Prepared for:
The City of Guelph

Stormwater Management Master Plan

Appendix O: Identification of Restoration Alternatives and Conceptual Design for Preferred Alternatives

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Reference #: 66636
October 2022
Final Report

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1.0 Introduction

Aquafor Beech has been retained by the City of Guelph to update the 2012 Stormwater Master Plan (SWM-MP). As part of this update, Aquafor is completed an assessment of the watercourse and river conditions within the City of Guelph limits, which included documenting erosion sites, assessing the existing conditions of the stream reaches, conducting Rapid Geomorphic Assessments to classify channel stability, and identification of watercourse restoration opportunities. The information collected will help inform potential long-term and sustainable restoration approaches and the final prioritization of erosion sites.

This report follows from the field investigations which have previously been reported in the following reports:

- Erosion Assessment Technical Memorandum – Field Investigations (August 2021)
- Geomorphic System Assessment Technical Memorandum – Field Investigations (August 2021)

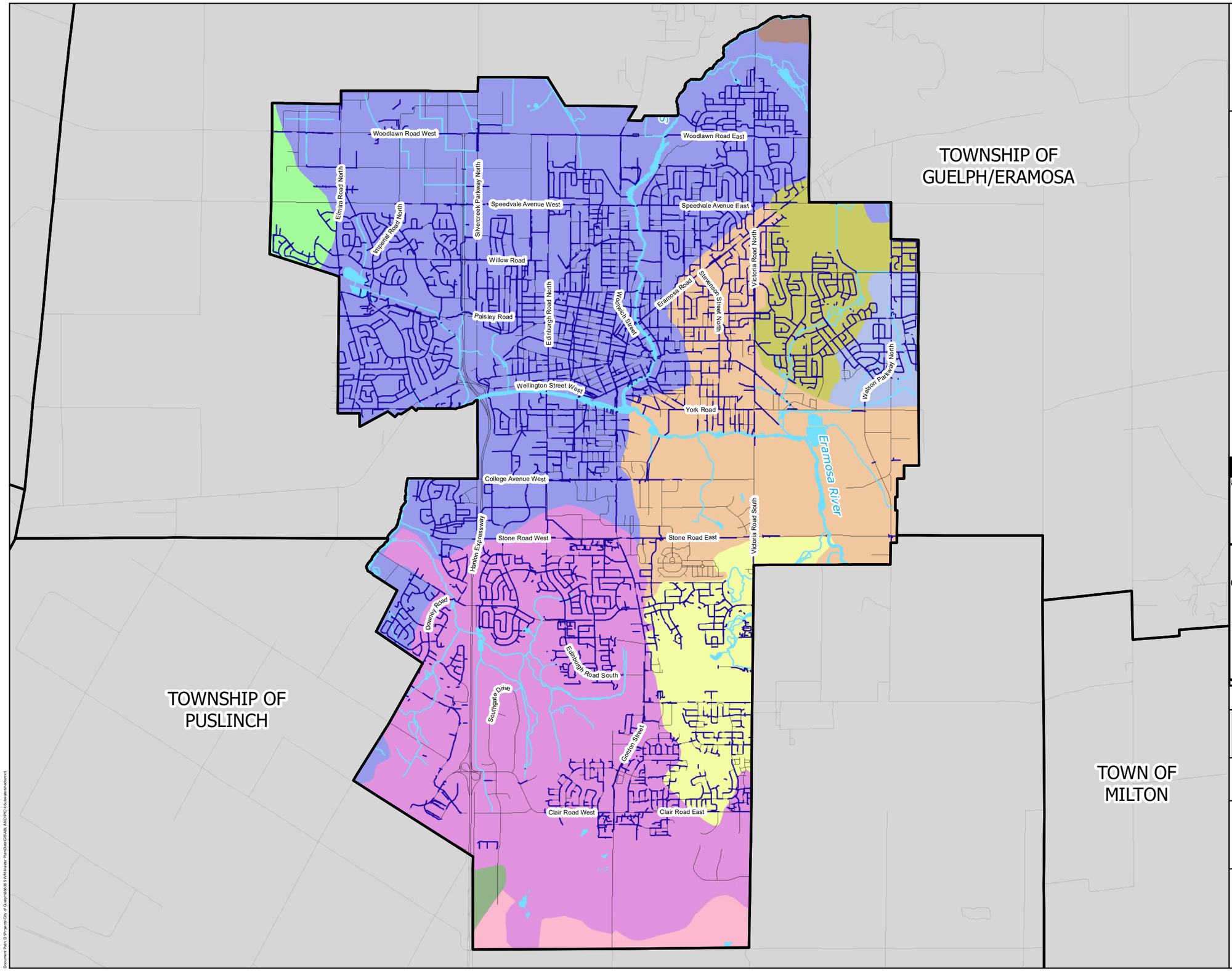
2.0 Study Area

After review of background data provided by the City, Aquafor identified approximately 90km of stream systems that extend through 7 distinct sub-watersheds and catchment areas, all of which ultimately all drain into the Speed River watershed **(Figure 3.1)**. The City of Guelph has a current population of approximately 141,000, adding more than 26,000 since 2006, and has been experiencing considerable growth during the last decade. Associated with increased development and urbanization are both direct and indirect factors of human activity on stream geomorphology. Direct impacts include changes of channel form, alignment, bank and bed materials; as well as in-stream structures including weirs, culverts, and dams. Indirect impacts relate primarily to changes in catchment land use which significantly influences the pathways and rates of water and sediment routing through the drainage networks.

3.0 Erosion Site Prioritization

As part of Task 3.3 of the Guelph Storm Water Management Master Plan (SWM-MP), the thirty (30) erosion sites identified during the field walks were classified as first-order groupings of individual and composite erosion sites. The resulting twenty-four (24) primary assessment opportunities (local and grouped sites) represent the key projects to be considered within system-wide prioritization and implementation plan of the SWM-MP. The evaluation of alternative solutions was completed for the twenty-four (24) resulting sites. A prioritization of the erosion opportunities is presented below in **Table 3.1**. The technical score reported in this table was originally developed by Aquafor Beech in the "Erosion Assessment Technical Memorandum – Field Investigations" dated August 17, 2021.

For each of the sites, four (4) preliminary alternative solutions will be evaluated using baseline information and a list of evaluation criteria, per the Municipal Class Environmental Assessment Process. Scoring of the criteria produce a preferred alternative based on the highest score, which will then be developed into a conceptual design. Cost estimates for engineering services (i.e., design, background studies such as geotechnical investigations) and construction costs for each of the preferred alternatives will be estimated for each of the preferred alternatives for each site.



CITY OF Guelph
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Legend

- Municipal Boundary
- Rivers
- Road Centreline
- Watercourse

Subwatershed (GRCA):

- Clythe Creek
- Ellis Creek
- Eramosa River - Lower
- Hadati Creek
- Hanlon Creek
- Irish Creek
- Mill Creek - Upper
- Speed River - Lower
- Speed River - Upper
- Torrance Creek

LOCATOR MAP

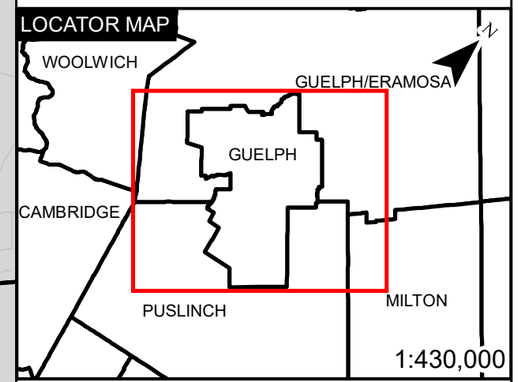

Figure 3.1

Study Area and Subwatersheds

Date: 2020-10-21
Projection: NAD83_UTM_Zone_17N
Data Source: City of Guelph, GRCA
Created by: J.R.

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Kilometres

Aquafor Beech Limited

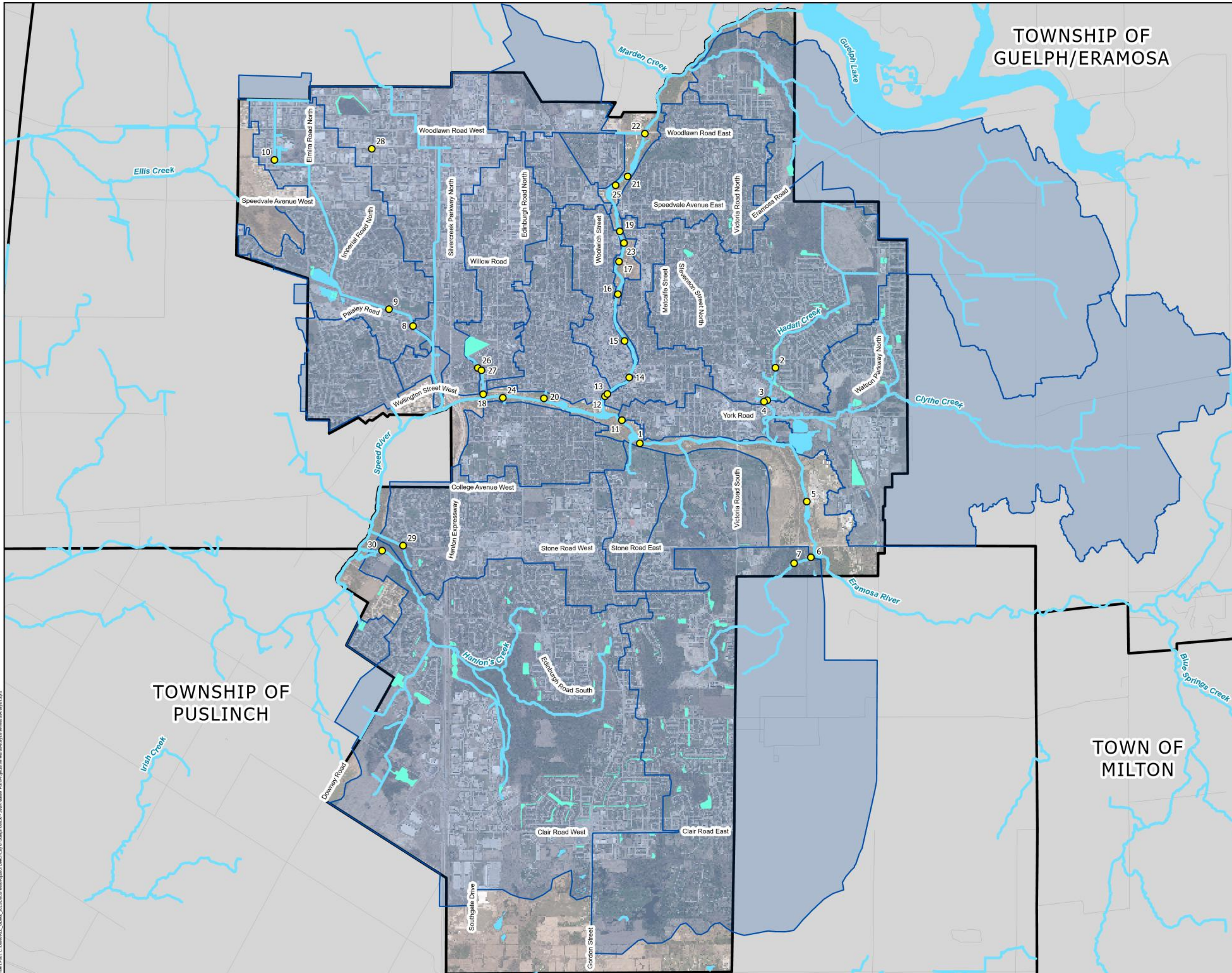
Table 3.1: Primary Erosion Assessment Opportunities

Watercourse	Reach	Field ID#	Date Assessed	Erosion Length	Risk	Technical Score
Individual Erosion Site Opportunities						
Hadati Creek	HC-A1	ES#4	June 17, 2020	10m	Road, stormwater outfall	86
Hanlon Creek	SR-F2	ES#29	August 6, 2020	10m	Stormwater outfall, bank erosion	79
Tributary of Speed River	SS-8	ES#10	July 7, 2020	2.5m	Stormwater outfall, bank erosion	79
Tributary of Speed River	Un-named	ES#28	July 28, 2020	4m	Stormwater outfall	79
Tributary of Speed River	SR-I2	ES#8	July 7, 2020	3m	Stormwater outfall, bank erosion	71
Speed River	SR-8	ES#14	July 14, 2020	30m	Sanitary sewer pipe	68
Tributary of Speed River	SR-I3	ES#9	July 7, 2020	5m	Stormwater outfall, bank erosion	67
Hadati Creek	HC-3	ES#2	June 4, 2020	10m	Private property, bank erosion	66
Speed River	SR-10	ES#23	July 14, 2020	11m	Exposed pipe (potential watermain)	65
Eramosa River	ER-1	ES#11	July 14, 2020	3m	Stormwater outfall, bank erosion	64
Speed River	SR-10	ES#17	July 14, 2020	5m	Stormwater outfall, bank erosion	64
Speed River	SR-10	ES#19	July 14, 2020	5m	Stormwater outfall	63
Speed River	SR-9	ES#15	July 14, 2020	3m	Stormwater outfall, retaining wall	63
Speed River	SR-12	ES#22	July 23, 2020	4m	Stormwater outfall, bank erosion	62
Speed River	SR-10	ES#16	July 14, 2020	8m	Weir, stormwater outfall	61
Torrance Creek	TC-3	ES#7	July 6, 2020	10m	Weir structure, bank erosion	58
Eramosa River	ER-1	ES#1	June 4, 2020	15m	Stormwater outfall	57
Eramosa River	ER-4	ES#5	June 30, 2020	5m	Pedestrian bridge	57
Hanlon Creek	HAC-1	ES#30	August 6, 2020	4m	Pedestrian bridge, trail	50
Speed River	SR-5	ES#24	July 24, 2020	10m	Weir, retaining wall	44

Watercourse	Reach	Field ID#	Date Assessed	Erosion Length	Risk	Technical Score
Composite Erosion Site Opportunities						
Tributary of Speed River	SR-K1 & SR-J1	ES#20 & ES#18	July 24, 2020	55m	Sanitary sewer exposed, retaining walls eroding around stormwater outfall and in poor condition, unknown pipe exposed in stream bed at SR-K1	82*
Speed River	SR-8	ES#12 & ES#13	July 14, 2020	40m	Retaining wall, stormwater outfalls	71
Silver Creek	SR-J2	ES#26 & ES#27	July 24, 2020	50m	Chute eroding slope backing onto private property, old dam structure and retaining wall outflanked and eroding	58
Speed River	SR-11	ES#25 & ES#21	July 23, 2020	50m	Retaining wall cracking and outflanked	51

*ES#18 (formerly identified as ES#23) and ES#20 (formerly identified as ES#25) have undergone interim construction works but will still need to be assessed for a final restoration alternative

The above erosion sites have also been shown on **Figure 3.2**.


TOWNSHIP OF
GUELPH/ERAMOSA
TOWNSHIP OF
PUSLINCH
TOWN OF
MILTON
Marden Creek
Guelph Lake
Ellis Creek
Hadati Creek
Clythe Creek
Speed River
Eramosa River
Hanlon's Creek
Irish Creek
Blue Springs Creek
Woodlawn Road West
Woodlawn Road East
Speedvale Avenue West
Speedvale Avenue East
Elmira Road North
Imperial Road North
Silvercreek Parkway North
Edinburgh Road North
Woolwich Street
Victoria Road North
Eramosa Road
Willow Road
Metcalfe Street
Stevenson Street North
Paisley Road
Watson Parkway North
Wellington Street West
York Road
College Avenue West
Victoria Road South
Hanlon Expressway
Stone Road West
Stone Road East
Edinburgh Road South
Downey Road
Clair Road West
Clair Road East
Southgate Drive
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CITY OF Guelph
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Legend

- Municipal Boundary
- HydroCentreline
- Erosion Site
- Watercourse
- Rivers
- SWM Facility
- Subwatershed

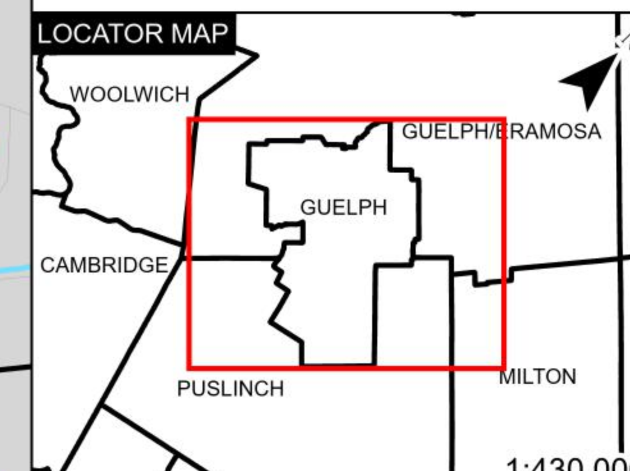

Figure 3.3

Identified
Erosion Sites

Date: 2022-10-31
Projection: NAD83_UTM_Zone_17N
Data Source: City of Guelph, GRCA
Created by: A.V.

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Kilometres

Aquafor Beech Limited

3.1 Creek Works Undertaken or Underway

The following environmental assessment studies, detailed designs and infrastructure and erosion restoration works have been completed, planned, or are in development since the completion of the field assessment in 2020:

- **Erosion Site ES#28** – Within the project limits of PN0081, pre-design 2032.
- **Erosion Site ES#14** – While no project has yet begun, the city has plans to remove this pipe with the design process beginning in 2022.
- **Erosion Site ES#2** – Within the study area of the Clythe Creek Subwatershed Study.

These sites have been evaluated, and preferred alternatives identified in the sections below.

4.0 Description of Restoration Alternatives

Following the EA procedure, each of the primary erosion sites was evaluated for different preliminary restoration alternatives. For this report, the following four (4) different preliminary alternatives were evaluated:

- Preliminary Alternative 1 – "Do Nothing"
- Preliminary Alternative 2 – Local Works (Local Works can be further defined as remove and replace, repair or stabilization works).
- Preliminary Alternative 3 – Reach Based Works
- Preliminary Alternative 4 – Removal of Risk

Each of the alternatives was evaluated using a list of City approved environmental, social, economic, and technical criteria, considering how the project will affect the environment and the surrounding community.

The following subsections provide general descriptions for each of these preliminary alternatives, followed by the evaluation of each preliminary alternative for each of the primary erosion sites.

4.1 Preliminary Alternative 1 – "Do Nothing"

The "Do-Nothing" option is a mandatory concept that must be considered in the Class EA process, as it helps to justify the need to undertake a remedial flood or erosion control project. It forms the basis of comparison against all other alternatives to determine whether the solutions provide better outcomes than just leaving the site alone, by identifying the existing and long-term risks associated with the current condition.

Should the "Do-Nothing" option, including other Conservation Authority programs such as land acquisition, habitat enhancement or maintenance works of existing infrastructure, be deemed to be a more acceptable solution, then there is no further consideration for remedial erosion action and the Class EA process terminates.

The environmental effects of a "Do Nothing" approach relate to the potential long-term effects of erosion on the terrestrial, cultural, aquatic and economic environments, as well as engineering components. Ultimately, all the existing hazard sites associated with noted Erosion Sites (e.g., eroding streambanks, deterioration of previous treatments, or degradation of habitat conditions) would remain. To maintain compliance with the City's Consolidated Linear Infrastructure Environmental Compliance

Approval, ongoing monitoring will be recommended for any sites where "Do Nothing" is selected as the preferred alternative.

The "Do Nothing" alternative will be summarized for each of the Erosion Site and Restoration Reach Opportunities, which will essentially represent the existing conditions of the site.

4.2 Preliminary Alternative 2 – Local Works

Local Works would involve undertaking stream restoration works at strategic locations in order to limit the impact of existing erosion.

Local works would reduce the level of risk by applying local bank or slope stabilization treatments using either hardened (engineered) type treatments, or more natural (vegetation and biotechnical engineered) type treatments. A key consideration for undertaking selective works is the understanding that the observed instability and risks are locally focused within a reach, and that the decision to apply local treatments to address the observed instability is not anticipated to initiate instability at other locations, thus resulting in increased erosion risk elsewhere within the reach.

The intent of these works would be to protect the adjacent features at risk (i.e., residential properties and infrastructure), both now, and in the future by anticipating channel activity that may occur in the vicinity of the at-risk areas. In the areas where works would be occurring, treatment options would benefit fish habitat and passage, and any natural channel processes that had previously been adversely affected by the erosion.

In the case that there are multiple local works options, preliminary alternatives will be distinguished by the nature of the works. Options include remove and replace, repairing the infrastructure, or stabilization of the existing infrastructure within the existing substrate or bank.

The cost of the local works will vary from site to site depending on the type of treatment and the extent of the required works. It should be noted that the selective works could be implemented in stages based on monitoring results, level of risk and available capital budget.

Design elements for selective works will be summarized by site or by reach as per the following subsections.

4.3 Preliminary Alternative 3 – Reach Based Works

Reach based channel restoration would involve a combination of Natural Channel Design (NCD) techniques and Geomorphic Referenced River Engineering (GRRE) generally referred to as a hybrid type design. Hybrid designs are most often found where project constraints dictate that the channel cannot be allowed to evolve or migrate naturally, or if the urbanization of the upstream watershed has created a regime that cannot be maintained under natural conditions. This alternative would ultimately be selected for a reach if it is determined that the "Do Nothing" or "Local Works" would not address, or in fact exacerbate erosion risk at its current location or transfer those effects of erosion up and/or downstream within the reach. For these sites, it is understood that there is systematic instability within the watercourse requiring a larger-scale and systematic approach to address the risk.

For the primary Erosion Site and Restoration Reach Opportunities, reach based works would include restoration of the stream to a naturalized form, maintaining a fixed alignment where property and/or

infrastructure constraints dictate, and grade control where necessary to prevent channel down cutting and to reintroduce hydraulic floodplain access. Moreover, this alternative would involve complete remedial works throughout the length of the reach(es) containing the erosion site(s), recreating the channel bed and banks using a combination of Natural Channel Design techniques, as well as more traditional river engineering and bioengineering methods.

During construction, this option would involve a high level of disruption to property owners, local residents, and habitat (including existing vegetation). Once completed however, it would provide improved long-term conditions in terms of the natural function and processes of the watercourse. All disrupted areas would be restored within the site, including appropriate plantings and seed mixes designed to provide stability and sustainability, with a long-term management plan to restore the riparian and terrestrial habitat functions.

The cost of the reach-based works will vary from site to site depending on the type of treatments and the extent of the required works. Generally, the costs of reach-based works will exceed the costs of the local works alternative, however as the approach includes a larger area of capital investment, it is expected that less maintenance work will need to be completed over the long-term.

4.4 Preliminary Alternative 4 – Removal of Risk

The removal of risk alternative would involve the realignment of risk (i.e., infrastructure) away from the channel. This alternative addresses the reoccurring issues associated with infrastructure and watercourse interactions, and looks at possible approaches of removing the interaction to provide the creek with sufficient space to naturally adjust and migrate without posing risks to municipal infrastructure or private property. Many of the Removal of Risk alternatives will also include channel restoration works (be it GRRE or NCD) to address the existing erosional issues identified, or to restore areas where excavation works will be required.

For the Erosion Site and Restoration Reach opportunities, removal of risk works could include such works as realignment of sections of sewers away from the channel, removal of abandoned infrastructure, or purchasing of private property to provide a larger meander belt and erodible corridor the channel to adjust. This alternative could include minor or major infrastructure changes, but will typically include localized remedial works within the channel (i.e., recreating the channel bed and banks using a combination of natural channel design techniques, as well as more traditional engineering and bioengineering methods).

During construction, this option would have varying levels of disruption to property owners, local residents, and habitat (including existing vegetation). This will depend on the scope of the works associated with the infrastructure realignment. However, once complete, not only will the existing erosional issues be addressed, but also the threat of future erosion risks will be greatly reduced. All disrupted areas would be restored within the site, including appropriate plantings and seed mixes designed to provide stability and sustainability, with a long-term management plan to restore the riparian and terrestrial habitat functions.

The cost of the removal of risk works will vary from site to site depending on the type of treatments and the extent of the required works. Depending on the extent of the land rights required (i.e., easements or acquisition) and the degree of infrastructure realignment required, the costs will be very site specific. Generally, the costs of removal of risk works will exceed the costs of the local works alternative,

however as the approach may include greater capital investment and/or will reduce future erosion risks, and thus it is expected that less maintenance work will need to be completed over the long-term.

5.0 Description of Evaluation Criteria

Evaluation of alternatives involves establishing alternative solutions based on the study objectives, technical considerations and relevant evaluation criteria. The evaluation criteria considered in assessing each alternative solution are shown in **Table 5.1,** and they include a series of evaluation criteria which were approved by the City, including Physical/Natural Environment, Social/Cultural, Economic and Technical/Engineering criteria. A score will be established through a multidisciplinary evaluation process for each alternative design, for each criterion listed. The score for each alternative solution will range from 1 to 10. A score of 1 indicates that the alternative solution scored low in relation to the criteria. Alternatively, a score of 10 indicates that the alternative solution scored high in satisfying the respective design criteria.

The overall preferred design was then based on an aggregate score from all the design criteria, normalized such that each category represented 25% of the total possible score. The intent was to identify the preferred retrofit design options. Provided in **Table 5.1** is a summary of the criteria used in the evaluation process. **Table 5.2** to **Table 5.5** provide further information with respect to description of the criteria and the methods used in assigning a score for each criterion.

Table 5.1: Criteria used in the Evaluation of selecting Preferred Alternatives

Environmental Assessment Categories	Criteria
Physical/ Natural Environment	• Potential Aquatic Habitat Benefit (Water Temperature) • Potential Aquatic Habitat Benefit (Fish Passage) • Potential to Reduce Erosion of Public Lands • Potential to Reduce Erosion of Private Lands • Potential to Reduce Stream bank and Stream bed Erosion • Potential to Enhance Groundwater Regime • Potential to Reduce Flooding • Potential to Improve Terrestrial Habitat • Integration with Existing Infrastructure • Integration with Existing Environment
Social/ Cultural	• Aesthetic / Recreation • Compatibility with Adjacent Land Use • Community Disruption • Public Health and Safety • Proximity to Historically Significant Properties • Located on Cultural Heritage Landscapes • Risk to Historical Landfill Sites
Economic	• Construction Costs • Operation Maintenance • Infrastructure Protection
Technical/Engineering	• Ease of Implementation • Agency Acceptance • Policy/Bylaw Requirements • Technical Feasibility

Table 5.2: Description of Physical/Natural Environment Criteria used for Selection of the Preferred Alternative

Criteria	Description of Criteria	Measures for Assigning Scores
Potential Aquatic Habitat Benefit (Water Temperature)	Potential to improve aquatic habitat by mitigating stream warming. Scoring based on the extent of the riparian cover and channel dimensions of the alternative.	Scoring ranges from 10 if the alternative provides good riparian shading and includes a low flow channel to 1 if the alternative does not provide good riparian shading and does not include a low flow channel
Potential Aquatic Habitat Benefit (Fish Passage)	Potential to improve aquatic habitats by creating/maintaining fish passage. Scoring based on the channel dimensions and removal of fish barriers.	Scoring ranges from 10 if the alternative includes a low flow channel and removes any existing fish barriers to 1 if the alternative does not include a low flow channel and does not remove any existing fish barriers.
Potential to Reduce Erosion of Public Lands	Potential to reduce the erosion of the public lands surrounding the stream.	Scoring ranges from 10 if the alternative has a high potential to reduce erosion concerns to 1 if there is limited potential
Potential to Reduce Erosion of Private Lands	Potential to reduce the erosion of the private lands surrounding the stream.	Scoring ranges from 10 if the alternative has a high potential to reduce erosion concerns or includes the acquisition of the lands to 1 if there is limited potential
Potential to Reduce Stream bank and Stream bed Erosion	Potential to reduce existing erosion within the stream study area.	Scoring ranges from 10 if the alternative has a high potential to reduce erosion concerns to 1 if there is limited potential
Potential to Enhance Groundwater Regime	Potential to enhance the groundwater connectivity to the channel.	Scoring ranges from 10 if the alternative has a high potential to enhance the groundwater connectivity to the channel to 1 if there is limited potential
Potential to Reduce Flooding	Potential to reduce the potential for flooding for properties adjacent to and downstream of the study area.	Scoring ranges from 10 if the alternatives has a high potential to reduce flooding potential, improve current conditions or acquire surrounding lands to 1 if there is limited potential.
Potential to Improve Terrestrial Habitat	Potential to improve terrestrial habitat conditions for native species within the riparian corridor of the study area; and/or to create new habitat.	Scoring ranges from 10 if the alternative has a high potential to improve terrestrial habitat conditions and/or to create new habitat to 1 if there is limited potential
Integration with Existing Infrastructure	Potential for the alternative to be integrated into existing infrastructure within the study area. Scoring based on integration with storm and sanitary sewers, roadways, surface walkways, trails and bridges.	Scoring ranges from 10 if the potential for the proposed retrofit option to be integrated with existing infrastructure is high to a 1 if the potential for integration is low.

Criteria	Description of Criteria	Measures for Assigning Scores
Integration with Existing Environment	Potential to integrate the alternative into the existing natural landscape. Scoring based on the impact to existing vegetation and the surrounding landscape features; and includes thermal regulation and increased baseflow benefits to downstream habitat (outside of the retrofit area).	Scoring ranges from 10 if the potential for the proposed retrofit option to be integrated with existing mature trees and the surrounding landscape features with minimal alteration is high to a 1 is the potential for integration is low and disturbance to natural landscape is low.

Table 5.3: Description of Social/Cultural Criteria used for Selection of the Preferred Alternative

Criteria	Description of Criteria	Measures for Assigning Scores
Aesthetic / Recreation	Potential for alternative to asset the community by integrating the study area with existing site activities (walking, jogging, mountain biking and hiking) and/or improve the site aesthetics.	Scoring ranges from 10 if there is a good potential to integrate facility into existing activities and/or improve aesthetics to 1 if there is minimal potential.
Compatibility with Adjacent Land Use	Potential for construction activities or future maintenance activities associated with the alternative to impact the adjacent land use. This also includes the impacts to access and egress for maintenance.	Scoring ranges from 10 if there are no impacts associated with construction and access/egress for operations and maintenance to 1 if impacts associated with construction and access/egress for operations and maintenance are anticipated.
Community Disruption	The potential of the alternative to disrupt the community during, or after the construction process. This will directly consider the surround land use (i.e., residential, commercial, industrial, recreational, etc.)	Scoring ranges from 10 if there is limited potential for community disruption works to 1 if the potential for community disruption is high.
Public Health and Safety Objectives	Public health and safety includes risk to private property, parking lots, roads, footbridges, and public trails	Scoring ranges from 10 if the safety risks associated with the alternative are minimal to 1 if significant public health and safety risks exist or could exist.
Proximity to Historically Significant Properties	The distance to nearest registered historically significant property is used to evaluate	Scoring ranges from 10 if the proposed erosion site poses an immediate risk to historically significant property; to 0 if there is minimal potential and/or the existing site is further away than what might be considered equivalent to a 100-year erosion potential.
Located on Cultural Heritage Landscapes	The location of the erosion site is coincident with an area designated a Cultural Heritage Landscape	Scoring ranges from 10 if the proposed erosion site is located on a designated Cultural Heritage Landscape; to 0 if it is not within this designation.
Risk to Historical Landfill Sites	Potential for the erosion site in question to risk the exposure and contamination of the waterway due to historical landfill material.	Scoring ranges from 10 if the proposed erosion site facility alternative has a high potential to contaminate the watercourse or surrounding environment either from failure to repair the existing infrastructure or from disturbance while restoration works are ongoing; to 0 if the proposed erosion site poses no risk to a historic landfill.

Table 5.4: Description of Economic Criteria used for Selection of the Preferred Alternative

Criteria	Description of Criteria	Measures for Assigning Scores
Construction Costs	The relative estimated cost as compared to the other alternatives of the proposed SWM facility alternative based on factors such as location, access/egress and disposal of excavated material based on most current O.Reg. and environmental policies	Scoring ranges from 10 if the relative capital cost, based on the identified factors, is low; to 1 if the relative capital cost is high.
Long term Operation Maintenance Costs	The relative cost of operating and maintaining the proposed SWM facility alternative based on factors such as access/ egress, sediment drying capability, ongoing cost, future permit requirements, maintenance access overall maintenance frequency and intensity.	Scoring ranges from 10 if the relative operation and maintenance cost, based on based on factors such as access/ egress, sediment drying capability, ongoing cost, future permit requirements, maintenance access overall maintenance frequency and intensity is low; to 1 if the relative operation and maintenance cost is high.
Life Cycle Costs (Capital and O&M costs)	The relative estimated life cycle cost as compared to the other alternatives of the SWM facility alternative based on the capital costs and operation and maintenance costs over the facility lifespan, including rehabilitation, refurbishment and or replacement at the end of the facility life expectancy.	Scoring ranges from 10 if the relative life cycle cost based on the capital costs and operation and maintenance costs over the facility lifespan, including rehabilitation, refurbishment and or replacement at the end of the facility life expectancy is low; to 1 if the relative life cycle cost is high.
Infrastructure Protection	Potential for the proposed SWM facility alternative to protect existing or future infrastructure including storm sewers and outfalls; as well as the protection of the facility function itself into the future (includes potential for damage based on proximity to erosion sites, migrating channels and or floodplains)	Scoring ranges from 10 if the alternative protects existing/proposed infrastructure thereby reducing risk; to 1 if existing/proposed infrastructure is left unprotected and represents a risk over the long term.

