Winnipeg

Water and Waste Department • Service des eaux et des déchets

Combined Sewer Overflow Master Plan

Part 1 – Abstract

Environment Act Licence No. 3042
Clause 11

Prepared for

Manitoba Sustainable Development

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CSO Master Plan – Part 1 – Abstract

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Acronyms and Abbreviations

AACE	American Association of Cost Engineers (AACE International)
CEC	Clean Environment Commission
City	City of Winnipeg
CS	combined sewer
CSO	combined sewer overflow
DEP	District Engineering Plan
EA No. 3042	Environment Act Licence No. 3042
GI	green infrastructure
LDS	land drainage sewer
MSD	Manitoba Sustainable Development
O&M	operations and maintenance
Preliminary Proposal	CSO Master Plan Preliminary Proposal
Province	Province of Manitoba
RTC	real time control
SAC	stakeholder advisory committee
SRS	storm relief sewer

1. Introduction

The City of Winnipeg (City) is proceeding with a major infrastructure upgrade program, called the Combined Sewer Overflow (CSO) Master Plan, which will reduce the amount of combined sewer flow entering our rivers from combined sewers.

Combined sewer overflows (CSOs) have been an issue in Winnipeg for many years. These types of sewers are a legacy from the past; while they have served us well, they no longer meet modern day standards for environmental protection.

After the enactment of the Manitoba Environment Act in 1988, the Province of Manitoba (Province) requested that the Clean Environment Commission (CEC), which was established under the Act, hold hearings on protecting Winnipeg's rivers and waterways. The hearings, which concluded in 1992, recommended that a CSO study be commissioned and work should start on reducing CSOs. The City completed the CSO study in 2002 and reported back to the CEC in 2003. The report included several recommendations for CSO management.

The operation of the combined sewer system in Winnipeg is governed by Environmental Act Licence No. 3042 (EA No. 3042), issued by the Province (through Manitoba Sustainable Development or MSD) in September of 2013. The City of Winnipeg's Combined Sewer Overflow Master Plan development project complies with all of the EA No. 3042 licence requirements.

EA No. 3042 required the City to submit a Preliminary Proposal for a master plan by December 31, 2015, followed by an updated plan by December 31, 2017.

The City submitted its Preliminary Proposal on December 18, 2015. It included the plans, costs, evaluation criteria and recommendations for the following five control options:

1) 85 percent Capture in a Representative Year
2) Four Overflows in a Representative Year
3) Zero Overflows in a Representative Year
4) No More than Four Overflows per Year
5) Complete Sewer Separation

The Preliminary Proposal recommended that the CSO control limit be "Control Option No. 1 – 85 percent Capture in a Representative Year." This option has the lowest capital cost of all the options, estimated at $1.3 billion in terms of 2014 dollar values, and is a major step forward for CSO management. Figure 1-1 illustrates the CSO Master Plan Timeline.

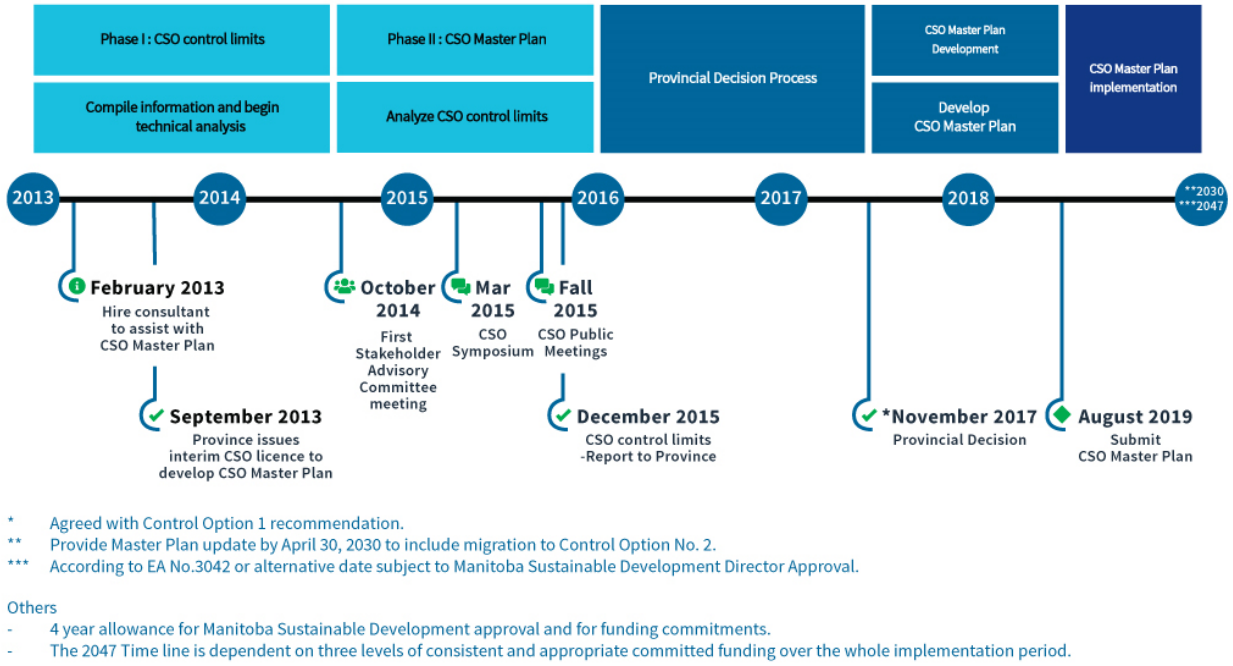

Figure 1-1 CSO Master Plan Timeline

In November 2017, MSD approved the Preliminary Proposal under the following conditions:

- Control Option No. 1 is to be implemented in such a way that the Master Plan can be expandable, allowing for the possibility of Control Option No. 2 – Four Overflows in a Representative Year, to be phased in.
- A CSO Master Plan, for Control Option No. 1, is to be submitted by August 31, 2019.
- An updated CSO Master Plan for Control Option No. 2 is to be submitted by April 30, 2030.
- The CSO Master Plan for Control Option No. 1 is to be implemented by December 31, 2045, unless otherwise approved by the Director of MSD.

The Master Plan's future control options will also be percent capture based to ensure there are no wasted investments and the program is expandable.

The City has continued work on the combined sewer system since the 2002 study and during the CSO Master Plan study and review periods. Since 2013, the City has invested over $90 million in systems and infrastructure in the combined sewer system. The work and associated costs are as follows:

- CSO Master Plan study and development - $5.4 million
- Interceptor Monitoring - $1.0 million
- District Flow Monitoring - $2.5 million
- Sewer Instrumentation - $0.5 million
- InfoWorks ICMLive (hydraulic sewer system model) - $0.4 million
- Sewer Separation
    - Cockburn - $53.0 million land drainage sewer (LDS) separation

    - Ferry Road - $13.0 million LDS separation
    - Jefferson East - $8.0 million LDS separation
- Latent Storage Dewatering Stations - $5.0 million
- Mission sewer cleaning - $0.9 million
- Bannatyne – North East Exchange Sustainable Drainage System - $0.5 million

Planned and committed work will continue until the CSO Master Plan is accepted and implementation begins. Once accepted, the objective is to continue on a percent capture reduction basis until the water quality objective is met.

