APPENDIX I
Erosion Control Protection Methods

General Erosion Control Opportunities

There are many techniques used to rehabilitate creeks that have been degraded due to erosion and that address the erosion mechanisms identified above. The use of each technique will depend on the site-specific requirements, including the available space, flow and velocity characteristics, location along the creek (i.e., at a riffle or bend), aquatic habitat requirements and the height of the bank. Wherever possible, a comprehensive approach to addressing erosion issues should be undertaken, including restoration of the degraded areas and a correction of the underlying causative factors of the erosion. This is the most effective method to achieve long-term mitigation of risk from creek erosion. A hierarchical process that considers passive methods progressing towards significant channel modification is followed; in constrained systems, such as is found in the study area, it is often necessary to impose the latter. These modifications seek to manage and control erosion forces rather than decrease them.

Certain locations and situations may benefit from localized spot restoration of specific erosion issues. Localized restoration can be necessary in many situations, but failure to address underlying causes can cause the problem to migrate to other areas. On the other hand, it is sometimes possible to adopt the “do nothing” alternative, and allow the creek to continue its natural processes. This approach can be used if it appears that the creek will eventually adopt a stable erosion and deposition regime without significant damage to property or infrastructure. The following sections describe some of the commonly used techniques for the rehabilitation of eroded areas.

Armour Stone Retaining Wall

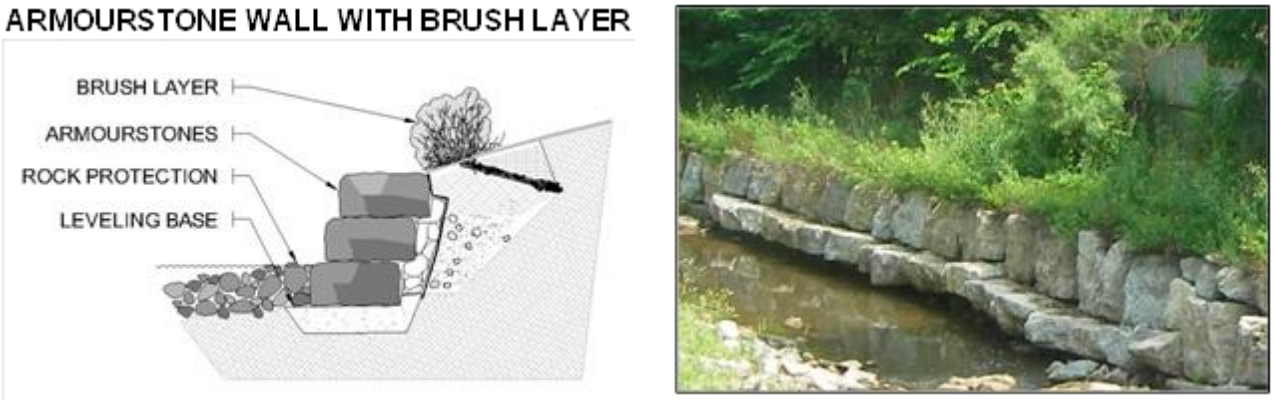
Armour stone retaining walls are used as a more natural-appearing and cost-effective (in most situations) method of providing erosion control. The walls consist of large, flat stones of dolomite, limestone or granite that are stacked and may be staggered; grouted concrete could be placed between joints. Compacted granular backfill is placed behind the wall to relieve potential geotechnical issues with the native materials. Bioengineering features (i.e., brush layers) can be placed at the top of the wall to further stabilize the bank, if sufficient light and moisture conditions are available. The use of armour stone walls can be effective along the outside bend of a pool where erosion tends to be greatest, or in other locations with high flow velocities (i.e., greater than 3 m/s).

Advantages:

- Will mitigate high erosion potential
- Is relatively cost-effective and requires little to no maintenance
- Can be placed at near-vertical side slopes where land is limited

Disadvantages:

- Requires heavy machinery for installation
- Provides minimal habitat potential
- Is not flexible in terms of adjusting to stream processes



Armour Stone Wall with Brush Layer Concept

Rock Revetment

Rock bank protection is used to protect the underlying soils from the erosive force of a channel, but is typically limited to use on sloping banks with sufficient soil stability. The stones are sized to resist the applied shear forces exerted at each particular location within the channel. The underlying fill material must be properly compacted prior to installation of the stones, in order to avoid a slope failure. Live stakes and other bioengineering features can optionally be placed between the stones to promote vegetative growth, increasing overall stability and contributing to riparian habitat.

Advantages:

- Rock is self-adjusting to small amounts of substrate consolidation or movement
- Slopes can dissipate stream energy more effectively than vertical walls
- Materials tend to be locally available and more cost effective than other structural alternatives
- Provides some aquatic habitat
- Rock can be easily repaired

Disadvantages:

- Rock has limitations in terms of the erosive forces that it can withstand, based on the maximum size stone easily available and practical to install
- Requires a sufficiently large area to accommodate slope, which may not be possible in constrained situations

Live Log Crib Wall

This bank protection feature consists of a structure of logs that are spiked together and then filled with soil and rocks. The crib is constructed along the existing bank line for the length of erosion or scour, and planted with live stakes. Brush mattress is installed at the ends to prevent bank erosion from flanking and compromising the structure. The logs serve as a shelter for vegetation to establish, after which the roots take the place of the logs in protecting the bank from erosion. These structures are typically used in constrained situations (similar to armour stone walls) and where the requirement for habitat is essential. They can also be used in more general situations of slope toe erosion, bank failure and bank scour conditions.

Advantages:

- Structure can be filled to near-vertical side slopes in constrained areas
- Provides stability above and below the water level
- Provides natural aquatic and terrestrial habitat
- Typically favoured by approval agencies

Disadvantages:

- Requires a large amount of material and labour
- Application can be dependent on over-story/riparian cover (i.e., success of live stakes requires appropriate moisture and light conditions)
- Complex design considerations

Live Log Crib Wall Concept

Bioengineering

Bioengineering rehabilitation methods use live dormant plant material – such as alder, dogwood, poplar or willow – in various ways that allow the plants to root and grow in eroded areas, stabilizing the bank with the roots. Bioengineering techniques include:

- Brush mattress – formed by placing and staking mats of dormant plant material over slopes, then covering with a light layer of soil and sometimes a temporary erosion resistant material, such as coir matting.
- Brush layer – formed by installing dormant plant material into a trench in the bank, used in conjunction with hardened toe protection (such as rip rap or armour stones) to stabilize the exposed portions of the bank during times of higher flows.
- Live fascine – formed of bound and staked rolls of dormant plant material that are laid in trenches along stream banks, typically combined with a brush mattress.

These techniques are often combined to form a comprehensive vegetative stabilization of the stream banks.

Advantages:

- Vegetation and natural materials used for protection complement and become an element of the local environment
- Vegetation is self-perpetuating and will continue to strengthen and stabilize the bank (assuming the stream forces do not overcome the vegetation)

- Provides both aquatic and terrestrial habitat

Disadvantages:

- Takes 1-3 years to fully develop
- Application can be limited in shaded areas (i.e., well established over-story)
- Often requires measures to protect the vegetation during development
- Does not generally resist high velocities
- Requires monitoring and maintenance

Brush Mattress Concept

Stream Training: Rock Vanes and Vortex Weirs

A rock vane is a protrusion into the channel at an angle from the stream bank that deflects flow away from the bank and scour pools. A vortex weir is a series of rocks that cross the stream in a 'V' formation, with the point of the 'V' looking upstream. The weir can have several benefits: it can hold back water upstream, reducing velocities and creating pool habitat; the shape of the weir deflects the flow away from the banks as it passes over the crest; the weir can mitigate the onset and progression of downcutting; and the shape of the weir can concentrate low flows.

Advantages:

- Reduces stream energy and redirects flow away from critical areas
- Provides vertical grade control to minimize bed incision

Disadvantages:

- Rock vane does not provide a means to re-establish the stream bank, banks must re-establish naturally

Terraced Floodplain

Constructing a terraced floodplain reduces the impact of high-flow or bankfull events by providing more flow area, reducing erosive velocities depending on the specific problems in each reach. This technique is most effective where flows larger than bankfull remain within the cross-section. Floodplain terracing would not be feasible in

constrained areas (e.g., valley walls in proximity to the creek or where property is immediately adjacent to the stream, given the need for additional space for the floodplain.

Floodplain terracing could also be used to increase flood storage area to reduce the regional flood elevation. Terraced flood plains may also not be feasible where the floodplain is low and has a low gradient towards the creek. Floodplain modification is typically combined with other rehabilitation techniques to stabilize the new banks.

Advantages:

- Cost effective way to decrease the stream energy by expanding the channel cross-section and flow area

Disadvantages:

- Can require large amounts of space
- Can impact nearby utilities by reducing fill/cover

Morphological Channel Modifications

Modifications of the planform, profile or cross-section can provide an opportunity to reduce or redistribute flow energy, hydraulic stresses on the boundaries, erosion potential within the channel, and improve cross-sectional flow capacity. Morphological enhancements can also enhance aquatic habitat conditions and/or diversity.

Advantages:

- Manage flow energy
- Re-establish channel form and functions
- Enhance aquatic habitat
- Opportunity to implement bioengineering bank protection methods

Disadvantages:

- Requires larger spatial footprint than existing channel, which may result in a loss of riparian vegetation
- Generally requires a longer construction period
- More costly than repair in place structures.

Creek Realignment

Realigning a channel can provide the opportunity to use natural channel design concepts, allowing the stream to be built according to the specific flow and sediment regimes for each reach, and incorporating morphological diversity that is beneficial for managing flows and enhancing aquatic habitat. This approach typically includes less hard structures, relying on vegetative treatment and channel plan/profile for stability and environmental function. This alternative can require a significant amount of space to route the new channel, but offers the most long-term benefit if designed and constructed correctly.

Advantages:

- Increase long term stability
- Initial stages can be completed with no instream work

Disadvantages:

- Results in a loss of existing substrate and streambed habitat
- Generally requires a longer construction period
- Typically more expensive than other alternatives; however, can be more cost-effective in the long term

Stream Realignment Design Concept

APPENDIX J
Alternative Evaluation Tables

East Morrison Creek Erosion Mitigation EA - Alternative Evaluation
Erosion Sites: E4 and E24

Criteria	Description	Maximum Score	Alternative 1: Do Nothing	Alternative 2: Continuous Monitoring	Alternative 3: Selective Works (Local)	Alternative 4: Reach-Scale Channel	Alternative 5: Removal of Risk
Physical / Natural Environment (25%)							
Management of Existing Erosion Risks	Effectiveness of the alternative to manage or mitigate erosion risks, both existing and ongoing, relative to the level of urgency.	5	1	2	4	5	3
Impacts to Aquatic and/or Terrestrial Habitat	Potential to provide greater improvements to aquatic and terrestrial species and habitat, while also considering potential construction impacts relative to existing condition.	5	4	4	2	2	3
Climate Change Adaptation/ Resiliency	Relative potential to provide additional hydrological and ecological resiliency, through physical, hydrological, and ecological redundancy for buffering extreme events and seasonal climate shifts. Ability to improve geomorphic stability and natural components of watercourse function.	5	1	3	3	5	4
	Criteria Subtotal		6	9	9	12	10
	Weighted Score (25% of final score)		10.0	15.0	15.0	20.0	16.7
Technical / Engineering (25%)							
Technical Feasibility	Constructability and construction access. Ability to limit impacts to existing infrastructure (e.g., sewers, watermains, gas, roads), including the feasibility of not intervening.	5	2	3	5	4	1
Approvability	Acceptability of agencies, community members and stakeholders. Less complexity of the Project: Consider permitting/coordination requirements with community members and stakeholders, etc.	5	2	3	5	4	1
Green Solutions	Potential to employ green solutions, such as bioengineering, plantings, natural channel and other “soft” erosion mitigation approaches.	5	2	3	3	5	5
	Criteria Subtotal		6	9	13	13	7
	Weighted Score (25% of final score)		10.0	15.0	21.7	21.7	11.7
Social / Cultural Environment (25%)							
Community Disruption and Recreational Impacts	Compatibility of proposed works with adjacent properties (i.e. removal or addition of features which reduces utility for neighbouring lands scores lower). Less or limited disruption to surrounding community and residents (e.g. access and use of park/trails).	5	3	3	4	2	1
Landowner and Public Acceptance	Ability to be accepted by landowners and community including First Nations and Indigenous consultation. This includes acceptance of impacts to trees.	5	1	2	5	4	1
Archaeological Impacts	Ability to protect built heritage resources, cultural heritage landscapes and archaeological resources.	5	4	4	3	1	2
	Criteria Subtotal		8	9	12	7	4
	Weighted Score (25% of final score)		13.3	15.0	20.0	11.7	6.7
Economic (25%)							
Construction and Capital Costs	Relative measure of initial costs to install/construct the proposed works.	5	5	4	3	2	1
Maintenance Costs	Relative measure of the ongoing maintenance costs in the creek.	5	3	3	4	5	4
Life-Cycle Costs	Relative measure of the lifespan of erosion mitigation works or existing assets.	5	3	3	4	5	5
	Criteria Subtotal		11	10	11	12	10
	Weighted Score (25% of final score)		18.3	16.7	18.3	20.0	16.7
Score (Maximum of 100 points)			**51.7**	**61.7**	**75.0**	**73.3**	**51.7**

East Morrison Creek Erosion Mitigation EA - Alternative Evaluation
Erosion Site: E11

Criteria	Description	Maximum Score	Alternative 1: Do Nothing	Alternative 2: Continuous Monitoring	Alternative 3: Selective Works (Local)	Alternative 4: Reach-Scale Channel	Alternative 5: Removal of Risk
Physical / Natural Environment (25%)							
Management of Existing Erosion Risks	Effectiveness of the alternative to manage or mitigate erosion risks, both existing and ongoing, relative to the level of urgency.	5	1	2	4	5	3
Impacts to Aquatic and/or Terrestrial Habitat	Potential to provide greater improvements to aquatic and terrestrial species and habitat, while also considering potential construction impacts relative to existing condition.	5	2	2	3	4	4
Climate Change Adaptation/ Resiliency	Relative potential to provide additional hydrological and ecological resiliency, through physical, hydrological, and ecological redundancy for buffering extreme events and seasonal climate shifts. Ability to improve geomorphic stability and natural components of watercourse function.	5	2	3	4	4	4
	Criteria Subtotal		5	7	11	13	11
	Weighted Score (25% of final score)		8.3	11.7	18.3	21.7	18.3
Technical / Engineering (25%)							
Technical Feasibility	Constructability and construction access. Ability to limit impacts to existing infrastructure (e.g., sewers, watermains, gas, roads), including the feasability of not intervening.	5	1	2	4	2	1
Approvability	Acceptability of agencies, community members and stakeholders. Less complexity of the Project: Consider permitting/coordination requirements with community members and stakeholders, etc.	5	2	3	5	4	1
Green Solutions	Potential to employ green solutions, such as bioengineering, plantings, natural channel and other “soft” erosion mitigation approaches.	5	1	2	3	4	5
	Criteria Subtotal		4	7	12	10	7
	Weighted Score (25% of final score)		6.7	11.7	20.0	16.7	11.7
Social / Cultural Environment (25%)							
Community Disruption and Recreational Impacts	Compatibility of proposed works with adjacent properties (i.e. removal or addition of features which reduces utility for neighbouring lands scores lower). Less or limited disruption to surrounding community and residents (e.g. access and use of park/trails).	5	4	4	3	2	1
Landowner and Public Acceptance	Ability to be accepted by landowners and community including First Nations and Indigenous consultation. This includes acceptance of impacts to trees.	5	2	3	5	3	1
Archaeological Impacts	Ability to protect built heritage resources, cultural heritage landscapes and archaeological resources.	5	4	4	3	1	2
	Criteria Subtotal		10	11	11	6	4
	Weighted Score (25% of final score)		16.7	18.3	18.3	10.0	6.7
Economic (25%)							
Construction and Capital Costs	Relative measure of initial costs to install/construct the proposed works.	5	5	4	3	2	1
Maintenance Costs	Relative measure of the ongoing maintenance costs in the creek.	5	2	3	4	5	4
Life-Cycle Costs	Relative measure of the lifespan of erosion mitigation works or existing assets.	5	2	3	4	5	5
	Criteria Subtotal		9	10	11	12	10
	Weighted Score (25% of final score)		15.0	16.7	18.3	20.0	16.7
Score (Maximum of 100 points)			**46.7**	**58.3**	**75.0**	**68.3**	**53.3**

East Morrison Creek Erosion Mitigation EA - Alternative Evaluation
Erosion Site: E5

Criteria	Description	Maximum Score	Alternative 1: Do Nothing	Alternative 2: Continuous Monitoring	Alternative 3: Selective Works (Local)	Alternative 4: Reach-Scale Channel	Alternative 5: Removal of Risk
Physical / Natural Environment (25%)							
Management of Existing Erosion Risks	Effectiveness of the alternative to manage or mitigate erosion risks, both existing and ongoing, relative to the level of urgency.	5	1	2	4	5	3
Impacts to Aquatic and/or Terrestrial Habitat	Potential to provide greater improvements to aquatic and terrestrial species and habitat, while also considering potential construction impacts relative to existing condition.	5	2	2	4	3	4
Climate Change Adaptation/ Resiliency	Relative potential to provide additional hydrological and ecological resiliency, through physical, hydrological, and ecological redundancy for buffering extreme events and seasonal climate shifts. Ability to improve geomorphic stability and natural components of watercourse function.	5	1	2	3	4	5
	Criteria Subtotal		4	6	11	12	12
	Weighted Score (25% of final score)		6.7	10.0	18.3	20.0	20.0
Technical / Engineering (25%)							
Technical Feasibility	Constructability and construction access. Ability to limit impacts to existing infrastructure (e.g., sewers, watermains, gas, roads), including the feasibility of not intervening.	5	2	3	5	4	1
Approvability	Acceptability of agencies, community members and stakeholders. Less complexity of the Project: Consider permitting/coordination requirements with community members and stakeholders, etc.	5	2	3	5	4	1
Green Solutions	Potential to employ green solutions, such as bioengineering, plantings, natural channel and other “soft” erosion mitigation approaches.	5	1	2	3	4	5
	Criteria Subtotal		5	8	13	12	7
	Weighted Score (25% of final score)		8.3	13.3	21.7	20.0	11.7
Social / Cultural Environment (25%)							
Community Disruption and Recreational Impacts	Compatibility of proposed works with adjacent properties (i.e. removal or addition of features which reduces utility for neighbouring lands scores lower). Less or limited disruption to surrounding community and residents (e.g. access and use of park/trails).	5	3	3	2	2	1
Landowner and Public Acceptance	Ability to be accepted by landowners and community including First Nations and Indigenous consultation. This includes acceptance of impacts to trees.	5	2	3	5	4	1
Archaeological Impacts	Ability to protect built heritage resources, cultural heritage landscapes and archaeological resources.	5	4	4	3	1	2
	Criteria Subtotal		9	10	10	7	4
	Weighted Score (25% of final score)		15.0	16.7	16.7	11.7	6.7
Economic (25%)							
Construction and Capital Costs	Relative measure of initial costs to install/construct the proposed works.	5	5	4	3	2	1
Maintenance Costs	Relative measure of the ongoing maintenance costs in the creek.	5	2	3	4	5	4
Life-Cycle Costs	Relative measure of the lifespan of erosion mitigation works or existing assets.	5	2	3	4	5	5
	Criteria Subtotal		9	10	11	12	10
	Weighted Score (25% of final score)		15.0	16.7	18.3	20.0	16.7
Score (Maximum of 100 points)			**45.0**	**56.7**	**75.0**	**71.7**	**55.0**

East Morrison Creek Erosion Mitigation EA - Alternative Evaluation
Erosion Site: E6

Criteria	Description	Maximum Score	Alternative 1: Do Nothing	Alternative 2: Continuous Monitoring	Alternative 3: Selective Works (Local)	Alternative 4: Reach-Scale Channel	Alternative 5: Removal of Risk
Physical / Natural Environment (25%)							
Management of Existing Erosion Risks	Effectiveness of the alternative to manage or mitigate erosion risks, both existing and ongoing, relative to the level of urgency.	5	1	2	5	4	3
Impacts to Aquatic and/or Terrestrial Habitat	Potential to provide greater improvements to aquatic and terrestrial species and habitat, while also considering potential construction impacts relative to existing condition.	5	4	4	2	1	3
Climate Change Adaptation/ Resiliency	Relative potential to provide additional hydrological and ecological resiliency, through physical, hydrological, and ecological redundancy for buffering extreme events and seasonal climate shifts. Ability to improve geomorphic stability and natural components of watercourse function.	5	2	3	4	3	3
	Criteria Subtotal		7	9	11	8	9
	Weighted Score (25% of final score)		11.7	15.0	18.3	13.3	15.0
Technical / Engineering (25%)							
Technical Feasibility	Constructability and construction access. Ability to limit impacts to existing infrastructure (e.g., sewers, watermains, gas, roads), including the feasibility of not intervening.	5	2	4	5	3	1
Approvability	Acceptability of agencies, community members and stakeholders. Less complexity of the Project: Consider permitting/coordination requirements with community members and stakeholders, etc.	5	2	4	5	3	1
Green Solutions	Potential to employ green solutions, such as bioengineering, plantings, natural channel and other “soft” erosion mitigation approaches.	5	1	2	3	4	5
	Criteria Subtotal		5	10	13	10	7
	Weighted Score (25% of final score)		8.3	16.7	21.7	16.7	11.7
Social / Cultural Environment (25%)							
Community Disruption and Recreational Impacts	Compatibility of proposed works with adjacent properties (i.e. removal or addition of features which reduces utility for neighbouring lands scores lower). Less or limited disruption to surrounding community and residents (e.g. access and use of park/trails).	5	4	4	3	2	1
Landowner and Public Acceptance	Ability to be accepted by landowners and community including First Nations and Indigenous consultation. This includes acceptance of impacts to trees.	5	2	3	5	2	1
Archaeological Impacts	Ability to protect built heritage resources, cultural heritage landscapes and archaeological resources.	5	4	4	3	1	2
	Criteria Subtotal		10	11	11	5	4
	Weighted Score (25% of final score)		16.7	18.3	18.3	8.3	6.7
Economic (25%)							
Construction and Capital Costs	Relative measure of initial costs to install/construct the proposed works.	5	5	4	3	2	1
Maintenance Costs	Relative measure of the ongoing maintenance costs in the creek.	5	2	3	4	5	4
Life-Cycle Costs	Relative measure of the lifespan of erosion mitigation works or existing assets.	5	2	3	4	5	5
	Criteria Subtotal		9	10	11	12	10
	Weighted Score (25% of final score)		15.0	16.7	18.3	20.0	16.7
Score (Maximum of 100 points)			**51.7**	**66.7**	**76.7**	**58.3**	**50.0**

East Morrison Creek Erosion Mitigation EA - Alternative Evaluation
Erosion Site: E7

Criteria	Description	Maximum Score	Alternative 1: Do Nothing	Alternative 2: Continuous Monitoring	Alternative 3: Selective Works (Local)	Alternative 4: Reach-Scale Channel	Alternative 5: Removal of Risk
Physical / Natural Environment (25%)							
Management of Existing Erosion Risks	Effectiveness of the alternative to manage or mitigate erosion risks, both existing and ongoing, relative to the level of urgency.	5	1	3	5	2	3
Impacts to Aquatic and/or Terrestrial Habitat	Potential to provide greater improvements to aquatic and terrestrial species and habitat, while also considering potential construction impacts relative to existing condition.	5	4	4	2	1	3
Climate Change Adaptation/ Resiliency	Relative potential to provide additional hydrological and ecological resiliency, through physical, hydrological, and ecological redundancy for buffering extreme events and seasonal climate shifts. Ability to improve geomorphic stability and natural components of watercourse function.	5	2	3	3	4	3
	Criteria Subtotal		7	10	10	7	9
	Weighted Score (25% of final score)		11.7	16.7	16.7	11.7	15.0
Technical / Engineering (25%)							
Technical Feasibility	Constructability and construction access. Ability to limit impacts to existing infrastructure (e.g., sewers, watermains, gas, roads), including the feasability of not intervening.	5	2	4	5	3	1
Approvability	Acceptability of agencies, community members and stakeholders. Less complexity of the Project: Consider permitting/coordination requirements with community members and stakeholders, etc.	5	2	4	5	3	1
Green Solutions	Potential to employ green solutions, such as bioengineering, plantings, natural channel and other “soft” erosion mitigation approaches.	5	2	3	3	4	5
	Criteria Subtotal		6	11	13	10	7
	Weighted Score (25% of final score)		10.0	18.3	21.7	16.7	11.7
Social / Cultural Environment (25%)							
Community Disruption and Recreational Impacts	Compatibility of proposed works with adjacent properties (i.e. removal or addition of features which reduces utility for neighbouring lands scores lower). Less or limited disruption to surrounding community and residents (e.g. access and use of park/trails).	5	2	3	2	1	1
Landowner and Public Acceptance	Ability to be accepted by landowners and community including First Nations and Indigenous consultation. This includes acceptance of impacts to trees.	5	2	3	5	2	1
Archaeological Impacts	Ability to protect built heritage resources, cultural heritage landscapes and archaeological resources.	5	4	4	3	1	2
	Criteria Subtotal		8	10	10	4	4
	Weighted Score (25% of final score)		13.3	16.7	16.7	6.7	6.7
Economic (25%)							
Construction and Capital Costs	Relative measure of initial costs to install/construct the proposed works.	5	5	4	3	2	1
Maintenance Costs	Relative measure of the ongoing maintenance costs in the creek.	5	3	3	4	5	4
Life-Cycle Costs	Relative measure of the lifespan of erosion mitigation works or existing assets.	5	3	3	4	5	5
	Criteria Subtotal		11	10	11	12	10
	Weighted Score (25% of final score)		18.3	16.7	18.3	20.0	16.7
Score (Maximum of 100 points)			**53.3**	**68.3**	**73.3**	**55.0**	**50.0**

