Canada's Tournament Capital

Drainage Capital Funding Increase

Prepared By: Michael Schaad, Utilities Engineer

Reviewed By: Deven Matkowski, Engineering Manager
Greg Wightman, Utility Services Manager

Division Director Sign Off

Executive Summary

The Drainage Capital Program is currently supported by $2.3 million of taxation funds per year. This business case recommends an increase in the program's annual taxation funding to $4.5 million per year in 2025 to allow for asset management, the construction of additional risk mitigation projects, and to address increasing costs.

Currently, the Drainage Capital Program funds the following categories of infrastructure:

- ***dike capitalized repairs, upgrades, and new structures***
- ***minor drainage collection system repairs, replacement, upgrades, and new structures (rainfall return period of five years or less)***
- ***major drainage collection system repairs, replacement, upgrades, and new structures (rainfall return period greater than 5 years and up to 100 years)***

Various levels of additional funding are explored in this business case; some require more funds than the recommended option and some require less. All the alternatives that require less funds than the recommended option result in increased levels of risk and may impact levels of service. By not increasing funding to the Drainage Capital Plan, decision makers acknowledge that they are potentially deferring projects 10 or more years and that there is a risk that a major rainfall or flood event will occur causing significant damage to infrastructure, public, and/or private property. They may also acknowledge that depending on the option selected, the renewal of assets may be deferred and that a backlog will accumulate becoming increasingly more difficult to manage in future years. If Council deems that an increase is not supportable, then the City Solicitor should be engaged to advise on appropriate steps to be taken.

Staff recommend that the City increase funding to the Drainage Capital Plan by $2.2 million per year in order to:

- renew critical drainage infrastructure requiring replacement prior to failure
- repair major deficiencies identified in existing dikes
- fund projects that are needed and currently cannot be supported in a timely manner within the existing 10-year capital plan
- take an incremental step towards funding asset management of the drainage system
- provide a much-needed one-time adjustment that helps offset the rising cost of construction, services, and approvals

Situational Overview (Terms of Reference)

The Drainage Capital Program is currently supported by $2.3 million of taxation funds per year. This business case seeks to increase the program's annual taxation funding to $4.5 million to allow for effective asset management, additional risk mitigation, and to address increasing costs.

The Engineering and Utility Services Division teams work closely together to provide effective asset management of existing drainage infrastructure and to identify potential risk mitigation opportunities that address storm water management and flood protection. The result of this work is the identification of additional asset management projects and risk mitigation projects which require increased annual funding. Through effective planning, these divisions are committed to identifying funding needs well in advance of the projects being required and as such, this increased funding is not being sought until 2025.

Provincial changes related to drainage infrastructure and flood protection work have increased the complexity and cost of most of the projects that are identified through asset management and risk mitigation efforts. Those changes include enhanced regulations, challenging permitting/approval processes, and an evolving landscape surrounding flood protection strategies.

Additionally, the cost of engineering consulting services, construction services, and materials continues to increase. These inflationary costs put pressures on the City's resources and its ability to deliver on capital projects.

Infrastructure Overview

The Drainage Capital Program funds the following drainage infrastructure:

- ***Dike capitalized repairs, upgrades, and new structures*** – there are the roughly 22 km of regulated earthen structures that provide protection against flooding along the rivers. Most of the dikes were constructed in the 70's, 80's, and 90's and are in varying states of repair. The current dike system generally provides protection against the 1:20 year flood return period. The City is also well prepared for flooding of the Thompson Rivers and has demonstrated that temporary flood protection measures to a 200 year level can be successfully implemented as a response during flood events. For context, Provincial guidelines recommend that flood protection be provided for the 1:200 year flood return period; however, until the Province has completed its update to the BC Flood Strategy, staff are not recommending changing the level of service of our dikes.

  Funding in this category goes to repairing existing dikes and upgrading infrastructure such as outfalls that go through the dikes. Existing dike funding is adequate for minor repairs but is not sufficient for larger repairs such as re-grading of eroded, over steepened slopes.

- ***Minor drainage collection system repairs, replacement, and upgrades*** *(piped system)* – the piped drainage system collects and discharges small rainstorm events (i.e. common or nuisance rain events). The current Design Criteria Manual requires that the minor system be designed to manage the 1:5 year return period or less; however, older drainage infrastructure was designed to a lower standard. Modern drainage practices also now incorporate climate change into the rainfall projections which impact infrastructure sizing previously not accounted for.

  Much of the rainfall events that occur within City boundaries are minor events. A minor event should not cause damage or induce a claim. In the event that the minor system is undersized and does not meet our current design standards, excess flow would spill into the major system (i.e. roads and gullies), which should convey it safely.

  Of note, the most recent watershed master plan for Valleyview, Rose Hill, and Juniper completed in 2023 did a thorough assessment of the minor system and found a large list of minor system deficiencies that do not meet our current standard. Inferring upon these results, it is likely that there exists a long list of minor system deficiencies throughout the City that have yet to be identified.

  With the frequency and severity of rainfall events increasing, staff are examining the need for upgrades to our existing minor drainage collection system to build resiliency against these events.

- ***Major drainage collection system repairs, replacement, and upgrades*** *(drainage ways and overland flood routes)* – when the minor system becomes overwhelmed, stormwater is designed to flow overland. To safely convey the water, the road network, drainage rights-of-ways, ditches and gullies are used to safely convey the water. A major event is one that exceeds a 1:5 year return period and the City's current design standard is to design to the 1:100 year return period, with some provincial ministries requiring 1:200 return periods for approval. However, due to changes in design standards, budgetary constraints, climate change, city growth, and the complexity of drainage systems, there are often deficiencies that need to be addressed. Often these deficiencies are revealed during storm events or through the City's master planning processes.

  The high intensity of these storms can result in debris flows, damage to infrastructure, damage to private property, have major societal disruptions, and in extreme cases have the potential to be a risk to life. While these storms are infrequent, they can cause significant property, infrastructure, and environmental damage.

Identified Projects

The recommended funding increase is supported by recent work completed by Engineering and Utilities Services. Examples of recent planning work that have identified the need for additional funding include the completion of storm water master plans, advancing internal asset management planning, and consultant led dike assessments. In all cases, these proactive planning efforts are identifying additional projects that require an increase in capital funding. Many of the projects that are being identified are likely candidates for disaster and risk mitigation type funding programs and staff will pursue grant opportunities whenever possible to offset the cost of these projects and lessen the reliance on taxation funding.

The funding request can be supported by the following examples:

- Valleyview, Rose Hill, and Juniper Master Watershed Plan identified approximately $19.5M in minor and major system upgrades to address level of service and risk.
- Studies completed in 2022 and 2023 of 5 of the City's 15 dikes identified slope stability, high and medium urgency repairs of $2.6M. Some of the smaller repair items can be managed under existing funding, but larger cost items such as slope regrading cannot. Further studies of the remaining dikes are anticipated to reveal additional projects. Dike repairs include:
  1. $900,000 to undertake repairs of Dike 90 along Schubert Drive that would include armouring of medium and high priority areas and regrade settled areas to the 1:20 year flood design elevation.
  2. $1,000,000 in slope repairs for Dikes 97 & 98 from 1304 River Street to 850 Lorne Street.
  3. $700,000 in slope repairs for Dike 101 from Kelly Drive to Singh Street.
- Preliminary asset management assessments based on infrastructure age suggest that to maintain the existing service levels of the drainage system an average of $2.3M to $3.6M per year may be required, depending on forecast horizons. (Completion of a drainage system asset management plan will confirm.).
- Individual, unfunded projects totalling $5.5M have also been identified in the short-term:

  1. $1.9M Peterson Creek overflow at Columbia Street. The creek transitions to a concrete culvert at Columbia Street and is undersized for a major rain event. The project will increase the capacity at this restriction by installing a bypass pipe mitigating the risk of flooding and washing out Columbia Street.

2. $1.8M pump station and drainage main upgrades for Oriole Road trap low, a planned major neighbourhood center in KAMPLAN. The City has a standing Council resolution identifying that R James Western Star is serviced by a 1:5 year return period (not the typical 1:100 year return period). With this location slated to be transformed into a higher use major neighbourhood, this project would increase the service standard from the existing 1:5 year to 1:25 year return period to protect this area subject to flooding.
3. $1.6M Parkview Phase 2 drainage upgrades, Phase 1 is funded with $1.33M. A previous major rain event revealed a major system deficiency when flooding and debris flow caused property damage at Parkview Drive and Westsyde Road. The project is part of the 10-year capital plan with construction beginning 2023/24, but due to escalating costs, additional funding is necessary to complete the project.
4. $200,000 channel armouring in Juniper. This project was identified through a call for service by a resident. A stream behind their property has been eroding the slope on their land causing some property damage. The project would see approximately 80 m of channel armoured to prevent further erosion.

