Appendix N

Drainage and Stormwater Management

Lakeshore Road West Improvements (Mississaga Street to Dorval Drive), Municipal Class Environmental Assessment

Stormwater Management Report
Town of Oakville
Project #TPB166147

Prepared for:

Town of Oakville
1225 Trafalgar Road, Oakville, ON L6H 0H3

11/23/2020
(Revised 04/06/2021)

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Stormwater Management Report
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Prepared for:

Town of Oakville
1225 Trafalgar Road, Oakville, ON L6H 0H3

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11/23/2020 (Revised 04/06/2021)

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1.0 Introduction

The Town of Oakville (Town) is completing a Schedule 'C' Municipal Class Environmental Assessment (Class EA) for improvements to Lakeshore Road West from Mississaga Street to Dorval Drive (ref. Figure 1.1. Key Plan). The improvements are required to meet the needs of the Town to the year 2031. The Town is considering a wide range of options to satisfy travel demand within the Lakeshore Road West Corridor and within the Study Area.

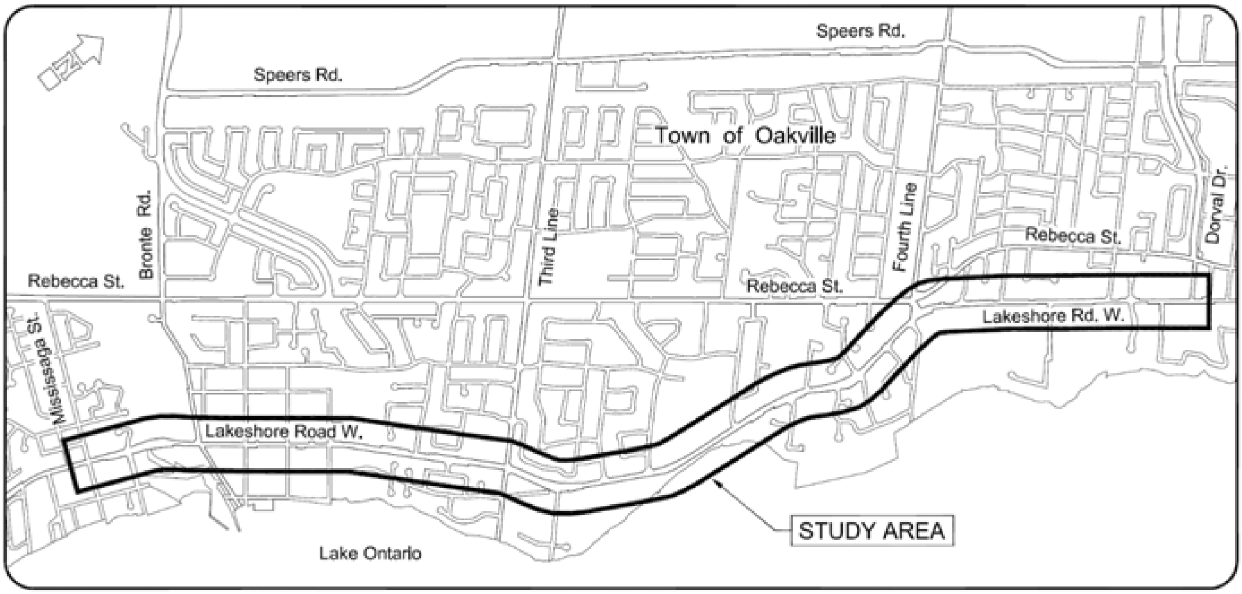


Figure 1.1. Key Plan

1.1 Project Description

Wood Environment & Infrastructure Solutions, a division of Wood Canada Limited (Wood) has been retained by the Town of Oakville to undertake the technical studies required to complete a Schedule 'C' Municipal Class Environmental Assessment (Class EA) for this section of Lakeshore Road West.

