,707	$ -	$ -	$ -	$ -	$ -	50	50	$ 214,853	$ 214,853	$ 389,128	$ 214,853	64%	36%	2034
				DN0236	23.6	247.8	5.2	675	3	0	$ 234	$ 877	900	900	$ 10,032	$ 24,052	$ 56,850	$ 136,402	$ 5,531	$ 20,708	$ -	$ 39,358	$ 4,502	$ 3,344	$ 56,850	$ 97,044	$ -	$ -	$ -	$ -	$ -	50	50	$ 48,522	$ 48,522	$ 87,880	$ 48,522	64%	36%	2034
				DN0234	91.4	248.0	5.2	675	3	0	$ 234	$ 877	900	900	$ 38,854	$ 93,150	$ 220,173	$ 528,267	$ 21,420	$ 80,199	$ -	$ 152,428	$ 17,435	$ 12,951	$ 220,173	$ 375,839	$ -	$ -	$ -	$ -	$ -	50	50	$ 187,920	$ 187,920	$ 340,347	$ 187,920	64%	36%	2034
				DN785	23.0	246.5	5.3	675	3	0	$ 234	$ 877	900	900	$ 9,777	$ 23,440	$ 55,405	$ 132,934	$ 5,390	$ 20,181	$ -	$ 38,357	$ 4,387	$ 3,259	$ 55,405	$ 94,577	$ -	$ -	$ -	$ -	$ -	50	50	$ 47,288	$ 47,288	$ 85,645	$ 47,288	64%	36%	2034
				DN0271	97.9	247.8	5.7	675	3	0	$ 234	$ 877	900	900	$ 41,617	$ 99,775	$ 235,831	$ 565,835	$ 22,943	$ 85,902	$ -	$ 163,268	$ 18,674	$ 13,872	$ 235,831	$ 402,567	$ -	$ -	$ -	$ -	$ -	50	50	$ 201,284	$ 201,284	$ 364,551	$ 201,284	64%	36%	2034
				DN0258	22.9	247.9	5.8	675	1	7	$ 234	$ 877	900	900	$ 9,735	$ 23,339	$ 55,164	$ 132,356	$ 5,367	$ 20,094	$ -	$ 38,190	$ 4,368	$ 3,245	$ 55,164	$ 94,165	$ -	$ -	$ -	$ -	$ -	90	10	$ 84,749	$ 9,417	$ 47,607	$ 84,749	36%	64%	2034
11.1				Total	1237.6										$ 526,104	$ 1,001,070	$ 2,593,114	$ 6,180,432	$ 290,032	$ 847,755	$ -	$ 1,706,680	$ 236,072	$ 153,314	$ 2,593,114	$ 4,473,752	$ -	$ -	$ -	$ -	$ -			$ 2,175,143	$ 2,298,608	$ 4,005,288	$ 2,175,143	64%	36%	
	Lorne Avenue	Ontario Street	Elizabeth Street	DN0158	92.6	247.0	3.6	450	4	0	$ 104	$ 496	825	825	$ 32,804	$ 61,570	$ 178,653	$ 409,540	$ 9,589	$ 45,925	$ -	$ 83,271	$ 23,215	$ 15,645	$ 178,653	$ 326,269	$ -	$ -	$ -	$ -	$ -	25	75	$ 81,567	$ 244,702	$ 327,972	$ 81,567	80%	20%	2034
				DN0157	92.0	247.8	4.2	450	3	0	$ 104	$ 496	825	825	$ 32,591	$ 61,171	$ 177,496	$ 406,886	$ 9,527	$ 45,627	$ -	$ 82,731	$ 23,064	$ 15,543	$ 177,496	$ 324,155	$ -	$ -	$ -	$ -	$ -	50	50	$ 162,078	$ 162,078	$ 244,809	$ 162,078	60%	40%	2034
				DN0156	91.4	248.0	4.3	450	3	0	$ 104	$ 496	825	825	$ 32,378	$ 60,772	$ 176,338	$ 404,232	$ 9,464	$ 45,330	$ -	$ 82,191	$ 22,914	$ 15,442	$ 176,338	$ 322,041	$ -	$ -	$ -	$ -	$ -	50	50	$ 161,021	$ 161,021	$ 243,212	$ 161,021	60%	40%	2034
				DN0541	110.0	247.8	4.6	600	4	0	$ 153	$ 567	825	825	$ 38,968	$ 73,139	$ 212,223	$ 486,494	$ 16,786	$ 62,348	$ -	$ 118,701	$ 22,182	$ 10,791	$ 212,223	$ 367,793	$ -	$ -	$ -	$ -	$ -	25	75	$ 91,948	$ 275,845	$ 394,546	$ 91,948	81%	19%	2034
				DN0206	110.9	248.0	5.0	600	3	100	$ 153	$ 567	825	825	$ 39,286	$ 73,737	$ 213,959	$ 490,475	$ 16,923	$ 62,858	$ -	$ 119,672	$ 22,363	$ 10,879	$ 213,959	$ 370,802	$ -	$ -	$ -	$ -	$ -	50	50	$ 185,401	$ 185,401	$ 305,073	$ 185,401	62%	38%	2034
				DN659	98.2	249.0	5.1	450	3	0	$ 104	$ 730	825	825	$ 34,787	$ 99,545	$ 236,554	$ 556,330	$ 10,169	$ 71,715	$ -	$ 122,826	$ 24,619	$ 27,830	$ 236,554	$ 433,504	$ -	$ -	$ -	$ -	$ -	50	50	$ 216,752	$ 216,752	$ 339,578	$ 216,752	61%	39%	2034
11.2				Total	595.1										$ 210,814	$ 429,934	$ 1,195,223	$ 2,753,957	$ 72,458	$ 333,804	$ -	$ 609,392	$ 138,356	$ 96,130	$ 1,195,223	$ 2,144,565	$ -	$ -	$ -	$ -	$ -			$ 898,767	$ 1,245,798	$ 1,855,190	$ 898,767	67%	33%	
	Piccadilly Street/Colborne Street	Miles Street	Pall Mall Street	DN0340	65.5	246.0	3.0	375	3	115	$ 100	$ 469	525	525	$ 7,496	$ 34,270	$ 126,369	$ 252,203	$ 6,568	$ 30,700	$ -	$ 55,902	$ 928	$ 3,570	$ 126,369	$ 196,301	$ -	$ -	$ -	$ -	$ -	50	50	$ 98,150	$ 98,150	$ 154,053	$ 98,150	61%	39%	2034
				TB0598	102.5	247.0	3.0	300	2	29	$ 89	$ 458	525	525	$ 11,731	$ 53,628	$ 197,753	$ 394,669	$ 9,161	$ 46,925	$ -	$ 84,129	$ 2,570	$ 6,704	$ 197,753	$ 310,540	$ -	$ -	$ -	$ -	$ -	75	25	$ 232,905	$ 77,635	$ 161,764	$ 232,905	41%	59%	2034
				TB0599	64.9	246.8	3.3	375	3	115	$ 100	$ 469	525	525	$ 7,428	$ 33,956	$ 125,212	$ 249,893	$ 6,508	$ 30,419	$ -	$ 55,390	$ 920	$ 3,537	$ 125,212	$ 194,502	$ -	$ -	$ -	$ -	$ -	50	50	$ 97,251	$ 97,251	$ 152,641	$ 97,251	61%	39%	2034
				TB0597	78.4	247.4	3.3	300	3	29	$ 89	$ 458	525	525	$ 8,973	$ 41,019	$ 151,257	$ 301,873	$ 7,007	$ 35,892	$ -	$ 64,348	$ 1,965	$ 5,127	$ 151,257	$ 237,525	$ -	$ -	$ -	$ -	$ -	50	50	$ 118,762	$ 118,762	$ 183,111	$ 118,762	61%	39%	2034
				TB0601	2.9	246.9	3.3	375	1	29	$ 100	$ 469	525	525	$ 332	$ 1,517	$ 5,595	$ 11,166	$ 291	$ 1,359	$ -	$ 2,475	$ 41	$ 158	$ 5,595	$ 8,691	$ -	$ -	$ -	$ -	$ -	90	10	$ 7,822	$ 869	$ 3,344	$ 7,822	30%	70%	2034
				TB0631	92.7	248.1	3.4	300	2	28	$ 89	$ 458	525	525	$ 10,610	$ 48,501	$ 178,846	$ 356,934	$ 8,286	$ 42,438	$ -	$ 76,085	$ 2,324	$ 6,063	$ 178,846	$ 280,849	$ -	$ -	$ -	$ -	$ -	75	25	$ 210,637	$ 70,212	$ 146,298	$ 210,637	41%	59%	2034
				DN0344	110.7	246.0	3.6	375	3	115	$ 100	$ 469	525	525	$ 12,670	$ 57,918	$ 213,574	$ 426,242	$ 11,101	$ 51,885	$ -	$ 94,479	$ 1,569	$ 6,033	$ 213,574	$ 331,763	$ -	$ -	$ -	$ -	$ -	50	50	$ 165,881	$ 165,881	$ 260,361	$ 165,881	61%	39%	2034
				TB0630	12.4	248.0	3.6	300	2	29	$ 89	$ 458	525	525	$ 1,419	$ 6,488	$ 23,923	$ 47,745	$ 1,108	$ 5,677	$ -	$ 10,178	$ 311	$ 811	$ 23,923	$ 37,568	$ -	$ -	$ -	$ -	$ -	75	25	$ 28,176	$ 9,392	$ 19,569	$ 28,176	41%	59%	2034
				TB0594	59.6	248.0	3.7	300	2	29	$ 89	$ 458	525	525	$ 6,821	$ 31,183	$ 114,986	$ 229,485	$ 5,327	$ 27,285	$ -	$ 48,918	$ 1,494	$ 3,898	$ 114,986	$ 180,567	$ -	$ -	$ -	$ -	$ -	75	25	$ 135,426	$ 45,142	$ 94,060	$ 135,426	41%	59%	2034
				TB0633	69.7	248.6	3.7	300	2	28	$ 89	$ 458	525	525	$ 7,977	$ 36,467	$ 134,472	$ 268,375	$ 6,230	$ 31,909	$ -	$ 57,208	$ 1,747	$ 4,558	$ 134,472	$ 211,167	$ -	$ -	$ -	$ -	$ -	75	25	$ 158,375	$ 52,792	$ 109,999	$ 158,375	41%	59%	2034
12				Total	659.3										$ 75,457	$ 344,946	$ 1,271,987	$ 2,538,585	$ 61,588	$ 304,487	$ -	$ 549,112	$ 13,869	$ 40,459	$ 1,271,987	$ 1,989,473	$ -	$ -	$ -	$ -	$ -	665	335	$ 1,253,386	$ 736,087	$ 1,285,200	$ 1,253,386	48%	52%	
	Waterloo Street	Central Avenue	Pall Mall Street	DN0544	60.7	244.4	3.1	375	2	26	$ 100	$ 469	525	525	$ 6,947	$ 31,758	$ 117,109	$ 233,721	$ 6,087	$ 28,450	$ -	$ 51,806	$ 860	$ 3,308	$ 117,109	$ 181,915	$ -	$ -	$ -	$ -	$ -	75	25	$ 136,436	$ 45,479	$ 97,284	$ 136,436	42%	58%	Build-out
				DN0392	60.1	245.0	3.4	375	2	26	$ 100	$ 469	525	525	$ 6,878	$ 31,444	$ 115,951	$ 231,411	$ 6,027	$ 28,169	$ -	$ 51,294	$ 852	$ 3,275	$ 115,951	$ 180,117	$ -	$ -	$ -	$ -	$ -	75	25	$ 135,088	$ 45,029	$ 96,323	$ 135,088	42%	58%	Build-out
				DN0545	60.1	245.4	3.7	375	2	26	$ 100	$ 469	525	525	$ 6,878	$ 31,444	$ 115,951	$ 231,411	$ 6,027	$ 28,169	$ -	$ 51,294	$ 852	$ 3,275	$ 115,951	$ 180,117	$ -	$ -	$ -	$ -	$ -	75	25	$ 135,088	$ 45,029	$ 96,323	$ 135,088	42%	58%	Build-out
				DN0389	59.0	246.0	4.2	375	2	26	$ 100	$ 469	525	525	$ 6,753	$ 30,869	$ 113,829	$ 227,175	$ 5,917	$ 27,653	$ -	$ 50,355	$ 836	$ 3,216	$ 113,829	$ 176,820	$ -	$ -	$ -	$ -	$ -	75	25	$ 132,615	$ 44,205	$ 94,560	$ 132,615	42%	58%	Build-out
13				Total	239.9										$ 27,457	$ 125,516	$ 462,839	$ 923,717	$ 24,057	$ 112,441	$ -	$ 204,747	$ 3,399	$ 13,075	$ 462,839	$ 718,970	$ -	$ -	$ -	$ -	$ -			$ 539,227	$ 179,742	$ 384,490	$ 539,227	42%	58%	
	Colborne Street	Waverley Place	Pall Mall Street	DN0353	47.5	244.6	2.8	375	3	27	$ 100	$ 469	450	450	$ 4,919	$ 23,558	$ 91,642	$ 180,177	$ 4,763	$ 22,263	$ -	$ 40,540	$ 155	$ 1,294	$ 91,642	$ 139,637	$ -	$ -	$ -	$ -	$ -	50	50	$ 69,819	$ 69,819	$ 110,358	$ 69,819	61%	39%	2019
				DN731	69.2	245.2	3.0	300	1	27	$ 89	$ 458	450	450	$ 7,166	$ 34,320	$ 133,508	$ 262,489	$ 6,185	$ 31,680	$ -	$ 56,797	$ 981	$ 2,640	$ 133,508	$ 205,692	$ -	$ -	$ -	$ -	$ -	90	10	$ 185,123	$ 20,569	$ 77,366	$ 185,123	29%	71%	2019
				DN0352	19.1	244.9	3.0	375	1	27	$ 100	$ 469	450	450	$ 1,978	$ 9,473	$ 36,850	$ 72,450	$ 1,915	$ 8,952	$ -	$ 16,301	$ 62	$ 520	$ 36,850	$ 56,149	$ -	$ -	$ -	$ -	$ -	90	10	$ 50,534	$ 5,615	$ 21,916	$ 50,534	30%	70%	2019
				DN0351	30.7	246.0	3.7	300	1	27	$ 89	$ 458	450	450	$ 3,179	$ 15,226	$ 59,230	$ 116,451	$ 2,744	$ 14,054	$ -	$ 25,198	$ 435	$ 1,171	$ 59,230	$ 91,254	$ -	$ -	$ -	$ -	$ -	90	10	$ 82,128	$ 9,125	$ 34,323	$ 82,128	29%	71%	2019
				DN0548	101.1	248.0	4.4	300	1	27	$ 89	$ 458	450	450	$ 10,469	$ 50,141	$ 195,052	$ 383,493	$ 9,036	$ 46,284	$ -	$ 82,980	$ 1,433	$ 3,857	$ 195,052	$ 300,513	$ -	$ -	$ -	$ -	$ -	90	10	$ 270,461	$ 30,051	$ 113,031	$ 270,461	29%	71%	2019
				DN0350	94.2	250.0	5.0	300	1	27	$ 89	$ 458	450	450	$ 9,754	$ 46,718	$ 181,740	$ 357,319	$ 8,420	$ 43,125	$ -	$ 77,317	$ 1,335	$ 3,594	$ 181,740	$ 280,003	$ -	$ -	$ -	$ -	$ -	90	10	$ 252,003	$ 28,000	$ 105,317	$ 252,003	29%	71%	2019
14				Total	361.8										$ 37,464	$ 179,435	$ 698,021	$ 1,372,380	$ 33,064	$ 166,358	$ -	$ 299,132	$ 4,401	$ 13,077	$ 698,021	$ 1,073,247	$ -	$ -	$ -	$ -	$ -			$ 910,068	$ 163,180	$ 462,312	$ 910,068	35%	65%	
	English Street/Dundas Street	Rectory Street	Lorne Avenue	DN0197	111.6	250.1	3.2	300	2	116	$ 89	$ 458	450	525	$ 12,773	$ 58,389	$ 215,310	$ 429,707	$ 9,975	$ 51,090	$ -	$ 91,598	$ 1,581	$ 4,258	$ 215,310	$ 331,723	$ 1,216	$ 3,041	$ -	$ 6,386	$ -	75	25	$ 248,792	$ 82,931	$ 174,529	$ 255,179	41%	59%	2019
				DN0198	53.8	249.9	3.3	300	3	116	$ 89	$ 458	450	525	$ 6,157	$ 28,148	$ 103,796	$ 207,153	$ 4,809	$ 24,630	$ -	$ 44,157	$ 762	$ 2,052	$ 103,796	$ 159,917	$ 586	$ 1,466	$ -	$ 3,079	$ -	50	50	$ 79,958	$ 79,958	$ 124,116	$ 83,037	60%	40%	2019
				DN0200	61.6	249.0	3.5	300	3	116	$ 89	$ 458	450	525	$ 7,050	$ 32,229	$ 118,845	$ 237,186	$ 5,506	$ 28,200	$ -	$ 50,559	$ 873	$ 2,350	$ 118,845	$ 183,102	$ 671	$ 1,679	$ -	$ 3,525	$ -	50	50	$ 91,551	$ 91,551	$ 142,110	$ 95,076	60%	40%	2019
				DN0199	88.3	250.0	3.6	300	2	116	$ 89	$ 458	450	525	$ 10,106	$ 46,199	$ 170,357	$ 339,993	$ 7,892	$ 40,424	$ -	$ 72,474	$ 1,251	$ 3,369	$ 170,357	$ 262,466	$ 962	$ 2,406	$ -	$ 5,053	$ -	75	25	$ 196,849	$ 65,616	$ 138,090	$ 201,902	41%	59%	2019
				DN0201	109.7	248.9	4.0	300	3	116	$ 89	$ 458	450	525	$ 12,555	$ 57,395	$ 211,644	$ 422,392	$ 9,805	$ 50,221	$ -	$ 90,038	$ 1,554	$ 4,185	$ 211,644	$ 326,076	$ 1,196	$ 2,989	$ -	$ 6,278	$ -	50	50	$ 163,038	$ 163,038	$ 253,076	$ 169,315	60%	40%	2019
				DN0570	112.5	249.0	4.5	300	3	116	$ 89	$ 458	450	525	$ 12,876	$ 58,860	$ 217,046	$ 433,173	$ 10,055	$ 51,503	$ -	$ 92,337	$ 1,594	$ 4,292	$ 217,046	$ 334,398	$ 1,226	$ 3,066	$ -	$ 6,438	$ -	50	50	$ 167,199	$ 167,199	$ 259,536	$ 173,637	60%	40%	2019
15				Total	537.5										$ 61,517	$ 281,220	$ 1,036,999	$ 2,069,603	$ 48,042	$ 246,068	$ -	$ 441,164	$ 7,616	$ 20,506	$ 1,036,999	$ 1,597,681	$ 5,859	$ 14,647	$ -	$ 30,758	$ -			$ 947,388	$ 650,293	$ 1,091,457	$ 978,146	53%	47%	
	Wellington Street	Hill Street	South Street	DS682	16.6	240.6	2.8	300	1	19	$ 89	$ 458	525	525	$ 1,900	$ 8,685	$ 32,026	$ 63,917	$ 1,484	$ 7,599	$ -	$ 13,625	$ 416	$ 1,086	$ 32,026	$ 50,292	$ -	$ -	$ -	$ -	$ -	90	10	$ 45,263	$ 5,029	$ 18,654	$ 45,263	29%	71%	Project created as a result of flow diversion so only required if flow diversion goes ahead.
				DS683	15.9	240.6	3.0	450	2	19	$ 104	$ 496	525	525	$ 1,820	$ 8,319	$ 30,676	$ 61,222	$ 1,646	$ 7,886	$ -	$ 14,298	$ 173	$ 433	$ 30,676	$ 46,924	$ -	$ -	$ -	$ -	$ -	75	25	$ 35,193	$ 11,731	$ 26,029	$ 35,193	43%	57%	
				DS684	60.2	241.6	3.0	300	1	19	$ 89	$ 458	525	525	$ 6,890	$ 31,497	$ 116,144	$ 231,796	$ 5,381	$ 27,560	$ -	$ 49,410	$ 1,509	$ 3,937	$ 116,144	$ 182,385	$ -	$ -	$ -	$ -	$ -	90	10	$ 164,147	$ 18,239	$ 67,649	$ 164,147	29%	71%	
				DS685	60.2	241.6	3.1	450	2	19	$ 104	$ 496	525	525	$ 6,890	$ 31,497	$ 116,144	$ 231,796	$ 6,234	$ 29,856	$ -	$ 54,135	$ 656	$ 1,640	$ 116,144	$ 177,661	$ -	$ -	$ -	$ -	$ -	75	25	$ 133,246	$ 44,415	$ 98,550	$ 133,246	43%	57%	
				DS686b	68.6	243.6	4.0	300	1	19	$ 89	$ 458	525	525	$ 7,851	$ 35,892	$ 132,350	$ 264,139	$ 6,131	$ 31,405	$ -	$ 56,305	$ 1,720	$ 4,486	$ 132,350	$ 207,834	$ -	$ -	$ -	$ -	$ -	90	10	$ 187,051	$ 20,783	$ 77,088	$ 187,051	29%	71%	
				DS687b	69.1	243.6	4.1	450	2	19	$ 104	$ 496	525	525	$ 7,908	$ 36,153	$ 133,315	$ 266,064	$ 7,155	$ 34,270	$ -	$ 62,138	$ 753	$ 1,883	$ 133,315	$ 203,926	$ -	$ -	$ -	$ -	$ -	75	25	$ 152,945	$ 50,982	$ 113,120	$ 152,945	43%	57%	
16				Total	290.6										$ 33,259	$ 152,042	$ 560,655	$ 1,118,934	$ 28,031	$ 138,576	$ -	$ 249,911	$ 5,228	$ 13,466	$ 560,655	$ 869,022	$ -	$ -	$ -	$ -	$ -			$ 717,844	$ 151,179	$ 401,090	$ 717,844	36%	64%	