Table 5.5: Description of Technical/Engineering Considerations Criteria used for Selection of the Preferred Alternative

Criteria	Description of Criteria	Measures for Assigning Scores
Ease of Implementation	The relative ease with which the alternative can be implemented taking into consideration approvals, adjacent landowner acceptance, length of time to implement	Scoring ranges from 10 if the alternative can be implemented easily to 1 if there are potential major hurdles associated with implementation.
Agency Acceptance	The willingness or representative agencies (City of Guelph, GRCA, DFO, MNRF) to accept the alternative based on relevant policy constraints and discussions	Scoring ranges from 10 if the alternative agrees with existing policies to 1 if the alternative contravenes existing policies
Policy/bylaw requirements	Policy or bylaw requirements of the representative agencies (City of Guelph, GRCA, DFO, MNR) that may be required to implement the alternative	Scoring ranges from 10 if the alternative does not require implementation of special policies/bylaw to 1 if considerable policy/bylaw preparation is required.
Technical Feasibility	The alternative is practical and can be feasibly implemented. Consideration is given to site conditions (soils, hydrology, groundwater regimes, flow rates, drainage area, etc.) and required construction works (e.g. realignment of large sections of sewers or roads)	Scoring ranges from 10 if the alternative is technically feasible to 1 if the implementation of the alternative is faced with mounting difficulties.

6.0 Evaluation Results

Based on the evaluation criteria outlined in **Table 5.2** to **Table 5.5**, the preferred alternative for each site was identified. **Table 6.1** summarizes the preferred alternative, while the detailed evaluation for each site can be found below**.**

Table 6.1: Preferred Alternative

Site		Works
ES #1	Eramosa Outfall	Remove and Replace Local Works
ES #2	Bank Erosion	Local Works
ES #4	Elizabeth Street Outfall	Local Works
ES #5	Pedestrian Bridge	Removal of Risk
ES #7	Stop Log Dam	Local Works
ES #8	Outfall and Bank Erosion	Stabilization Works
ES #9	Failing Storm Outfall	Remove and Replace Works
ES #10	Stormwater Outfall	Local Replacement Works
ES #11	Outfall and Scoured Bank	Local Stabilization Works
ES #12/13	Retaining Wall	Reach Based Works

Site		Works
ES #14	Decommissioned Sewer Pipe	Removal of Risk
ES #15	Outfall and Retaining Wall	Replacement Works
ES #16	Weir Outflanked	Do Nothing
ES #17	Outfall and Bank Erosion	Stabilization Works
ES #18	Exposed Sanitary Sewer	Reach Based Works
ES #19	Corroded Outfall	Do Nothing
ES #20	Exposed Sanitary Sewer	Reach Based Works
ES #25/21	Failed Retaining Wall	Replacement Works
ES #22	Slumped Headwall	Local Replacement Works
ES #23	Decommissioned Watermain	Removal of Risk
ES #24	Outflanked Weir and Wall	Local Works
ES #26/27	Dam and Slope Erosion	Removal of Risk
ES #28	Deteriorated CSP Outfall	Local Works
ES #29	Bank Erosion near Outfall	Local Repair Works
ES #30	Pedestrian Bridge Erosion	Replacement Works

Conceptual designs for each alternative were developed and can be found in **Appendix B**.

6.1 ES#1: Eramosa River, stormwater outfall – Reach ER-1

The Eramosa River flows west for over 7 km from Guelph/Eramosa Township, through the City of Guelph, to the Speed River at York Road and Wellington St. The drainage area covers a watershed of 29 km^2. The Eramosa drains rural areas to the East of Guelph with natural substrate and banks through the study area.

The reach at issue is in the main trunk channel of the Eramosa River. Erosion Site ES #1 is a 1200 mm outfall where armourstone and boulder material has been displaced downstream of the outfall apron. The grate on the face of the outfall is damaged and a scour pool is forming at the bank of the Eramosa River. A pedestrian bridge was installed across this channel in 2021 by the Guelph Hiking Trail Club on the James Street Trail – the bridge is referred to as the Gosling Bridge.

Preliminary Alternative 1: "Do Nothing"
The risks associated with ES #1 would not be addressed as the undermined stormwater infrastructure, erosion to the valley, and deterioration of the outfall channel, would remain. A monitoring plan would need to be implemented, to inspect the erosion and the infrastructure, as the infrastructure will have to be replaced when it fails, as it is providing an essential service to the stormwater sewer system of the tablelands around the golf course.

Although the "Do Nothing" alternative has no capital costs assigned, ongoing costs would be required to replace or repair the stormwater infrastructure. Additional costs would be borne by the residents due to loss of property value and property damage as the valley and banks of the Eramosa River continued to erode.

Preliminary Alternative 2: Local Repair Works
The local stabilization works alternative would involve reuse of the failed armourstone blocks to repair the outfall channel. The outfall channel would be re-established with the existing and replaced material. Maintenance of the outfall would see the gate repaired as well.

Preliminary Alternative 3: Local Remove and Replacement Works
The local replacement works alternative would involve removal of the failed armourstone and the outfall would be replaced with larger embedded armourstone and bioengineering. The outfall channel will be restored and scour protection placed at the bank. The outfall gate is also to be replaced.

Preliminary Alternative 4: Removal of Risk
Removal of the outfall is not considered at this time. The current stormwater network requires the existing infrastructure.

6.1.1 Evaluation of Alternatives

Each of the preliminary alternatives was scored using the criteria presented in **Section 5.0.** The full evaluation matrix presented in **Table 6.2**, showing the scoring for each alternative. Based on this evaluation, Local Remove and Replacement Works was selected as the preferred alternative.

Table 6.2: Summary of Criteria Evaluation for ES #1 in Reach ER-1 of Eramosa River

Evaluation Criteria	Do Nothing	Repair Works	Remove and Replace Works	Removal of Risk
Physical/Natural Environment				
Potential Aquatic Habitat Benefit (Water Temperature)	○	○	○	
Potential Aquatic Habitat Benefit (Fish Passage)	○	○	○	
Potential to Reduce Erosion of Public Lands	○	◑	●	
Potential to Reduce Erosion of Private Lands	○	◑	◕	
Potential to Reduce Stream Bank and Stream Bed Erosion	○	◑	◕	
Potential to Enhance Groundwater Regime	○	○	○	
Potential to Reduce Flooding	○	◕	◕	
Potential to Improve Terrestrial Habitat	○	◕	◕	
Integration with Existing Infrastructure	○	◑	◑	
Integration with Existing Environment	○	○	◔	
Social/Cultural Environment				
Aesthetic / Recreation	○	◑	◕	
Compatibility with Adjacent Land Use	◔	◑	◑	
Community Disruption	◔	◑	◑	
Public Health and Safety	◔	◑	●	
Historically Significant Property	●	●	●	
Heritage Landscape Location	◔	◕	●	
Risk to Historic Landfills	○	◕	●	
Economic Environment				
Construction Costs	●	◑	◑	
Operation and Maintenance Costs	◑	◑	◕	
Infrastructure Protection	◔	◑	●	
Technical/Engineering Considerations				
Ease of Implementation	●	◑	◑	
Agency Acceptance	◔	◕	◕	
Policy/Bylaw Requirements	◑	◕	◕	
Technical Feasibility	◑	◕	◕	
Total Score	◔	◑	◕	○

● = indicated that the retrofit design alternative scored high in satisfying the respective design criteria
○ = indicated the retrofit design option scored low in relation to the criteria

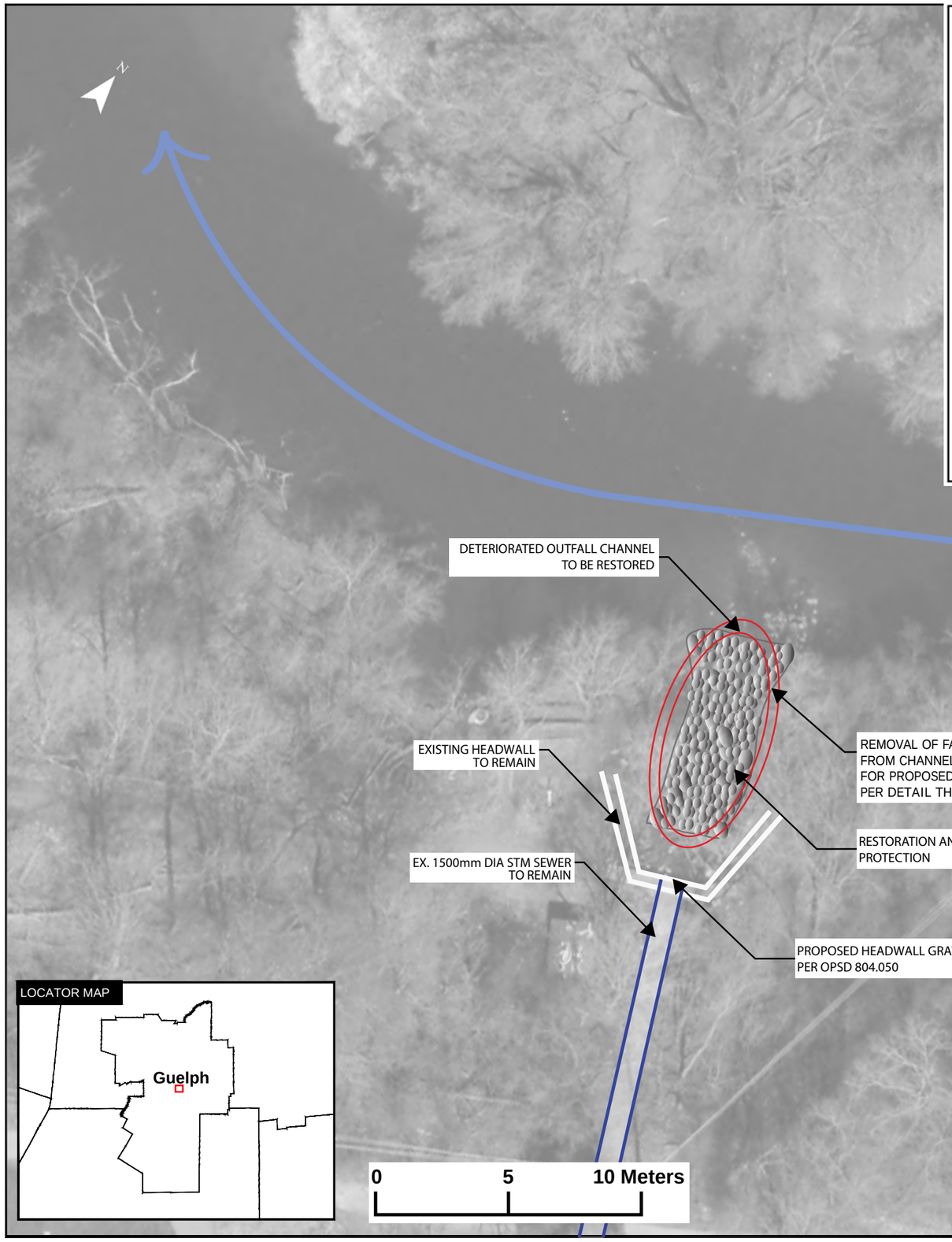
6.1.2 Preferred Alternative

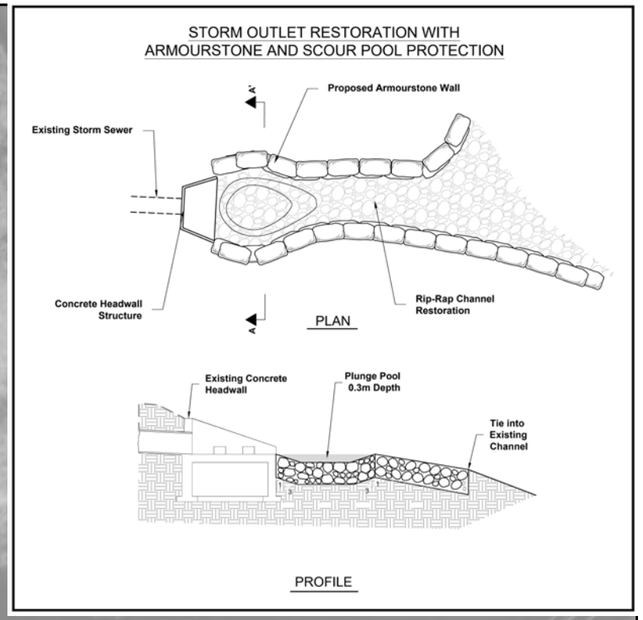
The local remove and replacement works alternative provides a cost-effective approach to stabilize the channel banks and replacement for the failed infrastructure. A conceptual design of the Local Remove and Replacement Works alternative is presented below in **Figure 6.1.**

The components of the Local Remove and Replacement Works Alternative would include:

- Removal of the failed armourstone from the outfall channel.
- Replacement of the outfall gate
- Restoration and boulder scour protection on the banks at the base of the outfall channel.

Refer to **Section 7.0** for estimated implementation costs.





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ALTERNATIVE DESCRIPTION:

The local remove and replacement works alternative provides a cost-effective approach to stabilize the channel banks and replacement for the failed infrastructure

The components of the Local Replacement Works Alternative would include:

- Removal of the failed armourstone from the outfall channel
- Replacement of the outfall gate
- Restoration and boulder scour protection on the banks and the base of the outfall

Location: ES1

Local Remove and Replacement Concept Design

Date: 2021-10-05 Projection:
NAD83_UTM_Zone_17N
Data Source: City of Guelph, GRCA
Created by: D.K.

6.2 ES#2: Hadati Creek, bank erosion and risk to private property – Reach HC-3

Hadati Creek is a tributary of Clythe Creek and flows southward over 4 km from Watson Parkway and Eastview Rd to Elisabeth Street and York Road. The drainage area covers a watershed of 5 km^2 through mostly low-density residential land in the east end of Guelph. Hadati Creek is a combination of channelized and piped sections, and park lands in the upper reaches.

Erosion Site ES #2 is located on the northeast bank of Hadati Creek 100 m downstream of Grange Road. Fallen trees and woody debris in Reach HC-3 have caused the creek to migrate laterally and erode into a 2 m high bank, posing a risk to private property. There is bank erosion protection upstream of the erosion site, but does not extend to this location.

Preliminary Alternative 1: "Do Nothing"
The risks to private property associated with ES #2 would not be addressed, as the exposed bank and debris obstruction would remain. A monitoring plan would need to be implemented, to inspect the obstruction and progression of the bank erosion.

Although the "Do Nothing" alternative has no capital costs assigned, ongoing costs would be required to maintain the stormwater infrastructure and road repairs.

Preliminary Alternative 2: Local Works
The local works alternative would involve removal of debris from the channel and restoration of the channel banks. To prevent further erosion, erosion control on the outside channel bend including a vegetated boulder treatment will be placed on the cutbank adjacent to the private property at risk.

Local Works at this site would restore approximately 10 m of the HC-3 reach of Hadati Creek.

Preliminary Alternative 3: Reach Based Works
Reach based works would address all the erosional issues within the channel segment south of Grange Road and north of Cedarvale Avenue. The overgrown vegetation will require reach-wide maintenance of the creek corridor to remove the debris and obstruction potential. Natural channel restoration would remediate the watercourse through the corridor with a more meandering geomorphology and bank erosion control.

Reach based works at this site would restore approximately 150 m of the HC-A1 reach of Hadati Creek.

Preliminary Alternative 4: Removal of Risk
The removal of risk alternative is not a practical alternative to consider in this instance.

6.2.1 Evaluation of Alternatives

Each of the preliminary alternatives was scored using the criteria presented in **Section 5.0.** The full evaluation matrix presented in **Table 6.3**, showing the scoring for each alternative. Based on this evaluation, Local Works was selected as the preferred alternative.

Table 6.3: Summary of Criteria Evaluation for ES #2 in Reach HC-3 of Hadati Creek

Evaluation Criteria	Do Nothing	Local Works	Reach Based Works	Removal of Risk
Physical/Natural Environment				
Potential Aquatic Habitat Benefit (Water Temperature)	◔	◑	◑	
Potential Aquatic Habitat Benefit (Fish Passage)	○	◑	◕	
Potential to Reduce Erosion of Public Lands	○	◕	◔	
Potential to Reduce Erosion of Private Lands	○	◑	◕	
Potential to Reduce Stream Bank and Stream Bed Erosion	○	◑	◕	
Potential to Enhance Groundwater Regime	○	○	○	
Potential to Reduce Flooding	○	◑	◕	
Potential to Improve Terrestrial Habitat	◑	◑	◔	
Integration with Existing Infrastructure	○	◑	◕	
Integration with Existing Environment	◑	◑	◔	
Social/Cultural Environment				
Aesthetic / Recreation	○	◑	◑	
Compatibility with Adjacent Land Use	◔	◑	◑	
Community Disruption	◔	◑	◔	
Public Health and Safety	◔	◑	●	
Historically Significant Property	○	○	○	
Heritage Landscape Location	○	○	○	
Risk to Historic Landfills	○	○	○	
Economic Environment				
Construction Costs	◕	◑	○	
Operation and Maintenance Costs	◔	○	○	
Infrastructure Protection	◑	◑	◑	
Technical/Engineering Considerations				
Ease of Implementation	●	◑	◑	
Agency Acceptance	◕	◕	◑	
Policy/Bylaw Requirements	○	○	○	
Technical Feasibility	◔	◑	◔	
Total Score	◔	◑	◔	○

● = indicated that the retrofit design alternative scored high in satisfying the respective design criteria

○ = indicated the retrofit design option scored low in relation to the criteria

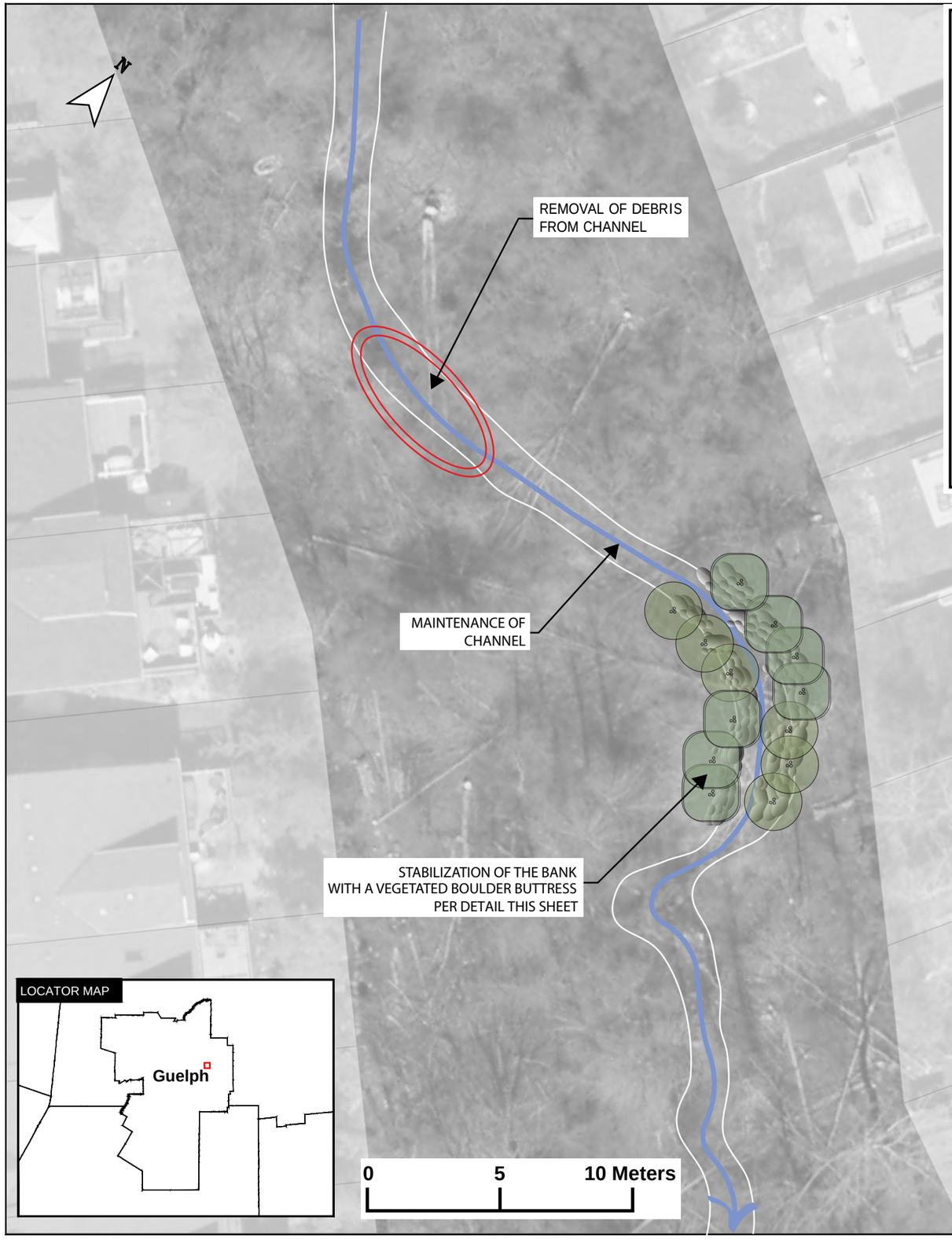
6.2.2 Preferred Alternative

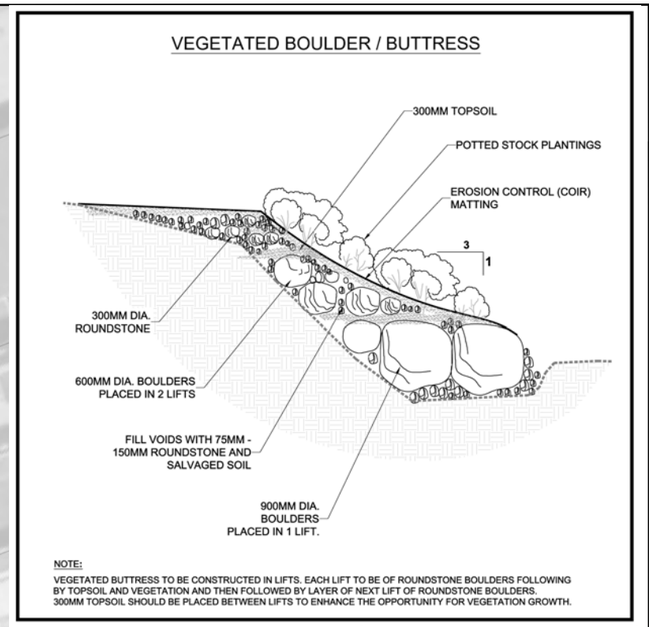
The local works alternative provides a cost-effective approach to stabilize the channel banks and remove the risk to the adjacent private property. This alternative provides erosion protection and stabilization to the channel within the corridor. A conceptual design of the Local Works alternative is presented below in **Figure 6.2.**

The components of the Local Works Alternative would include:

- Maintenance and debris removal of the channel through the reach.
- Stabilization of the bank with a vegetated boulder and rip rap treatment in the affected meander bend.

Refer to **Section 7.0** for estimated implementation costs.





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ALTERNATIVE DESCRIPTION:
The local remove and replacement works alternative provides a cost-effective approach to stabilize the channel banks and remove the risk to adjacent properties

The components of the Local Replacement Works Alternative would include:

- Maintenance and debris removal of channel through the reach
- Stabilization of the bank with a vegetated boulder and rip rap treatment in the affected meander bend

Location: ES2
Local Remove and Replacement Concept Design

Date: 2021-10-05 Projection:
NAD83_UTM_Zone_17N
Data Source: City of Guelph, GRCA
Created by: D.K.

6.3 ES#4: Hadati Creek, road and stormwater outfall – Reach HC-A1

Hadati Creek is a tributary of Clythe Creek and flows southward over 4 km from Watson Parkway and Eastview Road to Elizabeth Street and York Road. The drainage area covers a watershed of 5 km^2 through mostly low-density residential land in the east end of Guelph. Hadati Creek is a combination of channelized and piped sections, and park lands in the upper reaches.

Erosion Site ES #4 is located on the south side of Elizabeth St, at the confluence of the main channel and a piped section of a tributary. This erosion site is within 50 m of Erosion Site ES #3, a failed retaining wall adjacent to the Durose building between Elizabeth and Suburban Ave, the repair of which has been tendered already.

The ongoing issue at ES #4 is the erosion at the site of an outfall and an over-steepened section of the Elizabeth Street road bank. Channel widening and slope stability issues pose a risk of failure to the outfall, guardrail and road bed.

Preliminary Alternative 1: "Do Nothing"
The risks associated with ES #4 would not be addressed, as the exposed stormwater infrastructure, undermining of the guardrail, and deterioration of the roadbed, would remain. A monitoring plan would need to be implemented to inspect the erosion to the road and outfall.

Although the "Do Nothing" alternative has no capital costs assigned, ongoing costs would be required to maintain the stormwater infrastructure and road repairs.

Preliminary Alternative 2: Local Works
The local works alternative would involve outfall restoration with reinforcement of the road bank using a structural retaining wall. A concrete headwall would stabilize the storm water outfall and reinforce the Elizabeth St guard rail above.

Local Works at this site would restore approximately 10 to 15 m of the HC-A1 reach of Hadati Creek.

Preliminary Alternative 3: Reach Based Works
Reach based works would address all the erosional issues within the channel segment bounded by Industrial St and Beaumont Cres along Elizabeth Street. The channel Would be widened with armourstone to reinforce the exposed road bank and concrete headwall at the outfall location. Raising the channel bed will minimize the slope stability issues, with grade control along the length of the segment.

Reach based works at this site would restore approximately 120 m of the HC-A1 reach of Hadati Creek.

Preliminary Alternative 4: Removal of Risk
The stormwater pipe draining the roadway would be realigned to connect to the downstream segment that has a headwall, and the remaining infrastructure would be decommissioned and removed from the channel. This would effectively remove the risk posed by slope oversteepening.

The removal of risk works at this site would pipe approximately 120 m of Reach HC-A1 Hadati Creek.

6.3.1 Evaluation of Alternatives

Each of the preliminary alternatives was scored using the criteria presented in **Section 5.0.** The full evaluation matrix presented in **Table 6.4**, showing the scoring for each alternative. Based on this evaluation, Local Works was selected as the preferred alternative.

Table 6.4: Summary of Criteria Evaluation for ES #4 in Reach HC-A1 of Hadati Creek

Evaluation Criteria	Do Nothing	Local Works	Reach Based Works	Removal of Risk
Physical/Natural Environment				
Potential Aquatic Habitat Benefit (Water Temperature)	○	○	○	○
Potential Aquatic Habitat Benefit (Fish Passage)	○	○	○	○
Potential to Reduce Erosion of Public Lands	○	◑	◑	◕
Potential to Reduce Erosion of Private Lands	○	◕	◕	◕
Potential to Reduce Stream Bank and Stream Bed Erosion	○	◑	◕	◕
Potential to Enhance Groundwater Regime	○	○	○	◑
Potential to Reduce Flooding	○	◑	◕	◑
Potential to Improve Terrestrial Habitat	○	◑	◔	○
Integration with Existing Infrastructure	○	◑	◔	◑
Integration with Existing Environment	○	◑	◑	◔
Social/Cultural Environment				
Aesthetic / Recreation	○	◑	◕	◕
Compatibility with Adjacent Land Use	○	◑	◑	◕
Community Disruption	◕	◑	◔	◑
Public Health and Safety	◔	◑	●	●
Historically Significant Property	○	○	○	○
Heritage Landscape Location	○	○	○	○
Risk to Historic Landfills	○	○	○	○
Economic Environment				
Construction Costs	◑	◔	◔	○
Operation and Maintenance Costs	◑	◑	◑	◔
Infrastructure Protection	○	◑	◑	◕
Technical/Engineering Considerations				
Ease of Implementation	●	◕	◑	◔
Agency Acceptance	◑	◑	◔	○
Policy/Bylaw Requirements	○	○	○	○
Technical Feasibility	◕	◕	◑	◑
Total Score	◔	◑	◔	◔

● = indicated that the retrofit design alternative scored high in satisfying the respective design criteria

○ = indicated the retrofit design option scored low in relation to the criteria

6.3.2 Preferred Alternative

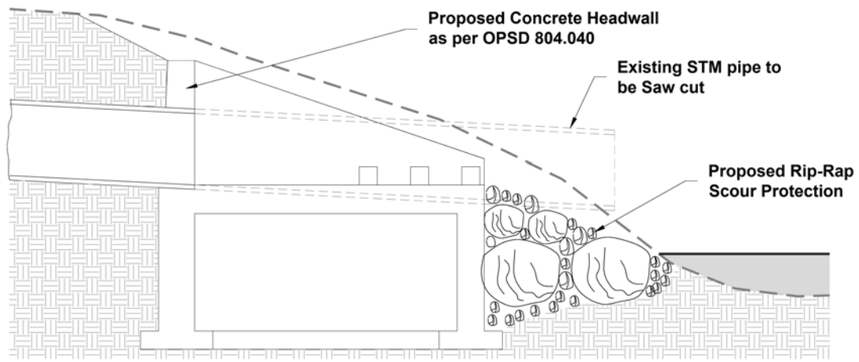
The local works alternative provides a cost-effective approach to protect the infrastructure at risk, and to incorporate structural components into a channelized system. Additionally, this alternative provides erosion protection to the road bank from the concrete stormwater outlet and retaining wall. A conceptual design of the Local Works alternative is presented below in **Figure 6.3.**

The components of the Local Works Alternative would include:

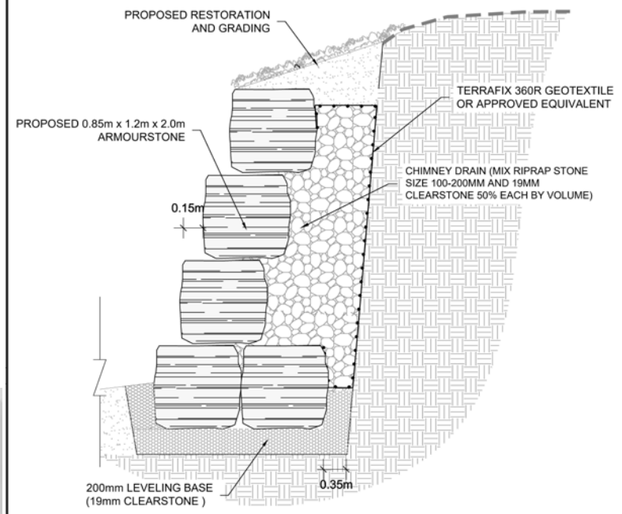
- Stabilization of the outfall pipe with a concrete headwall
- Structural reinforcement of the exposed shale roadbed
- Structural support of the compromised guard rail posts over the outfall

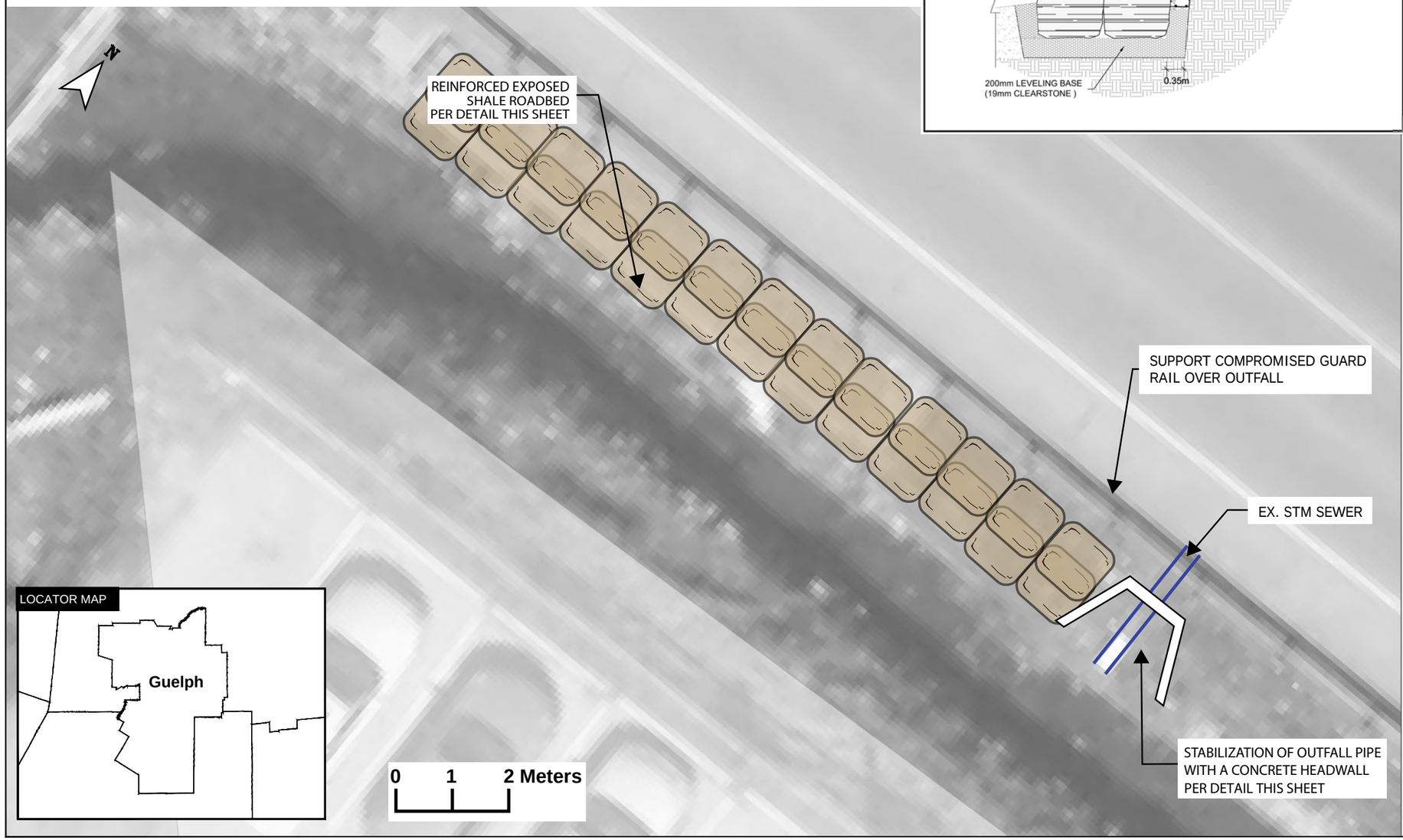
Refer to **Section 7.0** for estimated implementation costs.