East Morrison Creek Erosion Mitigation EA - Alternative Evaluation
Erosion Sites: E9, E10, E17

Criteria	Description	Maximum Score	Alternative 1: Do Nothing	Alternative 2: Continuous Monitoring	Alternative 3: Selective Works (Local)	Alternative 4: Reach-Scale Channel	Alternative 5: Removal of Risk
Physical / Natural Environment (25%)							
Management of Existing Erosion Risks	Effectiveness of the alternative to manage or mitigate erosion risks, both existing and ongoing, relative to the level of urgency.	5	1	4	4	2	3
Impacts to Aquatic and/or Terrestrial Habitat	Potential to provide greater improvements to aquatic and terrestrial species and habitat, while also considering potential construction impacts relative to existing condition.	5	4	4	2	1	3
Climate Change Adaptation/Resiliency	Relative potential to provide additional hydrological and ecological resiliency, through physical, hydrological, and ecological redundancy for buffering extreme events and seasonal climate shifts. Ability to improve geomorphic stability and natural components of watercourse function.	5	2	3	3	4	3
	Criteria Subtotal		7	11	9	7	9
	Weighted Score (25% of final score)		11.7	18.3	15.0	11.7	15.0
Technical / Engineering (25%)							
Technical Feasibility	Constructability and construction access. Ability to limit impacts to existing infrastructure (e.g., sewers, watermains, gas, roads), including the feasibility of not intervening.	5	3	5	3	2	1
Approvability	Acceptability of agencies, community members and stakeholders. Less complexity of the Project: Consider permitting/coordination requirements with community members and stakeholders, etc.	5	3	5	4	2	1
Green Solutions	Potential to employ green solutions, such as bioengineering, plantings, natural channel and other “soft” erosion mitigation approaches.	5	2	3	3	4	5
	Criteria Subtotal		8	13	10	8	7
	Weighted Score (25% of final score)		13.3	21.7	16.7	13.3	11.7
Social / Cultural Environment (25%)							
Community Disruption and Recreational Impacts	Compatibility of proposed works with adjacent properties (i.e. removal or addition of features which reduces utility for neighbouring lands scores lower). Less or limited disruption to surrounding community and residents (e.g. access and use of park/trails).	5	3	4	3	1	1
Landowner and Public Acceptance	Ability to be accepted by landowners and community including First Nations and Indigenous consultation. This includes acceptance of impacts to trees.	5	2	3	4	1	1
Archaeological Impacts	Ability to protect built heritage resources, cultural heritage landscapes and archaeological resources.	5	4	4	3	1	2
	Criteria Subtotal		9	11	10	3	4
	Weighted Score (25% of final score)		15.0	18.3	16.7	5.0	6.7
Economic (25%)							
Construction and Capital Costs	Relative measure of initial costs to install/construct the proposed works.	5	5	4	3	2	1
Maintenance Costs	Relative measure of the ongoing maintenance costs in the creek.	5	4	4	3	5	4
Life-Cycle Costs	Relative measure of the lifespan of erosion mitigation works or existing assets.	5	3	3	4	5	5
	Criteria Subtotal		12	11	10	12	10
	Weighted Score (25% of final score)		20.0	18.3	16.7	20.0	16.7
Score (Maximum of 100 points)			**60.0**	**76.7**	**65.0**	**50.0**	**50.0**

East Morrison Creek Erosion Mitigation EA - Alternative Evaluation
Erosion Sites: E14, E15, E16

Criteria	Description	Maximum Score	Alternative 1: Do Nothing	Alternative 2: Continuous Monitoring	Alternative 3: Selective Works (Local)	Alternative 4: Reach-Scale Channel	Alternative 5: Removal of Risk
Physical / Natural Environment (25%)							
Management of Existing Erosion Risks	Effectiveness of the alternative to manage or mitigate erosion risks, both existing and ongoing, relative to the level of urgency.	5	1	4	4	2	3
Impacts to Aquatic and/or Terrestrial Habitat	Potential to provide greater improvements to aquatic and terrestrial species and habitat, while also considering potential construction impacts relative to existing condition.	5	4	4	2	1	2
Climate Change Adaptation/Resiliency	Relative potential to provide additional hydrological and ecological resiliency, through physical, hydrological, and ecological redundancy for buffering extreme events and seasonal climate shifts. Ability to improve geomorphic stability and natural components of watercourse function.	5	2	4	3	4	3
	Criteria Subtotal		7	12	9	7	8
	Weighted Score (25% of final score)		11.7	20.0	15.0	11.7	13.3
Technical / Engineering (25%)							
Technical Feasibility	Constructability and construction access. Ability to limit impacts to existing infrastructure (e.g., sewers, watermains, gas, roads), including the feasibility of not intervening.	5	3	5	3	2	1
Approvability	Acceptability of agencies, community members and stakeholders. Less complexity of the Project: Consider permitting/coordination requirements with community members and stakeholders, etc.	5	4	5	3	2	1
Green Solutions	Potential to employ green solutions, such as bioengineering, plantings, natural channel and other “soft” erosion mitigation approaches.	5	2	3	3	4	5
	Criteria Subtotal		9	13	9	8	7
	Weighted Score (25% of final score)		15.0	21.7	15.0	13.3	11.7
Social / Cultural Environment (25%)							
Community Disruption and Recreational Impacts	Compatibility of proposed works with adjacent properties (i.e. removal or addition of features which reduces utility for neighbouring lands scores lower). Less or limited disruption to surrounding community and residents (e.g. access and use of park/trails).	5	3	4	2	1	1
Landowner and Public Acceptance	Ability to be accepted by landowners and community including First Nations and Indigenous consultation. This includes acceptance of impacts to trees.	5	3	4	2	1	1
Archaeological Impacts	Ability to protect built heritage resources, cultural heritage landscapes and archaeological resources.	5	4	4	3	1	2
	Criteria Subtotal		10	12	7	3	4
	Weighted Score (25% of final score)		16.7	20.0	11.7	5.0	6.7
Economic (25%)							
Construction and Capital Costs	Relative measure of initial costs to install/construct the proposed works.	5	5	4	3	2	1
Maintenance Costs	Relative measure of the ongoing maintenance costs in the creek.	5	4	4	3	4	4
Life-Cycle Costs	Relative measure of the lifespan of erosion mitigation works or existing assets.	5	3	3	4	5	5
	Criteria Subtotal		12	11	10	11	10
	Weighted Score (25% of final score)		20.0	18.3	16.7	18.3	16.7
Score (Maximum of 100 points)			**63.3**	**80.0**	**58.3**	**48.3**	**48.3**

APPENDIX K
Preliminary Functional Design Report and Drawings

PRELIMINARY FUNCTIONAL DESIGN REPORT

EAST MORRISON CREEK EROSION MITIGATION STUDY

Prepared for: **TOWN OF OAKVILLE**

Prepared by: **MONTROSE ENVIRONMENTAL SOLUTIONS CANADA INC.**

Version V1.0
March 2026
Oakville, Ontario

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PRELIMINARY FUNCTIONAL DESIGN REPORT

EAST MORRISON CREEK EROSION MITIGATION STUDY

Prepared for Town of Oakville, March 2026

March 30, 2026

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VERSION CONTROL

Version	Date	Issue Type	Filename	Description
V0.1	10-Sep-2025	Draft	36236 Preliminary Functional Design Report 2025-09-10 Draft v0.1.docx	Issued to client for review
V0.2	15-Jan-2026	Revised Draft	36236 Preliminary Functional Design Report 2026-01-15 draft v0.2.docx	Issued to client for stakeholder review
V1.0	31-Mar-2026	Final	36236 Preliminary Functional Design Report 2026-03-31 F V1.0.docx	Issued for public review

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APPENDICES

1 INTRODUCTION

The study area of East Morrison Creek from Postridge Drive to the Morrison-Wedgewood Diversion Channel was first identified as a high-priority "long" reach area of concern in the *Town of Oakville 2021 Creek Inventory and Assessment* (Aquafor Beech 2022). Key concerns include bank erosion within the creek, bank and valley slope stability, failure of erosion control measures, and threats to private property and municipal infrastructure. To address the identified erosion risks within the study area, the Town of Oakville (the Town) is undertaking a Schedule B Municipal Class Environmental Assessment (EA). Schedule B projects include Phase 1 to identify the problems and Phase 2 to evaluate alternative solutions. The purpose of the study is to develop, evaluate, and recommend preferred alternatives for erosion control within Reaches 39 to 45 of East Morrison Creek.

Montrose Environmental Solutions (Montrose, formerly Matrix Solutions Inc.) was retained to undertake this study on behalf of the Town. This included an assessment of existing conditions, development and evaluation of alternatives, and selection of the preferred solution which is documented in the *East Morrison Creek Erosion Mitigation Study – Environmental Study Report* (ESR; Montrose 2026).

The 23 erosion sites identified in the 2021 inventory (Aquafor Beech 2022) were reassessed by Montrose in 2023 and one additional site was identified. Twelve of the highest priority erosion sites were identified for inclusion in the EA evaluation. Through the Class EA process, multiple alternative solutions for erosion mitigation were developed and evaluated and a preferred alternative was selected for each of the sites. Selective works was selected as the preferred alternative for 6 of the sites and continuous monitoring was selected for the other 6 sites. Preliminary functional designs were prepared for the 6 sites where selective works was the preferred alternative. These sites were grouped into 3 project areas with local channel remediation and erosion control works.

The purpose of this report is to outline the preliminary functional designs for erosion mitigation works proposed within the East Morrison Creek study area. The report outlines the site conditions and proposed work, provides rational for the design approach, and defines the design criteria and technical specifications. It also provides preliminary recommendations for construction staging, implementation, and restoration.

2 EXISTING CONDITIONS

Existing conditions through the study area are described in Section 3 of the ESR. The 6 erosion sites, grouped into 3 project areas, where remedial work is proposed are summarized below.

2.1 Sites E4 and E24

Erosion sites E4 and E24 are adjacent valley contacts with slope and toe erosion that pose a risk to private properties at the top of the slope. The existing gabion basket toe protection in failing. These sites are located within a high-risk slope instability zone identified through the geotechnical assessment (Thurber 2025).

2.2 Sites E5, E6, and E7

Erosion sites E5, E6, and E7 are in close proximity and have been grouped into the second project area. They are located upstream of E4 and E24.

At E5 the gabion baskets lining both channel banks are constricting the channel and failing. A large scour pool has developed at the downstream extent. This poses a risk to the pedestrian trail and an upstream pedestrian bridge.

E6 is a perched stormwater outfall on the valley slope with a suspended gabion basket drop structure. A large scour pool has developed downstream, and it appears to be accelerating erosion at the toe of the valley slope which poses a risk to the outfall structure and private properties at top of slope.

E7 is a valley contact with toe erosion posing a risk to private property, a parking lot, at the top of the slope. E6 and E7 are located in another high-risk slope instability zone identified by Thurber (2025). Potential impacts at 1359 White Oaks Boulevard were observed, including fence posts migrating down slope and separation of the east portion of the parking lot.

2.3 Site E11

Erosion site E11 is located on the tributary of East Morrison Creek. There is a 1,500 mm diameter corrugated steel pipe (CSP) through a berm at a trail crossing of the tributary. A 200 mm diameter sanitary sewer with a concrete encasement also crosses the tributary at this location above the CSP. At the CSP outlet, the bottom of the culvert was corroded, and flow was undermining the pipe. The outlet was perched and there was a downstream scour pool. Continued erosion to the embankment at the culvert outlet poses a risk to the sanitary sewer above. Based on mapping of the sanitary sewer, the surveyed top of bank at the outlet was 1.88 m from the sewer.

2.4 Tree Inventory and SAR Assessment

A tree inventory was completed on June 11, 2025. A total of 495 trees were inventoried within the work areas proposed for selective works. Twenty-two species were observed, with Sugar maple (*Acer saccharum*) being the most common (n = 288). Other common species included ironwood (*Ostrya virginiana*) (n = 31), red oak (*Quercus rubra*) (n = 28), Norway maple (*Acer platanoides*) (n = 27), and white pine (*Pinus strobus*) (n = 21). No Species at Risk (SAR) or regionally rare trees were recorded.

A detailed arborist report is provided in Appendix K1 of this preliminary design report.

3 DESIGN OVERVIEW

3.1 Sites E4 and E24

The proposed work at E4 and E24 involves realigning the channel away from the toe of slope and replacing the existing gabion baskets with armourstone walls. The channel will be shifted approximately 2 m from the slope and the existing slope will be regraded and restored. The channel will be reconstructed with riffle-pool bed morphology using platy limestone (flagstone) similar to native materials. Channel banks should be restored using bioengineering. Vegetated flagstone buttress bank protection is proposed on outer bends, beyond the armourstone walls, where natural and gradual erosion processes are anticipated. Bed and bank treatments should tie-in smoothly to the existing upstream and downstream channel. Tree removals and site restoration will be required.

3.2 Sites E5, E6, and E7

The proposed work at E5 involves removal of the gabion baskets and reconstructing a wider channel with a natural channel design. The existing pedestrian bridge is proposed to be replaced with a wider span bridge to accommodate a wider channel. The channel will be reconstructed with riffle-pool bed morphology using platy limestone (flagstone) similar to native materials. Banks are to be restored with bioengineering. Vegetated flagstone buttress bank protection is proposed on outer bends where erosion is anticipated. Bed and bank treatments should tie-in smoothly to the existing upstream and downstream channel and the works proposed at E6. Tree removals and site restoration will be required.

At E6 the proposed work consists of removing the gabion basket drop structure, reinforcing the outfall with armourstone and reconstructing the outfall channel. Tiered armourstone apron protection is proposed to prevent incision and undermining of the outfall structure and erosion of the valley slope. Grouted armourstones installed below the apron are proposed with additional armourstones tied in as wingwalls to provide toe protection.

A formalized scour pool design is proposed downstream of the outfall and armourstone protection to dissipate flows from the outfall. The minimum pool depth is proposed to be 1 m relative to the outfall invert, in keeping with plunge pool design guidelines. The scour pool banks should be no steeper than 2:1 H:V.

A riffle is proposed to be constructed from the terminus of the scour pool to the tie-in with the outfall channel to provide a natural grade control to the scour pool. The riffle crest elevation will be constructed to match the outfall invert to reduce backwatering of the outfall. The channel banks along the riffle may be treated with a “softer” stabilizing treatment, such as coir cloth, live stakes, and plantings. This tributary outfall channel is to connect the E6 outfall to the main channel of East Morrison Creek at site E5.

At E7 a slight channel realignment is proposed to shift the channel away from the valley slope. Vegetated flagstone buttress protection is proposed along the toe of slope and the upper slope will be restored. The channel will be reconstructed with riffle-pool bed morphology using platy limestone (flagstone) similar to native materials. Channel banks should be restored using bioengineering. Bed and bank treatments should tie-in smoothly to the existing upstream and downstream channel. Tree removals and site restoration will be required. Site E7 restoration is located about 30 m upstream of sites E5/E6 with a proposed gap between the channel restoration works to be confirmed through detailed design.

3.3 Site E11

The proposed work at E11 involves retrofitting the CSP crossing, stabilizing the trail embankment with armourstone, and stabilizing the downstream channel. The CSP culvert will be reinforced with a slipliner and pressure grouted to fill the annular void. Armourstone headwalls/wingwalls will be installed to stabilize the embankment and prevent incision and undermining of the culvert. No change to the sanitary sewer above the CSP is proposed, but protection will be required during construction.

Tree removals and site restoration will be required. The upstream and downstream channel and banks/slopes should also be restored.

A formalized scour pool design is proposed downstream of the CSP to dissipate flows from the culvert. The minimum pool depth is proposed to be 1 m relative to the outfall invert, in keeping with plunge pool design guidelines. The scour pool banks should be no steeper than 2:1 H:V.

A rocky riffle ramp is proposed to be constructed from the terminus of the scour pool to the tie-in with the existing tributary to provide grade control. The riffle crest elevation will be constructed to match the outfall invert to reduce backwatering of the outfall. The channel banks along the riffle may be treated with a "softer" stabilizing treatment, such as coir cloth, live stakes, and plantings.

3.4 Natural Channel Design and Aquatic Habitat

Restoration of aquatic habitat should be incorporated into the design of the bankfull channel. Considerations such as appropriate channel substrate, maintenance of minimum water depths, consideration of swimming speeds and fish passage, and provision of shade and hiding area by riparian plantings should be addressed at detailed design.

Bank Treatments: Bank treatments/restoration, such as staked coir cloth and plantings, in combination with armourstone walls and flagstone buttresses.

Woody Material: Woody material should be incorporated into the floodplain restoration design and make use of existing root balls and/or dead trees containing habitat cavities where feasible.

Substrate: Bed substrate should be platy limestone or flagstone similar to native materials. Substrate will include a natural gradation of gravel and cobble at riffles, and fine to gravel sized material within pools. Substrate gradation will be specified at detailed design with respect to channel thresholds, substrate mobility, and sediment transport criteria.

Hydraulic Conditions and Aquatic Habitat: Given the width of the floodplain corridor and limited channel realignments, no significant changes to flood levels are expected. Fish passage considerations for the bankfull and low flow channel will be included at detailed design.

3.5 Erosion Mitigation Structures

Armourstone walls and vegetated flagstone buttress are the main erosion mitigation structures proposed for remedial works within the study area.

Armourstone walls consist of large, flat stones of dolomite, limestone or granite that are stacked and may be staggered. Compacted granular backfill is placed behind the wall to satisfy potential geotechnical drainage and stability issues, combined with tie-in coverage of the native materials. Bioengineering features (e.g., brush layers) can be installed at the top of the wall to further stabilize the bank, where sufficient light and moisture conditions are available. Armourstone walls are a relatively cost-effective method to mitigate high erosion potential in constrained situations. They facilitate less habitat potential than "softer" erosion mitigation techniques but are able to withstand higher velocities and can be placed at near-vertical side slopes where land is limited. Armourstone walls require heavy machinery for installation, but require little to no maintenance for decades.

Vegetated stone buttresses are used to minimize erosion and can also improve habitat within the restoration area. The treatment consists of layers of larger stone with mixture of smaller stone and soil between them. The stones are sized to resist the applied shear forces exerted at each particular location within the channel. East Morrison

Creek is a shale bedrock system; therefore, platy limestone or flagstone, similar to native materials, should be used instead of roundstone. A flagstone buttress consists of embedded armourstone at the toe of slope with a stack of flagstone on top. A flagstone mix is placed on top to create a 2:1 slope. The underlying fill material must be properly compacted prior to installation of the stones, in order to avoid a slope failure. Seasonally appropriate woody vegetation or other bioengineering features are placed between the stones to promote vegetative growth, increasing overall stability and contributing to riparian habitat.

3.6 Hydraulic and Floodline Assessment

Conservation Halton (CH) provided a HEC-RAS model of base conditions on East Morrison Creek that was updated with survey data to form a new Basis of Comparison existing conditions model and updated to reflect the proposed channel design conditions.

The model provided by CH includes associated files and an accompanying memorandum titled, *Morrison Wedgewood Floodplain Mapping Documentation for Use of Modelling* dated July 22, 2020. GIS mapping of HEC-RAS cross-section locations, as well as spills and flood hazards, was included in the package (data.gdb). The HEC-RAS model includes Morrison Creek from Dundas Street East to the confluence with the Morrison Wedgewood Diversion Channel. Within the study area, between Upper Middle Road East and the confluence, there are approximately 34 existing cross-sections, based on CH's 2018 LiDAR data.

3.6.1 Hydrology

Design flows for the tributary were taken from the *Flood Risk Mapping and Spill Quantification – Morrison-Wedgewood Diversion Channel Volume 1: Hydrologic Modelling Report* by Morrison Hershfield (2020). Per Figure 12 of the report, flow values from reference point 404 were used, where the tributary confluence with the main East Morrison channel is located. Flow values were consistent across each existing and future scenario in the hydrologic study. Tributary flows were added to steady flow scenario 2 within HEC-RAS as this is the scenario noted to used for regulatory purposes. Reach 6 extends from the newly added tributary to the confluence with the diversion channel.

The flows for the tributary and channel are summarized in Table 1 below.

TABLE 1 Existing peak flows within East Morrison Creek and Tributary

HEC-RAS Reach	River Station	2-year	5-year	10-year	25-year	50-year	100-year	Reg
EMC, Reach 1	5371.4	2.47	4.57	6.33	8.95	10.75	12.64	30.89
EMC, Reach 1	5152.4	2.26	4.41	7.08	8.92	10.69	12.60	31.75
EMC, Reach 1	4525.4	2.28	4.42	6.95	8.94	10.71	12.62	32.13
EMC, Reach 2	3726.4	11.65	18.16	22.77	29.44	34.36	39.95	44.53
EMC, Reach 2	3515.4	12.18	19.20	24.49	32.38	38.65	45.37	51.57
EMC, Reach 2	2518.4	12.74	20.26	26.06	34.52	40.76	47.64	53.40
EMC, Reach 2	2227.4	10.68	21.91	25.77	33.26	39.07	45.73	55.56

HEC-RAS Reach	River Station	2-year	5-year	10-year	25-year	50-year	100-year	Reg
EMC, Reach 2 (Upstream of Tributary)	1335	9.70	18.68	24.57	31.16	36.60	42.59	55.68
Tributary	1729	3.70	5.81	7.50	9.73	11.24	12.77	6.53
EMC, Reach 6 (Downstream of Tributary)	1004	10.99	19.17	26.86	34.27	39.95	46.22	62.47

3.6.2 Existing Conditions Hydraulic Assessment

The model provided by CH was updated with cross-sections surveyed by Montrose (formally Matrix) in October 2023. Existing sections were updated, and new cross-sections were added at surveyed locations in EMC Reach 2 and EMC Reach 6 Stations 5 to 1812, EMC-Trib Reach 5).

I:\TownOfOakville\36236\FiguresAndTables\2025\Report\ProgressReport2\0_ArcPro_36236\0_ArcPro_36236.aprx - Tabloid_P - 14-Jan-26, 04:34 PM - ECho - TID003

Easting (m)

604000 604500 605000 605500 606000 606500

Northing (m)

4816500 4816000 4815500 4815000 4814500 4814000 4813500 4813000

N

Postridge Dr

Eighth Line

Trafalgar Rd

Upper Middle Rd

EMC Reach 1

East Morrison Creek

Trib to EMC Reach 1

EMC Reach 2

Tributary EMC-Trib Reach 5

EMC Reach 6

EWC Reach 1

WWC Reach 1

MWDC Reach 1

MWDC Reach 2

MWDC Reach 3

Trib to WMC Reach 1

WMC Reach 1

WMC Reach 2

Munn's Cr Reach 1

4525.4

3726.4

3515.4

2518.4

2227.4

1729

1335

1004

Study Limits

Watercourse

HEC-RAS Sections

1:12,000 metres

120 0 120 240

NAD 1983 CSRS UTM Zone 17N

Imagery (2023) World Imagery: Peel Region, Town of Oakville, VantorHydrography (2017) Source: Ontario Ministry of Natural Resources and Forestry

MONTROSE ENVIRONMENTAL

Town of Oakville

East Morrison Creek Erosion Mitigation Environmental Assessment

HEC-RAS Sections

Date:	Project:	Submitter:	Reviewer:
January 2026	36236	A. Yates	P. Campbell

Figure 1

3.6.3 Proposed Conditions Hydraulic Assessment

The existing hydraulic model was updated where appropriate to reflect the proposed design, grading, and crossing structures. The model was updated with the proposed design surface for sites E4, E24, E5, E6, and E7. These sites are located in EMC Reach 6 of the model and span river stations 920 to 899, 828 to 739, and 676 to 338, see **Figure 2**.

An update was applied to the culvert crossing inlet type to reflect the proposed design changes to the headwall at site E11, located in the model at in the model culvert EMC Trib Reach 5: 1675.