	Riverside Park, Cavendish Park, Riverdale Park, Greenway Park	Riverside Park	Greenway Park	OS1084	31.7	230.8	3.4	1200	2	54	$ 676	$ 801	1500	1650	$ 38,354	$ 28,852	$ 61,159	$ 192,547	$ 38,040	$ 21,423	$ -	$ 89,194	$ 314	$ 7,429	$ 61,159	$ 103,352	$ -	$ -	$ -	$ -	$ -	75	25	$ 77,514	$ 25,838	$ 115,032	$ 77,514	60%	40%	Build-out
				OS1134	33.8	230.8	3.4	1200	2	54	$ 676	$ 801	1500	1650	$ 40,895	$ 30,763	$ 65,210	$ 205,302	$ 40,560	$ 22,842	$ -	$ 95,103	$ 335	$ 7,921	$ 65,210	$ 110,199	$ -	$ -	$ -	$ -	$ -	75	25	$ 82,649	$ 27,550	$ 122,653	$ 82,649	60%	40%	Build-out
				OS1139	98.5	230.1	3.5	1200	4	54	$ 676	$ 801	1500	1650	$ 119,175	$ 89,650	$ 190,036	$ 598,291	$ 118,200	$ 66,566	$ -	$ 277,149	$ 975	$ 23,083	$ 190,036	$ 321,142	$ -	$ -	$ -	$ -	$ -	25	75	$ 80,286	$ 240,857	$ 518,006	$ 80,286	87%	13%	Build-out
				CV0174	167.6	232.0	3.6	1050	2	81	$ 540	$ 763	1500	1650	$ 202,779	$ 152,541	$ 323,351	$ 1,018,007	$ 175,980	$ 90,429	$ -	$ 399,613	$ 26,799	$ 62,113	$ 323,351	$ 618,394	$ -	$ -	$ -	$ -	$ -	75	25	$ 463,795	$ 154,598	$ 554,211	$ 463,795	54%	46%	Build-out
				OS1364	106.7	231.5	3.6	1050	3	81	$ 540	$ 763	1500	1650	$ 129,096	$ 97,113	$ 205,856	$ 648,098	$ 112,035	$ 57,570	$ -	$ 254,407	$ 17,061	$ 39,543	$ 205,856	$ 393,691	$ -	$ -	$ -	$ -	$ -	50	50	$ 196,845	$ 196,845	$ 451,253	$ 196,845	70%	30%	Build-out
				OS1138	76.2	230.6	3.8	1200	4	54	$ 676	$ 801	1500	1650	$ 92,194	$ 69,353	$ 147,013	$ 462,841	$ 91,440	$ 51,496	$ -	$ 214,404	$ 754	$ 17,857	$ 147,013	$ 248,437	$ -	$ -	$ -	$ -	$ -	25	75	$ 62,109	$ 186,328	$ 400,732	$ 62,109	87%	13%	Build-out
				OS1141	99.1	230.2	3.9	1200	4	54	$ 676	$ 801	1500	1650	$ 119,901	$ 90,196	$ 191,194	$ 601,936	$ 118,920	$ 66,972	$ -	$ 278,838	$ 981	$ 23,224	$ 191,194	$ 323,098	$ -	$ -	$ -	$ -	$ -	25	75	$ 80,775	$ 242,324	$ 521,161	$ 80,775	87%	13%	Build-out
				OS1135	68.0	231.4	4.1	1200	2	54	$ 676	$ 801	1500	1650	$ 82,273	$ 61,890	$ 131,192	$ 413,034	$ 81,600	$ 45,954	$ -	$ 191,332	$ 673	$ 15,936	$ 131,192	$ 221,702	$ -	$ -	$ -	$ -	$ -	75	25	$ 166,277	$ 55,426	$ 246,757	$ 166,277	60%	40%	Build-out
				OS1143	48.8	230.1	4.2	1200	4	54	$ 676	$ 801	1500	1650	$ 59,043	$ 44,415	$ 94,150	$ 296,412	$ 58,560	$ 32,979	$ -	$ 137,309	$ 483	$ 11,436	$ 94,150	$ 159,104	$ -	$ -	$ -	$ -	$ -	25	75	$ 39,776	$ 119,328	$ 256,636	$ 39,776	87%	13%	Build-out
				OS1080	149.4	232.6	4.4	1050	2	81	$ 540	$ 763	1500	1650	$ 180,759	$ 135,976	$ 288,237	$ 907,459	$ 156,870	$ 80,609	$ -	$ 356,218	$ 23,889	$ 55,368	$ 288,237	$ 551,241	$ -	$ -	$ -	$ -	$ -	75	25	$ 413,431	$ 137,810	$ 494,028	$ 413,431	54%	46%	Build-out
				OS1082	94.5	232.3	4.5	1050	3	81	$ 540	$ 763	1500	1650	$ 114,336	$ 86,009	$ 182,319	$ 573,995	$ 99,225	$ 50,987	$ -	$ 225,319	$ 15,111	$ 35,022	$ 182,319	$ 348,677	$ -	$ -	$ -	$ -	$ -	50	50	$ 174,338	$ 174,338	$ 399,657	$ 174,338	70%	30%	Build-out
				OS1140	99.1	231.0	4.6	1200	4	54	$ 676	$ 801	1500	1650	$ 119,901	$ 90,196	$ 191,194	$ 601,936	$ 118,920	$ 66,972	$ -	$ 278,838	$ 981	$ 23,224	$ 191,194	$ 323,098	$ -	$ -	$ -	$ -	$ -	25	75	$ 80,775	$ 242,324	$ 521,161	$ 80,775	87%	13%	Build-out
				OS1083	95.9	232.8	5.1	1050	3	81	$ 649	$ 1,019	1500	1650	$ 121,779	$ 128,573	$ 231,014	$ 722,048	$ 100,695	$ 62,196	$ -	$ 244,336	$ 21,084	$ 66,377	$ 231,014	$ 477,711	$ -	$ -	$ -	$ -	$ -	50	50	$ 238,856	$ 238,856	$ 483,192	$ 238,856	67%	33%	Build-out
				OS1081	155.4	233.2	5.2	1050	3	81	$ 649	$ 1,019	1500	1650	$ 197,335	$ 208,345	$ 374,343	$ 1,170,034	$ 163,170	$ 100,785	$ -	$ 395,932	$ 34,165	$ 107,560	$ 374,343	$ 774,102	$ -	$ -	$ -	$ -	$ -	50	50	$ 387,051	$ 387,051	$ 782,983	$ 387,051	67%	33%	Build-out
				OS1160	118.9	231.0	5.3	1200	4	54	$ 812	$ 1,057	1500	1650	$ 150,985	$ 159,409	$ 286,418	$ 895,219	$ 142,680	$ 96,553	$ -	$ 358,849	$ 8,305	$ 62,856	$ 286,418	$ 536,370	$ -	$ -	$ -	$ -	$ -	25	75	$ 134,092	$ 402,277	$ 761,126	$ 134,092	85%	15%	Build-out
				OS1137	77.4	232.4	5.4	1200	4	54	$ 812	$ 1,057	1500	1650	$ 98,286	$ 103,770	$ 186,449	$ 582,758	$ 92,880	$ 62,853	$ -	$ 233,599	$ 5,406	$ 40,918	$ 186,449	$ 349,159	$ -	$ -	$ -	$ -	$ -	25	75	$ 87,290	$ 261,869	$ 495,468	$ 87,290	85%	15%	Build-out
				OS1161	85.3	230.9	5.5	1200	4	54	$ 812	$ 1,057	1500	1650	$ 108,318	$ 114,362	$ 205,479	$ 642,239	$ 102,360	$ 69,268	$ -	$ 257,442	$ 5,958	$ 45,094	$ 205,479	$ 384,797	$ -	$ -	$ -	$ -	$ -	25	75	$ 96,199	$ 288,598	$ 546,039	$ 96,199	85%	15%	Build-out
				WT1421	123.4	231.6	6.8	1200	4	54	$ 812	$ 1,057	1500	1650	$ 156,699	$ 165,442	$ 297,258	$ 929,100	$ 148,080	$ 100,207	$ -	$ 372,430	$ 8,619	$ 65,235	$ 297,258	$ 556,670	$ -	$ -	$ -	$ -	$ -	25	75	$ 139,167	$ 417,502	$ 789,933	$ 139,167	85%	15%	Build-out
				WT1420	80.6	231.4	6.9	1200	4	54	$ 812	$ 1,057	1500	1650	$ 102,350	$ 108,060	$ 194,157	$ 606,852	$ 96,720	$ 65,451	$ -	$ 243,257	$ 5,630	$ 42,609	$ 194,157	$ 363,595	$ -	$ -	$ -	$ -	$ -	25	75	$ 90,899	$ 272,696	$ 515,953	$ 90,899	85%	15%	Build-out
				OS1162	136.6	232.7	7.4	1200	4	54	$ 812	$ 1,057	1500	1650	$ 173,462	$ 183,140	$ 329,056	$ 1,028,485	$ 163,920	$ 110,926	$ -	$ 412,269	$ 9,542	$ 72,214	$ 329,056	$ 616,216	$ -	$ -	$ -	$ -	$ -	25	75	$ 154,054	$ 462,162	$ 874,431	$ 154,054	85%	15%	Build-out
				OS1142	115.8	233.8	7.7	1200	4	54	$ 812	$ 1,368	1500	1650	$ 167,875	$ 196,275	$ 329,439	$ 1,040,385	$ 138,960	$ 94,035	$ -	$ 349,493	$ 28,915	$ 102,240	$ 329,439	$ 690,892	$ -	$ -	$ -	$ -	$ -	25	75	$ 172,723	$ 518,169	$ 867,662	$ 172,723	83%	17%	Build-out
				OS1136	85.3	235.1	7.9	1200	4	54	$ 812	$ 1,368	1500	1650	$ 123,659	$ 144,579	$ 242,670	$ 766,363	$ 102,360	$ 69,268	$ -	$ 257,442	$ 21,299	$ 75,311	$ 242,670	$ 508,921	$ -	$ -	$ -	$ -	$ -	25	75	$ 127,230	$ 381,691	$ 639,133	$ 127,230	83%	17%	Build-out
				WT1770	3.5	235.4	10.6	1200	4	54	$ 943	$ 2,414	1500	1650	$ 5,913	$ 9,709	$ 11,750	$ 41,059	$ 4,200	$ 3,300	$ -	$ 11,250	$ 1,713	$ 6,409	$ 11,750	$ 29,809	$ -	$ -	$ -	$ -	$ -	25	75	$ 7,452	$ 22,357	$ 33,607	$ 7,452	82%	18%	Build-out
				OS1415	122.6	235.8	10.8	1200	4	54	$ 943	$ 2,414	1500	1650	$ 207,133	$ 340,099	$ 411,593	$ 1,438,236	$ 147,120	$ 115,593	$ -	$ 394,070	$ 60,013	$ 224,505	$ 411,593	$ 1,044,166	$ -	$ -	$ -	$ -	$ -	25	75	$ 261,041	$ 783,124	$ 1,177,194	$ 261,041	82%	18%	Build-out
17				Total	2274.1										$ 2,912,501	$ 2,838,719	$ 5,170,537	$ 16,382,635	$ 2,613,495	$ 1,605,234	$ -	$ 6,328,093	$ 299,006	$ 1,233,485	$ 5,170,537	$ 10,054,542	$ -	$ -	$ -	$ -	$ -			$ 3,814,625	$ 6,239,917	$ 12,568,010	$ 3,814,625	76%	24%	
	Becher Street, Wharncliffe Rd, Horton St W, Horton Park, Greenway Park	Ivey Park	Greenway Park	DS1561	58.0	234.5	-2.3	900	4	0	$ 425	$ 698	1500	1500	$ 58,479	$ 50,576	$ 111,899	$ 331,431	$ 24,656	$ 40,461	$ -	$ 97,675	$ 33,823	$ 10,115	$ 111,899	$ 233,756	$ -	$ -	$ -	$ -	$ -	25	75	$ 58,439	$ 175,317	$ 272,992	$ 58,439	82%	18%	Build-out
				OS7030	33.7	235.3	-1.4	900	3	0	$ 425	$ 698	1500	1500	$ 33,978	$ 29,386	$ 65,017	$ 192,573	$ 14,326	$ 23,509	$ -	$ 56,752	$ 19,652	$ 5,877	$ 65,017	$ 135,820	$ -	$ -	$ -	$ -	$ -	50	50	$ 67,910	$ 67,910	$ 124,663	$ 67,910	65%	35%	Build-out
				OS1032	41.4	238.8	2.1	900	3	0	$ 425	$ 698	1500	1500	$ 41,742	$ 36,101	$ 79,873	$ 236,573	$ 17,599	$ 28,881	$ -	$ 69,720	$ 24,142	$ 7,220	$ 79,873	$ 166,853	$ -	$ -	$ -	$ -	$ -	50	50	$ 83,427	$ 83,427	$ 153,146	$ 83,427	65%	35%	Build-out
				OS1052	54.2	237.1	2.7	1200	3	0	$ 676	$ 801	1500	1500	$ 54,647	$ 47,262	$ 104,568	$ 309,716	$ 36,628	$ 43,422	$ -	$ 120,076	$ 18,019	$ 3,840	$ 104,568	$ 189,640	$ -	$ -	$ -	$ -	$ -	50	50	$ 94,820	$ 94,820	$ 214,896	$ 94,820	69%	31%	Build-out
				OS1033	82.3	239.5	2.8	900	3	0	$ 425	$ 698	1500	1500	$ 82,979	$ 71,766	$ 158,781	$ 470,289	$ 34,986	$ 57,412	$ -	$ 138,597	$ 47,993	$ 14,353	$ 158,781	$ 331,692	$ -	$ -	$ -	$ -	$ -	50	50	$ 165,846	$ 165,846	$ 304,443	$ 165,846	65%	35%	Build-out
				OS1040	94.2	239.9	3.4	900	3	0	$ 425	$ 698	1500	1500	$ 94,977	$ 82,142	$ 181,740	$ 538,289	$ 40,044	$ 65,714	$ -	$ 158,638	$ 54,933	$ 16,428	$ 181,740	$ 379,652	$ -	$ -	$ -	$ -	$ -	50	50	$ 189,826	$ 189,826	$ 348,463	$ 189,826	65%	35%	Build-out
				OS1035	81.8	240.1	3.5	900	3	0	$ 425	$ 698	1500	1500	$ 82,475	$ 71,330	$ 157,817	$ 467,432	$ 34,773	$ 57,064	$ -	$ 137,755	$ 47,702	$ 14,266	$ 157,817	$ 329,676	$ -	$ -	$ -	$ -	$ -	50	50	$ 164,838	$ 164,838	$ 302,594	$ 164,838	65%	35%	Build-out
				OS1437	1245.8	235.9	4.1	1200	3	0	$ 676	$ 801	1500	1500	$ 1,256,078	$ 1,086,338	$ 2,403,522	$ 7,118,906	$ 841,912	$ 998,073	$ -	$ 2,759,976	$ 414,166	$ 88,265	$ 2,403,522	$ 4,358,930	$ -	$ -	$ -	$ -	$ -	50	50	$ 2,179,465	$ 2,179,465	$ 4,939,441	$ 2,179,465	69%	31%	Build-out
				OS1051	49.4	239.3	4.3	1200	3	0	$ 676	$ 801	1500	1500	$ 49,808	$ 43,077	$ 95,307	$ 282,288	$ 33,385	$ 39,577	$ -	$ 109,442	$ 16,423	$ 3,500	$ 95,307	$ 172,846	$ -	$ -	$ -	$ -	$ -	50	50	$ 86,423	$ 86,423	$ 195,865	$ 86,423	69%	31%	Build-out
				OS1042	140.9	242.0	5.6	900	3	0	$ 425	$ 1,019	1500	1500	$ 148,974	$ 180,458	$ 339,414	$ 1,003,268	$ 59,897	$ 143,598	$ -	$ 305,242	$ 89,077	$ 36,859	$ 339,414	$ 698,026	$ -	$ -	$ -	$ -	$ -	50	50	$ 349,013	$ 349,013	$ 654,255	$ 349,013	65%	35%	Build-out
				OS7014	56.5	241.6	6.4	1200	3	0	$ 812	$ 1,057	1500	1500	$ 59,737	$ 72,362	$ 136,103	$ 402,304	$ 45,881	$ 59,737	$ -	$ 158,427	$ 13,857	$ 12,625	$ 136,103	$ 243,877	$ -	$ -	$ -	$ -	$ -	50	50	$ 121,938	$ 121,938	$ 280,366	$ 121,938	70%	30%	Build-out
				OS1047	41.7	242.7	6.5	900	3	0	$ 425	$ 1,019	1500	1500	$ 44,089	$ 53,407	$ 100,451	$ 296,922	$ 17,727	$ 42,499	$ -	$ 90,338	$ 26,363	$ 10,909	$ 100,451	$ 206,584	$ -	$ -	$ -	$ -	$ -	50	50	$ 103,292	$ 103,292	$ 193,630	$ 103,292	65%	35%	Build-out
				OS1044	32.5	242.8	6.6	900	3	0	$ 425	$ 1,019	1500	1500	$ 34,362	$ 41,624	$ 78,289	$ 231,414	$ 13,816	$ 33,122	$ -	$ 70,407	$ 20,547	$ 8,502	$ 78,289	$ 161,007	$ -	$ -	$ -	$ -	$ -	50	50	$ 80,503	$ 80,503	$ 150,911	$ 80,503	65%	35%	Build-out
				OS1048	126.6	243.0	7.0	1200	3	0	$ 812	$ 1,057	1500	1500	$ 133,854	$ 162,143	$ 304,967	$ 901,446	$ 102,806	$ 133,854	$ -	$ 354,990	$ 31,049	$ 28,289	$ 304,967	$ 546,456	$ -	$ -	$ -	$ -	$ -	50	50	$ 273,228	$ 273,228	$ 628,218	$ 273,228	70%	30%	Build-out
				OS1050	98.5	243.7	8.2	1200	3	0	$ 812	$ 1,368	1500	1500	$ 119,175	$ 156,753	$ 280,223	$ 834,226	$ 79,987	$ 134,743	$ -	$ 322,095	$ 39,188	$ 22,010	$ 280,223	$ 512,131	$ -	$ -	$ -	$ -	$ -	50	50	$ 256,066	$ 256,066	$ 578,161	$ 256,066	69%	31%	Build-out
				OS1501	66.0	243.7	8.4	1200	3	0	$ 812	$ 1,368	1500	1500	$ 79,853	$ 105,032	$ 187,763	$ 558,974	$ 53,595	$ 90,285	$ -	$ 215,820	$ 26,258	$ 14,748	$ 187,763	$ 343,154	$ -	$ -	$ -	$ -	$ -	50	50	$ 171,577	$ 171,577	$ 387,397	$ 171,577	69%	31%	Build-out
18				Total	2303.5										$ 2,375,207	$ 2,289,758	$ 4,785,735	$ 14,176,050	$ 1,452,016	$ 1,991,951	$ -	$ 5,165,951	$ 923,191	$ 297,807	$ 4,785,735	$ 9,010,099	$ -	$ -	$ -	$ -	$ -			$ 4,446,611	$ 4,563,489	$ 9,729,439	$ 4,446,611	68%	32%	

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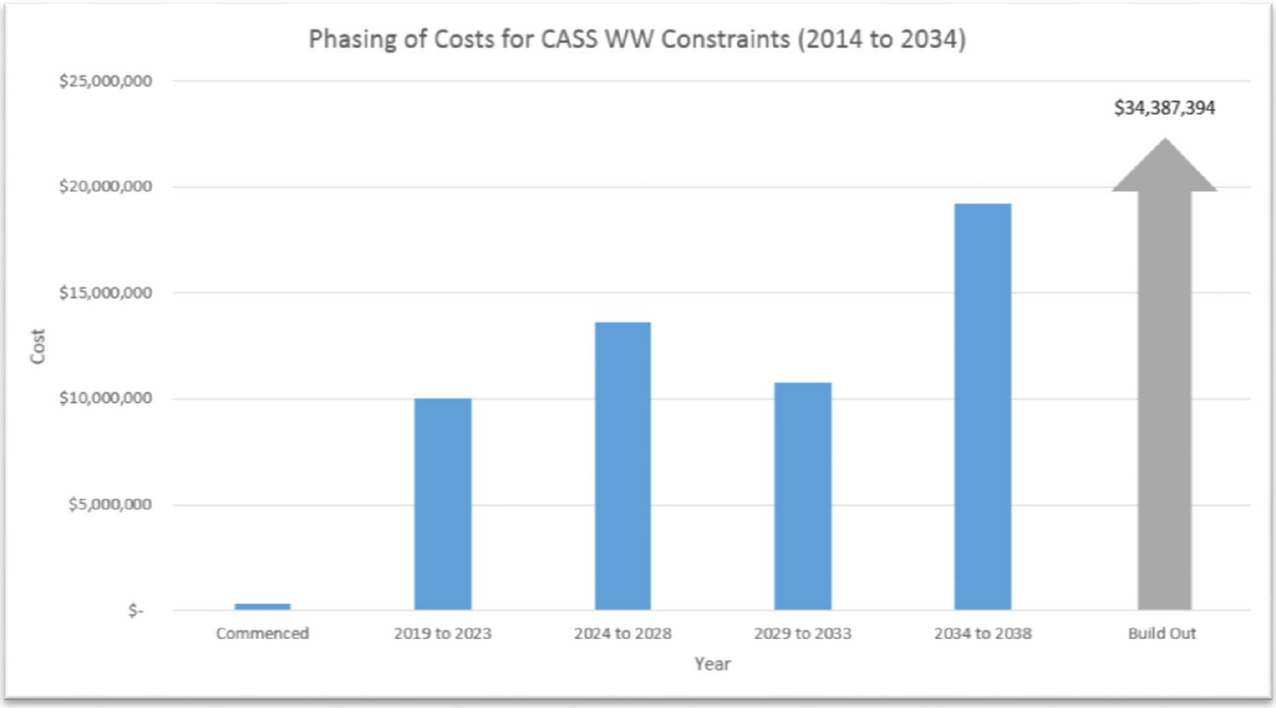


Figure 7: Phasing of Costs for CASS WW Constraints

7.2 Constraints Summary and Descriptions

The following Table 6 provides a summary and description of each of the identified constraints.

Table 6: Constraint Summary

#	Constraint Location	Cost, Phasing & Level of Service Trigger	Description
1	Dundas and Egerton St	Total Cost: $308,872 Phasing: Commenced Level of service: Minor surcharging	Growth caused the flow to exceed the pipe-full capacity. The issue is being resolved by a current life cycle renewal project which upgrades this sewer and diverts flow to Eleanor St. The project will be completed in 2017.
2	Dufferin and Adelaide North	Total Cost: $320,319 Phasing: Build-out Level of service: Minor surcharging	This is an existing LOS issue as the PFC is exceeded under existing conditions. There is no storm or combined sewer upstream so sewer separation will have no impact. Surcharging is caused by a shallow gradient upstream of the trunk sewer. A survey of the pipe is recommended as a steeper gradient would remove the need for a project. There is also a hydraulic jump in the upstream chamber. Growth upstream of this location occurs beyond 2034 so this constraint is not scheduled to be addressed as part of the CASS.
3-1	Thames Valley Pkwy (Between Riverside and Ridout)	Total Cost: $6,041,095 Phasing: 2024 Level of service: Flooding	The sewer running along the Thames Valley Parkway is surcharged under existing conditions. Surcharging as a result of the CASS growth cannot be resolved until the existing issues relating to this sewer are resolved. The upstream catchment is primarily sanitary, with some combined sewer. Sewer separation and I/I reduction measures would increase the feasibility and reduce the cost of a project. Additional flow has been added to this sewer by sending flow south using existing valves on Wellington St. Overflow SD-03_O disconnected to prevent increase in volume to river. The hydraulic grade line exceeds ground level at this location so a resolution to this constraint should be a priority. The majority of growth upstream is scheduled around the 2024 growth interval.
3-2	Thames Valley Pkwy (Between Ridout St. N and Clarence St.)	Total Cost: $5,839,452 Phasing: 2024 Level of Service: Flooding	See constraint 3-1 for details
3-3	Thames Valley Pkwy (Between Clarence and Wellington)	Total Cost: $642,887 Phasing: 2024 Level of Service: Freeboard is less than 1.8m below GL	See constraint 3-1 for details. No flooding but HGL is less than 1.8m below ground level, which would considered a basement flooding risk.
4	Thames St. (Between Dundas and King St.)	Total Cost: $770,546 Phasing: Build-out Level of Service: Freeboard is less than 1.8m below GL	There are limited options for separation as the upstream catchment contains only a small amount of combined sewer. The City of London has indicated that a resolution for this constraint will be evaluated and considered as part of the CCSS project.
5	King St. (Between Thames St. and Ridout St. N)	Total Cost: $1,645,338 Phasing: 2019 Level of Service: Flooding	Downstream of the Ridout Trunk and Pall Mall catchments, this section of sewer does not have much ground cover. There is an opportunity for sewer separation along the Dundas Relief Sewer.

#	Constraint Location	Cost, Phasing & Level of Service Trigger	Description
6-1	Ridout Trunk (Between Dundas and King)	Total Cost: $1,227,047 Phasing: 2034 Level of Service: Less than 1m of surcharging	Downstream of the Pall Mall catchment. The level of surcharge is lessened by overflows located upstream and downstream. There is opportunity for sewer separation along the Dundas Relief Sewer.
6-2	Ridout Trunk (Between Queens Av and Dundas)	Total Cost: $1,370,457 Phasing: 2034 Level of Service: Less than 1m of surcharging	Downstream of the Pall Mall catchment. Limited options for sewer separation but an I and I reduction program may be effective. The sewers here have a shallow gradient and are prone to sedimentation, if the sewer could be re-graded then the proposed pipe size could be reduced. The level of surcharge is lessened by overflows located upstream and downstream.
6-3	Ridout St Nth between Fullarton and Albert	Total Cost: $3,799,967 Phasing: 2019 Level of Service: Freeboard is less than 1.8m below GL	Downstream of the Pall Mall catchment. Limited options for sewer separation but an I and I reduction program may be effective. The sewers here have a shallow gradient and are prone to sedimentation, if the sewer could be re-graded then the proposed pipe size could be reduced. The level of surcharge is lessened by overflows located upstream and downstream.
7-1	Ridout Trunk North (Between Bathurst and King)	Total Cost: $1,878,190 Phasing: 2034 Level of Service: Exceeds 1m of surcharging but Freeboard is less than 1.8m below GL	Surcharged by flow. Egg-shaped sewer that has an incoming, large diameter, circular sewer on York Street. A hole has been knocked through the wall of the egg-shaped sewer to make the connection and this has created a weir from the circular sewer to the egg-shaped sewer. Removal of this weir removes the constraint along York Street. There are options for separation along York Street which will be undertaken as part of the CCSS study.
7-2	Bathurst St. (between Simcoe and Ridout)	Total Cost: $1,054,375 Phasing: 2034 Level of Service: Less than 1m of surcharging	Surcharged by flow. Options for separation upstream. As part of the solution to deal with this constraint, flow was diverted south, away from this constraint, through an existing valve at the intersection of Wellington Street and Hill Street.
7-3	Talbot St. (between Bathurst and Horton)	Total Cost: $569,565 Phasing: 2034 Level of Service: Less than 1m of surcharging	Surcharged by flow. Options for separation upstream. As part of the solution to deal with this constraint, flow was diverted south, away from this constraint, through an existing valve at the intersection of Wellington Street and Hill Street.
8	Maitland St. between Simcoe St and South St	Total Cost: $1,621,972 Phasing: 2034 Level of Service: 2m of surcharging but does not reach 1.8m below GL	Surcharged by flow. No options for separation upstream. Removing 50% of I/I would resolve capacity issues.
9	Clarence St and Queens Av	Total Cost: $1,119,354 Phasing: 2019 Level of Service: Freeboard is less than 1.8m below GL	Surcharged by flow. No options for separation but there is potential to send growth to neighbouring sewer systems so as not to increase existing surcharging. Removing 50% of I/I would resolve capacity issues.

#	Constraint Location	Cost, Phasing & Level of Service Trigger	Description
10-1	Pall Mall East and Talbot St	Total Cost: $10,757,048 Phasing: 2029 Level of Service: Limited surcharging due to overflow to the storm sewer	This constraint will potentially be impacted by two current projects, PPCP and the Shift Rapid Transit system. The overflows in this location need to meet MOE F-5-5 criteria but may be taken out of service if the sewer is re-routed as part of the PPCP and Shirt Rapid Transit system. If the sewer is disconnected at Richmond St. and Pall Mall St. because of the Shift Rapid Transit Tunnel, this will remove overflows PM01 and PM02, but means that more flow has to be conveyed for treatment. Phasing was initially 2034 based on the growth trends upstream of the constraint, however this was moved forward to 2029 to better coordinate with ongoing projects in the area (RT Shift and PPCP).
10-2	Pall Mall between Maitland and Adelaide	Total Cost: $1,814,126 Phasing: Build-out Level of Service: Minor surcharging	Minor surcharging with upstream growth not scheduled until beyond 2034.
11-1	William St to Lorne Av	Total Cost: $6,180,432 Phasing: 2034 Level of Service: Not surcharging beyond 1.8m below cover level, however the upstream overflows lessen the impact.	Surcharged by flow. Overflows upstream and downstream to the Pall Mall relief sewer. The strategy to resolve this constraint will depend on the outcome of the PPCP analysis.
11-2	Lorne Av between Elizabeth and Ontario	Total Cost: $2,753,957 Phasing: 2034 Level of Service: Not surcharging beyond 1.8m below cover level, however the upstream overflows lessen the impact.	Surcharged by flow. Overflows upstream and downstream to the Pall Mall relief sewer. The strategy to resolve this constraint will depend on the outcome of the PPCP analysis.
12	Piccadilly St. and Colborne	Total Cost: $2,538,585 Phasing: 2034 Level of Service: Significant surcharging but does not exceed 1.8m below GL	Surcharged by flow. This is a small diameter pipe (300 to 375mm) where the surcharge level does not reach 1.8m below ground level. As a result this can be considered a lower priority and further studies of the wet weather flow response should be undertaken to confirm flow.
13	Waterloo St between Pall Mall and Central Av	Total Cost: $923,717 Phasing: Build-out Level of Service: Significant surcharging but does not exceed 1.8m below GL	Surcharged by flow and from constraint in the downstream Pall Mall Trunk sewer. This is a small diameter pipe (375mm) where the surcharge level does not reach 1.8m below ground level. As a result this can be considered a lower priority and further studies of the wet weather flow response should be undertaken to confirm flow.

#	Constraint Location	Cost, Phasing & Level of Service Trigger	Description
14	Colborne St between Pall Mall and Hope St	Total Cost: $1,372,380 Phasing: 2019 Level of Service: Freeboard is less than 1.8m below GL	Surcharged by flow and from a constraint in the downstream Pall Mall Trunk sewer. This small diameter pipe (375mm) is considered a risk to basement flooding because the surcharge level exceeds 1.8m below ground level. This risk is reduced if the constraint in the Pall Mall Trunk Sewer is addressed.
15	English St	Total Cost: $2,069,603 Phasing: 2019 Level of Service: Freeboard is less than 1.8m below GL	Surcharged by flow. This is a small diameter sewer (300mm) where the freeboard is less than 1.8m below ground level and is classified as a risk to basement flooding.
16	Wellington St between Hill St and Front St	Total Cost: $1,118,934 Phasing: 2019 Level of Service: No existing issue, surcharging caused by diversion of flow to Front St.	As part of the solution for constraints 7-1, 7-2, and 7-3, flow was diverted towards Thames Valley Parkway and away from King St. Existing valve chambers have been used for diversion but the capacity needs to be increased and exiting route needs to be plugged. There are options for separation which would reduce impact of I/I through the downtown core if no diversion was implemented.
17*	Riverside Park	Total Cost: $16,382,635 Phasing: Build-out Level of Service: Exceeds 1m of surcharging but Freeboard is less than 1.8m below ground level	Surcharged by flow. Trunk sewer to the Greenway WWTP, north of the river and downstream of the CASS. This would include upsizing over the river crossing. Removing wet-weather flow from the model is effective at reducing the surcharging but there is a limited amount of combined sewer upstream of this location. This location is downstream of the catchment in the south of the CASS study area. Growth is scheduled to occur from 2019 onwards but for the purposes of coordination, this project has been pushed out to build-out.
18*	Becher St	Total Cost: $14,176,050 Phasing: Build-out Level of Service: Freeboard is less than 1.8m below ground level	Surcharged by flow. This is the trunk sewer going to the WWTP, south of the river. The project would need to include upsizing across the river. Sewer separation could be effective as it is downstream of the Ridout Trunk and the Dundas Relief Sewer. This location is downstream of the catchment in the north of the CASS study area. Growth is scheduled to occur from 2019 onwards but for the purposes of coordination, this project has been pushed out to build-out.

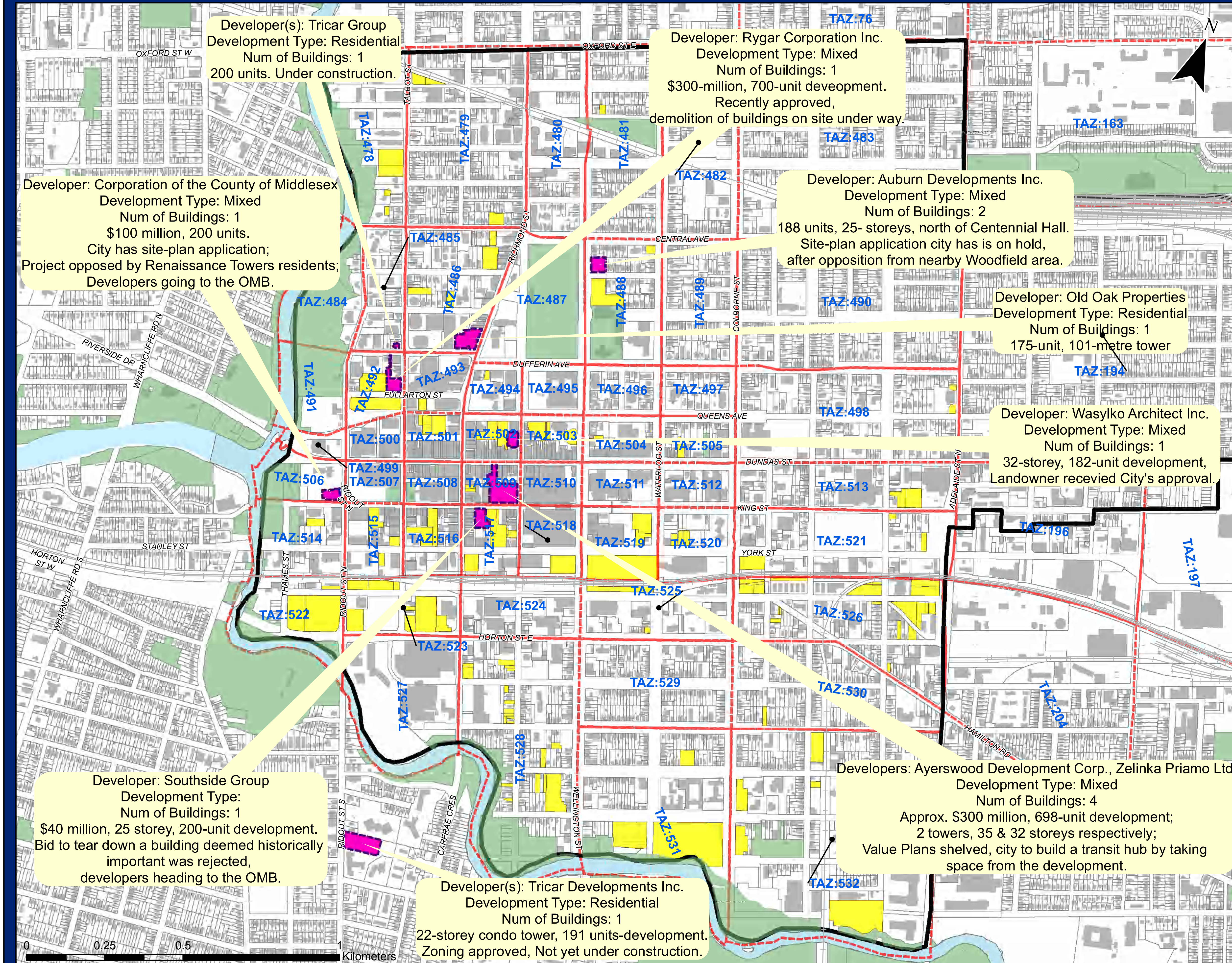
*Constraints 17 and 18 are outside of the CASS study area. The constraints are existing issues that will be made worse by growth. They are large scale issues with a significant capital cost to resolve through infrastructure improvements. In addition, because they are trunk sewers and convey flow from a very large upstream area they are subject to the impacts of all upstream catchment changes and work, from new growth to I/I reduction measures. As a results these projects are considered a special case and for these reasons the projects were agreed to be assigned to the 'build-out' time period, not necessarily because nothing will be done to them until build-out but more so that they do not skew the 2034 capital program and cost splitting.

7.3 Development Application Analysis

The City provided several active development application for the study area during the preparation of the CASS. This planning information was reviewed and used to further refine accuracy in the impact and capacity assessment analysis.

Development applications were received from the City. These contained information such as proposed number of units and phasing. Flow was calculated from the data provided and peaked using Harmon Peaking Factor. An analysis was then undertaken on the impact of this flow to the system and also the impact of the estimated cost of the constraints for each development application. This approach is consistent with how all new developments applications are assessed.

The purpose of this assessment was to understand the variability of cost associated with development occurring at different spatial locations within the Core Area. The location and details of the development applications are shown in Figure 8. The location of the development applications in relation to the constraints and details of the developments and associated costs are shown in Figure 9 and Table 7 respectively.