OUTFALL RESTORATION WITH CONCRETE HEADWALL



ARMOURSTONE RETAINING WALL





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ALTERNATIVE DESCRIPTION:
The local remove and replacement works alternative provides a cost-effective approach to protect the infrastructure at risk, incorporate structural components into a channelized system, and provide erosion protection

The components of the Local Replacement Works Alternative would include:

- Stabilization of the outfall pipe with a concrete headwall
- Structural reinforcement of the exposed shale roadbed
- Structural support of the compromised guard rail posts over the outfall

Location: ES4
Local Remove and Replacement Concept Design

Date: 2021-10-05 Projection:
NAD83_UTM_Zone_17N
Data Source: City of Guelph, GRCA
Created by: D.K.

6.4 ES#5: Eramosa River, pedestrian bridge – Reach ER-4

The Eramosa River flows west for over 7 km from Guelph/Eramosa Township, through the City of Guelph, to the Speed River at York Road and Wellington St. The drainage area covers a watershed of 29 km^2. The Eramosa drains rural areas to the East of Guelph with natural substrate and banks through the study area.

The reach at issue is in the main trunk channel of the Eramosa River. Erosion Site ES #5 is a collapsed pedestrian bridge that used to convey foot traffic to the factory on the northeast bank. While we have determined the appropriate alternative according to the following matrix, the preferred solution should be determined through a separate process. This may be captured as part of the cultural heritage district study that is currently underway.

Preliminary Alternative 1: "Do Nothing"
The risks associated with ES #1 would not be addressed as the deterioration of the wooden bridge would continue and a significant public safety risk would remain.

Preliminary Alternative 2: Local Repair Works
The local stabilization works alternative would involve repair of the fallen sections and reinforcement of the bridge supports. Fencing will need to be replaced and a structural monitoring program scheduled.

Preliminary Alternative 3: Local Replacement Works
The local replacement works alternative would involve Replace with single 50 - 60 m span bridge. Abutments require offsets beyond the 100-yr erosion hazard and banks to be restored with local scour protection.

Preliminary Alternative 4: Removal of Risk
The removal of risk alternative would involve decommissioning of the bridge and pillings, with restoration of the banks, leaving the abutments in place and integrated with erosion protection and bank restoration.

6.4.1 Evaluation of Alternatives

Each of the preliminary alternatives was scored using the criteria presented in **Section 5.0.** The full evaluation matrix presented in **Table 6.5**, showing the scoring for each alternative. Based on this evaluation, Removal of Risk was selected as the preferred alternative.

Table 6.5: Summary of Criteria Evaluation for ES #5 in Reach ER-4 of Eramosa River

Evaluation Criteria	Do Nothing	Repair Works	Replacement Works	Removal of Risk
Physical/Natural Environment				
Potential Aquatic Habitat Benefit (Water Temperature)	◑	◑	◑	◑
Potential Aquatic Habitat Benefit (Fish Passage)	◑	◑	◑	◑
Potential to Reduce Erosion of Public Lands	○	◑	◑	◕
Potential to Reduce Erosion of Private Lands	○	○	○	○
Potential to Reduce Stream Bank and Stream Bed Erosion	○	◑	◑	●
Potential to Enhance Groundwater Regime	○	○	○	○
Potential to Reduce Flooding	○	○	○	○
Potential to Improve Terrestrial Habitat	○	○	○	○
Integration with Existing Infrastructure	○	◔	◑	◕
Integration with Existing Environment	○	◑	◑	●
Social/Cultural Environment				
Aesthetic / Recreation	○	◑	◔	●
Compatibility with Adjacent Land Use	○	◔	◔	●
Community Disruption	○	○	○	○
Public Health and Safety	○	◑	●	●
Historically Significant Property	○	○	○	○
Heritage Landscape Location	◑	◕	○	○
Risk to Historic Landfills	○	○	○	○
Economic Environment				
Construction Costs	●	◕	◑	○
Operation and Maintenance Costs	○	◔	◑	●
Infrastructure Protection	○	◑	◑	◕
Technical/Engineering Considerations				
Ease of Implementation	●	◑	◑	◑
Agency Acceptance	◑	◑	◔	◔
Policy/Bylaw Requirements	○	○	○	○
Technical Feasibility	◕	◑	◑	◑
Total Score	◔	◔	◔	◑

● = indicated that the retrofit design alternative scored high in satisfying the respective design criteria

○ = indicated the retrofit design option scored low in relation to the criteria

6.4.2 Preferred Alternative

The removal of risk alternative provides a cost-effective approach to stabilize the channel banks and removal of the failed bridge. A conceptual design of the Removal of Risk alternative is presented below in **Figure 6.4.**

The components of the Removal of Risk Alternative would include:

- Decommissioning and removal of the bridge decking
- Removal of the wooden pilings from the channel
- Restoration and stabilization of the abutments in the banks.

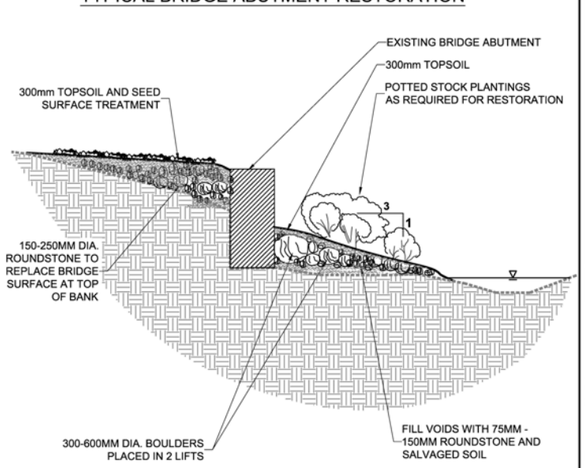
Refer to **Section 7.0** for estimated implementation costs.

RESTORATION AND STABILIZATION OF ABUTMENTS IN THE BANKS PER DETAIL THIS SHEET

REMOVAL OF BRIDGE DECKING

REMOVAL OF WOODEN PILINGS FROM CHANNEL

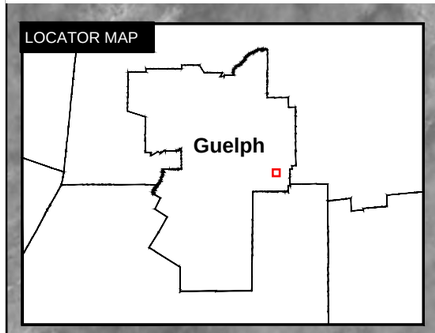
TYPICAL BRIDGE ABUTMENT RESTORATION



NOTE:

BANK RESTORATION MATERIALS TO BE PLACED IN LIFTS. EACH LIFT TO BE OF ROUNDSTONE FOLLOWING BY TOPSOIL AND VEGETATION AND THEN FOLLOWED BY LAYER OF NEXT LIFT OF ROUNDSTONE.
300MM TOPSOIL SHOULD BE PLACED BETWEEN LIFTS TO ENHANCE THE OPPORTUNITY FOR VEGETATION GROWTH.

LOCATOR MAP



0 10 20 Meters

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ALTERNATIVE DESCRIPTION

The removal of risk alternative provides a cost-effective approach to stabilize the channel banks and removal of the failed bridge.

The components of the Removal of Risk Alternative would include:

- Decommissioning and removal of the bridge decking.
- Removal of the wooden pilings from the channel.
- Restoration and stabilization of the abutments in the banks.

NOTE: As bridge is owned by IO, preferred solution could be captured as part of the cultural heritage disctrict study.

Location: ES5
Removal of Risk Alternative Concept Design

Date: 2021-10-05 Projection:
NAD83_UTM_Zone_17N
Data Source: City of Guelph, GRCA
Created by: D.K.

6.5 ES#7: Torrance Creek, weir structure and bank erosion – Reach TC-3

Torrance Creek is a tributary of Eramosa River and flows north over 3 km from Arkell Road to Stone Road. The drainage area covers a watershed of 11 km^2 through mostly green space and agricultural land with some low-density residential land in the east end of Guelph. Torrance Creek is a combination of channelized and storm water ponds.

Erosion Site ES #7 is located immediately downstream of a pond, 50 upstream of a rail line. The deteriorating conditions of the stop log dam shows cracking in the sides of the concrete and erosion at the base of the fall. The overall height of the fall is in excess of 3 m and could present a significant flood risk if it were to suddenly fail.

Preliminary Alternative 1: "Do Nothing"
The risks to private property associated with ES #7 would not be addressed, as the failed weir structure would continue to erode further. The knickpoint would migrate upstream and the weir structure would eventually be undermined.

Although the "Do Nothing" alternative has no capital costs assigned, ongoing costs would be required to maintain the grade control infrastructure to protect against flooding.

Preliminary Alternative 2: Local Works
The local works alternative would involve Partial decommission and local channel restoration to maintain the channel gradient while removing the fish barrier. Local Works at this site would restore approximately 20 m of the TC-3 reach of Torrance Creek.

Preliminary Alternative 3: Reach Based Works
The Reach Based Works alternative would involve a full decommission of the stop log dam with natural channel restoration through the upstream pond. The banks of the channel would be buttressed with natural stone material and include grade control throughout the reach. Reach based works at this site would restore approximately 50 m of the TC-3 reach of Torrance
Creek.

Preliminary Alternative 4: Removal of Risk
This alternative is accomplished though both the Local Works and Reach Based Works alternatives.

6.5.1 Evaluation of Alternatives

Each of the preliminary alternatives was scored using the criteria presented in **Section 5.0.** The full evaluation matrix presented in **Table 6.6**, showing the scoring for each alternative. Based on this evaluation, Local Works was selected as the preferred alternative.

Table 6.6: Summary of Criteria Evaluation for ES #7 in Reach TC-3 of Speed River

Evaluation Criteria	Do Nothing	Local Works	Reach Based Works	Removal of Risk
Physical/Natural Environment				
Potential Aquatic Habitat Benefit (Water Temperature)	○	◕	◕	
Potential Aquatic Habitat Benefit (Fish Passage)	◑	◕	◔	
Potential to Reduce Erosion of Public Lands	○	◕	◕	
Potential to Reduce Erosion of Private Lands	○	◕	◕	
Potential to Reduce Stream Bank and Stream Bed Erosion	○	◕	◑	
Potential to Enhance Groundwater Regime	◑	◕	◑	
Potential to Reduce Flooding	◔	◕	◑	
Potential to Improve Terrestrial Habitat	◔	◕	◑	
Integration with Existing Infrastructure	○	◕	◑	
Integration with Existing Environment	◔	◕	◑	
Social/Cultural Environment				
Aesthetic / Recreation	○	◕	◑	
Compatibility with Adjacent Land Use	◔	◕	◑	
Community Disruption	●	●	●	
Public Health and Safety	◔	◕	◑	
Historically Significant Property	○	○	○	
Heritage Landscape Location	○	○	○	
Risk to Historic Landfills	○	○	○	
Economic Environment				
Construction Costs	◕	◑	◔	
Operation and Maintenance Costs	◕	◔	◑	
Infrastructure Protection	◔	◕	◕	
Technical/Engineering Considerations				
Ease of Implementation	●	○	◔	
Agency Acceptance	◕	◑	◑	
Policy/Bylaw Requirements	◕	◑	◑	
Technical Feasibility	◕	◔	◑	
Total Score	◔	◕	◑	○

● = indicated that the retrofit design alternative scored high in satisfying the respective design criteria

○ = indicated the retrofit design option scored low in relation to the criteria

6.5.2 Preferred Alternative

The local works alternative provides a cost-effective approach to stabilize the channel gradient and restore the banks to a more stable profile. This alternative provides erosion protection and bank

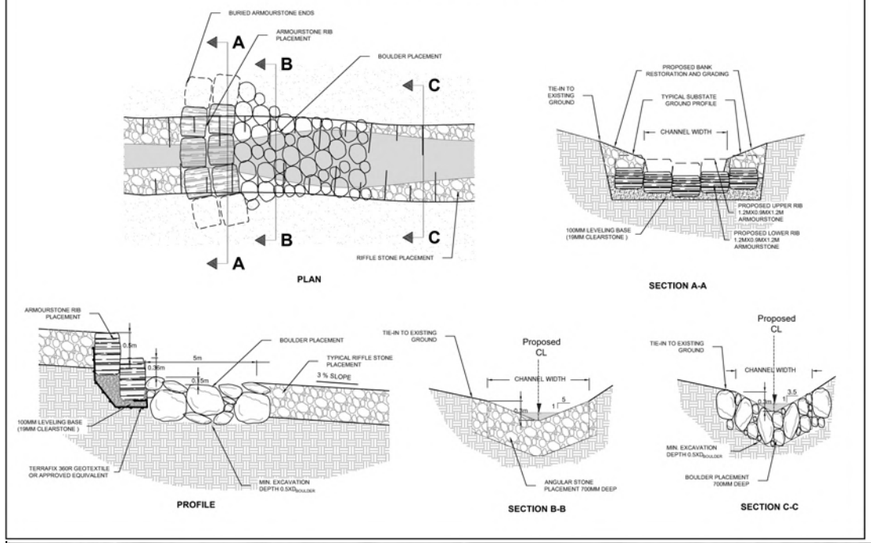
stabilization to the existing conditions. A conceptual design of the Local Works alternative is presented below in **Figure 6.5.**

The components of the Local Works alternative would include:

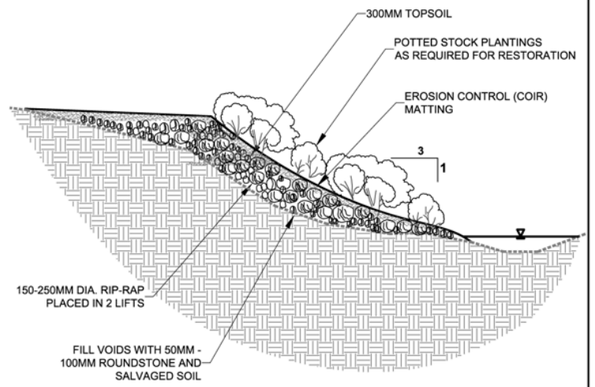
- Removal of the compromised stop log dam from the channel.
- Stabilization of the channel gradient with a boulder and armourstone cascade to remove a barrier to fish passage.
- Vegetated rip rap protection downstream to stabilize the banks.

Refer to **Section 7.0** for estimated implementation costs.

CASCADE POOL DROP STRUCTURE

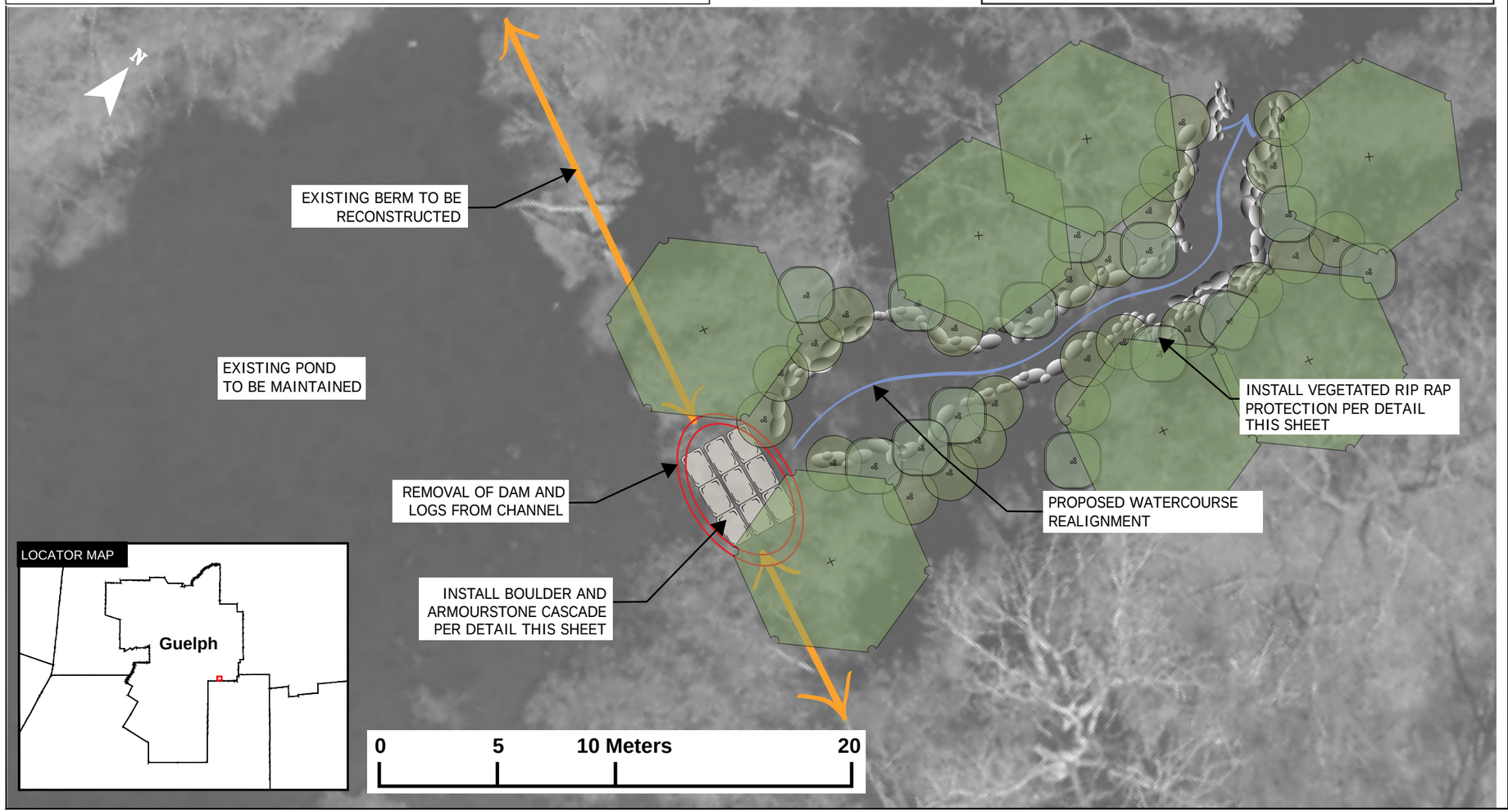


TYPICAL VEGETATED RIP-RAP RESTORATION



NOTE:

BANK STONE MATERIALS TO BE PLACED IN LIFTS. EACH LIFT TO BE OF ROUNDSTONE FOLLOWING BY TOPSOIL AND VEGETATION AND THEN FOLLOWED BY LAYER OF NEXT LIFT OF ROUNDSTONE.
300MM TOPSOIL SHOULD BE PLACED BETWEEN LIFTS TO ENHANCE THE OPPORTUNITY FOR VEGETATION GROWTH.



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ALTERNATIVE DESCRIPTION:

The local works alternative provides a cost-effective approach to stabilize the channel gradient and restore the banks to a more stable profile

The components of the Local Works Alternative would include:

- Removal of the compromised stop log dam from the channel
- Stabilization of the channel gradient with a boulder and armourstone cascade to remove a barrier to fish passage
- Vegetated rip rap protection downstream to stabilize the banks

Location: ES7
Local Works Alternative Concept Design

Date: 2021-10-05 Projection: NAD83_UTM_Zone_17N
Data Source: City of Guelph, GRCA
Created by: D.K.

6.6 ES#8: Speed River tributary, stormwater outfall and bank erosion – Reach SR-I2

The Speed River flows south and west for over 28 km through the City of Guelph, from Guelph Lake in the north to Guelph/Eramosa Township to the southwest of the city and ultimately drains to the Grand River downstream. The drainage area covers a watershed of 110 km^2 and is the largest subwatershed in the City of Guelph. The Speed flows though lake and wetlands in the headwaters and becomes a straight to gently meandering channel though the city, with reinforced banks and concrete grade control throughout.

The tributary at issue is a diversion channel that conveys storm water flow along the Hanlon Parkway to the Speed River. Erosion Site ES #8 is located on the north bank of the channel 60 m downstream of Paisley Road. A segment of the concrete outfall pipe has disconnected and is lying in the creek. The section of pipe that remains in the bank is outflanked.

Preliminary Alternative 1: "Do Nothing"
The risks associated with ES #8 would not be addressed. The failed outfall would remain, along with the eroding bank near the remaining concrete pipe. This option risks the stability of the outfall and overall morphology of this channel.

Preliminary Alternative 2: Local Works, Stabilization
The local stabilization works alternative would involve removal of the detached concrete pipe from the channel and restoring the bank with embedded armourstone stabilization around the pipe. Vegetated rip rap along the bank will prevent further bank erosion.

Local Works at this site would restore approximately 10 m of the SR-I2 reach of Speed River.

Preliminary Alternative 3: Local Works, Replacement
The local replacement works alternative would involve removal of the detached concrete pipe from the channel and replace with ODSB concrete headwall. Vegetated rip rap along the bank will prevent further bank erosion. Local Works at this site would restore approximately 10 m of the SR-F2 reach of Speed River.

Preliminary Alternative 4: Removal of Risk
Removal of the outfall is not considered at this time. The current stormwater network requires the existing infrastructure.

6.6.1 Evaluation of Alternatives

Each of the preliminary alternatives was scored using the criteria presented in **Section 5.0.** The full evaluation matrix presented in **Table 6.7**, showing the scoring for each alternative. Based on this evaluation, Stabilization Works was selected as the preferred alternative.

Table 6.7: Summary of Criteria Evaluation for ES #8 in Reach SR-I2 of Speed River

Evaluation Criteria	Do Nothing	Stabilization Works	Replacement Works	Removal of Risk
Physical/Natural Environment				
Potential Aquatic Habitat Benefit (Water Temperature)	○	○	○	
Potential Aquatic Habitat Benefit (Fish Passage)	○	○	○	
Potential to Reduce Erosion of Public Lands	○	◑	◑	
Potential to Reduce Erosion of Private Lands	○	◕	◕	
Potential to Reduce Stream Bank and Stream Bed Erosion	○	◑	◕	
Potential to Enhance Groundwater Regime	○	○	○	
Potential to Reduce Flooding	○	◔	◔	
Potential to Improve Terrestrial Habitat	○	◔	◔	
Integration with Existing Infrastructure	○	◑	◑	
Integration with Existing Environment	○	◕	◑	
Social/Cultural Environment				
Aesthetic / Recreation	○	◑	◔	
Compatibility with Adjacent Land Use	○	◕	◕	
Community Disruption	◑	◑	◑	
Public Health and Safety	◔	◑	◑	
Historically Significant Property	○	○	○	
Heritage Landscape Location	○	○	○	
Risk to Historic Landfills	○	○	○	
Economic Environment				
Construction Costs	●	◑	◔	
Operation and Maintenance Costs	◑	◕	◕	
Infrastructure Protection	○	◑	◑	
Technical/Engineering Considerations				
Ease of Implementation	●	◕	◑	
Agency Acceptance	◑	◕	◕	
Policy/Bylaw Requirements	◔	◕	◕	
Technical Feasibility	◕	◕	◑	
Total Score	◔	◑	◔	○

● = indicated that the retrofit design alternative scored high in satisfying the respective design criteria

○ = indicated the retrofit design option scored low in relation to the criteria

6.6.2 Preferred Alternative

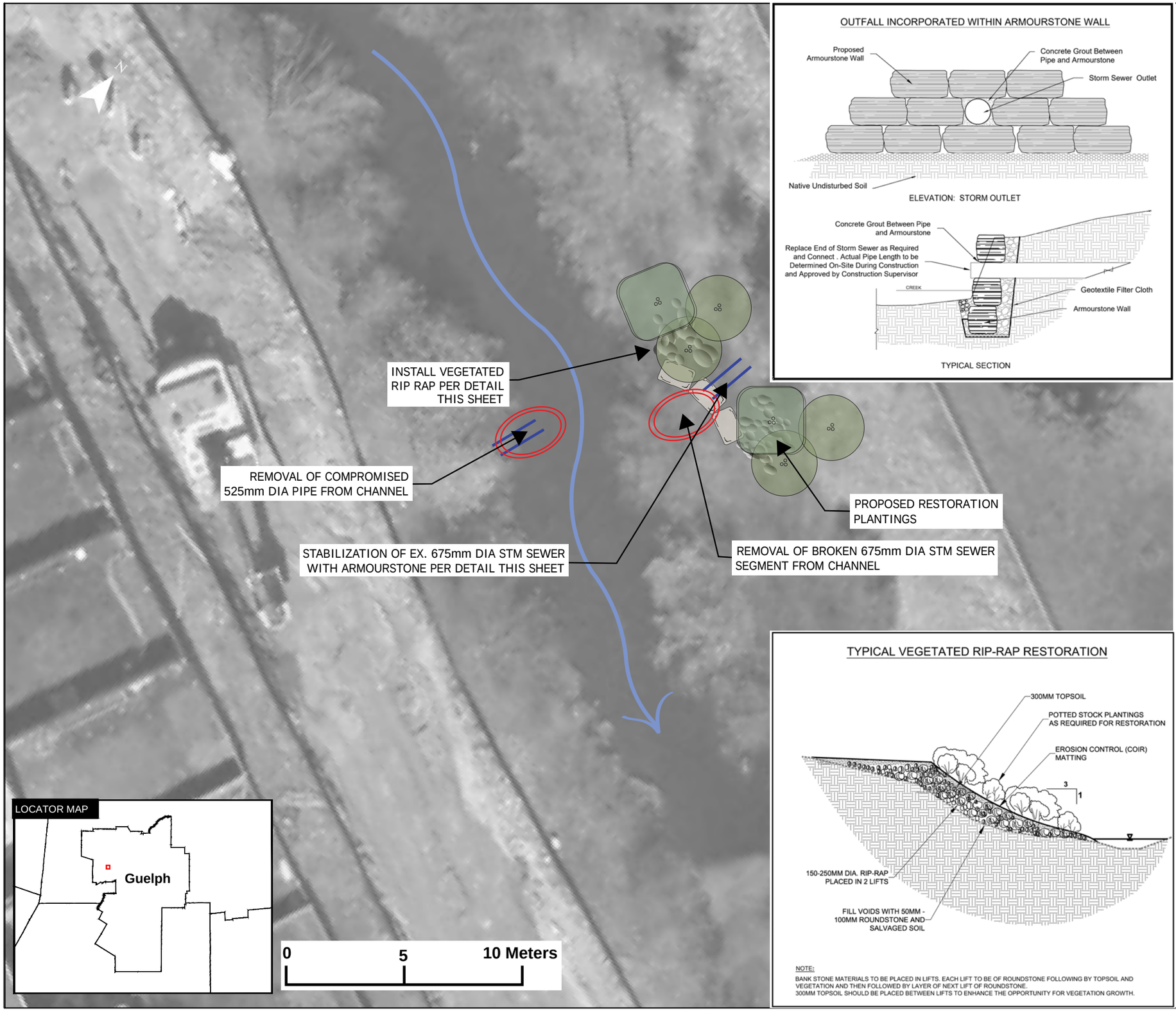
The local stabilization works alternative provides a cost-effective approach to stabilize the channel/infrastructure interaction and remove the risk to the surrounding bank. This alternative

provides erosion protection and stabilization to the existing concrete outfall and the banks and slopes of the channel corridor. A conceptual design of the Local Stabilization Works alternative is presented below in **Figure 6.6.**

The components of the Local Stabilization Works Alternative would include:

- Removal of the compromised pipe from the channel.
- Stabilization of the outfall pipe with armourstone.
- Vegetated rip rap bank protection at the banks and slope.

Refer to **Section 7.0** for estimated implementation costs.



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ALTERNATIVE DESCRIPTION:

The local stabilization works alternative provides a cost-effective approach to stabilize the channel/infrastructure interaction and remove the risk to the surrounding bank

The components of the Local Stabilization Works Alternative would include:

- Removal of the compromised pipe from the channel
- Stabilization of the outfall pipe with armourstone
- Vegetated rip rap bank protection at the banks and slope

Location: ES8
Local Stabilization Works Concept Design

Date: 2021-10-05 Projection:
NAD83_UTM_Zone_17N
Data Source: City of Guelph, GRCA
Created by: D.K.

6.7 ES#9: Speed River tributary, stormwater outfall and bank erosion – Reach SR-I3

The Speed River flows south and west for over 28 km through the City of Guelph, from Guelph Lake in the north to Guelph/Eramosa Township to the southwest of the city and ultimately drains to the Grand River downstream. The drainage area covers a watershed of 110 km^2 and is the largest subwatershed in the City of Guelph. The Speed flows though lake and wetlands in the headwaters and becomes a straight to gently meandering channel though the city, with reinforced banks and concrete grade control throughout.

The tributary at issue is a straight concrete lined diversion channel that conveys storm water flow towards the Hanlon Parkway to the Speed River. Erosion Site ES #9 is located on the south bank of the channel 60 m west of Paisley Road and Hewitt Lane. The edge of a storm water outfall is perched at the top of bank. A scour pool has developed below a grouted rip rap bank treatment and has undermined the outfall channel and bank.

Preliminary Alternative 1: "Do Nothing"
The risks associated with ES #9 would not be addressed. The failed outfall would remain, along with the undermined bank treatment. This option risks the stability of the outfall channel and continue to scour downstream.

Preliminary Alternative 2: Local Works, Repair
The local repair works alternative would involve restoring the eroded bank material and providing additional cover to the grouted rip rap. Boulder material at the base of the outfall will prevent undermining and minimize the erosion potential.

Local Repair Works at this site would restore approximately 8 m of the SR-I3 reach of the Speed River tributary.

Preliminary Alternative 3: Local Works, Replacement
The local replacement works alternative would involve removal of the grouted rip rap apron and adding a Vegetated boulder bank treatment to stabilize the outfall channel and substrate near the outfall. Local Replacement Works at this site would restore approximately 8 m of the SR-F2 reach of Speed River.

Preliminary Alternative 4: Removal of Risk
Removal of the outfall is not considered at this time. The current stormwater network requires the existing infrastructure.

6.7.1 Evaluation of Alternatives

Each of the preliminary alternatives was scored using the criteria presented in **Section 5.0.** The full evaluation matrix presented in **Table 6.8**, showing the scoring for each alternative. Based on this evaluation, Remove and Replace Works was selected as the preferred alternative.

Table 6.8: Summary of Criteria Evaluation for ES #9 in Reach SR-I3 of Speed River

Evaluation Criteria	Do Nothing	Local Repair Works	Remove and Replace Works	Removal of Risk
Physical/Natural Environment				
Potential Aquatic Habitat Benefit (Water Temperature)	○	○	○	
Potential Aquatic Habitat Benefit (Fish Passage)	○	○	○	
Potential to Reduce Erosion of Public Lands	○	◕	◕	
Potential to Reduce Erosion of Private Lands	○	○	○	
Potential to Reduce Stream Bank and Stream Bed Erosion	○	◑	◕	
Potential to Enhance Groundwater Regime	○	○	○	
Potential to Reduce Flooding	○	◔	◑	
Potential to Improve Terrestrial Habitat	○	◔	◑	
Integration with Existing Infrastructure	○	◑	◑	
Integration with Existing Environment	○	◑	◕	
Social/Cultural Environment				
Aesthetic / Recreation	○	◑	◔	
Compatibility with Adjacent Land Use	○	◑	◕	
Community Disruption	◕	◑	◑	
Public Health and Safety	◔	◕	◕	
Historically Significant Property	○	○	○	
Heritage Landscape Location	○	○	○	
Risk to Historic Landfills	○	○	○	
Economic Environment				
Construction Costs	●	◑	◑	
Operation and Maintenance Costs	◑	◑	●	
Infrastructure Protection	○	◑	◕	
Technical/Engineering Considerations				
Ease of Implementation	●	◕	◑	
Agency Acceptance	◑	◕	◕	
Policy/Bylaw Requirements	◔	◕	◕	
Technical Feasibility	●	◕	◕	
Total Score	◔	◔	◑	○

● = indicated that the retrofit design alternative scored high in satisfying the respective design criteria

○ = indicated the retrofit design option scored low in relation to the criteria

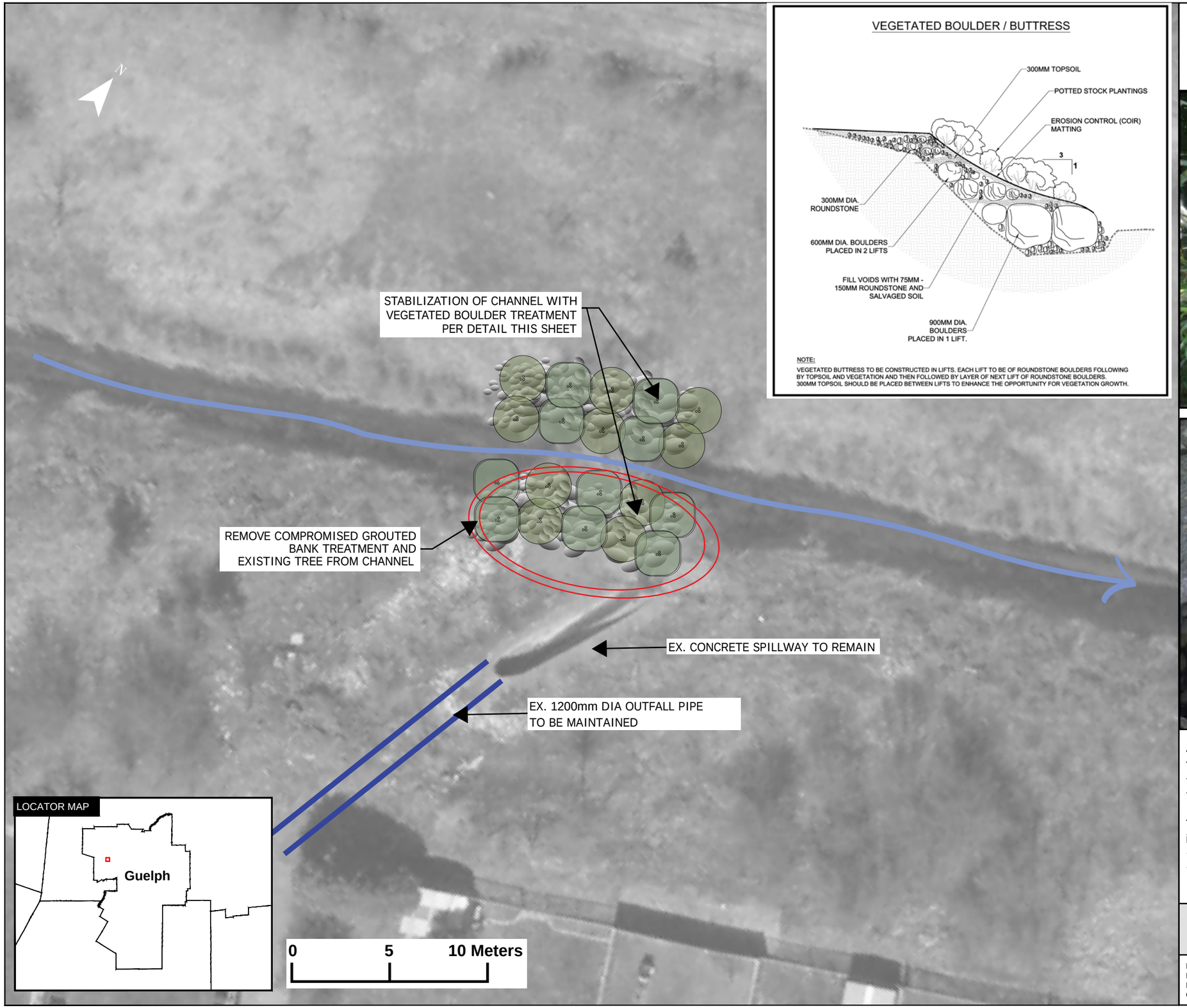
6.7.2 Preferred Alternative

The local replacement works alternative provides a cost-effective approach to stabilize the channel/infrastructure interaction and remove the risk to the surrounding bank. This alternative provides erosion protection and stabilization to the existing concrete outfall and the banks and slopes of the channel corridor. A conceptual design of the Remove and Replace Works alternative is presented below in **Figure 6.7.**

The components of the Remove and Replace Works Alternative would include:

- Removal of the compromised grouted bank treatment from the channel.
- Stabilization of the outfall channel and bank with a vegetated boulder treatment.