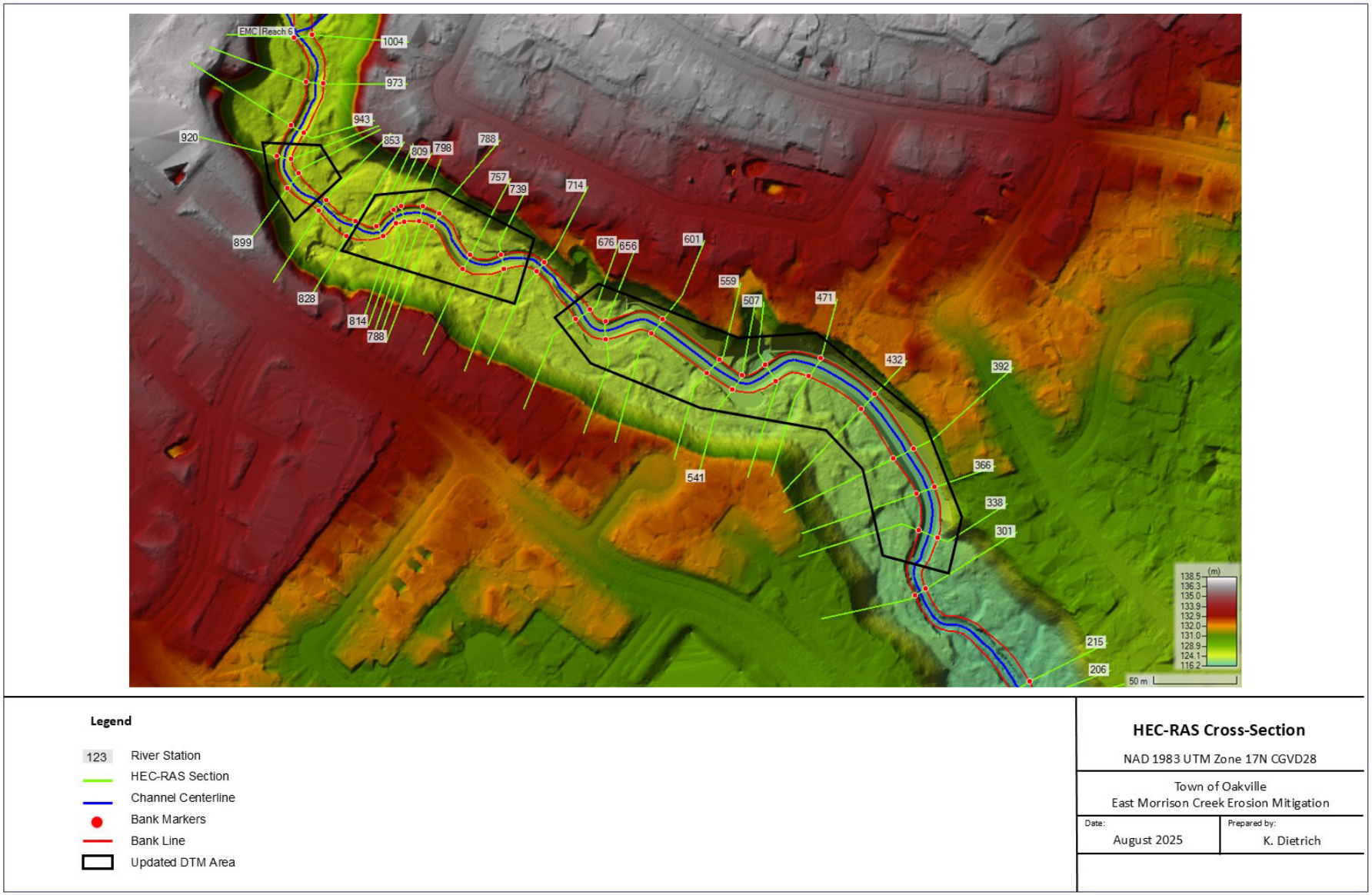

FIGURE 2 HEC-RAS DTM and Cross-section Updated Areas

To update the model cross-sections, the design surfaces for the proposed conditions were added to the terrain layer in *RAS Mapper*. Bank lines were added to the cross-sections within the proposed surface areas to update bank marker stations. See Table 6 for the full list of cross-sections with main channel topography updated. Reach lengths were updated where there was a change in channel alignment.

An update to the inlet structure type was made to site E11 in the model, culvert EMC Trib Reach 5: 1675, to reflect the proposed design changes to the headwall by changing the "Scale #" from "Pipe projecting from fill" to "Headwall."

Reach lengths were updated for each cross-section that also had the downstream cross-section updated, see **Table 2**.

TABLE 2 Summary of Model Updates

River Station	Cross-Section Updated	Bank Markers Updated	Main Channel Reach Length Updated
920	Yes	Yes	Yes
899	Yes	Yes	
828	Yes	Yes	Yes
814	Yes	Yes	Yes
809	Yes		Yes
798	Yes		Yes
788	Yes		Yes
757	Yes	Yes	Yes
739	Yes	Yes	
676	Yes		Yes
656	Yes	Yes	Yes
601	Yes		Yes
559	Yes		Yes
541	Yes	Yes	Yes
507	Yes	Yes	Yes
471	Yes	Yes	Yes
432	Yes	Yes	Yes
392	Yes		Yes
366	Yes		Yes
338	Yes	Yes	

Comparison tables for the existing conditions and proposed conditions of water surface elevation, channel velocity, and shear stress is provided in Appendix K2. The result of the updated HEC-RAS model demonstrates that the proposed conditions have minimal impact on the water elevation, meaning that changes to the flood lines are also minimal. While preliminary modelling shows local increases and decreases in the water level, on average across all events in the study area the water levels decrease in the range of 10 to 20 cm, with the majority of the

differences between -40 cm and + 10 cm. Channel velocity was found to have increased in sections of the channel at EMC Reach 6 river stations 757, 507, and 432, likely due to changes proposed changes in cross-section shape, which will require further investigation and adjustments to the channel profile at detailed design to ensure local channel erosion processes are not increased. The results of the channel shear stress show a similar relationships to the channel velocity output. As such, the hydraulic capacity of the channel is maintained for the purposes of the preliminary design, and updated hydraulic modelling for detailed design is expected to more accurately capture the acceptability and/or benefits of the modified channel conditions.

3.7 Restoration Plan

The ecological restoration plans for the proposed realignment corridor are to be further developed through detailed design by specialized creek restoration consultants in consultation with the Town, and with consideration of Conservation Halton and other relevant guidelines. The restoration objectives of the design should generally focus on establishing resilient and ecologically valuable native vegetation and habitat features facilitated by influencing the natural trajectory of the corridor as it matures post-implementation. Restoration objectives for the preliminary design are outlined as follows:

- establish robust riparian habitat through planting and seeding with species native to the region
- maximize canopy cover within the riparian corridor to enhance aquatic habitat through thermal mitigation and input of organic material to the water column
- utilize native shrub species along channel banks to bioengineer additional stability through root establishment
- consider additional habitat features where feasible (woody debris, wood and stone piles, bat habitat)
- complete invasive species monitoring and management along access routes and work areas to prevent the establishment of invasive species (invasive species monitoring and management plan to be coordination with the Town's current Town-wide initiatives)

Based on the concept plans for the project sites recommended through the East Morrison Creek Erosion Mitigation EA, preliminary recommendations for the tree preservation and compensation plans, and trail restoration plan, are provided in the following sections.

3.7.1 Preliminary Tree Preservation and Tree Compensation Plans

The total project work areas requiring vegetation and tree removal for construction is estimated to be approximately 1.9 ha distributed between the three sites. Additional areas of disturbance and tree impacts are expected along the access routes. The tree inventory results documented in Appendix K1 include 495 individual trees (DBH = 7 – 92 cm) representing 22 different species, heavily dominated by Sugar Maple (*Acer saccharum*). The ELC classifications within the proposed project areas are primarily Fresh – Moist Sugar Maple – Hardwood Deciduous Forest (FOD6-5), Dry – Fresh Sugar Maple – Oak Deciduous Forest (FOD5-3), and Dry – Fresh Hardwood – Hemlock Mixed Forest (FOM3-1).

A detailed vegetation restoration plan is to be developed for all disturbed areas with input from creek restoration specialists, ecologists and certified arborists. The selected plantings should target both riparian and upland areas with species consisting of a mixture of native deciduous and coniferous trees, shrubs, and seed mixes. The plan is

expected to include compensation for trees removed for construction in accordance with accepted ratios based on Town standards, and with reference to CH's *Guidelines for Landscaping and Rehabilitation Plans, Seed Mixes, and Native Species List* (Halton Region 2018) documents.

The Town's approach to tree protection and restoration includes making every effort to avoid the removal of heritage trees and minimize overall tree loss. Where removal is unavoidable, the Town adheres to a "no net loss or canopy cover" standard and will provide compensation for tree loss as a result of construction activities. Where trees are required to be removed from the banks to accommodate the proposed design, consideration is to be given to their replacement either at the same location or as close as possible to the original location. Where banks cannot be revegetated with trees because of space limitations, shrub vegetation are to be considered.

Per the Town's tree restoration approach, replacement plantings will consist of site-specific native species, selected to suit local conditions and avoid disruption to existing ecosystems. Restoration plantings have been designed to augment the total area of canopy cover through nodal tree plantings combined with shrub plantings and native seeding. Nodal tree plantings are intended to allow shrub and herbaceous understory to establish while the new canopy is allowed to develop through succession to woodlot and eventually to forest. The Town will consider a mix of younger plant stock to increase planting densities to help reach target replacement ratios and larger trees to provide shade, enhance planting feasibility, and ensure long-term success.

- Tree planting density is recommended to be at least 5 trees per 100 m^2 restored area. Shrub planting density is recommended to be at least 5 shrubs per 1 tree planted (i.e., minimum planting density of 5 trees and 25 shrubs per 100 m^2 restored area).
- Typical tree and shrub spacing are recommended to be 2.5 m and 1 m, respectively, resulting in approximately 5 trees and 25 shrubs per 50 m^2 restored area.
- Higher planting densities may be considered where feasible and approved by a qualified ecologist to maximize onsite compensation for tree removals and thus minimize offsite planting requirements.
- The approximate size distribution of planted trees is recommended to be:
    - 5% caliper
    - 50% whip and/or sapling
    - 45% seedling and/or plug
- Groundcover seed mixes to be specified by a qualified restoration specialist/ecologist with reference to established guidelines and best practices.
- Planting season April-December

Provisional planting recommendations by species, sizes, and densities/spacing, including sample nodal tree/shrub planting cells, are provided in Tables 3-5 and the preliminary design drawings, sheet 9 (Appendix K3).

Planting quantities and compensation requirements will be determined at detailed design based on tree removals and the final tree inventory including staging areas and access routes as well as Town standards and consultation. It is noted that Six Nations required a tree replacement ratio of 10:1, regardless of DBH, on a previous project with the Town. This was also communicated by Six Nations through consultation on this report, as document in

Appendix H6 of the ESR. In comparison to the recommendations outlined above, this would result in an estimated 1,900 trees and 9,500 shrubs planted within the disturbed 1.9 ha; compared to the 4,950 replacement trees at a 10:1 ratio outlined by the Six Nations.

TABLE 3 Preliminary Deciduous Tree Planting Recommendations

Deciduous Trees*							
Code	**Qty.**	**Botanical Name**	**Common Name**	**Cal. (mm)**	**Ht. (cm)**	**Root**	**Comments**
As		Acer saccharum	SUGAR MAPLE				
Si	7	*Salix interior*	SANDBAR WILLOW		120	BALLED AND BURLAPPED	SINGLE LEADER, FULL BRANCHING
Sn	7	*Salix nigra*	BLACK WILLOW		120	BALLED AND BURLAPPED	SINGLE LEADER, FULL BRANCHING
Ps	9	*Prunus serotina*	BLACK CHERRY	45-60		BALLED AND BURLAPPED	SINGLE LEADER, FULL BRANCHING
Ov	9	*Ostrya virginiana*	IRONWOOD	45-60		BALLED AND BURLAPPED	SINGLE LEADER, FULL BRANCHING
Ta	6	*Tilia americana*	AMERICAN BASSWOOD	60-75		BALLED AND BURLAPPED	SINGLE LEADER, FULL BRANCHING
Qr	10	*Quercus rubra*	RED OAK	60-75		BALLED AND BURLAPPED	SINGLE LEADER, FULL BRANCHING
Qa	10	*Quercus alba*	WHITE OAK	60-75		BALLED AND BURLAPPED	SINGLE LEADER, FULL BRANCHING
Fg	10	*Fagus grandifolia*	AMERICAN BEACH	60-75		BALLED AND BURLAPPED	SINGLE LEADER, FULL BRANCHING
Asi	11	*Acer saccharinum*	SILVER MAPLE	60-75		BALLED AND BURLAPPED	SINGLE LEADER, FULL BRANCHING
Cc	10	*Carya cordiformis*	BITTERNUT HICKORY	45-60		BALLED AND BURLAPPED	SINGLE LEADER, FULL BRANCHING
Co	6	*Carya ovata*	SHAGBARK HICKORY	45-60		BALLED AND BURLAPPED	SINGLE LEADER, FULL BRANCHING

*Exact tree placement to be determined onsite during construction

TABLE 4 Preliminary Coniferous Tree Planting Recommendations

Coniferous Trees*							
Code	**Qty.**	**Botanical Name**	**Common Name**	**Cal. (mm)**	**Ht. (cm)**	**Root**	**Comments**
To	12	*Thuja occidentalis*	EASTERN WHITE CEDAR		100	POTTED	STRAIGHT TRUNK, FULL CROWN
Ps	12	*Pinus strobus*	WHITE PINE		100	POTTED	STRAIGHT TRUNK, FULL CROWN

*Exact tree placement to be determined onsite during construction

TABLE 5 Preliminary Shrub Planting Recommendations

Shrub Plants						
Code	**Qty.**	**Botanical Name**	**Common Name**	**Ht. (cm)**	**Type**	**Remarks**
Hv	190	*Hamamelis virginiana*	WITCH-HAZEL	60	3 GAL.	MIN. 3 STEMS
Sc	190	*Sambucus canadensis*	BLACK ELDERBERRY	60	3 GAL.	MIN. 3 STEMS
Sp	190	*Salix petiolaris*	SLENDER WILLOW	60	3 GAL.	MIN. 3 STEMS
Cs	190	*Cornus stolonifera*	RED OSIER DOGWOOD	1.5 cm thick	LIVE STAKE	45-60 cm
Vl	190	*Viburnum lentago*	NANNYBERRY	60	3 GAL.	MIN. 3 STEMS
Rt	190	*Rhus typhina*	STAGHORN SUMAC	60	4 GAL.	BUSHY, FULL CROWN
Ca	190	*Cornus alternifolia*	ALTERNATE-LEAF DOGWOOD	60	3 GAL.	MIN. 3 STEMS
Cc	190	*Corylus cornuta*	BEAKED HAZEL	60	3 GAL.	BUSHY, FULL CROWN
Al	190	*Amelanchier arborea*	JUNEBERRY	45	3 GAL.	MIN. 3 STEMS
Cr	190	*Cornus racemosa*	GREY DOGWOOD	1.5 cm thick	LIVE STAKE	45-60 cm
Ro	190	*Rubus occidentalis*	BLACK RASPBERRY	45	1 GAL.	FULL, BUSHY
Ri	190	*Rubus idaeus*	RED RASPBERRY	45	1 GAL.	FULL, BUSHY

3.7.2 Trail Restoration Plan

The proposed access routes from City roads and potential staging areas identified utilize existing pedestrian trails into and through the East Morrison Creek valley. These pedestrian trails are primarily gravel surfaces and small span pedestrian bridges which cross the bankfull channel. Steeper access trails from upland roads include sections of asphalt, staircases and gates. A trail restoration plan is to be developed through detailed design, with some key issues and considerations listed below:

- A pedestrian traffic management and trail closure plan is required for implementation in conjunction with the construction access and trail restoration plans.
- Potential conflicts with existing infrastructure and utilities will require site-specific management plans (e.g., overhead electrical wires).
- Selective tree removals are expected to be required to allow for access of heavy equipment to the project sites, with preliminary observations provided in Appendix K1.
- For heavy traffic areas, protectively layer of wood chips and/or bark mulch, and potential use of underlying geogrid/geotextile, may be specified through detailed design to allow mitigate impacts to tree roots along the recreational gravel trails.
- Tree trimming to accommodate construction traffic and vehicles is expected and will require direction through design and tendering documents.
- Assessment of the removal, salvage and reinstatement or protection of existing trail infrastructure, including gateway features, stairs, armour stone, garbage cans, and signage.
- During construction, the contractor will be responsible for maintenance of all access routes, and restoration back to original or better condition (e.g., gravel trail, local sections of asphalt), with reference to detailed design and tendering specifications for the trail restoration plan.
- Trail restoration is expected to meet Town standards for safety and accessibility.

4 PERMITTING AND APPROVALS

4.1 Regulatory Agencies

The following natural heritage permits and approvals are anticipated for the project:

Department of Fisheries and Oceans Canada (DFO) – A Request for Review from the DFO will be required for the proposed construction works within East Morrison Creek and will determine whether a Letter of Advice or Fisheries Act Authorization will be applicable to the project. Any additional requirements identified by the DFO will be incorporated.

Conservation Halton (CH) – A permit under Section 28 of O. Reg. 41/24 for *Development, Interference with Wetlands and Alterations to Shorelines and Watercourses* is required from CH before any channel works.

Ontario Ministry of the Environment, Conservation, and Parks (MECP) – The proposed works will have minor impacts to candidate SAR bat habitat. To ensure compliance with the ESA, the project will be registered under the ESA 23.18 (1) 4 Threats to Health and Safety not Imminent - *Work to protect against drought, flooding, forest fires, unstable slopes and erosion as long as the protection does not include the building of new infrastructure.* A Notice of Activity and SAR Mitigation Plan shall be prepared prior to construction.

Licence to Collect Fish for Scientific Purposes – A fish salvage shall be completed in East Morrison Creek during dewatering. The acquisition of a License to Collect Fish for Scientific Purposes by a qualified individual shall be obtained from the MNR.

Wildlife Scientific Collectors Authorization – No wildlife is to be handled or relocated without a Wildlife Scientific Collectors Authorization from the MNR. This permit shall be obtained by a qualified individual prior to construction.

Damage or Danger Permit Under the Migratory Birds Regulations – A permit to remove the pileated woodpecker nesting cavities may be required if field assessments confirm them to be present.

4.2 Landowner Engagement

Landowner engagement will be required for proposed work on or near private properties. At erosion site E4, there are two private residential properties along Hillview Cresent that extend into the creek. Armourstone wall structures are proposed within these properties; therefore, an easement would be required. An additional 1-2 properties are within the proposed grading limits at erosion site E24. The proposed staging and access at erosion site E11 could impact driveway access for two properties on the Forest Glade Drive cul-de-sac. Engagement with these landowners should be initiated at the EA stage to facilitate property access and easement requirements.

There are several other properties within approximately 5 m of proposed access routes. Landowner engagement with any impacted properties should occur at detailed design when access routes are confirmed.

5 DESIGN EXPECTATIONS AND IMPLEMENTATION RECOMMENDATIONS

5.1 Construction Staging and Erosion and Sediment Control Plans

Preliminary construction access routes are provided in Appendix K3 (Sheet 1) and staging and ESC plans are to be refined through detailed design. Further considerations for detailed design are outlined below.

Temporary Water Management: A reliable means of managing and conveying creek flow though the site, such that the work can be completed in a dry condition, will be required. An arrangement that makes use of coffer dams and bypass pumps or pipes in a phased approach is proposed. For isolated work areas, a wet-weather contingency plan and fish/wildlife salvage and relocation will be required. As discussed above, water management within excavation areas of the work area will be required.

Access and Laydown: A construction access corridor and laydown area will be required to facilitate access to/from the site for large and heavy equipment and materials. As described above, an access route is proposed from White Oaks Boulevard, making use of connecting trails augmented for construction traffic. The access route will be required for the duration of construction. A centralized laydown area will be required for material stockpile,

storage, loading/offloading. Within the site, internal haul routes will be required. A secondary access route from Forest Glade Road is proposed to access site E11 on the tributary using the cul-de-sac as a staging area.

Erosion and Sediment Control: A phased erosion and sediment control plan is proposed, including measures such as silt fences, sediment traps, and check dams. To prevent mud and dust tracking, a mud mat will be required at each constriction access point. Silt laden dewatering effluent from active work areas must be treated for water quality using devices such as silt bags and filtration units prior to release to the surrounding environment. The requirements of erosion and sediment control will be summarized by an environmental protection plan.

Timing Windows and Phased Implementation: Seasonal timing windows associated with tree removals, ecological constraints, and weather, together with the project objectives and other constructability considerations, will be used to develop an implementation phasing plan and schedule.

5.2 Geotechnical Considerations

A geotechnical screening assessment of the study was completed as part of the EA report (Appendix D of ESR), and provisional recommendations for required detailed design recommendations are also provided in the EA report (Section 4.7).

5.3 Soil Management and Excess Soils

The project may generate some volume of excavated soils to be disposed offsite, which may require an interim stockpiling location to facilitate soil sampling, characterization, and disposal planning. The roles and requirements of O. Reg. 406/19 applicable to the project should be considered and carried forward for detailed design.

5.4 Construction Supervision

Protection of Existing Utilities and Infrastructure: The location and elevation of existing buried utilities and infrastructure within the work areas will be confirmed to establish the required protection both during construction and under the proposed conditions. For existing utilities and infrastructure near the proposed works, a pre- and post-condition closed circuit television (CCTV) inspection will be considered. Inspection and/or protection of far-field utilities, infrastructure, and structures will be considered where in proximity to construction vibration, loading, noise etc.

Construction supervision: Part time construction supervision should be performed to ensure that the objectives of the channel design and erosion mitigation works are realized. The supervisor will have experience in channel design and restoration. The supervision will enable construction issues to be addressed quickly and appropriately and ensure that important design details are implemented.

5.5 Monitoring Recommendations for Adaptive Management and Maintenance

Once the detailed design has been completed at each site, a monitoring plan should be developed in consultation with Conservation Halton.

Channels designed to mimic natural systems generally allow for some channel adjustments to occur in response to flows. Most adjustments to channel form will occur during the first year and then during large flow events, however channels may continue to adjust depending on the frequency and intensity of significant flows.

Sediment load from upstream sources may migrate into the site, further sculpting the cross-section planform and dimension periodically. To ensure adequate channel performance and profile stability, general field reconnaissance along the entire length of the work areas is recommended immediately after construction and after the first large flow event (20 mm storm event or greater) to identify any potential areas of concern. Monitoring should also visually assess channel and slope stability through the work areas to ensure design expectations are met and confirm that any remaining ESC measures in good repair. It is recommended that a pre-monitoring report will be produced to confirm that the site is stable and functioning as intended.

A 5-year post-construction monitoring program is proposed. The monitoring program should encompass a minimum of two bankfull flow events, which statistically is likely to occur within a period of five years. The 5-year post-construction monitoring program will begin following the completion of the channel works and site restoration. Monitoring should include benchmarked cross-sections, a benchmarked longitudinal channel profile, and a photographic inventory from known vantage points covering all key features within the restoration area. It is recommended that the first year of post-construction monitoring include visual ecological assessment in addition to the geomorphic survey and may include multi-season observations. This could include documentation in mid-spring and late summer / autumn to confirm that vegetation has established as intended. An annual report is required at the end of each monitoring year, which will include representative photographs from that year.

Following the establishment of monitoring, the collected data would be processed and presented in a summary report. Based on the results, a summary report of the observations would be prepared which would include a discussion around the results, channel performance as well as any relevant channel maintenance recommendations. Report sections will include description of pre-construction conditions, yearly summary of construction activities, including occurrences of SAR and mitigation measures implemented to avoid impacts.

5.6 As-Built Drawing and Analysis

An as-built survey shall be completed upon completion of all construction and restoration works. It is recommended that the as-built survey include collection of georeferenced unmanned aerial vehicle imagery to provide a visual record of finished conditions and allow for the development of a digital elevation model. This would be augmented using survey-grade GPS to record critical channel, floodplain, and headland features.

Once the collected survey data has been combined and subjected to a quality assurance/quality control process, the as-constructed surface should be compared to the design details to confirm conformance of the works. The comparative data should be presented as redlines overlain on the original design plans, specifically the plan view, profile, and cross-sections. Once the as-built design sheets are prepared, it is recommended that they be reviewed by a professional engineer and that a summary letter of the as-built findings is prepared.

5.7 Construction Cost Estimate

A high-level cost estimate was prepared to the nearest $100,000 for the proposed erosion mitigation works (**Table 6**). In North America, there is a standard for cost estimation; “ASTM E2516-11(2019), Standard Classification for Cost Estimate Classification System.” This standard sets five classes of estimates: Class 5, Class 4, Class 3, Class 2, and Class 1. In Canada, an alternate terminology is used as provided guidance by the federal government business practices. Cost classifications are Order of Magnitude (OME), Class D, Class C, Class B, and

Class A. For the building and general construction industry, the following are the boundaries in terms of expected accuracy.

- Class 5 or OME estimates have an expected accuracy from -30% to +50%
- Class 4 or Class D estimates, from -20% to +30%
- Class 3 or Class C estimates, from -15% to +20%
- Class 2 or Class B estimates, from -10% to +15%
- Class 1 or Class A estimates, from -5% to +10%

The accuracy of cost estimation is mainly dependent on the degree of project definition and the level of effort required to develop the estimate. Provided the estimate was prepared on the basis of a Conceptual Design, a nominal level of effort to develop the estimate and accuracy of the cost estimation should be expected. Conceptual design is defined as the beginning of a project when preliminary spatial needs have been identified, and a spatial program is being developed.

The costs provided herein represent a Class D estimate for the purposes of capital works planning, based on the length of channel works required, the type of channel works required, requirements for infrastructure alteration (such as wing walls), mobilization / demobilization, and restoration. In addition to construction costs, the estimates include a buffer for contingency costs of 20% of the construction cost. The total estimated construction costs are estimated at $3.5 million in 2025. Given the recommended investigations and assessments outlined in Sections 4.7 and 4.8 for detailed design and implementation, an additional 15% ($525K) is recommended to complete the engineering and supporting technical studies, for a total estimate of $4.025 million.

TABLE 6 Cost Estimate for the Preferred Alternatives

Erosion Site(s)	Description	Estimated Cost*
E4 & E24	Channel realignment away from toe of slope and replacement of gabion baskets with armourstone wall.	$1,800,000
E5, E6, & E7	E5: Removal of gabion baskets and channel realignment. E6: Erosion protection downstream of outfall. E7: Channel realignment and vegetated flagstone buttress at toe of slope.	$1,300,000
E11	Install slip liner and headwalls/wingwalls to reinforce culvert. Stabilize channel upstream and downstream.	$400, 000
	Total	**$3,500,000**

* An additional 15% recommended for engineering and supporting technical studies as noted in the text.

6 REFERENCES

Aquafor Beech Limited (Aquafor Beech). 2022. *Town of Oakville, 2021 Creek Inventory and Assessment*. Prepared for the Town of Oakville. Mississauga, Ontario. May 10, 2022.

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Thurber Engineering Ltd. (Thurber). 2025. *Geotechnical Slope Stability Hazard and Risk Assessment - Desktop Study & Site Inspection Report. East Morrison Creek Erosion Mitigation Study, Town of Oakville, Ontario*. Prepared for Matrix Solutions Inc. Oakville, Ontario. April 11, 2025.