London CANADA

716013 - City of London
Core Area Servicing Studies (CASS)
Wastewater Component

- Pumping Stations
- Rail
- Large Land Development Areas
- StudyArea
- Parks
- River
- Parcels
- Vacant Parcels
- Buildings
- Traffic Area Zones

Figure 8 : Location and Detail of Development Applications

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716013-22-NewDevelopment_EmpBuildout
November 2016
Data Source: City of London
Scale: 1:11,958 | NAD 1983 UTM Zone 17N

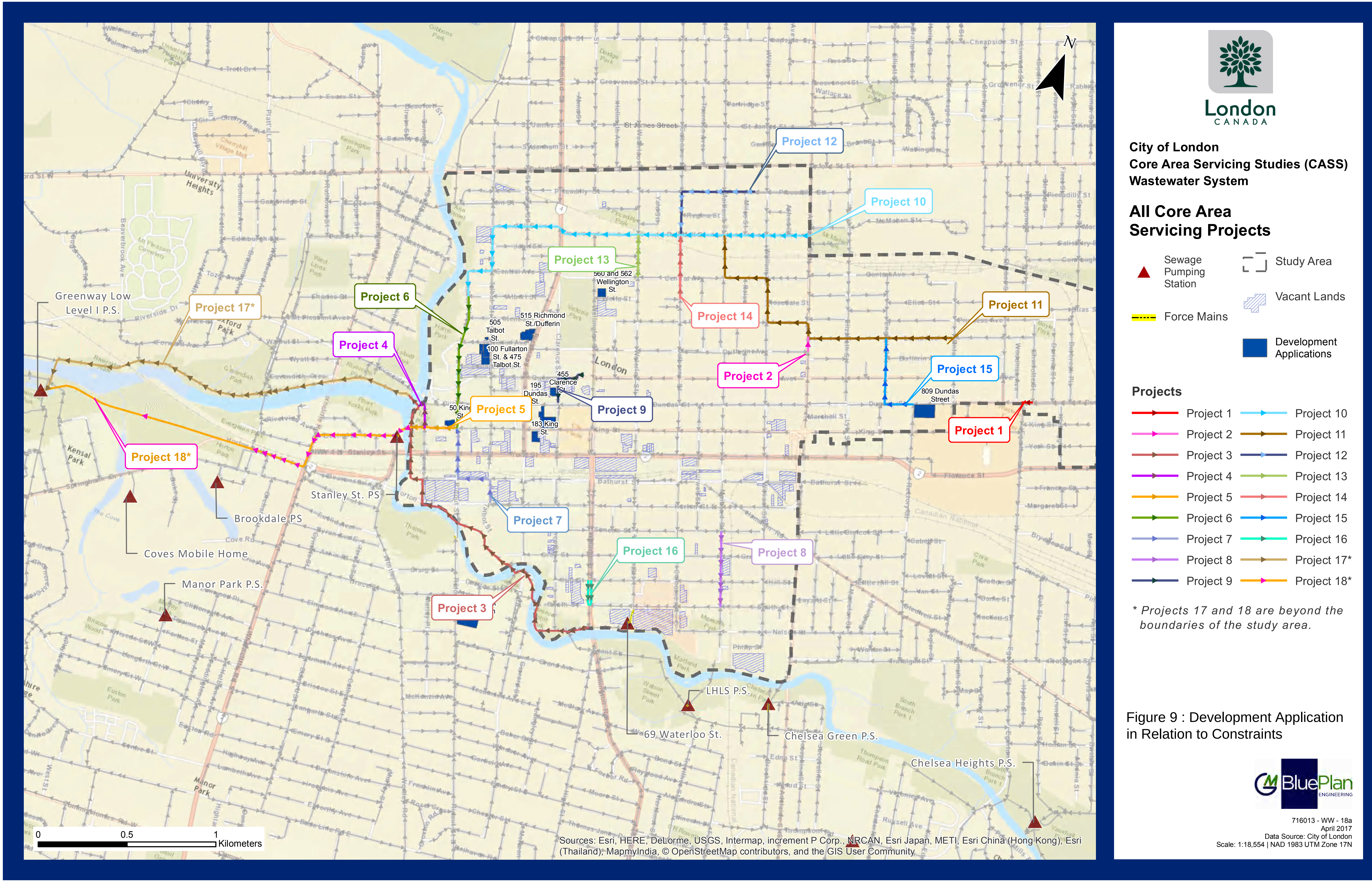


Figure 9 : Development Application in Relation to Constraints

Table 7: Downstream Constraints

Development	Associated Constraints	Comment	City Costs ($)	Growth Costs ($)	Total Constraint Costs ($)
809 Dundas Street	18, 17 (Greenway Trunk) 15, 11.1, 11.2, 10.1, 6.1, 6.2, 6.3, 5	Existing issue made worse by growth	$40,234,600	$20,127,935	$60,362,535
560 Wellington	10.1, 6.1, 6.2, 6.3, 5 (Constraint 5 requires splitting)	Local sewer has adequate capacity, downstream sewers under capacity	$10,985,214	$7,814,643	$18,799,857
515 Richmond	6.1, 6.2, 5	Existing issue made worse by growth	$2,325,584	$1,917,258	$4,242,842
455 Clarence Street	9, 6.1, 5 (Constraint 9 and 6.1 requires splitting)	Existing issue made worse by growth	$1,798,481	$2,193,259	$3,991,740
195 Dundas Street, 183 King, 50 King	5	Existing issue made worse by growth	$884,365	$760,973	$1,645,338

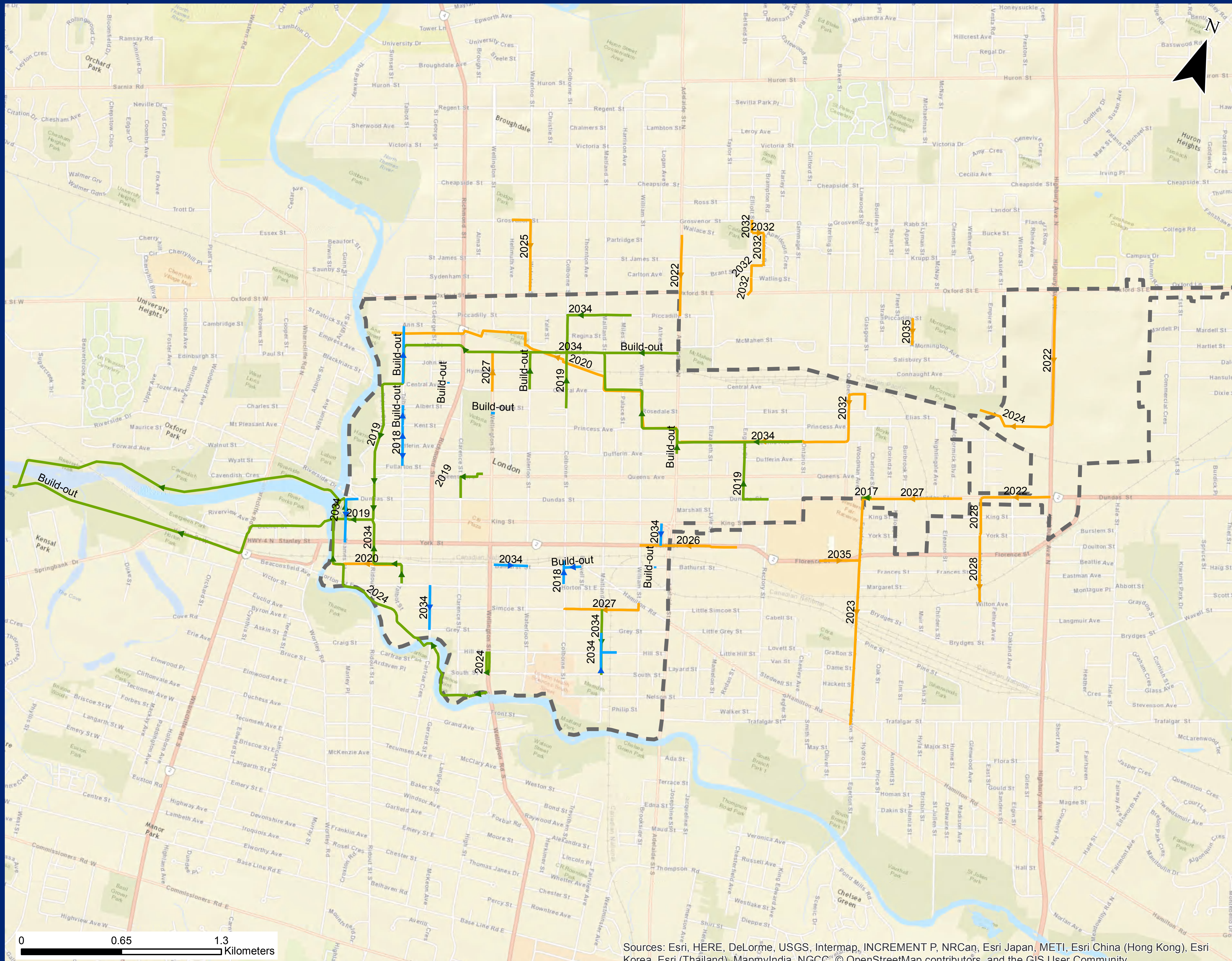
7.4 CASS Water, Wastewater and Stormwater Coordination

Coordination of projects between the three systems, water, wastewater and stormwater, is a critical component for the effective implementation of any required works. The CASS studies for water, wastewater and stormwater primarily provides the funding approach through the identification and costing of system constraints. As the City progresses their Development Charges Master Plan all drivers and needs will be aligned and actual projects developed and scheduled for implementation.

Throughout the CASS studies, the project teams for water, wastewater and stormwater coordinated and shared outputs in order to align works and provide early insight into any coordination that will need to occur.

The CASS study also considered the work of the Rapid Transit project and the Pollution Prevention Control Plan (PPCP) and held meetings with the lead consultant to ensure understanding. For the PPCP it was agreed, due the timing of the two projects that the CASS study move forward somewhat independent of the PPCP. However, the CASS study approach included typical year rainfall analysis to ensure that the recommended solutions did not increase overflow volume and frequency as a result of growth. Improvement were considered and reflected in the Benefit to Existing calculation to ensure that growth does not pay for an improved level of service. The PPCP project is ongoing. The CASS study and model has been provided to the PPCP consultant.

The water, wastewater and stormwater system constraints and an indication for the timeline of works is shown in Figure 10. The figure can be used to identify where system constraints overlap and coordination will likely be required.



London CANADA

City of London
Core Area Servicing Studies (CASS)

All Water, Wastewater and Stormwater Servicing Constraints

- Water Constraint
- Wastewater Constraint
- Stormwater Constraint
- Study_Area
- WATERBODY

Figure 10: CASS Water, Wastewater and Stormwater Coordination

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716013 - WW - 18a
December, 2017
Data Source: City of London
Scale: 1:24,738 | NAD 1983 UTM Zone 17N

8 Summary

The following section provides a summary of the key criteria used to generate the intervention program and the key outputs in terms of infrastructure needs and cost splits.

8.1 Design Criteria Summary

The design criteria used for the purposes of the CASS are:

- Average dry weather flow (DWF) of 230 L/cap/d (253l/cap/d with uncertain development factor)
- Harmon peaking factor applied to computer peak sanitary flow
- Infiltration allowance of 8,640 L/ha/d or 0.10 L/s/ha is not applicable to the CASS as intensification growth will not increase existing levels of extraneous flow
- Uncertain development factor of 1.1

Peak Flow = ((Population x (DWF * Uncertain Development Factor) x Peaking Factor)) + Infiltration

8.2 Level of Service for Infrastructure Planning

The following levels of service are specific and measurable. They will be used as the primary means to assess the needs and sizing of infrastructure:

- For sanitary sewer capacity assessments:
    - Based on current City practices, maintain the 85% full flow capacity trigger for sizing of infrastructure.
    - When using the London hydraulic model, utilize a 1 in 5-year design storm for sizing of new infrastructure.
    - No increase in volume or frequency of overflows due to development or redevelopment.
    - Meet post-development runoff requirements.

8.3 Growth Projections

Growth projections for full Build-out are provided in Table 8.

Table 8: Build-out Growth Projections

	Population	Employment	Units	ICI (m2)
Core Area Vacant Parcel Growth	42,301	3,958	24,850	162,969
Core Area TAZ Growth	13,250	650	7340	32,775
Sub-Total	**55,551**	**4,608**	**32,190**	**195,744**
Outside Core Area Growth	**89,569**	**14,115**	**46,803**	**886,313**
Total	**145,120**	**18,723**	**78,993**	**1,082,057**

8.4 Approach to Infrastructure Costs Estimation and Cost Splitting

Costs were generated using standard unit rate cost tables that were updated using the 2014 DC Background Study tables.

Details of how the cost for wastewater constraints was classified as a BTE or to facilitate growth is summarized as follows:

1. If the constraint is caused by growth, and there is no existing LOS issue then:
    a. The developed BTE split between the City and growth is assigned to the total cost of the project and based on condition assessment. For example, if the asset rating is 'very poor' then 90% of the total cost will be attributed as a BTE; if the asset rating is 'very good' then 10% of the total cost will be attributed as a BTE.
2. If there is an existing LOS issue as well as growth upstream, but no oversizing is required because of growth.
    a. Cost of replacing existing sewer is attributed the City. The difference between the cost of replacing the existing pipe and the cost to size the sewer to meet the LOS and growth requirements is to be split using the asset rating method.
3. If there is an existing LOS issue as well as growth upstream and oversizing is required to accommodate growth
    a. As point number 2, except the oversizing cost is attributed entirely to growth

A methodology based on the asset rating of the sewer was applied to allocate costs to the City or to growth where growth instigated or benefited from work to resolve constraints in the system.

8.5 Infrastructure Needs and Costs

A summary of the infrastructure needs and Costs is provided in Table 9.

Table 9: Summary of Infrastructure Costs

Constraint Number	Location	City Costs $	City Costs %	Growth Costs $	Growth Costs %	Total Costs	Phasing
1	Dundas and Egerton St	$-	0%	$308,872	100%	$308,872	Started
2	Dufferin and Adelaide North	$63,303	20%	$257,017	80%	$320,319	Build-out
3-1	Thames Valley Pkwy (Between Riverside and Ridout)	$5,022,574	83%	$1,018,521	17%	$6,041,095	2024
3-2	Thames Valley Pkwy (Between Ridout St. N and Clarence St.)	$4,983,156	85%	$856,296	15%	$5,839,452	2024
3-3	Thames Valley Pkwy (Between Clarence and Wellington)	$256,212	40%	$386,675	60%	$642,887	2024
4	Thames St. (Between Dundas and King St.)	$472,092	61%	$298,454	39%	$770,546	Build-out
5	King St. (Between Thames St. and Ridout St. N)	$884,365	54%	$760,973	46%	$1,645,338	2019
6-1	Ridout Trunk (Between Dundas and King)	$520,937	42%	$706,110	58%	$1,227,047	2034
6-2	Ridout Trunk (Between Queens Av and Dundas)	$920,283	67%	$450,174	33%	$1,370,457	2034
6-3	Ridout St Nth between Fullerton and Albert	$2,137,052	56%	$1,662,915	44%	$3,799,967	2019
7-1	Ridout Trunk North (Between Bathurst and King)	$1,017,970	54%	$860,220	46%	$1,878,190	2034
7-2	Bathurst St. (between Simcoe and Ridout)	$744,061	71%	$310,314	29%	$1,054,375	2034
7-3	Talbot St. (between Bathurst and Horton)	$355,091	62%	$214,474	38%	$569,565	2034
8	Maitland St. between Simcoe St and South St	$758,726	47%	$863,247	53%	$1,621,972	2034
9	Clarence St and Queens Av	$393,179	35%	$726,175	65%	$1,119,354	2019
10-1	Pall Mall East and Talbot St	$6,522,578	61%	$4,234,469	39%	$10,757,048	2029
10-2	Pall Mall between Maitland and Adelaide	$893,490	49%	$920,636	51%	$1,814,126	Build-out
11-1	William St to Lorne Av	$4,005,288	65%	$2,175,143	35%	$6,180,432	2034
11-2	Lorne Av between Elizabeth and Ontario	$1,855,190	67%	$898,767	33%	$2,753,957	2034
12	Piccadilly St. and Colborne	$1,285,200	51%	$1,253,386	49%	$2,538,585	2034
13	Waterloo St between Pall Mall and Central Av	$384,490	42%	$539,227	58%	$923,717	Build-out
14	Colborne St between Pall Mall and Hope St	$462,312	34%	$910,068	66%	$1,372,380	2019
15	English St	$1,091,457	53%	$978,146	47%	$2,069,603	2019
16	Wellington St between Hill St and Front St	$401,090	36%	$717,844	64%	$1,118,934	2024
17	Riverside Park	$12,568,010	77%	$3,814,625	23%	$16,382,635	Build-out
18	Becher St	$9,729,439	69%	$4,446,611	31%	$14,176,050	Build-out
	TOTAL	**$57,727,545**	**61%**	**$30,569,359**	**39%**	**$88,296,903**	

Appendix A Design Criteria, Level of Service and Policy Review

Design Criteria, Policy, and Level of Service Review

Core Area Servicing Studies (CASS) – Wastewater Component

Prepared by
GM BluePlan for:

London
CANADA

Project No. 716013
September 8, 2016

BluePlan
ENGINEERING

Version Updates

The following is a record of the changes/updates that have occurred on this document:

Version	Changes / Updates	Author	Date
Working Draft	First draft for discussion	LB	August 26, 2016
Formal Draft for Issue	Formal Draft for issue following City workshop held on August 31st 2016.	LB	September 7, 2016
Final	Final version as issued. No changes from previous version.	JJ	September, 2016

Glossary of Terms and Acronyms

The following table provides a summary of terms and acronyms that are commonly used throughout the report.

Term or Acronym	Definition
CASS	Core Area Servicing Study
DC	Development Charge
DWF	Dry Weather Flow
GMIS	Growth Management Implementation Strategy
GWI	Groundwater Infiltration
HDR	High Density Residential
I/I	Inflow and Infiltration
IQR	Interquartile Range
LDR	Low Density Residential
LOS	Level of Service
MDR	Medium Density Residential
PPCP	Pollution Prevention Control Plan
RDII	Rainfall-derived inflow and infiltration

Table of Contents

1 Introduction and Background

1.1 Background

The City of London is undertaking the Core Area Servicing Studies (CASS) to determine the infrastructure servicing requirements that will support the vision of the City's Official Plan for the core area of the City.

The CASS comprises a family of servicing studies that includes water, wastewater and stormwater that will form a critical component to enable City of London's growth aspirations. GM BluePlan was retained to undertake the wastewater component of the CASS, recognizing that coordination with several other ongoing/planned initiatives, including the SHIFT rapid transit project, would be required.

The study is being undertaken in support of the DC Background Study process to determine system improvements that will accommodate future growth projected to 2034, and ultimate build-out scenarios. Existing and future wastewater servicing requirements for the core area will be identified, aligning any proposed works with the City's 5-year growth forecasts.

1.2 Introduction

The review and recommendations provided in this memorandum addresses most of Task 1 in the project work plan, including the design criteria, policy and level of service review. The memorandum summarizes the baseline review undertaken to identify, understand and help achieve consensus on the following:

- Wastewater Design criteria;
- Ensuring current policies translate to intensification and infill growth, not just greenfield;
- Consideration of Level of Service (LOS) in relation to *Development Charge Act*. In particular the issue of DC funded projects not enhancing the existing Level of Service (LOS);
- Consideration of LOS in relation to wet weather flows and basement flooding, including outputs from the *Pollution Prevention Control Plan (PPCP)*;
- The development of criteria for DC funding eligibility and allocation; and,
- Consideration of policy for capacity reclaim projects, such as I/I reduction and water efficiency.

The memorandum is organized as follows:

1. Introduction and Background
2. Existing Design Criteria
3. Policy
4. Level of Service
5. Summary and Recommendations

The targets and approaches developed in Task 1 will form the basis for the definition of infrastructure projects resulting from the CASS. This review seeks to validate, confirm or amend, as appropriate, the criteria and assumptions that will be used for infrastructure planning within the City's core area.

The report is sectioned into the three key areas of review: Design Criteria, Policy and Level of Service to support Development Charges. A series of workshops will be held to engage City stakeholders to further discuss London's current practices, opportunities, and potential impacts as they relate to the City's core area and beyond.

London CANADA

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2 Design Criteria

2.1 Objectives

The purpose of this review and analysis was to assess and comment on the suitability of using the City's Design Criteria and approach of applying it to growth projections and hydraulic modelling to assess servicing impact for the CASS.

The scope of this project included a review of the City's current design criteria with a comparative review of industry best practice and the criteria used by other similar municipalities. GM BluePlan is currently assisting the City complete hydraulic modelling assignments. As added value we have leveraged this experience to provide an analysis of a selection of the City's latest flow monitoring data used for modelling purposes, in comparison to the current design criteria used by the City.

2.2 Existing Design Criteria

The approach to determining wastewater flows for both existing and future growth varies from municipality to municipality. However, in general, it is common practice to utilize a per capita sanitary flow rate multiplied by a peaking factor to produce a peak sanitary flow. An extraneous flow component is then added, typically as an area-based unit I/I rate to produce a peak wet weather flow.

For the City of London, the components of this design flow calculation are as follows:

- Average dry weather flow of 230 L/cap/d
- Harmon Peaking Factor applied to calculate peak sanitary flow
- Infiltration allowance of 8,640 L/ha/d or 0.10 L/s/ha
- Uncertain Development Factor of 1.0 or 1.1 (situation dependent)

For design purposes, the equation shown in Figure 1 shall be used to determine peak flows.

Peak Flow (Q) = population X per capita flow X peaking Factor (H) X uncertain development factor + infiltration

Where:	Peak Flow (Q)	= L/s
	Per Capita Flow	= 230 litres/capita/day
	Peaking Factor (H)	= Harmon (section 3.7)
	Uncertain Development Factor	= 1.0 or 1.1 (situation dependant)
	Infiltration Allowance	= 8640 litres/hectare/day (0.100L/ha/s)

Figure 1. City of London Design Criteria (taken from DSRM, 2015)

The City's current standards for wastewater infrastructure provides different criteria for the application of the above peak flow calculation, depending on the size of the catchment area. One of the key differences in the application of the design criteria lies in the land use classification density assumptions that are used to estimate projected population.

2.2.1 Tributary Areas Less than 200 Hectares

For tributary areas less than 200 hectares, the City provides specific population densities that apply to land uses within the tributary area on a zoning, lot, and area basis. The zoning densities are provided in Table 1, and the lot and area densities are provided in Table 3.

Table 1. Densities by Zoning <200ha

Zoning	Density (u/ha)	Density (ppu)	Calculated Density (p/ha)
Low Density	30	3.0	90
Medium Density	75	2.4	180
High Density	300	1.6	480

Different densities are provided based on geography for locations within the Downtown Area, the Central Area, and outside the Central Area, with and without a 25% bonusing provision as shown in Table 2.

Table 2. Densities by Location <200ha

Zoning	Density (u/ha)	Density with bonusing provision (25%)	People/Unit
Downtown Area	350	432.5	1.6
Central Area	250	312	
Outside Central Area	150	187.5	

Other residential land use densities are provided for single family, semi-detached on both a lot basis and an area basis, as shown in Table 3.

Table 3. Densities by Lot and Area <200ha

Zoning	Lot Basis Density	Area Basis
Single Family	3.0 ppu	30 u/ha @ 3.0 ppu
Semi-detached	6.0 ppu	30 u/ha @ 3.0 ppu
Multi-family	-	75 u/ha @ 2.4 ppu

The City specifies an Uncertain Development Factor of 1.1 to be applied to areas less than 200 hectares.

Commercial, institutional and industrial use densities are assumed to be 100 people/hectare. However, it should be noted that these densities may be adjusted where deemed appropriate by the City Engineer or where detailed information is available. Heavy water users will require the application of a higher design flow, and will require consultation with City staff to confirm specific requirements.

2.2.2 Tributary Areas Greater than 200 Hectares

For tributary areas greater than or equal to 200 ha, the residential, commercial and institutional densities are based on 55 people per hectare (gross area with any environmentally sensitive areas netted out). The Uncertain Development Factor is not anticipated to impact the peak flow calculation, as the City specifies a factor of 1.0 for areas greater than 200 hectares.

2.3 Assessment of Existing Land Use Classification Densities

Given the fact that design flows are a function of population, land use classification densities were also reviewed and compared against available and published information to provide a range of residential and non-residential densities being used across southern Ontario. Based on the review undertaken, land use densities vary in definition (e.g. what is high density) and units (e.g. persons per unit or persons per hectare). In general, however, these densities are intended to be used as a guideline in the absence of detailed plans. As such, summary tables were prepared how the City of London's design criteria compares to other municipalities.

Table 4 below provides a summary of the land use classification densities in person per unit.

Table 4. Population Equivalents based on Type of Housing (persons per unit)

Type	City of London < 200 ha	City of Toronto	City of Markham	City of Vaughan	City of Barrie	Town of Richmond Hill	Town of Aurora	Peel Region	Durham Region
Single Family	**3.00**	3.50	4.00	4.00	3.13	3.80	3.80	3.20	3.50
Semi-Detached	**3.00**	2.70	4.00	4.00	2.34	3.80	3.80	2.70	3.50
Townhouses	**2.40**	2.70	3.80	3.50	-	3.40	3.50	2.70	3.00
High Density Apartment	**-**	3.10	-	-	-	-	-	3.20	3.50
*Medium Density Apartments	**1.60**	2.10	3*	2.5*	1.67	2.7*	2.5*	2.70	2.50
Low Density Apartments	**-**	1.40	-	-	-	-	-	3.20	1.50

**Wherever apartment densities are provided as a single value, they are represented by the Medium Density Apartment type.*

Based on the above table, the City's population equivalents are generally in line with other municipalities. It should be noted however, that the City does have the lowest single family and townhouse densities compared to the surveyed municipalities. The City of London's densities are most similar to those of the City of Barrie. Table 5 below provides a summary of the land use classification densities in person per hectare.

Table 5. Land Use Classification Densities (persons per hectare)

Type	City of London (< 200 ha)	City of London (> 200 ha)	City of Hamilton	City of Toronto	City of Markham	Halton Region	Niagara Region	Peel Region	Durham Region
Single Family	**90**	55	60	170	70	55	55	50	60
Semi-Detached	**90**	55	75	270	70	100	100	70	100
Townhouses	**180**	55	110		175	135	135	175	125
High Density Apartment	**-**		varies	-		-	-		600
Medium Density Apartments	**240 - 480**		250	400	475	285	285	475	300
Low Density Apartments	**-**			-		-	-		150
Institutional	**100**	55	75 - 125	86	60	40	40		150
Light Commercial	**100**	55	125-750		100	90	90	50	300
Light Industrial	**100**		125 - 750	136	70	125	125	70	

It should be noted that the City of London's practice of defining area-specific design criteria is unique based on the industry review undertaken. As such, two columns for the City of London are shown above, one that applies for tributary areas less than 200 hectares and one for those greater than 200 hectares. For areas less than 200 hectares, it appears the City requires more conservative land use densities. Based on the above table, the City's density for areas less than 200 hectares for single family homes is the highest, second only to the City of Toronto. Other land use densities are generally within the range of other municipalities.

2.4 Assessment of Existing Design Criteria

The City of London's current design flow basis for estimating future flows is generally consistent with the methodology other municipalities currently practice. In the case of the City of London, an Uncertain Development Factor of 1.0 or 1.1 is applied (depending on the situation) above the peak dry weather flow component. This is considered a relatively unique application amongst other municipalities in Ontario and allows for a level of uncertainty in the estimation of design flows.

The City of London also specifies different land use classification densities based on the size of catchment area (defined as areas less than 200 hectares or greater than 200 hectares). The use of area-based land use classification densities is also considered a unique practice as seen with the industry review undertaken as part of the CASS.

Design Criteria should not be based on absolute observed information. Results from water billing data and Wastewater Pollution Control Plant flow data analysis should not be directly translated into Design Criteria. Design Criteria should provide a level of safety beyond actual average values to provide protection against peak and worst case scenarios. To illustrate the point, a bridge is not designed to take the average weight of cars, end to end across the bridge, as a sewer should not be designed to take average flows.

In order to further assess the suitability of the existing design criteria, a review of industry best practices, comparison of other municipalities and a flow survey monitor data analysis was completed.

2.5 Best Practice and Industry Review

A review of other municipal design criteria was undertaken in order to compare industry standards against the existing City of London criteria.

Several of the municipalities were selected for review based on similar geography, population, and discharge of wastewater effluent to comparable receiving waters, as they share parallels with London's wastewater system. This section summarizes the outcomes of this review.

This section reviews the following components:

- Dry weather flow per capita criteria
- Extraneous flow criteria used to calculate peak wet weather flow
- Peaking factor methodology
- Sewer design flow basis (peak flow equation)

2.5.1 *Dry Weather Flow*

The figure below shows a comparison of the dry weather per capita flow rates for select municipalities.

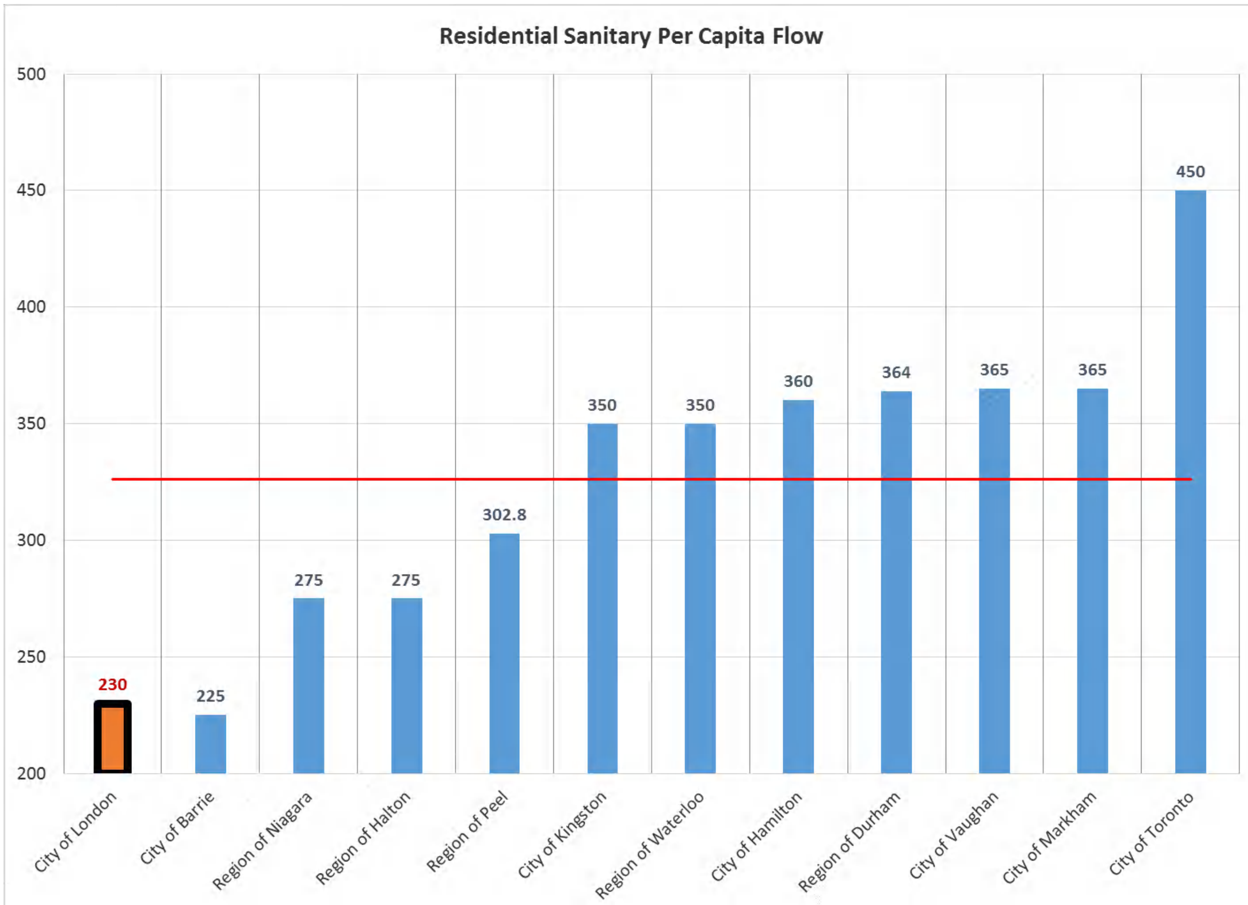

Figure 2: Dry Weather Flow Comparison

The range of residential sanitary flow rates varies widely within the MOECC guidelines between 225 L/cap/d and 450 L/cap/d. The average of the 12 municipalities shown above is **326 L/cap/d**, with the City of London being at the lower limit of the range. Only the City of Barrie has a lower criteria, at 225 L/cap/d (the minimum value recommended by the MOECC).

2.5.2 Inflow/Infiltration Allowance

The figure below shows the relative I/I allowances used by other municipalities across southern Ontario.