Additional system deficiencies are anticipated to be identified with the forthcoming East Kamloops Master Watershed Plan planned for completion December 2024 (Dallas, Barnhartvale, and Campbell Creek). Five other master plans are slated for completion in the near future and it is anticipated that they will also uncover additional system deficiencies that will require attention. It should also be expected that there will be additional projects identified during significant rain events not anticipated through planning. The total number and costs for these projects will not be known until they are identified and scoped.

Asset Management

The City has not completed and adopted a formal asset management plan for the flood protection and drainage systems. Initial work has been done to assess the criticality of drainage infrastructure, this was completed in 2016 and discussed further in the report. Preliminary work has been done to estimate future drainage main replacement needs based on age of material and the pipe's criticality. Age of material is a common method of assessing replacement, but it is recommended that the City integrate condition ratings of materials into its data collection to improve predictions, a task currently being pursued by Engineering and Utility Services. It is important to note that this analysis focuses on the City's largest drainage asset category, drainage mains, but other components would need to be considered in a fulsome asset management plan (i.e. pump stations, detention basins, dikes, etc.).

Based on age, some of the city's oldest drainage mains are coming due for replacement as of 2023. The City appears to have some leeway with planning for drainage main replacement as the bulk of our assets will be theoretically aging out and coming due for replacement starting in 2032 and onwards. Figure 1 shows the long-term age-based drainage main replacement needs using age as the sole parameter. It should be noted that Figure 1 is likely a worst-case scenario, after completion of a detailed asset management plan that includes condition assessments and criticality the peaks will likely be smoothed out and the plan extended. This would result in the average annual funding need being less than the currently estimated $7.6M. For example, not deferring highly critical drainage mains, but deferring medium and low criticality mains by 5-10 and 20 years respectively, would change the funding requirement to $6.3M annually—still a significant value.

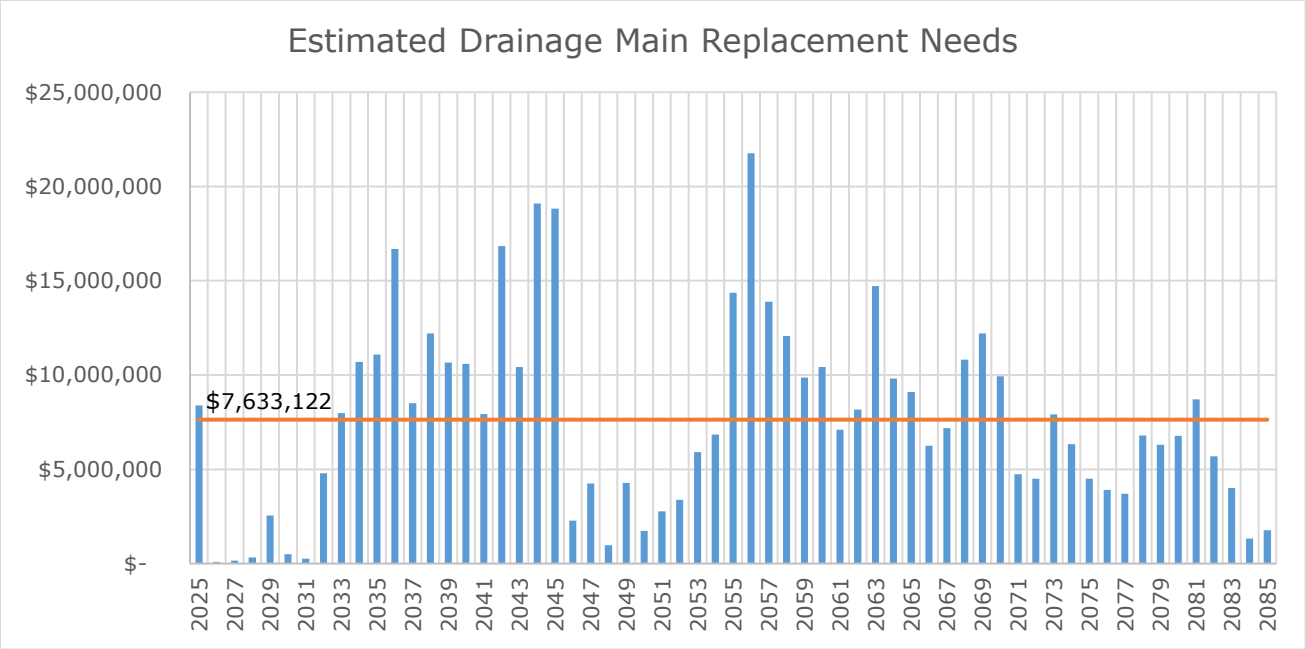


Figure 1: Long-Term, Age-Based Drainage Main Replacement Needs Based in 2023 Dollars (no deferral)

In Figure 1, there is a noticeable peak in 2025 of $8.4M which represents a growing backlog of assets beginning in 2023 that should be reviewed for replacement. The long-term asset management forecast in Figure 1 was for information only but provides context for what is coming outside of the current 5-to-10-year planning range. The focus of this business case is to address funding requirements for the immediate future. Focusing on the short-to mid-term, the asset replacement needs for the next 5 and 10 years are shown in Figure 2.

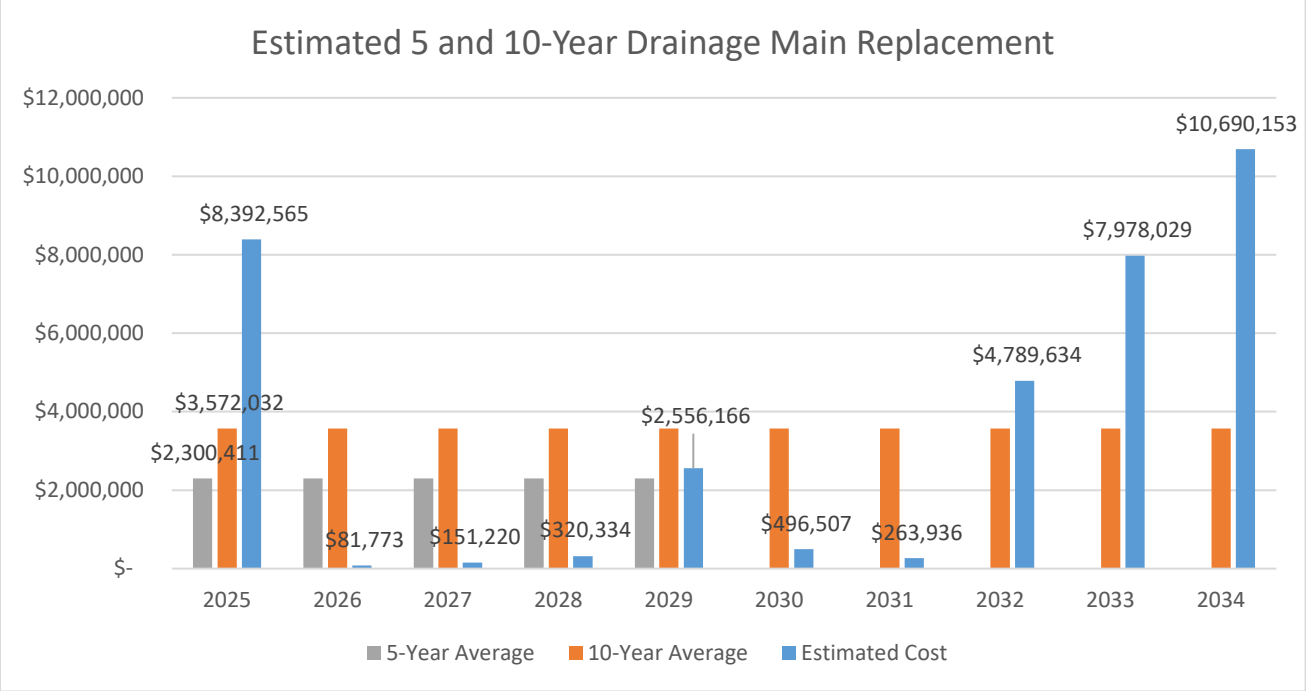


Figure 2: Projected Drainage Main Replacement Needs for the Next 10-Years in 2023 Dollars

In the next 5 years, the average age-based funding need for asset management is $2.3M annually, and for the next 10 years it is approximately $3.6M annually.