APPENDIX K1
Arborist Report

EAST MORRISON CREEK EROSION MITIGATION

ARBORIST TREE SUMMARY MEMO

Prepared for: **TOWN OF OAKVILLE**

Prepared by: **MONTROSE ENVIRONMENTAL SOLUTIONS CANADA INC.**

Version 1.0
March 2026
Oakville, Ontario

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Oakville, ON, Canada L6H 0G5
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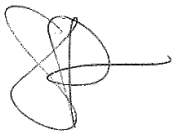
EAST MORRISON CREEK EROSION MITIGATION

ARBORIST TREE SUMMARY MEMO

Prepared for the Town of Oakville, March 2026

Adam Luke, B.Sc. ISA (ON-2853A)
Arborist/Restoration Specialist



reviewed by
Jessica Piette, B.ES, Dipl Env. Assessment
Senior Terrestrial Ecologist

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VERSION CONTROL

Version	Date	Issue Type	Filename	Description
V0.1	09-Sep-2025	Draft	36236-522 Arborist Memo 2025-09-09 Draft V0.1.docx	Issued to client for review
V0.2	15-Jan-2026	Revised Draft	36236-522 Arborist Memo 2026-01-15 Draft V0.2.docx	Issued to client for review
V1.0	31-Mar-2026	Final	36236-522 Arborist Memo 2026-03-31 Final V1.0.docx	Issued to client

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FIGURES

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APPENDICES

1 INTRODUCTION

The study area of East Morrison Creek (Figure 1) was identified as a high-priority "long" reach area of concern in the *Town of Oakville 2021 Creek Inventory and Assessment* (Aquafor Beech 2022). To address the identified erosion risks within the study area, the Town of Oakville (the Town) is undertaking a Schedule B Municipal Class Environmental Assessment (EA). The 23 erosion sites identified in the 2021 inventory were reassessed by Montrose in 2023 and one additional site was identified. Twelve of the highest priority erosion sites were identified for inclusion in the EA evaluation. Through the Class EA process, multiple alternative solutions for erosion mitigation were developed and evaluated and a preferred alternative was selected for each of the sites. Selective works was selected as the preferred alternative for 6 of the sites and continuous monitoring was selected for the other 6 sites. Preliminary functional designs were prepared for the 6 sites where selective works was the preferred alternative. These sites were grouped into 3 project areas with local channel remediation and erosion control works.

1.1 Study Area

This arborist memorandum outlines the tree inventory completed within the 3 project work areas where erosion mitigation works are proposed: E4 and E24; E5, E6, and E7; and E11. These three areas are critical to the proposed intervention plan, and the tree inventory conducted within these locations will play a key role in determining the feasibility and environmental impact of the proposed works. This memo describes the tree composition and distribution in these project areas, supporting the decision-making process for the remediation efforts.

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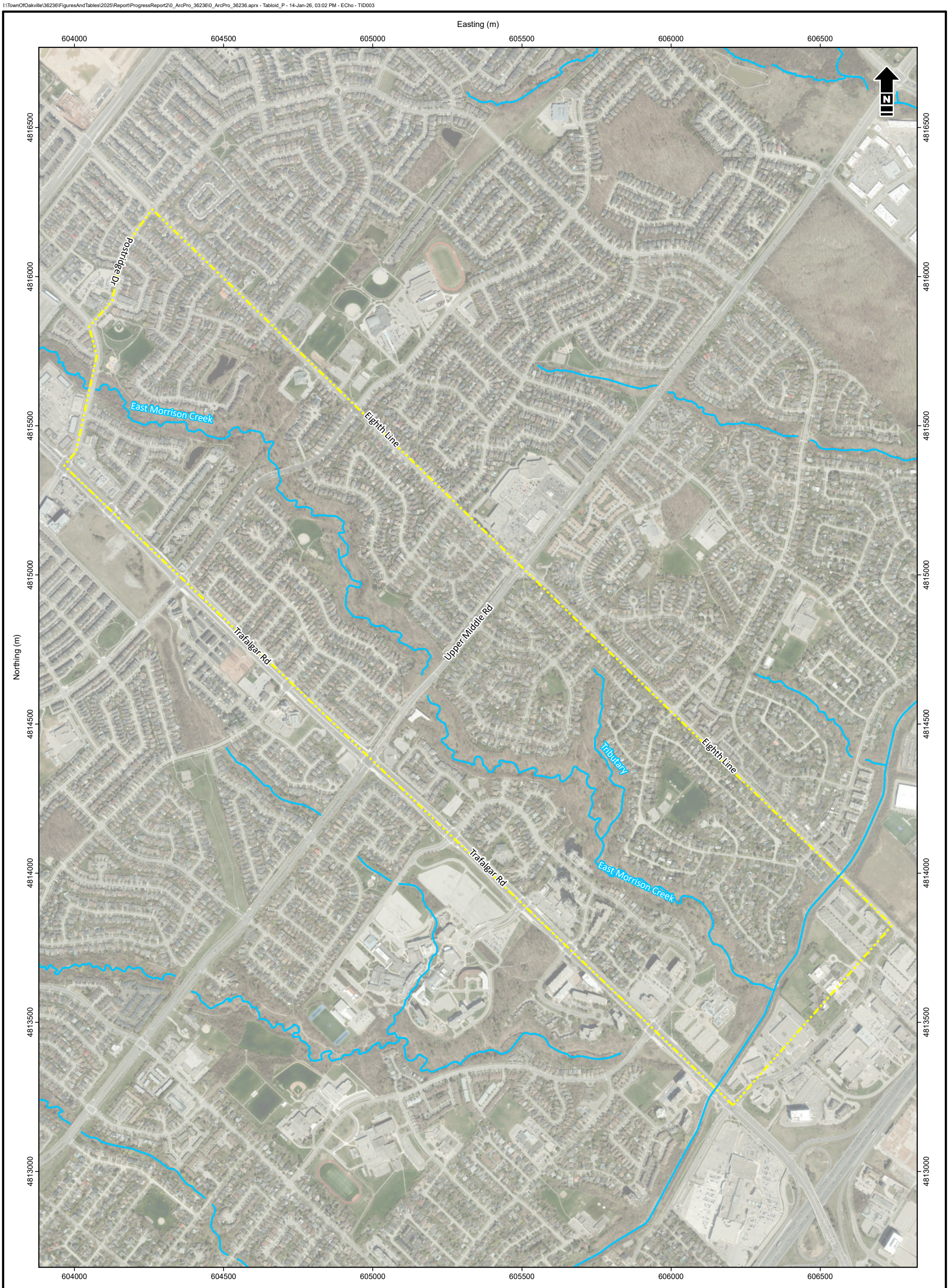

Study Limits

Watercourse

1:12,000 metres

120 0 120 240

NAD 1983 CSRS UTM Zone 17N

Imagery (2023) World Imagery: Peel Region, Town of Oakville, Vantor

MONTROSE ENVIRONMENTAL

Town of Oakville

East Morrison Creek Erosion Mitigation Environmental Assessment

Study Area

Date:	Project:	Submitter:	Reviewer:
January 2026	36236	A. Yates	P. Campbell

Figure 1

2 METHODOLOGY

Data Collection Parameters

- Diameter at Breast Height (DBH): The DBH of each tree was measured at 1.37 meters above ground level using a DBH tape.
- Tree Status (Alive/Dead)
- GPS Coordinates

Exclusions from Data Collection

- Radial Dripline Measurements: Measurements of the tree's radial dripline (canopy spread) were not included in this survey.
- Full Health Assessment: A comprehensive health assessment, including evaluation of diseases, pests, or structural defects, was not performed.

Tools and Equipment

- GPS Unit: Juniper Geode GNSS Receiver for recording the precise coordinates of each tree
- Stainless Steel Nails
- Aluminum Tree Tags
- Hammer
- Binoculars
- DBH Tape
- Camera
- Tool Belt
- Field tablet and GIS software

3 RESULTS AND DISCUSSION

The tree inventory results document 495 individual trees within the work areas shown in Appendix A. This includes 22 different species, heavily dominated by Sugar Maple (*Acer saccharum*) as this species is the most frequently recorded species across the site. Across the surveyed trees, the measured diameters at breast height (DBH) range between 7 cm to 92 cm. A full summary of tree composition can be found in Table 1 below, with a full breakdown of individual stems found in *Appendix B.* These results represent preliminary counts and are provided to guide early-stage design considerations; they are not a replacement for the more detailed inventories that may be required to be undertaken at the 30%, 60%, and 90% design stages.

Table 1 Tree Inventory – Species Summary

Common Species Name	Scientific Species Name	Number of Trees
Sugar Maple	*Acer saccharum*	288
Ironwood	*Ostrya virginiana*	31
Red Oak	*Quercus rubra*	28
Norway Maple	*Acer platanoides*	27
White Pine	*Pinus strobus*	21
Basswood	*Tilia americana*	19
American Beech	*Fagus grandifolia*	12
Black Cherry	*Prunus serotina*	12
Shagbark Hickory	*Carya ovata*	9
Eastern Hemlock	*Tsuga canadensis*	9
Black Locust	*Robinia pseudoacacia*	6
Bitternut Hickory	*Carya cordiformis*	6
White Elm	*Ulmus americana*	5
Manitoba Maple	*Acer negundo*	4
Ash sp.	*Fraxinus sp.*	4
Red Pine	*Pinus resinosa*	3
White Oak	*Quercus alba*	3
Apple sp.	*Malus sp.*	2
Cherry sp.	*Prunus sp.*	1
Willow sp.	*Salix sp.*	1
Red Maple	*Acer rubrum*	1
White Mulberry	*Morus alba*	1
Little Leaf Linden	*Tilia cordata*	1
Black Walnut	*Juglans nigra*	1

To provide a clearer understanding of site-specific conditions, the overall tree inventory has been broken down into the three work areas: E4 and E24; E5, E6, and E7; and E11. Each area varies in terms of tree density, species composition, and size distribution. The following subsections provide detailed summaries of each area.

3.1 E4 and E24

A total of 198 trees were recorded within the E4 and E24 areas (Figure 2 in Appendix A), representing 13 different species (Table 2). Sugar Maple (*Acer saccharum*) is the dominant species, with 127 stems (64% of the total). Other species such as ironwood (*Ostrya virginiana*), white pine (*Pinus strobus*), American beech (*Fagus grandifolia*), and black cherry (*Prunus serotina*) are present in smaller numbers, while conifers like eastern hemlock (*Tsuga canadensis*) and red pine (*Pinus resinosa*) add to the canopy mix.

The mean DBH is 27.7 cm, with sizes ranging from 7 to 92 cm. Twenty-two trees are 50 cm DBH or larger, including individuals of Sugar Maple, white pine, bitternut hickory, and red oak. These larger trees provide important habitat value and should be retained where possible. Four dead trees were also recorded in this area.

A portion of the erosion sites at E4 and E24 was not inventoried due to steep slopes and unsafe conditions, which limited safe access. It is estimated that between 48 and 54 additional trees exceeding 30 cm DBH are present in the uninventoried area located on the northern side of the watercourse. No stem count was completed for trees estimated to be under 30 cm DBH. The results presented here reflect only the portions of the site that could be safely accessed.

Table 2 Stem Count for E4 and E24

Common Species Name	Scientific Species Name	Number of Trees
American Beech	*Fagus grandifolia*	8
Basswood	*Tilia americana*	4
Bitternut Hickory	*Carya cordiformis*	3
Black Cherry	*Prunus serotina*	7
Eastern Hemlock	*Tsuga canadensis*	6
Ironwood	*Ostrya virginiana*	11
Norway Maple	*Acer platanoides*	9
Red Oak	*Quercus rubra*	1
Red Pine	*Pinus resinosa*	3
Shagbark Hickory	*Carya ovata*	2
Sugar Maple	*Acer saccharum*	127
White Elm	*Ulmus americana*	1
White Pine	*Pinus strobus*	16
Total	—	**198**

3.2 E5, E6, and E7

A total of 189 trees were recorded within the combined E5, E6, and E7 areas (Figure 3 in Appendix A), representing 21 different species (Table 3). Sugar Maple (*Acer saccharum*) is the dominant species with 87 stems (46% of the total). Other well-represented species include ironwood (*Ostrya virginiana*), red oak (*Quercus rubra*), and basswood (*Tilia americana*). Several additional species contribute to the overall canopy, including American beech (*Fagus grandifolia*), Norway Maple (*Acer platanoides*), white oak (*Quercus alba*), and white elm (*Ulmus americana*).

The mean DBH is 26.5 cm, with sizes ranging from 10 to 74 cm. Twenty-one trees are 50 cm DBH or larger, including individuals of Sugar Maple, red oak, white oak, white pine, and black walnut. These larger trees provide significant ecological and habitat value and should be prioritized for retention where feasible. The white pines (*Pinus strobus*) in this group act as super-canopy trees, standing above the surrounding woodland and serving as important structural features within the stand. In addition, four trees within this area were recorded as dead, which will require consideration for management or removal.

Table 3 Stem Count for E5, E6, and E7

Common Species Name	Scientific Species Name	Number of Trees
American Beech	*Fagus grandifolia*	4
Apple sp.	*Malus* sp.	1
Ash sp.	*Fraxinus* sp.	1
Basswood	*Tilia americana*	14
Bitternut Hickory	*Carya cordiformis*	3
Black Cherry	*Prunus serotina*	2
Black Locust	*Robinia pseudoacacia*	3
Black Walnut	*Juglans nigra*	1
Eastern Hemlock	*Tsuga canadensis*	2
Ironwood	*Ostrya virginiana*	19
Little Leaf Linden	*Tilia cordata*	1
Manitoba Maple	*Acer negundo*	4
Norway Maple	*Acer platanoides*	13
Red Maple	*Acer rubrum*	1
Red Oak	*Quercus rubra*	18
Shagbark Hickory	*Carya ovata*	2
Sugar Maple	*Acer saccharum*	87
White Elm	*Ulmus americana*	4
White Mulberry	*Morus alba*	1
White Oak	*Quercus alba*	3
White Pine	*Pinus strobus*	5
Total	—	**189**

3.3 E11

A total of 108 trees were recorded within the E11 area (Figure 4 in Appendix A), representing 11 different species (Table 4). The stand is strongly dominated by Sugar Maple (*Acer saccharum*), which accounts for nearly 70% of all stems (74 trees). Other species such as shagbark hickory (*Carya ovata*), ironwood (*Ostrya virginiana*), Norway Maple (*Acer platanoides*), and black cherry (*Prunus serotina*) occur at lower densities, with most other species represented by only one to five individuals.

The mean DBH is 19.6 cm, with sizes ranging from 10 to 58 cm. Six trees are 50 cm DBH or larger, including red oak, black locust, and willow. These larger trees provide important habitat value and should be retained where possible. No dead trees were recorded in this area.

Table 4 Stem Count for E11

Common Species Name	Scientific Species Name	Number of Trees
Apple sp.	*Malus* sp.	1
Ash sp.	*Fraxinus* sp.	3
Basswood	*Tilia americana*	3
Black Cherry	*Prunus serotina*	4
Black Locust	*Robinia pseudoacacia*	3
Cherry sp.	*Prunus* sp.	1
Ironwood	*Ostrya virginiana*	9
Norway Maple	*Acer platanoides*	5
Red Oak	*Quercus rubra*	1
Shagbark Hickory	*Carya ovata*	5
Sugar Maple	*Acer saccharum*	74
Willow sp.	*Salix* sp.	1
Total	—	**108**

4 RECOMMENDATIONS

4.1 Branch Pruning

It is recommended that all tree branch pruning to facilitate access, equipment staging, or safe tree removal be carried out following *ANSI A300 Tree Care Standards* (ANSI, 2023) and *Best Management Strategies* (Gilman, 2019). All works, including oversight, pruning, and tree removals, should be conducted by or under the direct supervision of an ISA Certified Arborist.

Pruning cuts should be clean and made just outside the branch collar to avoid damage to the trunk or leaving stubs. Avoid topping trees or removing branches arbitrarily to clear space. Selective pruning is advised to reduce end weight, provide necessary clearance, and maintain the tree's natural form and health.

Where access or operations require temporary clearance (such as for rigging, machinery movement, or fencing installation), the following guidelines are suggested:

- Maintain a minimum clearance height of approximately 4.0 m where equipment or vehicles will pass beneath branches.
- Limit live crown removal to no more than 30% within one growing season to minimize stress on the tree.
- It is recommended that, whenever possible, pruned debris remain on-site to limit the unnecessary spread of diseases, fungi, and pests. Where removal is required, debris should be disposed of in an appropriate manner that minimizes this risk.

Pruning is essential to maintain tree health and structural integrity, especially when trees are adjacent to construction or removal activities. Proper pruning helps reduce the risk of branch failure and limits wounds that could serve as entry points for pathogens. To minimize the risk of fungal infections such as oak wilt and other

diseases, pruning is generally recommended during the tree's dormant season, typically late fall through early spring (e.g., November to March), when sap flow is minimal, and pest activity is low. Following these pruning windows supports optimal healing and reduces the likelihood of infection, contributing to the long-term health of retained trees.

4.2 Root Pruning

Root pruning should be conducted with care to minimize damage and stress to trees retained adjacent to disturbance or construction zones. Prior to any excavation or trenching near trees, it is recommended that roots be exposed using non-destructive methods such as hydro vac excavation. This technique uses high-pressure water and vacuum to gently remove soil, allowing for precise identification and assessment of roots without mechanical damage.

Root cuts should be made cleanly with sharp tools such as root pruners or saws to encourage proper wound closure and reduce risk of decay. Excavation machinery should not be used for cutting roots, as this can cause tearing and excessive injury.

According to Town of Oakville guidelines, root pruning should generally avoid the inner portion of the Tree Protection Zone (TPZ) and is outlined below.

> *"Diameter of Trunk (DBH) in centimetres and required Tree Protection Zone Distance from trunk*
>
> - *<10 cm diameter requires 1.8 metre TPZ distance*
> - *10-30 cm diameter requires 2.4 metre TPZ distance*
> - *31-50 cm diameter requires 3.0 metre TPZ distance*
> - *51-60 cm diameter requires 3.6 metre TPZ distance*
> - *61-70 cm diameter requires 4.2 metre TPZ distance*
> - *71-80 cm diameter requires 4.8 metre TPZ distance*
> - *81-90 cm diameter requires 5.4 metre TPZ distance*
> - *91-100 cm diameter requires 6.0 metre TPZ distance*
>
> 1) *For trees over 100 cm. DBH, add 10 cm. to the TPZ for every one centimetre of DBH.*
> 2) *Roots can extend from the trunk to 2-3 times the distance of the drip line (Detail TP-1 Schedule 4 for further information).*
> 3) *Diameter at breast height (DBH) measurement of tree trunk taken at 1.37 metres above ground.*
> 4) *Tree Protection Zone distances are to be measured from the outside edge of the tree base towards the drip line and may be limited by an existing paved surface, provided the existing paved surface remains intact throughout the construction work." (*Town of Oakville, 2025)

Root cuts are ideally performed outside the TPZ radius; however, when pruning within the TPZ is unavoidable, cuts should be made no closer than 0.5 m from the trunk for smaller roots and at increasing distances for larger roots, depending on structural considerations.

Roots larger than 5 cm in diameter should only be pruned with approval from a supervising arborist. Exposed roots should be kept moist and covered with soil or mulch if left exposed for extended periods.

These procedures aim to maintain tree stability and health by reducing root injury, preventing infection, and supporting long-term survival adjacent to site disturbance.

4.3 Timing Window

It is recommended that all removals be avoided during the breeding bird season, which extends from April 1 to August 31, in accordance with the *Migratory Birds Convention Act, 1994* (Government of Canada 1994), as well as during the bat roosting period from April 1 to November 30, in accordance with the *Endangered Species Act, 2007* (Government of Ontario 2007) and the upcoming Species Conservation Act (2026). These timing restrictions help reduce impacts and avoid incidental harm to breeding birds and roosting bats.

If it is necessary to work during the breeding bird and bat roosting season, then mitigation measures to avoid incidental harm must be in place, such as pre-clearing nest sweeps, daily visual encounters, and wildlife salvages, conducted by a qualified biologist. Furthermore, permitting requirements may be required to ensure compliance with relevant environmental regulations. Restricting construction related activities outside of sensitive periods for local or significant wildlife species can limit disturbance during life-cycle stages.

5 CONCLUSION

The tree inventory provides an important snapshot of existing conditions but has several limitations. It documented species, DBH, and whether each tree was alive or dead, but it did not include a detailed health or structural assessment. Additionally, steep slopes and unsafe access prevented survey of a significant area on the north side of the reach (including parts of erosion sites E4 and E24), meaning some trees were only estimated. A total of 487 live and 8 dead stems were inventoried across the study area, and an estimated 48–54 additional trees over 30 cm DBH may occur in the un-surveyed section. Across the three erosion sites, E4 and E24 contained 198 trees, E5, E6, and E7 contained 189 trees, and E11 contained 108 trees representing 22 different species in total.

Given these constraints, the preferred design solution should assume that all inventoried trees may need to be removed to accommodate final grading and construction. However, during detailed design and grading, efforts should focus on refining alignment and grade limits to preserve as many high-quality trees as possible, pending comprehensive health assessments and an updated inventory of previously inaccessible areas. This approach will enable the project to balance development needs with tree preservation and habitat conservation

6 REFERENCES

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APPENDIX A
Tree Removal Figures

Easting (m)

605550 605700 605850 606000 606150 606300

Northing (m)

4814550 4814400 4814250 4814100 4813950 4813800

8Th Line

Trafalgar Road

3

N

East Morrison Work Area
Land Parcel
Erosion Site
Highway
Road
Watercourse
Tree Inventory

1:3,500 metres

40 0 40 80

NAD 1983 UTM Zone 17N

Reference: Produced under Licence with the Ontario Ministry of Northern Development, Mines, Natural Resources and Forestry © Queen's Printer for Ontario (2025). Imagery (2024) Peel Region, Town of Oakville, Maxar.

MONTROSE ENVIRONMENTAL

Town of Oakville

Oakville East Morrison Creek Erosion Mitigation EA Study

Arborist Summary Site Overview

Date:	Project:	Submitter:	Reviewer:
August 2025	36236	A. Luke	K. Keele

Figure 1

Easting (m)

605900 605950 606000 606050 606100 606150

Northing (m)

4814000 4813950 4813900 4813850 4813800

East Morrison Work Area
Land Parcel
Not Sampled Area
Erosion Site
Road
Watercourse
Tree Inventory
Potential Bat Habitat Tree

N

Reference: Produced under Licence with the Ontario Ministry of Northern Development, Mines, Natural Resources and Forestry © Queen's Printer for Ontario (2025). Imagery (2024) Peel Region, Town of Oakville, Maxar, Microsoft.

1:1,000 metres
10 0 10 20
NAD 1983 UTM Zone 17N

MONTROSE ENVIRONMENTAL

Town of Oakville
Oakville East Morrison Creek Erosion Mitigation EA Study

Arborist Summary
Site E4 and E24

Date:	Project:	Submitter:	Reviewer:
August 2025	36236	A. Luke	K. Keele

Figure 2

Easting (m)

605745 605780 605815 605850 605885

Northing (m)

4814075 4814040 4813970 4813935

East Morrison Work Area
Land Parcel
Erosion Site
Road
Watercourse
Tree Inventory

1:700 metres
8 0 8 16
NAD 1983 UTM Zone 17N

Reference: Produced under Licence with the Ontario Ministry of Northern Development, Mines, Natural Resources and Forestry © Queen's Printer for Ontario (2025). Imagery (2024) Peel Region, Town of Oakville, Maxar, Microsoft.

MONTROSE ENVIRONMENTAL

Town of Oakville
Oakville East Morrison Creek Erosion Mitigation EA Study

Arborist Summary
Site E5-7

Date:	Project:	Submitter:	Reviewer:
August 2025	36236	A. Luke	K. Keele

Figure 3

Easting (m)

605720 605740 605760 605780 605800 605820

Northing (m)

4814580 4814560 4814540 4814520 4814500

N

East Morrison Work Area
Land Parcel
Erosion Site
Road
Watercourse
Tree Inventory

1:400 metres
4 0 4 8
NAD 1983 UTM Zone 17N

Reference: Produced under Licence with the Ontario Ministry of Northern Development, Mines, Natural Resources and Forestry © Queen's Printer for Ontario (2025). Imagery (2024) Peel Region, Town of Oakville, Maxar, Microsoft.