Refer to **Section 7.0** for estimated implementation costs.



VEGETATED BOULDER / BUTTRESS

NOTE:

VEGETATED BUTTRESS TO BE CONSTRUCTED IN LIFTS. EACH LIFT TO BE OF ROUNDSTONE BOULDERS FOLLOWING BY TOPSOIL AND VEGETATION AND THEN FOLLOWED BY LAYER OF NEXT LIFT OF ROUNDSTONE BOULDERS. 300MM TOPSOIL SHOULD BE PLACED BETWEEN LIFTS TO ENHANCE THE OPPORTUNITY FOR VEGETATION GROWTH.

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ALTERNATIVE DESCRIPTION:

The local replacement works alternative provides a cost-effective approach to stabilize the channel/infrastructure interaction and remove the risk to the surrounding bank

The components of the Local Replacement Works Alternative would include:

- Removal of the compromised grouted bank treatment from the channel
- Stabilization of the outfall channel and bank with a vegetated boulder treatment

Location: ES9
Local Replacement Works Concept Design

Date: 2021-10-05 Projection:
NAD83_UTM_Zone_17N
Data Source: City of Guelph, GRCA
Created by: D.K.

6.8 ES#10: Speed River tributary, stormwater outfall and bank erosion – Reach SS-8

The Speed River flows south and west for over 28 km through the City of Guelph, from Guelph Lake in the north to Guelph/Eramosa Township to the southwest of the city and ultimately drains to the Grand River downstream. The drainage area covers a watershed of 110 km^2 and is the largest subwatershed in the City of Guelph. The Speed flows though lake and wetlands in the headwaters and becomes a straight to gently meandering channel though the city, with reinforced banks and concrete grade control throughout.

The tributary at issue is a minor drainage channel that has been daylighted and conveys storm water flow from an outfall. Erosion Site ES #10 is located on the southwest bank just north of Massey Road. The ongoing issue at ES #10 is a rusted out CSP outfall that is blocked with debris and undermined from the water flowing freely from the bottom of the pipe. There is significant erosion around the outfall which lacks a headwall and the bank has receded considerably.

Preliminary Alternative 1: "Do Nothing"
The risks associated with ES #10 would not be addressed. The rusted-out CMP storm outfall pipe would remain and the bank would continue to erode. This option risks the stability of the outfall and bank, along with the overall morphology of this drainage channel.

Preliminary Alternative 2: Local Works, Repair
The local repair works alternative would involve cleaning out and CCTV inspection of the pipe. Rip rap will be provided to prevent further scour protection.

Local Works at this site would restore approximately 15 m of the SR-F2 reach of Speed River.

Preliminary Alternative 3: Local Works, Replacement
The local replacement works alternative would involve cleaning out and CCTV inspection of the pipe and replacement of the deteriorated CSP with HDPE and local vegetated rip rap scour protection

The replacement works would restore approximately 15 m of the SS-8 reach of Speed River.

Preliminary Alternative 4: Removal of Risk
Removal of the outfall is not considered at this time. The proposed CCTV inspection will confirm Removal of Risk as a potential alternative.

6.8.1 Evaluation of Alternatives

Each of the preliminary alternatives was scored using the criteria presented in **Section 5.0.** The full evaluation matrix presented in **Table 6.9**, showing the scoring for each alternative. Based on this evaluation, Local Repair Works was selected as the preferred alternative.

Table 6.9: Summary of Criteria Evaluation for ES #10 in Reach SS-8 of Speed River

Evaluation Criteria	Do Nothing	Local Repair Works	Replacement Works	Removal of Risk
Physical/Natural Environment				
Potential Aquatic Habitat Benefit (Water Temperature)	○	○	○	
Potential Aquatic Habitat Benefit (Fish Passage)	○	○	○	
Potential to Reduce Erosion of Public Lands	○	◕	◕	
Potential to Reduce Erosion of Private Lands	○	○	○	
Potential to Reduce Stream Bank and Stream Bed Erosion	○	◕	◕	
Potential to Enhance Groundwater Regime	○	◔	◔	
Potential to Reduce Flooding	○	◑	◑	
Potential to Improve Terrestrial Habitat	○	◑	◑	
Integration with Existing Infrastructure	○	◑	◑	
Integration with Existing Environment	○	◑	◕	
Social/Cultural Environment				
Aesthetic / Recreation	○	◑	◑	
Compatibility with Adjacent Land Use	○	◕	◕	
Community Disruption	○	○	○	
Public Health and Safety	◔	◕	◕	
Historically Significant Property	○	○	○	
Heritage Landscape Location	○	○	○	
Risk to Historic Landfills	○	○	○	
Economic Environment				
Construction Costs	●	◑	◔	
Operation and Maintenance Costs	◕	◕	◕	
Infrastructure Protection	○	◕	◕	
Technical/Engineering Considerations				
Ease of Implementation	●	◕	◑	
Agency Acceptance	◑	◕	◕	
Policy/Bylaw Requirements	◔	◕	◕	
Technical Feasibility	●	◕	◑	
Total Score	◔	◕	◑	○

● = indicated that the retrofit design alternative scored high in satisfying the respective design criteria

○ = indicated the retrofit design option scored low in relation to the criteria

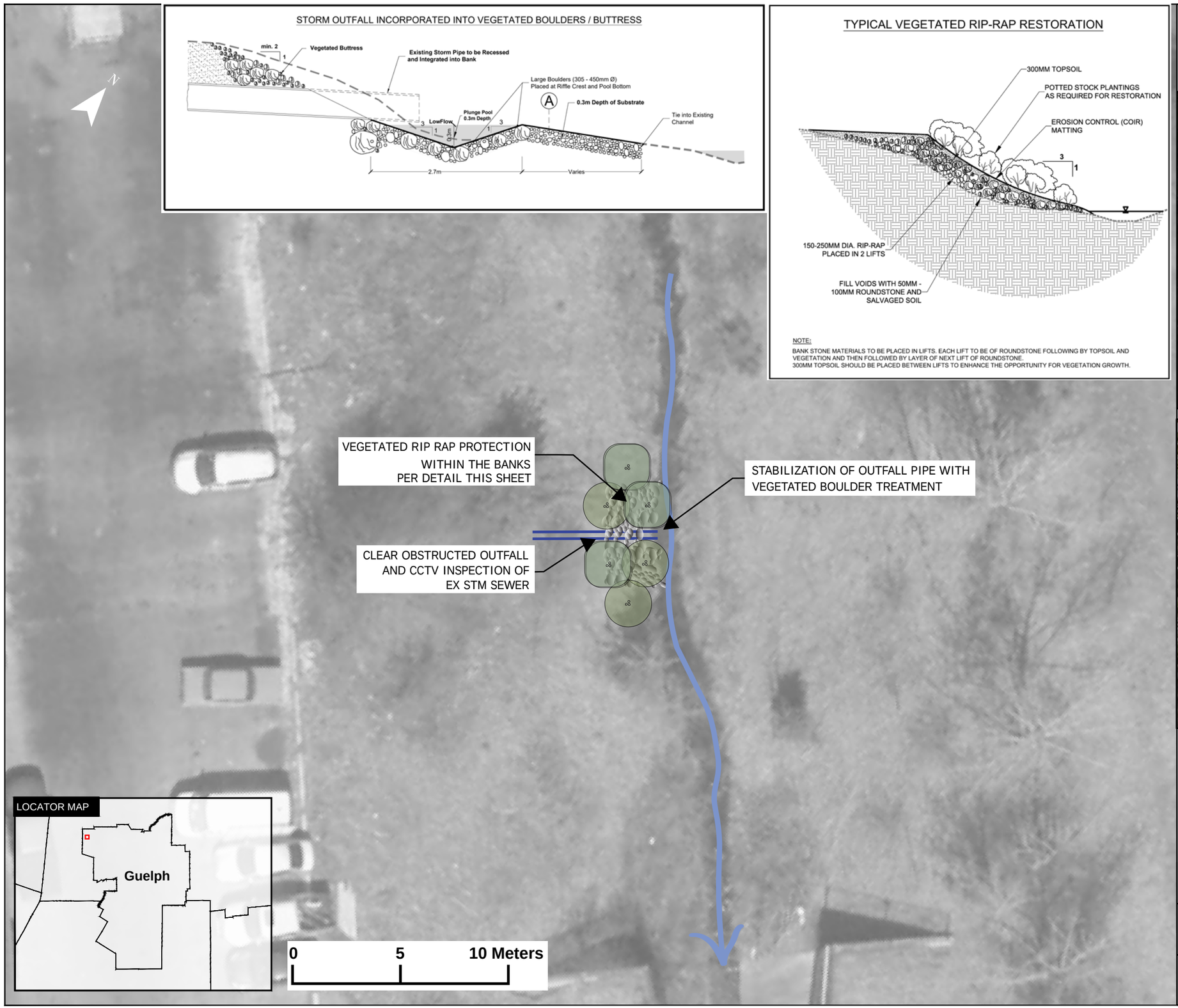
6.8.2 Preferred Alternative

The local repair works alternative provides a cost-effective approach to stabilize the channel/infrastructure interaction and remove the risk to the surrounding bank. Additionally, this alternative provides erosion protection to the private property adjacent to this narrow channel corridor as well as the existing CSP outfall. A conceptual design of the Local Repair Works alternative is presented below in **Figure 6.8.**

The components of the Local Repair Works Alternative would include:

- Clearing the obstructed outfall and CCTV inspection of the asset.
- Stabilization of the outfall pipe with a vegetated boulder treatment.
- Rip rap scour protection within the channel.

Refer to **Section 7.0** for estimated implementation costs.



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ALTERNATIVE DESCRIPTION:

The local replacement works alternative provides a cost-effective approach to stabilize the channel/infrastructure interaction and remove the risk to the surrounding bank

The components of the Local Repair Works Alternative would include:

- Clearing the obstructed outfall and CCTV inspection of the asset
  Replacement of pipe will be decided after the CCTV inspection
- Stabilization of the outfall pipe with a vegetated boulder treatment
- Rip rap scour protection within the banks

Location: ES10
Local Repair Works Concept Design

Date: 2021-10-05 Projection:
NAD83_UTM_Zone_17N
Data Source: City of Guelph, GRCA
Created by: D.K.

6.9 ES#11: Eramosa River, stormwater outfall and bank erosion – Reach ER-1

The Eramosa River flows west for over 7 km from Guelph/Eramosa Township, through the City of Guelph, to the Speed River at York Road and Wellington St. The drainage area covers a watershed of 29 km^2. The Eramosa drains rural areas to the East of Guelph with natural substrate and banks through the study area.

The reach at issue is in the main trunk channel of Eramosa River. Erosion Site ES #11 is a detached outfall and scoured outfall channel in reach ER-1. The concrete storm sewer pipe has been outflanked and undermined in the sandy channel bank.

Preliminary Alternative 1: "Do Nothing"
The risks associated with ES #11 would not be addressed. The detached stormwater pipe would remain in the scoured outfall channel and the bank would continue to erode.

Preliminary Alternative 2: Local Stabilization Works
The local stabilization works alternative would involve removal of the detached concrete pipe from the outfall channel and restoring the bank with embedded armourstone stabilization around the pipe. A boulder channel treatment will prevent scour in the outfall channel and further undermining of the outfall. Vegetated rip rap along the bank will prevent further bank erosion.

Local Works at this site would restore approximately 10 m of the ER-I1 reach of Eramosa River.

Preliminary Alternative 3: Local Works, Replacement
The local replacement works alternative would involve removal of the detached concrete pipe from the channel and replace with ODSB concrete headwall. Vegetated rip rap along the bank will prevent further bank erosion. Local Works at this site would restore approximately 10 m of the ER-I1 reach of Eramosa River.

Preliminary Alternative 4: Removal of Risk
Removal of the outfall is not considered at this time. The current stormwater network requires the existing infrastructure.

6.9.1 Evaluation of Alternatives

Each of the preliminary alternatives was scored using the criteria presented in **Section 5.0.** The full evaluation matrix presented in **Table 6.10**, showing the scoring for each alternative. Based on this evaluation, Local Stabilization Works was selected as the preferred alternative.

Table 6.10: Summary of Criteria Evaluation for ES #11 in Reach ER-1 of Eramosa River

Evaluation Criteria	Do Nothing	Local Stabilization Works	Replacement Works	Removal of Risk
Physical/Natural Environment				
Potential Aquatic Habitat Benefit (Water Temperature)	○	◔	◑	
Potential Aquatic Habitat Benefit (Fish Passage)	○	○	◑	
Potential to Reduce Erosion of Public Lands	○	◕	◕	
Potential to Reduce Erosion of Private Lands	○	○	○	
Potential to Reduce Stream Bank and Stream Bed Erosion	○	◕	◕	
Potential to Enhance Groundwater Regime	○	○	○	
Potential to Reduce Flooding	○	◔	◔	
Potential to Improve Terrestrial Habitat	◔	◔	◑	
Integration with Existing Infrastructure	◑	●	●	
Integration with Existing Environment	◑	◕	◕	
Social/Cultural Environment				
Aesthetic / Recreation	○	◕	◕	
Compatibility with Adjacent Land Use	○	●	◔	
Community Disruption	●	◕	◕	
Public Health and Safety	◑	◕	◑	
Economic Environment				
Construction Costs	●	◕	○	
Operation and Maintenance Costs	◔	◑	◑	
Infrastructure Protection	○	◑	◕	
Technical/Engineering Considerations				
Ease of Implementation	●	◕	◔	
Agency Acceptance	◔	◕	◑	
Policy/Bylaw Requirements	●	◕	◑	
Technical Feasibility	●	◕	◑	
Total Score	◔	◕	◑	○

● = indicated that the retrofit design alternative scored high in satisfying the respective design criteria

○ = indicated the retrofit design option scored low in relation to the criteria

6.9.2 Preferred Alternative

The local stabilization works alternative provides a cost-effective approach to stabilize the channel banks and repair the failed outfall. This alternative provides erosion protection and bank stabilization to the existing conditions A conceptual design of the Local Stabilization Works alternative is presented below in **Figure 6.9.**

The components of the Local Stabilization Works alternative would include:

- Removal of the compromised pipe from the channel.
- Stabilization of the outfall pipe with armourstone.
- Vegetated rip rap bank protection at the banks and slope.

Refer to **Section 7.0** for estimated implementation costs.

TYPICAL VEGETATED RIP-RAP RESTORATION

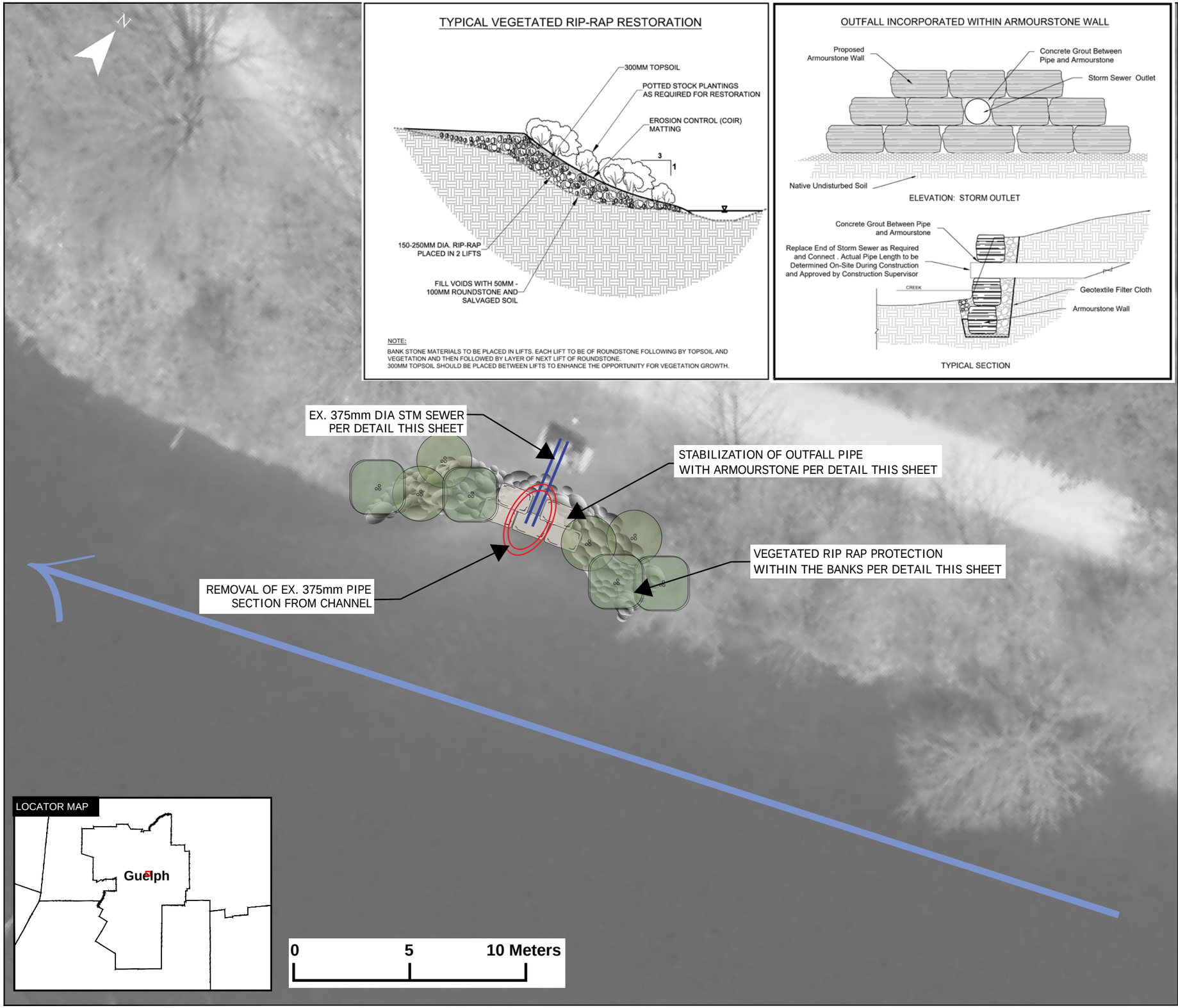
NOTE:

BANK STONE MATERIALS TO BE PLACED IN LIFTS. EACH LIFT TO BE OF ROUNDSTONE FOLLOWING BY TOPSOIL AND VEGETATION AND THEN FOLLOWED BY LAYER OF NEXT LIFT OF ROUNDSTONE.
300MM TOPSOIL SHOULD BE PLACED BETWEEN LIFTS TO ENHANCE THE OPPORTUNITY FOR VEGETATION GROWTH.

OUTFALL INCORPORATED WITHIN ARMOURSTONE WALL

ELEVATION: STORM OUTLET

TYPICAL SECTION



ALTERNATIVE DESCRIPTION:

The local stabilization works alternative provides a cost-effective approach to stabilize the channel banks and repair the failed outfall

The components of the Local Stabilization Works alternative would include:

- Removal of the compromised pipe from the channel
- Stabilization of the outfall pipe with armourstone
- Vegetated rip rap bank protection at the banks and slope

Location: ES11
Local Stabilization Works Concept Design

Date: 2021-10-05 Projection:
NAD83_UTM_Zone_17N
Data Source: City of Guelph, GRCA
Created by: D.K.

6.10 ES#12/13: Speed River, retaining wall and stormwater outfall– Reach SR-8

The Speed River flows south and west for over 28 km through the City of Guelph, from Guelph Lake in the north to Guelph/Eramosa Township to the southwest of the city and ultimately drains to the Grand River downstream. The drainage area covers a watershed of 110 km^2 and is the largest subwatershed in the City of Guelph. The Speed flows though lake and wetlands in the headwaters and becomes a straight to gently meandering channel though the city, with reinforced banks and concrete grade control throughout.

An unreinforced concrete retaining wall has deteriorated and failed in an outflanked segment along the channel. This wall protects the parking lot directly adjacent to the channel and prevents the erosion of the banks. Further upstream are outfalls on the same bank whose concrete headwalls show significant spalling and cracking.

Preliminary Alternative 1: "Do Nothing"
The risks associated with ES #12 and ES #13 would not be addressed. The failed retaining wall would remain and the crumbling concrete of the outfall would continue to deteriorate.

Preliminary Alternative 2: Local Works
The local works alternative would involve repair to local sections of wall failure and concrete spalling at the outfall. Outflanked wall sections would be filled in to restore the bank conditions.

Preliminary Alternative 3: Reach Based Works
The reach based works alternative would involve removal of extended lengths of the unreinforced concrete wall between the 2 erosion sites and replacement with armourstone. Further inspection may include 25 to 30 m of replace retaining wall along Reach SR-8.

Preliminary Alternative 4: Removal of Risk
The removal of risk alternative would be the complete removal of the unreinforced wall and naturalize the banks with vegetated boulder protection. This alternative would remove and restore 60 m of the bank between the two erosion sites.

6.10.1 Evaluation of Alternatives

Each of the preliminary alternatives was scored using the criteria presented in **Section 5.0.** The full evaluation matrix presented in **Table 6.11**, showing the scoring for each alternative. Based on this evaluation, the Reach Based Works alternative was selected as the preferred alternative.

Table 6.11: Summary of Criteria Evaluation for ES #12 and ES #13 in Reach SR-8 of Speed River

Evaluation Criteria	Do Nothing	Local Works	Reach Based Works	Removal of Risk
Physical/Natural Environment				
Potential Aquatic Habitat Benefit (Water Temperature)	◔	◑	◑	◑
Potential Aquatic Habitat Benefit (Fish Passage)	◑	◑	◑	◑
Potential to Reduce Erosion of Public Lands	○	◕	●	●
Potential to Reduce Erosion of Private Lands	○	◕	●	●
Potential to Reduce Stream Bank and Stream Bed Erosion	○	◕	●	●
Potential to Enhance Groundwater Regime	○	○	○	○
Potential to Reduce Flooding	○	◔	◔	◔
Potential to Improve Terrestrial Habitat	○	○	○	○
Integration with Existing Infrastructure	◑	◕	◕	◑
Integration with Existing Environment	◑	◑	◕	◕
Social/Cultural Environment				
Aesthetic / Recreation	○	◕	◕	●
Compatibility with Adjacent Land Use	○	◑	◕	◕
Community Disruption	●	◑	◑	◑
Public Health and Safety	◑	◕	◕	◑
Economic Environment				
Construction Costs	●	◑	◑	○
Operation and Maintenance Costs	◔	◑	●	●
Infrastructure Protection	○	◕	◕	●
Technical/Engineering Considerations				
Ease of Implementation	●	◑	◑	◔
Agency Acceptance	○	◑	◑	◑
Policy/Bylaw Requirements	◑	◑	◑	◑
Technical Feasibility	●	◕	◕	◔
Total Score	◔	◑	◕	◑

● = indicated that the retrofit design alternative scored high in satisfying the respective design criteria

○ = indicated the retrofit design option scored low in relation to the criteria

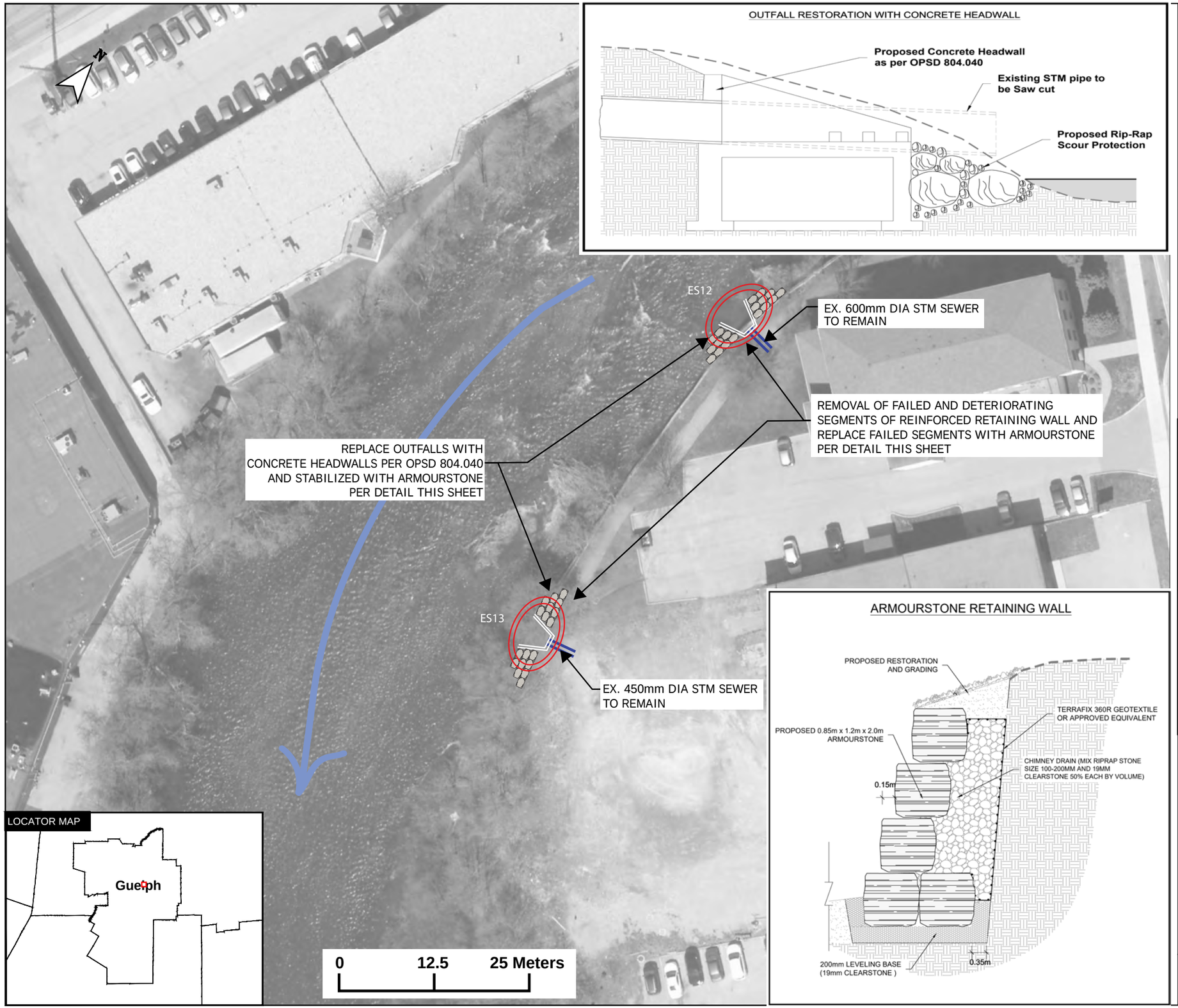
6.10.2 Preferred Alternative

The reach-based works alternative provides a cost-effective approach to stabilize the banks and storm sewer outfall infrastructure. Additionally, this alternative stabilizes the base of the adjacent parking lot. A conceptual design of the Reach Based Works alternative is presented below in **Figure 6.10.**

The components of the Reach Based Alternative would include:

- Removal of the failed and deteriorating segments of the unreinforced retaining wall
- Replacing failed segments with armourstone
- Replacement of the outfalls with concrete headwalls, stabilized with armourstone.

Refer to **Section 7.0** for estimated implementation costs.



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ALTERNATIVE DESCRIPTION:

The reach based works alternative provides a cost-effective approach to stabilize the banks and and storm sewer outfall infrastructure

The components of the Reach Based Alternative would include:

- Removal of the failed and deteriorating segments of the unreinforced retaining wall
- Replacing failed segments with armourstone
- Replacement of the outfalls with concrete headwalls, stabilized with armourstone

Location: ES12/13
Reach Based Works Concept Design

Date: 2021-10-05 Projection:
NAD83_UTM_Zone_17N
Data Source: City of Guelph, GRCA
Created by: D.K.

6.11 ES#14: Speed River, stormwater outfall and bank erosion – Reach SR-8

The Speed River flows south and west for over 28 km through the City of Guelph, from Guelph Lake in the north to Guelph/Eramosa Township to the southwest of the city and ultimately drains to the Grand River downstream. The drainage area covers a watershed of 110 km^2 and is the largest subwatershed in the City of Guelph. The Speed flows though lake and wetlands in the headwaters and becomes a straight to gently meandering channel though the city, with reinforced banks and concrete grade control throughout.

The reach at issue is in the main trunk channel of the Speed River. Erosion Site ES #14 is an exposed sanitary sewer crossing that is encased in grade control infrastructure 100 m upstream of Neeve Street Bridge. The sewer pipe has been decommissioned and confirmed by the City of Guelph. The concrete casement is broken and undermined in sections.

Preliminary Alternative 1: "Do Nothing"
The risks associated with ES #14 would not be addressed. The decommissioned sanitary sewer pipe would remain and continue to deteriorate. Leaving this infrastructure within the creek presents a significant and unnecessary fish barrier.

Preliminary Alternative 2: Local Works
The local works alternative would involve reinforcing and replacement of the concrete encasement to repair the existing sewer pipe exposure. Protective cover of the pipe in the form of a fixed riffle to extend up and downstream as a boulder/rip rap rocky ramp to prevent further undermining and scour. Local Works at this site would restore approximately 20 m of Reach SR-8 of Speed River.

Preliminary Alternative 3: Reach Based Works
Reach Based works are not considered at this time for a lateral crossing.

Preliminary Alternative 4: Removal of Risk
The removal of risk alternative would involve removal of sewer pipe and cap the buried infrastructure within the bank beyond the 100-yr erosion hazard limit. The banks would be restored with native vegetation and riparian cover. Realignment of the channel profile at the crossing site to maintain the existing channel gradient and prevent channel scour using a fixed riffle that allows fish passage.

6.11.1 Evaluation of Alternatives

Each of the preliminary alternatives was scored using the criteria presented in **Section 5.0.** The full evaluation matrix presented in **Table 6.12**, showing the scoring for each alternative. Based on this evaluation, Removal of Risk was selected as the preferred alternative.

Table 6.12: Summary of Criteria Evaluation for ES #14 in Reach SR-8 of Speed River

Evaluation Criteria	Do Nothing	Local Works	Removal of Risk	
Physical/Natural Environment				
Potential Aquatic Habitat Benefit (Water Temperature)	◔	◑	◑	
Potential Aquatic Habitat Benefit (Fish Passage)	◔	◑	●	
Potential to Reduce Erosion of Public Lands	◔	◕	●	
Potential to Reduce Erosion of Private Lands	○	○	○	
Potential to Reduce Stream Bank and Stream Bed Erosion	○	◔	◑	
Potential to Enhance Groundwater Regime	○	○	○	
Potential to Reduce Flooding	○	○	○	
Potential to Improve Terrestrial Habitat	○	○	○	
Integration with Existing Infrastructure	◔	◑	◑	
Integration with Existing Environment	◔	◕	●	
Social/Cultural Environment				
Aesthetic / Recreation	◑	◕	◔	
Compatibility with Adjacent Land Use	◔	◕	●	
Community Disruption	●	●	●	
Public Health and Safety	◔	◕	●	
Historically Significant Property	○	○	○	
Heritage Landscape Location	○	◑	●	
Risk to Historic Landfills	○	○	○	
Economic Environment				
Construction Costs	●	◔	◑	
Operation and Maintenance Costs	◔	◕	●	
Infrastructure Protection	◔	◕	●	
Technical/Engineering Considerations				
Ease of Implementation	◕	◔	◑	
Agency Acceptance	◔	◔	◕	
Policy/Bylaw Requirements	◔	○	◕	
Technical Feasibility	◕	◑	◕	
Total Score	◔	◑	◔	○

● = indicated that the retrofit design alternative scored high in satisfying the respective design criteria

○ = indicated the retrofit design option scored low in relation to the criteria

6.11.2 Preferred Alternative

The removal of risk alternative provides a cost-effective approach to stabilize the channel/infrastructure interaction and remove the risk to the failing infrastructure. This alternative provides erosion protection and gradient stabilization to the existing conditions. A conceptual design of the Removal of Risk alternative is presented below in **Figure 6.11.** The city has decommissioned this pipe and has plans to remove it. The design process is likely to initiate in 2022.