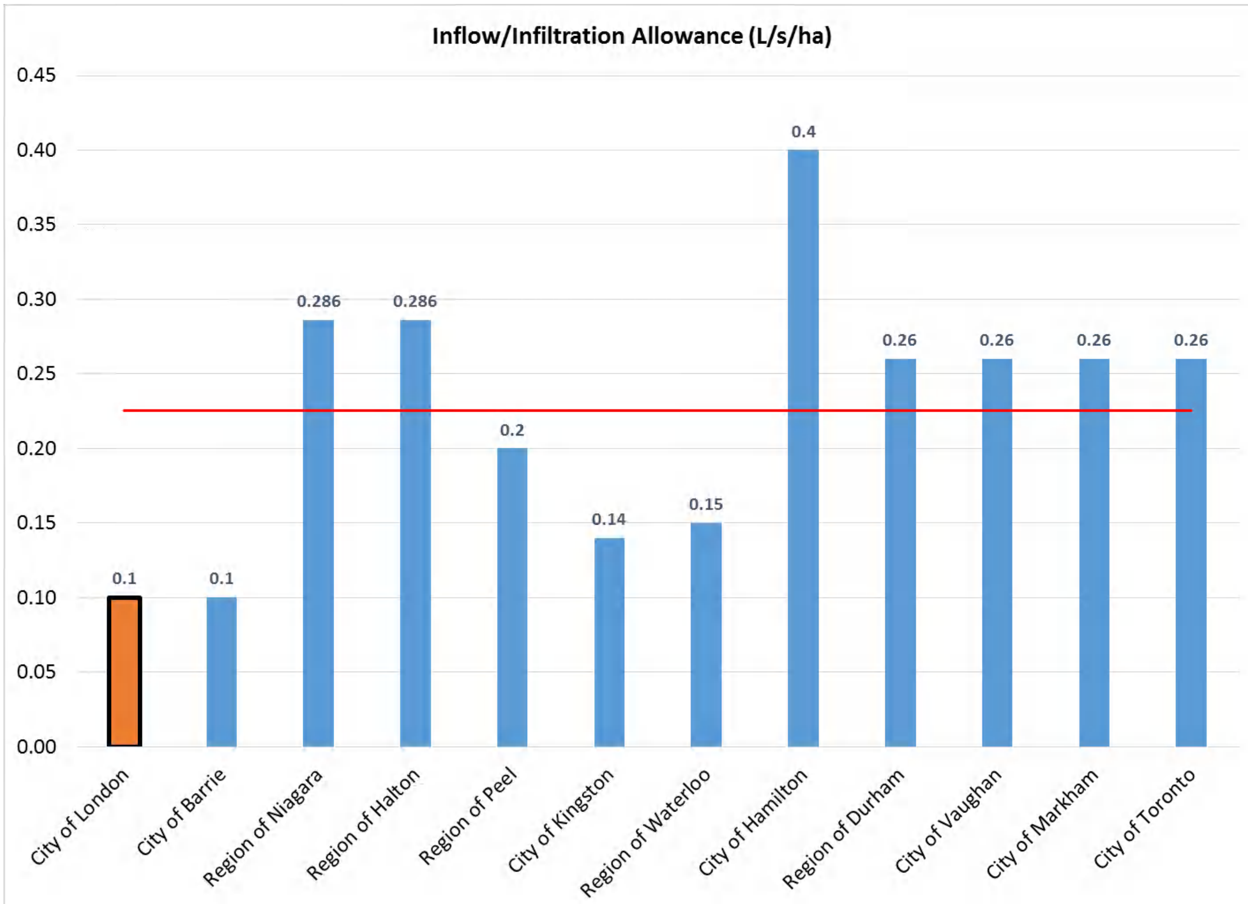

Figure 3: Extraneous Flow Comparison

The average of the 12 municipalities shown above is **0.23 L/s/ha**, with the City of London being at the bottom end of the range. The infiltration allowances being used in the City of London, Barrie, Kingston, and Region of Waterloo are more representative of the “infiltration” component of extraneous flow. The City of Barrie design standards includes text stating that the allowance “does not account for any other extraneous flows such as foundation drain connections, excessive flooding through maintenance hole covers, significant groundwater problems, etc. Where collection system infrastructure is being designed to convey flows from existing developed areas, the extraneous flow allowance used may be increased based on flow monitoring data and/or system modelling, as directed by the City of Barrie.” The current City of London standards do not have any similar statements; GM BluePlan suggests consideration of similar inclusion in future updates to the Design Standards.

Table 6 tabulates the existing per capita sanitary flow and extraneous flow rate allowances utilized by other municipalities within the Greater Toronto and surrounding area.

Table 6. Summary of Wastewater Flow Rate Criteria Review

Municipality / Guideline		[(1)]Population	Residential DWF (L/cap/d)	Extraneous Flow Allowance (L/s/ha)	Peaking Factor Methodology	Sewer Design Flow Basis (L/cap/d)	I/I Allowance Application
City of London, ON	Lake	366,151	230	0.100	Harmon Formula	PWWF = DWF*PF + II (uncertain development factor of 1.1 applies to parcels < 200 ha)	"infiltration allowance"
City of Hamilton, ON	Lake	519,949	360	0.400 - 0.600	Babbitt Formula (2 < M < 5)	PWWF = DWF*PF + II	"0.4 L/s/ha … for areas where the storm sewer is below the weeping tiles of the dwellings, or where a separate FDC sewer is proposed" "0.6 L/s/ha for areas where the weeping tiles of the dwellings are drained by sump pumps…"
City of Barrie, ON	Land-locked	187,013	225	0.10	Harmon Formula (min: 2.0, max: 4.0)	PWWF = DWF*PF + II	"Where infrastructure is being designed to convey flows from existing developed areas, the extraneous flow allowance may be increased based on flow monitoring data and/or system modelling, as directed by the City".
City of Vaughan, ON	Land-locked	288,301	364	0.260	Harmon Formula	PWWF = DWF*PF + II	"infiltration allowance, excluding Kleinburg … 0.23 L/s/ha for sewersheds within Kleinburg WPCP"
City of Markham, ON	Land-locked	301,709	365	0.260	Harmon Formula	PWWF = DWF*PF + II	"infiltration contribution"
City of Kingston, ON	Lake	159,561	350	0.14	Harmon Formula (min: 2.75, max: 4.0)	PWWF = DWF*PF + II	"infiltration contribution"
City of Ottawa, ON	Land-locked	883,391	350	0.28	Harmon Formula (max: 4.0)	PWWF = DWF*PF + II	
City of Toronto, ON	Lake	2,615,060	240 / 450	0.26	Harmon Formula	PWWF = DWF*PF + II	"240 L/cap/d … in fully separated storm and sanitary sewer areas where no D/S and FDs are connected to the sanitary sewer and II has been established" "450 L/cap/d … where new local sewers are planned or when a greenfield development is proposed"
[(2)]Region of Waterloo, ON	Land-locked	507,096	350	0.150	Harmon Formula	PWWF = DWF*PF + II	"infiltration allowance of 0.15 L/s/ha or as directed by the Municipality"
Niagara Region, ON	Lake	431,346	275	0.286	Harmon Formula	PWWF = DWF*PF + II	Extraneous Flow Allowance: "to account for additional wet weather flow in future, a wet weather allowance…"
Region of Halton, ON	Lake	501,669	275	0.286	Harmon Formula	PWWF = DWF*PF + II	"infiltration allowance"
Region of Peel, ON	Lake	1,296,814	302.8	0.20	Harmon Formula	PWWF = DWF*PF + II	"infiltration portion of sewage flow … additional allowance for foundation drains (FD) 0.08 L/s/FD, additional allowance for MH inflow 0.28 L/s/MH or 0.028 L/s/m of sewer length)
Region of Durham, ON	Lake	608,124	364	0.26 – 0.52	Harmon Formula	PWWF = DWF*PF + II	"0.26 L/s/ha when foundation drains *are not* connected to the sanitary sewer" "0.52 L/s/ha when foundation drains *are* connected to the sanitary sewer"
Ontario Ministry of the Environment and Climate Change (MOECC)	--	--	225 – 450	N/A	Harmon or Babbitt Formula	PWWF = DWF*PF + II	Currently, no explicit values of extraneous flow allowances are provided in the MOECC Design Guidelines for Sewage Works (2008). Previous versions of the design guidelines included 0.286 L/s/ha as "infiltration allowance … but is intended to cover the peak extraneous flows from all sources (i.e. infiltration and inflow), likely to contribute non-waste flows to the sewer system".

[(1)]Population based on 2011 Census data and therefore includes population not serviced by water and/or wastewater infrastructure.
[(2)]Design guidelines apply to a number of area municipalities including the City of Guelph, City of Kitchener, City of Cambridge, City of Waterloo, Township of Woolwich, Township of Wilmot, Township of North Dumfries, and Township of Wellesley.
Acronyms: PDWF = Peak Dry Weather Flow; PWWF = Peak Wet Weather Flow; II = Peak Inflow and Infiltration; PF = Peak Factor

2.6 Flow Survey Monitor Data Review and Analysis

To support the ongoing CASS, an analysis of flow monitoring data was completed in order to inform discussions around design criteria and actual flows observed in the City of London. The analysis leveraged the flow monitoring completed for the PPCP in the City of London that GM BluePlan carried out for Hydraulic Modelling Assignment 8 in 2015 and Assignment 9 in 2016.

Assignment 8 catchment covers a part of the City's downtown core. Assignment 9 catchment covers an area within the Southwest section of the City and is expected to be complete by Fall 2016.

The statistical analysis for the flow data presented in this report was completed using GM BluePlan's Wastewater Inflow and Infiltration Flow Analysis Tool (WiiFAT) and is based on **5 monitors** in Assignment 8 (out of 8 monitors installed) **plus 6 monitors** in Assignment 9 (out of 11 monitors installed). Not all monitors were used for the analysis due to a variety of reasons, including where the catchment area was very small, the monitor location was close to a flow split, where an overflow could skew the results or where the catchment population information created erroneous results.

The flow monitoring data was used to complete a suite of analyses, including a dry weather flow analysis and an extraneous wet weather flow analysis. The flow monitors recorded data for approximately 9 months, from April to December 2015.

Figure 4 shows the approximate location of Assignments 8 and 9 (including 9a and 9b).

Figure 4. Hydraulic Modelling Assignments Flow Monitor Catchment Areas

2.6.1 Flow Monitoring Data Analysis Methodology

A statistical analysis was completed for each flow monitor survey to identify average values, extent of variability, appropriate ranges, and potential outliers. The two key outputs that were assessed are:

- Dry Weather Per Capita Sanitary Flow (L/cap/d) – DWF
- Peak Unit RDII (L/s/ha).

Due to the large variation in observed DWF, a result of varying population, usage and seasonal amounts of groundwater infiltration (GWI), further analysis was completed in an attempt to isolate the sanitary flows from the base GWI.

It should be noted that the per capita sanitary flow and peak unit RDII values depend on the accuracy of the population numbers and catchment areas, which is why a statistical analysis can provide great value.

Statistical Analysis: Box-and-Whisker Plot

The statistical analysis that was used is a box-and-whisker plot; a graphical method of presenting the degree of dispersion and skewness of data points centered on a dataset's quartiles (the box) and upper and lower limits (the whiskers).

The lower limit of the box represents the 25th percentile, the upper limit of the box represents the 75th percentile, and the interior band is the median. The whiskers represent the lowest and highest data points within 1.5 interquartile range (IQR) of the first and third quartiles respectively, where the IQR is equal to the height of the box (Q1 to Q3). Any data points outside of the whiskers are considered outliers.

2.6.2 Per Capita Sanitary Flow

The average per capita sanitary flow rate was estimated as part of the dry weather flow analysis. It should be noted that these values are highly dependent on the accuracy of the estimated population numbers within the flow monitoring catchments. With probable outliers removed, the per capita sanitary flow rates range from ***110 - 425 L/cap/d*** with a median of ***275 L/cap/d***; the central 50% ranges from 148 - 300 L/cap/d.

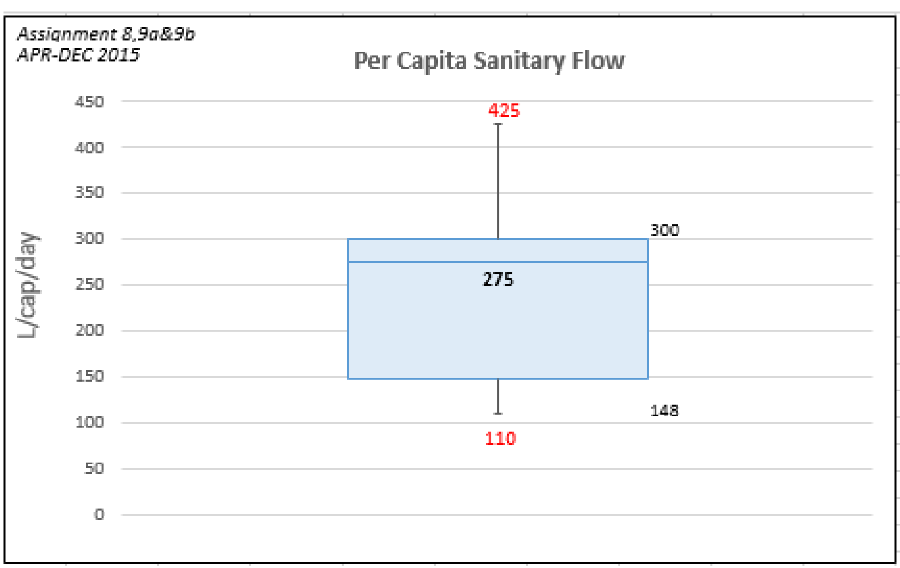

Figure 5. Flow Survey Analysis – Per Capita Sanitary Flow

2.6.3 *Rainfall Derived Inflow and Infiltration (RDII)*

The peak unit RDII rate was estimated as part of the wet weather flow analysis. This statistical analysis was completed for flow monitors located in sanitary sewers only. With probable outliers removed, the peak unit RDII rates range from **0.36 – 1.52** L/s/ha with an average of **0.82** L/s/ha; the central 50% ranges from 0.52 – 1.06 L/s/ha.

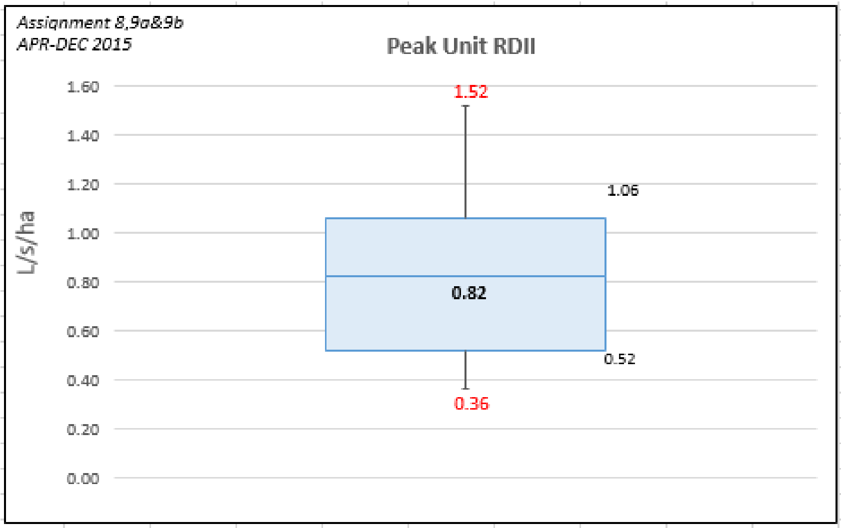

Figure 6: Flow Survey Analysis – Peak Unit RDII

2.6.4 *Base Groundwater Infiltration*

The base groundwater infiltration rate was estimated as part of the dry weather flow analysis. With probable outliers removed, the base groundwater infiltration rates from **0.02 – 0.12** L/s/ha with an average of **0.06** L/s/ha; the central 50% ranges from 0.03 – 0.08 L/s/ha.

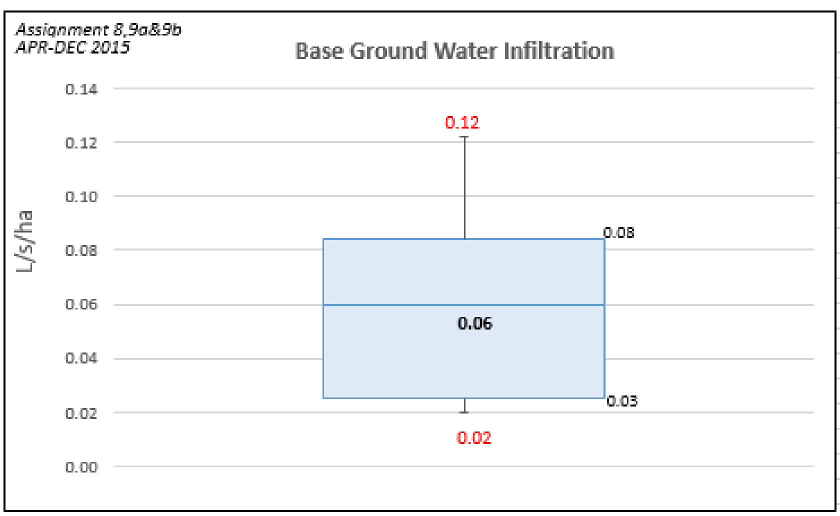

Figure 7. Flow Survey Analysis – Base GWI

Table 7 summarizes the results of the flow survey analysis.

Table 7. Flow Survey Results

Statistic	*Average DWF (L/cap/d)	*Peak Unit RDII (L/s/ha)	*Base GWI (L/s/ha)
Upper Limit	425	1.52	0.12
Median	**275**	**0.82**	**0.06**
Lower Limit	110	0.36	0.02

Results based on flow data collected and analyzed using **5 monitors in Assignment 8 (out of 8 monitors installed) **plus 6 monitors** in Assignment 9 (out of 11 monitors installed).*

The findings of this analysis indicate that the current dry weather (per capita) and extraneous flow criteria are not reflective of the City's performance of the existing wastewater collection system, in particular within growth areas and generally outside of the downtown area. Based on the results, the average observed DWF of 275 L/cap/d is almost 20% greater than the DWF criteria of 230 L/cap/d. The observed DWF is considered typical for Ontario municipalities and is more in line with the design criteria being used in other municipalities (e.g. Halton, Niagara, and Brantford).

The average observed peak unit RDII of 0.82 L/s/ha is more than eight times greater than the "infiltration allowance" of 0.1 L/s/ha. In fact, the infiltration allowance of 0.1 L/s/ha is more representative of the average base groundwater infiltration of 0.06 L/s/ha, and as such does not reflect the full extent of the "infiltration" or "inflow" components of the extraneous flow. The findings are significant especially considering the rainfall events, which ranged from long duration, small intensity to short duration, high intensity events were all characterized as less than 1 in 2 year events. However, the results are based on a small sample of monitors operational within a relatively short period of time.

2.7 Design Criteria Review Summary

The municipal benchmark indicated that the average per capita sanitary flow criteria for the municipalities reviewed is ***326L/cap/d*** (range from ***225 - 450***), and the average I/I allowance is ***0.23 L/s/ha*** (range from ***0.10 - 0.40***). Based on the City of London flow monitoring results reviewed, the average observed DWF of **275 L/cap/d**, almost 20% greater than the existing DWF criteria of 230 L/cap/d. The average observed peak unit RDII of **0.82 L/s/ha** is more than eight times greater than the existing "infiltration allowance" of 0.1 L/s/ha. In fact, the infiltration allowance of 0.1 L/s/ha is more representative of the average base groundwater infiltration of 0.06 L/s/ha, and as such does not reflect the full extent of the "infiltration" or "inflow" components of the extraneous flow.

It should be recognized that new growth, due to new construction and appliance standards and public awareness, is experiencing decreasing water use trends, which will likely decrease typical domestic wastewater generation rates. Extraneous flow, however, is becoming the more critical variable when determining the size of linear sanitary infrastructure. Flow monitoring can often provide beneficial insight into the system with regards to extraneous flow performance. When completing wet weather analyses, it is not uncommon to have areas with I/I rates above the "design allowance". With the increases in wet weather event intensity and frequency attributable to climate change, rainfall-derived inflow and infiltration (RDII) will continue to place a significant strain on the capacity of the receiving sanitary sewer system.

Like other Canadian municipalities, the City of London has prioritized the reduction of I/I through its commitment to undertake a number of measures to address wet weather related issues. These initiatives range in scope and include I/I studies (to identify and locate sources of RDII), the tactical abatement of extraneous flow in the existing system and on public/private property, and more pre-emptive measures such as changes in policies, bylaws, design criteria, and or construction/inspection standards. While new growth areas are typically assumed to be efficient and "tighter" systems, the use of design criteria needs to consider long-term flow projections and the condition of the systems over time. Moreover, the prevalence of I/I issues in new subdivisions have become increasingly apparent to municipalities, evidenced through flow monitoring and inspections. As such, a reasonable design criteria allocation for I/I is considered good practice to maintain some flexibility for system capacity in the long-term planning of subcatchment areas.

The industry review shows that the City of London has adopted a DWF criteria that is below the average of other Ontario municipalities. It appears that this has been done to reflect a continuing trend across the industry to lower the per capita design rates based on the trend of decreasing water consumption. However, given the observed DWF rates in London that exceed the 230 L/cap/d, we recommend, at a minimum, the continued use of the City's uncertain development factor (1.1) for the application of growth. This would result in a per capita rate of ***253 L/cap/d*** (230 x 1.1 = 253).

The City of London's current I/I "allowance" is also reflective of the City's commitment to abatement of I/I in the existing system and prevention through construction of "tighter" systems. The industry review shows the trend to appear relatively stable, with municipalities reviewed for the CASS averaging 0.23 L/s/ha. However, it is also known that some municipalities, such as the Region of Peel are considering increasing their design I/I allowance to reflect true performance of the system. Given the observed peak unit I/I rates in London that exceed the current criteria, we recommend the City review their I/I criteria. In addition, in the short term, we recommend including a statement in the City's design standards that allows for adjustment to the standards for extenuating circumstances or the availability of observed data. For example: The city may direct the designer to apply a higher allowance, as appropriate, based on observed data, known extraneous connections or other pertinent information. For the purposes of the wastewater component of the CASS, I/I flow allowances will not impact the assessment as the application of intensification growth in an existing built area does not include the addition of I/I flows.

2.8 Design Criteria Summary

The following summarizes the design criteria that will be used for the purposes of the CASS:

- Average dry weather flow (DWF) of 230 L/cap/d
- Harmon Peaking Factor applied to computer peak sanitary flow
- Infiltration allowance of 8,640 L/ha/d or 0.10 L/s/ha → ***not applicable to the CASS as intensification growth will not increase existing levels of extraneous flow***
- Uncertain Development Factor of 1.1
- Peak Flow = (Population * DWF * Peaking Factor * Uncertain Development Factor) + Infiltration

3 Policy

3.1 Introduction

The purpose of Development Charges policy is to ensure that growth pays for growth in an equitable manner. The CASS wastewater project focusses on growth in a downtown core context which brings existing infrastructure and existing constraints into consideration with the new requirements to service growth. This presents challenges around the funding of intensification projects which need to be balanced with benefit to existing customers, concurrent roads and transit improvements and level of service. The Development Charges Act has been in place since 1997 and effectively used by municipalities to collect and fund required servicing.

A 2015 amendment to the *Development Charges Act* introduced new policies. One of these new requirements is that municipalities must now consider areas-specific charges for all services as part of their background studies. However, the Province has not provided details describing how municipalities would go about meeting this requirement.

As such, City staff will need to consider the following for future DC Background Studies:

- Options for area delineation (e.g. built boundary vs greenfield)
- Types of services suitable for an area-specific DC
- Financial and administrative implications of adopting area-specific DCs
- Alternative methods for structure of DC rates to achieve the policy objectives and priorities (e.g. allocation of costs to intensification areas)

The industry DC policy review will provide alternative methods of determining DC-eligible works for intensification and infill (i.e. non-greenfield areas) and recommendations on any suggested changes to the existing Local Service Policy that are appropriate for the City of London. It is understood that the costs for linear infrastructure works identified as part of the CASS will need to address non-growth costs, growth costs, and the Res/ICI allocations for the City's wastewater system.

The City of London's DC By-law and Local Service Policy for Wastewater infrastructure (2014 DC Study, Appendix N) was reviewed and compared against those used by other municipalities. Section 3.5 provides a summary of the findings.

3.2 Existing DC Bylaw

The City of London Development Charges By-law was adopted under the Development Charges Act (1997) as a means to recover the service related costs for new growth. The City's Local Service Policy for Wastewater infrastructure currently does not differentiate between infill, intensification, or greenfield growth areas. The following outlines the existing DC bylaw.

3.2.1 Local Service Policy

The following provides the definition of "local service" under the Development Charges Act, 1997 (DCA) for wastewater services provided by the City of London and is intended to determine the eligible capital costs for inclusion in the development charges (DC) calculation for the City.

A "local service" is defined as an infrastructure asset that is:

- Internal to a development, or
- External to a development, but is needed to support or link to a specific development

Local services are not to be included in the calculation of development charge rates and are considered to be the direct responsibility of the developer (s.59 of the DCA) and shall be recovered under other agreements with the landowner or developer.

In the case of the City of London, all sewers required to service growth larger than 450mm Ø and satisfy a regional benefit are eligible for Development Charges. If a sewer is identified by the City as strategic and provides regional benefit then any size sewer can be considered eligible for Development Charges.

In other cases where sewers are not providing regional benefit then sewers greater that 250mm Ø are eligible for DCs.

The full Local Service Policy is provided for reference in Appendix A.

3.2.2 Growth/Non Growth

The *2014 Wastewater Servicing Master Plan Update and Development Charge Background Study* provides a Benefit to Existing (BTE) or non-growth share calculation. This uses the pipe cost of the replacement required, discounted for any residual life, and assumes a life expectancy of **80 years** for buried infrastructure. An approximated value of **10%** was assumed as the **local share of the intensification infrastructure**. The actual local cost is to be determined once development occurs and is calculated on a flow proportional basis.

To determine growth/non-growth components, the following procedures apply:

- For new pipe works driven by growth needs, non-growth components are primarily 0% (unless existing areas were to be serviced, then the percentage would reflect this), and growth components were 100%.
- For facility related components, expansion requirements were driven by engineering reports of a re-design nature where available (i.e. Greenway WWTP, Adelaide WWTP and Vauxhall WWTP). Growth/Non-Growth allocations are then determined by confirming flows to each facility, and future flow requirements.
- Growth oversizing for trunk sewer works is determined by calculating the post period benefit the installed capacity to be provided to the future flow capacity.
- Growth oversizing for facilities were addressed by pro-rating the future installed capacity.

3.3 Assessment of Existing DC Practices

The City's 2014 DC identifies works required to service growth over a 20 year period from 2014 through 2033 within the Growth Management Implementation Strategy (GMIS) boundary. These works were also sized to address future growth needs based on the City's Urban Growth Boundary (UGB) and/or Build Out information. Smaller service areas, less than 250 mm diameter were considered to be direct developer responsibility.

Based on a review of the distribution of servicing costs (Table 3-7), it appears that DCs are currently calculated as follows:

Growth Costs = Total Estimated Costs – (Non-Growth Costs for Water + Wastewater + Stormwater),

where Non-Growth Costs = Replacement Cost – Unused Life Credit

Replacement costs are determined based on the unit costs for pipes (Table 3-3) multiplied by the length of pipe. Unused Life Credit assumes a life expectancy of 80 years for buried infrastructure. It should be noted that the replacement costs appear very low for these projects but are attributed to the low unit pipe costs presented in Table 3-3, which do not include the cost of installation.

3.4 DC Terminology and Definitions

This section provides a discussion on the key components that make up growth and non-growth related needs and corresponding costs, including oversizing, post period benefit, and benefit to existing. The definitions below are those proposed for use in the CASS project. The methodologies presented herein reinforce the need for on-going review and updating of the DC horizon and projected capital program. In Ontario, a DC By-law has a maximum of life of 5 years. This ensures updating of the DC to capture the rolling change of in-period projects.

3.4.1 Oversizing

Local Servicing Policies define infrastructure that is considered to be the direct responsibility of the developer and infrastructure that should be included in the calculation of the Development Charges rate. The Local Servicing Policy establishes the size and parameters of when the developer is required to pay the full cost of installation of sanitary sewers. This is described as the “Direct Developers Contribution”. Should the size of the local infrastructure be required to be greater than the minimum local servicing sizes (i.e. to support external development), Development Charges contributions shall be made, this is referred to as “oversizing”. The Municipality contributes, through the Development Charges Fund towards the cost to install the infrastructure on a “Flat Rate” basis. “Flat Rate” is defined as the cost difference between the size required for internal and external development and the size required to service internal development (the “Direct Development Contribution”).

3.4.2 Post period benefit

Although development charge planning horizons are typically 10 to 20 years, it is good engineering practice to provide sufficient capacity to meet infrastructure servicing requirements beyond 20 years, particularly for large diameter trunk piping and major structural components of facilities. Post-period benefit is taken into account with projects that provide an additional allowance to service growth beyond the planning period. The difference in cost for the recommended size of infrastructure to meet the planning (DC) horizon and the size of infrastructure selected that would serve post period growth. Planning projections for full build out scenarios can be used to indicate the extent of additional flows beyond the planning (DC) horizon.

3.4.3 Grants and subsidies

The application of grants, subsidies and funding from other sources is an important consideration for development charges. Particular relevance is the SHIFT rapid transit project that may generate needs to relocate infrastructure, creating opportunity to upsize or separate existing sewers to accommodate growth. The application of funding from SHIFT will need to be equitably calculated.

Similarly, any other grants or funding will require consideration when assessing the Benefit to Existing. Should the funds be accounted for before any BTE calculation or should it be applied after, to either the rate base or growth portions? These questions are case specific and relate to the source and reason for funding.

3.4.4 Approaches to Apportionment

Most municipalities have a Region or City-wide Development Charge, where two tier municipalities typically have both Region and local DC rates. DCs are intended to account for all costs associated with growth, commonly referred to as "soft costs" (e.g. police services, hospitals, libraries, community services, etc) and "hard" costs (e.g. transportation/roads, stormwater, water, and wastewater).

Several Municipalities have periodically applied area specific development charges to account for major differences in servicing costs due to geographic location and the increased cost to service and provide projects/infrastructure solely required for those areas.

3.4.5 Benefit to Existing

Benefit to Existing (BTE) represents the non-growth components identified for certain projects which benefit the existing service area. These components are typically associated with upgrade to the existing systems or facilities necessary to continue to provide service to existing residential and ICI users. These projects may also involve upgrades or expansions which provide additional capacity to meet growth in the service area. Given that the CASS is focused in the City's core area, with aging infrastructure that has experienced historic flooding issues in the past, it is anticipated that many CASS projects identified will have associated BTE components.