The CSO Master Plan provides a roadmap for this large, long-term infrastructure program. The program will include several types of construction projects across all 43 combined sewer districts at a total estimated 2019 capital cost in excess of $2 billion. Cost sharing between the three levels of government (federal, provincial and city) will be necessary to maintain affordability and to complete the implementation close to 2045. The implementation timeline will be impacted if no, or reduced, federal or provincial funding, or both, is made available.

2. Our Submission

This CSO Master Plan provides a roadmap for this large, long-term infrastructure program. The program will include several types of construction projects across all 43 combined sewer districts. It is compliant with EA No. 3042 and meets the conditions outlined by MSD's approval of the Preliminary Proposal in November 2017.

The Plan describes the technical approach used for project evaluation and selection, scheduling of projects, and potential risks and opportunities.

The CSO Master Plan is arranged into three main parts:

Part 1 – Abstract is a summary of the CSO Master Plan.

Part 2 – Technical Report documents the approach used for project selection and master plan development.

Part 3 – CSO Master Plan Details is presented in three parts:

- Part 3A – CSO Master Plan Summary provides specific details and is intended to be updated to current conditions on an ongoing basis.
- Part 3B – District Engineering Plans (DEPs) are provided for all 43 combined sewer districts, including site-specific information and proposed project details.
- Part 3C – Standard Details provides information and assumptions for implementation of technologies common to multiple districts.

The entire report has been prepared in compliance with the EA No. 3042 request for submission of a CSO Master Plan including DEPs, proposed monitoring plans, and an implementation schedule for Control Option No. 1 – 85 Percent Capture in a Representative Year.

3. Background on Winnipeg Combined Sewers

Combined sewers were installed from the late 19th century until the early 1960s. They collect wastewater from homes, businesses, and industries, as well as surface runoff from rainstorms and snow melt in a single piping system. The sanitary sewage is diverted from the combined sewers to sewage treatment plants during dry weather. During wet weather, however, the system can be overwhelmed with a combination of sanitary sewage and high volumes of storm runoff. The diluted wastewater collected in the combined sewers overflows to our local rivers in order to protect residents from basement flooding. These overflows are also known as CSOs. Typical CSO and storm relief sewer (SRS) arrangements are shown on Figure 3-1. Additionally, the City has a series of videos and graphics on its website.

The combined sewer system services about one-third of Winnipeg. It consists of 43 combined sewer districts, as shown on Figure 3-2. All but two sewer districts have an outfall located on the banks of either the Assiniboine or Red Rivers. There are a total of 76 CSO outfall locations including 41 primary outfalls located at each primary diversion and 35 secondary outfalls to divert excess flows that occur during large rainfall and reduce the risk of basement flooding.

Winnipeg's combined sewer system is continually upgraded. Diversion weirs were installed in the 1930s to collect sewage for Winnipeg's first sewage treatment plant, the North End Wastewater Pollution Control Centre. This marked a monumental improvement in river water quality. As our city grew and modernized, the frequency of basement flooding increased. The City responded by adding capacity to the combined sewer districts. This additional capacity was gained through the installation of a SRS in parallel to the existing combined sewers. Interconnections between the two sewer types and the diversion of road drainage into the SRS led to a reduction in basement flooding.

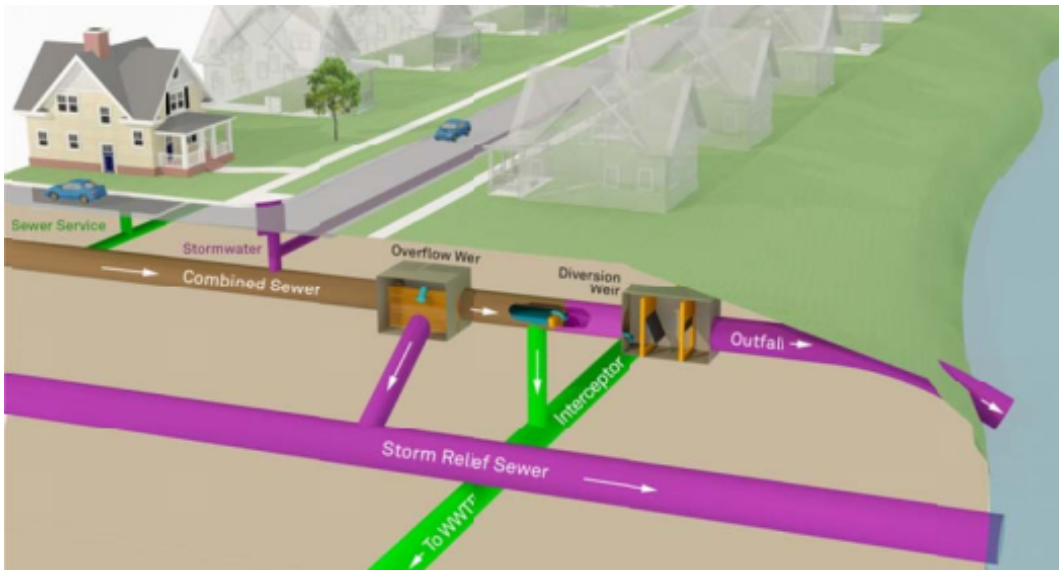

Figure 3-1 Typical CSO and SRS Arrangement

Basement flooding continues to be a concern for combined sewer districts. They are particularly susceptible because of the direct connection of the service line from basements to the combined sewers. Basement flood protection is taken into account as part of all combined sewer district improvement projects.

Water quality is a key driver behind the CSO Master Plan. Water quality was assessed as part of a two year program to collect and evaluate the contribution of nutrients and bacteria from CSOs to the rivers and Lake Winnipeg. The results, which are included in the Preliminary Proposal, indicate that CSOs contribute approximately 0.3 percent of Total Phosphorus and 0.1 percent of the Total Nitrogen that enters Lake Winnipeg.

Bacteria levels in the rivers spike during snowmelt and CSO events, with CSOs representing a minor portion of the overall contribution. The bacteria value is highest during the initial flush of the sewers and subsequently decreases back to the normal level over the two to three days following a wet weather event. The Preliminary Proposal water quality analysis indicates 44 exceedance days per year for both the baseline and Control Option No. 1. The CSO program will only have a marginal impact on the number of days when bacteria levels will exceed regulatory guidelines.