The components of the Removal of Risk Alternative would include:

- Removal of the compromised pipe from the channel.
- Stabilization of the crossing with a fixed riffle over the grade control infrastructure at the site of the crossing.
- Cap the pipe in the banks at an offset equivalent to the 100-yr erosion limit.
- The banks restored with native vegetation and riparian cover.
- Restoration off the banks at the existing crossings.

Refer to **Section 7.0** for estimated implementation costs.

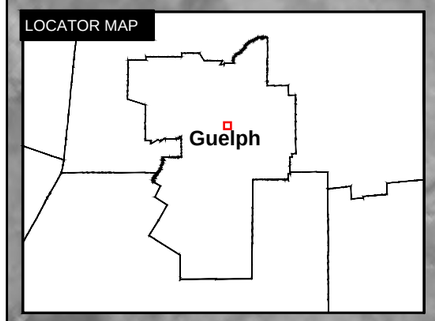
CAP EX. DECOMMISSIONED SANITARY SEWER IN BANKS TO AN OFFSET EQUIVALENT TO 100-YR EROSION LIMIT. COVER WITH NATIVE BACKFILL

REMOVAL OF EX. 1200mm DIA DECOMMISSIONED SANITARY SEWER FROM CHANNEL

RESTORATION OF BANKS AT EXISTING CROSSING WITH NATIVE VEGETATION

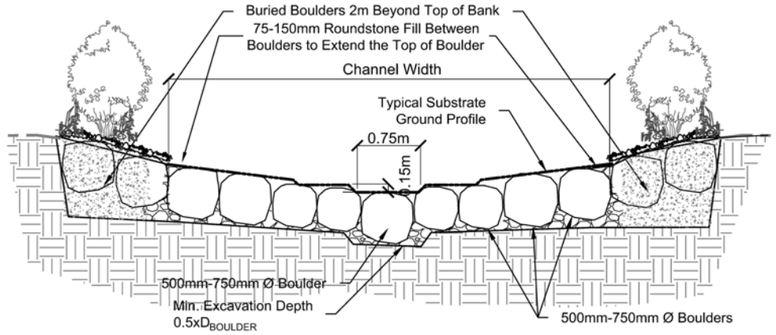
STABILIZATION OF CROSSING WITH A FIXED RIFFLE PER DETAIL THIS SHEET

LOCATOR MAP



0 5 10 Meters

FIXED RIFFLE CROSSING



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ALTERNATIVE DESCRIPTION:

The removal of risk alternative provides a cost-effective approach to stabilize the channel/infrastructure interaction and remove the risk to the failing infrastructure.

The components of the Removal of Risk Alternative would include:

- Removal of the compromised pipe from the channel.
- Stabilization of the crossing with a fixed riffle over the grade control infrastructure at the site of the crossing.
- Cap the pipe in the banks at an offset equivalent to the 100-yr erosion limit.
- Restoration of the banks at the existing crossings with native vegetation

Location: ES14
Removal of Risk Concept Design

Date: 2021-10-05 Projection:
NAD83_UTM_Zone_17N
Data Source: City of Guelph, GRCA
Created by: D.K.

6.12 ES#15: Speed River, stormwater outfall and retaining wall – Reach SR-9

The Speed River flows south and west for over 28 km through the City of Guelph, from Guelph Lake in the north to Guelph/Eramosa Township to the southwest of the city and ultimately drains to the Grand River downstream. The drainage area covers a watershed of 110 km^2 and is the largest subwatershed in the City of Guelph. The Speed flows though lake and wetlands in the headwaters and becomes a straight to gently meandering channel though the city, with reinforced banks and concrete grade control throughout.

A concrete outfall pipe outlets to the Speed River on the west bank, immediately downstream of the Heffernan Street Bridge. This outfall lacks a headwall and has scoured the base of a stone retaining wall at the base of the outfall. The retaining wall continues to deteriorate and risks undermining the outfall.

Preliminary Alternative 1: "Do Nothing"
The risks associated with ES #15 would not be addressed. The failing stone retaining wall would continue to deteriorate and the scour pool at the base of the outfall will enlarge. A monitoring plan would need to be implemented to inspect the erosion and the risk to the retaining wall and the proximity to the bridge regularly.

Preliminary Alternative 2: Local Works, Repair
The local repair works alternative would involve masonry repair of the exposed bank and the stone retaining wall. The base of the outfall will be protected with boulder scour protection that extends into the channel. Local repair works at this site would restore approximately 10 m of Reach SR-9 of Speed River.

Preliminary Alternative 3: Local Works, Replacement
The local replacement works alternative would involve masonry repair of the exposed bank and the stone retaining wall. An embedded boulder scour pad will prevent undermining of the repaired wall, and a concrete headwall will be placed in the existing retaining wall. Local replacement works at this site would restore approximately 10 m of Reach SR-9 of Speed River.

Preliminary Alternative 4: Removal of Risk
Removal of the outfall is not considered at this time. The current stormwater network requires the existing infrastructure.

6.12.1 Evaluation of Alternatives

Each of the preliminary alternatives was scored using the criteria presented in **Section 5.0.** The full evaluation matrix presented in **Table 6.13**, showing the scoring for each alternative. Based on this evaluation, the Local Replacement Works alternative was selected as the preferred alternative.

Table 6.13: Summary of Criteria Evaluation for ES #15 in Reach SR-9 of Speed River

Evaluation Criteria	Do Nothing	Local Repair Works	Local Replacement Works	Removal of Risk
Physical/Natural Environment				
Potential Aquatic Habitat Benefit (Water Temperature)	○	○	○	
Potential Aquatic Habitat Benefit (Fish Passage)	○	○	○	
Potential to Reduce Erosion of Public Lands	○	◔	◕	
Potential to Reduce Erosion of Private Lands	○	○	○	
Potential to Reduce Stream Bank and Stream Bed Erosion	○	◔	◕	
Potential to Enhance Groundwater Regime	○	○	○	
Potential to Reduce Flooding	○	○	○	
Potential to Improve Terrestrial Habitat	○	○	○	
Integration with Existing Infrastructure	◔	◑	◑	
Integration with Existing Environment	◑	◑	◑	
Social/Cultural Environment				
Aesthetic / Recreation	◔	◑	◑	
Compatibility with Adjacent Land Use	◔	◑	◑	
Community Disruption	◕	◑	◑	
Public Health and Safety	○	◑	◕	
Historically Significant Property	○	○	○	
Heritage Landscape Location	◔	◑	◑	
Risk to Historic Landfills	○	○	○	
Economic Environment				
Construction Costs	●	◕	◔	
Operation and Maintenance Costs	◔	◔	◕	
Infrastructure Protection	○	◑	◕	
Technical/Engineering Considerations				
Ease of Implementation	●	◑	◑	
Agency Acceptance	◑	◑	◕	
Policy/Bylaw Requirements	◔	◑	◑	
Technical Feasibility	●	◕	◑	
Total Score	◔	◔	◑	○

● = indicated that the retrofit design alternative scored high in satisfying the respective design criteria

○ = indicated the retrofit design option scored low in relation to the criteria

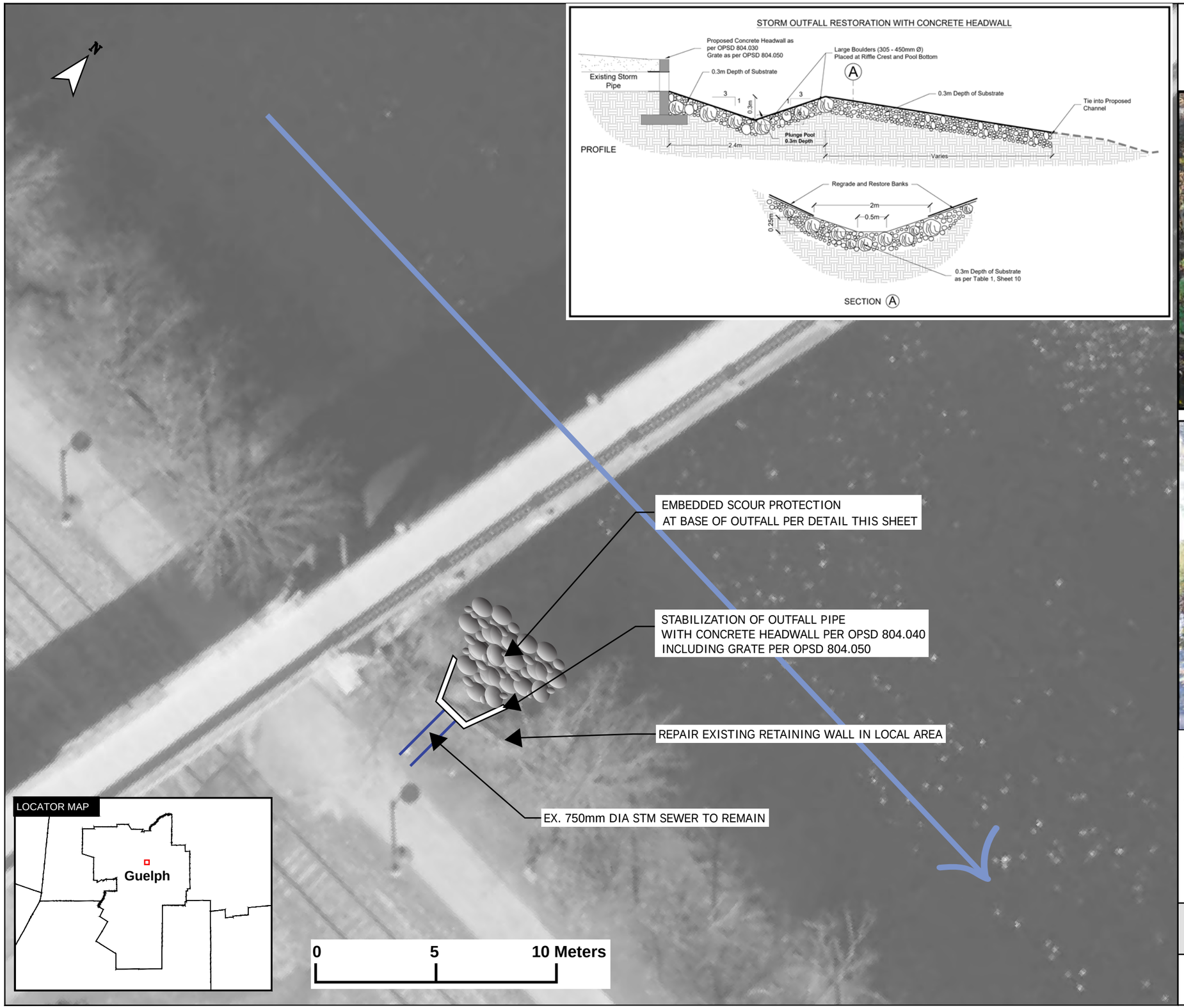
6.12.2 Preferred Alternative

The local replacement works alternative provides a cost-effective approach to stabilize the concrete outfall pipe and repair the failed stone retaining wall. This alternative provides erosion protection to the existing conditions. A conceptual design of the Local Replacement Works alternative is presented below in **Figure 6.12.**

The components of the Local Replacement Works alternative would include:

- Repair of the existing retaining wall.
- Stabilization of the outfall pipe with a concrete headwall.
- Embedded scour protection at the base of the outfall.

Refer to **Section 7.0** for estimated implementation costs.



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ALTERNATIVE DESCRIPTION:

The local replacement works alternative provides a cost-effective approach to stabilize the concrete outfall pipe and repair the failed stone retaining wall.

The components of the Local Stabilization Works alternative would include:

- Repair of the existing retaining wall.
- Stabilization of the outfall pipe with a concrete headwall.
- Embedded scour protection at the base of the outfall.

Location: ES15
Local Replacement Works Concept Design

Date: 2021-10-05 Projection:
NAD83_UTM_Zone_17N
Data Source: City of Guelph, GRCA
Created by: D.K.

6.13 ES#16: Speed River, Concrete weir and stormwater outfall– Reach SR-10

The Speed River flows south and west for over 28 km through the City of Guelph, from Guelph Lake in the north to Guelph/Eramosa Township to the southwest of the city and ultimately drains to the Grand River downstream. The drainage area covers a watershed of 110 km^2 and is the largest subwatershed in the City of Guelph. The Speed flows though lake and wetlands in the headwaters and becomes a straight to gently meandering channel though the city, with reinforced banks and concrete grade control throughout.

A concrete weir has been outflanked immediately upstream of a stormwater outfall with a concrete headwall. A previous bank treatment has used boulder material to repair the erosion and protect the eroded bank near the outfall.

Preliminary Alternative 1: "Do Nothing"
The risks associated with ES #16 would not be addressed. The channel would continue to outflank the weir in high flow events and erode the bank adjacent to the storm water outfall. Prolonged bank exposure may risk the outfall also. Provided the boulder treatment remains stable, the outfall shows no immediate indicators of undermining. A monitoring plan would need to be implemented to monitor ongoing risk to the infrastructure.

Preliminary Alternative 2: Local Works, Repair
The local repair works alternative would involve removal of the existing boulder material from the previous repair and extend the existing weir beyond the 100-year erosion limit. Armourstone or vegetated boulder material embedded in the bank to stabilize the channel and the adjacent outfall.

Preliminary Alternative 3: Reach Based Works
Reach Based works are not considered at this time for the grade control and outfall as both are considered integral to the overall infrastructure.

Preliminary Alternative 4: Removal of Risk
Removal of weir and construction of boulder riffle to maintain channel gradient. This option removes the fish barrier and provides comparable channel gradient to existing conditions.

6.13.1 Evaluation of Alternatives

Each of the preliminary alternatives was scored using the criteria presented in **Section 5.0.** The full evaluation matrix presented in **Table 6.14**, showing the scoring for each alternative. Based on this evaluation, the "Do Nothing" alternative was selected as the preferred alternative.

Table 6.14: Summary of Criteria Evaluation for ES #16 in Reach SR-10 of Speed River

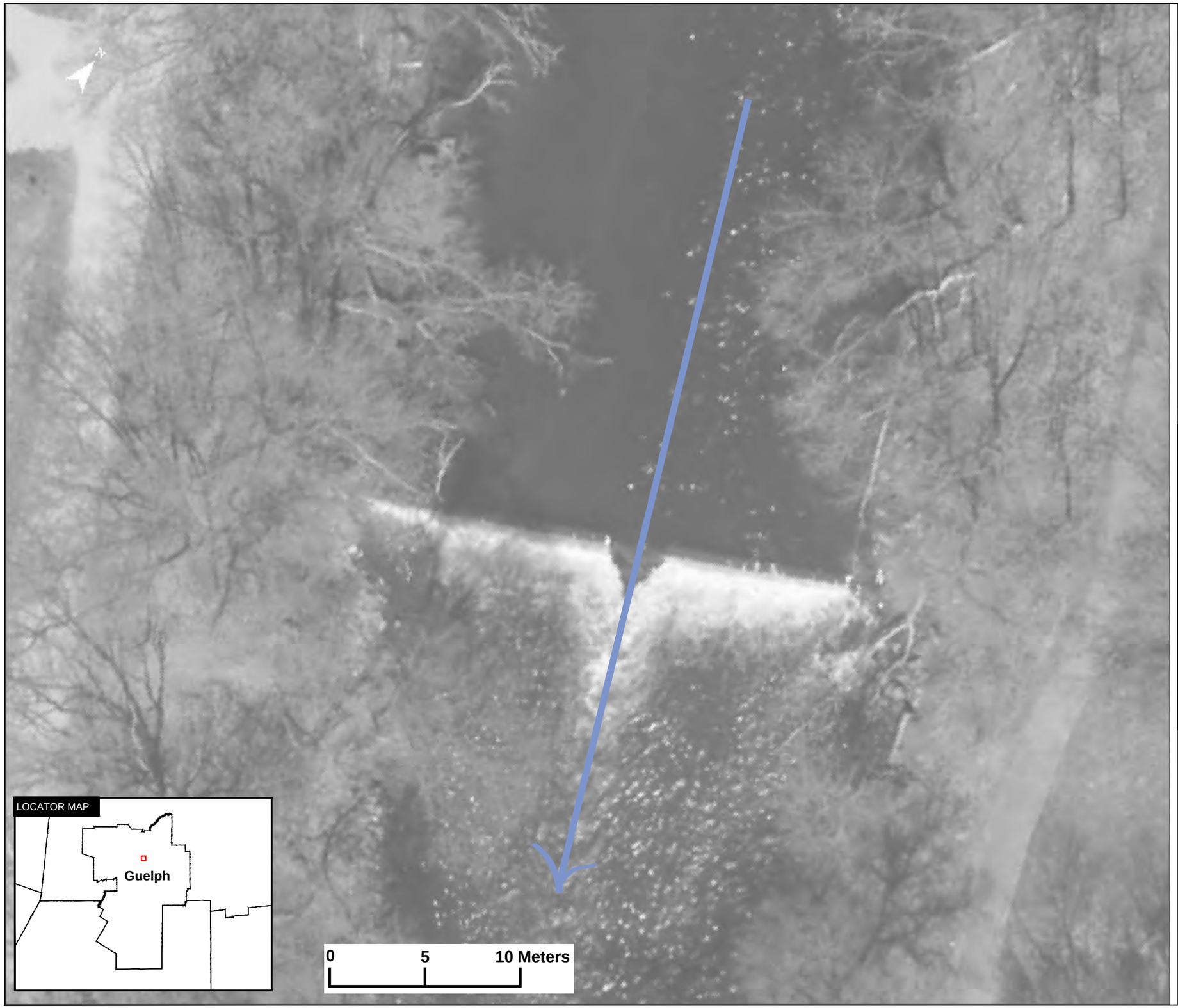
Evaluation Criteria	Do Nothing	Local Works	Removal of Risk	
Physical/Natural Environment				
Potential Aquatic Habitat Benefit (Water Temperature)	○	○	○	
Potential Aquatic Habitat Benefit (Fish Passage)	○	◕	◕	
Potential to Reduce Erosion of Public Lands	◑	◕	◑	
Potential to Reduce Erosion of Private Lands	◑	◕	◑	
Potential to Reduce Stream Bank and Stream Bed Erosion	◑	◕	◔	
Potential to Enhance Groundwater Regime	○	○	○	
Potential to Reduce Flooding	◕	◕	◔	
Potential to Improve Terrestrial Habitat	◑	◑	◔	
Integration with Existing Infrastructure	◕	◕	◔	
Integration with Existing Environment	◑	◑	◕	
Social/Cultural Environment				
Aesthetic / Recreation	◑	◔	◕	
Compatibility with Adjacent Land Use	◕	◑	◕	
Community Disruption	●	◑	◔	
Public Health and Safety	◑	◑	○	
Historically Significant Property	○	○	○	
Heritage Landscape Location	◕	◑	◕	
Risk to Historic Landfills	○	○	○	
Economic Environment				
Construction Costs	●	◔	○	
Operation and Maintenance Costs	◑	◔	◕	
Infrastructure Protection	◑	◕	○	
Technical/Engineering Considerations				
Ease of Implementation	●	◑	○	
Agency Acceptance	◕	◑	◔	
Policy/Bylaw Requirements	◑	◑	◔	
Technical Feasibility	●	◕	◔	
Total Score	◕	◑	◔	

● = indicated that the retrofit design alternative scored high in satisfying the respective design criteria

○ = indicated the retrofit design option scored low in relation to the criteria

6.13.2 Preferred Alternative

The “Do Nothing” alternative provides a cost-effective solution to the channel/infrastructure interaction. While this alternative provides no additional erosion protection or stabilization to the existing outfall or banks, the existing scour protection appears stable enough to recommend monitoring the erosion site until the banks show increased risk to the outfall.



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ALTERNATIVE DESCRIPTION:

The “Do Nothing” alternative provides a cost-effective solution to the channel/infrastructure interaction.

While this alternative provides no additional erosion protection or stabilization to the existing outfall or banks, the existing scour protection appears stable enough to recommend monitoring the erosion site until the banks show increased risk to the outfall.

Location: ES16
“Do Nothing” Concept Design

Date: 2021-10-05 Projection:
NAD83_UTM_Zone_17N
Data Source: City of Guelph, GRCA
Created by: D.K.

6.14 ES#17: Speed River, stormwater outfall and bank erosion – Reach SR-10

The Speed River flows south and west for over 28 km through the City of Guelph, from Guelph Lake in the north to Guelph/Eramosa Township to the southwest of the city and ultimately drains to the Grand River downstream. The drainage area covers a watershed of 110 km^2 and is the largest subwatershed in the City of Guelph. The Speed flows though lake and wetlands in the headwaters and becomes a straight to gently meandering channel though the city, with reinforced banks and concrete grade control throughout.

A metal outfall pipe is elevated above the channel, creating a scour pool at the base. The lack of headwall allows runoff and high stage flows to erode the bank around the pipe.

Preliminary Alternative 1: "Do Nothing"
The risks associated with ES #17 would not be addressed. The elevated stormwater pipe would remain and the scoured bank at the base of the outfall would continue to undermine the pipe.

Preliminary Alternative 2: Local Stabilization Works
The local stabilization works alternative would involve removal of wood debris and scour protection at the base of the outfall. A competent base level support for the pipe would be rebuilt and vegetated boulders and bioengineering will be used to stabilize the pipe and extend the lifespan of the infrastructure. Local Works at this site would restore approximately 10 m of Reach SR-10 of Speed River.

Preliminary Alternative 3: Local Works, Replacement
The local replacement works alternative would involve placement of an ODSB concrete headwall at the end of pipe. Vegetated rip rap along the bank will prevent further bank erosion. Local replacement works at this site would restore approximately 6 m of Reach SR-10 of Speed River.

Preliminary Alternative 4: Removal of Risk
Removal of the outfall is not considered at this time. The current stormwater network requires the existing infrastructure.

6.14.1 Evaluation of Alternatives

Each of the preliminary alternatives was scored using the criteria presented in **Section 5.0.** The full evaluation matrix presented in **Table 6.15**, showing the scoring for each alternative. Based on this evaluation, Local Stabilization Works was selected as the preferred alternative.

Table 6.15: Summary of Criteria Evaluation for ES #17 in Reach SR-10 of Speed River

Evaluation Criteria	Do Nothing	Stabilization Works	Local Works	Removal of Risk
Physical/Natural Environment				
Potential Aquatic Habitat Benefit (Water Temperature)	○	○	○	
Potential Aquatic Habitat Benefit (Fish Passage)	○	○	○	
Potential to Reduce Erosion of Public Lands	○	◑	◑	
Potential to Reduce Erosion of Private Lands	○	◑	◑	
Potential to Reduce Stream Bank and Stream Bed Erosion	○	◕	◕	
Potential to Enhance Groundwater Regime	○	○	○	
Potential to Reduce Flooding	○	○	○	
Potential to Improve Terrestrial Habitat	○	◔	◔	
Integration with Existing Infrastructure	◔	◑	◑	
Integration with Existing Environment	◑	◔	◔	
Social/Cultural Environment				
Aesthetic / Recreation	◔	◑	◑	
Compatibility with Adjacent Land Use	◔	◕	◕	
Community Disruption	◕	◑	◑	
Public Health and Safety	◑	◑	◑	
Historically Significant Property	○	○	○	
Heritage Landscape Location	◔	◑	◑	
Risk to Historic Landfills	○	○	○	
Economic Environment				
Construction Costs	●	◑	◔	
Operation and Maintenance Costs	◔	◑	◑	
Infrastructure Protection	○	◑	◑	
Technical/Engineering Considerations				
Ease of Implementation	◕	◑	◑	
Agency Acceptance	◔	◑	◑	
Policy/Bylaw Requirements	◔	◑	◑	
Technical Feasibility	●	◕	◑	
Total Score	◔	◑	◔	○

● = indicated that the retrofit design alternative scored high in satisfying the respective design criteria

○ = indicated the retrofit design option scored low in relation to the criteria

6.14.2 Preferred Alternative

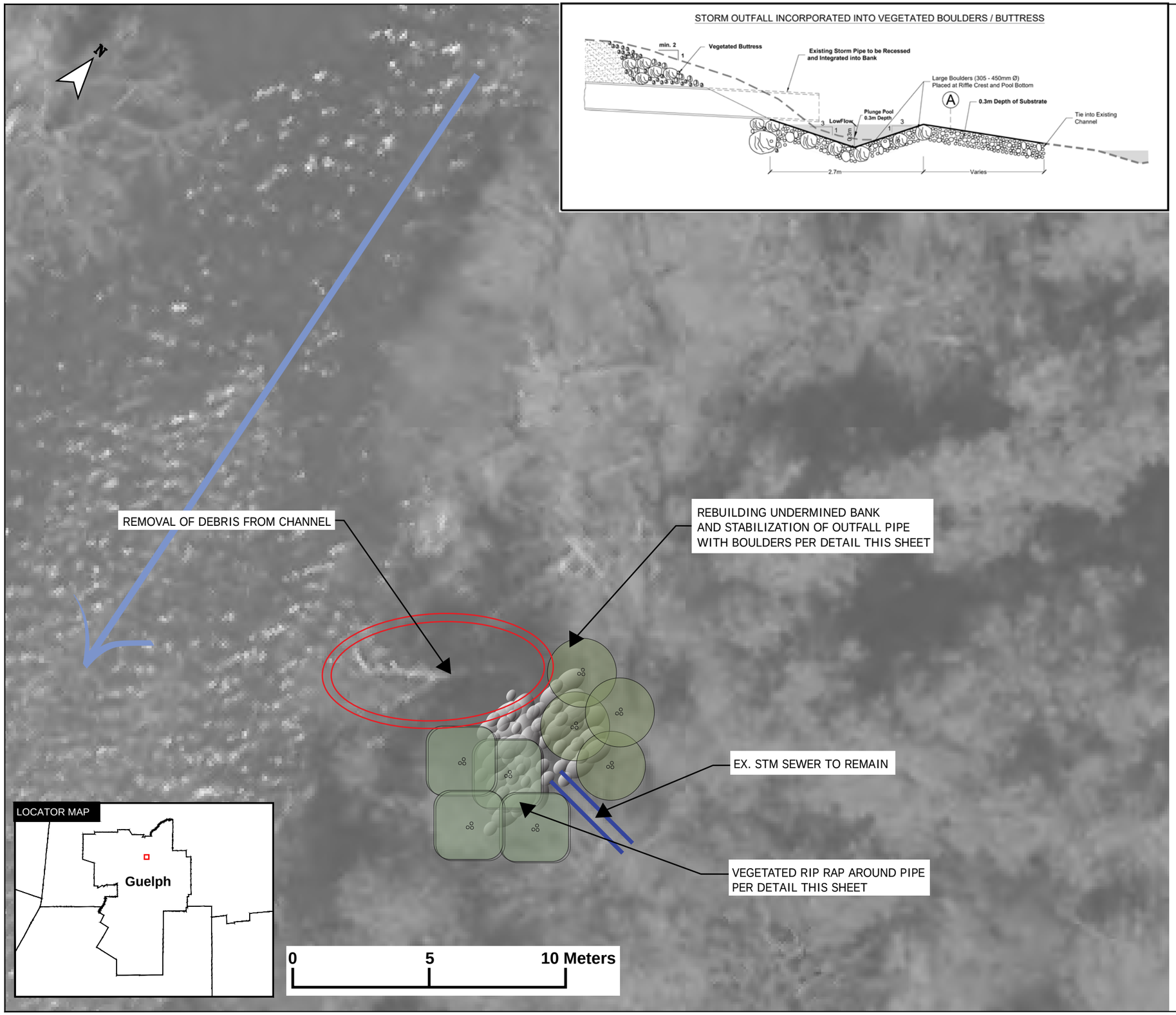
The local stabilization works alternative provides a cost-effective approach to stabilize the channel/infrastructure interaction and remove the risk to the surrounding bank. This alternative

provides erosion protection and stabilization to the existing outfall and the banks of the channel. A conceptual design of the Local Stabilization Works alternative is presented below in **Figure 6.14.**

The components of the Local Stabilization Works Alternative would include:

- Removal of the debris from the channel.
- Rebuilding the undermined bank and stabilization of the outfall pipe with boulders.
- Vegetated rip rap bank protection around the pipe.

Refer to **Section 7.0** for estimated implementation costs.



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ALTERNATIVE DESCRIPTION:

The local stabilization works alternative provides a cost-effective approach to stabilize the channel/infrastructure interaction and remove the risk to the surrounding bank

The components of the Local Stabiliazation Works Alternative would include:

- Removal of the debris from the channel
- Rebuilding the undermined bank and stabilization of the outfall pipe with boulders.
- Vegetated rip rap bank protection around the pipe

Location: ES17
Local Stabilization Works Concept Design

Date: 2021-10-05 Projection:
NAD83_UTM_Zone_17N
Data Source: City of Guelph, GRCA
Created by: D.K.

6.15 ES#18: Speed River tributary, exposed sanitary sewer – Reach SR-J1

The Speed River flows south and west for over 28 km through the City of Guelph, from Guelph Lake in the north to Guelph/Eramosa Township to the southwest of the city and ultimately drains to the Grand River downstream. The drainage area covers a watershed of 110 km^2 and is the largest subwatershed in the City of Guelph. The Speed flows though lake and wetlands in the headwaters and becomes a straight to gently meandering channel though the city, with reinforced banks and concrete grade control throughout.

The tributary at issue includes a minor drainage channel that conveys storm water flow from an outfall, and was previously identified as ES #23. The scouring of the channel since the construction of this crossing has led to the degradation of the channel. Hydraulic modelling and erosion potential analysis have identified this exposure as susceptible to failure. Emergency works have provided a temporary solution to the imminent risk to this infrastructure.

The components of Emergency Works included:

- Replacement of failed armourstone
- Installation of armourstone cascade over the sewer line

Realignment of the channel by regrading the upstream and downstream of the sewer crossing

Preliminary Alternative 1: "Do Nothing"
The risks associated with ES #18 would not be addressed. The exposed sanitary main would remain unstabilized on the drainage channel banks.

Preliminary Alternative 2: Local Works
The local repair works alternative would involve armourstone encasement of the exposed sanitary main and cascade grade control within the existing channel width. This was completed as emergency works in 2022, but is not a sufficient long-term solution.

Preliminary Alternative 3: Reach-Based Works
The reach-based works would include removal, replacement, and lowering of the sanitary sewer main, such that a minimum cover of at least 1 m (preferred) is provided.

Preliminary Alternative 4: Removal of Risk
Removal of the sanitary sewer is not considered at this time. The current wastewater network requires the existing infrastructure.

6.15.1 Evaluation of Alternatives

Each of the preliminary alternatives was scored using the criteria presented in **Section 5.0.** The full evaluation matrix presented in **Table 6.16**, showing the scoring for each alternative. Based on this evaluation, the Reach-Based Works alternative was selected as the preferred alternative. Final confirmation regarding how much the sanitary sewer can be lowered is still required from the Wastewater Master Plan before the concept can be developed.