The premise is that any costs associated with BTE should be removed from the Development Charge rate calculation. There are several way to calculate BTE, each with advantages and disadvantages, which in many cases are dependent on the situation that they are applied.

3.5 Review of Other Municipalities

GM BluePlan completed a review of other municipality's publically available information regarding Development Charges policy. Generally, the Development Charge rates are available but the specific details of approach, such as how was BTE actually calculated, was not readily available.

The case studies below, for the most part, are based on working knowledge and not publically available information. The examples have been chose to highlight specific features relevant to the City of London, such as: area specific DCs, approach to intensification DCs, inclusion of capacity gain projects (I/I reduction) and pre-defined DC growth/non growth splits.

3.5.1 Halton Region

3.5.1.1 Halton's Area Specific DC

The Region serves as an example of a municipality that has used an area specific approach to DCs in the past. One of the drivers for this was the "big pipe" transfer of lake-based water supply to the Town of Milton. The premise of separating the DCs for Milton from those of its neighbouring municipalities to the south, was based on the question of "*why should development outside of Milton help front the costs of infrastructure purely needed to meet growth in Milton?"* As a result, the Region adopted an area-specific DC for Milton.

3.5.1.2 Halton's Approach to Intensification Projects

Halton Region provides a good example of a municipality that demonstrates evolving DC policies over time. In 2012, the Region of Halton's DC Background Study identified specific intensification projects included in the DC. A new DC Eligibility policy also included pipes smaller than the standard minimum size as defined through the Local Servicing Policy.

In the latest 2017 DC Background Study, projects have changed and Benefit to Existing review has been undertaken to include intensification projects. The Region of Halton's current DC policy framework accounts for residential vs employment growth, benefit to existing users of water and wastewater services, and benefit to growth beyond the Region's planning period (e.g. 2031). The Region recently underwent a process to review the need for infrastructure projects, which ranged from security/redundancy requirements, growth related, and non-growth related needs.

A Benefit to Existing (BTE) ratio was calculated as the ratio of the existing capacity deficiency, relative to the total increase in capacity required for both existing and growth needs. BTE was calculated as:

BTE = Existing deficiency / (growth flow + existing deficiency)

When considering intensification, critical security/redundancy requirements and impacts on critical existing trunk infrastructure were also considered. For projects involving construction in intensification areas, additional cost escalation factors were applied to project costs, providing additional provisions for utility coordination/relocation, urban reinstatement, and urban construction impacts.

The Region has adopted a capital implementation plan containing projects being classified into the following three categories:

1. ***Capacity:*** Projects related to Region-wide needs of water supply/wastewater treatment or supporting the transfer/conveyance of capacity.
2. ***Distribution – Greenfield:*** Projects that support service to Greenfield growth outside the current urban built boundary
3. ***Distribution – Built Boundary:*** Projects that support service to growth within the current urban built boundary, including infill and intensification within urban growth centres and corridors

Figure 8 below illustrates the application of the above concept to a water distribution network. This simplified schematic shows a booster pumping station transferring water supply via a trunk watermain to the next subsequent pressure zone filling a reservoir within a greenfield area. The trunk watermain and pumping stations are Category 1 projects as they provide Region-wide capacity to the system. The reservoir is a Category 2 project as it supports growth to a greenfield area outside the built boundary. The local watermains are Category 3 as it provides distribution within the built boundary.

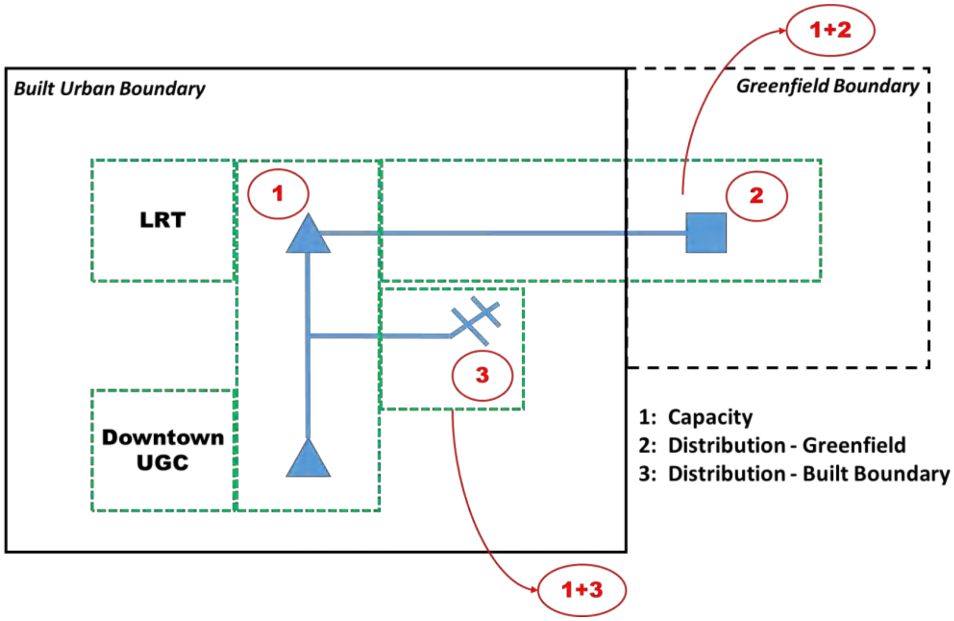

Figure 8. Project DC Classification Schematic

The cost of the local watermains will be split among Categories 1 and 3, as those projects benefit from the increased Region-wide capacity (Project 1) and from growth within the current urban built boundary (Project 3). Similarly, the cost of the reservoir will be split among Categories 1 and 2.

3.5.2 City of Hamilton: Pre-defined Growth/Non Growth Splits

The City of Hamilton identifies projects throughout the City and rolls the costs up into a uniform DC in order for the City to ensure securing DC funding for the budget year. The City now applies an ***intensification lump sum allowance, where the split is 50% development and 50% rate base***.

Similar to the City of London, the City of Hamilton has received full capital funding from the Province for a Light Rail Transit (LRT). Currently, the City is looking to initiate a study that will consider implications of the LRT on existing services, including relocation of existing infrastructure and sewer separation. This study will present an opportunity for the City to update the BTE approach specifically for intensification areas.

3.5.3 Region of Peel: inclusion of I/I reduction costs in DCs

The Region of Peel's 2014 DC program resulted in additional programs that included $100 million for inflow and infiltration reduction mitigation measures and initiatives. The latest DC update includes a distribution and collection system review that will be used to identify further local water and wastewater projects. The Region, like the City of Hamilton, identifies all the projects and rolls them up into a uniform DC. However, with increased pressure for intensification growth and increased costs of infrastructure to extend services into greenfield areas, the Region is now undertaking area-specific cost reviews to assess value and cost of area-specific development (i.e. cost of infrastructure vs DC revenue).

3.5.4 City of Ottawa: Incentivizing Intensification Growth

DC rates sometimes reflect a municipality's desire to effect or promote more efficient land use. For instance, the City of Ottawa levies a lower DC ($16,447 / unit) for development within the inner boundary of the city's designated Greenbelt than areas beyond the outer boundary of the Greenbelt ($24,650 / unit).[1]

3.6 Review of Alternative BTE Methodologies

The following section reviews the existing BTE methodology and compares it to several alternative summarizing the advantage and disadvantages of each.

3.6.1 Method 1 – Age of pipe using cost of pipe material (existing approach)

The current City of London practice to calculate BTE is based on 'Age of Pipe' and 'Unused Life Credit' methodology.

The approach is documented in the 2014 Wastewater Servicing Master Plan (Section 3.9.3). As noted, it is based on cost of pipe material, not the full replacement value required, discounted for any residual life. The reasoning for using only cost of pipe is not provided. The approach assumes a life expectancy of 80 years for buried infrastructure.

$$Unused\ life\ Credit = \frac{80-Age}{80}\ X\ (Cost\ of\ pipe)[minimum\ value = 0]$$

Noted in the Master Plan, following this calculation an approximated value of 10% is used as the local share of the intensification infrastructure. The actual local cost will be determined at the time of the initiating development and would be calculated on a flow proportional basis.

The following provides a simplified hypothetical example to highlight the potential impact on the cost split calculation:

- Assume existing pipe is 300mmØ
- Assume existing pipe is 60 years old
- Assume life expectancy is 80 years
- Like for Like replacement value is $800 k
- Pipe material cost is $200 k
- Under growth conditions a 400mmØ is required at a cost of $1 million

Cost of pipe approach calculation:

Total growth project cost:	= $1 million
60/80 = 0.75 (age factor) * $200k (cost of pipe)	= $150k (benefit to existing)
$1m (Project cost) - $150k (age credit)	= $850k
10% of $850k (local service, 10%)	= $85k (benefit to existing)
$850k (age factored project cost) - $85k (10% local service)	= $765k Total DC Cost

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[1] *Development Charge Consultation Document. Development Charges Act.*

Advantages and disadvantages of using this approach to calculate BTE are summarized as follows:

Advantages	Disadvantages
Was used in 2014 DC Background study	In downtown core many pipes exceed assumed life ages; no unused life credit but sewer still serviceable
Unused life credit provides estimate of BTE	Assumed life age definition subject to challenge
Relatively easy to apply	Accurate asset data required to identify age of pipe
Understandable concept easy to communicate to stakeholders	Significant BTE differences between cost of pipe and cost of replacement. Cost of pipe approach difficult to justify
No specialist tools (e.g. hydraulic modelling software) required	

3.6.2 *Method 2 – Age of pipe using cost of full pipe replacement*

A variation to the existing approach could use the full like for like replacement cost and apply the unused life credit factor to that cost. This would likely produce a larger Benefit to Existing component of cost but could be more equitable and justifiable as an approach to calculate BTE. In addition, where the existing pipe has exceeded the assumed life expectancy a default minimum percentage remaining (e.g. 10%) can be applied to acknowledge the fact that whilst the pipe has exceeded expected age it is still in serviceable condition.

The following provides a simplified hypothetical example to highlight the potential impact on the cost split calculation:

- Assume existing pipe is 300mmØ
- Assume existing pipe is 60 years old
- Assume life expectancy is 80 years
- Like for Like replacement value is $800 k
- Pipe material cost is $200 k
- Under growth conditions a 400mmØ is required at a cost of $1 million

Cost of pipe replacement approach:

Total growth project cost	= $1 million
$1m - $800k (growth component only cost)	= $200k
60/80 = 0.75 (age factor) * $800k (cost of replacement)	= $600k (benefit to existing)
$800k (replacement cost) - $600k (BTE)	= $200k
$200k (growth component cost) + $200k (age remaining cost)	= $400k Total DC Cost

Advantages and disadvantages of using this approach to calculate BTE are summarized as follows:

Advantages	Disadvantages
Similar in concept to the 2014 DC Background study	Different approach to agreed and implemented 2014 DC study
Unused life credit provides estimate of BTE	In downtown core many pipes exceed assumed life ages; no unused life credit but sewer still serviceable
Relatively easy to apply	Assumed life age definition subject to challenge
Understandable concept easy to communicate to stakeholders	Accurate asset data required to identify age of pipe
No specialist tools (e.g. hydraulic modelling software) required	Significant BTE differences between cost of pipe and cost of replacement. Cost of pipe approach difficult to justify

3.6.3 Method 3 - Level of Service Range Approach

For intensification projects, the calculation of benefit to existing (BTE) can be complicated. The following approach seeks to apply simple rules that align with an industry recognized levels of service. The simplicity of the approach provides transparency and understanding to all stakeholders.

For the City of London, the accepted level of service is to achieve F-5-5 requirements of wet weather flow capture. Although not documented, it is inherent to provide protection against service interruption or issues (flooding) for a 1in5 year design storm event. The target level of service is to provide capacity for these flows in all sewers without causing surcharge. However, the assessment of these triggers, flooding and surcharge, are very different. ***Flooding*** is observable and usually occurs as a direct level of service failure from the customer perspective. It is validated through observable events. ***Surcharge*** is usually not observable and is usually assessed using a computer hydraulic model. It is therefore a theoretical level of service failure. Surcharge can occur without any adverse customer impacts.

The following defines the categories and associated cost splits to apply for the varying potential circumstances.

- If there is no existing issues, surcharge or flooding, and the growth flows trigger an issue then 100% of costs are attributable to growth

- If there is an existing theoretical LOS failure (exceeding 85% pipe full but less than 100% during a 1in5 year event) then costs are split 75/25, majority to growth. The premise here is that no project would be implemented to mitigate the existing theoretical issues as there is no customer LOS driver. The theoretical response to development would be that there is no additional available capacity therefore a new pipe is required to convey growth flows.

- If there is an existing theoretical LOS failure (surcharge greater than 100% pipe full during a 1in5 year event) then costs are split 50/50, majority to growth. The premise here is that no project would be implemented to mitigate the existing theoretical issues as there is no customer LOS driver. The theoretical response to development would be that there is no additional available capacity therefore a new pipe is required to convey growth flows.

- If there is an existing theoretical LOS failure related to flooding or surcharge to within 1.8m of ground level, then cost are split 75/25, majority to the rate base. This may be supported by assessing recent observed and reported flooding incident records.

- If there is an existing theoretical and repeated observable flooding issue that can be attributed to inadequate capacity of the sewer system then 100% of costs are attributable to the rate base. If a pipe is oversized to convey future growth flows then that portion of the costs are attributable to growth.

- If there is existing capacity to allow growth to proceed without compromising the defined LOS target LOS issues then no project is required and no costs incurred.

This approach applies cost splits as a predefined range based on Level of service. Advantages and disadvantages are summarized as follows:

Advantages	Disadvantages
Provides a defined range of BTE estimates	Different approach to agreed and implemented 2014 DC study
BTE splits relate directly to Level of Service	Requires and relies on availability and quality of hydraulic modelling tools
Understandable concept easy to communicate to stakeholders	Some scenarios may not be appropriately calculated
Allows for BTE differentiation between projects and scenarios	

3.6.4 Method 4 - Deficiency Ratio Approach

This approach requires the use of a hydraulic model to assess existing flows and existing capacity deficits to provide a ratio with proposed growth flows. The approach has been used by other municipalities for DC rate allocation. The analysis of capacity, in terms of which pipe to assess, can create some subjectivity and challenge to the approach. In addition the technical nature of the method means that non-technical stakeholders can find it difficult to fully understand.

BTE share is ratio of the existing capacity deficiency, relative to the total increase in capacity required for both existing and growth

BTE Calculated as existing deficiency / (growth flow + existing deficiency)

An Example: an existing sewer has a pipe full capacity of 100l/s. Peak flows in the existing sewer are 120l/s. This results in an existing deficiency of 20l/s (120l/s – 100l/s = 20l/s). New proposed growth flows equate to 40l/s. The resulting equation is 20l/s (existing deficiency) / 60l/s (growth flow + existing deficiency) = 0.33 BTE factor.

This method is further described in Section 3.5.1.

Advantages and disadvantages of using this approach to calculate BTE are summarized as follows:

Advantages	Disadvantages
Provides specific project by project BTE estimates	Different approach to agreed and implemented 2014 DC study
Result is not skewed by proportion of existing flow in relation to growth flow	Requires and relies on availability and quality of hydraulic modelling tools
Deficiency ratio calculation provides equitable split of costs	Requires significant technical assessment to identify existing capacity deficit
	Open to some subjectivity during assessment; what pipe, pipes etc. are included?
	Complex concept not easy to communicate to stakeholders

3.6.5 Method 5 - Flow Ratio Approach

This approach is very similar to method 4. The difference is that existing capacity deficit is not calculated. It is just the existing versus growth flows that are assessed.

This is conceptually a very simple approach. BTE is calculated as the ratio between the existing sewer flows and the existing plus proposed growth flows.

BTE Calculated as existing flows / (growth flow + existing flows)

An Example: Peak flows in the existing sewer are 120l/s. New proposed growth flows equate to 40l/s. The resulting calculation is 120l/s (existing flows) / 160l/s (growth flow + existing flows) = 0.75 BTE factor.

Advantages and disadvantages of using this approach to calculate BTE are summarized as follows:

Advantages	Disadvantages
Provides a defined range of BTE estimates	Different approach to agreed and implemented 2014 DC study
Potentially accurate calculation; project by project specific assessment	Requires and relies on availability and quality of hydraulic modelling tools
Easier to apply than the deficiency ratio approach	Complex concept not easy to communicate to stakeholders
	Not appropriate for combined systems where existing flows far exceed proposed growth flows.

3.6.6 *Method 6 – Default Percentage*

This approach is the most simple and therefore requires the least amount of analysis. This approach has been used by municipalities for lump sum line items on DC programs before specific projects are defined.

All projects are 50% development charges and 50% rate base.

Advantages and disadvantages of using this approach to calculate BTE are summarized as follows:

Advantages	Disadvantages
Most simple approach	Different approach to agreed and implemented 2014 DC study
No analysis required	Oversimplifies BTE calculation
Understandable concept easy to communicate to stakeholders	No differentiation between different project scenarios
Stakeholders more aware of eligible amounts	Arbitrary split may not be equitable

The table below summarizes the advantages and disadvantages for each approach and assigns a score to each key criteria listed, where '✓' is the lowest or worst and '✓✓✓' is the highest or best score.

The categories used are described as follows:

- Simple concept: the ease of the approach to be understood by non-technical stakeholders
- Easy to apply: how easy and quickly the approach can be applied and the BTE calculation completed
- Technical Resources: the extent of technical staff and tools (software) required to complete the approach
- Potential Accuracy: how likely on a project by project basis the approach is to calculate the most accurate BTE calculation
- Subject to Challenge: how many variables are used in the approach that could be subject to challenge by stakeholders
- Versatility: the ability of the approach to produce equitably results for various scenarios, project types and system types (i.e. combined, sanitary).
- Overall: a general assessment of the approach considering all criteria.

Method	Simple Concept	Easy to Apply	Technical Resources Required	Potential Accuracy	Subject to Challenge	Versatility	Overall
Method 1 – Age of Pipe (pipe only cost)	✓✓	✓✓	✓✓	✓✓	✓✓✓	✓	✓✓
Method – Age of Pipe (replacement cost)	✓✓	✓✓	✓✓	✓✓✓	✓✓	✓	✓✓
Method 3 – Level of Service Range Approach	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓✓
Method 4 – Deficiency Ratio Approach	✓	✓	✓	✓✓✓	✓✓	✓✓✓	✓✓✓
Method 5 – Flow Ratio Approach	✓	✓	✓	✓	✓✓	✓	✓
Method 6 – Default Percentage	✓✓✓	✓✓✓	✓✓✓	✓	✓	✓✓	✓✓

4 Level of Service

4.1 Existing Level of Service

A Level of Service (LOS) review was undertaken to provide a baseline assessment for determining which projects are DC eligible.

In accordance with the DC Act, this is “to ensure that municipalities do not improve their existing levels of service through capital improvements funded by developer contributions, the Act provides protection under (s.5 (1) 4.)”.

The previous DC utilized replacement costs to establish the existing standard (as required by regulation) and provide a comparison between:

- the current cost estimate of planned future services, and;
- the current cost equivalent (considering quality and quantity) of existing services.

However, the 2014 Master Plan and the 2014 DC Update reports do not clearly define LOS in respect to infrastructure requirements for the existing system or growth related needs.

4.1.1 Collection System

Collection system LOS are often based on modelled flows under a specified design event. For a given event, thresholds such as percentage pipe full can be selected that initiate action. These thresholds can vary for pipe types and size, most commonly for trunk and locally defined sewers. Most important for the CASS study is the need to define LOS thresholds that can be used to identify when an infrastructure project is required.

For the purposes of the CASS, it is recommended that a typical trigger for linear infrastructure improvements be based on a 1in5 year and 1in25 year design events. For local sewers, which are usually at a shallower depth it is recommended that a flow threshold for a 1in5 year event of 85% d/D^{max} be used to initiate mitigative measures. For trunk sewers, which are usually deeper with fewer property connections, it is recommended that a threshold of 100% d/D^{max} be used. A 1in25 year event should be used to assess flooding, with predicted manhole flooding or surcharge to within 1.8m of ground level used as an intervention threshold.

These criteria rely on the hydraulic model to be identified, and are therefore theoretical. It may be necessary to identify LOS that is based on observed or reported information, e.g. flooding incidents to meet the needs of other Development Charge components, such as the BTE calculation Method 2, which uses the observed and theoretical measures to identify project requirements.

The occurrence of combined sewers in the City of London complicates the definition of LOS, as collection systems flows and capacities are regulated and relieved by Collection System Overflows (CSOs). In some cases this means that a virtually unlimited amount of growth flows could be accommodated within the pipe system without reaching a threshold, because a CSO relieves the system. However, the growth flow would be discharging from the CSO and as such must be subject to a LOS, as described below.

4.1.2 Treatment

The City of London's wastewater system has approximately 257 overflows and cross-connections between sanitary and combined or sanitary and storm sewers throughout the City[2]. Within the CASS area, there are a number of sanitary sewer overflow connections and interconnections which have led to historic basement flooding in the core area. Due to the nature of the City's combined system, level of service for wastewater treatment and overflow objectives follow the MOECC's F-5-5 regulations as outlined below:

- Requires all dry weather flow and 90% of wet weather flow to be captured and treated (primary treatment) in a typical year
- Minimize adverse impacts caused by CSOs
- Be in minimum compliance with Ontario Water Quality Objectives with respect to *E.coli* at CSO-impacted beaches for 95% of the time, during the period of June 1st to September 30th
- Minimum level of treatment for wet weather flows above dry weather flows is primary treatment or equivalent (30% BOD5 removal and 50% TSS removal)
- For beach protection, additional controls above the minimum CSO controls

[2] *AECOM. 2014. 2014 Wastewater Servicing Master Plan Update and Development Charge Background Study.*

5 Summary

5.1 Design Criteria Summary

Based on the flow monitoring results reviewed, the average observed DWF of **275 L/cap/d** is almost 20% greater than the DWF criteria of 230 L/cap/d. The municipal industry review shows that the City of London has adopted a DWF criteria that is well below the average of other Ontario municipalities. It appears that this has been done to reflect a continuing trend across the industry to lower the per capita design rates based on the trend of decreasing water consumption. However, given the observed DWF rates in London that exceed the 230 L/cap/d and the supporting findings from the industry review, we recommend, at a minimum, using the City's uncertain development factor (1.1) for the application of growth. This would result in a per capita rate of ***253 L/cap/d*** (230 x 1.1 = 253).

The average observed peak unit RDII of **0.82 L/s/ha** is more than eight times greater than the "infiltration allowance" of 0.1 L/s/ha. In fact, the infiltration allowance of 0.1 L/s/ha is more representative of the average base groundwater infiltration of 0.06 L/s/ha, and as such does not reflect the full extent of the "infiltration" or "inflow" components of the extraneous flow. The industry review shows that the municipalities reviewed averaged an I/I allowance of 0.23 L/s/ha. Given the observed peak unit I/I rates in London that exceed the current criteria, we recommend the City review their I/I criteria. In addition, in the short term, we recommend including a statement in the City's design standards that allows for adjustment to the standards for extenuating circumstances or the availability of observed data. For example: "The City may direct the designer to apply a higher allowance, as appropriate, based on observed data, known extraneous connections or other pertinent information". For the purposes of the wastewater component of the CASS, I/I flow allowances will not impact the assessment as the application of intensification growth in an existing built area does not include the addition of I/I flows.

5.2 Policy Summary

Under the DC Act, any municipality has the ability to use a number of mechanisms that it deems suitable in the establishment of DC rates. Although it is beyond the scope of the CASS to develop a DC Study, the CASS provides the opportunity for the City to start aligning a number of methodological and policy issues that ultimately provide key input into the process of calculating and apportioning DCs.

A review of existing City of London policies was completed, the industry DC policy review, in addition to other influencing policies and regulations. In general, it is recommended that the policies developed as part of the CASS (with respect to intensification) duly consider the following:

1. City-wide vs area-specific DC (as per DC Act requirements)
2. Local Service Policy
    - Oversizing
3. DC Eligibility
    - Minimum pipe sizing
    - Strategic projects for growth
    - Alternative infrastructure solutions (LIDs, I/I reduction, water conservation, sewer separation)
    - Level of Service (established LOS, assigning DC cost over and above that)

4. Benefit to Existing
5. Oversizing
6. Post Period Benefit
7. Application of funding (grants, etc.)
    - SHIFT Rapid Transit policy for relocation of infrastructure and cost allocation
8. Res/Non res splits
    - Work from home, no fixed place of work
    - People, jobs, units, and gross floor area (GFA)
9. Incentives
    - Intensification driven
    - Employment incentive
    - Innovation (new technologies)

The information provided on Policy is intended to aid decision making. Of particular importance for the CASS study is to decide on the approach to the BTE calculation. The five documented options being:

- Method 1 – Age of Pipe
- Method 2 – Level of Service Range Approach
- Method 3 – Deficiency Ratio Approach
- Method 4 – Flow Ratio Approach
- Method 5 – Default Percentage

5.3 Level of Service Summary

A review of the existing City of London LOS was completed with consideration to industry best practice, from which recommendations were drawn. In general, it is recommended that MOECC F-5-5 regulations for CSOs continue to be followed and infrastructure solutions be identified so that current LOS be maintained, particularly overflow frequency and volume performance. However, where opportunities exist, options should be considered to improve the LOS.

5.3.1 Level of Service for Infrastructure Planning

The following levels of service are specific and measurable. They will be used as the primary means to assess the needs and sizing of infrastructure:

- For sanitary sewer capacity assessments:
    - Based on current City practices, maintain the 85% full flow capacity trigger for sizing of infrastructure.
    - When using the London hydraulic model, utilize a 1 in 5-year design storm for sizing of new infrastructure.
    - No increase in volume or frequency of overflows due to development or redevelopment.
    - Meet post-development runoff requirements.
- Develop a historical design storm unique to the City of London based on actual rainfall data. IDF curves should also consider climate change, leveraging best available industry tools.

GENERAL

G-1. Claimability

Any item listed as claimable, subsidizable, or eligible for funding from a development charge reserve fund must also be provided for in the approved DC rates. To the extent that specific cost sharable works and projects cannot be identified as to location or timing, there should be a contingency provided for in the estimates that is incorporated into the rates.

It is important that the City continue to monitor between DC Background Studies, the accuracy of the estimates and assumptions used to establish the rates. To the extent that substantial variations are identified, Council should be advised and will need to consider whether to increase or decrease the rates in accordance with the monitoring observations.

G-2. DC Fund reimbursements for Exempted Development

The City currently exempts Industrial development, and certain specified forms of Institutional development from the payment of development charges. These exemptions support economic development and not-for-profit development initiatives.

With respect to any non-statutory exemptions the City approves in its DC policy, the City will pay for these exemptions through non-DC supported contributions to the respective DC reserve funds. This meets the legislative requirement that exemptions or reductions to charges otherwise payable not be recovered from other, non-exempt forms of development (DCA s.5(6)3.)

G-3. Non-Growth Works that Benefit the Existing Population

Where minor works funded in part from the CSRF are subject to this policy and also include a non-growth component in the DC Background Study, funding of that portion of the works must wait until the City has approved sufficient funds in its Council approved capital budgets, or Council makes provision for a Reserve Fund designated for use in funding the non-growth share of DC funded works, to pay for that non-growth portion of the works. The non-growth portion of the funding shall be identified in the City's Capital Works Budget and approved by Council.

G-4. Use of Contingencies

Works listed as eligible in the Development Charges Background Study, or with the approval of the City Engineer, in consultation with the Director, Development Finance, drawn from a contingency and/or an alternative to a work listed in the Background Study may be funded from the CSRF. The claimability of such a work would be subject to inclusion in the development agreement (for works less than $50,000 subject to approved funding in the Capital Budget) or subject to execution of a Municipal Servicing and Financing agreement prior to commencement of the work. The works funded from the CSRF under this paragraph would be subject to rules similar to those described for minor CSRF eligible works contained in this section with respect to eligibility, tender and claim completeness and submission.

G-5. Exceptions

The Development Charge By-law allows for exceptions to projects listed in the DC Background Study for works listed as eligible in the Development Charges Background Study, or with the approval of the City Engineer, in consultation with the Director, Development Finance, drawn from a contingency and/or substituted for a work listed in the Background Study may be claimable.

WASTEWATER

SS-1. Regional Trunk Sewers (CSRF- Sanitary Sewerage)
All sewers required to service future development with a diameter greater than 450mm are considered to satisfy a regional benefit to growth and are to be identified as separate projects in the DC Background Study and are eligible for a claim from the CSRF- Sanitary Sewerage.

All sewers of any diameter required to service future development and that are identified as a strategic need by the City Engineer are considered to satisfy a regional benefit to growth and are to be identified as separate projects in the DC Background Study and are eligible for a claim from the CSRF- Sanitary Sewerage.

In order to be eligible for a claim as a Regional Trunk Sewer, the sewer must have no Private Drain Connections to individual residential units otherwise the "Sewer Oversizing" policy applies.

SS-2. Sewer Oversizing (CSRF - Minor Sanitary Sewers)
Sanitary Sewers, which are not Regional Trunk Sewers, with all of the following attributes are eligible for a subsidy from the CSRF - Minor Sanitary Sewers:

- The sewer services external developable areas, and
- The sewer is greater than 250mm in diameter.

The oversized portion (>250mm) is eligible for a subsidy payable based on an average oversizing cost and is stated in terms of a $/m of pipe constructed. The oversizing subsidy amounts are to be reflected in an appendix of the DC Bylaw. The oversizing subsidy amounts cover the cost per metre of all associated eligible costs including engineering, manholes, restoration, etc.

SS-3. Pumping Stations (CSRF- Sanitary Sewerage)
The upgrading or construction of new regional pumping stations are to be identified as separate projects in the DC Background Study and are eligible for a claim from the CSRF- Sanitary Sewerage. These projects must also be identified in the Development Charges Background Study. A figure showing the location of all of these pumping stations is provided in the Sanitary Master Servicing Study.

SS-4. Temporary Pumping Stations (Developer Cost)
The cost of any temporary pumping stations or forcemains is borne by the developer. Approval of temporary works is at the discretion of the City Engineer. Where a temporary facility precedes the construction of a permanent facility, the developer that requires the temporary facility will be required to also assist in making provision for the permanent facility (e.g. provide land for permanent facility) as a condition of approval for the temporary facility. In order for a temporary work to proceed there must first be provisions for the permanent work within the current Development Charge Background Study.

SS-5. Wastewater Treatment Upgrades (CSRF- Sanitary Sewerage)
All wastewater treatment upgrades considered to satisfy a regional benefit to growth and are to be identified as separate projects in the DC Background Study and are eligible for a claim from the CSRF- Sanitary Sewerage.

SS-6. Temporary Sanitary Sewerage Systems (Developer Cost)
Costs of all sanitary sewage systems that are temporary or are not defined in the DC Background Charge Study shall be borne by the Developer. Approval of temporary works is at the discretion of the City Engineer. Where a temporary facility precedes the construction of a permanent facility, the developer that requires the temporary facility will be required to also assist in making provision for

the permanent facility (e.g. secure land for permanent facility) as a condition of approval for the temporary facility. In order for a temporary work to proceed there must first be provisions for the permanent work within the current Development Charge Background Study.