MONTROSE ENVIRONMENTAL

Town of Oakville

Oakville East Morrison Creek Erosion Mitigation EA Study

Arborist Summary
Site E11

Date:	Project:	Submitter:	Reviewer:
August 2025	36236	A. Luke	K. Keele

Figure 4

APPENDIX B
Tree Inventory

Common Species Name	DBH (cm)	Tree Health
Red Oak	58	
Red Oak	58	
Black Locust	54	
Willow sp.	54	
Red Oak	53	
Red Oak	50	
Red Oak	46	
Basswood	38	
Red Oak	37	
Norway Maple	36	
Red Oak	33	
Black Locust	32	
Red Oak	31	
Sugar Maple	29	
Black Cherry	28	
Sugar Maple	28	
Sugar Maple	28	
Shagbark Hickory	27	
Sugar Maple	27	
Sugar Maple	26	
Sugar Maple	26	
Sugar Maple	24	
Sugar Maple	23	
Black Cherry	22	
Ash sp.	22	Dead
Sugar Maple	22	
Sugar Maple	22	
Sugar Maple	22	
Sugar Maple	22	
Sugar Maple	22	
Sugar Maple	21	
Sugar Maple	21	
Sugar Maple	21	
Sugar Maple	20	
Sugar Maple	20	
Ash sp.	19	Dead
Sugar Maple	19	
Shagbark Hickory	19	
Red Oak	19	
Sugar Maple	19	
Sugar Maple	18	
Sugar Maple	18	
Sugar Maple	18	
Sugar Maple	18	
Sugar Maple	18	
Sugar Maple	18	
Apple sp.	17	
Black Cherry	17	
Black Cherry	17	
Sugar Maple	17	
Sugar Maple	17	
Sugar Maple	17	
Sugar Maple	17	
Sugar Maple	17	
Sugar Maple	17	
Norway Maple	16	
Sugar Maple	16	
Sugar Maple	16	
Black Locust	16	
Norway Maple	16	
Sugar Maple	16	
Sugar Maple	16	
Shagbark Hickory	15	
Sugar Maple	15	
Shagbark Hickory	14	
Sugar Maple	14	
Norway Maple	14	
Sugar Maple	14	
Ironwood	14	
Sugar Maple	14	
Sugar Maple	14	
Sugar Maple	14	
Sugar Maple	14	
Sugar Maple	13	
Sugar Maple	13	
Sugar Maple	13	

Common Species Name	DBH (cm)	Tree Health
Sugar Maple	13	
Cherry Sp.	13	
Norway Maple	13	
Sugar Maple	13	
Sugar Maple	13	
Sugar Maple	13	
Sugar Maple	12	
Sugar Maple	12	
Sugar Maple	12	
Sugar Maple	12	
Sugar Maple	12	
Sugar Maple	12	
Sugar Maple	12	
Sugar Maple	12	
Sugar Maple	12	
Ash sp.	12	
Sugar Maple	12	
Sugar Maple	11	
Sugar Maple	11	
Sugar Maple	11	
Sugar Maple	11	
Sugar Maple	11	
Sugar Maple	11	
Sugar Maple	11	
Sugar Maple	11	
Sugar Maple	11	
Sugar Maple	11	
Shagbark Hickory	10	
Sugar Maple	10	
Sugar Maple	10	
Sugar Maple	10	
Sugar Maple	10	
Sugar Maple	10	
Sugar Maple	10	
Sugar Maple	10	
Sugar Maple	10	
Sugar Maple	10	
Sugar Maple	10	
White Oak	74	
Red Oak	74	
Sugar Maple	72	
Red Oak	70	
Red Oak	64	
Red Oak	63	
White Pine	63	
Red Oak	62	
Red Oak	61	
Red Oak	60	
Red Oak	60	
White Pine	59	
White Pine	58	
Red Oak	58	Dead
Red Oak	56	
White Oak	55	
Sugar Maple	55	
Red Oak	54	
Black Walnut	53	
Sugar Maple	51	
Sugar Maple	50	
Sugar Maple	49	
Sugar Maple	48	Dead
Red Oak	47	
Sugar Maple	45	
Sugar Maple	44	
White Pine	44	
Sugar Maple	44	
Red Oak	44	
Sugar Maple	42	
Sugar Maple	42	
Red Oak	41	
Red Oak	41	
Red Maple	40	
Norway Maple	40	
Black Locust	40	
Sugar Maple	40	
Red Oak	40	
Sugar Maple	39	
Sugar Maple	39	

Common Species Name	DBH (cm)	Tree Health
Sugar Maple	38	
White Oak	38	
Eastern Hemlock	36	
Manitoba maple	35	
Manitoba maple	35	
Basswood	34	
Sugar Maple	34	
Basswood	34	
Bitternut Hickory	33	
Basswood	32	
Apple sp.	32	
American Beech	32	
Basswood	32	
Sugar Maple	31	
Sugar Maple	31	
Sugar Maple	30	
Norway Maple	30	
Shagbark Hickory	30	
Red Oak	30	
Sugar Maple	30	
Sugar Maple	30	
Sugar Maple	30	
Sugar Maple	30	
Sugar Maple	29	
Black Locust	28	
Ironwood	28	
Sugar Maple	28	
Sugar Maple	28	
Sugar Maple	27	
Sugar Maple	26	
Sugar Maple	26	
Sugar Maple	25	
Sugar Maple	24	
Sugar Maple	24	
Sugar Maple	24	
Sugar Maple	24	
Basswood	24	
Ironwood	23	
Sugar Maple	23	
American Beech	23	
Basswood	23	
Basswood	23	
Sugar Maple	23	
Sugar Maple	23	
Sugar Maple	22	
Eastern Hemlock	22	
White Pine	22	Dead
Basswood	22	
Norway Maple	22	
Sugar Maple	22	
Sugar Maple	21	
Basswood	21	
Sugar Maple	21	
Norway Maple	20	
Bitternut Hickory	20	
Sugar Maple	20	
Basswood	20	
American Beech	20	
Sugar Maple	20	
Sugar Maple	20	
Sugar Maple	20	
Sugar Maple	20	
Sugar Maple	20	
White Elm	20	
Sugar Maple	20	
Sugar Maple	20	
Norway Maple	20	
Norway Maple	20	
Red Oak	20	
Sugar Maple	20	
Sugar Maple	19	
Norway Maple	19	
Sugar Maple	19	
Manitoba maple	19	

Common Species Name	DBH (cm)	Tree Health
White Elm	19	
Sugar Maple	19	
Sugar Maple	19	
Sugar Maple	18	
Ironwood	18	
Ironwood	18	
Norway Maple	18	
White Elm	18	
Sugar Maple	18	
Ironwood	18	
Norway Maple	17	
Little Leaf Linden	17	
Sugar Maple	17	
Basswood	17	
White Elm	17	
Sugar Maple	17	
Sugar Maple	17	
Ironwood	17	
Sugar Maple	17	
Ironwood	16	
Basswood	16	
Sugar Maple	16	
Sugar Maple	16	
Ironwood	16	
Ironwood	16	
Sugar Maple	16	
Sugar Maple	15	
Norway Maple	15	
White Mulberry	15	
Ironwood	15	
Sugar Maple	15	
Ironwood	14	
Norway Maple	14	
Bitternut Hickory	14	
Sugar Maple	14	
Shagbark Hickory	14	
Sugar Maple	14	
Sugar Maple	14	
Ironwood	14	
Sugar Maple	14	
Sugar Maple	14	
Sugar Maple	13	
Basswood	13	
Sugar Maple	13	
Ironwood	13	
Basswood	13	
Black Cherry	12	
Black Cherry	12	
Ironwood	12	
Ironwood	12	
Ash sp.	12	Dead
Norway Maple	12	
Ironwood	12	
Ironwood	12	
Sugar Maple	11	
Sugar Maple	11	
Sugar Maple	11	
Sugar Maple	11	
Norway Maple	11	
Sugar Maple	11	
American Beech	11	
Sugar Maple	11	
Manitoba maple	11	
Sugar Maple	11	
Sugar Maple	11	
Ironwood	11	
Sugar Maple	11	
Sugar Maple	11	
Sugar Maple	10	
Black Locust	10	
Sugar Maple	10	
Ironwood	10	
Sugar Maple	10	
Sugar Maple	10	

Common Species Name	DBH (cm)	Tree Health
Sugar Maple	10	
Red Oak	92	
Sugar Maple	83	
White Pine	73	
Red Pine	72	
Sugar Maple	70	
White Pine	66	
White Pine	64	
Red Pine	62	Dead
White Pine	62	
White Pine	60	
White Pine	59	
Sugar Maple	59	
White Pine	58	
Bitternut Hickory	57	
Red Pine	56	
White Pine	56	
White Pine	56	
Sugar Maple	54	
White Pine	52	
Sugar Maple	52	
Basswood	51	
White Pine	50	
White Pine	49	
Eastern Hemlock	47	
White Pine	46	Dead
Sugar Maple	46	
Sugar Maple	46	
Sugar Maple	45	
Sugar Maple	45	
Sugar Maple	44	
American Beech	44	
Sugar Maple	43	
White Pine	43	
White Pine	43	
Eastern Hemlock	43	
Shagbark Hickory	43	
Bitternut Hickory	43	
Sugar Maple	42	
Sugar Maple	41	
Sugar Maple	41	
Sugar Maple	41	
Sugar Maple	40	
White Pine	39	
Bitternut Hickory	39	
Sugar Maple	37	
Sugar Maple	37	
Sugar Maple	37	
Norway Maple	37	
Sugar Maple	37	
Sugar Maple	37	
Sugar Maple	36	
Sugar Maple	36	
Sugar Maple	36	
Sugar Maple	36	
Sugar Maple	35	
Sugar Maple	35	
Sugar Maple	35	
Sugar Maple	34	
Sugar Maple	34	
Sugar Maple	34	
Sugar Maple	33	
Basswood	33	
Sugar Maple	33	
Sugar Maple	32	
Sugar Maple	31	
Sugar Maple	31	
Eastern Hemlock	31	
Sugar Maple	31	
Sugar Maple	31	
Sugar Maple	31	
Sugar Maple	31	
Black Cherry	30	Dead
Sugar Maple	30	

Common Species Name	DBH (cm)	Tree Health
Eastern Hemlock	30	
Sugar Maple	29	
Eastern Hemlock	29	
Eastern Hemlock	29	
Sugar Maple	29	
Black Cherry	28	
Sugar Maple	28	
Sugar Maple	27	
Sugar Maple	27	
Sugar Maple	27	
Sugar Maple	27	
Sugar Maple	26	
American Beech	26	
Sugar Maple	25	
Ironwood	25	
Sugar Maple	25	
Sugar Maple	25	
Sugar Maple	25	
Sugar Maple	25	
Ironwood	25	
Sugar Maple	24	
Sugar Maple	24	
Sugar Maple	24	
Sugar Maple	23	
Sugar Maple	23	
Black Cherry	23	
Sugar Maple	23	
Sugar Maple	23	
Sugar Maple	22	
Sugar Maple	22	
Ironwood	22	
Ironwood	22	
Sugar Maple	21	
Sugar Maple	21	
American Beech	21	
Black Cherry	21	
Ironwood	21	
Sugar Maple	20	
Sugar Maple	20	
Sugar Maple	20	
Sugar Maple	19	
Sugar Maple	19	
Sugar Maple	19	
Sugar Maple	19	
Norway Maple	19	
Sugar Maple	19	
Sugar Maple	19	
Sugar Maple	19	
Sugar Maple	19	
Norway Maple	18	
Sugar Maple	18	
Sugar Maple	18	
Basswood	18	
Sugar Maple	18	
Sugar Maple	18	
Sugar Maple	18	
Norway Maple	18	
Shagbark Hickory	17	
Sugar Maple	17	
Sugar Maple	17	
Sugar Maple	17	
Sugar Maple	17	
Sugar Maple	17	
Sugar Maple	16	
Sugar Maple	16	
Sugar Maple	16	
Sugar Maple	16	
Black Cherry	16	
Ironwood	16	
Sugar Maple	16	
Ironwood	16	
Sugar Maple	15	
Sugar Maple	15	
Basswood	15	

Common Species Name	DBH (cm)	Tree Health
Sugar Maple	15	
Sugar Maple	15	
Ironwood	15	
Sugar Maple	15	
Sugar Maple	15	
Sugar Maple	14	
Sugar Maple	14	
Sugar Maple	14	
Sugar Maple	14	
Sugar Maple	14	
American Beech	14	Dead
Ironwood	13	
Sugar Maple	13	
Norway Maple	13	
Sugar Maple	13	
Sugar Maple	13	
Sugar Maple	13	
Sugar Maple	13	
Black Cherry	13	
Sugar Maple	13	
Sugar Maple	13	
White Elm	13	
Sugar Maple	13	
Norway Maple	13	
Sugar Maple	13	
Sugar Maple	12	
Ironwood	12	
Sugar Maple	12	
Sugar Maple	12	
Sugar Maple	12	
American Beech	12	
American Beech	12	
Sugar Maple	11	
Norway Maple	11	
Ironwood	11	
Sugar Maple	11	
Sugar Maple	11	
Sugar Maple	11	
Sugar Maple	11	
Sugar Maple	11	
Sugar Maple	11	
Norway Maple	11	
American Beech	11	
Sugar Maple	11	
American Beech	10	
Sugar Maple	10	
Sugar Maple	10	
Sugar Maple	10	
Norway Maple	10	
Sugar Maple	10	
Black Cherry	8	
Sugar Maple	7	

Colour Code
E5, E6, E7
E4 & E24
E11

APPENDIX K2
Hydraulic Modeling Results

APPENDIX K2 – HYDRAULIC MODELING RESULTS

TABLE K2.1 Comparison of Surface Elevations for Proposed and Existing Conditions

River Station	Plan	Water Surface Elevation (m)						
		Return Period						
		2 year	5 year	10 year	25 year	50 year	100 year	Regional
920	Proposed	124.8	125.03	125.25	125.43	125.52	125.58	125.82
	Existing	124.8	125.01	125.26	125.44	125.53	125.61	125.82
899	Proposed	124.56	124.81	125.02	125.21	125.32	125.41	125.56
	Existing	124.46	124.72	124.97	125.1	125.34	125.42	125.58
828	Proposed	124.14	124.5	124.64	124.75	124.81	124.88	125.04
	Existing	124.36	124.58	124.7	124.79	124.85	124.92	125.07
814	Proposed	123.96	124.24	124.44	124.53	124.6	124.66	124.82
	Existing	124.25	124.51	124.62	124.71	124.76	124.82	124.96
809	Proposed	123.81	124.14	124.38	124.5	124.56	124.62	124.74
	Existing	124.02	124.38	124.5	124.57	124.63	124.69	124.85
798	Proposed	123.64	123.93	124.15	124.29	124.39	124.45	124.74
	Existing	123.95	124.21	124.38	124.46	124.52	124.57	124.82
788	Proposed	123.48	123.71	123.88	124.04	124.18	124.28	124.47
	Existing	123.55	123.82	124.05	124.25	124.34	124.41	124.6
757	Proposed	122.93	123.18	123.44	123.66	123.73	123.8	123.96
	Existing	122.8	123.21	123.53	123.74	123.83	123.91	124.09
739	Proposed	122.64	123.06	123.4	123.63	123.71	123.79	123.99
	Existing	122.66	123.07	123.4	123.63	123.71	123.8	123.99
676	Proposed	121.86	122.07	122.28	122.46	122.56	122.67	122.88
	Existing	121.75	121.99	122.28	122.48	122.58	122.7	122.86
656	Proposed	121.64	121.88	122.11	122.33	122.45	122.61	122.89
	Existing	121.62	122.02	122.33	122.56	122.69	122.82	123.02
601	Proposed	121.25	121.49	121.65	121.79	121.93	122.05	122.42
	Existing	121.06	121.35	121.59	121.91	122.13	122.23	122.61
559	Proposed	120.69	120.91	121.1	121.26	121.37	121.48	121.77
	Existing	120.59	120.81	120.96	121.13	121.29	121.43	121.72
541	Proposed	120.52	120.76	120.97	121.17	121.33	121.46	121.62
	Existing	120.29	120.53	120.74	120.96	121.07	121.17	121.38
507	Proposed	120.22	120.44	120.63	120.79	120.91	121.06	121.45
	Existing	120.14	120.5	120.74	120.92	121.02	121.12	121.34
471	Proposed	119.88	120.11	120.3	120.47	120.58	120.66	121.04
	Existing	120.05	120.41	120.64	120.8	120.89	120.98	121.2
432	Proposed	119.38	119.62	119.81	119.96	120.07	120.22	120.56

River Station	Plan	Water Surface Elevation (m)						
		Return Period						
		2 year	5 year	10 year	25 year	50 year	100 year	Regional
	Existing	119.96	120.3	120.55	120.72	120.81	120.89	121.11
392	Proposed	118.94	119.15	119.34	119.5	119.6	119.7	119.98
	Existing	119.63	119.84	120.03	120.28	120.41	120.55	120.71
366	Proposed	118.59	118.88	119.08	119.2	119.29	119.44	119.68
	Existing	119.14	119.5	119.66	119.82	119.86	120.13	120.37
338	Proposed	118.44	118.78	119.01	119.15	119.22	119.27	119.42
	Existing	118.42	118.77	118.98	119.09	119.15	119.21	119.49

TABLE K2.2 Comparison of Channel Velocity for Proposed and Existing Conditions

River Station	Plan	Velocity (m/s)						
		Return Period						
		2 year	5 year	10 year	25 year	50 year	100 year	Regional
920	Proposed	2.06	2.62	2.71	2.8	2.92	3.14	3.33
	Existing	2.26	3.01	3.07	3.18	3.32	3.53	3.83
899	Proposed	2.25	2.57	2.67	2.65	2.68	2.73	3.06
	Existing	2.32	2.72	2.79	3.09	2.7	2.84	3.17
828	Proposed	1.96	1.56	1.69	1.82	1.91	2.01	2.25
	Existing	1.4	1.56	1.77	1.95	2.08	2.2	2.49
814	Proposed	2.06	2.32	2.3	2.5	2.61	2.75	2.94
	Existing	1.65	1.69	1.92	2.11	2.26	2.4	2.7
809	Proposed	2.4	2.51	2.34	2.42	2.55	2.7	3.03
	Existing	2.47	2.22	2.42	2.67	2.79	2.92	3.11
798	Proposed	2.34	2.53	2.55	2.64	2.67	2.8	2.63
	Existing	2.38	2.58	2.67	2.92	3.1	3.27	3.13
788	Proposed	2.2	2.58	2.87	3	2.97	3.03	3.32
	Existing	2.46	2.88	3.09	3.03	3.14	3.29	3.56
757	Proposed	2.24	2.56	2.55	2.5	2.69	2.87	3.29
	Existing	0.95	1.1	1.22	1.33	1.46	1.6	1.9
739	Proposed	2	2.06	2.01	2.02	2.15	2.26	2.5
	Existing	1.61	1.8	1.87	1.92	2.05	2.17	2.42
676	Proposed	2.13	2.62	2.82	2.91	3.05	3.18	3.53
	Existing	2.25	2.66	2.61	2.68	2.82	2.92	3.42
656	Proposed	2.09	2.49	2.52	2.42	2.46	2.34	2.33
	Existing	1.52	1.76	1.81	1.8	1.84	1.87	2.11

River Station	Plan	Velocity (m/s)						
		Return Period						
		2 year	5 year	10 year	25 year	50 year	100 year	Regional
601	Proposed	2.03	2.45	2.83	3.1	3.16	3.25	3.19
	Existing	2.49	3.02	3.32	3.23	3.09	3.25	3.06
559	Proposed	2.19	2.65	2.91	3.13	3.28	3.46	3.74
	Existing	2.04	2.59	3.04	3.28	3.31	3.42	3.69
541	Proposed	1.93	2.32	2.52	2.53	2.52	2.56	3.05
	Existing	2.29	2.68	2.9	2.85	2.97	3.08	3.4
507	Proposed	2.17	2.62	2.91	3.11	3.24	3.25	3.06
	Existing	1.31	1.51	1.7	1.88	2.03	2.2	2.57
471	Proposed	1.99	2.43	2.7	2.91	3.06	3.31	3.19
	Existing	1.23	1.47	1.71	1.94	2.11	2.3	2.62
432	Proposed	2.15	2.55	2.86	3.1	3.24	3.29	3.34
	Existing	1.24	1.62	1.77	1.93	2.08	2.27	2.61
392	Proposed	2.02	2.53	2.82	3.05	3.22	3.43	3.72
	Existing	2.13	2.69	2.96	2.86	2.88	2.86	3.28
366	Proposed	2.15	2.4	2.67	3.01	3.23	3.25	3.58
	Existing	2.63	2.69	3.08	3.31	3.73	3.33	3.5
338	Proposed	1.61	1.8	2	2.24	2.46	2.72	3.22
	Existing	1.73	2.01	2.27	2.61	2.9	3.18	3.38

TABLE K2.3 Comparison of Channel Shear Stress for Proposed and Existing Conditions

River Station	Plan	Shear Stress (N/m^2)						
		Return Period						
		2 year	5 year	10 year	25 year	50 year	100 year	Regional
920	Proposed	60.07	89.05	88.19	89.08	95.09	108.19	114.9
	Existing	66.96	110.02	106.61	109.29	117.07	130.13	147.17
899	Proposed	77.02	90.44	89.42	83	81.8	82.91	100.25
	Existing	78.94	95.54	92.3	109.21	78.21	85.15	102.51
828	Proposed	53.58	29.57	32.93	37.03	40.47	43.89	53.24
	Existing	22.54	26.51	33.09	39.29	44.01	48.97	60.93
814	Proposed	59.98	67.54	62.12	71.5	76.52	83.59	92.07
	Existing	33.75	32.82	41.5	49.27	55.52	61.97	76.88
809	Proposed	84.04	82.79	66.09	68.05	74.39	81.96	100.07
	Existing	84.99	60.06	69.04	82.53	88.96	96.19	105.2
798	Proposed	79.54	83.18	79.28	81.54	80.97	87.68	72.55
	Existing	71.95	77.99	80.01	93.24	104.13	114.22	99.95
788	Proposed	69.48	87.1	103.03	108.1	101.58	102.46	117.5

River Station	Plan	Shear Stress (N/m^2)						
		Return Period						
		2 year	5 year	10 year	25 year	50 year	100 year	Regional
	Existing	81.87	103.75	112.66	104.04	110.14	118.79	134.92
757	Proposed	71.33	84.81	78.48	71.72	81.86	91.46	115.84
	Existing	11.53	13.91	15.85	18.14	21.59	25.47	35.08
739	Proposed	54.16	50.79	44.9	42.87	48.09	52.18	61.3
	Existing	34.57	38.11	38.1	38.48	43.36	47.72	57.22
676	Proposed	67.71	93.25	99.56	99.76	106.82	112.68	131.61
	Existing	76.08	93.95	81.18	80.79	87.04	90.52	120.67
656	Proposed	64.85	83.59	79.56	68.12	68.39	59.14	55.24
	Existing	29.23	35.54	35.42	33.63	34.47	34.57	42.76
601	Proposed	60.76	80.06	101.82	117.14	117.72	120.76	106.51
	Existing	87.73	117.6	134.84	119.91	105.65	115.23	95.02
559	Proposed	72.14	96.19	107.92	119.01	126.76	137.19	150.28
	Existing	61.44	90.37	118.81	130.95	128.66	132.29	144.62
541	Proposed	54.63	71.01	77.44	73.36	69.78	70.13	95.94
	Existing	78.7	97.6	107.07	96.81	101.6	106.53	123.35
507	Proposed	70.08	92.76	107.79	116.96	123.35	120.18	97.71
	Existing	23.39	27.82	33.18	38.95	44.17	50.84	66.94
471	Proposed	58.54	79.07	92.42	103.06	111.25	127.48	111.28
	Existing	19.55	25.42	32.44	40.1	46.61	54.26	67.89
432	Proposed	68.6	87.92	104.49	117.65	125.66	125.45	121.1
	Existing	18.68	29.71	33.67	39.25	44.85	52.56	67.03
392	Proposed	59.97	86.12	101.4	114.1	124.09	138.14	154.11
	Existing	68.03	98.77	111.46	96.2	94.16	90.07	113.97
366	Proposed	68.69	76.51	89.51	109.88	123.6	120.58	138.79
	Existing	94.67	89.23	112.68	126.1	159.03	121.38	130.19
338	Proposed	36.01	40.93	47.44	57.19	67.59	81.86	110.55
	Existing	40.6	49.93	60.52	77.24	94.66	111.63	118.7

TABLE K2.4 Water Surface Elevation, Velocity, and Shear Stress HEC-RAS Output for Proposed Conditions