When considering replacement of drainage mains, not all minor system components are equally critical. An example of this would be the consequence of a small diameter storm main on a local road failing compared to a large diameter trunk main crossing a busy road; the consequence of failure of the large diameter main that services a large area is greater than the small storm main. The AECOM report *Utility Criticality Assessment and Inspection Plan, 2016* applied a methodology, in consultation with City staff, to determine the criticality of various drainage system components. The estimated cost of high criticality drainage mains projected to age out in the next 10 years and their expected replacement is shown in Figure 3.

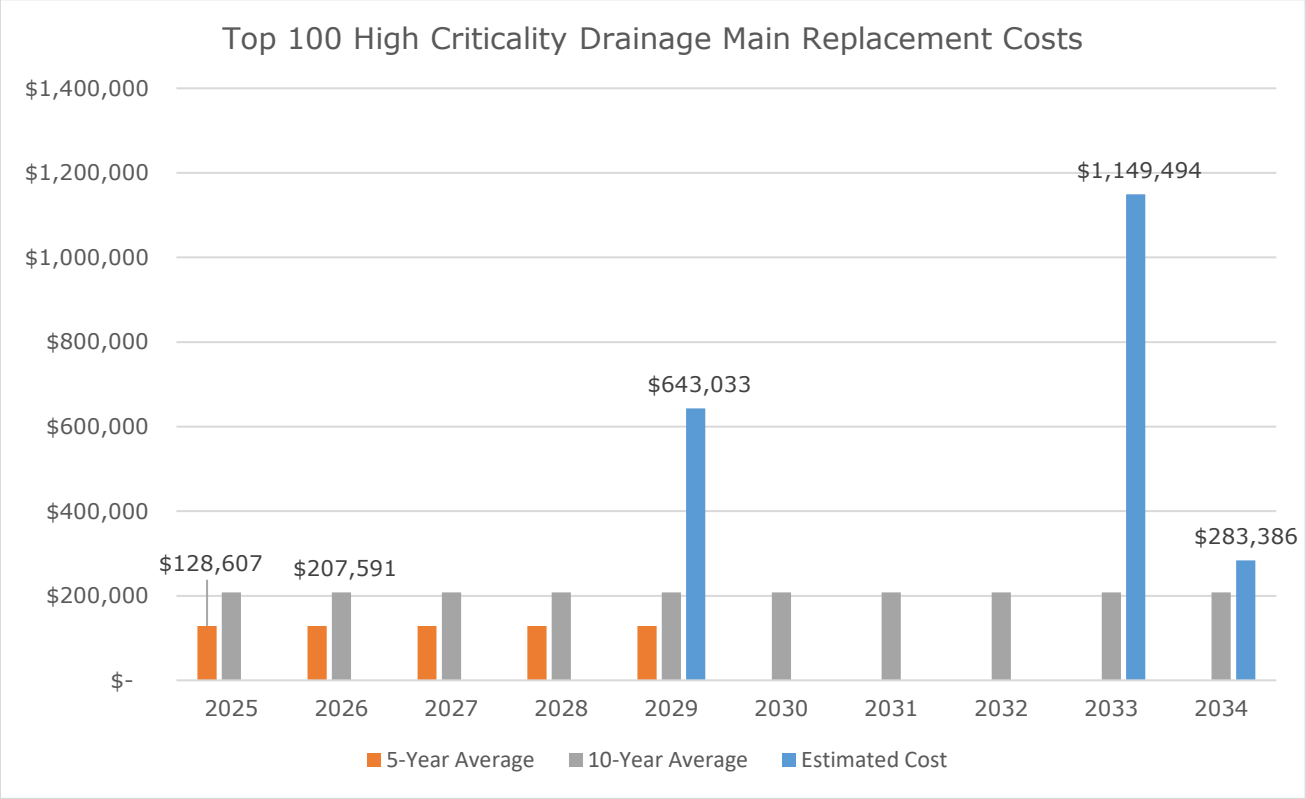


Figure 3: 10 Year Estimated Cost to Replace High Criticality Drainage Mains in 2023 Dollars

The City is only now beginning to see drainage infrastructure age-out and require renewal. It is recommended that at a minimum the drainage system mains with the highest criticality be replaced prior to failure, however it would be prudent to begin increasing funding to address asset replacement as future funding needs are uneven in the coming years and are projected to be substantial.

Increasing Costs

The Drainage Capital Program was last adjusted in 2015. From 2015 to 2023, according to Statistics Canada, the non-residential construction costs across 11 metropolitan areas increased 45% and in Vancouver costs have risen 51%. In recent years, massive disruptions to supply chains and increasing interest rates have resulted in the price of goods and services increasing

in all sectors. Without an adjust for inflation, the City is achieving significantly less with the current level of funding. This proposed adjustment in 2025 is necessary to support the projects identified in the short term, but also bolster capital investment into risk management long-term.

Options (Alternatives) Considered

The options presented below are constructed by considering the probability and consequence of failure for the different infrastructure components of the drainage system. The recommendations consider the likely risk associated with different storm and flood events and is discussed in greater detail in the benefit and cost analysis section. The costs are in 2023 dollars and are the recommended annual increase for each option.

Option 1: Status Quo

This option would result in no change to the taxation funding level that supports the Drainage Capital Program, and it would remain at $2.3M annually. This is not Administration's preferred option. The City progressively achieves less with the funding provided and levels of service are anticipated to decrease. Projects will continue to be identified and will accumulate. Identified risks will not be managed and their consequences left unmitigated.

This option will defer identified projects beyond the existing 10-year Drainage Capital Plan leaving risks unmitigated until that time. It acknowledges that there are serious repairs recommended for several of the City's dikes and the risk of not repairing them along with the corresponding potential failure during a major event would need to be accepted. Under this option the City would in effect be running drainage infrastructure to failure. This will artificially help to maintain the current taxation rate in the short term, but this method is the most expensive means of managing infrastructure in the long-term. When projects can be planned and delivered smoothly in advance, the overall cost of the projects are less (Utility Criticality Assessment and Inspection Plan, 2016).

Option 2: Minimum funding increase

This option is the suggested minimum annual funding increase to ensure that the highest priority risks are mitigated. These include:

- addressing the critical drainage main asset maintenance renewals over the next five years
- performing the identified major dike repairs over the next five years
- constructing $3M worth of recommended major system upgrades that have been pre-identified over the next five years

This option does not contemplate most asset maintenance costs that are forthcoming, upgrades to the minor system, or provide any leeway for additional high risk mitigation projects as they are identified.

By accepting this option, Council would be acknowledging that asset renewal is being deferred and will accumulate resulting in a backlog of projects and higher funding requirements in the future.

Option 3: Recommended funding increase

This option is the recommended annual funding increase to ensure that the highest priority risks are mitigated, and that the City positions itself to begin addressing asset management of the

drainage system. It takes the recommended funding items identified in Option 2 and adds additional funding for more robust short-term asset management.

A drainage system asset management plan has not been finalized nor adopted, however the initial projections presented here are likely lean because they do not include all drainage assets. The addition of asset management is recommended as a first step in what is anticipated to be incremental and recurring increases required to address this looming problem. Creation and adoption of a formal drainage asset management plan is a priority for the Engineering and Utilities Services divisions going forward. For this option it is assumed that some drainage mains can be deferred once condition assessments have been completed reducing the overall asset management ask from $2,300,000 to $1,100,000 annually. This assumes that critical infrastructure cannot be deferred, but that high and medium rated infrastructure can be deferred 5-10 years and 20 years respectively, averaged over a 10 year period. The values provided here are considered adequate for current planning and budgeting purposes.

This recommendation includes:

- addressing anticipated drainage system asset renewals over the next five years with critical and high importance infrastructure being prioritized first
- performing identified major dike repairs over the next five years
- constructing $3M worth of recommended major system upgrades that have been pre-identified over the next five years

This option does not contemplate most asset maintenance costs during and beyond the five year planning period, upgrades to the minor system, or provide any leeway for additional high risk mitigation projects as they become identified in the next five years. Any new projects would be scheduled beyond 2030 or need to be brought forward for additional funding. This option is a good incremental increase for asset management.