SS-7. Local Service Costs (Developer Cost)

Any pipe or portion of a larger pipe that is less than or equal to 250mm in diameter are referred to as local works, and undertaken at the Developer's expense.

Appendix B Cost Estimation Approach Review

City of London: Project Cost Estimation Approach

Technical Memorandum

Wasterwater Core Area Servicing Study (CASS)

Prepared by
GM BluePlan for:

London
CANADA

The City of London, Ontario, Canada

Project No. 716013
May 10, 2017

BluePlan
ENGINEERING

Version Updates

The following is a record of the changes/updates that have occurred on this document.

Version	Changes / Updates	Author	Date
1	DRAFT: First draft issued for review	James Jorgensen	October 2017
2	FINAL	James Jorgensen	May 2017

Table of Contents

1 Introduction

1.1 Background and Context

GM BluePlan was retained by the City of London to undertake the Wastewater Core Area Servicing Study (CASS). The project scope included the need to review the City's approach to project cost estimation, provide information on other industry approaches, review recent tender information and recommend an appropriate methodology for consideration by City staff. This Memo presents the results of this work.

The method of costing infrastructure projects within the City of London is not specifically documented. Approaches to costing are included on a project by project basis. The most pertinent of which is the 2014 Wastewater Servicing Master Plan (WWSMP) and the Development Charges (DC) Background study.

Infrastructure project cost estimates are used to create short, medium and long-term budgets and impact funding requirements and ultimately customer and developer charges. To ensure consistency, transparency and greater accuracy of cost estimates, appropriate to the level of study detail, a consistent cost estimation methodology is required. The cost estimation approach must consider current cost estimation practices and complement long-term infrastructure planning studies.

1.2 Purpose

The City of London is looking to formalize and document an approach to project cost estimation that provides a consistent, transparent, and auditable approach to costing capital projects. The City wants to understand the industry best practices of cost estimation and develop and adopt a methodology that best fits its needs.

1.3 Aims and Objectives

The primary aim of the task is:

- Provide a recommended cost estimation methodology and unit cost rates for use in the CASS.

To achieve the aim, the objectives of the task are:

- To review and understand the cost estimation methodology used in the 2014 WWSMP and DC Background Study.
- To review and consider recent City of London project tender costs.
- To review and understand the industry best practices of cost estimation.

2 Baseline Review

2.1 City of London Current Practice

The City does not have an existing consistent formal cost estimation framework. However, the current approach is considered to be that used for the 2014 Wastewater Servicing Master Plan (WWSMP) and Development Charges (DC) Background Study. This approach and the unit costs was reviewed and accepted by stakeholders as part of these studies. Any changes to this approach and/or unit costs in the future will need to be documented and justified.

The City prepares cost estimates for all infrastructure projects. For planning level projects it is often a retained consultant that creates the cost estimate, such as those created for the 2014 WWSMP and DC study. Design level estimates are often prepared internally. The consistency of the cost estimates, from planning to design level projects, relies on staff and consultant communications and previous knowledge. From this experience key areas that require consistency include the calculation of unit rates, specific project components such as crossings, construction management and overhead costs and the application of contingency and accuracy ranges.

2.1.1 2014 Wastewater Servicing Master Plan and DC Costing Approach

The approach used was very simple. Unit costs were prepared and agreed for Pipe Cost, Construction Cost (open cut and tunnelling) and Restoration Cost. The actual unit rates used are provided in Appendix A. To these base costs, engineering at 15% and contingency at 20% were added.

Unit costs were defined for varying depths of installation at 2.5m increments. It is understood that this level of detail was in part at the request of the development community.

Only the restoration made allowance for different conditions, such as urban or rural and project complexity was not considered. No additional costs, such as road, creek, rail, utility crossings were considered.

The Pipe Costs were based on Concast concrete pipe quoted rates and following review were considered appropriate and comprehensive and defined based on diameter and depth.

The Construction Costs were based on previous tender costs and included trenching, labour, equipment, bedding, backfill, compaction, dewatering and maintenance holes. Following review at the time of preparation the costs were considered reasonable for both open cut and tunnelling.

The Restoration Costs were based on a 2003 study. The costs were defined for five surface conditions: open, landscape, rural, urban and ecosystem. Rates for rural and urban are based on transportation cost tables and maybe overestimates when applied to restoration of pipe installation, rather than full road construction or replacement. However, because the approach does not have the ability to include additional cost components such as road, creek, utility crossings or soft costs such as geotechnical and property costs it seems that the restoration component of the unit rates has been inflated in order to provide a conservative estimate of potential total project costs.

2.2 City of London Tender Analysis

Tenders for recent projects were provided by the City of London for the estimation of sewer installation costing. All the projects included multiple infrastructure types, most with road, water, sanitary and storm sewer components. This makes the disaggregation of cost components difficult, especially in terms of restoration costs, which are hidden within full road reconstruction costs. As a result the analysis completed focusses on the sanitary sewer costs. The following provides a description of each of the projects reviewed, followed by tables of summarized results:

T1. ***Contract 7 2016 Lifecycle Renewal Program. Ashland Avenue Reconstruction***: The Tenderer, Omega Contractors Inc., proposed to reconstruct Ashland Avenue for a total cost of $2,242,538. 34% of the estimated cost was allotted to roadwork, 11% to Sanitary sewers and appurtenances, 6% to Storm Sewers and appurtenances, 24% to Watermain and appurtenances, approximately 7% to contingency and the remainder to other miscellaneous tasks such as landscaping, traffic control, overhead pole support, allowance for overtime, etc.

T2. ***Dufferin: 2015 Infrastructure Lifecycle Renewal Program - Contract #4***: The Tenderer, Omega Contractors Inc., proposed to reconstruct Dufferin Avenue for a total cost of $3,621,054. 31% of the estimated cost was allotted to roadwork, 5% to Sanitary sewers and appurtenances, 7% to Storm Sewers and appurtenances, 8% to Watermain and appurtenances, approximately 8% to contingency and the remainder to other tasks such as installation of the London hydro duct, traffic signals and street lighting, and bell network upgrades.

T3. ***Contract No1: 2016 infrastructure renewal program***: The Tenderer, L82 Construction Limited, proposed an infrastructure renewal program for a total cost of $4,327,420. 30% of the estimated cost was allotted to roadwork, 19% to Sanitary Sewers, 13% to Storm Sewers, 13% to Watermains , approximately 9% to contingency and the remainder to other tasks such as installation of the London hydro duct, traffic signals and street lighting, and bell network upgrades.

T4. ***McCormick Area Reconstruction: 2016 Infrastructure Lifecycle Renewal***: The Tenderer, Ere-Ex Construction Inc., proposed to reconstruct the McCormick Area as part of the infrastructure renewal program for a total cost of $3,085,067. 30% of the estimated cost was allotted to roadwork, 28% to Sanitary Sewers, 13% to Storm Sewers, 14% to Watermains, approximately 8% to contingency and the remainder to other miscellaneous tasks.

T5. ***Florence Street/Kellogg Lane: 2016 Infrastructure Lifecycle Renewal Program***: The Tenderer, J-AAR Excavation Limited, proposed an infrastructure renewal program at Florence Steer and Kellogg Lane for a total cost of $5,783,877. 20% of the estimated cost was allotted to roadwork, 10% to Sanitary Sewers and appurtenances, 35% to Storm Sewers and appurtenances, 13% to Watermains and appurtenances, 0.6% to Electrical work, approximately 16% to contingency and the remainder to other miscellaneous tasks.

T6. ***2015 Infrastructure Lifecycle Renewal Program: Contract #1***: The Tenderer, BLUE-CON Constructors, proposed an infrastructure renewal program for a total cost of $ 4,949,495. 31% of the estimated cost was allotted to roadwork, 11% to Sanitary Sewers, 37% to Storm Sewers, 10% to Watermains, 1.8% to Electrical work, approximately 9% to contingency and the remainder to other miscellaneous tasks such as installation of the London hydro duct, outlet channel improvements, removals, etc.

Table 1, below details the main cost components of each tender and includes the meterage of sanitary sewer and number of manholes.

Table 1: Tender Project Details

#	Project:	Total Bid	Road works	Sanitary Sewers	Storm Sewers	Water mains	Sewer Mainline (m)	Connection Sewer (m)	# of Manholes
T1	Contract 7 2016 Lifecycle Renewal Program. Ashland Avenue Reconstruction	$2,242,538	$758,347	$242,253	$127,358	$539,037	420	475	11
T2	Dufferin: 2015 Infrastructure Lifecycle Renewal Program - Contract #4	$3,621,054	$1,137,026	$194,611	$251,875	$285,617	104	264	3
T3	Contract No1: 2016 infrastructure renewal program	$4,327,420	$1,311,237	$803,820	$567,196	$572,172	810	610	15
T4	McCormick Area Reconstruction: 2016 Infrastructure Lifecycle Renewal Program	$3,085,067	$940,584	$57,016	$402,484	$433,914	1060	105	19
T5	Florence Street/Kellogg Lane: 2016 Infrastructure Lifecycle Renewal Program: Contract #9	$5,783,877	$1,171,008	$550,315	$2,041,655	$750,793	916	495	18
T6	2015 Infrastructure Lifecycle Renewal Program: Contract #1	$4,949,495	$1,531,547	$536,978	$1,329,699	$489,049	775	0	12

The costs for Sanitary Sewers in each tender were broken down to manholes and sewers. The Manhole diameters included in the tenders were 1200mmØ, 1500mmØ, 1800mmØ and 2400mmØ, and the manhole depth ranged between 2.0 meters to 3.0 meters.

Table 2 summarizes the average unit cost for manholes of varying diameters. The average cost was derived by taking the total cost of manholes divided by the number of manholes required.

Table 2: Manhole Tender Cost Summary

Manhole diameter (mm Ø)	T1 ($)	T2 ($)	T3 ($)	T4 ($)	T5 ($)	T6 ($)	Avg. Unit Cost
1200	4,091	5,837	6,782	6,160	3,745	4,281	5,149
1500			11,242		5,137		8,190
1800			20,191				20,191
2400					12,000		12,000

Similarly for the sewer, the total sewer cost was divided by the total meterage to calculate a cost per meter. For this assessment the costs and meterage associated with connection/lateral sewers was not included and only sewers with a diameter greater than 200mm were included in the analysis. The unit cost for each sanitary sewer were provided. Table 3, below, summarizes the average unit cost for sewers of varying diameters as estimated by the Tenderers. The cost of Manholes per pipeline meter was estimated to be $131, based on the total manhole cost divided by the length of sanitary sewer. This provides a total unit cost per meter for manholes and sewers, but does not include restoration for reasons stated above.

Table 3: Sanitary Sewer Tender Cost Summary

Pipe Size (mm)	T1 ($/m)	T2 ($/m)	T3 ($/m)	T4 ($/m)	T5 ($/m)	T6 ($/m)	Avg. Cost ($/m)	Manhole Cost ($/m)	Total Cost ($/m)
200	127	196	309	323	65	234	209	131	340
250			176	269		234	226	131	357
300				317	140	262	240	131	371
375			196	330			263	131	394
450	263						263	131	394
675			466				466	131	597

The total unit costs shown in Table 3 account for pipe material and construction and compare favourably with those used in the 2014 WWMSP and DC study show and those recommended in this report (Section 3.2).

2.3 Summary of Industry Best Practice Review: Key Considerations for Cost Estimation

The full industry review is provided in Appendix B. The industry best practice review provides a summary highlighting different cost estimation framework methodologies and principles used by other organizations. The review covered many types and variations of cost estimation approaches. The cost estimation frameworks that were reviewed include those for the following five (5) organizations:

1. Public Works and Government Services Canada
   a. Guide to Cost Predictability in Construction: An Analysis of Issues Affecting the Accuracy of Construction Cost Estimates.
   b. PPP Canada: Schematic Design Estimate Guide
   c. The National Project Management System (NPMS)
2. State of Queensland Government (Australia) - Project Cost Estimating Manual (Transport Infrastructure)
3. Ministry of Transportation and Infrastructure (MOTI) – British Columbia
4. Alberta Electric System Operator (AESO)
5. The Association of Advancement in Cost Engineering (AACE) International.

All of the frameworks reviewed included similar concepts. Each identified classes of estimate to which ranges of accuracy and levels of contingency are applied. Table 4 below show the key features of each of the frameworks reviewed, outlining the classes that each framework uses and the associated accuracy range that applies to each.

Table 4: Summary of Cost Frameworks Key Features

Organization	Classes	Accuracy Range (%)	Key features/comments
Public Works	Class A Class B Class C Class D	+/- 20 to +/- 30 +/- 15 to +/- 20 +/- 10 to +/- 15 +/- 5 to +/- 10	Classes linked to project definition/level of completion. Comparable Class definition to other reviewed frameworks which are linked to data/information requirements to achieve each estimate. Different accuracy ranges defined for simple and complex project
Queensland Government	Category 1 Category 2 Category 3 Category 4 Category 5 Category 6	*None* *None* -15/+20 -10/+15 -5/+10 -2.5/+5	Classes are linked to project definition and are comparable to the AACE International principles. Accuracy ranges are only define for more detailed stages and do not consider simple and complex projects. The variations between simple and complex projects are considered in the cost estimation methodology.
MOTI	Conceptual Planning Preliminary Design Pre-Tender	+/- 35 +/- 35 +/- 20 +/- 20 +/- 10	Classification principles and cost estimating methodology follow AACE International. 5 Classes defined by descriptions directly related to project planning stage. Provides definition of costing method for each Class.
AESO	Class 5 Class 4 Class 3 Class 2 Class 1	L: -20 to -50 H: +30 to +100 L: -15 to -30 H: +20 to +50 L: -10 to -20 H: +10 to +30 L: -5 to -15 H: +5 to +20 L: -3 to -10 H: +3 to +15	Classification principles and cost estimating methodology follow AACE International. Accuracy ranges related to project complexity and ranges not uniform plus/minus. Requires data maturity assessment to identify which class estimate is achievable.
AACE	Class 5 Class 4 Class 3 Class 2 Class 1	L: -20 to -50 H: +30 to +100 L: -15 to -30 H: +20 to +50 L: -10 to -20 H: +10 to +30 L: -5 to -15 H: +5 to +20 L: -3 to -10 H: +3 to +15	AACE completed studies that included the collection of project cost estimates and their associated actual costs for all five classes. The projects varied in complexity and costs and were used for an empirical analysis to determine the appropriate accuracy ranges for each class. The final accuracy ranges were generated at a 90% confidence interval.

All of the cost estimation framework reviewed consider different stages of a project including planning and design. The maturity or stage of the project, with a specific degree of data and information, will define the method or class of cost estimate, the appropriate contingency to be applied, and the expected accuracy range of the estimate. The frameworks provide guidelines that users can follow to develop consistent and transparent cost estimates. The frameworks provide a defendable approach to cost estimation.

3 City of London Approach to Cost Estimation

The approach suggested for use in the CASS is based on the industry review and the current approaches used by the City. It follows the same concept used for the 2014 Wastewater Servicing Master Plan; generate project costs from unit rates then add contingency and other associated costs. However, the suggested methodology defines different classes of cost estimate and ranges of accuracy and contingency, the ability to add additional costs related to the environmental condition, such as urban or greenfield and apply cost uplift based on project complexity. The goal of the cost estimation method is to provide a consistent and traceable approach to the estimate project costs that will help minimize the variance between cost estimates and final project budgets. The approach will improve communication and understanding between stakeholders.

3.1 Approach and Methodology

The cost estimation approach uses a classification system to categorize different cost estimate classes. These classes represent different phases of planning and design, and subsequently different methods of cost estimation and levels of accuracy. This framework complements the generic approach developed by the Association of Advancement in Cost Estimating (AACE) International, and also has similarities to the Government of Canada (GOC) approach. For the purposes of the CASS project it is expected that all of the cost estimates will follow a Class 4 estimate. However, it is important to establish the level of accuracy that can be expected and as the project matures through planning to design, how the higher class estimates refine the costs.

Figure 1 shows the cost estimate process flow diagram. Each of the key components of the diagram is described below, Including:

- Cost Estimate Classes
- Project Complexity
- Area Condition
- Estimate Accuracy Range
- Construction and Project Contingency
- Construction Provisional and Allowance
- Additional Costs

The unit costs and all the above components are contained in an excel spreadsheet that includes the City of London's standard project details sheet. The spreadsheet is the working tool that brings all the cost components together to create a project cost estimate. The template spreadsheet is provided in Appendix C. The following sections describe the methodology for each cost component.

Costing Methodology. City of London. Wastewater Core Area Servicing Study (CASS).

Step 1. Define Project Type

Project Type	Project Type Description
New infrastructure	Projects involving construction of new infrastructure, typically funded from DCs.
Replacement	Projects involving replacement, relining, etc. of existing infrastructure.

Step 2. Define Project Classification

Estimate Class	Estimate Class Description	End Usage/Major Deliverables
Class 4	Infrastructure Planning Cost Estimate	Study to support investment decisions based on sufficient knowledge to identify high-level risk.
Class 3	Conceptual Design Cost Estimate	Basis for budgeting and approvals.
Class 2	Preliminary Design Cost Estimate	Used for project cost control during design; initial design estimate.
Class 1	Detailed Design Cost Estimate	Final cost review in preparation for construction; tender-ready.

Step 3. Define Project Complexity

Project Complexity	Complexity Description
High complexity	Projects with high cost, broad scope of work, multiple alternatives/alignments, etc.
Low complexity	Projects with low cost, defined scope of work, few if any alternatives

Step 4. Define Project Details

Project Detail	Detail Description
Diameter	Nominal diameter of the proposed water main to provide the required level of service.
Length	Approximate length of the proposed water main based on the alignment (whether assumed or determine through more rigorous analysis).
Construction Methodology	The method by which the water main will be installed (e.g., open cut, trenchless).
Construction Depth	The depth of excavation required to install the water main assuming that open cut construction is chosen (e.g., normal, deep).
Construction Environment	The general environment within which the water main will be constructed (e.g., greenfield, suburban, urban).
Crossings	Identification of the type and number of crossings associated with the water main installation (e.g., creeks, roads, railways, major utilities).
Appurtenances	Identification of the type and number of appurtenances required for the proposed water main (e.g., valves, chambers, hydrants, etc.).
Other Considerations	Coordination with other capital works that could impact schedule and cost.

Step 5. Calculate Total Construction Cost

❶ INSTALLATION COST
Basic cost to install the sewer main and associated appurtenances calculated using various unit rates for pipe, valve and chamber sizes and type of crossings.

Includes: Sewer main installation (unit rate x length), crossings (count x unit rate for size and type of crossing), manholes and chambers (included in unit rate).

+

❷ CONSTRUCTION UPLIFT
Allowance for the increased cost of constructing in built-up areas, applied to the base construction cost.

Construction Environment		
Greenfield	Suburban	Urban
0%	20%	30%

=

❸ BASE CONSTRUCTION COST
Total cost to construct the actual water main and associated appurtenances, not including tasks such as traffic management, mobilization, inspections, etc.

❸ = ❶ + ❷

+

❹ ADDITIONAL CONSTRUCTION COSTS
Additional costs associated with construction not covered under the base construction cost or the construction uplift, including mobilization, traffic management, inspections, etc. A percentage is applied to the sewer main construction cost based on the complexity of the project.

Project Complexity		
Low		High
10%		20%

+

❺ PROVISIONAL ALLOWANCE
Provisional allowance for labour and materials over and above the sewer main construction cost, a standard item on construction tenders. A provisional allowance of 10% is applied to all projects.

=

❻ TOTAL CONSTRUCTION COST
Total cost of constructing the sewer main including all items that make up a construction tender.

❻ = ❸+ ❹ + ❺

Step 6. Calculate Project Contingency

❼ PROJECT CONTINGENCY
An allowance for contingency that recognizes both the complexity of the project and the project classification in terms of the certainty regarding scope of work, alignment, construction methodology, property requirements, geotechnical/hydrogeological issues, etc. The contingency will become smaller as the project moves closer to implementation.

	Project Complexity		
	Low		High
Class 4	20%		30%
Class 3	15%		25%
Class 2	10%		20%
Class 1	10%		15%

Step 7. Calculate Soft Costs

a) For new infrastructure (i.e., growth-related)

❾ GEOTECHNICAL/ HYDROGEOLOGICAL
>

Project Complexity		
Low		High
0.5%		2.0%

+

❿ PROPERTY/EASEMENTS
>

Project Complexity		
Low		High
1.0%		2.0%

+

⓫ ENGINEERING/DESIGN (INTERNAL)
>

Total Cost		
<$10m	$10-$50m	>$50m
4%	6%	8%

+

⓬ DESIGN/CONTRACT ADMINISTRATION (EXTERNAL)

Total Cost		
<$10m	$10-$50m	>$50m
10%	12%	15%

=

⓭ TOTAL SOFT COSTS (GROWTH)

⓭ = ❾ + ❿ + ⓫ + ⓬

b) For replacement

⓮ ENGINEERING & CONSTRUCTION ADMIN COST	4%

+

⓯ DEVELOPMENT INSPECTORS COST	4%

+

⓰ MISC EXP - CAP PROJECTS	15%

=

⓱ TOTAL SOFT COSTS (NON-GROWTH)

⓱ = ⓮ + ⓯ + ⓰

Step 10. Determine Funding Source(s)

Determine the funding source or sources based on the key driver(s) of the project.

Growth-related		Non-Growth related
In-Period	Out of By-law (OBL)	

Step 11. Compile Capital Plan

❽ is entered as the CONSTRUCTION component

⓭ is entereed as the DESIGN component

Figure 1: Cost Estimation Process Flow Diagram

3.2 Unit Rates

Suggested unit rates are provided in Appendix D. They are based on supplier material costs, tender analysis and historic project costs from multiple municipalities across southern Ontario. In this recommended approach the unit rates are the starting point or base for a cost estimate. Many other factors and criteria are applied to the unit rates. Therefore caution is advised when comparing recommended unit rates in isolation with those used for previous studies. Only full and complete costs estimates should be compared.

3.3 Cost Estimate Classes

The classification table (Table 5) provides a description of the proposed estimate classes and their end usage or deliverables. Appendix E includes expanded details on each class including the basis for the estimate and the associated accuracy range that can be expected based on the project complexity. Accuracy range will be discussed further in Section 3.6.

Table 5 – Cost Estimation Classes

Estimate Class	Estimate Class Description	End Usage / Major Deliverables
Class 4	Planning Cost Estimate	Infrastructure Planning/Master Planning. Justification for project planning funding. Minimum information requirements.
Class 3	Concept Design Cost Estimate	Basis for budgeting and approvals.
Class 2	Preliminary Design Cost Estimate	Used for project cost control during design; initial detailed estimate.
Class 1	Detailed Design Cost Estimate	Final cost review in preparation for construction; tender ready.

3.4 Project Complexity

The Table below provides general definition of project complexity.

Table 6 – Project Complexity Descriptions

Project Complexity	Complexity Description
High Complexity	Projects with high cost, broad scope of work, multiple alternatives/alignments, etc.
Low Complexity	Projects with low cost, defined scope of work, few if any alternatives

3.5 Area Condition

Area Condition provides an allowance for the increased cost of constructing in built-up areas, applied to the base construction cost. Table 7 below provides a general definition and the construction uplift cost percentage of the area condition.

Table 7 – Area Condition Descriptions

Construction Environment	Environment Description	Construction Cost Uplift %
Rural	Greenfield construction with no environmental constraints	0%
Suburban	Developed built up environment	20%
Urban	Heavily developed built up environment – downtown area	30%

3.6 Estimated Accuracy Range

The accuracy range is defined by the cost estimate class and the project complexity. The diagram below (Figure 2) shows how the estimate varies based on the two input criteria. The accuracy percentage applies to the total base cost plus all allowances and contingencies.

An accuracy range is an acknowledgment that even with a formal cost estimation framework, and appropriate contingencies, actual costs may still vary as a result of 'unknown unknowns', such as changes in the economy or new future innovative technologies. These unknowns can just as easily result in a lower final cost as a higher one, even with the application of an appropriate contingency. A recent example is the value of the Canadian dollar. In 2013, the Canadian dollar was at par with the American dollar, and in 2016 it is $0.75. If an American supplier is being used for the project, a final cost in 2016 will significantly vary from that estimated in 2013. This variance should not be associated with the contingency amount.

The accuracy range is not an additional contingency and should not be used for budgeting or funding purposes but rather be a representation of the level of confidence or vulnerability associated with a cost estimate (base + contingency). The concept of an accuracy range is that after the inclusion of an appropriate contingency, it is just as likely that the final cost will be below the estimate as above and it is therefore expected that the long-term aggregate of cost estimates (base + contingency), within each class, will balance out.

The accuracy range for each class is comprised of a high and low value to provide flexibility with respect to the project complexity and corresponding levels of cost estimating confidence.

In summary, as the class and project details increase (left to right in Figure 2), or as the project complexity decreases (top to bottom in Figure 2), the cost estimate is less vulnerable to 'unknown unknowns' and therefore the accuracy range will be less.

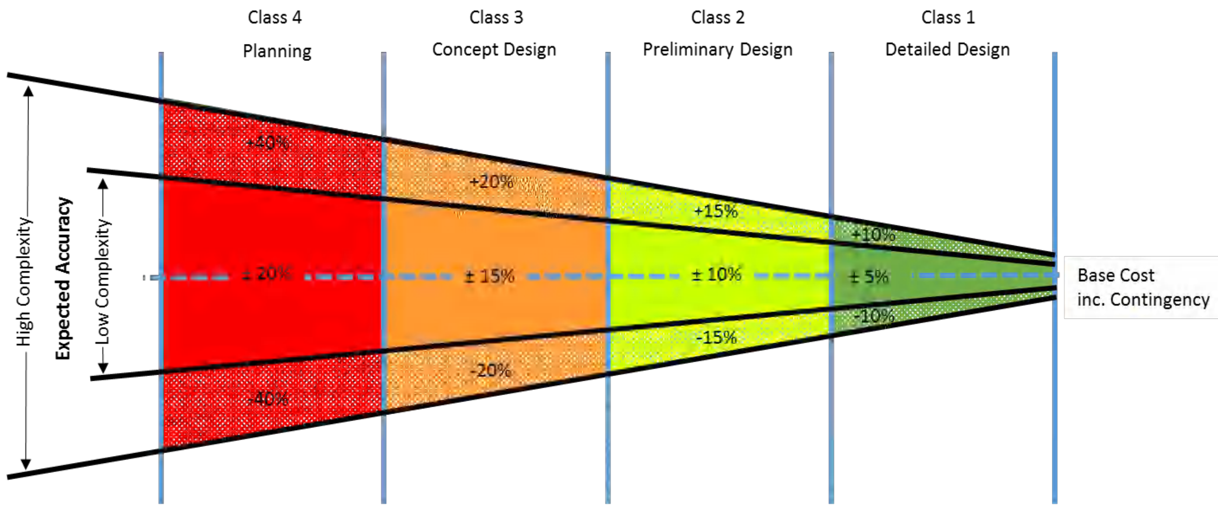

Figure 2: Cost Estimate Accuracy Ranges

3.7 Construction and Project Contingency

There is a certain amount of risk and uncertainty associated with each class of cost estimation. The associated risk and uncertainty is minimized with the addition of a contingency. Contingencies are an allowance for risks that are known or anticipated at early stages of the project definition, i.e. they represent probable events that are 'known unknowns' and experience has shown are likely to occur. They cannot be attributed to specific items in the base estimate but need to be considered in addition to the base cost. It should be noted that a project contingency does not cover changes in scope, which are dealt with on their own and should be defined in the project management plan

Two types of contingency are recommended for use; construction contingency and project contingency.

3.7.1 Construction Contingency

Construction contingency is a percentage contingency amount applied to the base construction costs. It accounts for any additional construction costs not included in the unit rates, valves and crossings. It includes Mod/Demob, connections, inspection, hydrants, signage, traffic management, bonding, insurance. Construction contingency changes with project complexity, as follows:

Low Complexity Construction Contingency: 10%

High Complexity Construction Contingency: 20%

3.7.2 Project contingency

Project contingency is a percentage applied to the entire project cost inclusive of all soft costs and fees. It accounts for any additional cost associated to any part of the project including soft cost such as consultant engineering and design, geotechnical and property costs. As such the project contingency changes with project complexity as well as project estimate class, as shown in Figure 3, below.

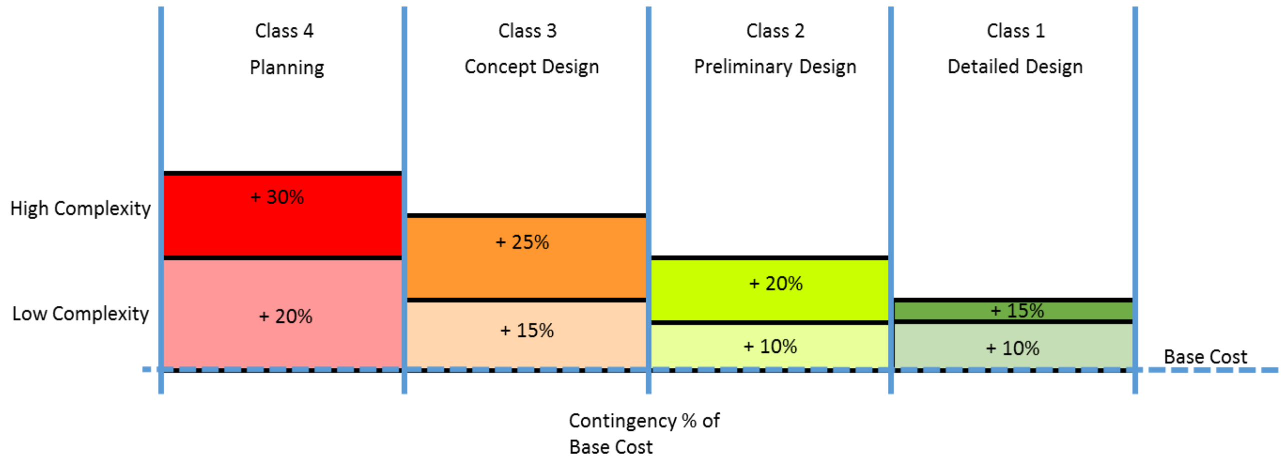

Figure 3: Cost Estimate Contingency Amounts

3.8 Construction Provisional and Allowance

It is recommended that a provisional amount be applied to the base constr4uction costs in the event of increased construction labour and or material costs. Provisional Project Cost remain separate from the primary project cost but must be accounted for budgeting purposes. Regardless of estimate class or project complexity it is recommended that 10% of the base construction cost is applied as a Provisional Allowance.

3.9 Additional Costs

Additional Costs capture all soft costs associated with the project. If available, actual quoted costs should be used. In the absence of this information percentage amounts, applied to the base construction costs, are recommended. Such costs are related to project complexity and total project cost, as such percentages vary accordingly. Table 8, below, shows the percentages to be applied for high and low complexity and different value projects.