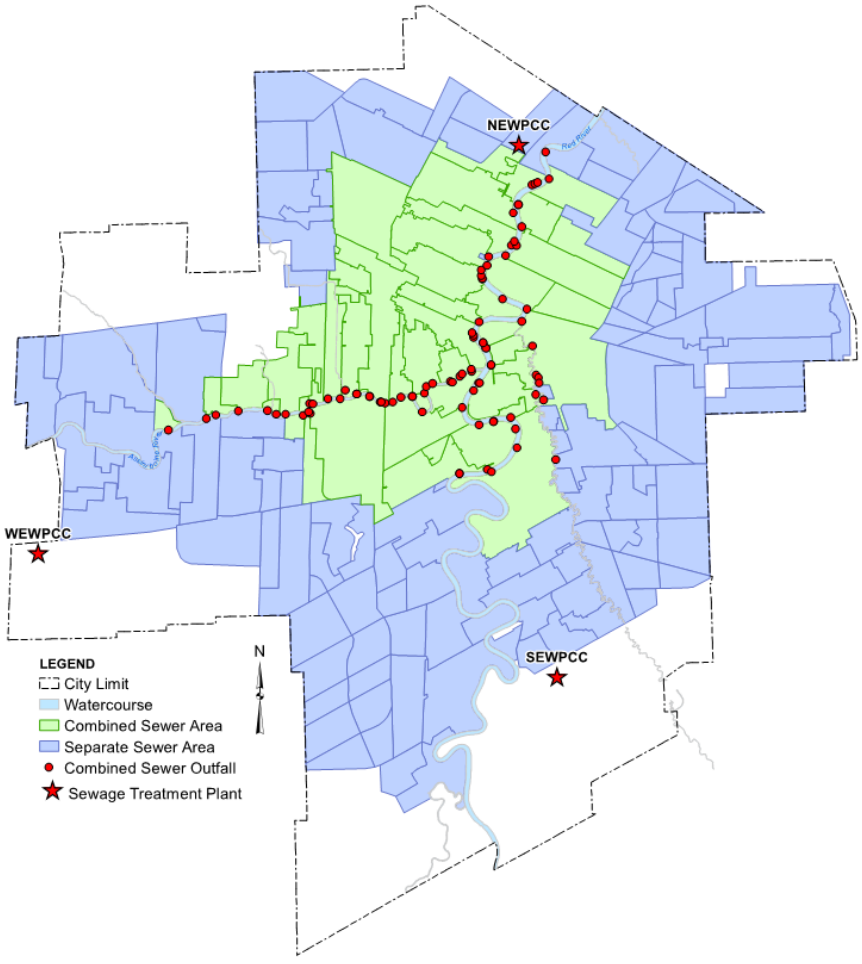

Figure 3-2 Sewer Areas and Outfalls

4. Stakeholder Engagement

The impacts of the CSO Master Plan are widespread, and the importance of open and transparent stakeholder engagement is essential to its success. The City engaged with MSD, environmental groups, and Winnipeg residents and will continue to do so, when appropriate, throughout implementation.

4.1 Regulatory Engagement

The City and MSD worked together to develop the CSO Master Plan. This included a regulatory liaison group (comprising of senior managers) and a regulatory working group.

The City met with the two groups on several occasions to report on progress and discuss issues. A clarification document was prepared to track issues and resolutions. Some of the key clarifications addressed include definitions for Representative Year, Overflow, and Percent Capture Calculation[1].

Additional requirements of EA No. 3042 were reviewed and addressed through parallel submissions and meetings. Some of these additional items included a public education plan, interim monitoring plan, notification plan and annual reporting. EA No. 3042 and related submissions can be found on the MSD website.

4.2 Public Engagement

Public engagement has and will continue to play a role in the CSO Master Plan. In the early stages, when the City needed public input on control options, it focused on public education and consultation. Some of the tools the City utilized in this early phase included a blog that was open for public comments, an email Q&A option, a CSO learning video, media interviews and public meetings.

Three public meetings were held to gather input and receive feedback. A stakeholder advisory committee (SAC) was setup to review the study methods and objectives and provide advice on their delivery.

Word cloud from 2015 CSO Symposium (word size is based on frequency of use)

The SAC provided advice and direction as to how to value and evaluate the information gathered at these events, from blog comments and email comments. The information gathered helped build the Preliminary Proposal.

For this phase of the CSO Master Plan, with the decision of control limit being made by the regulators and the CSO Master Plan focusing on engineering solutions, public engagement has focused on public education. The City is developing new communication tools and products, including a series of CSO videos, infographics (see the example on Figure 4-1), and an updated website that includes a notification tool which will monitor the CSO Master Plan's progress. The City will release the tools early in the CSO Master Plan's implementation.

[1] Licence Clarifications. Environment Act Licence No. 3042. City of Winnipeg. October 2015

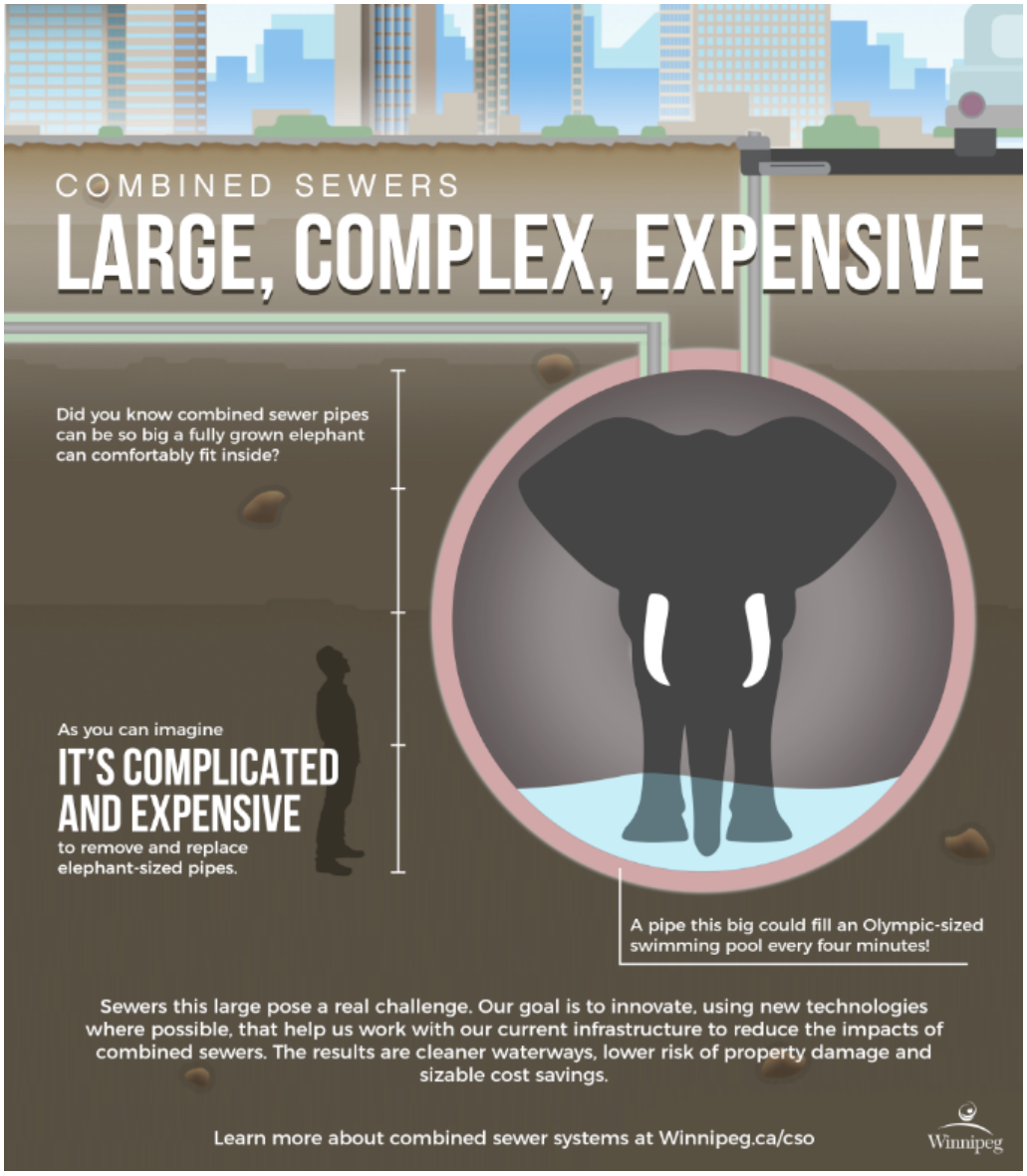

Figure 4-1 Infographic: Combined Sewer Size

5. Master Plan Development

The CSO Master Plan provides a roadmap for achieving the system wide performance objective of 85 Percent Capture in the Representative Year. The CSO Master Plan includes DEPs, cost and performance estimates, and an implementation schedule for the proposed CSO control solutions.