Option 4: Full funding increase

This option would see an annual taxation increase that ensures most deficiencies in the drainage system that have been identified are addressed. This funding increase would include:

- addressing the projected drainage system asset renewals over the next five years in full
- performing the identified major dike repairs over the next five years
- constructing all of the existing major system upgrades already identified over the next five years

This option does not provide any leeway for additional projects that may be identified within the next five years. Any new projects would be scheduled beyond 2030 or need to be brought forward to request additional funding.

Financial Considerations (Benefit/Cost Analysis)

Option 1: Status Quo

Description of Costs		2024	2025	2026	2027	2028
Capital:						
	Critical Mains	-	-	-	-	-
	Dike Repairs	-	-	-	-	-
	Major System Projects	-	-	-	-	-
	Total Capital	-	-	-	-	-

Description of Costs		2024	2025	2026	2027	2028
Operating:						
	N/A	-	-	-	-	-
Total Operating		-	-	-	-	-
Total Spend by Year		**-**	**-**	**-**	**-**	**-**

Option 2: Minimum funding increase

Description of Costs		2024	2025	2026	2027	2028
Capital:						
	Critical Mains	$130,000	$130,000	$130,000	$130,000	$130,000
	Dike Repairs	$500,000	$500,000	$500,000	$500,000	$500,000
	Major System Projects	$600,000	$600,000	$600,000	$600,000	$600,000
	Total Capital	*$1,230,000*	*$1,230,000*	*$1,230,000*	*$1,230,000*	*$1,230,000*
Operating:						
Total Operating		-	-	-	-	-
Total Spend by Year		***$1,230,000***	***$1,230,000***	***$1,230,000***	***$1,230,000***	***$1,230,000***

Option 3: Recommended funding increase

Description of Costs		2024	2025	2026	2027	2028
Capital:						
	Asset replacement	0	$1,100,000	$1,100,000	$1,100,000	$1,100,000
	Dike Repairs	0	$500,000	$500,000	$500,000	$500,000
	Major System Projects	0	$600,000	$600,000	$600,000	$600,000
	Total Capital	*0*	*$2,200,000*	*$2,200,000*	*$2,200,000*	*$2,200,000*
Operating:						
Total Operating		-	-	-	-	-
Total Spend by Year		***$0***	***$2,200,000***	***$2,200,000***	***$2,200,000***	***$2,200,000***

Option 4: Full funding increase

Description of Costs		2024	2025	2026	2027	2028
Capital:						
	Asset replacement	$2,300,000	$2,300,000	$2,300,000	$130,000	$130,000
	Dike Repairs	$500,000	$500,000	$500,000	$500,000	$500,000
	Major System Projects	$1,100,000	$1,100,000	$1,100,000	$600,000	$600,000
	Total Capital	*$3,900,000*	*$3,900,000*	*$3,900,000*	*$3,900,000*	*$3,900,000*
Operating:						
Total Operating		-	-	-	-	-
Total Spend by Year		***$3,900,000***	***$3,900,000***	***$3,900,000***	***$3,900,000***	***$3,900,000***

Project Prioritization

The following is a suggested framework for prioritizing the different drainage and flood assets. It follows a commonly recognized risk-based methodology that is proven and systematic. The outcome provides a rating based on risk that decision makers can use as part of their assessment.

The likelihood of an event occurring and the consequence of that event correspond to the risk. This risk analysis was used when determining the proposed options and recommendations to assist with their prioritization. Different probability ranges were selected that relate to different components of the drainage system.

Dike infrastructure probabilities:

- 1:20 year return period for floods was chosen because the city's dikes are mostly constructed to meet this criteria. The dikes should not overtop and should remain intact during this event so long as they are in good condition. Temporary flood protection measures may need to be deployed in years with larger than 1:20 freshets.
- 1:200 year return period for floods was chosen because this is the Provincial design standard and the elevation used for land use planning in the City.

Drainage system probabilities:

- 1:5 year return period for storms is the maximum design criteria that the minor (piped) system in the city is to be designed to using current standards. Rainfall events of this size or smaller should be able to be managed by the minor system adequately.
- 1:100 year return period for storms is the design standard for overland flow paths in the city. When a rain event exceeds the 1:5 year event, flow will be conveyed over roads, drainage rights-of-ways, ditches, and gullies. The City's current design standard is to ensure that this storm event can be conveyed safely.

Applying this information, Table 1 summarizes the probability breakdown and suggests a corresponding rating. Table 2 is a suggested matrix of consequences based on various social, economic, and environmental parameters. Applying these relationships to the types of storm and flood events that could occur, results in the risk relationship determined from Table 3 and summarized in Table 4. Professional judgment is recommended when using these tables.

Table 1: Likelihood and Associated Rating

Likelihood	Rating	Recurrent Impact
Very likely	1	Almost every year (annual chance: >50%)
Likely	2	Once in 2 to 5 years (annual chance: 20% - 50%)
Possible	3	Once in 5 to 10 years (annual chance: 10% to 20%)
Unlikely	4	Once in 10 to 50 years (annual chance: 2% to 10%)
Very Unlikely	5	Once in 50 years to 100+ years (annual chance: <2%)

Modified from EGBC Legislated Flood Assessments in a Changing Climate in BC, 2018

Table 2: Consequence of Failure Matrix

Indices	1	2	3	4	5	6
	Negligible	**Minor**	**Moderate**	**Major**	**Severe**	**Catastrophic**
Safety (Injury/Loss of Life)	Minor injuries of few individuals	Major injury of 1 person	Major injury of several persons	Single fatality	<10 fatalities	>10 fatalities
Economic (Monetary Losses)	Negligible; no business interruption; <$1,000	Some asset loss; <$10,000 damages	Serious asset loss; several days business interruption; <$100,000	Major asset loss; several weeks business interruption; <$1 million	Severe asset loss; several months business interruption; <$10 million	Total loss of asset; 1 year or more business interruption; >$10 million
Social and Cultural	Negligible impact	Slight impact; recoverable within days	Moderate impact; recoverable within weeks	Recoverable within months	Long-term (years) loss of social and cultural values	Complete loss of significant social and cultural values
Intangibles (Personal Suffering)	Negligible impact	Slight impact; recoverable within days	Moderate impact; recoverable within weeks	Personal hardship; usually recoverable within months	Leaves significant personal hardship for years	Irreparable personal hardship
Ecological (Flora and Fauna)	Negligible impact	Slight impact; recoverable within days	Moderate impact; recoverable within weeks	Recoverable within months	Severe species loss	Irreparable species loss

Modified from EGBC Legislated Flood Assessments in a Changing Climate in BC, 2018

Table 3: Risk Matrix

Description	#	Probability	Negligible	Minor	Moderate	Major	Severe	Catastrophic
			1	2	3	4	5	6
Very likely	1	20% - >50%	M	H	H	VH	VH	VH
Likely	2	10% - 20%	L	M	H	H	VH	VH
Possible	3	2% - 10%	L	L	M	H	H	VH
Unlikely	4	1% - 2%	VL	L	L	M	H	H
Very Unlikely	5	<1%	VL	VL	L	L	M	H

Modified from EGBC Legislated Flood Assessments in a Changing Climate in BC, 2018

Table 4: Possible Risk of Flood and Stormwater Return Periods

Description	Probability	Consequence	Risk
1:20 year flood event (5% chance)	Possible	Major	High
1:200 year flood event (0.5% chance)	Very Unlikely	Catastrophic	High
1:5 year storm event (20% chance)	Likely	Negligible	Low
1:100 year storm event (1% chance)	Unlikely	Major-Severe	Medium-High

To manage risk, funding should preferentially be allocated to the infrastructure that supports mitigating the highest risk events, thereby providing the greatest benefit. Based on the analysis in Table 4, funding priorities should go to the following in descending order:

1. Dikes – Ranked as a high risk for both the 1:20 and 1:200 probabilities. Ensuring dikes are in good condition and capable of providing dependable service during worst case conditions is recommended. This is intuitive as flooding has the potential to impact large areas causing significant hardship, property damage, and in extreme cases risk to life.
2. Major storm events – Ranked as medium to high risk. Concentrated torrents of flow can cause significant disruption and damage to property. These events could spread over a large area, as in the case of flooding by Peterson Creek, or smaller areas in more channelized corridors. Rainfall events can be localized or city wide, and the range of possible risk is large. The City should construct, upgrade, and renew infrastructure that can convey major storm events that mitigates and lowers risk.
3. Minor storm events – Ranked as low risk. This system when overwhelmed should by default flow into the major system causing no damage. It is when the major system is not working correctly that damages occur. Upgrading and renewing the minor system is a balance between how much to fund for renewals and upgrades (i.e. asset management), and the collective cost of staff time and materials preforming repairs, responding to calls for service, and the political concerns raised from the community when the system does not function as intended.