Table 6.16: Summary of Criteria Evaluation for ES #18 in Reach SR-J1 of Speed River

Evaluation Criteria	Do Nothing	Local Works	Reach Based Works	Removal of Risk
Physical/Natural Environment				
Potential Aquatic Habitat Benefit (Water Temperature)	○	◑	●	
Potential Aquatic Habitat Benefit (Fish Passage)	○	○	◑	
Potential to Reduce Erosion of Public Lands	○	◑	◕	
Potential to Reduce Erosion of Private Lands	○	○	○	
Potential to Reduce Stream Bank and Stream Bed Erosion	○	◕	●	
Potential to Enhance Groundwater Regime	○	○	○	
Potential to Reduce Flooding	○	○	◑	
Potential to Improve Terrestrial Habitat	○	○	○	
Integration with Existing Infrastructure	○	◑	◕	
Integration with Existing Environment	○	◔	◑	
Potential for sewage / treated water to enter streams from pipes and vice versa	○	◑	●	
Social/Cultural Environment				
Aesthetic / Recreation	○	◑	◑	
Compatibility with Adjacent Land Use	○	◑	◑	
Community Disruption	◕	◑	◔	
Public Health and Safety	○	◑	●	
Historically Significant Property	○	○	○	
Heritage Landscape Location	○	◔	◑	
Risk to Historic Landfills	○	○	○	
Economic Environment				
Construction Costs	◕	◑	○	
Operation and Maintenance Costs	○	◑	◕	
Infrastructure Protection	○	◑	●	
Technical/Engineering Considerations				
Ease of Implementation	◕	◔	○	
Agency Acceptance	◕	◑	◑	
Policy/Bylaw Requirements	◕	◑	◔	
Technical Feasibility	●	◑	○	
Total Score	◔	◔	◑	○

● = indicated that the retrofit design alternative scored high in satisfying the respective design criteria

○ = indicated the retrofit design option scored low in relation to the criteria

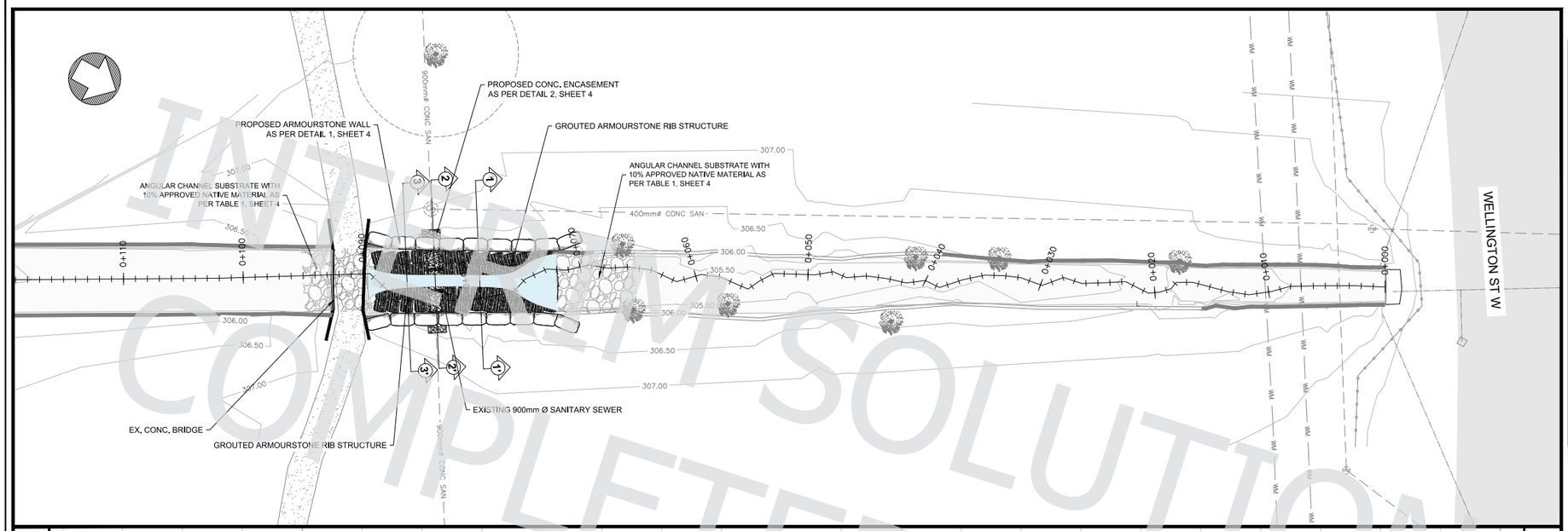
6.15.2 Preferred Alternative

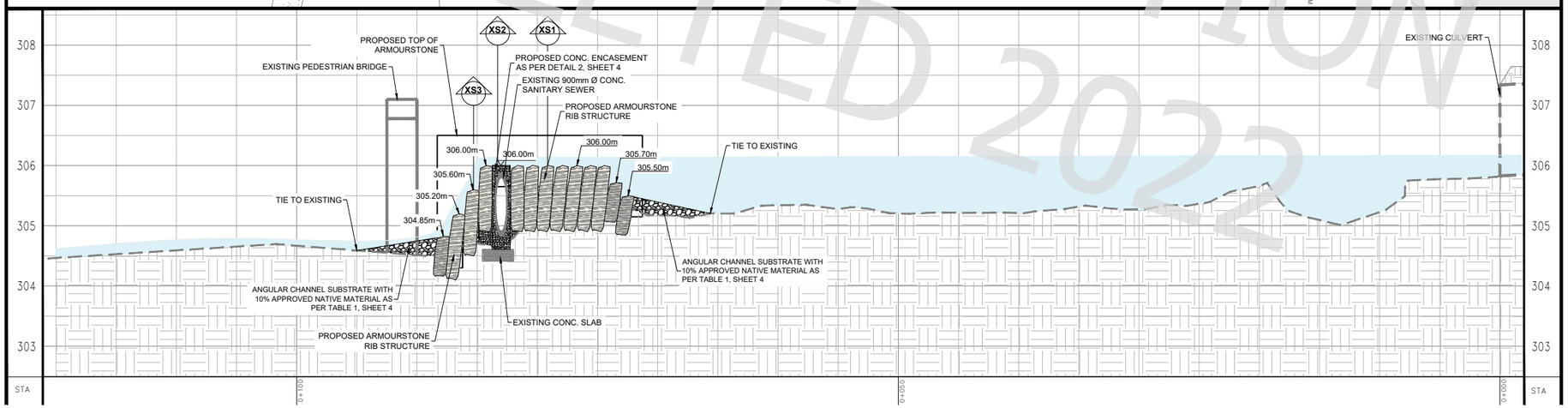
The reach-based works alternative provides a long-term approach to stabilize the channel/infrastructure interaction and minimize future risks to the channel or the infrastructure. The design of the emergency works alternative is presented below in **Figure 6.14.** Final confirmation regarding how much the sanitary sewer can be lowered is still required from the Wastewater Master Plan before the concept can be developed.

The components of the Reach-Based Works Alternative would include:

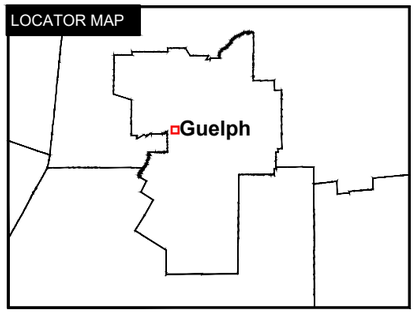
- Removal of the existing sanitary sewer between ES#18/20 and the Wastewater Treatment Plant.
- Replace sanitary sewer along this length after lowering it to provide at least 1m of cover over the sewer at both ES#18 and ES#20.
- Rebuilding and stabilizing of the channels.

Refer to **Section 7.0** for estimated implementation costs.





LOCATOR MAP



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ALTERNATIVE DESCRIPTION:

The emergency works alternative provided a cost-effective approach to stabilize the infrastructure and channel banks

The components of the Emergency Works included:

- Replacement of the failed bank armourstone
- Installation of an armourstone cascade over the sewer line
- Realignment of the channel upstream by regrading downstream and upstream of the crossing

Location: ES18
Emergency Works Concept Design

Date: 2021-10-05 Projection:
NAD83_UTM_Zone_17N
Data Source: City of Guelph, GRCA
Created by: D.K.

6.16 ES#19: Speed River, stormwater outfall – Reach SR-10

The Speed River flows south and west for over 28 km through the City of Guelph, from Guelph Lake in the north to Guelph/Eramosa Township to the southwest of the city and ultimately drains to the Grand River downstream. The drainage area covers a watershed of 110 km^2 and is the largest subwatershed in the City of Guelph. The Speed flows though lake and wetlands in the headwaters and becomes a straight to gently meandering channel though the city, with reinforced banks and concrete grade control throughout.

A corrugated metal outfall pipe is exposed in the bed of the channel 300 m downstream of Speedvale Ave. The outfall pipe extends across the floodplain and is filled with sediment with the top of the pipe eroded.

Preliminary Alternative 1: "Do Nothing"
The risks associated with ES #19 would not be addressed. The exposed and eroded stormwater pipe would remain in the wetland. The erosion risk to the bank and outfall channel is minor, but a monitoring plan would need to be implemented to monitoring any ongoing changes.

Preliminary Alternative 2: Local Works, Repair
The local repair works alternative would involve removal of sediment from the pipe and CCTV inspection of the outfall. Rip rap erosion control will provide scour protection to stabilize the remaining outfall channel segment. Local replacement works at this site would restore approximately 20 m of Reach SR-10 of Speed River.

Preliminary Alternative 3: Local Works, Replacement
The local replacement works alternative would involve removal of sediment from the pipe and CCTV inspection of the outfall. Replace the deteriorated CSP with HDPE and local vegetated rip rap scour protection. Local replacement works at this site would restore approximately 20 m of Reach SR-10 of Speed River.

Preliminary Alternative 4: Removal of Risk
Confirm decommissioned status of pipe, followed by the removal of the deteriorated pipe segment. A rip rap channel treatment should be applied to the outfall channel from valley slope to the main channel.

6.16.1 Evaluation of Alternatives

Each of the preliminary alternatives was scored using the criteria presented in **Section 5.0.** The full evaluation matrix presented in **Table 6.17**, showing the scoring for each alternative. Based on this evaluation, the "Do Nothing" alternative was selected as the preferred alternative.

Table 6.17: Summary of Criteria Evaluation for ES #19 in Reach SR-10 of Speed River

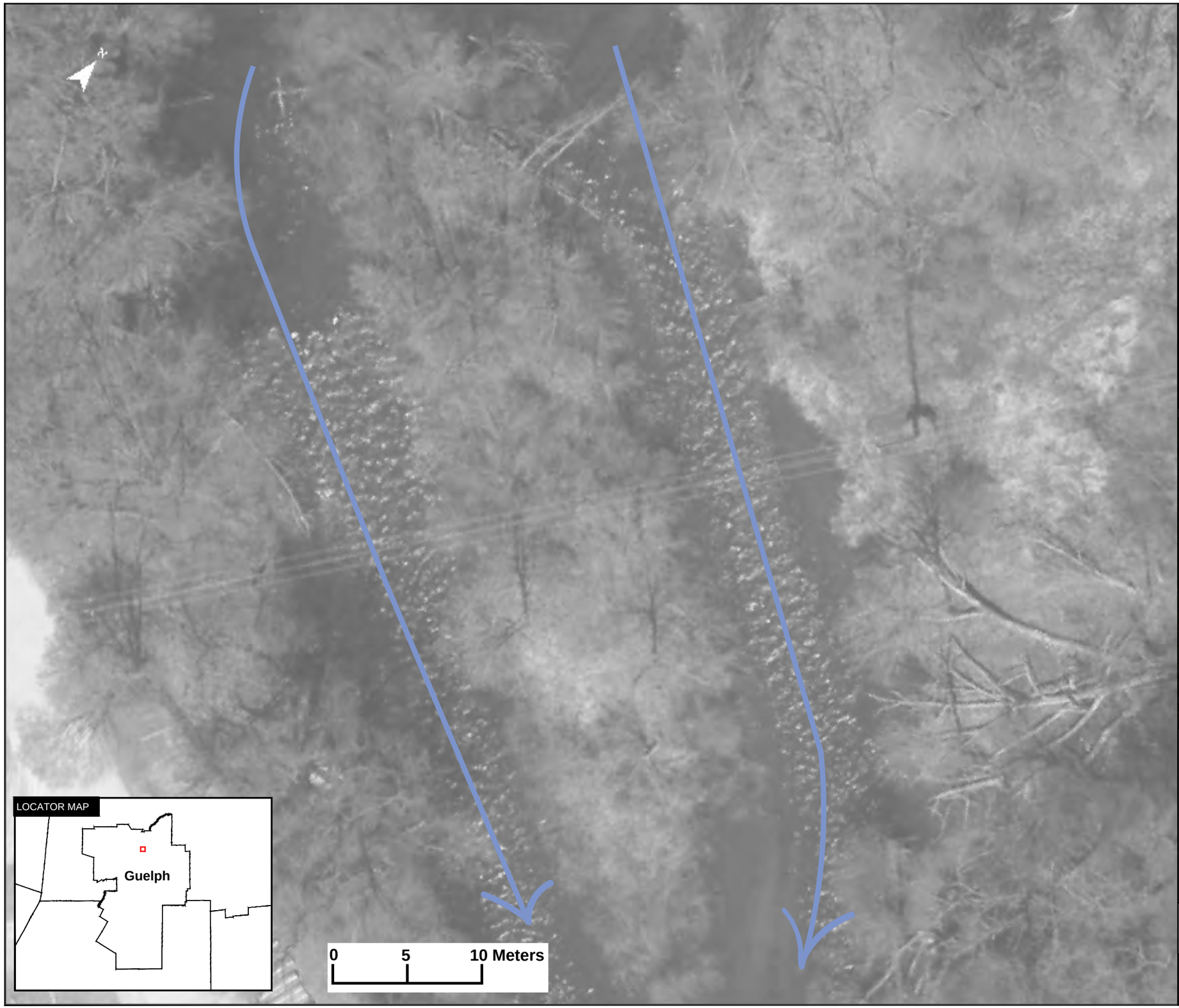
Evaluation Criteria	Do Nothing	Repair Works	Replacement Works	Removal of Risk
Physical/Natural Environment				
Potential Aquatic Habitat Benefit (Water Temperature)	○	○	○	○
Potential Aquatic Habitat Benefit (Fish Passage)	○	○	○	○
Potential to Reduce Erosion of Public Lands	○	○	○	○
Potential to Reduce Erosion of Private Lands	○	○	○	○
Potential to Reduce Stream Bank and Stream Bed Erosion	○	○	○	○
Potential to Enhance Groundwater Regime	○	○	○	○
Potential to Reduce Flooding	○	○	○	○
Potential to Improve Terrestrial Habitat	○	○	○	○
Integration with Existing Infrastructure	◔	◑	◑	◑
Integration with Existing Environment	◔	◑	◑	◑
Social/Cultural Environment				
Aesthetic / Recreation	◑	◑	◑	◑
Compatibility with Adjacent Land Use	◑	◑	◑	◑
Community Disruption	◕	◑	◑	◑
Public Health and Safety	◑	◑	◑	◑
Historically Significant Property	○	○	○	○
Heritage Landscape Location	○	○	○	○
Risk to Historic Landfills	○	○	○	○
Economic Environment				
Construction Costs	●	◑	◑	◔
Operation and Maintenance Costs	◑	◑	◑	◕
Infrastructure Protection	◔	◔	◔	◔
Technical/Engineering Considerations				
Ease of Implementation	●	◑	◑	◑
Agency Acceptance	●	◑	◑	◑
Policy/Bylaw Requirements	◑	◑	◑	◕
Technical Feasibility	●	◑	◑	◑
Total Score	◑	◔	◔	◔

● = indicated that the retrofit design alternative scored high in satisfying the respective design criteria

○ = indicated the retrofit design option scored low in relation to the criteria

6.16.2 Preferred Alternative

The “Do Nothing” alternative provides a cost-effective solution to the channel/infrastructure interaction. While this alternative provides no erosion protection or stabilization to the existing outfall or banks, leaving this embedded pipe in the floodplain posses no risk of erosion or barrier to fish passage.



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ALTERNATIVE DESCRIPTION:

The “Do Nothing” alternative provides a cost-effective solution to the channel/infrastructure interaction.

While this alternative provides no erosion protection or stabilization to the existing outfall or banks, leaving this embedded pipe in the floodplain posses no risk of erosion or barrier to fish passage.

Location: ES19
“Do Nothing” Concept Design

Date: 2021-10-05 Projection:
NAD83_UTM_Zone_17N
Data Source: City of Guelph, GRCA
Created by: D.K.

6.17 ES#20: Speed River tributary, exposed sanitary sewer – Reach SR-K1

The Speed River flows south and west for over 28 km through the City of Guelph, from Guelph Lake in the north to Guelph/Eramosa Township to the southwest of the city and ultimately drains to the Grand River downstream. The drainage area covers a watershed of 110 km^2 and is the largest subwatershed in the City of Guelph. The Speed flows though lake and wetlands in the headwaters and becomes a straight to gently meandering channel though the city, with reinforced banks and concrete grade control throughout.

The tributary at issue includes a minor drainage channel that conveys storm water flow from the lower confluence of Howett Creek, and was previously identified as ES #25. The scouring of the channel since the construction of this crossing has led to the degradation of the channel. Hydraulic modelling and erosion potential analysis have identified this exposure as susceptible to failure. Emergency works have provided a temporary solution to the imminent risk to this infrastructure.

The components of Emergency Works included:

- Replacement of failed armourstone
- Installation of armourstone cascade over the sewer line

Realignment of the channel by regrading the upstream and downstream of the sewer crossing

Preliminary Alternative 1: "Do Nothing"
The risks associated with ES #20 would not be addressed. The exposed sanitary main would remain unstabilized on the drainage channel banks.

Preliminary Alternative 2: Local Works
The local repair works alternative would involve armourstone encasement of the exposed sanitary main and cascade grade control within the existing channel width. This was completed as emergency works in 2021, but is not a sufficient long-term solution.

Preliminary Alternative 3: Reach-Based Works
The reach-based works would include removal, replacement, and lowering of the sanitary sewer main, such that a minimum cover of at least 1 m (preferred) is provided.

Preliminary Alternative 4: Removal of Risk
Removal of the sanitary sewer is not considered at this time. The current wastewater network requires the existing infrastructure.

6.17.1 Evaluation of Alternatives

Each of the preliminary alternatives was scored using the criteria presented in **Section 5.0.** The full evaluation matrix presented in **Table 6.16**, showing the scoring for each alternative. Based on this evaluation, the Reach-Based Works alternative was selected as the preferred alternative.

Table 6.18: Summary of Criteria Evaluation for ES #20 in Reach SR-K1 of Speed River

Evaluation Criteria	Do Nothing	Local Works	Reach Based Works	Removal of Risk
Physical/Natural Environment				
Potential Aquatic Habitat Benefit (Water Temperature)	○	◑	●	
Potential Aquatic Habitat Benefit (Fish Passage)	○	○	◑	
Potential to Reduce Erosion of Public Lands	○	◑	◕	
Potential to Reduce Erosion of Private Lands	○	○	○	
Potential to Reduce Stream Bank and Stream Bed Erosion	○	◕	●	
Potential to Enhance Groundwater Regime	○	○	○	
Potential to Reduce Flooding	○	○	◑	
Potential to Improve Terrestrial Habitat	○	○	○	
Integration with Existing Infrastructure	○	◑	◕	
Integration with Existing Environment	○	◔	◑	
Potential for sewage / treated water to enter streams from pipes and vice versa	○	◑	●	
Social/Cultural Environment				
Aesthetic / Recreation	○	◔	◑	
Compatibility with Adjacent Land Use	○	◔	◑	
Community Disruption	◕	◑	◔	
Public Health and Safety	○	◑	●	
Historically Significant Property	○	○	○	
Heritage Landscape Location	○	◔	◑	
Risk to Historic Landfills	○	○	○	
Economic Environment				
Construction Costs	◕	◑	○	
Operation and Maintenance Costs	○	◑	◕	
Infrastructure Protection	○	◑	●	
Technical/Engineering Considerations				
Ease of Implementation	◕	◔	○	
Agency Acceptance	◕	◑	◑	
Policy/Bylaw Requirements	◕	◑	◔	
Technical Feasibility	●	◑	○	
Total Score	◔	◔	◑	○

● = indicated that the retrofit design alternative scored high in satisfying the respective design criteria

○ = indicated the retrofit design option scored low in relation to the criteria

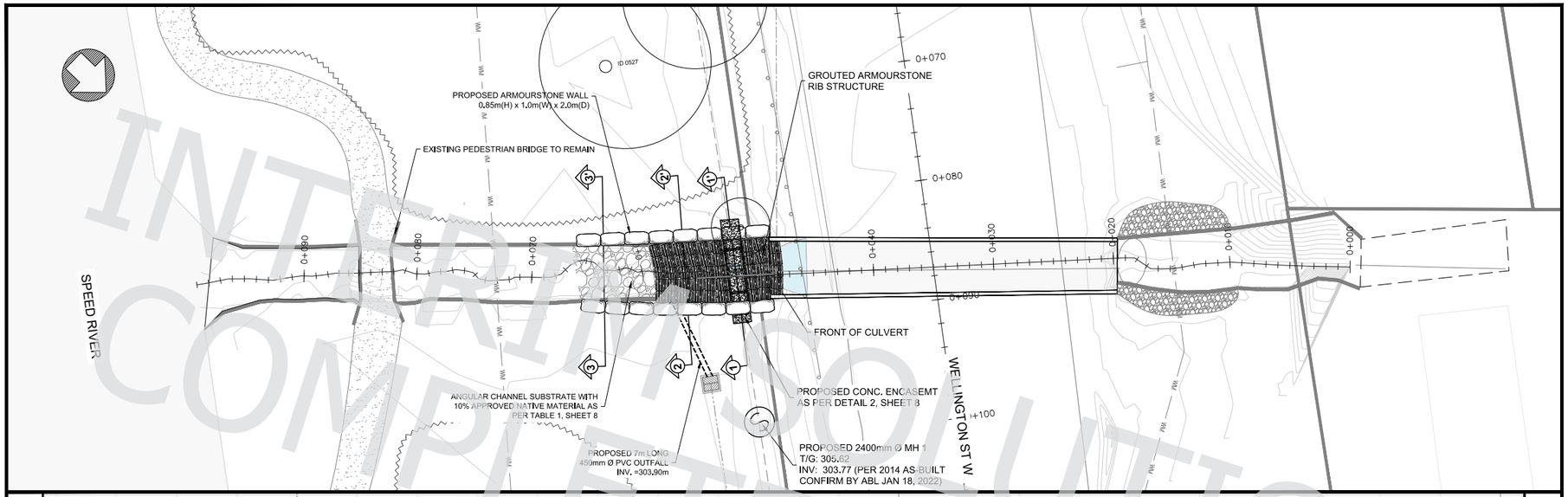
6.17.2 Preferred Alternative

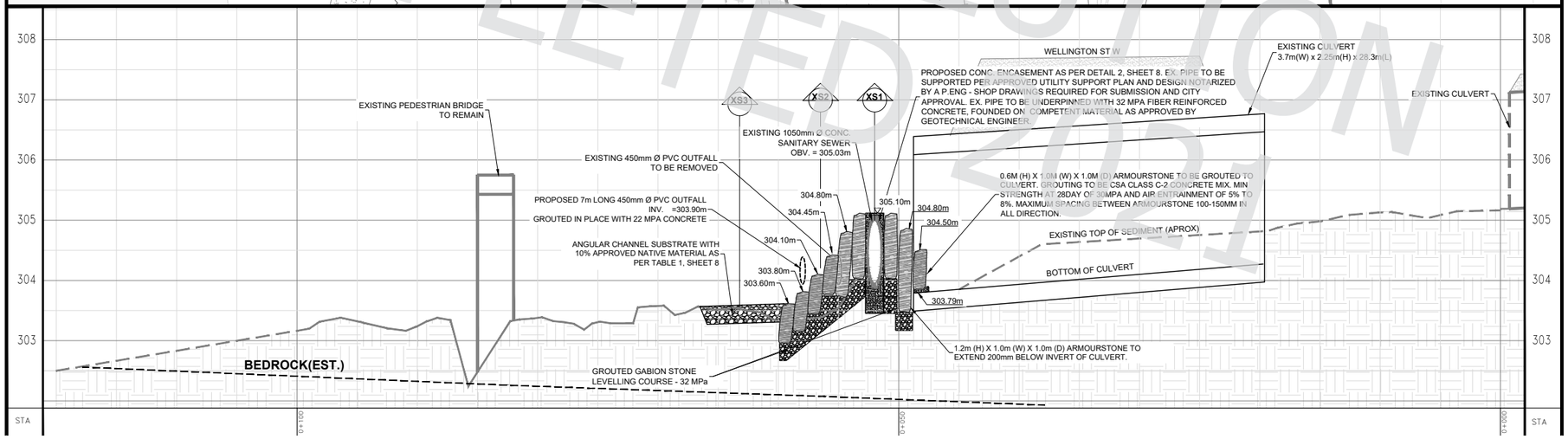
The reach-based works alternative provides a long-term approach to stabilize the channel/infrastructure interaction and minimize future risks to the channel or the infrastructure. The design of the emergency works is presented below in **Figure 6.14.** Final confirmation regarding how much the sanitary sewer can be lowered is still required from the Wastewater Master Plan before the concept can be developed.

The components of the Reach-Based Works Alternative would include:

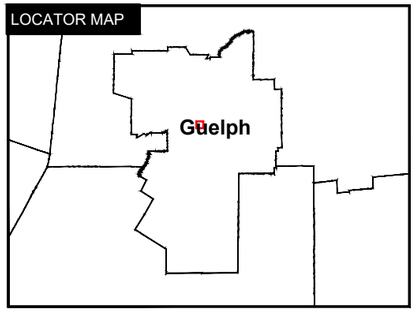
- Removal of the existing sanitary sewer between ES#18/20 and the Wastewater Treatment Plant.
- Replace sanitary sewer along this length after lowering it to provide at least 1m of cover over the sewer at both ES#18 and ES#20.
- Rebuilding and stabilizing of the channels.

Refer to **Section 7.0** for estimated implementation costs.





LOCATOR MAP



ALTERNATIVE DESCRIPTION:

The emergency works alternative provided a cost-effective approach to stabilize the infrastructure and channel banks

The components of the Emergency Works included:

- Replacement of the failed bank armourstone
- Installation of an armourstone cascade over the sewer line
- Realignment of the channel upstream of the crossing with armourstone
- Realignment of the channel downsream of the crossing with stone material

Location: ES20
Emergency Works Concept Design

Date: 2021-10-05 Projection:
NAD83_UTM_Zone_17N
Data Source: City of Guelph, GRCA
Created by: D.K.

6.18 ES#25/21: Speed River, retaining wall – Reach SR-11

The Speed River flows south and west for over 28 km through the City of Guelph, from Guelph Lake in the north to Guelph/Eramosa Township to the southwest of the city and ultimately drains to the Grand River downstream. The drainage area covers a watershed of 110 km^2 and is the largest subwatershed in the City of Guelph. The Speed flows though lake and wetlands in the headwaters and becomes a straight to gently meandering channel though the city, with reinforced banks and concrete grade control throughout.

An unreinforced concrete retaining wall is outflanked adjacent to concrete weirs along the channel. This wall protects the banks of park space and, in the case of ES #21, a historic landfill site. The retaining wall is cracked and segments have heaved and displaced.

Preliminary Alternative 1: "Do Nothing"
The risks associated with ES #25 and ES #21 would not be addressed. Bank erosion associated with overtopping and seasonal frost heave would continue to recede the banks further, displace the broken wall segments and ultimately cause the wall to fail.

As site ES #21 is a historic landfill site, continual monitoring would be required to ensure the containment of contaminants to the Speed River.

Preliminary Alternative 2: Local Works, Repair
The local works alternative would involve repair of the retaining wall near concrete weirs and 15 m up and downstream. This includes repair of the unreinforced failed concrete segments at both sites and infilling the eroded material behind the retaining wall.

Preliminary Alternative 3: Local Works, Replacement
The reach based works alternative would involve armourstone replacement of unreinforced concrete wall at ES #21 with vegetated boulder tie in extending to ES #25 and restored stable bank slope.

Preliminary Alternative 4: Removal of Risk
Due to the historic landfill, the naturalization of the bank and removal of the retaining wall would not be permitted.

6.18.1 Evaluation of Alternatives

Each of the preliminary alternatives was scored using the criteria presented in **Section 5.0.** The full evaluation matrix presented in **Table 6.19**, showing the scoring for each alternative. Based on this evaluation, the Local Replacement Works alternative was selected as the preferred alternative.

Table 6.19: Summary of Criteria Evaluation for ES #25 and ES #21 in Reach SR-11 of Speed River

Evaluation Criteria	Do Nothing	Repair Works	Replacement Works	Removal of Risk
Physical/Natural Environment				
Potential Aquatic Habitat Benefit (Water Temperature)	○	○	○	○
Potential Aquatic Habitat Benefit (Fish Passage)	○	○	○	○
Potential to Reduce Erosion of Public Lands	◔	◑	◕	○
Potential to Reduce Erosion of Private Lands	○	○	○	○
Potential to Reduce Stream Bank and Stream Bed Erosion	◔	◑	◕	○
Potential to Enhance Groundwater Regime	○	○	○	○
Potential to Reduce Flooding	○	○	○	○
Potential to Improve Terrestrial Habitat	◔	◑	◕	○
Integration with Existing Infrastructure	◔	◕	◑	○
Integration with Existing Environment	◔	◑	◑	○
Social/Cultural Environment				
Aesthetic / Recreation	◔	◕	◕	●
Compatibility with Adjacent Land Use	◔	◑	●	○
Community Disruption	◑	◔	◔	○
Public Health and Safety	◔	◕	●	○
Historically Significant Property	○	○	○	○
Heritage Landscape Location	◔	◕	◑	◔
Risk to Historic Landfills	◔	◑	◕	○
Economic Environment				
Construction Costs	◕	◑	◔	○
Operation and Maintenance Costs	○	◔	◕	○
Infrastructure Protection	○	◕	●	○
Technical/Engineering Considerations				
Ease of Implementation	◔	◕	◕	○
Agency Acceptance	○	◕	◕	○
Policy/Bylaw Requirements	○	◑	◕	○
Technical Feasibility	◕	◑	◑	○
Total Score	◔	◑	◕	○

● = indicated that the retrofit design alternative scored high in satisfying the respective design criteria

○ = indicated the retrofit design option scored low in relation to the criteria

6.18.2 Preferred Alternative

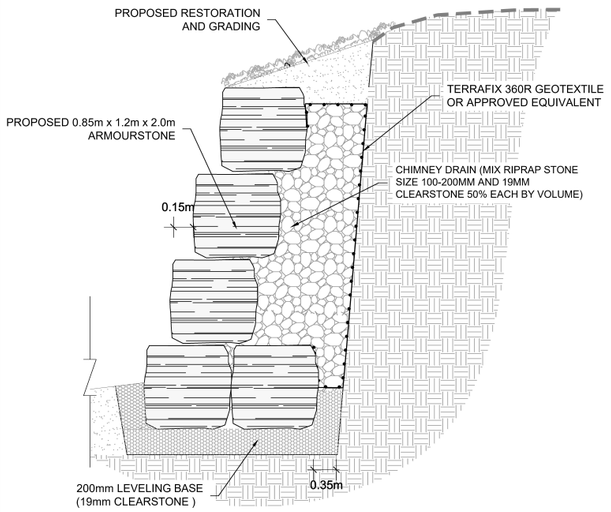
The local replacement works alternative provides a cost-effective approach to stabilize the channel banks and maintain the integrity of the historic landfill containment. A conceptual design of the Local Replacement Works alternative is presented below in **Figure 6.18.**

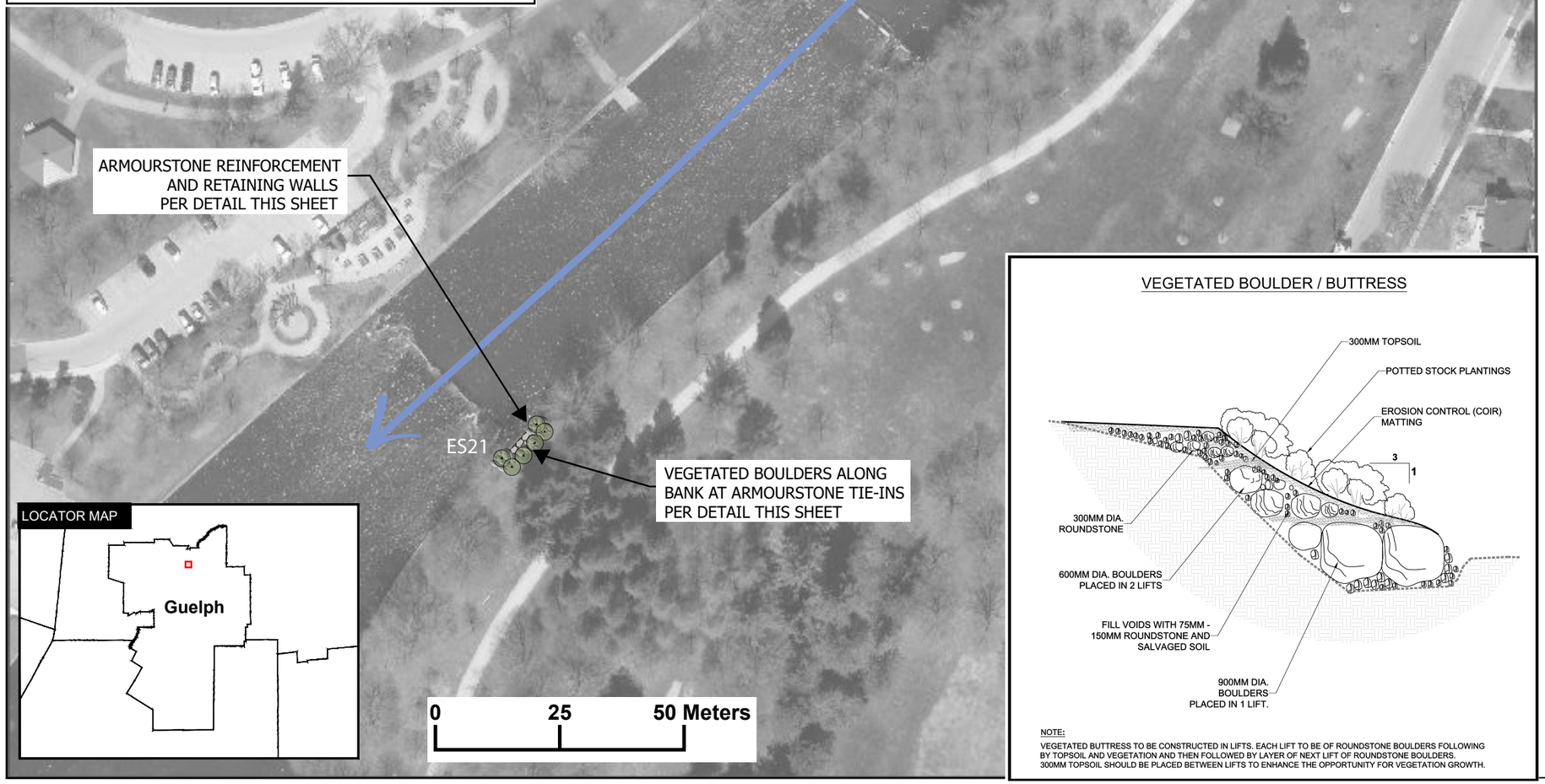
The components of the Local Replacement Works Alternative would include:

- Removal of the failed unreinforced retaining wall segments
- Armourstone reinforcement and retaining walls at the site of the weir in ES #21
- Vegetated boulders imbedded along the bank at the armourstone tie-ins to ES #21 and at ES #25 to restore the bank with bioengineering.

Refer to **Section 7.0** for estimated implementation costs.

ARMOURSTONE RETAINING WALL





VEGETATED BOULDER / BUTTRESS

NOTE:

VEGETATED BUTTRESS TO BE CONSTRUCTED IN LIFTS. EACH LIFT TO BE OF ROUNDSTONE BOULDERS FOLLOWING BY TOPSOIL AND VEGETATION AND THEN FOLLOWED BY LAYER OF NEXT LIFT OF ROUNDSTONE BOULDERS. 300MM TOPSOIL SHOULD BE PLACED BETWEEN LIFTS TO ENHANCE THE OPPORTUNITY FOR VEGETATION GROWTH.

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ALTERNATIVE DESCRIPTION:

The local replacement works alternative provides a cost-effective approach to stabilize the channel banks and maintain the integrity of the historic landfill containment

The components of the Local Replacement Works Alternative would include:

- Removal of the failed unreinforced retaining wall segments
- Armourstone reinforcement and retaining walls at the site of the weir in ES#21
- Vegetated boulders imbedded along the bank at the armourstone tie-ins to ES#21 and at ES#25 to restore the bank with bioengineering

Location: ES21/25
Local Replacement Concept Design

Date: 2021-10-05 Projection:
NAD83_UTM_Zone_17N
Data Source: City of Guelph, GRCA
Created by: D.K.