5.1 Design Basis

The CSO Master Plan is designed to take the current sewer system from an estimated 74 percent capture rate to an 85 percent capture rate (based on a 1992 Representative Year). This equates to an additional 2.3 million cubic metres of wastewater being captured and treated on average every year. The Representative Year was affirmed as 1992 following an assessment of historical rainfall records.

The Representative Year is applied as a uniform rainfall across the entire combined sewer system. Using this metric, computer modelling could then help us plan ways to further manage CSOs to meet our 85 percent capture goal.

Combined sewers are located in older neighbourhoods, where some changes relating to infill housing and redevelopment are expected. However, any changes will need to comply with EA No. 3042 Clause 8, which states that new developments cannot cause increases to CSOs. Therefore, cost estimates do not include an allowance to account for the potential cost of redevelopment. The 2037 development estimates for the impact of growth from separated sewer areas that experience high rates of new development are considered conservative even for 2045.

Percent capture is the key metric for program design and compliance. Percent capture is calculated as the volume of wet weather flow treated in comparison to the total volume of wet weather flow collected. The calculation incorporates the definitions as stated in EA No. 3042 and as agreed to with MSD during the development for the CSO Master Plan.

Compliance reporting for Control Option No. 1 will be based on the Representative Year and measured by Percent Capture.

5.2 CSO Technologies

There are two broad classes of technologies used for CSO control—grey and green infrastructure. Grey infrastructure refers to the conventional infrastructure projects such as sewer pipes or storage tanks. Green infrastructure (GI) refers to those that use natural hydrologic processes to keep rainwater out of the sewer systems. The CSO Master Plan focuses on traditional and well established grey infrastructure, but also includes opportunities for GI components.

5.3 Project Development

The CSO Master Plan includes the assessment and evaluation of collection systems using asset and operational data to support the proposed solutions.

Control technologies were first evaluated for use alone or in combination with other technologies for each combined sewer district. After the initial selection of technologies, their performance was evaluated using computer simulations. The individual district models were combined to evaluate the system wide performance.

The CSO Master Plan includes the following types of projects:

- **Committed Sewer Separation:** Sewer separation projects with committed funding will continue in the following five sewer districts:
    - Cockburn
    - Ferry Road
    - Riverbend
    - Parkside
    - Jefferson East

  These projects were previously identified for basement flooding relief, with tangible benefits. The separation option was selected for CSO mitigation while still providing basement flooding relief. These projects

encompass a large part of the implementation cost, with the existing remaining committed funding required surpassing $140 million. Nearly $100 million worth of sewer separation has been completed since 2013, and sewer separation work completed prior to 2013 is estimated to be in excess of $300 million.

- **Additional Sewer Separation:** The evaluation identified ten districts where additional sewer separation is estimated to be more beneficial than storage options. The additional sewer separation by installation of new LDSs has a higher capital cost but will have lower long-term operations and maintenance costs.
- **In-line Storage:** In-line storage accesses the storage volume already available in the existing combined sewers. It is maximized by installing a control gate that closes to store combined sewage and opens during significant rain events to avoid increasing the risk of basement flooding. In-line storage will use existing pump stations where available. For the ten districts that do not have pump stations, gravity flow controllers are recommended to control discharges to the interceptor.
- **Latent Storage:** The storage volume already available in relief sewers with separate outfalls is referred to as latent storage. This type of storage requires a new pump station to pump captured flows back to the combined sewer system. Latent storage has been identified for 13 locations.
- **Off-line Storage:** Off-line storage is new sewer infrastructure that adds additional storage capacity to the system. Off-line tank and tunnel storage were both considered in the evaluations. Tunnel storage was identified as the preferred option of the two off-line storage options.
- **Floatables Screening:** A reduction in the volume of floatables reaching the rivers may be achieved by adding screens at each of the outfall locations where floatables are found to be an issue. An off-line screen is installed at every primary outfall when hydraulic and operational considerations would allow for it**.** This off-line approach for first-flush screening has been included at 25 locations.

5.4 Cost Overview

A conceptual level Class 5 estimate was developed for the CSO Master Plan. A Class 5 estimate is defined by the American Association of Cost Engineers International (AACE) Cost Estimate Classification System[2] as having a project definition of zero to two percent to be used in a conceptual study with an expected range of accuracy from -50 percent to +100 percent. Estimating methods for a Class 5 estimate include historical comparisons, parametric models and judgment based on experience.

Capital costs were primarily based on local cost estimates for readily available items such as sewer pipes and chamber installations. Standard unit rates based on sewer length were used to quantify and estimate the sewer separation work. A cost estimation spreadsheet was used to generate costs for technologies with which the City had little experience (less than 20 percent of the total plan capital costs). This spreadsheet looked at projects completed in other cities and applied factors to adjust to Winnipeg conditions.

The capital cost in 2019 dollar values for the CSO Master Plan program is listed in Table 5-1.

2 AACE International. 1997. Cost Estimate Classification System – As Applied In Engineering, Procurement, and Construction for the Process Industries. AACE International Recommended Practice No. 18R 97

A breakdown of the cost for each control technology applied in the CSO Master Plan is shown on Figure 5-1. The cost estimates presented in Table 5-1 and on Figure 5-1 do not include the following:

- Investments made since 2013 in projects that provide basement flooding relief and reduce CSO's.
- Upgrades to the sewage treatment facilities to accommodate wet weather flows.
- Future operations and maintenance costs for CSO program upgrades.

The upper range of the Class 5 estimate (+100 percent) is used for budgeting purposes, giving a total estimated capital cost of $2.3 billion in 2019 dollars.