Cost/Benefit of Individual Projects

The risk related to dikes and major storm events was proven to be relatively high and should be considered as priority. This section will review the individual dike and major system projects and provide additional decision-making information related to each one. It will attempt to quantify the possible cost of damages being mitigated, but it is important to remember that not all consequences can have a cost assigned to them, there are other social, cultural, and environmental damages and disruptions to consider.

In all options except Option 1, dikes, critical infrastructure, and infrastructure that addresses major storm events are recommended to mitigate the greatest risks and provide the greatest benefits. Options 2 through 4 differ in how the City chooses to initiate its drainage asset management plan and the amount allocated towards new major system projects. The individual projects for dikes and major system upgrades are assessed in greater detail below.

Dikes

Infrastructure funding of dikes provides the greatest return on investment. The consequence of a major flood was previously classified as either major or catastrophic. These classifications correspond with potential impacts having up to or greater than $10M in damages, including other serious non-monetary impacts to service, the economy, societal impacts, cultural impacts, and the environment. At a minimum it is recommended that funding be increased so that our existing dikes can be maintained to minimize the potential for failure during a major flood event.

This business case does not contemplate changing the current design standard of the existing dike system (1:20 year flood event), although the Engineering division does recommend that a long-term flood strategy be developed that would assess the potential for upgrading the diking system to the provincial 1:200 year construction standard. A study would also help monetize the risk and consequence of different flood levels of service, providing further clarity for decision makers. This study is recommended to be completed after the Province has published the update to their Flood Strategy that is currently in development. While the City waits for the

Province to publish their flood strategy, it is recommended that detailed dike condition assessment continue to be completed for the remaining dikes to inform a future long-term flood strategy.

Dike 90 – Schubert Drive

This project is supported by a study completed in 2022 by the engineering and professional services firm WSP. It identified $900,000 worth of repairs including armouring of medium and high priority areas and the regrading of settled areas to the 1:20 year flood design elevation. Specific concerns included heavy localized erosion on the water side of dike that could lead to sloughing and a loss of dike integrity. Another concern is unstable trees that could uproot, this results in the root wad creating a large hole in the dike that can be scoured resulting in piping, possible loss of dike integrity, and ultimately failure.

The report considered high risk deficiencies as those that would occur during a 20-year flood event and that would cause significant erosion and damage. Whereas medium risk deficiencies were those in which existing damage would be further exasperated during the next 20-year flood event. At the 1:20 year flood level, this dike protects an estimated 285 residential properties, the apartments and townhouse on Beach Ave and Kitchener Cres (ground level unit count exceeds 65, one apartment building is unknown), and the Henry Grube Education Centre.

The estimated cost of damages is not known, but depending on the severity of a flood, property values can be negatively affected by 15% to 60% (Ebbwater Consulting). A sample of six single family properties on the property listing website MLS indicates that the average home in this area is approximately $590,000. For an order of magnitude cost, applying the average home value to the 285 properties (not the apartments or townhouses, pricing was not available for those), then there is a total estimated value of $168M. Using the range of 15% to 60% in possible property damage results in $25M and $101M in estimated damages respectively. Further study is recommended to confirm the estimated damages.

Given that there is a 5% chance that a 1:20 year flood will occur each year, statistically there is a 64% chance of this occurring once in 20 years.

Dikes 97 & 98 – River, Lorne, and Front Streets

This project is supported by a study completed in 2023 by TRUE Consulting. It identified $1M worth of repairs including regrading and armouring of eroded sections. Specific concerns included heavy localized erosion on the water side of the dike that could lead to sloughing, a loss of dike integrity, and ultimately failure.

Properties protected by these dikes include:

- 44 Townhouses
- tennis court facilities on Front Street
- River Street dog park
- River Street skate park
- Exhibition Park and tennis courts
- Kamloops Yacht Club
- River Street community garden

One neighbouring property not in the flood plain but listed on MLS indicates that a townhouse could be valued at $750,000. For an order of magnitude cost, applying the home value to the 44 properties and assigning a $500,000 allowance for the Yacht Club, there is an estimated value of $33.5M. Using the range of 15% to 60% in possible property damage and assigning an

allowance to clean up city recreational properties of $200,000, results in $5.2M and $20.3M in estimated cost of damages respectively. Further study is recommended to confirm the estimated damages.

There is a 5% chance that a 1:20 year flood will occur each year, statistically there is a 64% chance of this occurring once in 20 years.

Dike 101 – Kelly Drive to Singh Street

This project is supported by a study completed in 2023 by TRUE Consulting. It identified $700,000 worth of repairs including regrading and armouring of eroded sections. Specific concerns included heavy localized erosion on the water side of the dike that could lead to sloughing, loss of dike integrity, and ultimately failure.

One property in the flood plain was listed on MLS and five others from the neighbourhood but outside of the floodplain were used to estimate property values in the area at $565,000. This dike provides limited protection because downstream and connected to it is an orphan dike. An orphan dike is one that no jurisdiction is taking responsibility for and was not assessed as part of this study. If repairs are made to Dike 101, and the orphan dike fails, then flood waters would wrap around and flood behind. The Province is currently updating their flood strategy and the City is waiting to review the final document. Staff recommend that the City pursue a flood protection planning study that should include orphan dikes once the provincial study is complete and guidance to municipalities given.

To assess the properties being protected by this dike it was assumed only those that are perpendicular to the dike would be used, this totaled 59 properties. To determine an order of magnitude value of the homes being protected, the estimated home value was applied to the 59 properties resulting in an estimated total value of $33M. Using the range of 15% to 60% results in $5M and $20M in estimated cost of damages respectively. Further study is recommended to confirm the estimated damages.

Given that there is a 5% chance that a 1:20 year flood will occur each year, statistically there is a 64% chance of this occurring once in 20 years. While there is an orphan dike adjacent to Dike 101, it is still prudent and good practice to ensure our infrastructure is maintained and in good working order. If left unrepaired, further degradation and damage will result in increased future repair costs or failure of the dike.

Major System

The major system was the next highest risk and had a consequence rating of major or severe. These consequence ratings correspond with potential damages of less than $1M or less than $10M respectively depending on the size and extent of the storm event, in addition to the other serious non-monetary impacts to service, the economy, societal impacts, cultural impacts, and the environment that would also occur. With a consequence rating of major or severe, the duration to recover is also less than a flood, but still potentially significant at weeks or months. The major system runs throughout the City, wherever there is a road or natural drainage way, this makes it much more difficult to identify, assess and quantify. While the major system extends throughout the entire system, individual projects will only affect those within the vicinity of overland flooding, not unlike dikes which affect those within the floodplain.

There are 13 identified watersheds within city limits. To date, only 5 of the 13 master watersheds have had master plans completed. The current Drainage Capital Program is populated for the next 10 years with projects identified from the first four of these five master

plans. This business case brings forth the first major system project for funding from the most recent, fifth, mater plan completed in 2023 (The $1.8M Oriole Road trap low project). The next watershed master plan will identify further projects and is slated for completion December 2024.

$1.9M Peterson Creek Overflow at Columbia Street

Peterson Creek transitions to a concrete culvert at Columbia Street and is undersized for a 1:200 year storm event, this is the Provincial regulated standard when a road crosses a stream. It is also undersized for the 1:100 year storm event which is the City design standard. Because the culvert is undersized, Peterson Creek will backup and flow onto Columbia Street affecting infrastructure and flooding properties fanning out from 10th Avenue underpass to Sandman Centre. This project will increase capacity at Columbia Street by installing a bypass pipe.

This project was confirmed by a study that was completed in 2022 by TRUE Consulting that modelled flood routes from Peterson Creek at Columbia Street down to the South Thompson River. The modelling simulated the effect an upgraded bypass pipe would have on flooding. In summary, upgrading the capacity at Columbia Street will protect Columbia Street, the infrastructure in the road, and numerous properties downstream spanning many city blocks. However, this one upgrade is still not sufficient to protect against all flooding downstream on Peterson Creek.

Appendix A has copies of the flood figures for reference that shows the flood routes with and without the Columbia Street bypass upgrade. This project has a significant impact on many businesses and residents (approximately 130+), including protecting Sandman Centre, Memorial Arena, Lansdowne Village, and Kamloops RCMP. Additional study would be required to determine the exact number of properties affected, the severity of the impacts, and estimate the cost of potential damages during a flood event.