6.19 ES#22: Speed River, stormwater outfall and bank erosion – Reach SR-12

The Speed River flows south and west for over 28 km through the City of Guelph, from Guelph Lake in the north to Guelph/Eramosa Township to the southwest of the city and ultimately drains to the Grand River downstream. The drainage area covers a watershed of 110 km^2 and is the largest subwatershed in the City of Guelph. The Speed flows though lake and wetlands in the headwaters and becomes a straight to gently meandering channel though the city, with reinforced banks and concrete grade control throughout.

A concrete headwall and concrete stormwater pipe have become detached and exposed on the east bank immediately downstream of Woodlawn Road. The sandy banks in this reach are easily erodible and have undermined and outflanked the slumped headwall.

Preliminary Alternative 1: "Do Nothing"
The risks associated with ES #22 would not be addressed. The exposed and slumped headwall would remain. Bank erosion will continue to erode the bank around the stormwater infrastructure.

Preliminary Alternative 2: Local Works, Repair
The local repair works alternative would involve embedded armourstone stabilization of the concrete headwall. A vegetated rip rap bank treatment will prevent to erosion and stabilize the bank. Local works at this site would restore approximately 10 m of Reach SR-12 of Speed River.

Preliminary Alternative 3: Local Works, Replacement
The local replacement works alternative would involve removal and replacement of the concrete headwall with armourstone stabilization. The bank will be reinforced with a vegetated boulder treatment. Local replacement works at this site would restore approximately 10 m of Reach SR-12 of Speed River.

Preliminary Alternative 4: Removal of Risk
Removal of the outfall is not considered at this time. The current stormwater network requires the existing infrastructure.

6.19.1 Evaluation of Alternatives

Each of the preliminary alternatives was scored using the criteria presented in **Section 5.0.** The full evaluation matrix presented in **Table 6.20**, showing the scoring for each alternative. Based on this evaluation, the Local Replacement Works alternative was selected as the preferred alternative.

Table 6.20: Summary of Criteria Evaluation for ES #22 in Reach SR-12 of Speed River

Evaluation Criteria	Do Nothing	Repair Works	Replacement Works	Removal of Risk
Physical/Natural Environment				
Potential Aquatic Habitat Benefit (Water Temperature)	○	○	○	
Potential Aquatic Habitat Benefit (Fish Passage)	○	○	○	
Potential to Reduce Erosion of Public Lands	◔	◑	◕	
Potential to Reduce Erosion of Private Lands	○	○	○	
Potential to Reduce Stream Bank and Stream Bed Erosion	○	◔	◑	
Potential to Enhance Groundwater Regime	○	○	○	
Potential to Reduce Flooding	○	○	○	
Potential to Improve Terrestrial Habitat	◔	◑	◑	
Integration with Existing Infrastructure	◔	◑	◕	
Integration with Existing Environment	◔	◔	◑	
Social/Cultural Environment				
Aesthetic / Recreation	◔	◑	◑	
Compatibility with Adjacent Land Use	◔	◑	◑	
Community Disruption	●	◑	◑	
Public Health and Safety	◔	◑	◕	
Historically Significant Property	○	○	○	
Heritage Landscape Location	◔	◑	◑	
Risk to Historic Landfills	○	○	○	
Economic Environment				
Construction Costs	◕	◑	◑	
Operation and Maintenance Costs	◔	◑	◕	
Infrastructure Protection	◔	◑	◕	
Technical/Engineering Considerations				
Ease of Implementation	●	◕	◑	
Agency Acceptance	◕	◕	◕	
Policy/Bylaw Requirements	◑	◕	◕	
Technical Feasibility	●	◕	◕	
Total Score	◔	◔	◑	○

● = indicated that the retrofit design alternative scored high in satisfying the respective design criteria

○ = indicated the retrofit design option scored low in relation to the criteria

6.19.2 Preferred Alternative

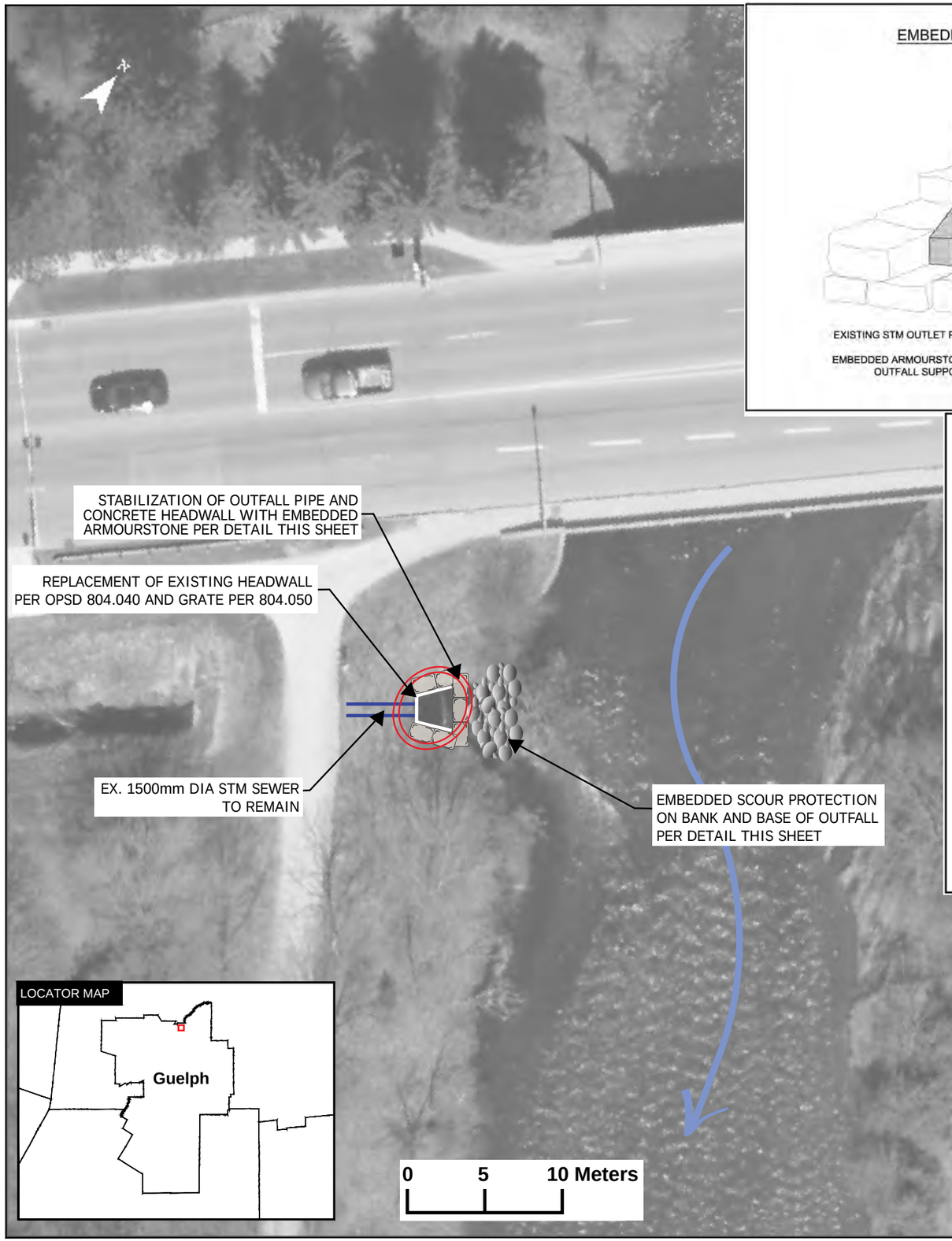
The local replacement works alternative provides a cost-effective approach to stabilize the concrete headwall and restore the eroded bank downstream of Woodlawn Road. This alternative provides

erosion protection to the existing conditions. A conceptual design of the Local Replacement Works alternative is presented below in **Figure 6.19.**

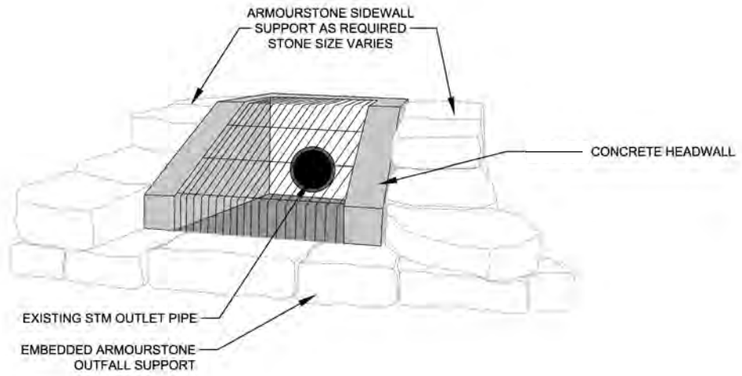
The components of the Local Replacement Works alternative would include:

- Replacement of the existing headwall.
- Stabilization of the outfall pipe and concrete headwall with embedded armourstone.
- Embedded scour protection on the bank and at the base of the outfall.

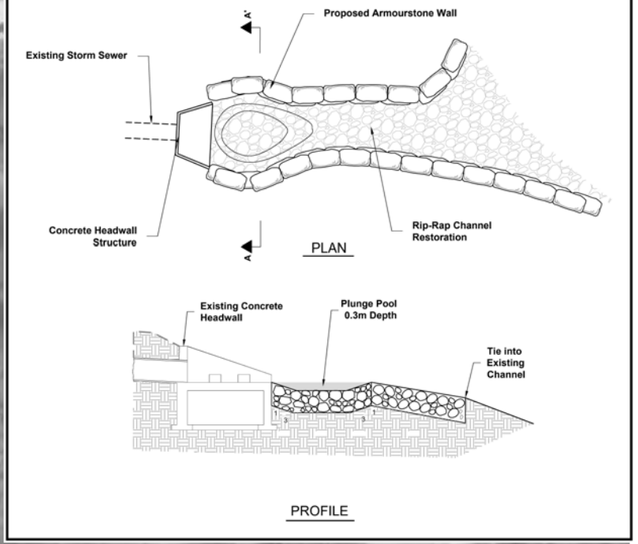
Refer to **Section 7.0** for estimated implementation costs.



EMBEDDED ARMOURSTONE OUTFALL SUPPORT



STORM OUTLET RESTORATION WITH ARMOURSTONE AND SCOUR POOL PROTECTION



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ALTERNATIVE DESCRIPTION:

The local replacement works alternative provides a cost-effective approach to stabilize the concrete headwall and restore the eroded bank downstream of Woodlawn Road

The components of the Local Replacement Works alternative would include:

- Replacement of the existing headwall
- Stabilization of the outfall pipe and concrete headwall with embedded armourstone
- Embedded scour protection on the bank and at the base of the outfall

Location: ES22
Local Replacement Works Concept Design

Date: 2021-10-05 Projection: NAD83_UTM_Zone_17N
Data Source: City of Guelph, GRCA
Created by: D.K.

6.20 ES#23: Speed River, exposed pipe – Reach SR-10

The Speed River flows south and west for over 28 km through the City of Guelph, from Guelph Lake in the north to Guelph/Eramosa Township to the southwest of the city and ultimately drains to the Grand River downstream. The drainage area covers a watershed of 110 km^2 and is the largest subwatershed in the City of Guelph. The Speed flows though lake and wetlands in the headwaters and becomes a straight to gently meandering channel though the city, with reinforced banks and concrete grade control throughout.

The reach at issue is in the main trunk channel of the Speed River. Erosion Site ES #23 is an exposed watermain crossing that is directly over the channel substrate 500 m downstream of Speedvale Avenue. The pipe has been decommissioned and confirmed by the City of Guelph.

Preliminary Alternative 1: "Do Nothing"
The risks associated with ES #23 would not be addressed. The decommissioned pipe would remain and continue to deteriorate. Leaving this infrastructure within the creek presents a significant and unnecessary fish barrier and presents the potential to accumulate debris.

Preliminary Alternative 2: Local Works
The local works alternative would involve creating a protective cover over the pipe in the form of a fixed riffle to extend up and downstream as a boulder/rip rap rocky ramp to prevent undermining and scour. Local Works at this site would restore approximately 10 m of Reach SR-10 of Speed River.

Preliminary Alternative 3: Reach Based Works
Reach Based works are not considered at this time for a lateral crossing.

Preliminary Alternative 4: Removal of Risk
The removal of risk alternative would involve removal of the pipe and cap the buried infrastructure within the bank beyond the 100-yr erosion hazard limit.

6.20.1 Evaluation of Alternatives

Each of the preliminary alternatives was scored using the criteria presented in **Section 5.0.** The full evaluation matrix presented in **Table 6.21**, showing the scoring for each alternative. Based on this evaluation, Removal of Risk was selected as the preferred alternative.

Table 6.21: Summary of Criteria Evaluation for ES #23 in Reach SR-18 of Speed River

Evaluation Criteria	Do Nothing	Local Works	Removal of Risk	
Physical/Natural Environment				
Potential Aquatic Habitat Benefit (Water Temperature)	○	○	○	
Potential Aquatic Habitat Benefit (Fish Passage)	○	◔	●	
Potential to Reduce Erosion of Public Lands	◔	◑	◕	
Potential to Reduce Erosion of Private Lands	○	○	○	
Potential to Reduce Stream Bank and Stream Bed Erosion	○	◑	◕	
Potential to Enhance Groundwater Regime	○	○	○	
Potential to Reduce Flooding	◔	◕	◕	
Potential to Improve Terrestrial Habitat	◑	◑	◑	
Integration with Existing Infrastructure	◑	◑	◑	
Integration with Existing Environment	◔	◑		
Social/Cultural Environment				
Aesthetic / Recreation	◔	◑	●	
Compatibility with Adjacent Land Use	○	◑	●	
Community Disruption	●	◑	◑	
Public Health and Safety	◔	◑	●	
Historically Significant Property	○	○	○	
Heritage Landscape Location	◔	◑	◕	
Risk to Historic Landfills	○	○	○	
Economic Environment				
Construction Costs	●	○	◔	
Operation and Maintenance Costs	◔	◕	●	
Infrastructure Protection	◔	◕	◕	
Technical/Engineering Considerations				
Ease of Implementation	◕	◑	◑	
Agency Acceptance	◕	○	◑	
Policy/Bylaw Requirements	◕	◑	●	
Technical Feasibility	●	◑	◑	
Total Score	◔	◑	◕	

● = indicated that the retrofit design alternative scored high in satisfying the respective design criteria

○ = indicated the retrofit design option scored low in relation to the criteria

6.20.2 Preferred Alternative

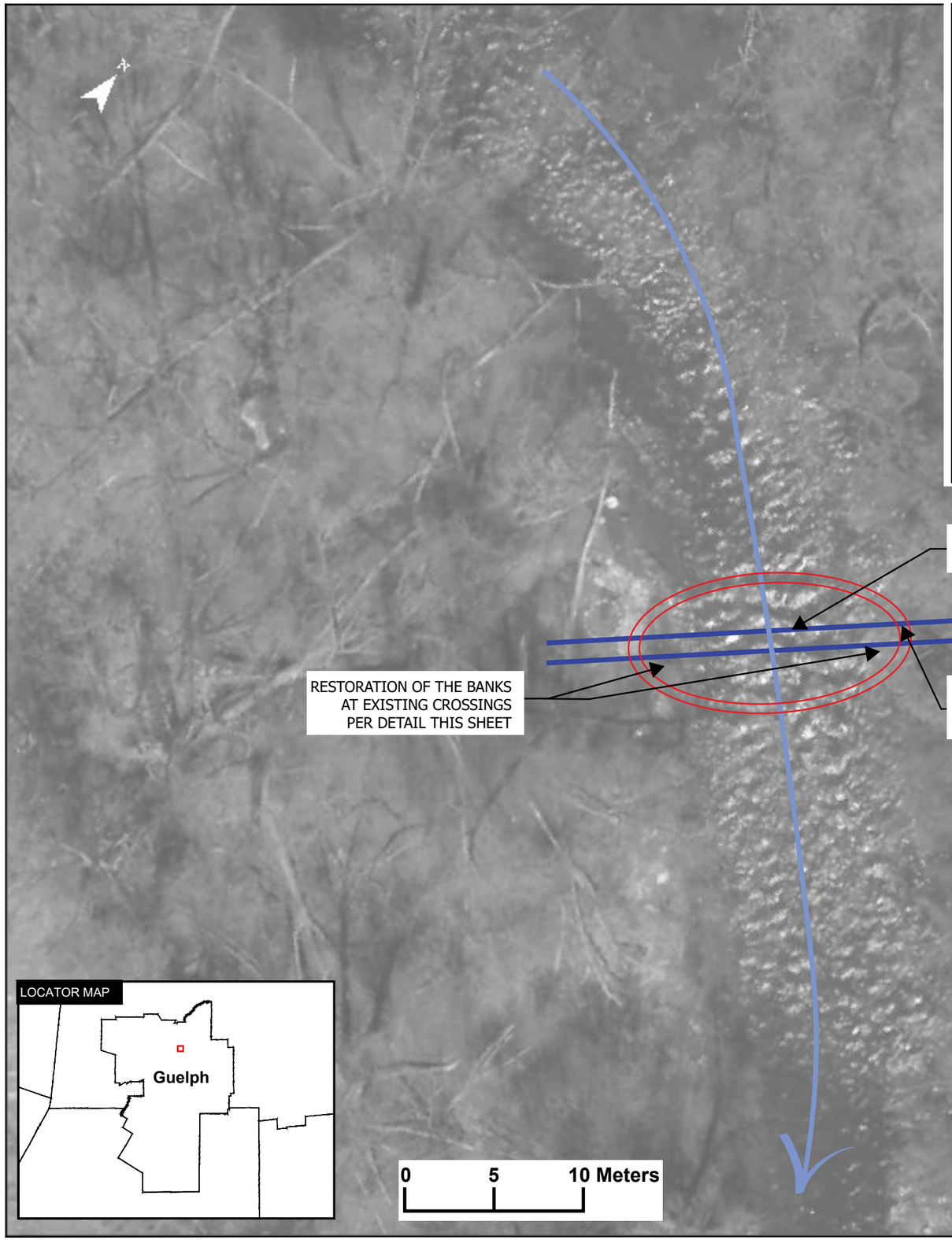
The local works alternative provides a cost-effective approach to stabilize the channel banks and remove the decommissioned infrastructure and low flow fish barrier. This alternative provides a naturalized

option to the channel. A conceptual design of the Removal of Risk alternative is presented below in **Figure 6.20.**

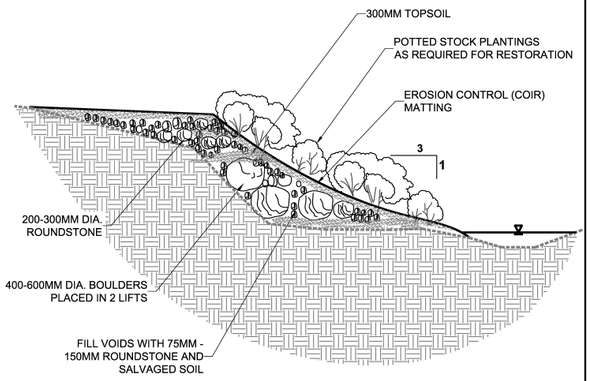
The components of the Removal of Risk Works Alternative would include:

- Removal of the pipe from the channel.
- Cap the pipe in the banks at an offset equivalent to the 100-yr erosion limit.
- Restoration off the banks at the existing crossings.

Refer to **Section 7.0** for estimated implementation costs.



TYPICAL BANK RESTORATION



NOTE:

BANK RESTORATION MATERIALS TO BE PLACED IN LIFTS. EACH LIFT TO BE OF ROUNDSTONE FOLLOWING BY TOPSOIL AND VEGETATION AND THEN FOLLOWED BY LAYER OF NEXT LIFT OF ROUNDSTONE.
300MM TOPSOIL SHOULD BE PLACED BETWEEN LIFTS TO ENHANCE THE OPPORTUNITY FOR VEGETATION GROWTH.

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ALTERNATIVE DESCRIPTION:

The removal of risk alternative provides a cost-effective approach to stabilize the channel banks and remove the decommissioned infrastructure and low flow fish barrier

The components of the Removal of Risk Alternative would include:

- Removal of the pipe from the channel
- Cap the pipe in the banks at an offset equivalent to the 100-yr erosion limit
- Restoration of the banks at the existing crossing

Location: ES23
Removal of Risk Concept Design

Date: 2021-10-05 Projection:
NAD83_UTM_Zone_17N
Data Source: City of Guelph, GRCA
Created by: D.K.

6.21 ES#24: Speed River, concrete weir and retaining wall– Reach SR-5

The Speed River flows south and west for over 28 km through the City of Guelph, from Guelph Lake in the north to Guelph/Eramosa Township to the southwest of the city and ultimately drains to the Grand River downstream. The drainage area covers a watershed of 110 km^2 and is the largest subwatershed in the City of Guelph. The Speed flows though lake and wetlands in the headwaters and becomes a straight to gently meandering channel though the city, with reinforced banks and concrete grade control throughout.

A concrete weir has deteriorated and outflanked the retaining wall immediately adjacent to and downstream of the weir.

Preliminary Alternative 1: "Do Nothing"
The risks associated with ES #24 would not be addressed. The channel would continue to outflank the weir and erode the bank behind the retaining wall.

Preliminary Alternative 2: Local Works
The local repair works alternative would involve removal of the unreinforced concrete wall near weir. Armourstone or embedded material in the bank would stabilize channel flow and prevent further outflanking.

Preliminary Alternative 3: Reach Based Works
The reach based works alternative would involve vegetated boulders on the banks extending to the concrete weir, including the bank 15 m upstream. A fixed riffle grade control structure would be used to replace the failed mid-channel segments of the weir and can be similarly replaced over time.

Preliminary Alternative 4: Removal of Risk
The removal of risk alternative would be the complete removal of the weir and construction of a boulder riffle channel segment to maintain the channel gradient. This option removes the fish barrier and provides comparable channel gradient to existing conditions. The boulders would extend to the banks and replace the failing retaining wall in the segment close to the weir.

6.21.1 Evaluation of Alternatives

Each of the preliminary alternatives was scored using the criteria presented in **Section 5.0.**The full evaluation matrix presented in **Table 6.22**, showing the scoring for each alternative. Based on this evaluation, the Local Works alternative was selected as the preferred alternative.

Table 6.22: Summary of Criteria Evaluation for ES #24 in Reach SR-5 of Speed River

Evaluation Criteria	Do Nothing	Local Works	Reach Based Works	Removal of Risk
Physical/Natural Environment				
Potential Aquatic Habitat Benefit (Water Temperature)	○	○	○	
Potential Aquatic Habitat Benefit (Fish Passage)	○	◔	◑	
Potential to Reduce Erosion of Public Lands	○	◑	◕	
Potential to Reduce Erosion of Private Lands	○	○	○	
Potential to Reduce Stream Bank and Stream Bed Erosion	○	◑	◕	
Potential to Enhance Groundwater Regime	○	○	○	
Potential to Reduce Flooding	○	◔	◔	
Potential to Improve Terrestrial Habitat	○	◑	◑	
Integration with Existing Infrastructure	◔	◑	◑	
Integration with Existing Environment	◔	◑	◑	
Social/Cultural Environment				
Aesthetic / Recreation	◔	◑	◑	
Compatibility with Adjacent Land Use	◔	◑	◑	
Community Disruption	◕	◑	◔	
Public Health and Safety	◑	◑	◑	
Historically Significant Property	○	○	○	
Heritage Landscape Location	○	◑	◑	
Risk to Historic Landfills	○	○	○	
Economic Environment				
Construction Costs	◕	◑	◔	
Operation and Maintenance Costs	◔	◑	◕	
Infrastructure Protection	◔	◑	◑	
Technical/Engineering Considerations				
Ease of Implementation	●	◑	○	
Agency Acceptance	◕	◑	◔	
Policy/Bylaw Requirements	●	◑	◑	
Technical Feasibility	●	◑	◑	
Total Score	◔	◑	◔	○

● = indicated that the retrofit design alternative scored high in satisfying the respective design criteria

○ = indicated the retrofit design option scored low in relation to the criteria

6.21.2 Preferred Alternative

The local works alternative provides a cost-effective approach to stabilize the channel banks and maintain the channel gradient. Additionally, this alternative addresses future erosion as the aging

concrete continues to deteriorate. A conceptual design of the Local Works alternative is presented below in **Figure 6.21.**

The components of the Local Works Alternative would include:

- Removal of the failed and deteriorating segments of the weir
- Replacing failed segments with a fixed boulder riffle, integrated with and stabilizing competent weir sections
- Restoration and stabilization of the banks at the weir with a combination of boulder, armourstone and bioengineering

Refer to **Section 7.0** for estimated implementation costs.

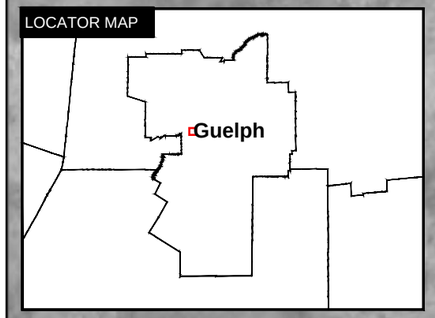
RESTORATION AND STABILIZATION OF BANKS WITH BOULDERS, ARMOURSTONE AND BIOENGINEERING

REMOVAL OF FAILED AND DETERIORATING SEGMENTS OF WEIR

REPLACE FAILED SEGMENTS WITH FIXED BOULDER RIFFLE, INTEGRATED WITH STABILIZING COMPETENT WEIR SECTIONS

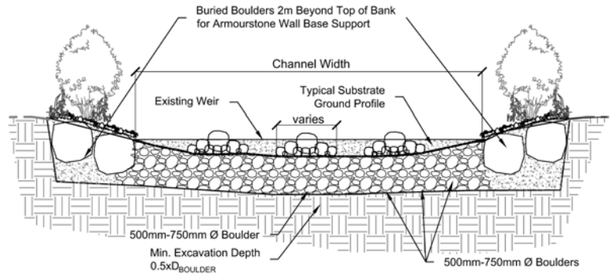
RESTORATION AND STABILIZATION OF BANKS WITH BOULDERS, ARMOURSTONE AND BIOENGINEERING

LOCATOR MAP

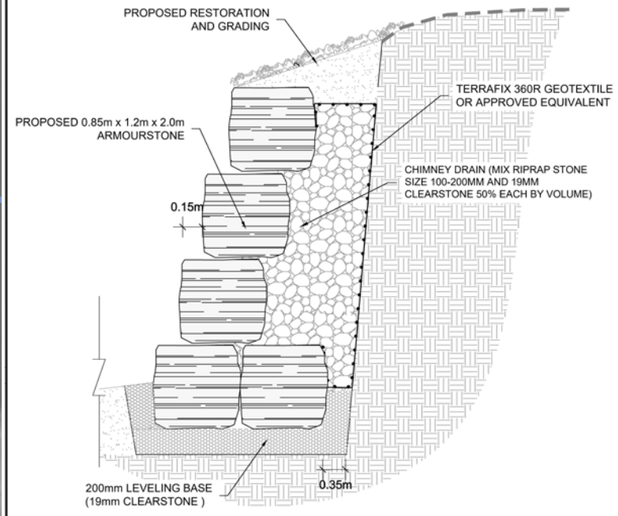


0 5 10 Meters

WEIR AND BOULDER RIFFLE



ARMOURSTONE RETAINING WALL



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ALTERNATIVE DESCRIPTION:

The local works alternative provides a cost-effective approach to stabilize the channel banks and maintain the channel gradient

The components of the Local Stabilization Works alternative would include:

- Removal of the failed and deteriorating segments of the weir
- Replacing failed segments with a fixed boulder riffle, integrated with and stabilizing competent weir sections
- Restoration and stabilization of the banks at the weir with a combination of boulder, armourstone and bioengineering

Location: ES24
Local Works Concept Design

Date: 2021-10-05 Projection:
NAD83_UTM_Zone_17N
Data Source: City of Guelph, GRCA
Created by: D.K.

6.22 ES#26/27: Speed River tributary, stop log dam and private property –Reach SR-J2

The Speed River flows south and west for over 28 km through the City of Guelph, from Guelph Lake in the north to Guelph/Eramosa Township to the southwest of the city and ultimately drains to the Grand River downstream. The drainage area covers a watershed of 110 km^2 and is the largest subwatershed in the City of Guelph. The Speed flows though lake and wetlands in the headwaters and becomes a straight to gently meandering channel though the city, with reinforced banks and concrete grade control throughout.

The tributary at issue is the segment of Howitt Creek through Howitt Park. The channel has previously been dammed and the concrete retaining wall now remains. The concrete walls are outflanked and the channel is actively scouring the exposed knickpoint just downstream of the dam. Where the channel is in contact with the steep valley walls, bank erosion presents a risk to the private property at the top of slope.

A Natural Heritage Study should be completed during preliminary design to study potential impacts to upstream Wetland by removing the weir. Also, as part of the 89 Beechwood townhomes construction, this area was required to undergo restoration and as such several new species have been planted – worth noting such that the detailed design attempts to mitigate impacts to recently-planted species.

Preliminary Alternative 1: "Do Nothing"
The risks associated with ES #26 and ES #27 would not be addressed, as the exposed bank and valley slope, would continue to erode further.

A monitoring plan would need to be implemented, to inspect the erosion to the channel and banks at the downstream knickpoint. Although the "Do Nothing" alternative has no capital costs assigned, ongoing costs would be required through monitoring and the effects of potential flooding.

Preliminary Alternative 2: Local Works
The local works alternative would involve erosion control at the toe of slope and valley slope stabilization with armourstone or embedded boulder material. A grade control drop structure to prevent further degradation and migration of the knickpoint.

Preliminary Alternative 3: Reach Based Works
The reach-based works alternative would involve channel realignment away from the valley slope and erosion control on the banks to reinforce the stable slope. The corridor provides an opportunity for a natural channel design to be integrated with a grade control structure at the downstream tie in.

Preliminary Alternative 4: Removal of Risk
The removal of risk alternative involves removal of the weir structure. The channel would be allowed to re-equilibrate within the corridor. A grade control cascade structure will be constructed to minimize the scour potential downstream of the weir.

6.22.1 Evaluation of Alternatives

Each of the preliminary alternatives was scored using the criteria presented in **Section 5.0.** The full evaluation matrix presented in **Table 6.23**, showing the scoring for each alternative. Based on this evaluation, Removal of Risk was selected as the preferred alternative.

Table 6.23: Summary of Criteria Evaluation for ES #26 and ES #27 in Reach SR-J2 of Speed River

Evaluation Criteria	Do Nothing	Local Works	Reach Based Works	Removal of Risk
Physical/Natural Environment				
Potential Aquatic Habitat Benefit (Water Temperature)	○	○	○	◔
Potential Aquatic Habitat Benefit (Fish Passage)	○	○	○	○
Potential to Reduce Erosion of Public Lands	○	◑	◑	◑
Potential to Reduce Erosion of Private Lands	○	◑	◑	◑
Potential to Reduce Stream Bank and Stream Bed Erosion	○	◑	◑	◔
Potential to Enhance Groundwater Regime	○	○	○	○
Potential to Reduce Flooding	○	○	○	◑
Potential to Improve Terrestrial Habitat	○	◑	◑	◑
Integration with Existing Infrastructure	○	◑	◑	◔
Integration with Existing Environment	◑	◔	◔	◔
Social/Cultural Environment				
Aesthetic / Recreation	○	◑	◑	◑
Compatibility with Adjacent Land Use	◑	◑	◑	◑
Community Disruption	◕	◑	◑	◑
Public Health and Safety	○	◑	◑	◑
Historically Significant Property	○	○	○	○
Heritage Landscape Location	◑	◑	◑	◑
Risk to Historic Landfills	○	○	○	○
Economic Environment				
Construction Costs	●	◔	◔	◑
Operation and Maintenance Costs	◔	◑	◑	●
Infrastructure Protection	○	◑	◑	◑
Technical/Engineering Considerations				
Ease of Implementation	●	◑	◑	◑
Agency Acceptance	◕	◑	◔	◑
Policy/Bylaw Requirements	◔	◑	◑	◔
Technical Feasibility	●	◑	◑	◑
Total Score	◔	◔	◔	◑

● = indicated that the retrofit design alternative scored high in satisfying the respective design criteria

○ = indicated the retrofit design option scored low in relation to the criteria

6.22.2 Preferred Alternative

The removal of risk alternative provides a cost-effective approach to stabilize the channel and mitigate the scour potential downstream. Additionally, this alternative removes the fish barrier to the upstream reaches. A conceptual design of the Removal of Risk alternative is presented below in **Figure 6.22.**

The components of the Removal of Risk Alternative would include:

- Removal of the failed weir and retaining wall
- Armourstone cascade through the site of the weir
- Vegetated boulders imbedded at the toe of slope where the channel is in contact with the valley wall.

Refer to **Section 7.0** for estimated implementation costs.