Table 5-1 CSO Master Plan Program Capital Cost Estimate (2019 Dollars)

Item	Program Cost
Estimated Capital Cost	$1,045,800,000
Green Infrastructure Allowance	$104,600,000
Subtotal – Capital Cost Estimate	**$1,150,400,000**
Class 5 Estimate Range of Accuracy: -50% to +100%	$575,200,000 to $2,300,800,000
Total Capital Cost for Budgeting Purposes	**2,300,800,000**

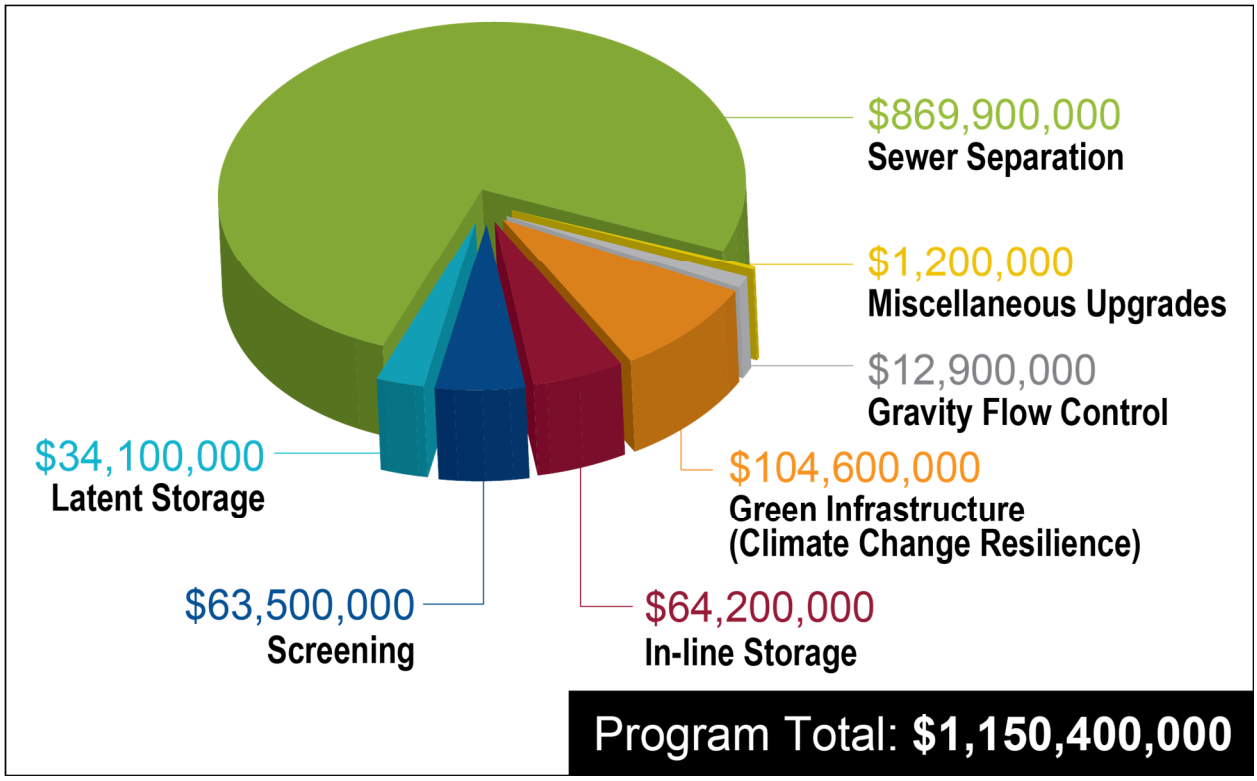

Figure 5-1 CSO Master Plan Capital Cost Summary (2019 Dollars)

5.5 Changes in Capital Cost Estimates

The CSO Master Plan capital cost estimate was developed to a Class 5 level of estimate with an expected range of accuracy from -50 percent to +100 percent. In the Preliminary Proposal, a different approach was used, whereby a range of -30 percent to +50 percent was applied to the base estimate and the total capital cost was reported as having an upper limit of $1.3 billion.

If the same approach being applied now was used in the Preliminary Proposal phase, the resulting upper end of the estimated costs would equate to $1.7 billion, which is about 30 percent higher than that reported for the Preliminary Proposal.

Table 5-2 provides a comparison between the Preliminary Proposal and CSO Master Plan project level capital costs. It shows the variance in projects selected and the impact on overall program cost.

Table 5-2 Project Selection Comparison – Preliminary Proposal and CSO Master Plan

Control Option	Preliminary Proposal 2014 Dollar Values		Master Plan 2019 Dollar Values	
	Number of Districts	Total Costs	Number of Districts	Total Costs
Latent Storage	11	$23,600,000	13	$29,300,000
Flap Gate Control	0	N/A	2	$4,800,000
Gravity Flow Control	0	N/A	10	$12,900,000
Control Gate	10	$77,400,000	24	$64,200,000
Screen			25	$63,500,000
Off-line Storage	8	$112,800,000	0	N/A
Storage Tunnel	4	$96,600,000	0	N/A
Sewer Separation	5	$519,100,000	15	$869,900,000
Additional	0	N/A	3	$1,300,000
SUBTOTAL	**24**	**$829,500,000**	**41**	**$1,045,800,000**
Green Infrastructure	N/A	N/A	41	$ 104,600,000
SUBTOTAL		**$829,500,000**		**$1,150,400,000**

This difference in estimated cost shown for the Preliminary Proposal and the CSO Master Plan in Table 5-2 is attributed to the following:

- A change in the City's use of the classification range of accuracy for cost estimating. For the Preliminary Proposal, +50 percent of capital cost was used to represent the budget estimating amount. In 2015, the City moved to the AACE classification system, and the top end of the accuracy range was increased to +100 percent of capital cost.
- GI was as accounted for by applying an allowance to the capital cost estimate of 10 percent for the CSO Master Plan. GI was not included in the Preliminary Proposal.
- Construction cost escalation from 2014 to 2019 equating to about 16 percent.
- An increase in the amount of sewer separation projects selected for control options, which have a higher capital cost, but lower operating costs.

Table 5-3 provides a comparison of the capital cost associated with the 2015 Preliminary

Proposal and the CSO Master Plan. These values reflect a Class 5 estimating range.

Table 5-3 Capital Cost Summary – Preliminary Proposal and CSO Master Plan

Program Scenario	Preliminary Proposal 2014 Capital Costs	Master Plan 2019 Capital Costs
Class 5 Estimated Capital Costs	$829,500,000	$1,045,800,000
Green Infrastructure Allowance	Not Included	$104,600,000
Subtotal – Capital Cost Estimate	**$829,500,000**	**$1,150,400,000**
Class 5 Estimate Range of Accuracy: -50% to +100%	($414,750,000) $829,500,000	($575,200,000) $1,150,400,000
Total Capital Cost Range	$414,750,000 to $1,659,000,000	$575,200,000 to $2,300,800,000

Table 5-4 provides a secondary comparison of the capital cost for each submission. In this comparison, the 2014 estimate is inflated to 2019 dollars using an annual inflation rate of 3 percent. The GI costs associated with the CSO Master Plan are excluded to show a more representative comparison.

Operations and maintenance (O&M) is not included in capital costs. They would be over and above the costs shown in Table 5-3. The high cost of the program raises concerns about affordability, and program funding considerations are presented in the following section.

Table 5-4 Capital Cost Comparison – Preliminary Proposal and CSO Master Plan

Item	Preliminary Proposal 2014-Capital Costs	Preliminary Proposal 2019-Capital Costs	Master Plan 2019- Capital Costs (March MP)
Base Construction with Markup	$829,500,000	$962,000,000	$1,045,800,000
Base Cost + 50% Estimating Allowance	$1,245,000,000 *	$1,444,200,000	$1,568,700,000
Base Cost + 100% Estimating Allowance	$1,659,000,000	$1,924,000,000	$2,091,600,000

5.6 Financial Considerations

The current method for funding the CSO Master Plan is through the sewer utility on a user-pay basis. The rates have been steadily rising for several years and are expected to continue to rise because of obligations to make major infrastructure upgrades.