Deciding not to fund this project runs the risk of flooding resulting in major societal impacts, damage to the environment, and significant property damage should the city receive a 1:100 or 1:200 year storm event. The statistical probability of one of these two events occurring in the coming years is summarized in the table below.

Return Period	5 years	20 years	100 years	200 years
1:100 year return period	5%	18%	63%	87%
1:200 year return period	2%	10%	39%	63%

While the table above is the probability of one event occurring in a given period, there still exists a chance each year, and that multiple events may occur, albeit at a lower probability.

$1.6M Parkview Drainage Upgrades

A major rain event in 2015 revealed a system deficiency when flooding and debris flows caused property damage at Parkview Drive and Westsyde Road, and threatened Rhonmore Cres and properties on the east side of Westsyde Road. The storm return period is not known and the severity of the storm cannot be correlated with the return period (i.e. was it 1:20 year or 1:100 year event). However, flooding occurred and debris was deposited on public and private property. The project is part of the 10-year capital plan with construction beginning 2023/24, but due to escalating costs an additional $1.6M in funding is necessary to complete the project.

The project includes debris catchers, channel and ditch improvements, pipe upgrades, barriers, and other drainage improvements to safely convey a 1:100 year return period from the upper

hillside along Parkview Drive. The project fronts 55 properties on Parkview Drive, many of which will benefit from better drainage and a safer overland flood route. The eight properties on Rhonmore Cres will also benefit as improvements will enhance the direction of flood waters away from their road. Barriers will be erected on Westsyde Road to help keep flood waters and possible debris on the road and away from properties on the east side of Westsyde Road (i.e. Oak Dale Mobile Home Community and Elston Drive).

The possible damages caused by a major event (an event greater than the 1:5 year return period) is not known. It could be estimated that properties along the gullies and on the east side of Parkview Drive might be flooded, this totals 21 properties. A storm flood is shorter and causes less damage than inundation by a river, the Government of Canada suggests that a flooded basement costs $40,000 (Canada.ca, March 7, 2022) to repair on average. At 21 properties and $40,000 per, the total estimated damages, before any other cleanup or quality of life impacts, could total $880,000. Further study would be required to confirm the number of properties impacted and the estimated cost of damages.

The statistical chance of an event occurring at least once is summarized in the following table.

Return Period	5 years	20 years	50 years	100 years
1:5 year return period	67%	99%	100%	100%
1:20 year return period	23%	64%	92%	99%
1:50 year return period	10%	33%	64%	87%
1:100 year return period	5%	18%	39%	63%

While the table above is the probability of one event occurring in a given period, there still exists a chance each year, and that multiple events may occur, albeit at a lower probability.

Deciding not to fund this project runs the risk of flooding resulting in major societal impacts suffering, damage to the environment, possible damage to infrastructure, and property damage should the City receive a major storm event.

$1.8M Oriole Road Trap Low

The Official Community Plan has identified the vicinity east of Oriole Road as a planned major neighbourhood center. Within this area, the City has a standing Council resolution identifying that R James Western Star is serviced by a 1:5 year return period (not the typical 1:100 year return period). There are other adjacent properties that are subject to flooding but currently have no Council resolution policy defence in place. This area is a trap low, a low point where water cannot escape, and is subject to flooding. It is serviced by a stormwater pump station sized for the 1:5 year return period. Looking to improve the level of service in conjunction with it being transformed into a higher use major neighbourhood, this project would increase the service standard from the existing 1:5 year to a 1:25 year return period. To achieve the 1:100 year level of service, staff are working with developers to acquire stormwater storage to offset pumping and piping needs.

This project is a recommendation of two past reports, a 1995 report that recommended a series of upgrades after the City received numerous flooding claims, and the more recent 2023 Valleyview, Juniper, and Rose Hill Watershed Masterplan. The more recent 2023 report modelled the flood area and it shows that it affects several residential and commercial properties in the area (Appendix B). The 2022 assessed value of the land and structures subject to flooding as shown in Appendix B are estimated to be $9.6M (BC Assessment, 2023). The potential cost of damage from a 1:100 year storm event is not known and is difficult to quantify without detailed

study. Unlike a flood caused by the river, a stormwater induced flood would be shorter in duration and likely less destructive. For an order of magnitude cost of damages, the low end of the river flood damage range (15%) was applied, resulting in total damage potentially being $1.4M.

Claims and settlements made with the City in 1999 and earlier totaled $305,055 (2023 CAD). There have been two claims made against the City in the study area since 1999, and no monies have been paid out.

If this project was not to proceed, it is recommended that a revised Council resolution be passed that would include all affected properties in the trap low. It would also be advisable to establish a Development Permit Area for this area and all trap lows within city limits.

$0.2M Channel Armouring in Juniper.

This project was identified through a call for service by a resident. A stream behind their property has been eroding the slope on their land causing some private property damage. While there is a baseflow in the stream, the primary cause of the erosion is likely due to stormwater flows from the city's stormwater drainage system. The project would see approximately 80 m of channel armouring to prevent further erosion along the private properties but would not address reinstating already eroded lands. The project would size the erosion protection to meet the 1:100 year storm event.

All funding has been allocated in the 10-year capital project and additional funds are needed to address community concerns in a timely manner. Inaction will result in further erosion, further loss of private property, damage to the existing fence, and additional staff time and resources managing calls for service. The stream parallels three other adjacent properties that may also eventually be subject to future loss of private property. The cost of damages is not estimated, and costs associated with potential claims is not known.

Asset Management

The City is at a point where replacement of its existing drainage assets will soon be unavoidable and replacement will be required. Decision makers have the opportunity to implement incremental increases to fund asset management now and thereby keep future funding requirements lower and minimize future rate increases. Deferring asset renewal now will create a snowball effect that increases the future total cost and corresponding rates of taxation. This can be highlighted in Table 5 where the total renewal costs are summarized and adjusted based on the option selected:

Table 5: Remaining Balance of Asset Renewal Costs Adjusted by Option

Years	Option 1	Option 2	Option 3	Option 4
5 years	$ 19.9M	$ 19.2M	$ 14.4M	$ 0
10 Years	$ 44.1M	$ 42.8M	$ 33.1M	$ 21.1M
15 Years	$ 103.3M	$ 101.3M	$ 86.8M	$ 68.8M

It can be observed that anticipated asset renewal costs accelerate with time, therefore it is recommended that the City begin funding asset renewal in an incremental manner beginning in 2025 by either approving option 3 or 4. Table 5 does not contemplate deferral of asset renewal and is based on the predicted replacement times and costs shown in Figure 1.

Minor Drainage System

When the minor system is overwhelmed, the flow should be able to be safely conveyed by the major system. However, there are components of the minor system that are more critical than others and should be kept in good working order to prevent damage to City infrastructure and the environment. At a minimum these critical components should be maintained and replaced prior to failure. Failure could result in significant service disruptions, repair costs, and environmental damage. While it is difficult to predict the cost of a failure, it would not be unrealistic to assume that it could be substantial. Replacement of critical infrastructure is recommended as the costs is reasonable relative to the potential resultant service disruption and cost of a repair due to a significant failure. The consequence of not funding replacement of critical drainage infrastructure could result in unplanned and potentially costly repairs to infrastructure and the environment. Therefore, the benefit in renewing critical infrastructure is anticipated to outweigh the costs.

Options 2, 3 and 4 all consider asset management and would address critical infrastructure replacement as the first priority. Therefore, each of these options if selected would address this concern.

The vast majority of the minor drainage system is considered to have low criticality and the consequence of a failure is assumed to be low. As previously mentioned, to bring Valleyview, Rose Hill, and Juniper up to today's standard it is estimated to cost $19.5 M. If we wish to be proactive and upgrade our existing system to be compliant with today's current design standard, then additional funding to make upgrades to the minor system is required beyond what is recommended in the options presented in this business case. However, it will be more cost effective to manage deficiencies until such time as the system can be upgraded either during a planned road or utility upgrade project, or when it is due to be renewed under an asset management plan.

Due to the low priority of the minor system and the fact that any deficiency in it would be absorbed by the major system, no option contemplates funding to address its deficiencies. However, good planning dictates that when performing asset renewal under options 2, 3 and 4 that the City would make the necessary upgrades to address deficiencies at that time. This may result in different levels of service throughout the system that may or may not be in alignment with today's design standards for many years until upgrades are made.