REINFORCEMENT OF THE VALLEY TOE OF SLOPE

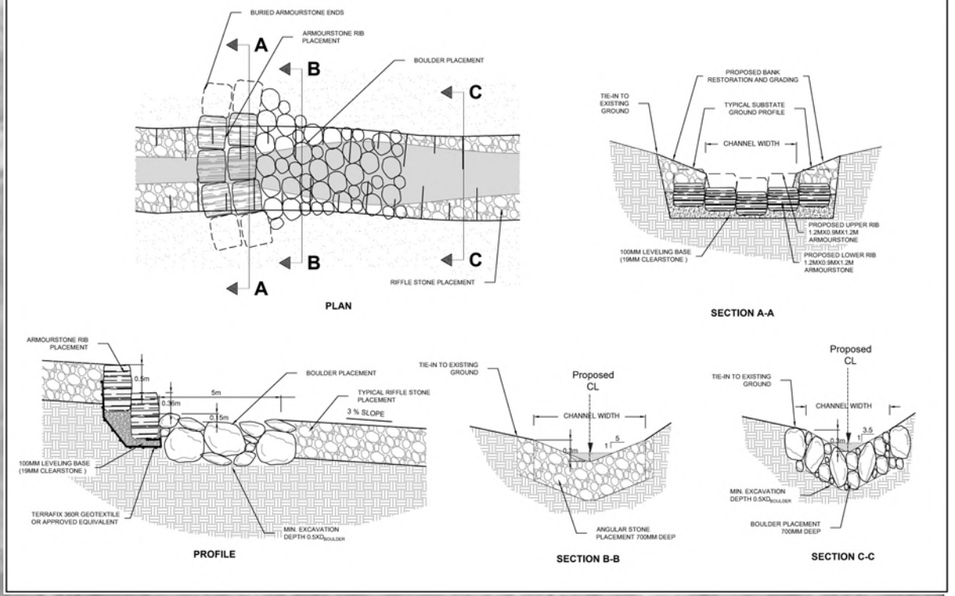
ES26A

ARMOURSTONE CASCADE THROUGH SITE OF WEIR AND VEGETATED BOULDERS EMBEDDED IN TOE OF SLOPE

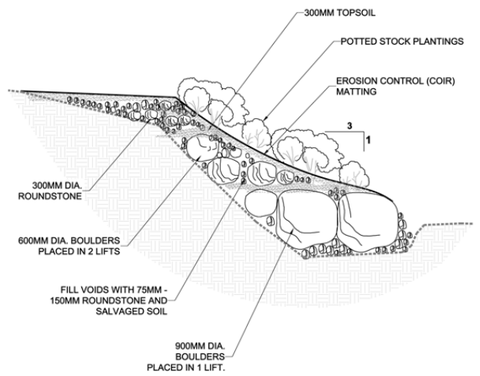
REMOVAL OF FAILED WEIR AND RETAINING WALL

ES27

CASCADE POOL DROP STRUCTURE

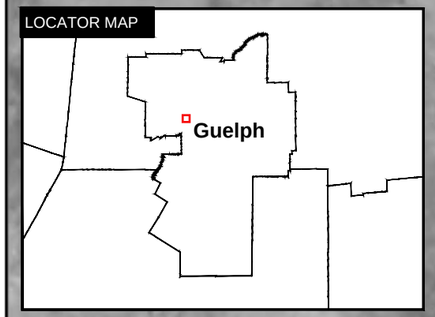


VEGETATED BOULDER / BUTTRESS



NOTE:
VEGETATED BUTTRESS TO BE CONSTRUCTED IN LIFTS. EACH LIFT TO BE OF ROUNDSTONE BOULDERS FOLLOWING BY TOPSOIL AND VEGETATION AND THEN FOLLOWED BY LAYER OF NEXT LIFT OF ROUNDSTONE BOULDERS. 300MM TOPSOIL SHOULD BE PLACED BETWEEN LIFTS TO ENHANCE THE OPPORTUNITY FOR VEGETATION GROWTH.

LOCATOR MAP



0 5 10 Meters

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ALTERNATIVE DESCRIPTION:

The removal of risk alternative provides a cost-effective approach to stabilize the channel and mitigate the scour potential downstream

The components of the Removal of Risk Alternative would include:
- Removal of the failed weir and retaining wall
- Armourstone cascade through the site of the weir
- Vegetated boulders imbedded at the toe of slope where the channel is in contact with the valley wall

Location: ES26/27
Removal of Risk Concept Design

Date: 2021-10-05 Projection:
NAD83_UTM_Zone_17N
Data Source: City of Guelph, GRCA
Created by: D.K.

6.23 ES#28: Speed River tributary, stormwater outfall – Unnamed Reach

The Speed River flows south and west for over 28 km through the City of Guelph, from Guelph Lake in the north to Guelph/Eramosa Township to the southwest of the city and ultimately drains to the Grand River downstream. The drainage area covers a watershed of 110 km^2 and is the largest subwatershed in the City of Guelph. The Speed flows though lake and wetlands in the headwaters and becomes a straight to gently meandering channel though the city, with reinforced banks and concrete grade control throughout.

The tributary at issue is a minor drainage channel that has been daylighted and conveys storm water flow from an outfall. Erosion Site ES #28 is located on the southwest bank on the east side of Imperial Road North. The ongoing issue at ES #28 is a rusted out CSP outfall that was been undermined from the water from the bottom of the pipe. There is bank erosion apparent from the outfall which lacks a headwall. The bank erosion is located on the bank of a railbed that crosses Imperial Road.

Preliminary Alternative 1: "Do Nothing"
The risks associated with ES #28 would not be addressed. The rusted-out CMP storm outfall pipe would remain and the bank would continue to erode. This option risks the stability of the outfall and bank, along with the stability of the railbed slope.

Preliminary Alternative 2: Local Works
The local works alternative would involve removal of the compromised pipe and replacement with HDPE. The outfall would be stabilized with the installation of a concrete headwall and armourstone bank protection. Rip rap scour protection at the base of the outfall will prevent future undermining of the adjacent railbed.

Local Works at this site would restore approximately 10 m of the unnamed reach of Speed River.

Preliminary Alternative 3: Reach Based Works
The reach-based works alternative would involve rip rap channel protection and vegetated boulder bank protection to stabilise the segment from Imperial Road to the engineered bend downstream. The deteriorated CSP will be replaced with HDPE and a concrete headwall

The reach-based works would restore approximately 70 m of the unnamed reach.

Preliminary Alternative 4: Removal of Risk
Removal of the outfall is not considered at this time.

6.23.1 Evaluation of Alternatives

Each of the preliminary alternatives was scored using the criteria presented in **Section 5.0.** The full evaluation matrix presented in **Table 6.24**, showing the scoring for each alternative. Based on this evaluation, Local Works was selected as the preferred alternative.

Table 6.24: Summary of Criteria Evaluation for ES #28 in an unnamed reach of Speed River

Evaluation Criteria	Do Nothing	Local Works	Reach Based Works	Removal of Risk
Physical/Natural Environment				
Potential Aquatic Habitat Benefit (Water Temperature)	○	○	○	
Potential Aquatic Habitat Benefit (Fish Passage)	○	○	○	
Potential to Reduce Erosion of Public Lands	○	◑	◕	
Potential to Reduce Erosion of Private Lands	○	○	○	
Potential to Reduce Stream Bank and Stream Bed Erosion	○	◑	◕	
Potential to Enhance Groundwater Regime	○	○	○	
Potential to Reduce Flooding	○	◑	◑	
Potential to Improve Terrestrial Habitat	○	◑	◑	
Integration with Existing Infrastructure	○	◕	◕	
Integration with Existing Environment	○	◕	◕	
Social/Cultural Environment				
Aesthetic / Recreation	○	◑	◑	
Compatibility with Adjacent Land Use	○	◑	◑	
Community Disruption	○	◑	◔	
Public Health and Safety	○	◑	◕	
Historically Significant Property	○	○	○	
Heritage Landscape Location	○	○	○	
Risk to Historic Landfills	○	○	○	
Economic Environment				
Construction Costs	●	◕	◑	
Operation and Maintenance Costs	◑	◑	◔	
Infrastructure Protection	○	◑	◑	
Technical/Engineering Considerations				
Ease of Implementation	●	◑	◔	
Agency Acceptance	◑	◑	◔	
Policy/Bylaw Requirements	○	◕	◕	
Technical Feasibility	◕	◕	◑	
Total Score	◔	◑	◔	○

● = indicated that the retrofit design alternative scored high in satisfying the respective design criteria

○ = indicated the retrofit design option scored low in relation to the criteria

6.23.2 Preferred Alternative

The local works alternative provides a cost-effective approach to stabilize the channel/infrastructure interaction and remove the risk to the surrounding bank. Additionally, this alternative provides erosion

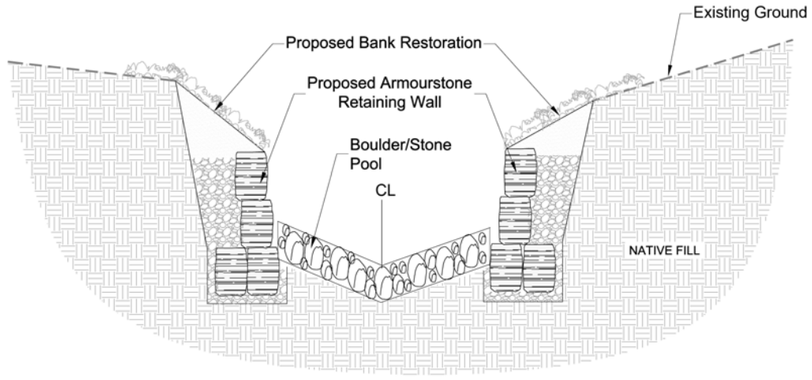
protection to the railbed adjacent to this narrow channel corridor as well as the existing CSP outfall. A conceptual design of the Local Works alternative is presented below in **Figure 6.23.** This project lies within the limits of the City of Guelph's project PN0081, predesign 2032.

The components of the Local Repair Works Alternative would include:

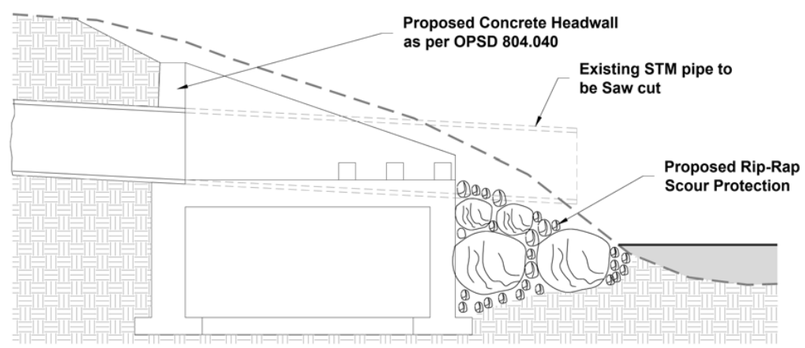
- Replacement of the compromised pipe with an HDPE alternative.
- Stabilization of the outfall pipe with a concrete headwall.
- Armourstone bank protections and rip rap scour protection within the channel.

Refer to **Section 7.0** for estimated implementation costs.

ARMOURSTONE RETAINING WALL BANKS
WITH SCOUR POOL PROTECTION



OUTFALL RESTORATION WITH CONCRETE HEADWALL



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ALTERNATIVE DESCRIPTION:

The local works alternative provides a cost-effective approach to stabilize the channel/infrastructure interaction and remove the risk to the surrounding bank

The components of the Local Repair Works Alternative would include:

- Replacement of the compromised pipe with an HDPE alternative
- Stabilization of the outfall pipe with a concrete headwal
- Armourstone bank protections and rip rap scour protection within the channel.

Location: ES28
Local Works Concept Design

Date: 2021-10-05 Projection:
NAD83_UTM_Zone_17N
Data Source: City of Guelph, GRCA
Created by: D.K.

6.24 ES#29: Speed River tributary, stormwater outfall and bank erosion – Reach SR-F2

The Speed River flows south and west for over 28 km through the City of Guelph, from Guelph Lake in the north to Guelph/Eramosa Township to the southwest of the city and ultimately drains to the Grand River downstream. The drainage area covers a watershed of 110 km^2 and is the largest subwatershed in the City of Guelph. The Speed flows though lake and wetlands in the headwaters and becomes a straight to gently meandering channel though the city, with reinforced banks and concrete grade control throughout.

The tributary at issue is a minor drainage channel that conveys storm water flow from an outfall and connects to a higher order tributary of Hanlon Creek. Erosion Site ES #29 is located on the south side of a walking trail that extends from the western limit of Stone Rd near a parking lot used for use of the trail. The ongoing issue at ES #29 is the erosion of the grouted stone retaining wall adjacent to the CSP outfall at the beginning of the reach. The wall has completely deteriorated and the exposed bank eroded to outflank the outfall.

Preliminary Alternative 1: "Do Nothing"
The risks associated with ES #29 would not be addressed. The outflanked outfall would remain, along with the eroding bank near the walking path on the bank. This option risks the stability of the outfall and overall morphology of this minor tributary.

Preliminary Alternative 2: Local Works, Repair
The local repair works alternative would involve restoring the bank with a boulder treatment or vegetated buttress to repair the bank profile and protect the outfall and banks. Bioengineering consisting of willow and dogwood plantings will stabilize the bank further.

Local Works at this site would restore approximately 10 m of the SR-F2 reach of Speed River.

Preliminary Alternative 3: Local Works, Replacement
The local replacement works alternative would involve installation of a concrete headwall. Rip rap protection will be placed at the toe of bank near the outfall and an angular stone channel treatment will prevent channel scour and potential undermining of the headwall and outfall pipe.

Local Works at this site would restore approximately 10 m of the SR-F2 reach of Speed River.

Preliminary Alternative 4: Removal of Risk
Removal of the outfall is not considered at this time. The current stormwater network requires the existing infrastructure.

6.24.1 Evaluation of Alternatives

Each of the preliminary alternatives was scored using the criteria presented in **Section 5.0.** The full evaluation matrix presented in **Table 6.25**, showing the scoring for each alternative. Based on this evaluation, Local Repair Works was selected as the preferred alternative.

Table 6.25: Summary of Criteria Evaluation for ES #29 in Reach SR-F2 of Speed River

Evaluation Criteria	Do Nothing	Repair Works	Replacement Works	Removal of Risk
Physical/Natural Environment				
Potential Aquatic Habitat Benefit (Water Temperature)	○	○	○	
Potential Aquatic Habitat Benefit (Fish Passage)	○	○	○	
Potential to Reduce Erosion of Public Lands	○	◑	◕	
Potential to Reduce Erosion of Private Lands	○	○	○	
Potential to Reduce Stream Bank and Stream Bed Erosion	○	◑	◑	
Potential to Enhance Groundwater Regime	○	○	○	
Potential to Reduce Flooding	○	◑	◑	
Potential to Improve Terrestrial Habitat	○	◔	◑	
Integration with Existing Infrastructure	○	◑	◔	
Integration with Existing Environment	○	◑	◑	
Social/Cultural Environment				
Aesthetic / Recreation	○	◑	◑	
Compatibility with Adjacent Land Use	○	◑	◑	
Community Disruption	○	◑	◑	
Public Health and Safety	○	◑	◕	
Historically Significant Property	○	○	○	
Heritage Landscape Location	○	○	○	
Risk to Historic Landfills	○	○	○	
Economic Environment				
Construction Costs	●	◕	◑	
Operation and Maintenance Costs	◑	◑	◔	
Infrastructure Protection	○	◑	◕	
Technical/Engineering Considerations				
Ease of Implementation	●	◑	◑	
Agency Acceptance	◑	◑	◔	
Policy/Bylaw Requirements	○	◕	◕	
Technical Feasibility	◕	◕	◑	
Total Score	◔	◑	◔	○

● = indicated that the retrofit design alternative scored high in satisfying the respective design criteria

○ = indicated the retrofit design option scored low in relation to the criteria

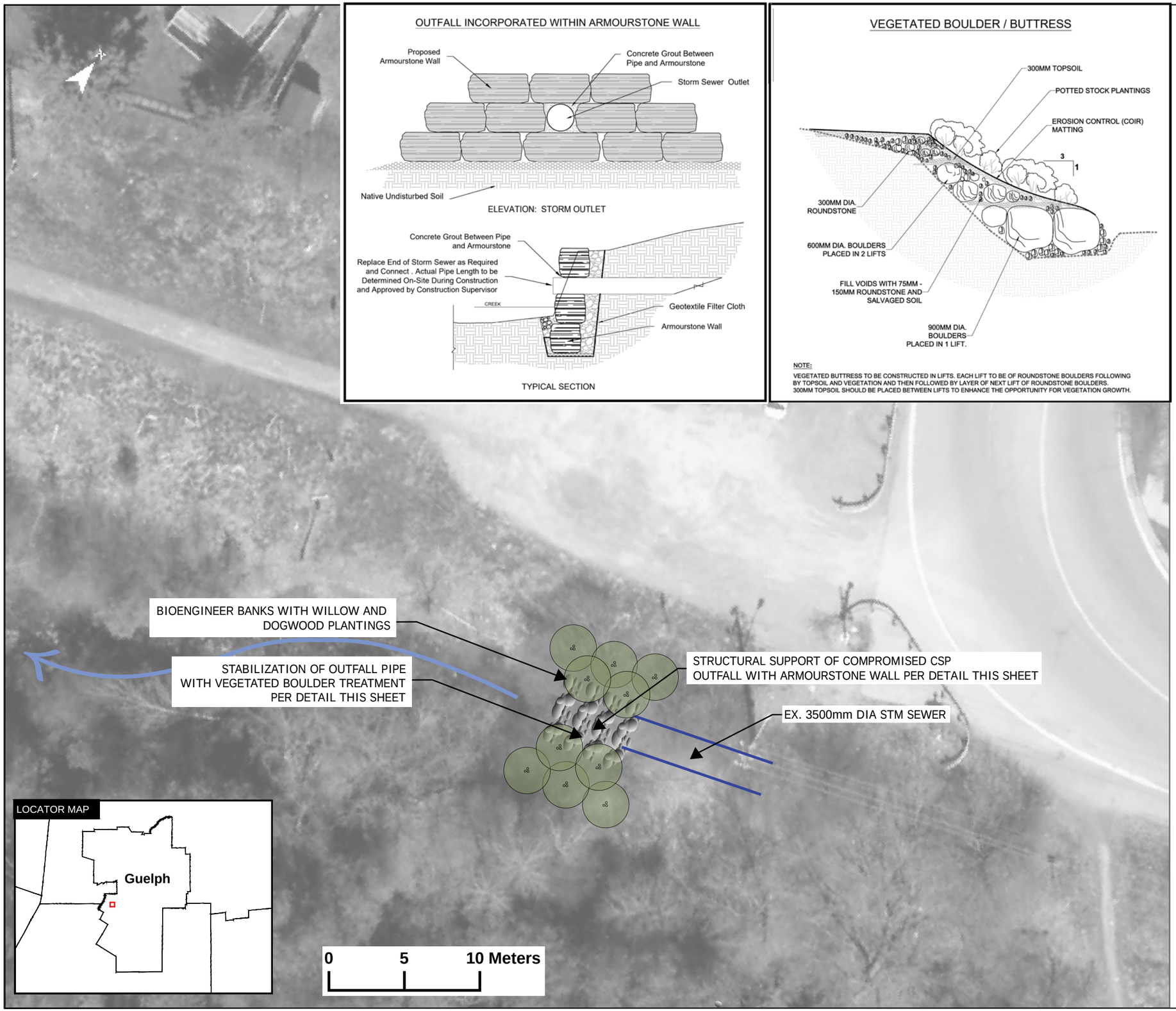
6.24.2 Preferred Alternative

The local works alternative provides a cost-effective approach to stabilize the channel/infrastructure interaction and remove the risk to the surrounding infrastructure. Additionally, this alternative provides erosion protection to the trail bank as well as the existing CSP outfall. A conceptual design of the Local Works alternative is presented below in **Figure 6.24.**

The components of the Local Works Alternative would include:

- Stabilization of the outfall pipe with a vegetated boulder treatment.
- Sustainable bioengineering of the banks with willow and dogwood plantings which provide integration with the existing riparian environment
- Structural support of the compromised CSP outfall.

Refer to **Section 7.0** for estimated implementation costs.



OUTFALL INCORPORATED WITHIN ARMOURSTONE WALL

ELEVATION: STORM OUTLET

TYPICAL SECTION

VEGETATED BOULDER / BUTTRESS

NOTE:

VEGETATED BUTTRESS TO BE CONSTRUCTED IN LIFTS. EACH LIFT TO BE OF ROUNDSTONE BOULDERS FOLLOWING BY TOPSOIL AND VEGETATION AND THEN FOLLOWED BY LAYER OF NEXT LIFT OF ROUNDSTONE BOULDERS. 300MM TOPSOIL SHOULD BE PLACED BETWEEN LIFTS TO ENHANCE THE OPPORTUNITY FOR VEGETATION GROWTH.

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ALTERNATIVE DESCRIPTION:

The local works alternative provides a cost-effective approach to stabilize the channel/infrastructure interaction and remove the risk to the surrounding infrastructure

The components of the Local Works Alternative would include:

- Stabilization of the outfall pipe with a vegetated boulder treatment
- Sustainable bioengineering of the banks with willow and dogwood plantings which provide integration with the existing riparian environment
- Structural support of the compromised CSP outfall

Location: ES29
Local Works Concept Design

Date: 2021-10-05 Projection:
NAD83_UTM_Zone_17N
Data Source: City of Guelph, GRCA
Created by: D.K.

6.25 ES#30: Hanlon Creek Creek, pedestrian bridge and bank erosion – Reach TC-3

Hanlon Creek is a tributary of Speed River and flows north over 14 km through several tributaries from Gordon Street and Clair Road to the Speed River west of Hwy 6. The drainage area covers a watershed of 21 km^2 through mostly green space and low-density residential land in the west end of Guelph. Hanlon Creek is a combination of small channels, storm water ponds and wetlands.

Erosion Site ES #30 is located 200 m south west of the western end of Stone Road. The deteriorated abutment on the cutbank of a small pedestrian bridge posses a risk to both public safety and erosion to the connecting trail and bank.

Preliminary Alternative 1: "Do Nothing"
The risks to private property associated with ES #7 would not be addressed. The outflanked abutments would remain, along with the eroding cutbank near the bridge.

Preliminary Alternative 2: Local Repair Works
The local repair works alternative would involve repairing the concrete abutments with an armourstone bank treatment and footing.

Preliminary Alternative 3: Local Replacement Works
The local replacement works alternative would involve armourstone bank protection along the meander bend to prevent further bank erosion and risk to the trail. The new bridge design will require an offset of the abutments to beyond the erosion hazard limit and to be replaced with a longer pedestrian bridge.

Preliminary Alternative 4: Removal of Risk
The removal of risk alternative would involve bridge removal and the trail to be realigned to either loop back to itself or to join the existing trail network elsewhere.

6.25.1 Evaluation of Alternatives

Each of the preliminary alternatives was scored using the criteria presented in **Section 5.0.** The full evaluation matrix presented in **Table 6.26**, showing the scoring for each alternative. Based on this evaluation, Local Replacement Works was selected as the preferred alternative.

Table 6.26: Summary of Criteria Evaluation for ES #30 in Reach HAC-1 of Hanlon Creek.

Evaluation Criteria	Do Nothing	Repair Works	Replacement Works	Removal of Risk
Physical/Natural Environment				
Potential Aquatic Habitat Benefit (Water Temperature)	○	○	○	○
Potential Aquatic Habitat Benefit (Fish Passage)	○	○	○	○
Potential to Reduce Erosion of Public Lands	○	◑	◕	○
Potential to Reduce Erosion of Private Lands	○	○	○	○
Potential to Reduce Stream Bank and Stream Bed Erosion	○		◑	○
Potential to Enhance Groundwater Regime	○	○	○	○
Potential to Reduce Flooding	○	○	◔	○
Potential to Improve Terrestrial Habitat	○	◔	◔	○
Integration with Existing Infrastructure	○	◑	◑	○
Integration with Existing Environment	○	◑	◑	◑
Social/Cultural Environment				
Aesthetic / Recreation	○	◑	◑	●
Compatibility with Adjacent Land Use	○	◑	◕	○
Community Disruption	◔	◑	◑	○
Public Health and Safety	○	◑	◕	◑
Historically Significant Property	○	○	○	○
Heritage Landscape Location	○	◕	◑	○
Risk to Historic Landfills	○	○	○	○
Economic Environment				
Construction Costs	○	◑	◑	◑
Operation and Maintenance Costs	◑	◔	◔	◑
Infrastructure Protection	○	◑	◑	◔
Technical/Engineering Considerations				
Ease of Implementation	●	◑	◑	◑
Agency Acceptance	◑	◑	◑	◔
Policy/Bylaw Requirements	○	◑	◕	○
Technical Feasibility	◕	◑	◑	◑
Total Score	◔	◔	◑	◔

● = indicated that the retrofit design alternative scored high in satisfying the respective design criteria

○ = indicated the retrofit design option scored low in relation to the criteria

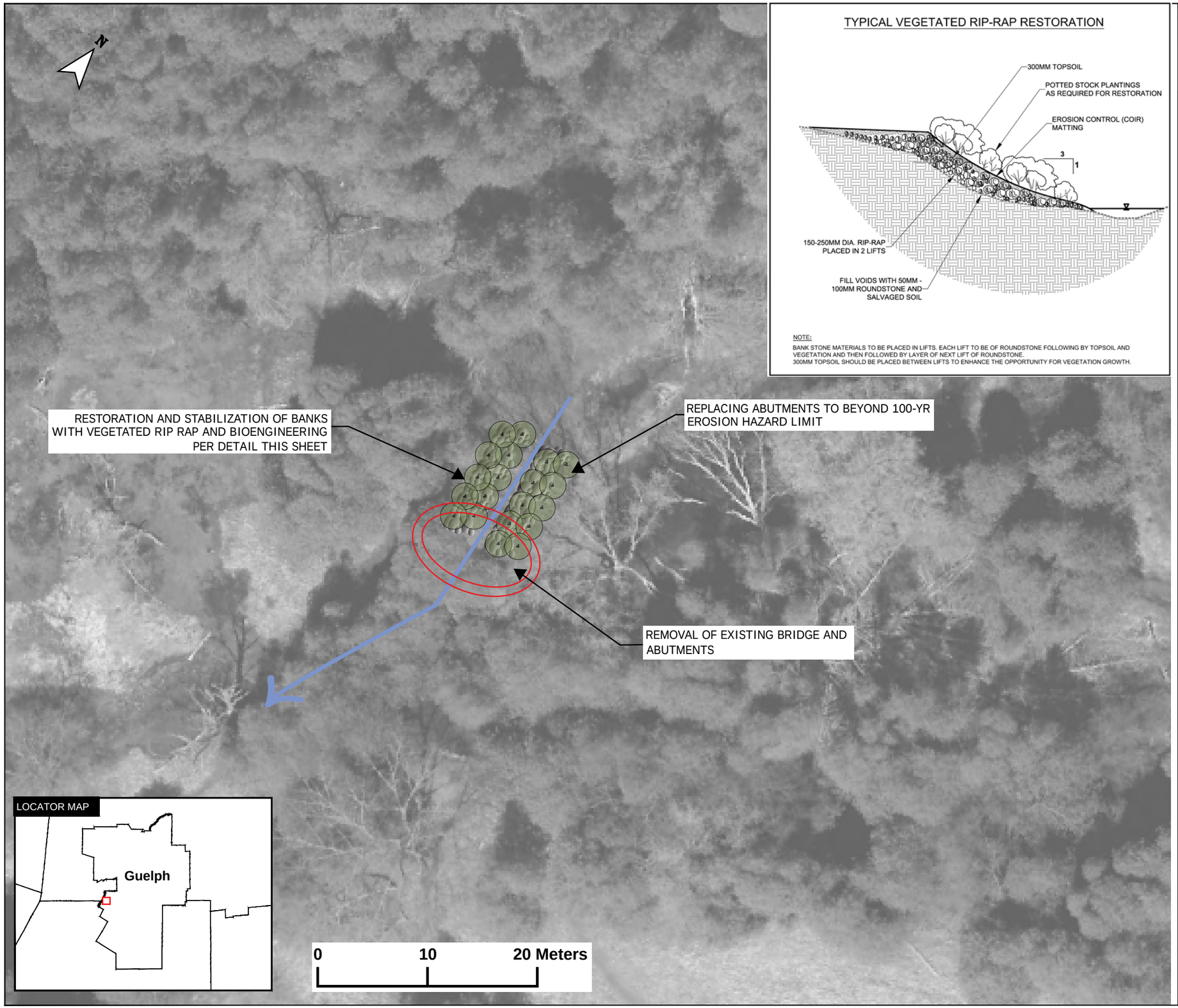
6.25.2 Preferred Alternative

The local replacement works alternative provides a cost-effective approach to stabilize the channel banks and replacement for the failed bridge. Additionally, this alternative addresses future erosion hazard concerns. A conceptual design of the Local Replacement Works alternative is presented below in **Figure 6.25.**

The components of the Local Replacement Works Alternative would include:

- Removal of the existing bridge and abutments
- Replacing the abutments to beyond the 100-yr erosion hazard limit
- Restoration and stabilization of the banks with vegetated rip rap and bioengineering

Refer to **Section 7.0** for estimated implementation costs.



TYPICAL VEGETATED RIP-RAP RESTORATION

NOTE:

BANK STONE MATERIALS TO BE PLACED IN LIFTS. EACH LIFT TO BE OF ROUNDSTONE FOLLOWING BY TOPSOIL AND VEGETATION AND THEN FOLLOWED BY LAYER OF NEXT LIFT OF ROUNDSTONE.
300MM TOPSOIL SHOULD BE PLACED BETWEEN LIFTS TO ENHANCE THE OPPORTUNITY FOR VEGETATION GROWTH.

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ALTERNATIVE DESCRIPTION:

The local replacement works alternative provides a cost-effective approach to stabilize the channel banks and replacement for the failed bridge

The components of the Local Replacement Works Alternative would include:

- Removal of the existing bridge and abutments
- Replacing the abutments to beyond the 100-yr erosion hazard limit
- Restoration and stabilization of the banks with vegetated rip rap and bioengineering

Location: ES30
Local Replacement Concept Design

Date: 2021-10-05 Projection:
NAD83_UTM_Zone_17N
Data Source: City of Guelph, GRCA
Created by: D.K.

7.0 Cost Estimates and Permitting Requirements

Class C cost estimates were developed for each site, and are presented in **Table 8.1**. This table also includes expected permits, and whether the design and construction can be completed internally by the City, or whether an external team is recommended.

8.0 Next Steps

The Erosion Assessment Field Investigations report (November 2020) provided a score out of 100 for each erosion site, which provides a semi quantitative measure of risk and opportunity to guide subsequent decisions regarding stream restoration opportunities within the SWM-MP. However, the final prioritization will be determined by integrating this score with other stormwater, infrastructure, and environmental management objectives as part of the forthcoming Implementation Plan.

Table 8.1: Class C Cost Estimates and Permitting Requirements

Site		Works	Permits	Cost (Thousands)	Design In-House / External	Construction Design In-House / External	Notes
ES #1	Eramosa Outfall	Remove and Replace Local Works	GRCA, MECP-SAR	$180 - $240	External	External	
ES #2	Bank Erosion	Local Works	GRCA, DFO, MNRF, MECP-SAR	$240 - $360	External	External	Access Issues
ES #4	Elizabeth Street Outfall	Local Works	GRCA, DFO, MNRF, MECP-SAR	$960 - $1200	External	External	
ES #5	Pedestrian Bridge	Removal of Risk	GRCA, DFO, MNRF, MECP-SAR	$840 - $960	Internal	External	
ES #7	Stop Log Dam	Local Works	GRCA, DFO, MNRF-SAR, MNRF LIRA, MECP-SAR	$1440 - $1800	External	External	Major access Issues.
ES #8	Outfall and Bank Erosion	Stabilization Works	GRCA, DFO, MNRF, MECP-SAR	$180 - $240	External	External	
ES #9	Failing Storm Outfall	Remove and Replace Works	GRCA, DFO, MNRF, MECP-SAR	$360 - $480	External	External	
ES #10	Stormwater Outfall	Local Replacement Works	GRCA, DFO	$120	Internal	Internal	
ES #11	Outfall and Scoured Bank	Local Stabilization Works	GRCA, DFO	$180 - $240	External	External	
ES #12/13	Retaining Wall	Reach Based Works	GRCA, DFO, MNRF, MECP-SAR	$480 - $600	External	External	
ES #14	Decommissioned Sewer Pipe	Removal of Risk	GRCA, DFO, MNRF, MECP-SAR	$1200 - $1800	External	External	Access Issues
ES #15	Outfall and Retaining Wall	Replacement Works	GRCA, DFO	$480 - $600	External	External	
ES #16	Weir Outflanked	Do Nothing	n/a	$12 (annual)	Internal	Internal	Do Nothing - Monitoring Only. Cost is annual
ES #17	Outfall and Bank Erosion	Stabilization Works	GRCA, MECP-SAR	$180 - $240	External	External	
ES #18	Exposed Sanitary Sewer	Reach Based Works	GRCA, DFO, MNRF, MECP-SAR	N/A	External	External	Cost is pending feasibility confirmation from Wastewater Master Plan
ES #19	Corroded Outfall	Do Nothing	n/a	$12 (annual)	Internal	Internal	Do Nothing - Monitoring Only. Cost is annual
ES #20	Exposed Sanitary Sewer	Reach Based Works	GRCA, DFO, MNRF, MECP-SAR	N/A	External	External	Cost is pending feasibility confirmation from Wastewater Master Plan
ES #25/21	Failed Retaining Wall	Replacement Works	GRCA, DFO, MNRF, MECP-SAR	$840 - $1080	External	External	
ES #22	Slumped Headwall	Local Replacement Works	GRCA	$180	Internal	Internal	
ES #23	Decommissioned Watermain	Removal of Risk	GRCA, DFO, MNRF, MECP-SAR	$120 - $150	Internal	Internal	Significant issues with access. Park restoration needed. If work is completed externally, costs may increase to $200k - $250k.
ES #24	Outflanked Weir and Wall	Local Works	GRCA, DFO, MNRF, MECP-SAR	$960 - $1200	External	External	
ES #26/27	Dam and Slope Erosion	Removal of Risk	GRCA, DFO, MNRF-SAR, MNRF LIRA, MECP-SAR	$840 - $1080	External	External	
ES #28	Deteriorated CSP Outfall	Local Works	GRCA	$180 - $240	External	External	
ES #29	Bank Erosion near Outfall	Local Repair Works	GRCA, DFO, MNRF, MECP-SAR	$180	External	External	
ES #30	Pedestrian Bridge Erosion	Replacement Works	GRCA, DFO	$120	External	External	
			TOTAL COST	$8,880 - 11,310*			

* Excluding Sites ES#18 and ES#20 and $24,000 annually to monitor ES#16 and ES#19.