Rate studies suggest that the upper threshold of affordability is $30 million per year for the Combined Sewer Overflow and Basement Flood Management Strategy capital program. With the City's commitment to current sewer separation projects (average annual capital costs of $30 million); implementing the CSO Master Plan within the timeframe identified in EA No. 3042 may be financially unsustainable even with support from other levels of government.

The City carried out an affordability assessment documented in the Preliminary Proposal based on current and future utility rates to assess the impacts of the Plan; the Plan was found to be unaffordable to complete in accordance with EA No. 3042 using City funding only. One of the recommendations from the CEC hearings was to share the cost with the federal and provincial governments.

The CSO Master Plan was developed with three funding scenarios:

- **Scenario 1** – Tri-level funding agreement between the Government of Canada, Manitoba Government, and the City of Winnipeg. For the purposes of this scenario, funding was capped at $30 million per year each, with a total estimated capital expenditure of $90 million per year (2019 dollars).
- **Scenario 2** – Bi-level funding agreement between the City of Winnipeg and either the Manitoba Government or the Government of Canada, at $30 million per year each, with a total estimated capital expenditure of $60 million per year (2019 dollars).
- **Scenario 3** – City-only funding with a total estimated capital expenditure of $30 million per year (2019 dollars).

5.7 Program Development

The CSO Master Plan will allow flexibility to manage the many projects within the defined annual budget.

A series of assumptions were included to facilitate the development of the program as follows:

- Three percent inflation per year for annual funding
- Three percent inflation per year for construction costs
- A four-year startup period at beginning of program: this includes a two-year allowance for any major alteration of EA No. 3042 and a two-year allowance to secure federal and provincial funding commitments
- Funding arrangements are consistent for the entire implementation period

Additional details are included in Part 2 – Technical Report. The phasing and scheduling of the projects was kept the same for each scenario. The different annual budgets for each scenario were then applied to determine total costs and timelines. The City will seek funding from the federal and provincial governments per the 2003 CEC recommendations. Reduced or delayed funding, any changes to inflation rates, or the failure to increase annual budgets to match assumptions will result in cost increases and a longer implementation timeline. The impacts of the three funding scenarios are shown in Table 5-5.

Annual cost escalation at three percent for construction is a significant risk. If committed funding is less than forecasted, it could result in four times the capital costs and take three times longer to implement. To put cost escalation into context, construction of the Shoal Lake Aqueduct cost approximately $17 million in 1919 dollars. That same project, if completed in 2019, would see project costs escalate to over $1.15 billion.

Table 5-5 CSO Master Plan Funding Scenario Evaluation Results (2019 Dollars)

Program Scenario	Description	Funding by	Annual Budget	Timeline
Scenario 1	3 Levels of Funding 3 x $30 Million	Tri-level Government of Canada, Manitoba Government and the City of Winnipeg	$90 Million	27 years (2047)
Scenario 2	2 Levels of Funding 2 x $30 Million	Bi-Level City of Winnipeg and either the Manitoba Government or the Government of Canada	$60 Million	39 years (2059)
Scenario 3	1 Level of Funding 1 x $30 Million	One Level City Only	$30 Million	75 years (2095)

As seen in Table 5-5, only Scenario 1 would allow the CSO Master Plan to be completed near the 2045 deadline, as directed by the Province. In contrast, Scenario 3 is estimated to be complete by 2095 (75 years). Scenarios 2 and 3 are intended as guides to illustrate impacts on implementation with reduced funding.

The City will begin implementing the CSO Master Plan when directed by the Province in order to meet this legal requirement, regardless of what funding the City may or may not receive from other levels of government. The fallback position (in case the other levels of government do not participate in funding the program) will be to follow either Scenario 2 or Scenario 3, depending on the number of funding sources and amounts.

6. Risks and Opportunities

There are a number of risks and significant consequences with a plan of this size and scope. Individual project risk responses and contingency allowances were not directly identified at this conceptual design stage, but recognition and general allowance for risk is included in the upper end of the range of cost estimates (i.e., +100 percent AACE estimating contingency). Risks are managed on a project by project basis.

The following risks and opportunities may impact the CSO Master Plan.

6.1 Risks

6.1.1 Program Implementation

A number of significant factors associated with funding and scheduling during implementation must be considered as follows:

- **Funding:** There is a risk that funding from other levels of government will not be available over the life of the CSO Master Plan. To mitigate this risk, the City will continue its work with the allocated $30 million annual budget. The City will also continue to request funding from the federal and provincial governments.

- **Cost:** There are many sources of cost risks. For example, some of the proposed technologies are new and may not have been used in environments like Winnipeg. To mitigate risks like these, the City will take advantage of experience and knowledge from other jurisdictions to verify that we are making smart decisions as the CSO Master Plan evolves.

- **Schedule:** There are many sources of schedule risks. Major delays may result from funding shortages or high bid costs. Existing limitations of engineering and construction service capacity or extended project approvals may cause delays to implementation plans. This risk will be mitigated by streamlining bidding techniques and providing early notice to the design and construction industries regarding CSO Master Plan projects.

6.1.2 Migration to Control Option No. 2

The regulatory requirement for the Master Plan to be expandable, shifting from Control Option No. 1 to Control Option No. 2, represents a significant risk to the CSO Master Plan. Expanding to Control Option No. 2 would increase costs and likely increase the timeline in order to implement the CSO Master Plan in an affordable manner. This risk can be mitigated through continued work with MSD and further technical analysis. Specific detail on the complexities of mitigating this risk can be found in Section 5 of the Part 2 – Technical Report.

Control Option No. 2 was the second highest level of control considered in the Preliminary Proposal, with a performance metric of four overflows in a representative year. The main impacts associated with upgrading to Control Option No. 2 are as follows:

- The performance metric changes from a system-wide to a district-based limit, meaning that each district would be required to meet a four overflow limit for the Representative Year. To achieve this, the configuration of projects changes for Control Option No. 2. This reconfiguration is not directly aligned with the project configuration for Control Option No. 1, and projects completed as part of meeting 85 percent capture would not necessarily be useful in meeting the long-term water quality objective.

- It would require a higher level of control, increasing to an equivalent level of capture of approximately 98 percent as compared to 85 percent for Control Option No. 1. The exact percentage needs to be confirmed and agreed with MSD prior to the 2030 submission and needs to meet the equivalent water quality bacterial performance reduction as Control Option No. 2 presented in the Preliminary Proposal.

The City has concerns with the cost and affordability of upgrading to a higher level of

control in a further accelerated timeline, especially considering the limited additional river use benefits.

The City understands that the future expandability of the program is critical to meeting future regulatory requirements; therefore, the City has chosen to move ahead with a plan that will maintain Percent Capture as the performance measure. The required Percent Capture target needed to meet the regulatory water quality objective will be determined prior to the 2030 master plan update submission. Any analysis required to demonstrate equivalent water quality performance will be reported on in the 2030 update.

6.1.3 Climate Change

The increase in extreme weather events is a potential risk to the performance of the CSO program.

The program is based on a 1992 Representative Year, which could become less representative if rainfall events increase over time. Increased rainfalls would not change the 1992 performance estimates, but the frequency of actual overflows could gradually increase and not meet desired outcomes.

The Preliminary Proposal showed an increase in the frequency of small rainfall events, but an unchanged trend for larger events. Because the CSO control system will capture the smaller events, this trend would not be detrimental to the program performance. However, there is a high degree of uncertainty in the long-term trends, and the opposite effect would occur if the frequency of large events increases.