River Station	Return Period																			
	2 year			5 year			10 year			25 year			50 year			100 year			Regional		
	W.S. Elev.	Chnl Vel	Shear Stress	W.S. Elev.	Chnl Vel	Shear Stress	W.S. Elev.	Chnl Vel	Shear Stress	W.S. Elev.	Chnl Vel	Shear Stress	W.S. Elev.	Chnl Vel	Shear Stress	W.S. Elev.	Chnl Vel	Shear Stress	W.S. Elev.	Chnl Vel	Shear Stress
	(m)	(m/s)	(N/m^2)	(m)	(m/s)	(N/m^2)	(m)	(m/s)	(N/m^2)	(m)	(m/s)	(N/m^2)	(m)	(m/s)	(N/m^2)	(m)	(m/s)	(N/m^2)	(m)	(m/s)	(N/m^2)
920	124.8	2.06	60.07	125.03	2.62	89.05	125.25	2.71	88.19	125.43	2.8	89.08	125.52	2.92	95.09	125.58	3.14	108.19	125.82	3.33	114.9
899	124.56	2.25	77.02	124.81	2.57	90.44	125.02	2.67	89.42	125.21	2.65	83	125.32	2.68	81.8	125.41	2.73	82.91	125.56	3.06	100.25
828	124.14	1.96	53.58	124.5	1.56	29.57	124.64	1.69	32.93	124.75	1.82	37.03	124.81	1.91	40.47	124.88	2.01	43.89	125.04	2.25	53.24
814	123.96	2.06	59.98	124.24	2.32	67.54	124.44	2.3	62.12	124.53	2.5	71.5	124.6	2.61	76.52	124.66	2.75	83.59	124.82	2.94	92.07
809	123.81	2.4	84.04	124.14	2.51	82.79	124.38	2.34	66.09	124.5	2.42	68.05	124.56	2.55	74.39	124.62	2.7	81.96	124.74	3.03	100.07
798	123.64	2.34	79.54	123.93	2.53	83.18	124.15	2.55	79.28	124.29	2.64	81.54	124.39	2.67	80.97	124.45	2.8	87.68	124.74	2.63	72.55
788	123.48	2.2	69.48	123.71	2.58	87.1	123.88	2.87	103.03	124.04	3	108.1	124.18	2.97	101.58	124.28	3.03	102.46	124.47	3.32	117.5
757	122.93	2.24	71.33	123.18	2.56	84.81	123.44	2.55	78.48	123.66	2.5	71.72	123.73	2.69	81.86	123.8	2.87	91.46	123.96	3.29	115.84
739	122.64	2.00	54.16	123.06	2.06	50.79	123.4	2.01	44.9	123.63	2.02	42.87	123.71	2.15	48.09	123.79	2.26	52.18	123.99	2.5	61.3
676	121.86	2.13	67.71	122.07	2.62	93.25	122.28	2.82	99.56	122.46	2.91	99.76	122.56	3.05	106.82	122.67	3.18	112.68	122.88	3.53	131.61
656	121.64	2.09	64.85	121.88	2.49	83.59	122.11	2.52	79.56	122.33	2.42	68.12	122.45	2.46	68.39	122.61	2.34	59.14	122.89	2.33	55.24
601	121.25	2.03	60.76	121.49	2.45	80.06	121.65	2.83	101.82	121.79	3.1	117.14	121.93	3.16	117.72	122.05	3.25	120.76	122.42	3.19	106.51
559	120.69	2.19	72.14	120.91	2.65	96.19	121.1	2.91	107.92	121.26	3.13	119.01	121.37	3.28	126.76	121.48	3.46	137.19	121.77	3.74	150.28
541	120.52	1.93	54.63	120.76	2.32	71.01	120.97	2.52	77.44	121.17	2.53	73.36	121.33	2.52	69.78	121.46	2.56	70.13	121.62	3.05	95.94
507	120.22	2.17	70.08	120.44	2.62	92.76	120.63	2.91	107.79	120.79	3.11	116.96	120.91	3.24	123.35	121.06	3.25	120.18	121.45	3.06	97.71
471	119.88	1.99	58.54	120.11	2.43	79.07	120.3	2.7	92.42	120.47	2.91	103.06	120.58	3.06	111.25	120.66	3.31	127.48	121.04	3.19	111.28
432	119.38	2.15	68.6	119.62	2.55	87.92	119.81	2.86	104.49	119.96	3.1	117.65	120.07	3.24	125.66	120.22	3.29	125.45	120.56	3.34	121.1
392	118.94	2.02	59.97	119.15	2.53	86.12	119.34	2.82	101.4	119.5	3.05	114.1	119.6	3.22	124.09	119.7	3.43	138.14	119.98	3.72	154.11
366	118.59	2.15	68.69	118.88	2.4	76.51	119.08	2.67	89.51	119.2	3.01	109.88	119.29	3.23	123.6	119.44	3.25	120.58	119.68	3.58	138.79
338	118.44	1.61	36.01	118.78	1.8	40.93	119.01	2	47.44	119.15	2.24	57.19	119.22	2.46	67.59	119.27	2.72	81.86	119.42	3.22	110.55

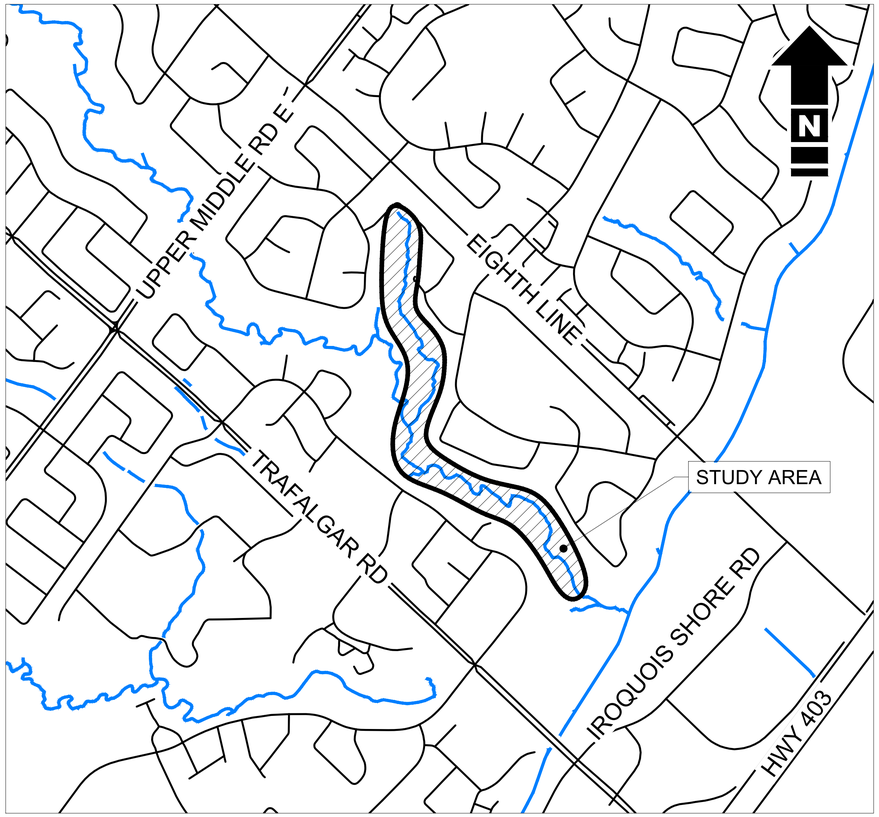
APPENDIX K3
Preliminary Design Drawings

TOWN OF OAKVILLE

EAST MORRISON CREEK EROSION MITIGATION STUDY
PRELIMINARY FUNCTIONAL DESIGN DRAWINGS

PROJECT No. 36236

ISSUED FOR REVIEW



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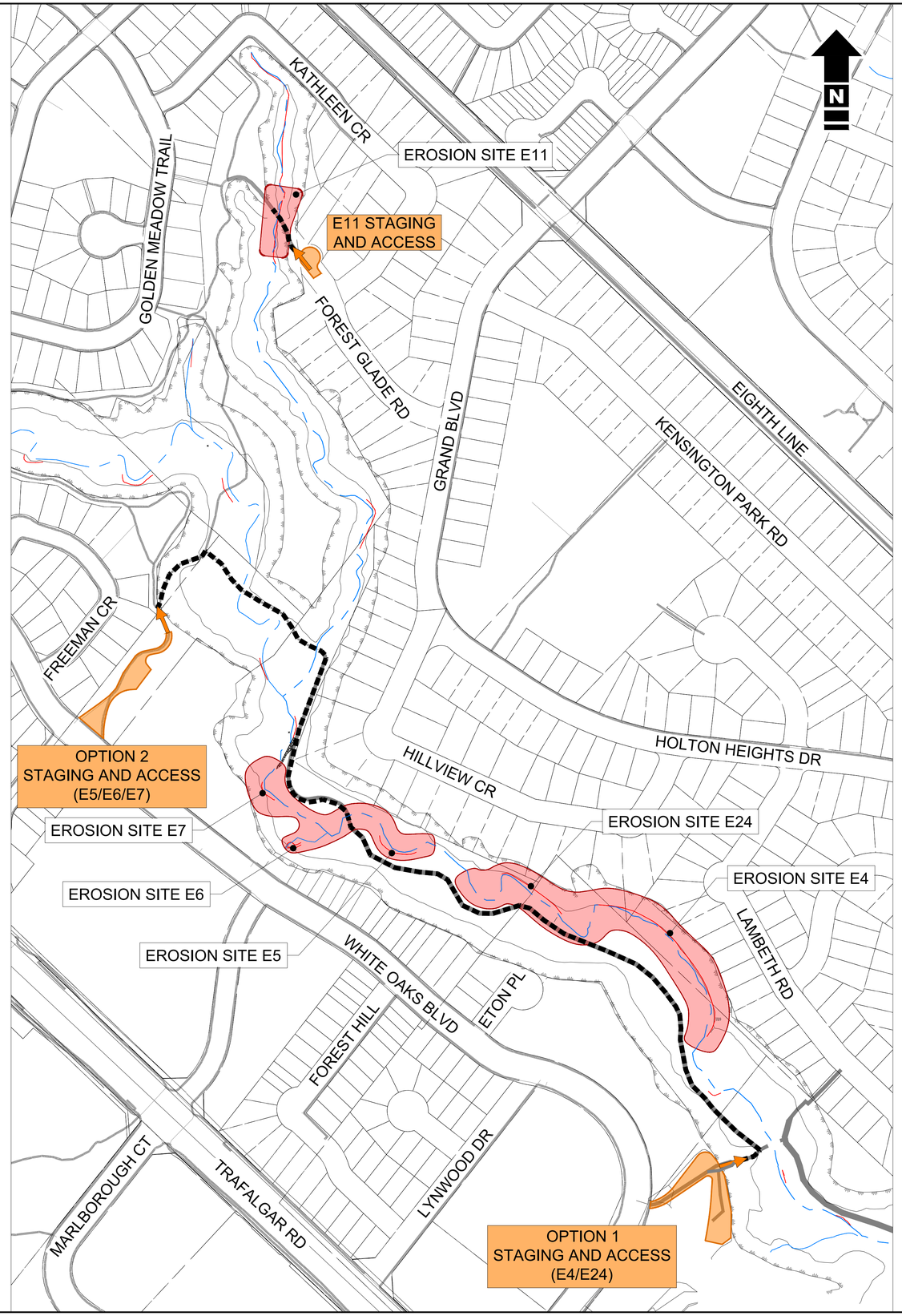
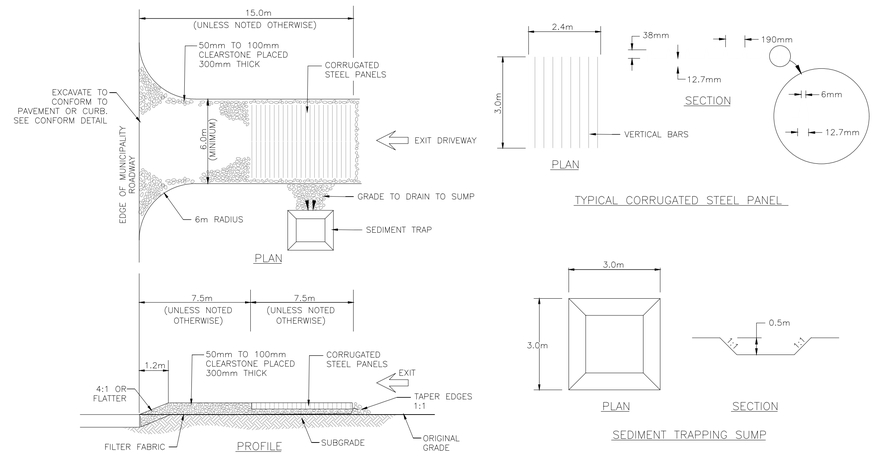
DRAWING INDEX

DWG.	REV.	DATE	TITLE
1	C	2026/01/15	STAGING, ACCESS, AND EROSION & SEDIMENT CONTROL
2	C	2026/01/15	EROSION SITES E4 AND E24 PLAN AND PROFILE
3	C	2026/01/15	EROSION SITES E4 AND E24 SECTIONS
4	C	2026/01/15	EROSION SITES E5, E6 & E7 PLAN AND PROFILE
5	C	2026/01/15	EROSION SITES E5, E6 & E7 SECTIONS
6	C	2026/01/15	EROSION SITES E11 PLAN AND PROFILE
7	C	2026/01/15	EROSION SITES E11 SECTIONS
8	C	2026/01/15	TYPICALS AND DETAILS
9	C	2026/01/15	RESTORATION PLAN

OAKVILLE

20 mm WHEN PRINTED ON PAPERSIZE



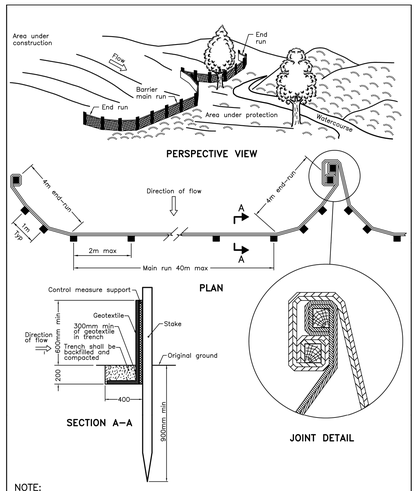


DETAIL EXIT MUDMAT

N.T.S.

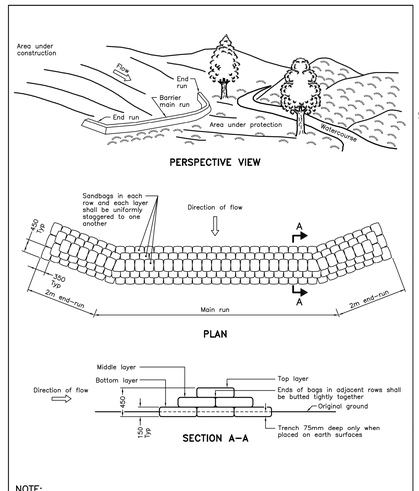
LEGEND

- PROPERTY LINE
- STORM SEWER
- SANITARY SEWER
- WATERCOURSE THALWEG
- EROSION SITE
- TOP OF EMBANKMENT
- TOE OF EMBANKMENT
- ESTIMATED WORK AREA LIMITS
- PROPOSED STAGING AREA
- PROPOSED ACCESS ROUTE



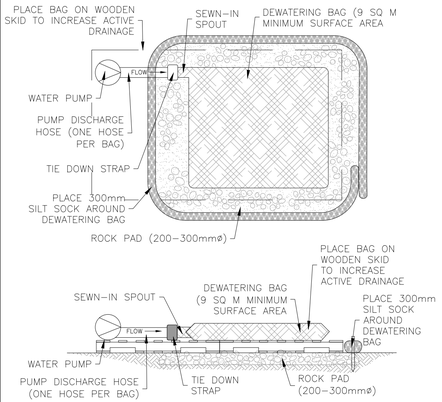
NOTE:
A All dimensions are in millimetres unless otherwise shown.

ONTARIO PROVINCIAL STANDARD DRAWING	Nov 2021	Rev 3
HEAVY-DUTY SILT FENCE BARRIER		OPSD 219.130



NOTE:
A All dimensions are in millimetres unless otherwise shown.

ONTARIO PROVINCIAL STANDARD DRAWING	Nov 2015	Rev 2
SANDBAG BARRIER		OPSD 219.150

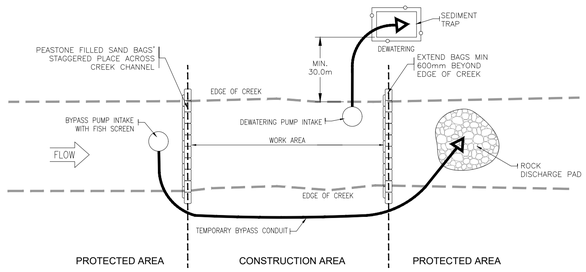


DETAIL SEDIMENT TRAP (BAG)

SCALE: N.T.S.

ACCESS AND STAGING NOTES:

1. RECOMMENDED ACCESS ROUTES IDENTIFIED FOR EACH PROJECT AREA, WITH EXIT MUDMATS TO BE INSTALLED BETWEEN PERMANENT ROADWAYS AND TEMPORARY CONSTRUCTION ACCESS ROADS.
   - OPTION 1 (E4/E24) – PREFERRED ROUTE FOR ALL WITHIN MAIN VALLEY, BUT IT IS NOTED THAT LOW HANGING ELECTRICAL WIRES WILL NEED TO BE TEMPORARILY OR PERMANENTLY MOVED.
   - OPTION 2 (E5/E6/E7) – SECONDARY ACCESS ROUTE MAY BE CONSIDERED, BUT REQUIRES TWO CREEK CROSSINGS AND IS NOT PREFERRED
   - E11 STAGING AND ACCESS – POTENTIAL IMPACTS TO DRIVEWAY ACCESS FOR RESIDENTS OF FOREST GLADE ROAD CUL-DE-SAC TO BE MITIGATED
2. SILT FENCING TO BE INSTALLED AROUND WORK AREAS IN ACCORDANCE WITH DETAILED SEDIMENT AND EROSION CONTROL PLANS (AT DETAILED DESIGN), INCLUDING TREE PROTECTION AND PROJECT BOUNDARY FENCING AS NEED FOR TRAIL CLOSURE AND PEDESTRIAN SAFETY.
3. MULCH LAYER TO BE INSTALLED ALONG ACCESS ROUTES TO PROTECT EXISTING TRAILS AND TREE ROOTS, AND REMOVED AT PROJECT COMPLETION TO RESTORE TRAILS TO PRE-CONSTRUCTION CONDITIONS OR BETTER
4. BYPASS PUMPING AND DEWATERING PLANS (SPECIFIED AT DETAILED DESIGN) TO BE IMPLEMENTED FOR CREEK ISOLATION, INCLUDING COFFERDAM SAND BAG BARRIERS (PEA-GRAVEL FILLED), PUMP AROUND SYSTEMS, AND DEWATERING SEDIMENT TRAPS



DETAIL CREEK ISOLATION

N.T.S.

MONTROSE ENVIRONMENTAL GROUP CANADA INC.

CERTIFICATE OF AUTHORIZATION No.: 100187406

Professional Engineers Ontario

No.	DATE	DESCRIPTION	BY	CHK.	DRN.
C	01/15/26	ISSUED FOR REVIEW	AY	PC	HP
B	12/10/25	ISSUED FOR REVIEW	AY	RP	HP
A	09/04/25	DRAFT FOR REVIEW	AY	RP	HP

STAGING, ACCESS, AND EROSION & SEDIMENT CONTROL

DATE:	TECHNICAL:	REVIEWER:	DRAWN:
DEC 2025	A. YATES	P. CAMPBELL	H. PIAGNO

PROJECT:	REVISION:	SHEET:
36236	C	1

20 mm WHEN PRINTED ON ANSI D - 22" x 34" (L)

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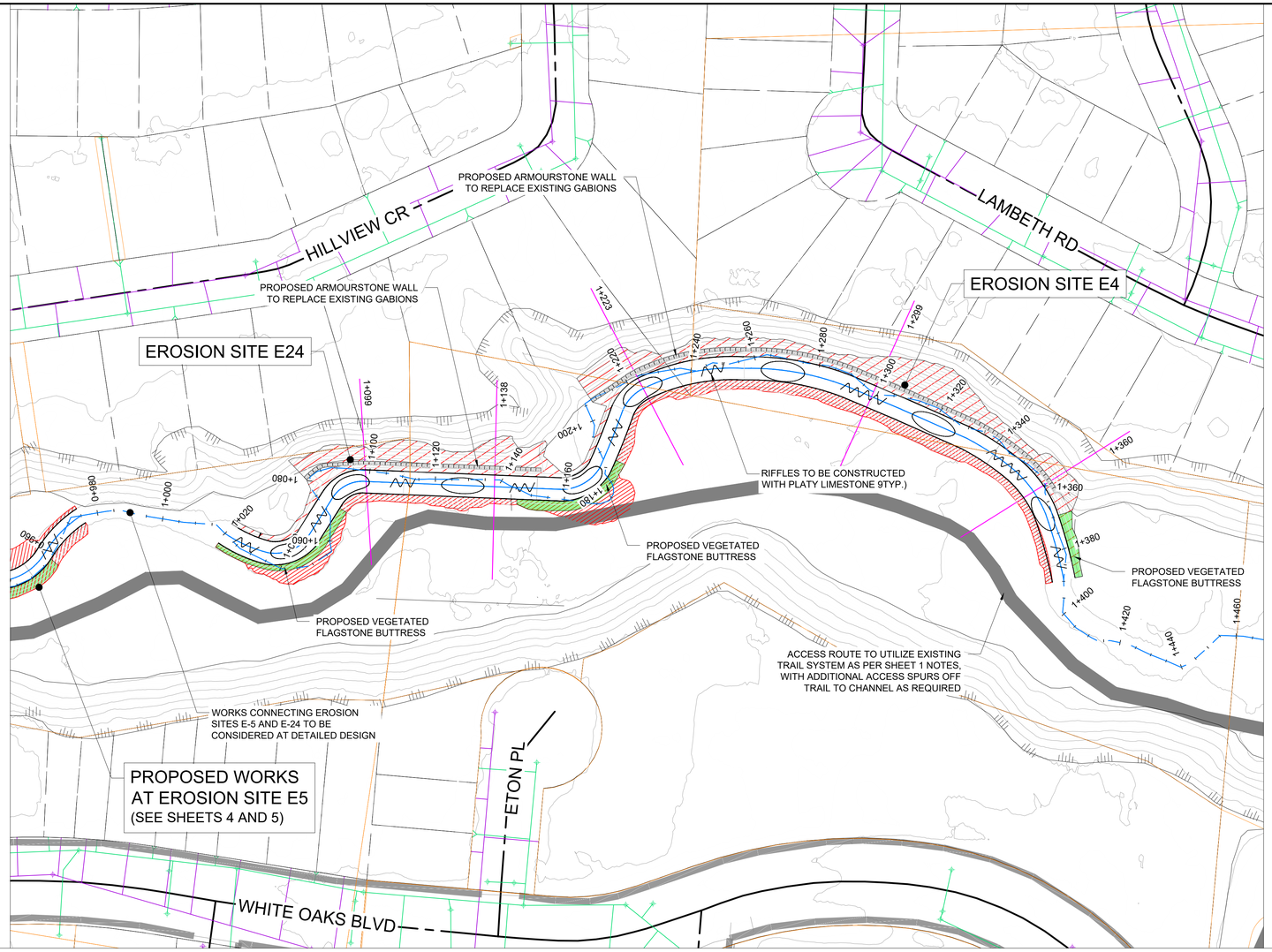
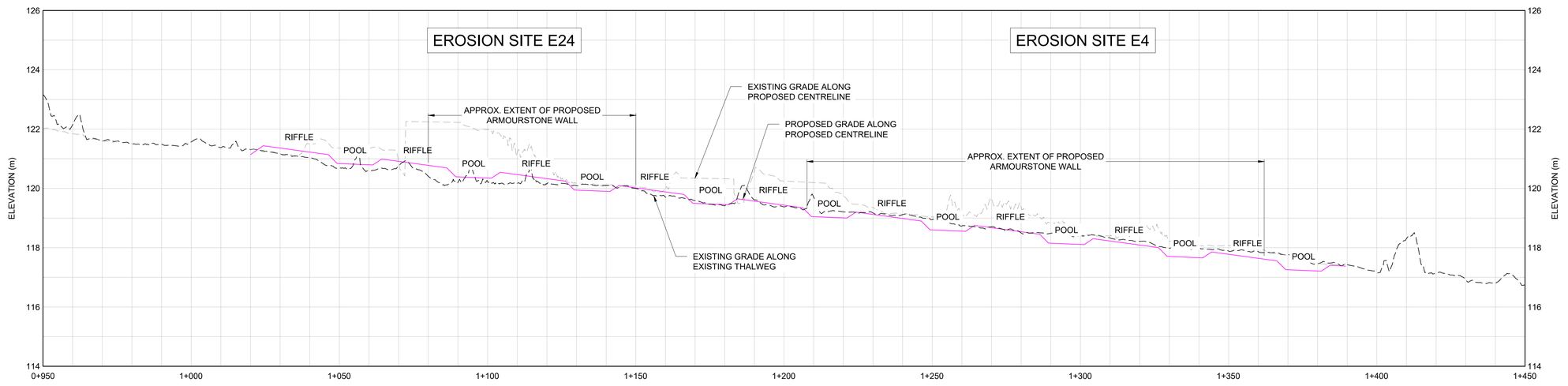




LEGEND

- PROPERTY LINE
- EASEMENT BOUNDARY
- ROAD CENTRELINE
- STORM SEWER
- STORM CATCHBASIN
- SANITARY SEWER
- SANITARY MAINTENANCE HOLE
- EXISTING CONTOURS
- WATERCOURSE THALWEG
- TOP OF EMBANKMENT
- TOE OF EMBANKMENT
- EXISTING GABION
- EXISTING RIPRAP
- EXISTING TRAIL
- PROPOSED CHANNEL
- PROPOSED CHANNEL C/L
- BANK RESTORATION
- SLOPE RESTORATION
- VEGETATED FLAGSTONE BUTTRESS
- PROPOSED RIFFLE
- PROPOSED POOL
- 0+000 SECTION LINE

0 25 50 Meters

SCALE 1:750

REFERENCE:

MONTROSE ENVIRONMENTAL GROUP CANADA INC.