Cost Component		High Complexity	Low Complexity
Geotechnical / Hydrogeological / Materials		2% of construction cost	0.5% of construction cost
Property Requirements		2% of construction cost	1% of construction cost
Consultant Engineering/Design	Total Construction Cost <$10M	15% of construction cost	
Consultant Engineering/Design	Total Construction Cost $10M - $50M	12% of construction cost	
Consultant Engineering/Design	Total Construction Cost >$50M	10% of construction cost	
In House Labour/Engineering/ Wages/CA	Total Construction Cost <$10M	8% of construction cost	
In House Labour/Engineering/ Wages/CA	Total Construction Cost $10M - $50M	6% of construction cost	
In House Labour/Engineering/ Wages/CA	Total Construction Cost >$50M	4% of construction cost	
Non-refundable HST		1.76% of Total costs	

Table 8: Additional Cost Components

4 Summary

The City of London does not have a consistent approach to cost estimation and has historically completed infrastructure planning level estimates on a project by project basis. The approach used for the 2014 WWMSP and DC Background Study has been proven to provide conservative level estimates that have consistency provided adequate budget values to implement projects. However, the approach does not have much flexibility to account for variation of cost components across projects.

A review of recent City of London project tenders showed that the unit costs used for the 2014 WWMSP and those recommended here for materials and construction were reasonable although it was difficult to provide relational comparison with restoration costs.

The industry best practice review identified a need for the City to consider establishing cost estimation classes, ranges of contingency and accuracy and the ability to specify varying project complexity to their cost estimation approach.

The recommended cost estimation approach complements previous approaches and seeks to enhance the approach by including greater flexibility to account for project variances and provide estimate classes, contingency and accuracy ranges, defined project complexity and environmental conditions. The results is a traceable and defendable cost estimation approach that can be used across City departments for a variety of projects and be consistently used as a project matures through planning to design phases.

Cost Estimation Approach Review
APPENDICES

London CANADA

BluePlan ENGINEERING

Cost Estimation Approach Review
Appendix A 2014 WWSMP and DC unit costs

Pipe Cost

Diameter

Depth	250	300	375	450	525	600	675	750	825	900	975	1050	1200	1350	1500	1650	1800	1950	2100
2.5	65	75	90	95	105	140	215	280	325	390	430	495	620	755	925	1,110	1,340	1,555	1,780
5	65	75	90	95	105	140	215	280	325	390	515	595	745	910	970	1,165	1,410	1,635	1,870
7.5	65	75	90	95	120	160	245	320	415	450	515	595	745	910	1,110	1,330	1,610	1,865	2,140
10	65	75	90	95	120	160	245	320	415	450	605	690	865	1,060	1,295	1,550	1,875	2,175	2,495
12.5	65	75	90	120	120	190	245	320	415	450	605	690	865	1,060	1,295	1,550	1,875	2,175	2,495

CONSTRUCTION COSTS - Open Cut - Pipe Cost NOT Included

Diameter

Depth	250	300	375	450	525	600	675	750	825	900	975	1050	1200	1350	1500	1650	1800	1950	2100
2.5	405	420	430	455	480	520	535	575	610	640	675	700	735	770	800	835	860	905	935
5	605	620	635	670	725	770	805	850	930	935	935	935	970	1,005	1,175	1,230	1,300	1,360	1,460
7.5	710	725	735	795	825	910	945	1,000	1,000	1,080	1,125	1,160	1,255	1,355	1,460	1,555	1,665	1,785	1,890
10	1,010	1,075	1,135	1,295	1,435	1,585	1,720	1,875	1,940	2,055	2,085	2,110	2,215	2,315	2,420	2,545	2,675	2,785	2,880
12.5	2,090	2,100	2,110	2,150	2,205	2,225	2,285	2,345	2,340	2,360	2,380	2,415	2,445	2,485	2,555	2,675	2,875	3,085	3,320

CONSTRUCTION COSTS - Tunnelling - Pipe Cost NOT Included

Diameter

Depth	250	300	375	450	525	600	675	750	825	900	975	1050	1200	1350	1500	1650	1800	1950	2100
5	3,990	4,755	5,025	5,490	5,895	6,295	6,630	6,900	7,170	7,435	7,705	7,970	8,240	8,505	8,770	9,040	9,305	9,580	9,850
10	4,035	4,890	5,160	5,625	5,825	6,495	6,770	7,100	7,435	7,770	8,035	8,305	8,570	8,840	9,105	9,380	9,645	9,915	10,180
15	4,180	5,025	5,360	5,760	6,095	6,700	7,035	7,370	7,705	8,105	8,370	8,640	8,905	9,175	9,445	9,715	9,980	10,250	10,515
20	4,320	5,160	5,490	5,895	6,360	6,900	7,300	7,705	8,035	8,440	8,705	9,040	9,240	9,515	9,780	10,050	10,315	10,585	10,850
25	4,465	5,290	5,625	6,095	6,630	7,100	7,570	7,970	8,370	8,770	9,040	9,305	9,580	9,850	10,115	10,380	10,650	10,915	11,185
30	4,570	5,425	5,760	6,295	6,835	7,370	7,835	8,240	8,640	9,040	9,445	9,715	9,980	10,250	10,515	10,785	11,050	11,320	11,585

RESTORATION

Condition	Open	Landscape	Rural	Urban	Ecosystem
Depth					
2.5	0	400	1,600	1,770	840
5	0	510	2,040	2,210	1,070
7.5	0	600	2,450	2,610	1,270
10	0	710	2,920	3,080	1,480
12.5	0	810	3,400	3,540	1,680

Cost Estimation Approach Review
Appendix B Industry Best Practice Review

Contents:

1. Introduction

The industry best practice review provides a summary highlighting different cost estimation framework methodologies and principles used by other organizations. The review covered many types and variations of cost estimation approaches. The cost estimation frameworks that were reviewed include those for the following five (5) organizations:

6. Public Works and Government Services Canada
   a. Guide to Cost Predictability in Construction: An Analysis of Issues Affecting the Accuracy of Construction Cost Estimates.
   b. PPP Canada: Schematic Design Estimate Guide
   c. The National Project Management System (NPMS)
7. State of Queensland Government (Australia) - Project Cost Estimating Manual (Transport Infrastructure)
8. Ministry of Transportation and Infrastructure – British Columbia
9. Alberta Electric System Operator
10. The Association of Advancement in Cost Engineering (AACE) International.

2. Public Works and Government Services Canada

This review summarizes the following documents by Public Works and Government Services Canada:

1. Guide to Cost Predictability in Construction: An Analysis of Issues Affecting the Accuracy of Construction Cost Estimates.
2. PPP Canada: Schematic Design Estimate Guide
3. The National Project Management System (NPMS)

The cost management strategy presented by Public Works and Government Services Canada, focuses on planning, estimating, monitoring, and controlling project costs throughout all phases of a project from inception to completion. To do so, the National Project Management System (NPMS) developed a Real Property Projects Model. This model describes requirements that ensure the total project costs that are established are managed in a systematic manner (from master planning to detailed design) and provides a framework that explains how cost estimates are to be determined at each stage. The model includes 3 stages, 9 phases, control points, and deliverables.

Project Inception Stage

- Definition Phase

Project Identification Stage

- Initiation phase
- Feasibility
- Analysis
- Identification Close Out

Project Delivery Stage

- Planning
- Design
- Implementation
- Delivery Close Out

There are four classes of cost estimation that are used in the NPMS Model, Class A-D. Minimum requirements for estimate preparation are provided in the form of a checklist for each estimate category. A brief description and summary of the four classes is provided.

Class D

- Used in the early stages of project identification and planning.
- Estimates based on initial functional program and broad concepts.
- Unit cost analysis based on a comprehensive list of requirements and assumptions
- Examples of requirements:
    - Project plan detailing project function
    - Floor-to-floor heights and general floor plan configurations
    - Geographical location, site configuration, soil land rock information, utility services
    - Cost limitations and allowances.

Class C

- Used in the conceptual design stages of the project
- Construction cost estimates using schematic design development
- Higher level of detail with reasonable allowance for construction unit costs, contingencies, contract fees and level of risk.
- Elemental cost analysis based on comprehensive list or requirements and assumptions
- Quantities of major elements are assessed and measured
- Examples of minimum requirements:
    - Principal floor plans, architectural sketch
    - Structural foundation system based on geotechnical information
    - Typical framing system
    - Roof system selection
    - Mechanical/electrical/plumbing outline (suggested equipment for early design)
    - Storm drainage solution.

Class B

- Used in the design development stages of the project
- Substantive estimate with increased level of design details; high quality and reliable.
- Includes design of major systems
- Examples of minimum requirements:
    - Structural foundation design, geotechnical report including borehole soils information
    - Structural framing design, design loads
    - Selection of equipment, sizes, and performance requirements
    - One line design diagrams for mechanical, electrics and plumbing systems.

Class A

- Used in the implementation phase or pre-tender (final estimate before tender call)
- Cost estimates prepared using 100% measure quantities
- Detailed systems and component design
- Summary showing items of work, quantities, unit prices and amounts, and trade breakdown of pre-tender estimate.
- Examples of minimum requirements:
    - Details of stairs, toilet rooms, etc.
    - Specific details and condition (millwork, handrails)

- Full descriptions of elevators, HVAC, fire protection, security
- Final site drawings.

The complexity of a project may vary and therefore there are different degrees of estimating. Expectations for the accuracy of an estimate must be realistic as there are many different variables even within a single class; projects can range from standard and repetitive to high complexity such as leading edge environmental projects. Those that are unique may require project-specific evaluation. The following figure presents the principles behind different classes with different project complexities.

COST ESTIMATE VARIANCE MATRIX ± %

Class of Estimates	Based On	Project Complexity: LOW	Project Complexity: HIGH
D	Concept sketch design	20	30
C	33% Design development	15	20
B	66% Design development	10	15
A	100% complete tender documents	5	10
Unique Projects, Circumstances, or Risks		Varies	Add to Above %

A project cost plan was generated that acts as a template with a critical breakdown of project total costs into elements, components, and targets. It can be used for cost estimation as well as managing budgets over the life of the project from the early planning stages to completion. It is an evolving document that will increase in precision as phases are completed. As a project advances through the cost estimation classes, the details that go into the estimates will increase along with the accuracy of the cost estimates.

3. <u>Queensland Government – Project Cost Estimating Manual (Transport Infrastructure)</u>

The Department of Transport and Main Roads has developed a manual that provides rules and standards for developing cost estimates for all transport infrastructure projects. The generic process used to estimate project costs is as follows:

- Establish project scope,
- Estimate and resource planning,
- Cost estimate development,
- Risk identification/quantification,
- Escalation,

- Review and Approval.

There are six (6) estimate categories that consist of different levels of project definition. Depending on the category, the cost estimation process will vary in detail, available information, confidence, and end usage. The following table presents the category descriptions.

	Category 1	Category 2	Category 3	Category 4	Category 5	Category 6
Level of Project Definition	<2%	1% to 15%	10% to 40%	30% to 65%	40% to 80%	50% to 100%
Estimate Basis	No formal scope	Simple scope and strategy	Agreed scope, preferred option	Schematic design	Developed design	Contract details
Input to:	Initial budget	Project phase budget or detailed budget	Detailed budget	Basic cost management	Detailed cost management	Implementation phase budget and cost control
Information Available	Similar projects	QTRIP candidate project details	Project plan, option analysis, investigations	Schematic design	Detailed design, full drawings and documents	Accepted Tender
Confidence	Very low	Low	Low to Medium	Medium	Medium to high	High
End Usage	Concept screening	Study or feasibility	Budget Authorisation, Control	Budget Authorisation, Control	Authorisation, Check tender	Cost control
Expected at Project Stage	Pre-project	Proposal	Business Case	Preliminary Design	Detailed Design	Implementation

The manual describes the different cost groups used for different activities including the following:

1. Construction Contractor's Cost: direct job cost, indirect job costs, and offsite overhead and margin. These costs depend on the required forecast accuracy and the level of available data detail.
2. Principal's Costs: these costs are associated to the department of transportation and main roads. They are calculated as a percentage of construction costs or refer to similar completed projects with escalation and adjustments considered.
3. Base Estimate: is the combination of the construction contractor's cost and the principal's cost.
4. Risk and Contingencies: a quantitative or qualitative risk assessment is completed to determine the appropriate contingency.
5. Total Project Cost: is the combination of the base estimate and contingency.
6. Escalation: is a unit rate to be applied that considers a variety of factors (inflation, market conditions, supply constraints, project complexity).

Contingencies are quantified using the risk management process detailed in AS/NZS ISO 31000:2009. The manual notes that it is difficult to be prescriptive with respect to how contingency costs should be applied, so the following table provides an expected contingency range.

Estimate Stage	Level of Project Definition	Typical Contingency Ranges
Strategic Estimate	1% to 15%	40% to 70%
Project Proposal Estimate	1% to 15%	40% to 70%
Options Analysis Estimate	N/A	N/A
Business Case Estimate (P90)	10% to 40%	30% to 40%
Preliminary Design Estimate (P90)	50% to 55%	20% to 30%
Detailed Design Estimate (P90)	40% to 80%	10% to 20%

Although a contingency is applied to the base estimate, which represents the “known unknowns” that experience has shown will likely occur, there are limitations with the “unknown unknowns” associated with the economy or other external factors that are not predictable. For this reason a percentage variance of completed project costs (i.e. accuracy range) is provided for categories 3-6. It is expected that any individual project estimate should fall between these ranges at a 90% confidence factor. It considers the overall performance of the estimates by comparing estimates at different stages against the final budget cost. The following table provides an overview of the different project phases for the Transport System Manager (TSM) framework.

TSM Phase	Project Phase	Cost estimate Document	Percentage variance of Completed Project Cost	
			Lower	Upper
4	Concept	Business Case	-15%	+20%
5	Development	Preliminary Design	-10%	+15%
5	Development	Detailed Design	-5%	+10%
5	Implementation	Construction	-2.5%	+5%

The project cost estimating manual provides estimating tools and techniques describing the different estimating methods. Each estimate category requires a different method of cost estimating based on the level of data and project detail. An increase in project detail allows for a more rigorous cost estimate and subsequently more confidence and better accuracy. The following table presents the cost estimate methods for different estimate stages.

The manual considers three (3) different types of projects that represent varying complexities. Each type of complexity will result in different levels of cost estimating accuracy and therefore the cost estimating methods are considered separately. The three project types include:

1. Type 1 Project: complex/high or extreme risk.
2. Type 2 Project: straightforward/medium risk.
3. Type 3 Project: simple/ low risk

Estimate Stage	Project Type 1	Project Type 2	Project Type 3
Strategic or Pre Project	Unit Rate method	Global	Global Estimate
Proposal	Unit Rate method	Unit Rate method	Global Estimate
Options Analysis	60% value at Unit Rates Estimate, 40% value at First Principles Estimate	Unit Rate method	Global Estimate
Business Case	First Principles Estimate at WBS 4 or 6	Approx 60% value of estimate by Unit Rates, 40% by First Principles	Unit Rate method
Preliminary Design	First Principles Estimate at WBS 4 or 5	Approx 20% value of estimate by Unit Rates, 80% by First Principles	Not applicable
Detailed Design	First Principles Estimate at WBS 4 or 5	First Principles Estimate at WBS 5	First Principles Estimate at WBS 5

Global Estimate: An approximate method of estimating using an inclusive “all in” unit rates.

Unit Rate Estimate: More accurate unit rates, still largely inclusive "all in" rates although cost based on historic unit rates.

First Principles Estimate: Project specific costs based on detailed study of work methods, resources and materials.

Hybrid: Uses features from both the unit rate method (for low risk items) and first principles method (for high risk items).

4. Ministry of Transportation and Infrastructure – British Columbia

The Ministry of Transportation and Infrastructure (MOTI) in British Columbia has developed guidelines for a framework that is used to develop, prepare, and maintain cost estimates for capital and rehabilitation projects. The framework provides consistent, realistic, and appropriate cost estimates for different stages of a project’s life cycle. The guidelines were created with the intention of being concise and easy to follow rather than a comprehensive document or user manual for specific cost estimation. The purpose of the guidelines is to produce the best cost estimate using the information that is available at the specific phase of the project.

A cost estimate classification system is used to categorize projects depending on their maturity level of project definition; this is a common approach used in the estimating industry. As the project advances and the phases become more detailed, from project inception, to planning, to design, to construction, the accuracy range narrows corresponding to less risk and uncertainty with respect to the project cost estimates. The guidelines for classifying a project follows a recognized and industry accepted system developed by the Association for the Advancement of Cost Engineering (AACE). The estimate classifications clearly identify the information used to make the estimate and the associated accuracy that is expected; it improves communication between all stakeholders.

The following table presents MOTI's classification system.

Estimate Level	% of Project Development Completed	Project Phase	Purposes of Estimate (typical reason or end use)	Methodology (typical estimating method and basis)	Expected Accuracy Range
Conceptual	0% to 2%	Initial early planning; Corridor planning	Feasibility study. Justification for project planning funding. Screening of options.	*Method*: Parametric *Basis*: Historical costs of similar past projects	+/- 35%
Planning	1% to 15%	Project planning; initial preliminary design	Business Case to support investment decision. Based on sufficient knowledge of site conditions adequate to identify high level risk.	*Method*: Parametric, Elemental Parametric *Basis*: Historical costs of similar projects, and historical avg. unit costs for work activities.	
Preliminary	10% to 40%	Preliminary design completed	Budgeting and approvals. Upon acceptance, this estimate often becomes the bases for developing a budget.	*Method*: Elemental Parametric *Basis*: Historical bid-based (avg. unit costs) for detailed work activities	+/- 20%
Design	30% to 90%	Detailed design on-going	Used for project cost control during design. Typically the initial detailed estimate.	*Method*: Elemental Parametric, Detailed Costing *Basis*: unit prices of initial design quantities from full site assessment.	
Pre-Tender	80% to 100%	Detailed design complete, ready for tender	Tender ready. Final cost review in preparation for construction. Used to obligate construction funds and evaluate contractor bids.	*Method*: Detailed Costing, "Schedule 7" *Basis*: unit prices of final design quantities, full site assessment & construction market evaluation	+/- 10%

The classes are defined with stage names rather than numbers or letters to provide clarity with respect to the phase of the project. The different methods of estimation are described as follows:

- *Parametric*: high level estimate using parameters (unit costs) developed from historical databases, engineering practices, and technologies; the appropriateness of the unit costs will depend on project definition and accuracy of the historical data. These estimate are intended at early stages before any detailed cost estimate or preliminary design; not as a basis for approving a project budget.
- *Elemental Parametric*: the cost estimate includes elements such as design, land acquisition, and construction, and parameters that need to be defined such as lane widths, depth of material, tunnel width, and height. This method is used in the planning or design stage
- *Detailed Cost*: this is the most accurate cost estimate. Each cost item is quantified and priced individually. There are two approaches.
    - Cost-based approach: based on determining contractors' cost for labour, equipment, materials, etc.
    - Historical bid-based approach: uses historical unit cost data or recent average unit prices.

The framework includes three sections; general project information, assumptions used in the cost estimation process, and cost estimate breakdown. The framework template includes worksheets for each section that make up a submission package.

- The project information worksheet includes information such as project description and location, scope statement, estimate level.
- The assumptions worksheet includes relevant project assumption, working papers and calculations, identification of risk and uncertainty, and description of contingency.
- The cost elements worksheet includes a detailed cost estimate breakdown of all elements including:
    - Project management
    - Planning
    - Engineering/Design
    - Environment
    - Property acquisition
    - Construction
    - Contingency
    - A description of each cost element, the activities involved, and considerations for determining the estimates are provided by the MOTI in the appendix of the guidelines.

An important step in the MOTI cost estimation framework is the performance measures and feedback review, which is done on a periodic basis. The MOTI monitors the success of the guidelines in terms of the accuracy of the cost estimates to look for improvements. Audits are conducted each year on certain projects of different values and complexity that reviews compliance, accuracy, and completeness. Annual reviews are also completed on a sample of projects to compare the cost estimates against the project budgets for different project stages. These reviews will provide insight on how the guidelines can be updated and revised.

5. Alberta Electric System Operator

In 2013 Alberta Electric System Operator (AESO) formed a group called the Industry Working Group to provide feedback on the cost estimation framework used for transmission development. The group recommended the adoption of the practices of the Association for the Advancement of Cost Engineering (AACE). This industry wide practice provides guidelines for using project classification to assess project cost estimates. Through this report, AESO reviewed AACE's principles, described the methodology, and provided recommendations for project classification and cost estimation.

There are five (5) classes of cost estimation that were used to construct the following table:

Estimate Class	Level of Project Definition	End Usage	Industry Usage	Accuracy Range	Major Deliverables	Estimation Method
5	0% to 2%	Screening or Feasibility	Long-term Transmission Plan Feasibility Assessment Screening Alternatives	L: -20 to -50 H: +30 to +100	Conceptual Layout Project Initiation Long-term Transmission Plan	Parametric, Judgment or Analogy
4	1% to 15%	Concept Study of Feasibility	Need Assessment Study Scope Preferred Option	L: -15 to -30 H: +20 to +50	Preliminary Functional Spec Single Line Diagrams Study Scope Project Plan	Parametric, Equipment Factored
3	10% to 40%	Design Development Budget Authorization	Need Assessment Proposal to Provide Service Facility Application Preferred Option	L: -10 to -20 H: +10 to +30	Final Functional Spec Siting & Routing Preliminary Engineering Approved Budget & Schedule	Semi Detailed Unit Costs
2	30% to 75%	Control or Bid/Tender	Post Permit & License Revised Budget (180 day PPS) Approved Cost Estimate (ACE)	L: -5 to -15 H: +5 to +20	Completed Detailed Engineering Permits & Licenses Geo Tech Vendor Negotiation Contracts	Detailed Unit Costs
1	65% to 100%	Bid Tender	Fixed Price Contracts	L: -3 to -10 H: +3 to +15	Contract	Final Detailed Unit Costs

The levels of accuracy differ from those used in the aforementioned MOTI framework in that an accuracy range is used as oppose to a single +/-. Using a low (L) and high (H) range for accuracy provides flexibility when preparing cost estimates depending on different levels of project complexity. Projects may be placed under the same estimate class (based on the project phase and detail of the associate information) however they may vary in complexity and uniqueness; which is why a range provides additional flexibility. Similar to the MOTI framework, as the project definition increases so does the associated accuracy due to the decrease in risk.

The accuracy range does not represent the contingency that is applied to the cost estimate. The estimate accuracy range is an allowance for the discrepancies in costs that are unknown or not anticipated such as changes in the economy whereas contingencies are an allowance for significant risks that are known or anticipated at early stages of project definition. Contingencies are applied to the point estimate before the accuracy range.

The following table provides project deliverable characteristics for the different classes:

	Class 5	Class 4	Class 3	Class 2	Class 1
Project Definition	0% to 2%	1% to 15%	10% to 40%	30% to 75%	65% to 100%
Usage	Screening or Feasibility	Concept Study of Feasibility	Design Development Budget Authorization	Control or Bid/Tender	Bid Tender
AACE Accuracy Range	L: -20 to -50 H: +30 to +100	L: -15 to -30 H: +20 to +50	L: -10 to -20 H: +10 to +30	L: -5 to -15 H: +5 to +20	L: -3 to -10 H: +3 to +15
Scope	General	Assumed	Preliminary	Defined	Defined
Capacity	Assumed	Preliminary	Defined	Defined	Defined
Location	None	General	Preliminary	Defined	Defined
Geotechnical	None	None	Assumed	Defined	Defined
Project Plan	None	General	Preliminary	Defined	Defined
Schedule	None	General	Preliminary	Defined	Defined
Escalation	None	Assumed	Preliminary	Defined	Defined
WBS	None	General	Defined	Defined	Defined
Cost Breakdown Structure	None	General	Defined	Defined	Defined
Contract Strategy	Assumed	Assumed	Preliminary	Defined	Defined
Contingency	General	Assumed	Preliminary	Defined	Defined

The overall approach recommended by AESO provides a general understanding of the concepts used to classify project cost estimates and avoids misrepresentation of the various classes. The five (5) class approach to cost estimation provides better accuracy, enhanced project cost predictability, and a framework for greater consistency between project cost estimates throughout the project's life cycle. The recommendations by AESO are to be revised and implemented so that transmission facility owners will be required to submit estimates using the AACE practice described in this review.

6. AACE International Recommended Practice No. 17R-97 & No. 18R-97 – Cost Estimate Classification System

The AESO and MOTI cost estimation frameworks are based on the Cost Estimate Classification System recommended by the Association for the Advancement of Cost Engineering (AACE) International. It is a practice that provides guidelines on classifying projects to determine the appropriate cost estimation methodology and associated accuracy range to be expected. A matrix is developed that categorizes different levels of cost estimation based on the design maturity of the project. The development of the matrix can be applied across different industries as it is comprised of generic principles that identify, benchmark, and evaluate multiple characteristics of the estimate class. AACE International describes their approach "so that any industry can better assess, define, and communicate their own processes and standards in the light of generally-accepted cost engineering practice" and have created a generic template that can be used by any organization

The guidelines define major characteristics of cost estimate classes, use a degree of project definition to categorize a project, and reflects generally-accepted practise in the cost engineering profession. The Recommended Practice No. 17R-97 and No. 18R-97 provide an overview of the classification system and an example using the process industry. The following figure is an example for the process industry:

	Primary Characteristic	*Secondary Characteristic*			
ESTIMATE CLASS	LEVEL OF PROJECT DEFINITION Expressed as % of complete definition	END USAGE Typical purpose of estimate	METHODOLOGY Typical estimating method	EXPECTED ACCURACY RANGE Typical variation in low and high ranges [a]	PREPARATION EFFORT Typical degree of effort relative to least cost index of 1 [b]
Class 5	0% to 2%	Concept Screening	Capacity Factored, Parametric Models, Judgment, or Analogy	L: -20% to -50% H: +30% to +100%	1
Class 4	1% to 15%	Study or Feasibility	Equipment Factored or Parametric Models	L: -15% to -30% H: +20% to +50%	2 to 4
Class 3	10% to 40%	Budget, Authorization, or Control	Semi-Detailed Unit Costs with Assembly Level Line Items	L: -10% to -20% H: +10% to +30%	3 to 10
Class 2	30% to 70%	Control or Bid/ Tender	Detailed Unit Cost with Forced Detailed Take-Off	L: -5% to -15% H: +5% to +20%	4 to 20
Class 1	50% to 100%	Check Estimate or Bid/Tender	Detailed Unit Cost with Detailed Take-Off	L: -3% to -10% H: +3% to +15%	5 to 100

Notes: [a] The state of process technology and availability of applicable reference cost data affect the range markedly. The +/- value represents typical percentage variation of actual costs from the cost estimate after application of contingency (typically at a 50% level of confidence) for given scope.

[b] If the range index value of "1" represents 0.005% of project costs, then an index value of 100 represents 0.5%. Estimate preparation effort is highly dependent upon the size of the project and the quality of estimating data and tools.

AACE International has completed previous studies that involved the collection of cost estimates and actual capital cost data for all five classes from over 25 projects with costs ranging from 50 million to over 3 billion. This data was used for an empirical analysis to come up with appropriate accuracy ranges. The final accuracy ranges were generated at a 90% confidence interval.

To better understand the classification of projects (i.e. choosing a level of project definition) AACE recommends an Input Checklist/Maturity Matrix. The matrix provides examples of general project data and the maturity level as well as relative deliverables that would fit under each class. This matrix is an example for the process industry:

	ESTIMATE CLASSIFICATION				
General Project Data:	CLASS 5	CLASS 4	CLASS 3	CLASS 2	CLASS 1
Project Scope Description	General	Preliminary	Defined	Defined	Defined
Plant Production/Facility Capacity	Assumed	Preliminary	Defined	Defined	Defined
Plant Location	General	Approximate	Specific	Specific	Specific
Soils & Hydrology	None	Preliminary	Defined	Defined	Defined
Integrated Project Plan	None	Preliminary	Defined	Defined	Defined
Project Master Schedule	None	Preliminary	Defined	Defined	Defined
Escalation Strategy	None	Preliminary	Defined	Defined	Defined
Work Breakdown Structure	None	Preliminary	Defined	Defined	Defined
Project Code of Accounts	None	Preliminary	Defined	Defined	Defined
Contracting Strategy	Assumed	Assumed	Preliminary	Defined	Defined
Engineering Deliverables:					
Block Flow Diagrams	S/P	P/C	C	C	C
Plot Plans		S	P/C	C	C
Process Flow Diagrams (PFDs)		S/P	P/C	C	C
Utility Flow Diagrams (UFDs)		S/P	P/C	C	C
Piping & Instrument Diagrams (P&IDs)		S	P/C	C	C
Heat & Material Balances		S	P/C	C	C
Process Equipment List		S/P	P/C	C	C
Utility Equipment List		S/P	P/C	C	C
Electrical One-Line Drawings		S/P	P/C	C	C
Specifications & Datasheets		S	P/C	C	C
General Equipment Arrangement Drawings		S	P/C	C	C
Spare Parts Listings			S/P	P	C
Mechanical Discipline Drawings			S	P	P/C
Electrical Discipline Drawings			S	P	P/C
Instrumentation/Control System Discipline Drawings			S	P	P/C
Civil/Structural/Site Discipline Drawings			S	P	P/C

- None (blank): development of the deliverable has not begun.
- Started (S): work on the deliverable has begun.
- Preliminary (P): work on the deliverable is advanced.
- Complete (C): the deliverable has been reviewed and approved as appropriate.

AACE notes that the specific characteristics and their relationships will vary amongst industries, whether it be level of project definition, end usage, or expected accuracy. The framework and guidelines were developed with the intention of being a benchmark so that any firm or organization can develop a classification matrix with a checklist of requirements that suits their industry or needs.

The following figure presents a comparison of different classification systems. It demonstrates the variety of guidelines associated with cost estimation classes unique to the firm or organization.

INCREASING PROJECT DEFINITION (↓)

AACE Classification Standard	ANSI Standard Z94.0	AACE Pre-1972	Association of Cost Engineers (UK) ACostE	Norwegian Project Management Association (NFP)	American Society of Professional Estimators (ASPE)
Class 5	Order of Magnitude Estimate -30/+50	Order of Magnitude Estimate	Order of Magnitude Estimate Class IV -30/+30	Concession Estimate Exploration Estimate Feasibility Estimate	Level 1
Class 4	Budget Estimate -15/+30	Study Estimate	Study Estimate Class III -20/+20	Authorization Estimate	Level 2
Class 3		Preliminary Estimate	Budget Estimate Class II -10/+10	Master Control Estimate	Level 3
Class 2	Definitive Estimate -5/+15	Definitive Estimate	Definitive Estimate Class I -5/+5	Current Control Estimate	Level 4
Class 1		Detailed Estimate			Level 5 Level 6

7. Summary

The following table provides a summary of the five frameworks reviewed, outlining the key features of each.