The CSO Master Plan includes a provision for a response to climate change through the use of GI, rather than more complex and costly changes to the planned grey infrastructure. A 10 percent funding allowance is included in the budget for GI, which is over and above the Preliminary Proposal estimate.

The CSO Master Plan prioritizes sewer separation work upfront; this makes our system more resilient to climate change, as runoff will primarily be directed to LDSs.

6.1.4 Program Feasibility and Sustainability

Aside from the funding requirements and affordability issues, there are a number of other factors to be considered regarding the feasibility of completing this work by 2047. These considerations are described as follows:

- **Affordability:** The City's Water and Waste Department finances its capital and operating budgets for the sewer utility on a user-pay basis through sewer rates. The City takes a longer-term view of rates to provide stability for its rate payers. The rates have steadily been rising for several years and are expected to continue to rise because of major obligations for wastewater treatment plant upgrading and replacement and refurbishment of aging infrastructure; however, continuous increases are not sustainable.
- **Public impact:** Sewer separation projects are planned throughout the combined sewer system and will encompass large sections of the sewer districts. These projects can take several years to complete, resulting in extended periods of impact on residents and businesses.
- **Construction capacity:** The local construction industry is committed to assisting the City with its objectives. While it is assumed that the industry will add resources to meet the City's needs, it is expected that there would be a delay in the ability of the industry to adjust to the additional number and types of projects.
- **City delivery capacity:** To meet the 2047 implementation timeline, the City would have to triple the size of its current capital delivery program from $30 million to $90 million with increased work associated with implementing key aspects of the CSO Master Plan. To achieve this would require additional resources and time to expand.
- **O&M**: New infrastructure will be added that will require additional employees and resources. Some of this infrastructure will be new to the City and will require additional training and supplier support.

- **Other City services impact:** Coordination with other City services will be needed to minimize impacts and identify planning overlap. Services that will be impacted include Transit, Public Works, and Fire Paramedic and Police. Aligning with street renewals will be difficult, but necessary. Coordinating sewer work with street renewals will avoid unnecessary re-work, so that newly renovated streets already have the required sewer work completed.

- **Project overlap:** There are multiple competing infrastructure needs within the City to consider (e.g., sewage treatment plant upgrades) as well as the possibility of additional requirements in the future that cannot be forecast.

- **Proof of concept:** A period of time for technology evaluations and pilot studies is intended to validate and gain comfort in the control option selections. This implies that there is a possibility of rejection, which may lead to the need for more costly substitutes.

6.1.5 Basement Flooding

A major objective of the CSO Master Plan is to avoid compromising basement flooding protection or system operability through the modification of infrastructure, or installation and operation of new equipment. These risks can be mitigated by identification of alternative technologies for control gates, latent storage, screening, and real time control (RTC), followed by completing pilot studies to prove and validate the installations prior to implementing across several districts.

6.2 Opportunities

Opportunities to improve or enhance the CSO Master Plan were identified during its development. These can be realized in several different ways and are described in the following subsections.

6.2.1 Engineering Refinements

Value engineering provides a structured method for reviewing the costs and benefits of conceptual plans, from the perspective of adding value. Value engineering exercises should be carried out early in the conceptual design stage to achieve best value for money in the projects.

The DEPs for each of the combined sewer districts has been developed to a conceptual level. As shown on Figure 6-1, the DEPs will be further developed through the value management, additional studies and through design to construction.

Figure 6-1 Key Design Stages in Life of a CSO Project

6.2.2 Public Engagement

The CSO Master Plan will impact all residents directly through an increase in sewer rates, and traffic disruption. If the CSO Master Plan is implemented under Scenario 1, it could potentially triple the current amount of annual sewer separation work. The public's opinion and buy-in is important to the actual and perceived success of the program and can best be managed through a structured communication program. Communicating what is going on in neighbourhoods and why, as well as managing expectations, are essential to the success of the CSO Master Plan.

6.2.3 Real Time Control

RTC involves installing flow monitors and flow control structures in the sewer system to

optimize the capacity during wet weather events, reducing the volume of CSO discharge to the rivers, while still protecting against basement flooding. RTC provides for an increased capture rate by adjusting the operation of the system based on real time data collection. RTC has the potential to offset the grey infrastructure requirements by optimizing the existing system. The City is currently adding instrumentation and sensors to collection systems to better understand the sewer operation. The next stage is to refine the communication link between sensors and control elements to add enhanced operator control. In this way, flow from one part of the system can be controlled to free up capacity in other parts of the system during localized wet weather events. The collection system can be balanced, and flow to the sewage treatment plants can be controlled to reduce peaks. This is a significant change in the way the collection system will be operated. By undertaking the sewer separation project earlier in the implementation, runoff will be removed from the combined sewer system, creating more capacity to store flows using RTC.

6.2.4 Green Infrastructure

CSO GI projects get their designations primarily because of their use of natural systems to reduce runoff. Some examples of GI include porous pavements, bio retention, and rain harvesting. An example of a rain garden installed at a commercial property is shown on Figure 6-2.

Figure 6-2 Rain Garden

The CSO Master Plan recommends that GI demonstration or pilot projects are undertaken to gain experience with the technologies and to confirm performance in Winnipeg's cold climate and heavy clay soils. Issues such as its initial performance and ability to recover after a storm event, freeze-thaw durability, maintenance requirements, and long-term sustainability require further investigation. GI or low impact development standards may be developed to lead the direction of the GI investments.

A budget of 10 percent of the capital program is included in the CSO Master Plan budget, with implementation to commence after a trial and testing period. This later schedule for implementation of GI would still allow it to be considered as a response to the impacts of climate change.

6.2.5 Alternative Floatables Management Approach

The floatables management approach in the CSO Master Plan is based on outfall screening. Screening is not the most effective approach for many of our sewer districts due to many factors including the surrounding environment and the sewer system set-up.

The City has identified an alternative approach to floatables management, which is similar to a successful program run by the City of Ottawa. This proposed new approach targets source control as a potential alternative to screening. This is expected to achieve similar or better results while eliminating end-of-pipe screening.

The alternative floatables management plan provides a significant opportunity to achieve the intended results, while avoiding the high capital and long-term O&M costs of screening facilities.

6.2.6 Industry and Community Collaboration

A program of this scope will create opportunities for partnerships and collaboration with industry and community groups to create mutually positive benefits.

Trends suggest that industry is moving toward greener practices, such as seeking opportunities to create environmentally positive partnerships

and promoting the green aspects of their organizations through environmentally positive initiatives. As such, industry may be willing to invest in technologies that could benefit the CSO Master Plan through storm water reduction or other site-specific means.

There are community groups like Save Our Seine, who are aware of the environmental benefits of including GI in the CSO Master Plan program and who already promote green technologies. The City will continue to engage with these groups on the CSO Master Plan.

6.2.7 Project Innovation

The CSO Master Plan was completed at a conceptual planning level for project optimization and cost-effectiveness evaluations. One of our key objectives was to use tried and true technologies and approaches and avoid riskier options. As part of finding opportunities for innovation and cost-effectiveness, it is essential that the proposed control options and selected technologies are revisited as new information becomes available during the implementation of the CSO Master Plan.