CERTIFICATE OF AUTHORIZATION No.: 100187406

Professional Engineers Ontario

REVISION

No.	DATE	DESCRIPTION	BY	CHK.	DRN.
C	01/15/26	ISSUED FOR REVIEW	AY	PC	HP
B	12/10/25	ISSUED FOR REVIEW	AY	RP	HP
A	09/04/25	DRAFT FOR REVIEW	AY	RP	HP

MONTROSE ENVIRONMENTAL

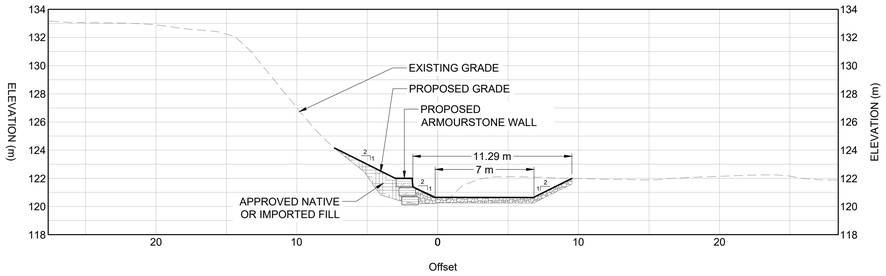
EROSION SITES E4 AND E24 PLAN AND PROFILE

DATE:	TECHNICAL:	REVIEWER:	DRAWN:
DEC 2025	A. YATES	P. CAMPBELL	H. PIAGNO

PROJECT:	REVISION:	SHEET:
36236	C	2

20 mm WHEN PRINTED ON ANSI D - 22" x 34" (L)

STATION 1+099



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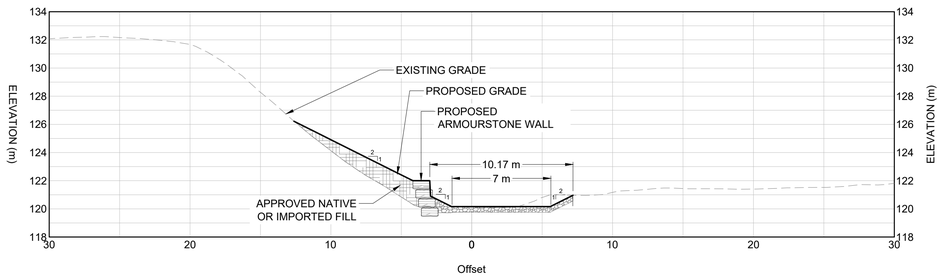

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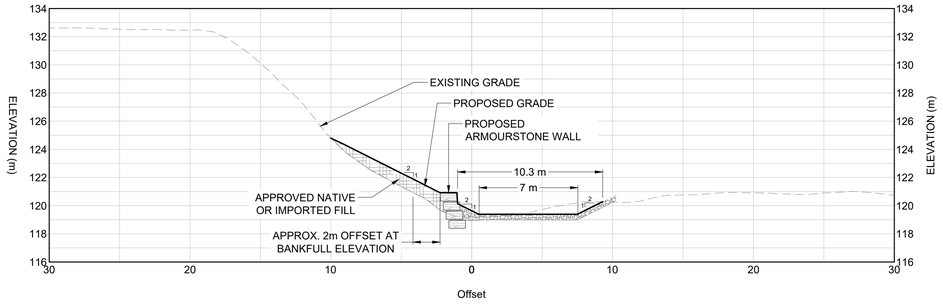

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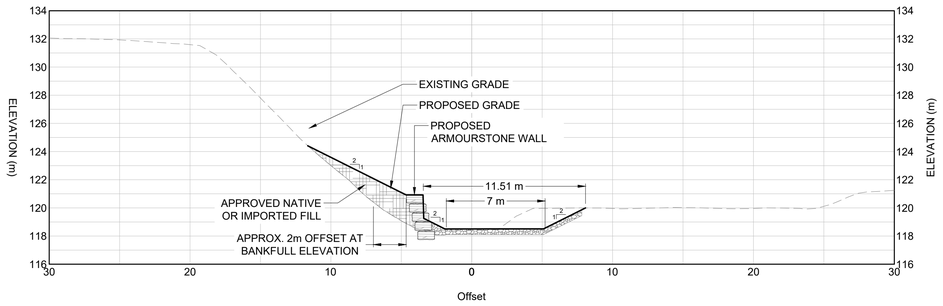

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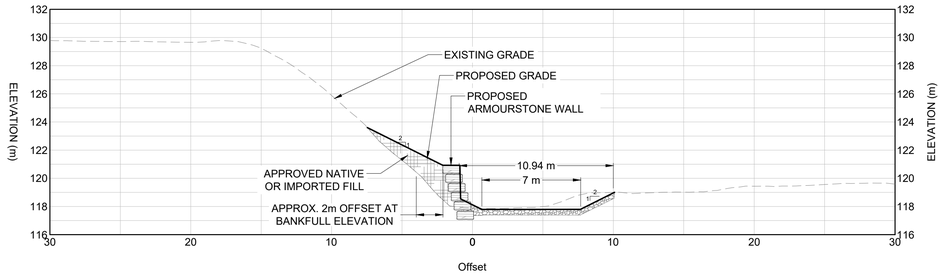

0 10 20 Meters

SCALE 1:200

REFERENCE:

MONTROSE ENVIRONMENTAL GROUP CANADA INC.

CERTIFICATE OF AUTHORIZATION No.: 100187406

Professional Engineers Ontario

REVISION

No.	DATE	DESCRIPTION	BY	CHK.	DRN.
C	01/15/26	ISSUED FOR REVIEW	AY	PC	HP
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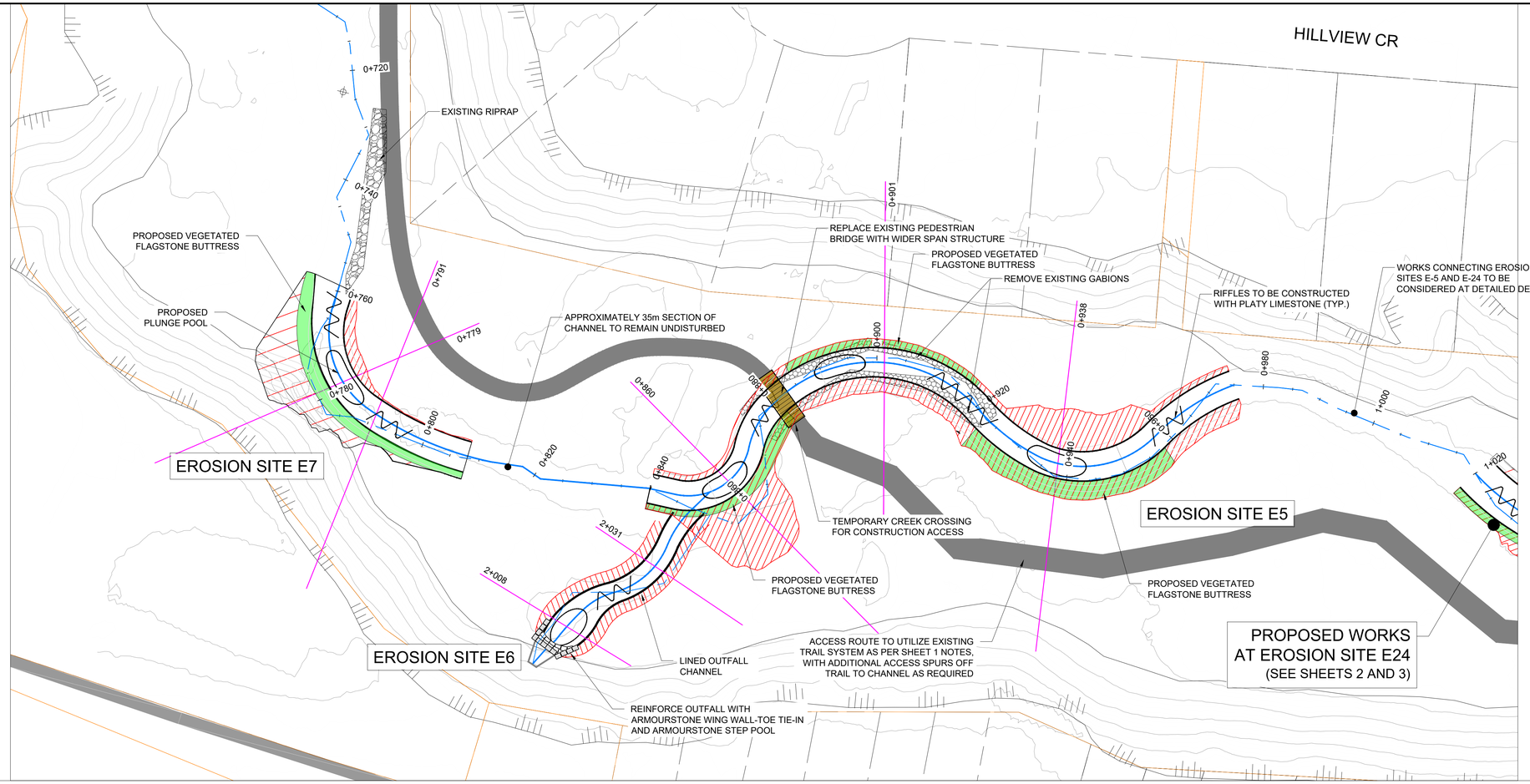
MONTROSE ENVIRONMENTAL

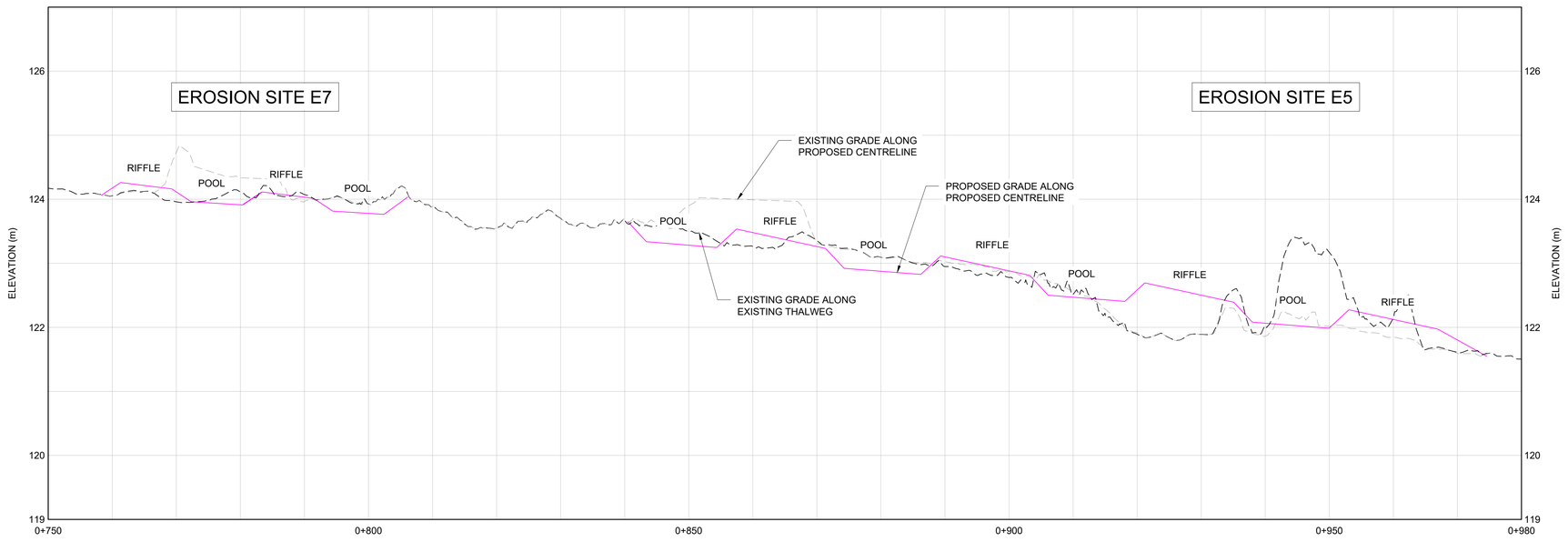
EROSION SITES E4 AND E24 SECTIONS

DATE:	TECHNICAL:	REVIEWER:	DRAWN:
DEC 2025	A. YATES	P. CAMPBELL	H. PIAGNO

PROJECT:	REVISION:	SHEET:
36236	C	

= 20 mm WHEN PRINTED ON ANSI D - 22" x 34" (L)





LEGEND

- PROPERTY LINE
- EASEMENT BOUNDARY
- ROAD CENTRELINE
- STORM SEWER
- STORM CATCHBASIN
- SANITARY SEWER
- SANITARY MAINTENANCE HOLE
- EXISTING CONTOURS
- WATERCOURSE THALWEG
- TOP OF EMBANKMENT
- TOE OF EMBANKMENT
- EXISTING GABION
- EXISTING RIPRAP
- EXISTING TRAIL
- PROPOSED CHANNEL
- PROPOSED CHANNEL C/L
- BANK RESTORATION
- SLOPE RESTORATION
- VEGETATED FLAGSTONE BUTTRESS
- PROPOSED RIFFLE
- PROPOSED POOL
- 0+000 SECTION LINE

0 15 30 Meters

SCALE 1:400

REFERENCE:

MONTROSE ENVIRONMENTAL GROUP CANADA INC.

CERTIFICATE OF AUTHORIZATION No.: 100187406

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No.	**DATE**	**DESCRIPTION**	**BY**	**CHK.**	**DRN.**

MONTROSE ENVIRONMENTAL

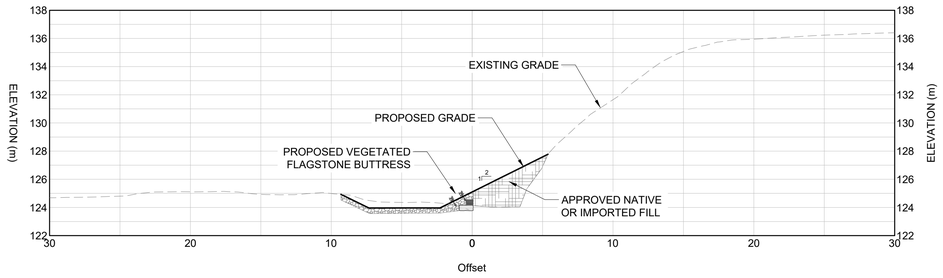
EROSION SITES E5, E6 & E7 PLAN AND PROFILE

DATE:	TECHNICAL:	REVIEWER:	DRAWN:
DEC 2025	A. YATES	P. CAMPBELL	H. PIAGNO

PROJECT:	REVISION:	SHEET:
36236	C	4

= 20 mm WHEN PRINTED ON ANSI D - 22" x 34" (L)

STATION 0+779



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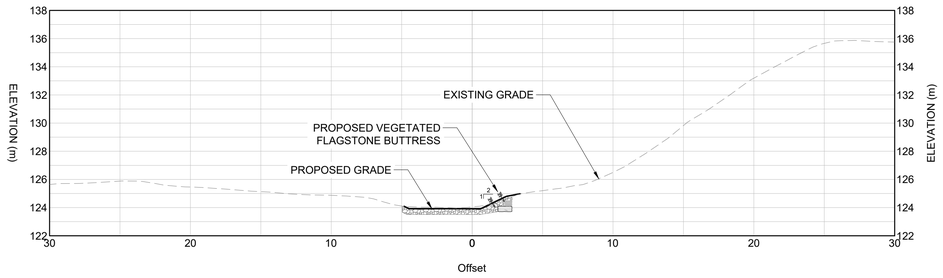

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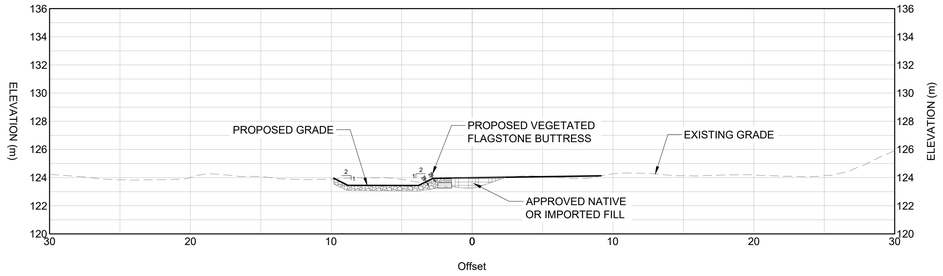

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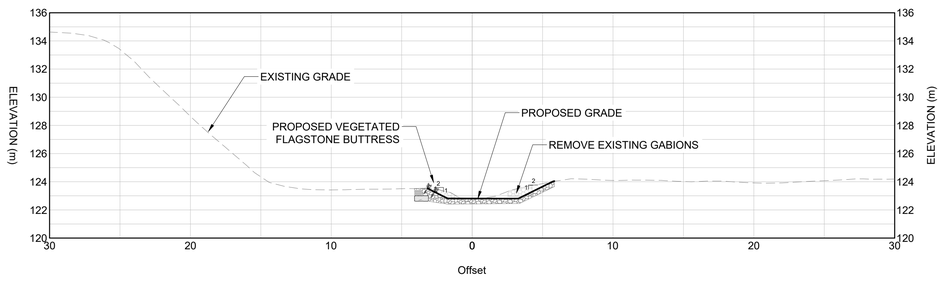

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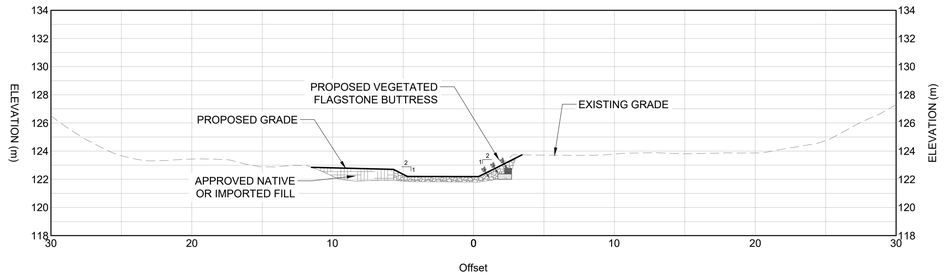
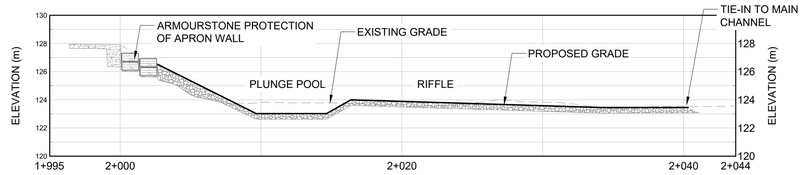
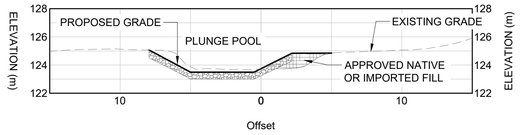


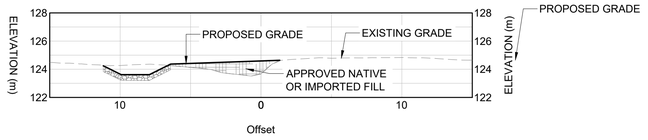
OUTFALL CHANNEL PROFILE (E6)



STATION 2+008 (OUTFALL PLUNGE POOL)



STATION 2+031 (OUTFALL CHANNEL)



0 10 20 Meters

SCALE 1:200

REFERENCE:

MONTROSE ENVIRONMENTAL GROUP CANADA INC.

CERTIFICATE OF AUTHORIZATION
No.: 100187406

Professional Engineers Ontario

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No.	**DATE**	**DESCRIPTION**	**BY**	**CHK.**	**DRN.**

MONTROSE ENVIRONMENTAL

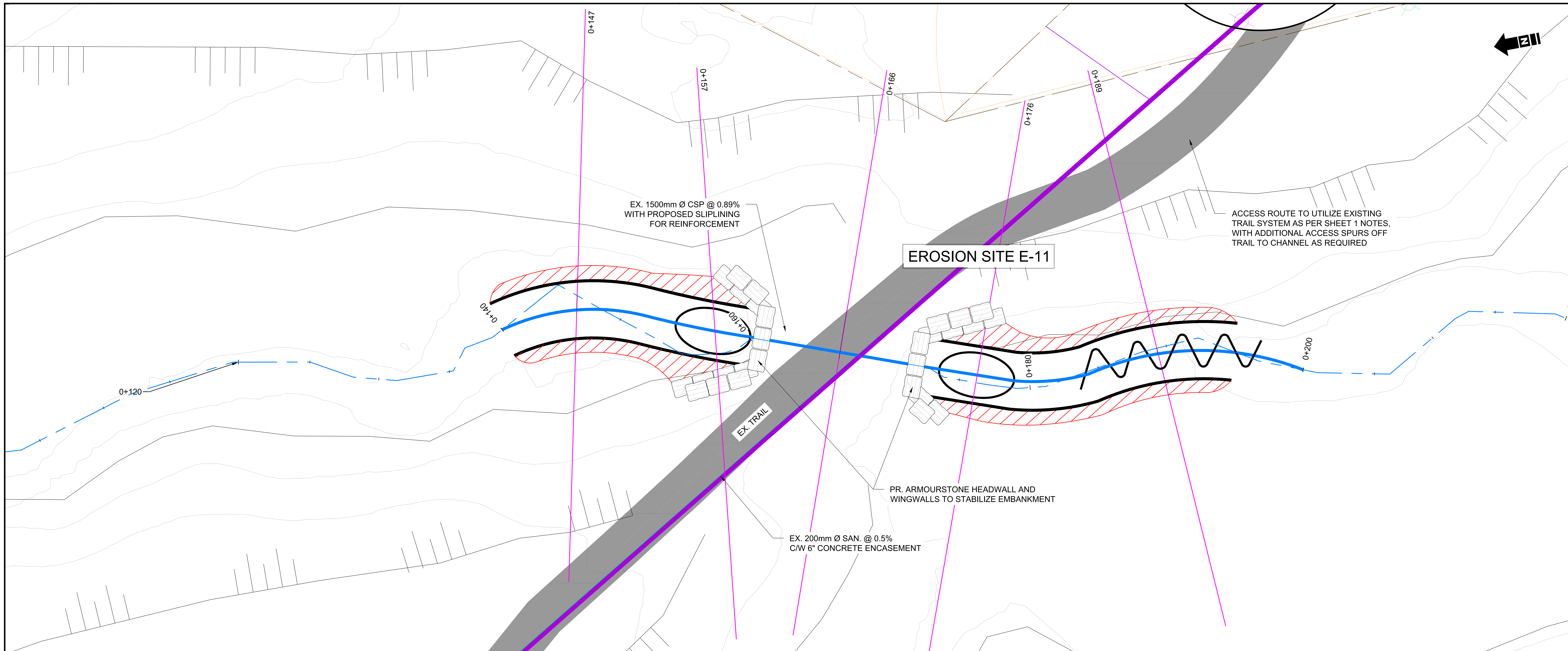
EROSION SITES E5, E6 & E7 SECTIONS

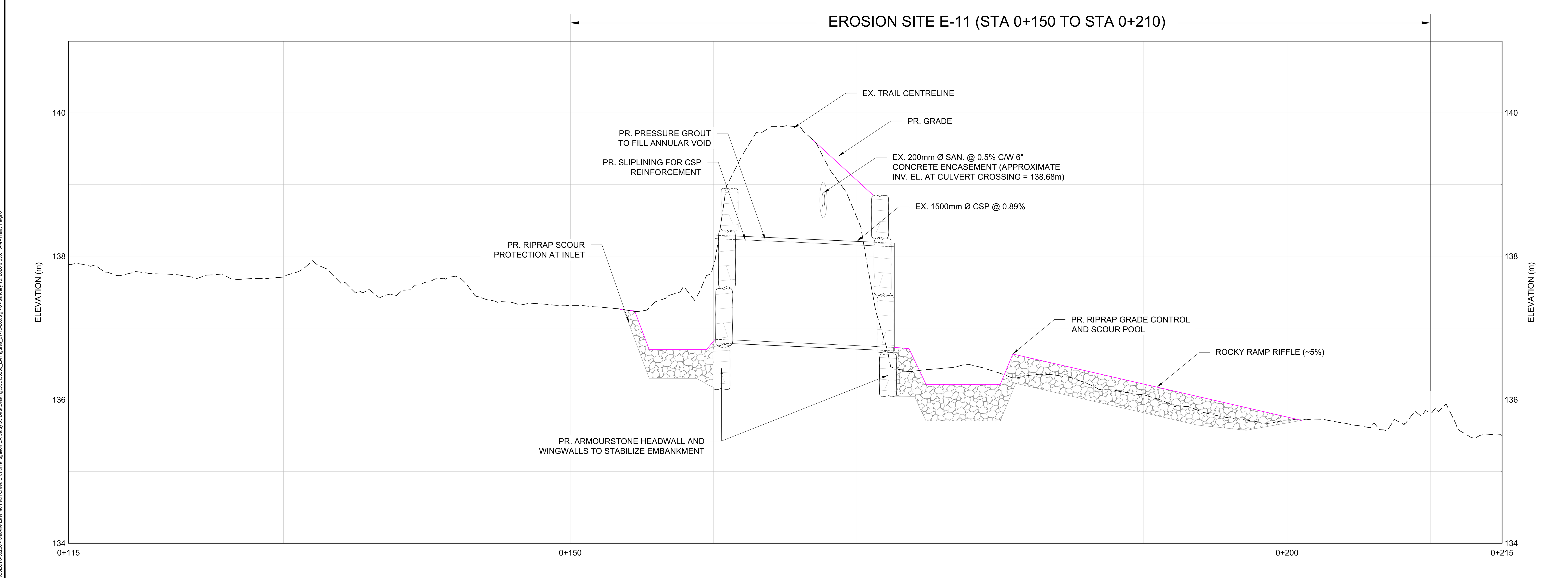
DATE:	TECHNICAL:	REVIEWER:	DRAWN:
DEC 2025	A. YATES	P. CAMPBELL	H. PIAGNO

PROJECT:	REVISION:	SHEET:
36236	C	5

20 mm WHEN PRINTED ON ANSI D - 22" x 34" (L)

N:\PROJECTS\36236 - Oakville East Morrison Creek Erosion Mitigation\5 EA Study\03 Data\Drafting\CIVIL\36236_E5 Figures_01-15-26.dwg - 5 - January 15, 2026 8:33:01 AM - Haley Piagno





LEGEND

- PROPERTY LINE
- EASEMENT BOUNDARY
- ROAD CENTRELINE
- STORM SEWER
- STORM CATCHBASIN
- SANITARY SEWER
- SANITARY MAINTENANCE HOLE
- EXISTING CONTOURS
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- TOP OF EMBANKMENT
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- EXISTING GABION
- EXISTING RIPRAP
- EXISTING TRAIL
- PROPOSED CHANNEL
- PROPOSED CHANNEL C/L
- BANK RESTORATION
- SLOPE RESTORATION
- VEGETATED FLAGSTONE BUTTRESS
- PROPOSED RIFFLE
- PROPOSED POOL
- 0+000 SECTION LINE

0 5 10 Meters
SCALE 1:150

REFERENCE:

MONTROSE ENVIRONMENTAL GROUP CANADA INC.
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Professional Engineers Ontario

REVISION

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MONTROSE ENVIRONMENTAL

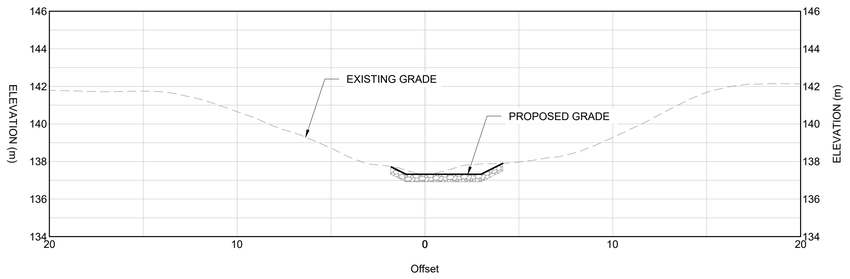
EROSION SITE E11 PLAN AND PROFILE

DATE:	TECHNICAL:	REVIEWER:	DRAWN:
DEC 2025	A. YATES	P. CAMPBELL	H. PIAGNO

PROJECT:	REVISION:	SHEET:
36236	C	6

= 20 mm WHEN PRINTED ON ANSI D - 22" x 34" (L)

STATION 0+146



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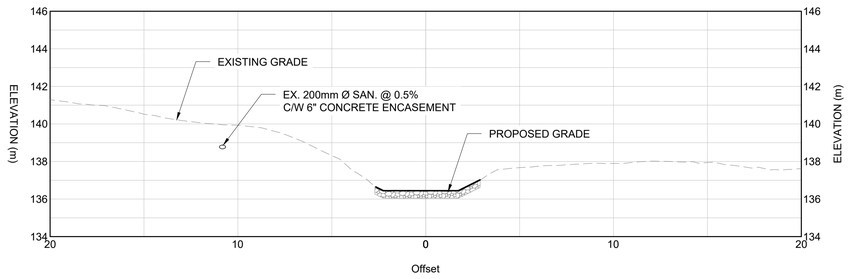

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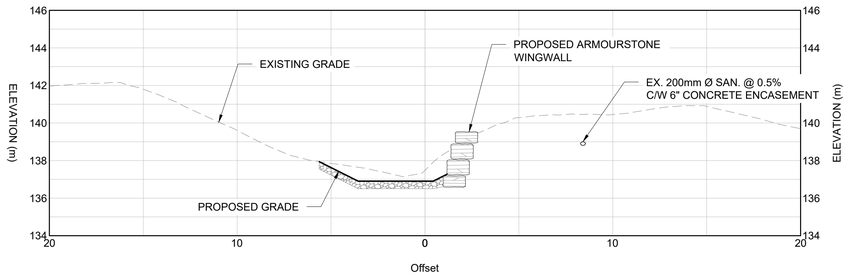
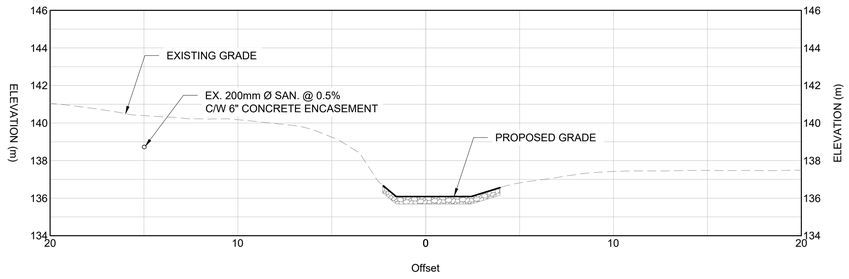
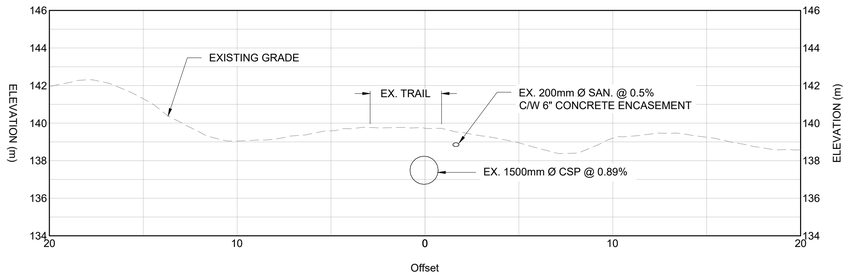


STATION 0+189



STATION 0+166



LEGEND

- PROPERTY LINE
- EASEMENT BOUNDARY
- ROAD CENTRELINE
- STORM SEWER
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- PROPOSED CHANNEL
- PROPOSED CHANNEL C/L
- BANK RESTORATION
- SLOPE RESTORATION
- VEGETATED FLAGSTONE BUTTRESS
- PROPOSED RIFFLE
- PROPOSED POOL

0 5 10 Meters

SCALE 1:200

REFERENCE:

MONTROSE ENVIRONMENTAL GROUP CANADA INC.

CERTIFICATE OF AUTHORIZATION No.: 100187406

Professional Engineers Ontario

REVISION					
C	01/15/26	ISSUED FOR REVIEW	AY	PC	HP
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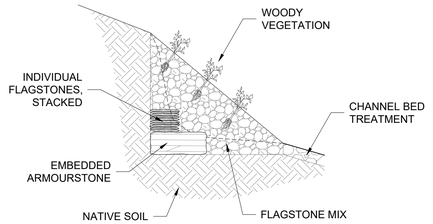
No.	**DATE**	**DESCRIPTION**	**BY**	**CHK.**	**DRN.**

EROSION SITE E11 SECTIONS

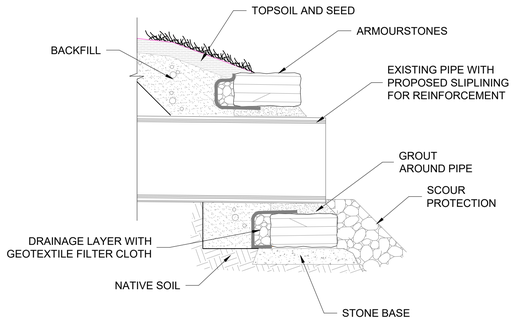
DATE:	TECHNICAL:	REVIEWER:	DRAWN:
DEC 2025	A. YATES	P. CAMPBELL	H. PIAGNO

PROJECT:	REVISION:	SHEET:
36236	C	7

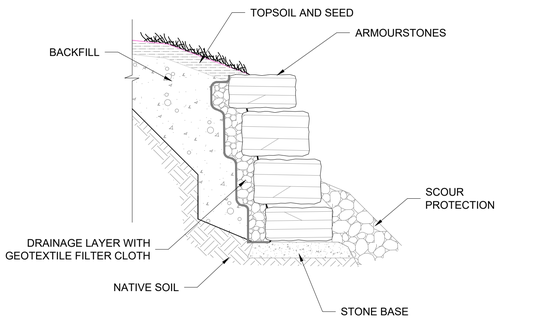
1 = 20 mm WHEN PRINTED ON ANSI D - 22" x 34" (L)



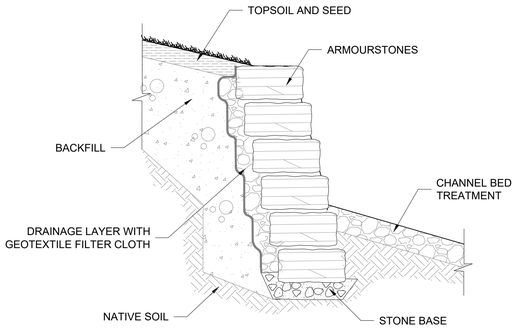
DETAIL TYPICAL VEGETATED FLAGSTONE BUTTRESS
1:50



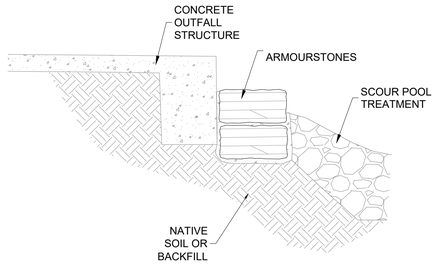
DETAIL CULVERT THROUGH ARMOURSTONE HEADWALL
1:50



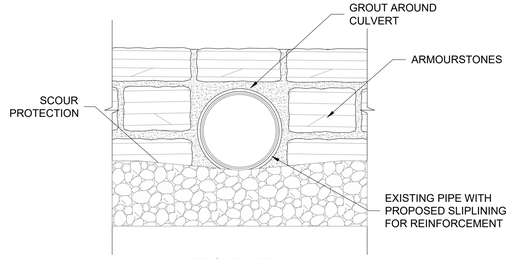
SIDE VIEW



DETAIL TYPICAL ARMOURSTONE RETAINING WALL
1:50

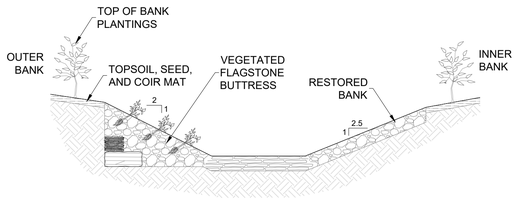


DETAIL TYPICAL ARMOURSTONE PROTECTION OF APRON WALL
1:50

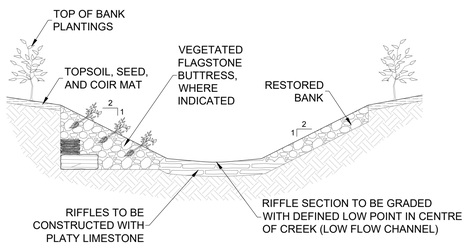


FRONT VIEW

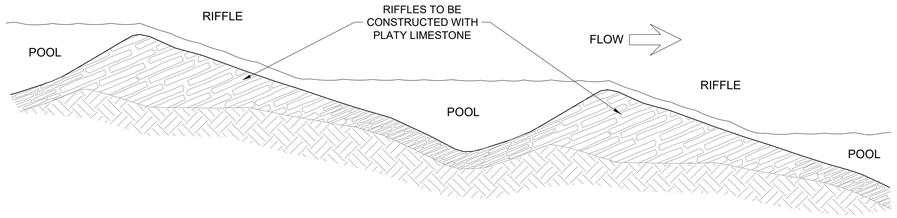
DETAIL ARMOURSTONE HEADWALL AROUND CULVERT
1:50



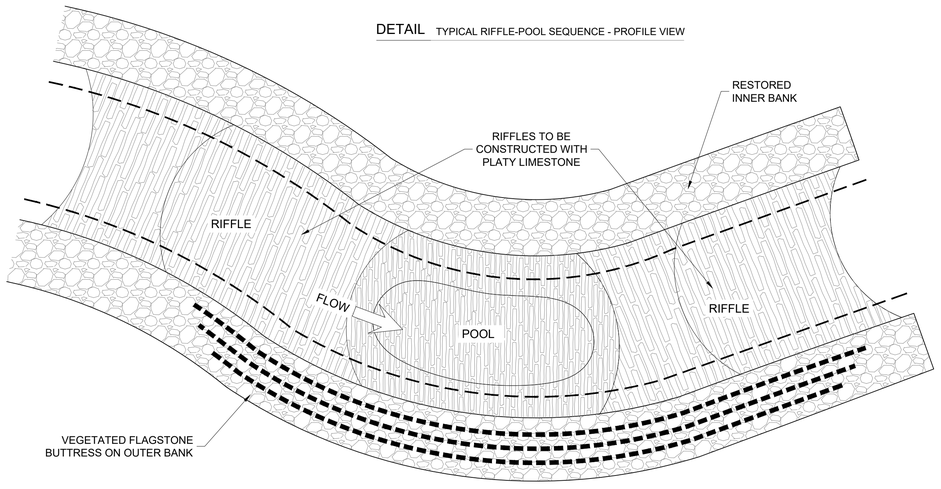
DETAIL TYPICAL POOL - SECTION VIEW
NTS



DETAIL TYPICAL RIFFLE - SECTION VIEW
NTS



DETAIL TYPICAL RIFFLE-POOL SEQUENCE - PROFILE VIEW



DETAIL TYPICAL RIFFLE-POOL SEQUENCE - PLAN VIEW
NTS

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CERTIFICATE OF AUTHORIZATION
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Professional Engineers Ontario

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MONTROSE ENVIRONMENTAL

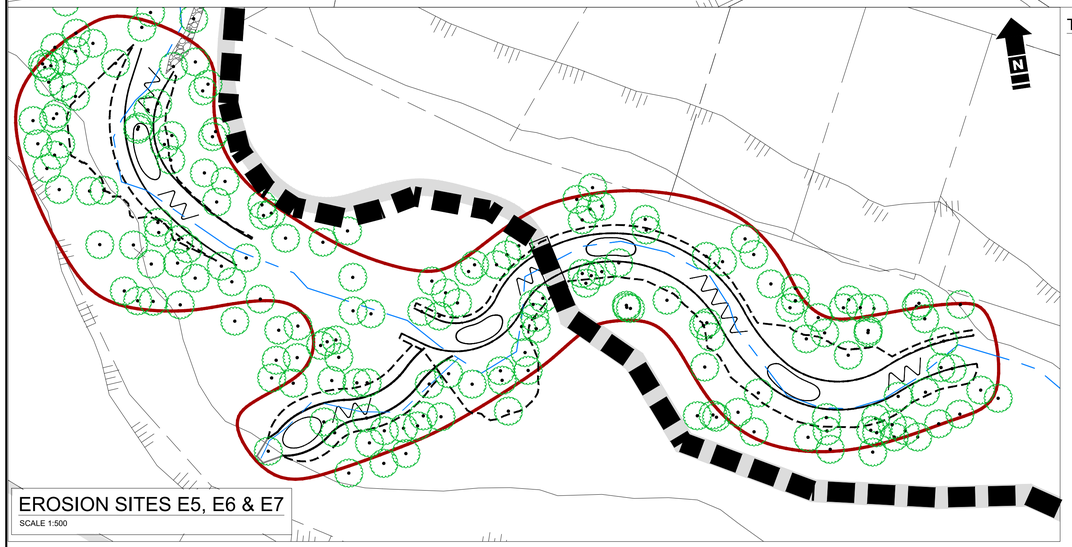
TYPICALS AND DETAILS

DATE:	TECHNICAL:	REVIEWER:	DRAWN:
DEC 2025	A. YATES	P. CAMPBELL	H. PIAGNO

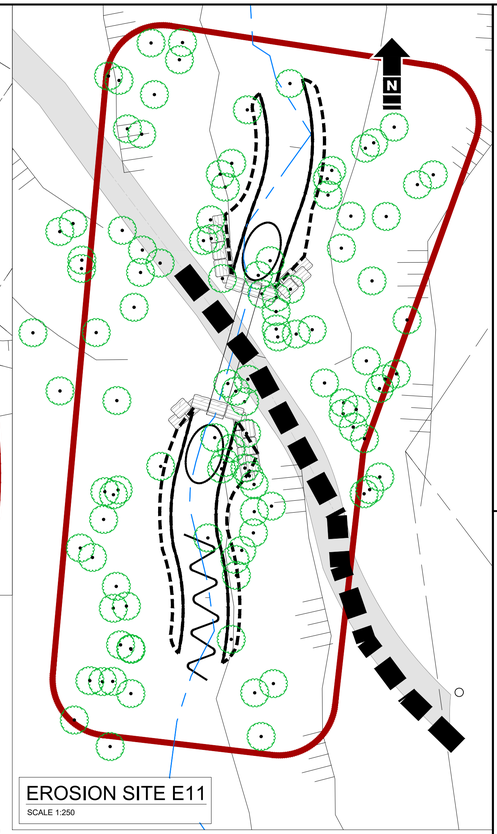
PROJECT:	REVISION:	SHEET:
36236	C	8

= 20 mm WHEN PRINTED ON ANSI D - 22" x 34" (L)

EROSION SITES E4 AND E24
SCALE 1:500



EROSION SITES E5, E6 & E7
SCALE 1:500



EROSION SITE E11
SCALE 1:250

TREE REMOVAL AND PRUNING NOTES:

- A TREE SURVEY FOUND 495 TREES (LIVE AND DEAD) WITHIN OR NEAR THE ESTIMATED WORK AREA BOUNDARIES, ACROSS ALL SITES. A LARGE PORTION OF THE NORTH BANK AT EROSION SITES E4 AND E24 WAS INACCESSIBLE DURING THE SURVEY. A PRELIMINARY STEM COUNT IN THIS SECTION ESTIMATED APPROXIMATELY 50 TREES EXCEEDING 30cm DBH; THIS ESTIMATE IS SUBJECT TO REVISION FOLLOWING A MORE DETAILED INVENTORY DURING THE DESIGN PHASE TOTAL TREES SURVEYED AND ESTIMATED: 495 + 50 = 545 TREES)
- THE DISTRIBUTION OF DBH VALUES DEMONSTRATES THAT MOST TREES ARE SMALL-TO-MEDIUM-SIZED (10-20 CM DBH). THE SMALLEST RECORDED DBH IS 7 CM AND THE LARGEST IS 92 CM; THE MEAN DBH IS 25.5 CM. WHEN GROUPED INTO FIVE CATEGORIES (0-10 CM, 10-20 CM, 20-30 CM, 30-50 CM AND 50+ CM), THE 10-20 CM CATEGORY CONTAINS THE MOST TREES (235), FOLLOWED BY 20-30 CM (97) AND 30-50 CM (93). FORTY_SIX TREES EXCEED 50 CM DBH.
- FOR THE TIME BEING, IT SHOULD BE ASSUMED THAT ALL INVENTORIED TREES MAY NEED TO BE REMOVED TO ACCOMMODATE THE WORKS. ADDITIONAL TREES ALONG THE ACCESS ROUTE (NOT SURVEYED) MAY ALSO NEED TO BE REMOVED. HOWEVER, DURING DETAILED DESIGN, EFFORTS SHOULD FOCUS ON REFINING THE DESIGN AS WELL AS ACCESS, STAGING, AND CONSTRUCTION PLANS TO PRESERVE AS MANY HIGH-QUALITY TREES AS POSSIBLE.
- REMOVALS SHOULD BE AVOIDED DURING THE BREEDING BIRD SEASON, WHICH EXTENDS FROM APRIL 1 TO AUGUST 31 AS WELL AS THE BAT ROOSTING PERIOD (APRIL 1 TO NOVEMBER 30) TO REDUCE IMPACTS AND AVOID INCIDENTAL HARM UNDER THE MBCA AND BATS UNDER THE ESA.
- TREES TO BE RETAINED MAY NEED TO BE PRUNED TO FACILITATE ACCESS, EQUIPMENT STAGING, SAFE TREE REMOVAL, OR OTHER WORKS.
- IT IS RECOMMENDED THAT ALL TREE BRANCH PRUNING BE CARRIED OUT FOLLOWING ANSI A300 (PART 1) - PRUNING STANDARDS AND ISA BEST MANAGEMENT PRACTICES. ALL WORKS, INCLUDING OVERSIGHT, PRUNING AND TREE REMOVALS, SHOULD BE CONDUCTED BY OR UNDER THE DIRECT SUPERVISION OF AN ISA CERTIFIED ARBORIST.
- ROOT PRUNING SHOULD BE CONDUCTED WITH CARE TO MINIMIZE DAMAGE AND STRESS TO TREES RETAINED ADJACENT TO DISTURBANCE OR CONSTRUCTION ZONES. PRIOR TO ANY EXCAVATION OR TRENCHING NEAR TREES, IT IS RECOMMENDED THAT ROOTS BE EXPOSED USING NON-DESTRUCTIVE METHODS SUCH AS HYDRO VAC EXCAVATION.

RESTORATION PLANTING NOTES:

- TREE PLANTING DENSITY SHALL BE AT LEAST 5 TREES PER 100m^2 RESTORED AREA. SHRUB PLANTING DENSITY SHALL BE AT LEAST 5 SHRUBS PER 1 TREE PLANTED (I.E. MINIMUM PLANTING DENSITY OF 5 TREES AND 25 SHRUBS PER 100m^2 RESTORED AREA)
- TYPICAL TREE AND SHRUB SPACING SHALL BE 2.5m AND 1m, RESPECTIVELY, RESULTING IN APPROXIMATELY 5 TREES AND 25 SHRUBS PER 50m^2 RESTORED AREA.
- HIGHER PLANTING DENSITIES MAY BE CONSIDERED WHERE FEASIBLE AND APPROVED BY A QUALIFIED ECOLOGIST TO MAXIMIZE ONSITE COMPENSATION FOR TREE REMOVALS AND THUS MINIMIZE OFFSITE PLANTING REQUIREMENTS.
- SIZE DISTRIBUTION OF PLANTED TREES SHALL BE APPROXIMATELY:
  - 5% CALIPER
  - 50% WHIP AND/OR SAPLING
  - 45% SEEDLING AND/OR PLUG
- GROUNDCOVER - QUALIFIED ECOLOGIST TO DESIGNATE SEED MIX(ES), INCLUDING SPECIES PERCENTAGE BY WEIGHT AND APPLICATION RATE(S).

LEGEND

- PROPERTY LINE
- STORM SEWER
- SANITARY SEWER
- WATERCOURSE THALWEG
- TOP OF EMBANKMENT
- TOE OF EMBANKMENT
- APPROX. LIMITS OF GRADING
- ESTIMATED WORK AREA LIMITS
- PROPOSED ACCESS ROUTE
- EXISTING TREE (SURVEYED)

TREE REMOVALS

Project Sites	Approx. Area (m^2)	Estimated Tree Removals < 30 cm DBH	Estimated Tree Removals ≥ 30 cm DBH	Dominant Species	Other Species
E4/E24	11,400	124*	124**	Sugar Maple	American Beech, Basswood, Bitternut Hickory, Black Cherry, Eastern Hemlock, Ironwood, Norway Maple, Red Oak, Red Pine, Shagbark Hickory, White Pine
E5/E6/E7	5,450	126	63		American Beech, Apple sp., Ash sp., Basswood, Bitternut Hickory, Black Cherry, Black Locust, Eastern Hemlock, Ironwood, Little Leaf Linden, Manitoba Maple, Norway Maple, Red Maple, Red Oak, Shagbark Hickory, White Elm, White Mulberry, White Oak, White Pine
E11	1,740	95	13		Apple sp., Ash sp., Basswood, Black Cherry, Black Locust, Ironwood, Norway Maple, Red Oak, Shagbark Hickory, Willow sp.
TOTAL	18,590	545			

*Number of trees <30cm DBH on North bank is unknown
**Including approximately 50 trees ≥30 cm on North bank

RESTORATION PLANTINGS

RECOMMENDED TREE SPECIES

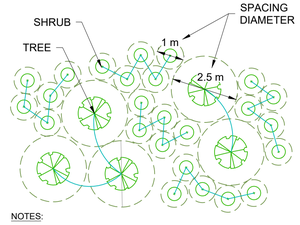
Botanical Name	Common Name
Acer saccharum	Sugar Maple
Salix interior	Sandbar Willow
Salix nigra	Black Willow
Prunus serotina	Black Cherry
Ostrya virginiana	Ironwood
Tilia americana	American Basswood
Quercus rubra	Red Oak
Quercus alba	White Oak
Fagus grandifolia	American Beech
Acer saccharinum	Silver Maple
Carya cordiformis	Bitternut Hickory
Carya ovata	Shagbark Hickory
Thuja occidentalis	Eastern White Cedar
Pinus strobus	White Pine

RESTORATION PLANTINGS

RECOMMENDED SHRUB SPECIES

Botanical Name	Common Name
Hamamelis virginiana	Witch-Hazel
Sambucus canadensis	Black Elderberry
Salix petiolaris	Slender Willow
Cornus stolonifera	Red Osier Dogwood
Viburnum lentago	Nannyberry
Rhus typhina	Staghorn Sumac
Cornus alternifolia	Alternate-leaf Dogwood
Corylus cornuta	Beaked Hazel
Amelanchier arborea	Juneberry
Cornus racemosa	Grey Dogwood
Rubus occidentalis	Black Raspberry
Rubus idaeus	Red Raspberry

NOTE: PLANTING QUANTITIES WILL BE DETERMINED BASED ON TREE REMOVALS TO BE CONFIRMED DURING DETAILED DESIGN; COMPENSATION REQUIREMENTS WILL DEPEND ON THE SIZE, SPECIES, AND QUANTITY OF TREES TO BE REMOVED.



NOTES:

1. PLANT LIKE TREES IN CLUSTERS OF 2-3
2. PLANT LIKE SHRUBS IN CLUSTERS OF 5-7
3. SHRUB TO TREE RATIO = 5:1

SAMPLE PLANTING CELL

(APPROX. 50m^2)

MONTROSE ENVIRONMENTAL GROUP CANADA INC.
CERTIFICATE OF AUTHORIZATION No.: 100187406
Professional Engineers Ontario

No.	DATE	DESCRIPTION	BY	CHK.	DRN.
C	01/15/26	ISSUED FOR REVIEW	AY	PC	HP
B	12/10/25	ISSUED FOR REVIEW	AY	RP	HP
A	09/04/25	DRAFT FOR REVIEW	AY	RP	HP

MONTROSE ENVIRONMENTAL

RESTORATION PLAN

DATE: DEC 2025 | TECHNICAL: A. YATES | REVIEWER: P. CAMPBELL | DRAWN: H. PIAGNO
PROJECT: 36236 | REVISION: C | SHEET: 9

= 20 mm WHEN PRINTED ON ANSI D - 22" x 34" (L)

N:\PROJECTS\36236 - Oakville East Morrison Creek Erosion Mitigation EA Study\03 Data\Drafting\C3D\36236_EA Figures_01-15-26.dwg - 9 - January 15, 2026 9:33:01 AM - Hilary Piagno