Risk Analysis

A risk analysis was discussed earlier in the report that assisted with prioritizing projects and developing the options. This section will elaborate on various possible risks and provide solutions where possible.

The overtopping or breach of a dike could have severe or catastrophic consequences and has a high risk. Further degradation of, and failure to address identified deficiencies in, the dikes increases risk exposure. As per Table 2 above, the general consequences of this type of event could result in, depending on the severity of the event, the following:

- safety – a fatality - major
- economic – <$10M and in severe cases >$10M in damages – severe/catastrophic
- social and cultural – long-term or complete loss of social and cultural values – catastrophic
- intangibles – significant (years) or irreparable hardship - catastrophic
- ecological – severe or irreparable loss of species and or habitat - severe

By not funding dike repairs, decision makers acknowledge these risks and accept that they may occur during a major event resulting in damages similar to those outlined. Funding dike repairs is recommended.

A major storm event with a 1:100 year recurrence could have a major or severe consequence and was given a medium to high risk. Major system projects that are deferred will leave risk unmitigated and susceptible to risk should an event occur. As per Table 2 above, the general consequences of this type of event could result in, depending on the severity of the event, the following:

- safety – single fatality or major injuries - major
- economic – major asset loss with several weeks of business interruption; <$1M in damages - major
- social and cultural – recoverable within months - major
- intangibles – personal hardship usually recoverable in months but potentially significant (years) of hardship - major
- ecological – recoverable within months or severe loss of species and or habitat - major

By not funding the additional major system projects, decision makers acknowledge that they are deferring these projects 10 or more years and that there is a risk that a major event will occur in that time potentially causing damages as outlined. Funding major system projects is recommended.

Aging infrastructure will result in increasing maintenance and repair costs as infrastructure degrades and gradually fails. The deferral of asset renewal costs creates a future funding risk as demonstrated earlier in the report. Addressing asset renewal early will offset future costs and the magnitude of taxation increases. At a minimum, funding for the replacement of critical assets is recommended (Option 2).

The preferred option (Option 3) is to address the highest risk items along with an incremental amount allocated for asset management. This incremental amount will not cover all of the projected asset renewal costs forecasted but positions the City for success going forward. It is believed that once the City fully incorporates condition assessments into the life cycle analysis of its drainage assets, that some asset renewal could be deferred. There is a risk that condition assessments will not achieve this deferral, but the first step is to incorporate the condition information into a robust drainage system asset management plan and reforecast the anticipated expenditures.

When it comes to the higher risk, low probability infrastructure in the drainage and flood protection systems there is the possibility that the city will not have a major flood event or a major storm event. These events are high risk due to their consequence, but their likelihood is generally low. It is possible that Council approves additional taxation, that staff repair and construct infrastructure, but that the event does not occur in the short-term. While this may be the case, it is prudent to plan accordingly under the assumption that an event will occur, because in all likelihood it will occur eventually, unexpectedly, and without warning. It should also be noted that with climate change, the frequency and severity of major storm events are increasing, thus increasing the probability and importance of having well designed and maintained infrastructure.

There is a risk that climate change is not predicted correctly. In one scenario new and renewed infrastructure is upsized to accommodate higher flows that do not materialize. The cost to

incrementally increase the size of a project at time of construction is generally minimal compared to having a subsequent retrofit project at a later date. The worst case is that we underestimate climate change flows and infrastructure will need greater maintenance, will have a lower level of service, or require upgrades/retrofits. To mitigate this risk, all watershed master plans use the latest in climate science during their development. The 2024 watershed master plan will also be developing a new intensity duration frequency curve that incorporates climate change for use in all future development and drainage projects.

Many drainage projects are linked with provincial and federal approvals. There is a risk that funding may be approved, taxes collected, and that projects are delayed due to approvals. Delays and complications in the approvals process may also result in some small cost overruns. A delay could result in a carry forward, particularly in the first year. This can be managed through good planning and providing adequate budget and time for approvals.

The initial year after increased Capital Drainage Program funding approval there could be a carry forward. This would most likely occur at the onset of approval for additional funding because major capital projects can often take multiple years to plan, design, and construct. The earlier a funding increase is approved the more time is available for procurement and the allocation of resources towards completing projects quickly.

Environmental Stewardship

Addressing the critical and major system infrastructure will have a net positive effect by mitigating various risks to the environment. Water has enormous destructive capacity when flowing at high velocity and in large volume. Ensuring during major storm and flood events that the flow of water is conveyed safely mitigates the risk that soil will be eroded. Eroded soils can expose, undermine, and damage infrastructure and property. It can also convey large volumes of sediment, debris, and vegetation that can result in the destruction or loss of fish habitat. Options 2 is the recommended minimum funding required to address known issues.

Climate change is increasing the frequency and severity of storms in our region and this trend is anticipated to continue. To address this, planning and engineering practices now incorporate climate change in predictive modelling and designs. This will put additional stress on all aspects of the drainage system and could result in higher rates of erosion. To address this, upgrades to infrastructure are necessary to prevent erosion and new projects need to incorporate climate change into the flow projections.

Newer designs and requirements for approvals are leaning towards greener infrastructure solutions. These solutions are applied at all levels of drainage infrastructure. Past practices of filling in ravines and developing in low points are no longer recommended and are instead used for the conveyance and safe storage of overland flows. Other past practices of concrete or rip rap channels are also being phased out for more environmentally sensitive solutions that involve revegetation and other green armouring techniques. The use of green practices is generally considered environmentally positive and may have some benefits when it comes to habitat and greenhouse gas reductions.

In all instances it is the dikes, major system, and critical components of the minor system that will have the greatest environment impacts.

Proposed Schedule

It is recommended that Option 3 be approved and implemented for 2025.

Conclusion/Recommendation

Through planning and operations, the Engineering and Utility Services divisions continue to work to manage and mitigate drainage and flood related risks within the city. Operations and long-term planning are expected to continue to identify drainage and flood protection infrastructure projects that require attention. Since the last funding adjustment in 2015, increasing costs due to market driven elements and regulatory changes have left the City with less capital leverage than it used to have. An increase in funding is required to deliver the same quantity and quality of project that it used to deliver and meet current infrastructure funding requirements.

This business plan presented four options for adjusting the Drainage Capital Program each option outlining how the funding would be allocated. The options and the funding allocation were guided by an assessment that determined the potential risk associated with each component of the drainage and flood protection system. The options were then structured to address the risks in a hierarchical approach.

The first option is not recommended. Without a change to funding a deficit in infrastructure investment will accrue that will have consequences. The primary consequences will be neglect of the diking system that could have catastrophic consequences during a major flood year. Other consequences include:

- the inability to fund the renewal of critical infrastructure prior to failure resulting in significant risk
- a ballooning asset management deficit that will become more difficult to address the longer it is delayed
- important major system upgrades that have been identified that would be deferred beyond the current 10-year planning cycle resulting in an ongoing unmitigated risk until resolved

It is recommended that the City increase funding to the Drainage Capital Plan by selecting Option 3. This option will:

- renew critical drainage infrastructure requiring replacement prior to its failure
- repair major deficiencies identified in existing dikes
- fund $3M in major system upgrades that are needed and currently cannot be supported in a timely manner within the existing 10-year capital plan
- take an incremental step towards funding asset management of the drainage system
- provide a much needed one-time adjustment that helps offset the rising cost of construction

This option will not cover all of the currently projected asset management costs within the 5-year horizon. It is assumed that some of these costs can be deferred once condition assessments have been incorporated into an asset management plan. There is a risk that this deferral may not be correct and that the assets will need to be replaced sooner than anticipated. Since high criticality infrastructure will be dealt with first, it will be the low and medium infrastructure that will be deferred. The result would be increased operations and maintenance to perform repairs as well as service disruptions resulting in increased calls for service and resident complaints.

Option 2 may be feasible if decision makers wish to accept a deferral in asset management, but acknowledge that this deferral will result in an accumulation of costs and more substantial increases in the future.

CONCURRENCE

FTE Request – Human Resources

No FTE requests are required for any of the options presented. However, if the City wishes to construct some of the additional drainage capital funded projects internally, additional FTE's could be supported through capital funding.