7. CSO Master Plan Implementation under Scenario 1

To achieve implementation close to the 2045 deadline, the City will assume that Scenario 1 funding will be in place: that is, three-way shared funding with two other senior levels of government. The CSO implementation plan will comply with EA No. 3042, meeting Control Option No. 1 – 85 Percent Capture in a Representative Year and be completed by December 31, 2047. Two years are included for a major alteration of the licence, plus two years for funding commitments. If combined licence alteration/approval and funding commitments are achieved in less than four years, then the implementation timeline will be correspondingly improved.

The implementation plan details for this recommendation are summarized in Part 3A of this report, and the corresponding DEPs are included in Part 3B.

The program will gradually reduce the volume of CSOs from an estimated average of 5.2 million cubic metres per year in the year 2013 to 2.9 million cubic metres per year by program completion in 2047, based on the Representative Year (Figure 7-1). This corresponds to an increase in capture percentage from 74 percent in 2013 to 85 percent in 2047. The CSO volume reduction is calculated at 2.3 million cubic metres for the Representative Year.

Annual budgeting for this plan requires three-way shared funding of $30 million per year per funding party, based on 2019 dollar values. Budgets will require annual increases for inflation for the full implementation period to meet the 2047 implementation timeline.

An example implementation schedule is shown as Figure 7-2.

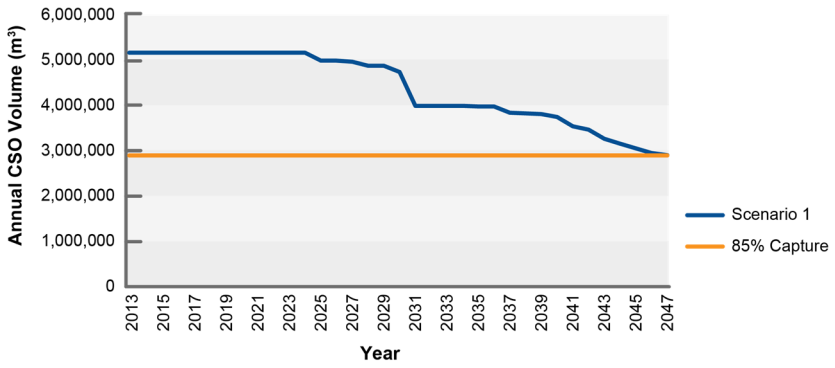

Figure 7-1 CSO Volume Reduction Timeline

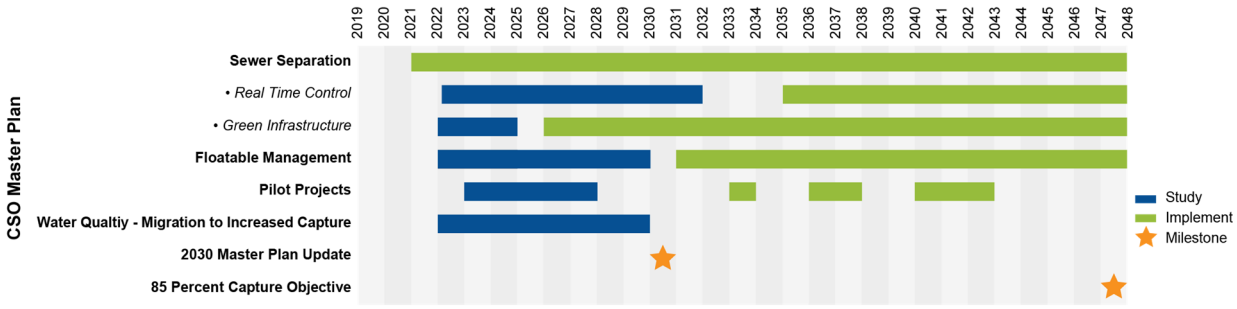

Figure 7-2 Example Implementation Schedule

8. Next Steps

The CSO Master Plan sets out a path forward to reduce the volume of combined sewer overflows by 2.3 million cubic metres for the representative year. Acceptance of the CSO Master Plan will require the City to implement this large and costly long-term program impacting about one-third of the serviced sewer area in the City.

Once complete, the CSO Master Plan will increase the estimated level of capture of combined sewage from 74 to 85 percent. The program will demonstrate environmental stewardship and achieve a level of control in compliance with EA No. 3042 and a level of control recognized by the U.S. Environmental Protection Agency for the protection of rivers and lakes.

While the program objective is to improve water quality, the program is defined by overflow volumes and is not based on water quality metrics at this time. Reducing the volume of overflow has a corresponding reduction in any water quality detriment caused by CSOs. The program will reduce the amount of diluted sanitary sewage discharged to the Red and Assiniboine Rivers, improving the rate of compliance with bacterial limits and providing a reduction of floatables material. There will be a minimal reduction in nutrient loading to the rivers.

8.1 Implementation

Following submission of the CSO Master Plan, the City will continue with the committed sewer separation projects and annual CSO results reporting as required by EA No. 3042. The scope of work will be expanded once the CSO Master Plan is approved and the City receives direction from MSD. This will include CSO Master Plan progress reporting and implementation of the Master Plan.

The City has experience with sewer separation, and existing plans (in Cockburn, Ferry Road, and Jefferson sewer districts) will continue. These projects are extensive, and the construction impacts will be significant. Many sewers and large diameter tunnels will be required. An example of a large diameter tunnel shaft is shown on Figure 8-1.

Figure 8-1 Tunnelling Shaft for Jacking Pipe on Taylor Avenue - Cockburn District

8.1.1 Secure Funding

The City has assessed the program costs and has determined that carrying out the CSO program concurrent with its other commitments is unaffordable to its utility rate payers. Assistance from the senior levels of government will be required to complete the program based on Control Option No. 1 in accordance with EA No. 3042. Funding and cost sharing arrangements should be reassessed following selection of the implementation period. Consideration of the CEC recommendation for one-third shared funding from each level of government will be required.

The program implementation has assumed a startup period of four years following submission of this CSO Master Plan to allow for a major alteration and decision from MSD and for multi-year committed tri-government funding agreements to be put in place.

An increased future commitment for migration to Control Option No. 2 will make the financial situation more extreme and require increased commitments from the other levels of government.

The Water and Waste Department will transition from the master planning phase to program management for the implementation phase following acceptance by the Province of the CSO Master Plan recommendations and confirmation of funding commitments. If the City is directed to proceed with the CSO Master Plan without any funding assistance or with reduced funding commitments from the other levels of government, the City will comply. However, the program completion timeline will be based on the City's current maximum affordability limit of $30 million per year.

8.1.2 2030 CSO Master Plan Update

The CSO Master Plan will be implemented in a way that allows for continual improvement and adaptation to changes. Currently an updated CSO Master Plan is required in 2030. The update will report on findings from the multiple studies and pilot projects planned to occur during the initial implementation period. The results of the investigations will add further certainty regarding the risks and opportunities identified in Section 6. Close collaboration with MSD on regulatory issues will be required throughout the evaluation period to arrive at manageable and practicable solutions.

8.1.3 Annual Progress Reporting

Clause 13 of EA No. 3042 triggers annual progress reporting to begin after the MSD has accepted the proposed CSO Master Plan. This includes a summary of planned and completed projects and an estimate of the system performance for the 1992 Representative Year.