Organization	Classes	Accuracy Range (%)	Key features/comments
Public Works	Class A Class B Class C Class D	+/- 20 to +/- 30 +/- 15 to +/- 20 +/- 10 to +/- 15 +/- 5 to +/- 10	Classes linked to project definition/level of completion. Comparable Class definition to other reviewed frameworks which are linked to data/information requirements to achieve each estimate. Different accuracy ranges defined for simple and complex project
Queensland Government	Category 1 Category 2 Category 3 Category 4 Category 5 Category 6	*None* *None* -15/+20 -10/+15 -5/+10 -2.5/+5	Classes are linked to project definition and are comparable to the AACE International principles. Accuracy ranges are only define for more detailed stages and do not consider simple and complex projects. The variations between simple and complex projects are considered in the cost estimation methodology.
MOTI	Conceptual Planning Preliminary Design Pre-Tender	+/- 35 +/- 35 +/- 20 +/- 20 +/- 10	Classification principles and cost estimating methodology follow AACE International. 5 Classes defined by descriptions directly related to project planning stage. Provides definition of costing method for each Class.
AESO	Class 5 Class 4 Class 3 Class 2 Class 1	L: -20 to -50 H: +30 to +100 L: -15 to -30 H: +20 to +50 L: -10 to -20 H: +10 to +30 L: -5 to -15 H: +5 to +20 L: -3 to -10 H: +3 to +15	Classification principles and cost estimating methodology follow AACE International. Accuracy ranges related to project complexity and ranges not uniform plus/minus. Requires data maturity assessment to identify which class estimate is achievable.
AACE	Class 5 Class 4 Class 3 Class 2 Class 1	L: -20 to -50 H: +30 to +100 L: -15 to -30 H: +20 to +50 L: -10 to -20 H: +10 to +30 L: -5 to -15 H: +5 to +20 L: -3 to -10 H: +3 to +15	AACE completed studies that included the collection of project cost estimates and their associated actual costs for all five classes. The projects varied in complexity and costs and were used for an empirical analysis to determine the appropriate accuracy ranges for each class. The final accuracy ranges were generated at a 90% confidence interval.

Cost Estimation Approach Review
Appendix C Project Costing Spreadsheet

London CANADA

BluePlan ENGINEERING

DEVELOPMENT CHARGE PROJECT SHEET

GMIS AREA:		DC PROJ #:	
PROJECT:		CAPITAL #:	
		DATE:	
LEAD:			
CONSTRUCTION YR:			

PROJECT SUMMARY

DESCRIPTION:	LOCATION:
LANDS IMAPCTED BY PROJECT:	

DEVELOPMENT CHARGE ESTIMATE (000's of $)

TOTAL COST:	#REF!	AMOUNT ELIGIBLE FOR DC:	#REF!

G/Ng SPLIT:

Growth	non-Growth
0%	0%

G/Ng DESCRIPTION: Brief description how G/nG was derived for this project

RICI SPLITS:

Res.	Comm.	Inst.	Ind.
0%	0%	0%	0%

RICI DESCRIPTION: Brief description how RICI split was derived for this project

PREVIOUS STUDIES: Provide brief description about how estimates or scope were updated if project was identified in previous studies. Was project previously a UWRF?

OTHER INFORMATION: Identify any other information pertinent to the project, i.e. intended lead, consideration with other projects, criticality in terms of facilitating growth, potential environmental impacts to estimates, limitations due to EA's, cost sharing agreements between City or developers, etc. Other comments may include the timing associated with commencing an EA for the project, issuing an engineering assignment to pre-design components of the work, etc.

ENVIRONMENTAL ISSUES AND CHALLENGES

TRIGGERS AFFECTING PROJECT NEED

GROWTH/NON-GROWTH AND OVERSIZING JUSTIFICATION

PROPERTY REQUIREMENTS

PERMITS AND APPROVALS REQUIRED

	YES	NO	If yes, describe type:
MOE Permit to Take Water			
MOE Certificate of Approval/Form 1 - Water			
ECA - Sewage			
ECA - Air			
Class Environmental Assessment			
Ministry of Natural Resources			
Department of Fisheries Approval			
Transport Canada/Navigable Waters			
Archaeological Stage 1, 2, 3, 4			
Marine Archaeological			
Site Plan			
Building Permit			
Conservation Permit			
Ministry of Transport - Encroachment Order			
Rail Crossing			
Gas Pipeline Crossing			
Other			

London
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Class Estimate Type:	Class 1	Class adjusts Construction Contingency and expected accuracy		= Field has drop down
Project Complexity	High	Default = High. Complexity adjusts Construction Contingency, and expected accuracy		= Field must be manually populated
Accuracy Range:	10%			= Field auto-filled based on project details
Area Condition:	Rural	Area Condition uplifts unit cost and restoration		

PROPOSED DIAMETER:	0 mm		**CLASS EA REQUIREMENTS:**	A+
TOTAL LENGTH:	0 m		**CONSTRUCTION ASSUMPTION:**	Sewer 5m
Tunnelled		#DIV/0!		
Open Cut	0 m	#DIV/0!		

COST ESTIMATION SPREADSHEET

COMPONENT	RATE (%)	RATE ($)	UNIT	ESTIMATED QUANTITY	COST PER UNIT	SUB-TOTAL	COMMENTS
Construction Cost							
Pipe Construction - Open Cut			m	0 m	#N/A	#N/A	Existing road ROW
Pipe Construction - Tunneling			m	0 m	#N/A	#N/A	
Pipe Construction Uplift (Based on Area Conditions)	0%					#N/A	
Minor Creek Crossings			ea.	0	#N/A	#N/A	
Major Creek Crossings			ea.	0	#N/A	#N/A	
Road Crossings			ea.	0	#N/A	#N/A	
Major Road Crossings (Highway)			ea.	0	#N/A	#N/A	
Utility Crossings			ea.	0	#N/A	#N/A	
Pumping Station			l/s	0	$0	$0	
Storage (In Ground)			m3	0	$2,000	$0	
Treatment			ML/d		$750,000	$0	
Additional Construction Costs	20%		ea.			#N/A	Includes Mod/Demob,connections, inspection, hydrants, signage, traffic management, bonding, insurance
Provisional & Allowance	10%		ea.			#N/A	Provisional Labour and Materials in addition to base construction cost
Sub-Total Construction Base Costs						**#N/A**	
Geotechnical / Hydrogeological / Materials	2.0%					#N/A	
Geotechnical Sub-Total Cost						**#N/A**	
Property Requirements	2.0%					#N/A	
Property Requirements Sub-Total						**#N/A**	
Consultant Engineering/Design	#N/A					#N/A	includes planning, pre-design, detailed design, training, CA, commissioning
Consultant Engineering/Design Sub-Total		**$0**				**#N/A**	
In House Labour/Engineering/Wages/CA	#N/A					#N/A	
In-house Labour/Wages Sub-Total		**$0**				**#N/A**	
Project Contingency	15%					#N/A	Construction Contingency is dependent on Cost Estimate Class and Project Complexity
Project Contingency Sub-Total		**$0**				**#N/A**	
Non-Refundable HST	1.76%					#N/A	
Non-Refundable HST Sub-Total						**#N/A**	
Total (2016 Dollars)						**#N/A**	
Other Estimate							
Chosen Estimate						**#N/A**	**2016 Estimate**

COST ESTIMATE SUMMARY - FOR PHASING ESTIMATING ONLY

PROJECT COMPONENT	PROJECT COMPONENT DESCRIPTION	PERCENTAGE	TOTAL	YEAR	COMMENTS
Study	Feasibility study, EA	2%	#N/A		
Design	Design fees, Town fees for design, contract admin	13%	#N/A		
Construction	Town fees, base costs and project contingency	85%	#N/A		
TOTAL			**#N/A**		

Appendix D Proposed Unit Rate Tables

2016 Unit Costs

Sewer Unit Costs

5 m depth

Diameter	Outer Diameter	Depth to Invert	Min Trench Width	Excavation			Granular Bedding				Pipe			Backfill			Subtotal Unit Cost	Restoration	Manhole Allowance	Total Unit Cost
				Volume	Cost	Unit Cost	Depth	Volume	Cost	Unit Cost	Supply Cost	Install	Pipe Supply + Install	Vol	Cost	Unit Cost				
(mm)	(m)	(m)	(m)	(m^3/m)	($/$m^3$)	($/m)	(m)	(m^3/m)	($/$m^3$)	($/m)	($/m)	($/m)	($/m)	(m^3/m)	($/$m^3$)	($/m)	($/m)	($/m)	($/m)	(2016 $/m)
300	0.445	5	1.0	5.0	32	$ 160		1.0	67	$ 67	$ 77	$ 44	$ 122	4.0	13	53	$ 402	$ 106	$ 110	**$ 618**
375	0.52	5	1.1	5.5	32	$ 176		1.0	67	$ 67	$ 96	$ 44	$ 140	4.5	13	60	$ 443	$ 106	$ 110	**$ 659**
450	0.58	5	1.2	6.0	32	$ 192		1.1	67	$ 74	$ 123	$ 44	$ 167	4.9	13	65	$ 498	$ 107	$ 110	**$ 715**
525	0.66	5	1.3	6.5	32	$ 208		1.2	67	$ 81	$ 148	$ 44	$ 192	5.3	13	70	$ 551	$ 108	$ 110	**$ 769**
600	0.76	5	1.4	7.0	32	$ 224		1.4	67	$ 94	$ 195	$ 44	$ 239	5.6	13	74	$ 632	$ 108	$ 110	**$ 850**
675	0.88	5	1.7	8.5	32	$ 272		1.9	67	$ 128	$ 295	$ 53	$ 348	6.6	13	87	$ 835	$ 122	$ 110	**$ 1,068**
750	0.97	5	1.8	9.0	32	$ 288		2.0	67	$ 134	$ 390	$ 53	$ 443	7.0	13	93	$ 958	$ 123	$ 110	**$ 1,191**
825	1.06	5	1.9	9.5	32	$ 304		2.2	67	$ 148	$ 452	$ 53	$ 505	7.3	13	97	$ 1,054	$ 124	$ 110	**$ 1,288**
900	1.14	5	1.9	9.5	32	$ 304		2.4	67	$ 161	$ 542	$ 53	$ 595	7.1	13	94	$ 1,155	$ 126	$ 110	**$ 1,390**
975	1.23	5	2.0	10.0	32	$ 320		2.5	67	$ 168	$ 625	$ 53	$ 678	7.5	13	99	$ 1,265	$ 139	$ 110	**$ 1,514**
1050	1.32	5	2.3	11.5	32	$ 368		3.1	67	$ 208	$ 715	$ 53	$ 768	8.4	13	111	$ 1,455	$ 140	$ 110	**$ 1,705**
1200	1.46	5	2.5	12.5	32	$ 400		3.4	67	$ 228	$ 896	$ 53	$ 949	9.1	13	121	$ 1,698	$ 142	$ 110	**$ 1,949**
1350	1.67	5	2.7	13.5	32	$ 432		3.9	67	$ 262	$ 1,096	$ 60	$ 1,155	9.6	13	127	$ 1,976	$ 144	$ 110	**$ 2,230**
1500	1.81	5	2.8	14.0	32	$ 448		4.2	67	$ 282	$ 1,341	$ 60	$ 1,401	9.8	13	130	$ 2,261	$ 158	$ 110	**$ 2,529**
1800	2.16	5	3.2	16.0	32	$ 512		5.1	67	$ 343	$ 1,942	$ 60	$ 2,001	10.9	13	144	$ 3,000	$ 162	$ 110	**$ 3,273**
2100	2.51	5	3.5	17.5	32	$ 560		6.0	67	$ 403	$ 2,581	$ 60	$ 2,641	11.5	13	152	$ 3,756	$ 166	$ 110	**$ 4,032**
2400	2.88	5	3.9	19.5	32	$ 624		7.0	67	$ 470	$ 3,433	$ 60	$ 3,493	12.5	13	166	$ 4,753	$ 170	$ 110	**$ 5,033**
3000	3.56	5	4.6	23.0	32	$ 736		9.0	67	$ 605	$ 5,261	$ 60	$ 5,320	14.0	13	185	$ 6,846	$ 178	$ 110	**$ 7,134**

Sewer Unit Costs

10 m depth

Diameter	Outer Diameter	Depth to Invert	Min Trench Width	Excavation			Granular Bedding				Pipe			Backfill			Subtotal Unit Cost	Restoration	Manhole Allowance	Total Unit Cost
				Volume	Cost	Unit Cost	Depth	Volume	Cost	Unit Cost	Supply Cost	Install	Pipe Supply + Install	Vol	Cost	Unit Cost				
(mm)	(m)	(m)	(m)	(m^3/m)	($/$m^3$)	($/m)	(m)	(m^3/m)	($/$m^3$)	($/m)	($/m)	($/m)	($/m)	(m^3/m)	($/$m^3$)	($/m)	($/m)	($/m)	($/m)	(2016 $/m)
300	0.445	10	1.0	35.0	$ 45	$ 1,575		1.0	67	$ 67	$ 77	$ 44	$ 122	34.0	13	450	$ 2,214	$ 195	$ 200	**$ 2,609**
375	0.52	10	1.1	36.0	$ 45	$ 1,620		1.0	67	$ 67	$ 96	$ 44	$ 140	35.0	13	464	$ 2,291	$ 195	$ 200	**$ 2,686**
450	0.58	10	1.2	37.0	$ 45	$ 1,665		1.1	67	$ 74	$ 123	$ 44	$ 167	35.9	13	476	$ 2,382	$ 200	$ 200	**$ 2,782**
525	0.66	10	1.3	38.0	$ 45	$ 1,710		1.2	67	$ 81	$ 148	$ 44	$ 192	36.8	13	488	$ 2,471	$ 200	$ 200	**$ 2,871**
600	0.76	10	1.4	39.0	$ 45	$ 1,755		1.4	67	$ 94	$ 195	$ 44	$ 239	37.6	13	498	$ 2,587	$ 202	$ 200	**$ 2,989**
675	0.88	10	1.7	42.0	$ 45	$ 1,890		1.9	67	$ 128	$ 295	$ 53	$ 348	40.1	13	531	$ 2,897	$ 205	$ 200	**$ 3,302**
750	0.97	10	1.8	43.0	$ 45	$ 1,935		2.0	67	$ 134	$ 390	$ 53	$ 443	41.0	13	543	$ 3,056	$ 208	$ 200	**$ 3,463**
825	1.06	10	1.9	44.0	$ 45	$ 1,980		2.2	67	$ 148	$ 452	$ 53	$ 505	41.8	13	554	$ 3,187	$ 215	$ 200	**$ 3,602**
900	1.14	10	1.9	44.0	$ 45	$ 1,980		2.4	67	$ 161	$ 542	$ 53	$ 595	41.6	13	551	$ 3,288	$ 218	$ 200	**$ 3,705**
975	1.23	10	2.0	45.0	$ 45	$ 2,025		2.5	67	$ 168	$ 625	$ 53	$ 678	42.5	13	563	$ 3,434	$ 220	$ 200	**$ 3,853**
1050	1.32	10	2.3	48.0	$ 45	$ 2,160		3.1	67	$ 208	$ 715	$ 53	$ 768	44.9	13	595	$ 3,731	$ 223	$ 200	**$ 4,154**
1200	1.46	10	2.5	50.0	$ 45	$ 2,250		3.4	67	$ 228	$ 896	$ 53	$ 949	46.6	13	617	$ 4,044	$ 225	$ 200	**$ 4,470**
1350	1.67	10	2.7	52.0	$ 45	$ 2,340		3.9	67	$ 262	$ 1,096	$ 60	$ 1,155	48.1	13	637	$ 4,394	$ 225	$ 200	**$ 4,820**
1500	1.81	10	2.8	53.0	$ 45	$ 2,385		4.2	67	$ 282	$ 1,341	$ 60	$ 1,401	48.8	13	647	$ 4,714	$ 225	$ 200	**$ 5,139**
1800	2.16	10	3.2	57.0	$ 45	$ 2,565		5.1	67	$ 343	$ 1,942	$ 60	$ 2,001	51.9	13	688	$ 5,596	$ 233	$ 200	**$ 6,029**
2100	2.51	10	3.5	60.0	$ 45	$ 2,700		6.0	67	$ 403	$ 2,581	$ 60	$ 2,641	54.0	13	715	$ 6,459	$ 246	$ 200	**$ 6,905**
2400	2.88	10	3.9	64.0	$ 45	$ 2,880		7.0	67	$ 470	$ 3,433	$ 60	$ 3,493	57.0	13	755	$ 7,598	$ 253	$ 200	**$ 8,052**
3000	3.56	10	4.6	71.0	$ 45	$ 3,195		9.0	67	$ 605	$ 5,261	$ 60	$ 5,320	62.0	13	821	$ 9,941	$ 273	$ 200	**$ 10,414**

London
CANADA

BluePlan ENGINEERING

Watermain & Forcemain Unit Costs

5 m depth

Diameter	Outer Diameter (Concrete)	Depth to Invert	Min Trench Width	Excavation Volume	Excavation Cost	Excavation Cost	Granular Bedding Depth	Granular Bedding Volume	Granular Bedding Cost	Granular Bedding Cost	Pipe Supply Cost	Pipe Install	Pipe Supply + Install	Backfill Vol	Backfill Cost	Backfill Cost	Subtotal Unit Cost	Restoration	Total Unit Cost	TWINNING COST. Total Unit Cost +40% for twin
(mm)	(m)	(m)	(m)	(m^3/m)	(\$/m^3)	(\$/m)	(m)	(m^3/m)	(\$/m^3)	(\$/m)	(\$/m)	(\$/m)	(\$/m)	(m^3/m)	(\$/m^3)	(\$/m)	(\$/m)	(\$/m)	(2016 \$/m)	(2016 \$/m)
150		5					1.1				$ 77			0.0			0		**0**	**0**
200		5					1.1	1.0			$ 96			-1.0			0		**0**	**0**
250		5					1.1	1.1			$ 123			-1.1			0		**0**	**0**
300		5					1.1	1.2			$ 148			-1.2			0		**0**	**0**
350		5					1.1	1.4			$ 195			-1.4			0		**0**	**0**
400	0.50	5	1.0	5.3	$ 45	$ 236	1.1	1.9	$ 67	$ 128	$ 295	$ 57	$ 353	3.4	$ 13	$ 44	$ 761	$ 107	**$ 868**	**$ 1,215**
450	0.55	5	1.0	5.3	$ 45	$ 236	1.1	2.0	$ 67	$ 134	$ 390	$ 57	$ 447	3.3	$ 13	$ 43	$ 861	$ 107	**$ 968**	**$ 1,355**
500	0.60	5	1.2	6.3	$ 45	$ 284	1.1	2.2	$ 67	$ 148	$ 452	$ 57	$ 510	4.1	$ 13	$ 54	$ 995	$ 108	**$ 1,104**	**$ 1,545**
600	0.73	5	1.2	6.3	$ 45	$ 284	1.1	2.4	$ 67	$ 161	$ 542	$ 162	$ 705	3.9	$ 13	$ 52	$ 1,201	$ 108	**$ 1,309**	**$ 1,833**
750	0.90	5	1.7	8.9	$ 45	$ 402	1.1	2.5	$ 67	$ 168	$ 625	$ 162	$ 787	6.4	$ 13	$ 85	$ 1,442	$ 123	**$ 1,565**	**$ 2,191**
900	1.10	5	1.9	13.3	$ 45	$ 599	1.1	3.1	$ 67	$ 208	$ 715	$ 162	$ 877	10.2	$ 13	$ 135	$ 1,819	$ 126	**$ 1,944**	**$ 2,722**
1050	1.26	5	2.1	14.4	$ 45	$ 649	1.1	3.4	$ 67	$ 228	$ 896	$ 189	$ 1,085	11.0	$ 13	$ 146	$ 2,108	$ 140	**$ 2,248**	**$ 3,147**
1200	1.42	5	2.4	16.9	$ 45	$ 762	1.1	3.9	$ 67	$ 262	$ 1,096	$ 221	$ 1,316	13.0	$ 13	$ 173	$ 2,514	$ 142	**$ 2,655**	**$ 3,718**
1350	1.62	5	2.6	20.6	$ 45	$ 928	1.1	4.2	$ 67	$ 282	$ 1,341	$ 303	$ 1,644	16.4	$ 13	$ 218	$ 3,072	$ 144	**$ 3,216**	**$ 4,503**
1500	1.80	5	2.8	22.1	$ 45	$ 992	1.1	3.1	$ 67	$ 207	$ 1,606	$ 347	$ 1,954	19.0	$ 13	$ 251	$ 3,404	$ 158	**$ 3,562**	**$ 4,987**
1650	1.98	5	3.0	23.6	$ 45	$ 1,063	1.1	5.1	$ 67	$ 343	$ 1,942	$ 380	$ 2,322	18.5	$ 13	$ 245	$ 3,973	$ 158	**$ 4,131**	**$ 5,783**
1800	2.15	5	3.2	27.6	$ 45	$ 1,240	1.1	3.5	$ 67	$ 233	$ 2,252	$ 398	$ 2,650	24.1	$ 13	$ 319	$ 4,442	$ 162	**$ 4,605**	**$ 6,446**
2100	2.45	5	3.5	30.6	$ 45	$ 1,378	1.1	6.0	$ 67	$ 403	$ 2,581	$ 398	$ 2,979	24.6	$ 13	$ 326	$ 5,087	$ 166	**$ 5,253**	**$ 7,354**

Crossings

Sewer Trenchless Crossings

Assumed Length Stated on table and includes manhole each side of crossing

For Creeks & Trans Canada		For Regional Roads, Rail and Hydro Corridors		For Freeways, Major Creek Crossings	
Length =	20	Length =	60	Length =	150
Diameter	2016 $ Cost	Diameter	2016 $ Cost	Diameter	2016 $ Cost
200	$66,000	200	$118,000	200	$235,000
250	$66,000	250	$118,000	250	$235,000
300	$66,000	300	$118,000	300	$235,000
375	$166,000	375	$418,000	375	$985,000
450	$196,000	450	$448,000	450	$1,015,000
525	$196,000	525	$448,000	525	$1,015,000
600	$196,000	600	$448,000	600	$1,015,000
675	$246,000	675	$498,000	675	$1,065,000
750	$246,000	750	$498,000	750	$1,065,000
825	$316,000	825	$708,000	825	$1,590,000
900	$366,000	900	$758,000	900	$1,640,000
975	$366,000	975	$758,000	975	$1,640,000
1050	$416,000	1050	$808,000	1050	$1,690,000
1200	$416,000	1200	$808,000	1200	$1,690,000
1350	$480,000	1350	$1,000,000	1350	$2,170,000
1500	$480,000	1500	$1,000,000	1500	$2,170,000
1650	$480,000	1650	$1,000,000	1650	$2,170,000
1800	#N/A	1800	#N/A	1800	#N/A
2100	#N/A	2100	#N/A	2100	#N/A
2400	#N/A	2400	#N/A	2400	#N/A
3000	#N/A	3000	#N/A	3000	#N/A

Forcemain/Watermain Trenchless Crossings

Assumed Length Stated on table and includes valve each side of crossing

For Creeks & Trans Canada		For Regional Roads, Rail and Hydro Corridors		For Freeways, Major Creek Crossings	
Length =	20	Length=	60	Length=	150
Diameter	2016 $ Cost	Diameter	2016 $ Cost	Diameter	2016 $ Cost
150	$29,000	150	$81,000	150	$198,000
200	$30,000	200	$82,000	200	$199,000
250	$30,000	250	$82,000	250	$199,000
300	$37,000	300	$89,000	300	$206,000
350	$45,000	350	$97,000	350	$214,000
400	$203,000	400	$455,000	400	$1,022,000
450	$208,000	450	$460,000	450	$1,027,000
500	$220,000	500	$472,000	500	$1,039,000
600	$248,000	600	$500,000	600	$1,067,000
750	$296,000	750	$548,000	750	$1,115,000
900	$378,000	900	$770,000	900	$1,652,000
1050	$439,000	1050	$831,000	1050	$1,713,000
1200	$507,000	1200	$899,000	1200	$1,781,000

Manhole Costs

Inflation 2%

Diameter	Manhole Size	10m deep Cost 2016$	5m deep Cost 2016$
200	1200	$20,000	$11,000
250	1200	$20,000	$11,000
300	1200	$20,000	$11,000
325	1200	$20,000	$11,000
350	1200	$20,000	$11,000
375	1200	$20,000	$11,000
450	1500	$35,000	$25,000
525	1500	$35,000	$25,000
600	1500	$35,000	$25,000
675	1800	$60,000	$40,000
750	1800	$60,000	$40,000
825	1800	$60,000	$40,000
900	2400	$85,000	$50,000
975	2400	$85,000	$50,000
1050	3000	$110,000	$60,000
1200	3000	$110,000	$60,000
1350	3000	$110,000	$60,000
1500	3000	$110,000	$60,000
1650	3000	$110,000	$60,000
1800	Special Construction	#N/A	#N/A
2100	Special Construction	#N/A	#N/A
2400	Special Construction	#N/A	#N/A
3000	Special Construction	#N/A	#N/A

Assuming for Crossings all Manholes are 5-10m deep

Tunelling Construction Costs

Inflation 2%

Diameter	Cost 2016$	2016 $ Cost
150	$ 1,214	$ 1,300
200	$ 1,214	$ 1,300
250	$ 1,214	$ 1,300
300	$ 1,214	$ 1,300
325	$ 1,214	$ 1,300
350	$ 1,214	$ 1,300
375	$ 5,543	$ 6,300
400	$ 5,752	$ 6,300
450	$ 6,170	$ 6,300
500	$ 6,588	$ 6,300
525	$ 6,797	$ 6,300
600	$ 7,425	$ 6,300
675	$ 8,052	$ 6,300
750	$ 8,679	$ 6,300
825	$ 9,306	$ 9,800
900	$ 9,934	$ 9,800
975	$ 10,561	$ 9,800
1050	$ 11,188	$ 9,800
1200	$ 12,443	$ 9,800
1350	$ 13,697	$ 13,000
1500	$ 14,952	$ 13,000
1650	$ 16,207	$ 13,000
1800	$ 17,461	$ 13,000
2100	$ 19,970	$ 13,000
2400	$ 22,480	$ 13,000
3000	$ 27,498	$ 13,000

Forcemain / Watermain Valve Costs

Inflation 2%

Diameter (mm)	Cost 2016$	2016 $ Cost
150	$1,595	$ 1,600
200	$1,965	$ 2,000
250	$2,203	$ 2,200
300	$5,741	$ 5,500
350	$9,278	$ 10,000
400	$38,540	$ 35,000
450	$41,204	$ 40,000
500	$47,041	$ 45,000
600	$61,210	$ 55,000
750	$85,184	$ 85,000
900	$90,909	$ 90,000
1050	$121,627	$ 110,000
1200	$155,519	$ 140,000
1350		$ 150,000
1500		$ 175,000
1650		$ 200,000
1800		$ 225,000
2100		$ 250,000

Manhole unit rates

Pipe Dia.	Manhole Dia.	Spacing	Cost 5m	Cost 10m
375-600	1500	100	$12,501	$20,752
675-825	1800	100	$19,869	$32,983
900-975	2400	125	$34,606	$57,446
1050-1650	3000	150	$38,977	$64,702
1800-3000	Special Construction	150	$50,092	$83,153

London
CANADA

BluePlan ENGINEERING

Facilities

Water			
Reservoirs - New Construction	$	900,000	($/ML)
Reservoirs - Expansion			($/ML)
Water Pumping Stations ≤ 150L/s	$	23,000	($/L/s)
Water Pumping Stations > 150 L/s ≤ 600 L/s	$	13,000	($/L/s)
Water Pumping Stations >600 L/s	$	11,000	($/L/s)
WTP			

Wastewater				
Wastewater Pumping Stations ≤ 150L/s	150	$	23,000	($/L/s)
Wastewater Pumping Stations > 150 L/s ≤ 600 L/s	600	$	13,000	($/L/s)
Wastewater Pumping Stations >600 L/s		$	11,000	($/L/s)
New Pumps Existing Building		$	5,000	($/L/s)
Storage (in ground)		$	2,000	($/m3)
Rock Excavation - Extra Factor		$	450	($/sqmt)
Pre treatment (headworks)		$	360,000	ML/D
Primary treatment		$	60,000	ML/D
Secondary treatment		$	250,000	ML/D
Thickening/dewatering/storage/unloading		$	68,000	ML/D
Incineration		$	182,000	ML/D
Disinfection/de-chlorination		$	11,000	ML/D
Outfall		$	7,500	LM
Extra Factor		$	450	Per ML/D for Rock Excavation
New Treatment Unit Cost		$	750,000	ML/D

Cost Estimation Approach Review
Appendix E Estimate Class Descriptions

CLASS 4 ESTIMATE: Planning Cost Estimate	
Description: Includes high level cost estimate with a long-term project horizon. Desktop level analysis based on preliminary investigations, anticipated project needs, and engineer's best judgement based on limited information. **Example of Typical Study/Design Level:** Master Plan, Infrastructure Plan, Capital Budgeting **End Usage:** Concept screening; justification for project planning funding. Useful for planning purposes in preparation for project pre-design. Shall be included in Capital Projects List.	**Estimating Methods Used:** An approximate method of estimating using an inclusive "all in" unit rates, typically based on historic data. (e.g. sewer cost per meter) **Expected Accuracy Range:** Low Complexity → High Complexity +/- 20 → +/- 40

CLASS 3 ESTIMATE: Concept Design Cost Estimate	
Description: Includes detailed costing for budgeting purposes. Includes more detailed knowledge of specific criteria to generate more component related costing. **Example of Typical Study/Design Level:** 5-Year Business Plan Conceptual Design **End Usage:** Basis for budgeting and approvals.	**Estimating Methods Used:** Uses features from both the unit rate method (for low risk items) and first principles method (for high risk items). **Expected Accuracy Range:** Low Complexity → High Complexity +/- 15 → +/- 20

CLASS 2 ESTIMATE: Preliminary Design Cost Estimate

Description:

The cost estimate generated from this class can be used as a basis for fund appropriation. Uses more detailed knowledge and more costing components including more field investigations and preliminary design reports.

Example of Typical Study/Design Level:

Preliminary Design

End Usage:

Used for project cost control during design; initial detailed estimate.

Estimating Methods Used:

Uses features from both the unit rate method (for low risk items) and first principles method (for high risk items).

Expected Accuracy Range:

Low Complexity		High Complexity
+/- 10	→	+/- 15

CLASS 1 ESTIMATE: Detailed Design Cost Estimate

Description:

This class will generate a cost estimate representing the Engineer's final estimate based on completed plans. The estimated cost will reflect current market conditions in the constructing community. The goal of this cost estimate is to match the median bid received during the bidding process.

Example of Typical Study/Design Level:

Detailed Design

End Usage:

Final cost review in preparation for construction; tender ready.

Estimating Methods Used:

Project specific costs based on detailed study of work methods, resources and materials. For example, material costs based on current supplier quotes. All project components costed individually.

Expected Accuracy Range:

Low Complexity		High Complexity
+/- 5	→	+/- 10