Construction / Schedule / Build Capacity - Capital Projects

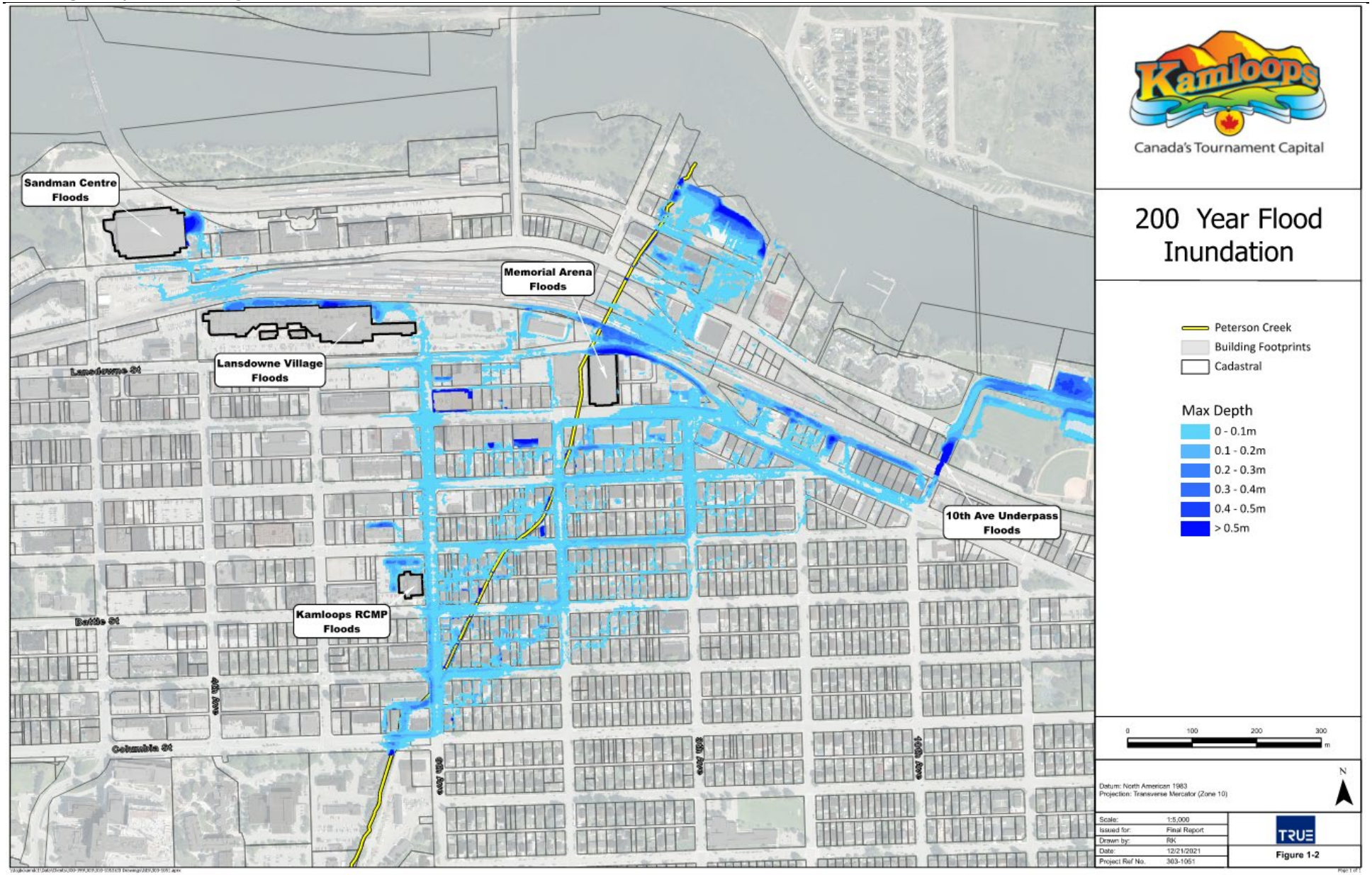
Staff in the Engineering and Utility Services divisions have consulted with the Capital Projects division and believe that the request to increase annual funding to $4.5 million dollars annually will provide a Drainage Capital Program that can be delivered with existing internal resources, though it will require leveraging additional external resources.

Completed by the Corporate Services Department

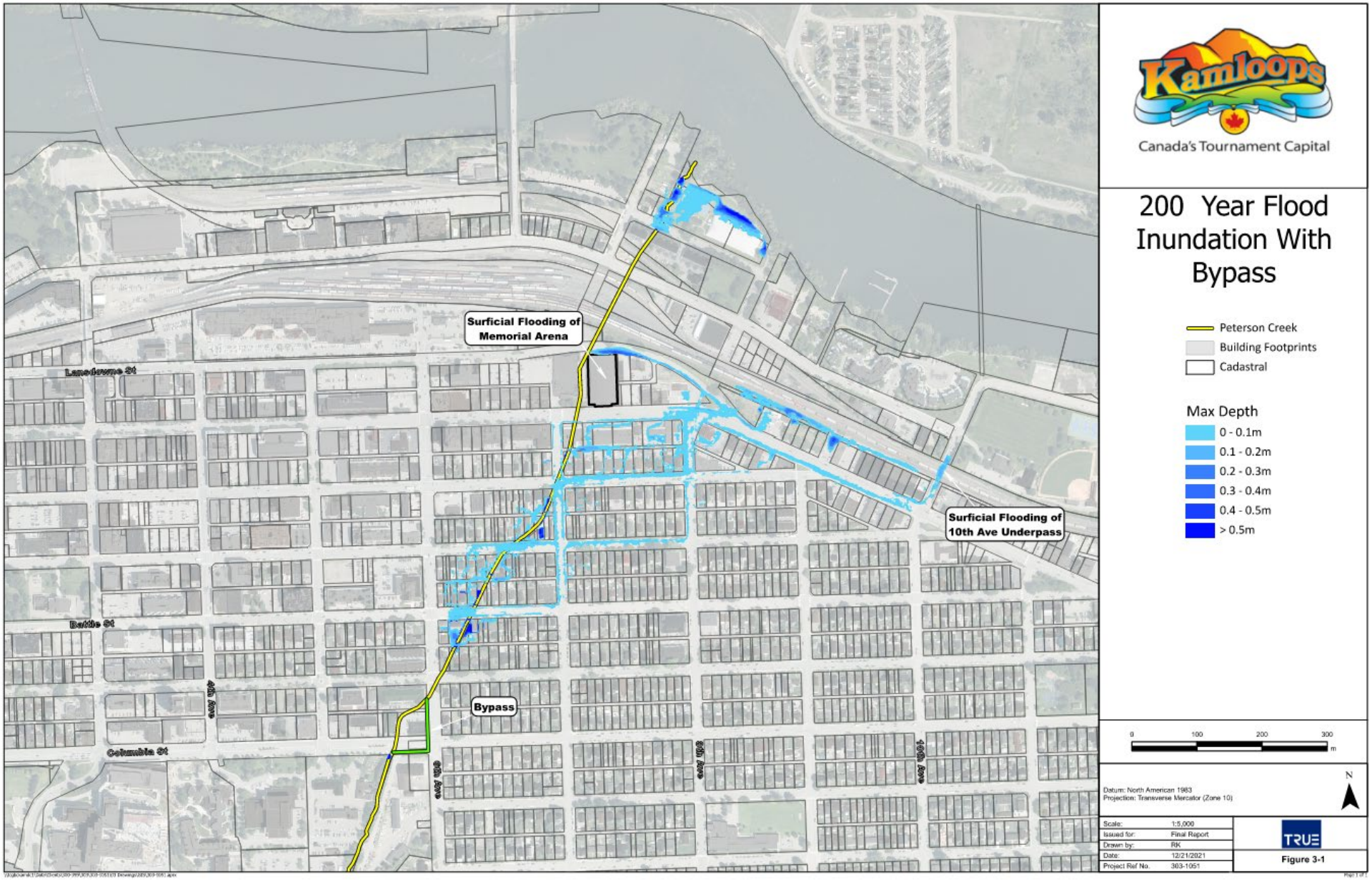
Proposed Funding Options

Funding Sources	2024	2025	2026	2027	2028
Taxation	$0	$2,200,000			
Total	$0	$2,200,000			

Appendix A



Peterson Creek 200 Year Flood Inundation



Peterson Creek 200 Year Flood Inundation after Constructing Bypass at Columbia Street

Appendix B

REPORT FOR:
VALLEYVIEW, ROSE HILL, JUNIPER MASTER WATERSHED PLAN,

SNC·LAVALIN
Building what matters

Figure 3-7 Flooding Map in the Oriole Road Neighborhood