In order to best address deficiencies (short term and long term issues related to future growth, operational, geometric and capacity issues) along Lakeshore Road, a number of road improvement alternatives will be examined as part of the study, including widening of the roadway, cross-section improvements, intersection improvements, accommodation of pedestrians and cyclists, and enhancement of traffic control. In addition, the impact of such improvements on the social and natural environments will be examined.

The proposed road improvements will include urbanization, widening and intersection improvements. This section of Lakeshore Road West, in its current 2020 condition, is partially urbanized with some sections being rural in section and draining to roadside ditches, and has various lane configurations with and without turning lanes.

The road improvements proposed by the Class EA will increase impervious coverage within the Lakeshore Road right-of-way (R.O.W.) in various sections and will be a fully urbanized R.O.W. (i.e. curb and gutter on both sides).

1.2 Background Information Collection and Review

The project limits, herein referred to as the Study Area, include approximately 6 km of Lakeshore Road. The Study Area is a major west-east arterial road, located within the Bronte Creek, Fourteen Mile Creek and McCraney Creek watersheds, with hydraulic crossings of each watercourse.

To assess the existing drainage systems and associated hydraulic crossings for the Study Area, previously completed reports, mapping, drawings and other documents have been obtained and reviewed. Summaries of the background information has been provided with this report as noted.

1.1.1 Reports

The following reports have been reviewed for background use in the drainage system assessment and analysis. Reports have been provided by the Town of Oakville.

Fourteen Mile Creek and McCraney Creek Study (Wood, ongoing)
The Town of Oakville Town-wide Flood Study, 2008, established on a priority basis, creek reaches that should be further investigated for flooding mitigation, recommending that Fourteen Mile Creek and McCraney Creek Systems be investigated first. Wood is preparing a Class Environmental Assessment to investigate the extent of flooding risk along the Fourteen Mile Creek and McCraney Creek Systems and to develop a comprehensive plan of flood mitigation measures to reduce the risk of flooding. To understand the flooding risk on both creek systems, the hydrologic and hydraulic models for the creek systems have been updated. A series of flood mitigation measures to reduce flood damages and reduce the risk to life are being evaluated, leading to preferred mitigation measures

Coronation Park Channel Improvements Detail Design Study (Wood, Constructed Spring 2019)
Subsequent to the May 2017, Coronation Drainage Improvements Class Environmental Assessment, the Town of Oakville retained Wood to prepare the detailed design for the easterly drainage channel improvements within Coronation Park. The channel profile, width and alignment were improved to increase flow capacity and reduce flooding risk within Coronation Park. The construction of the channel was completed in Spring 2019.

Town of Oakville, Stormwater Master Plan Study (Wood, June 2020)
Wood was retained by the Town of Oakville to prepare a Storm Sewer Master Plan for the southern area of Oakville. The Town of Oakville has been impacted by extreme storm events, leading to flood and erosion damage. As such the Town of Oakville initiated a multi-phase Storm Sewer Master Plan. Wood commenced with the study in 2011, conducting a preliminary assessment of infrastructure deficiencies and needs. This study concurrently involved a conditions assessment (using ZOOM™ Camera technology) to establish storm sewer system condition, and allow for an integrated examination of needs based on priorities. Wood also conducted a detailed assessment of the storm sewer system performance while providing recommendations for addressing the storm sewers and roadways that do not meet the town's performance conveyance standards.

One of the recommendations from the Stormwater Master Plan is the requirement of constructing 25 mm source controls in the form of low impact development (LID) best management practices (BMPs). The 25 mm source controls were sized to offset the impacts of land use intensification and climate change while maintaining the existing level of service for the minor system during the town's 5 year design storm event. The source controls were recommended to be implemented in both the private and public realm; infrastructure renewal projects, such as roadway reconstruction, could provide the opportunity to implement source controls on the town's roadways. Furthermore, the Stormwater Master Plan recommended that the source controls be implemented on all developed and undeveloped areas, as climate change, with increased precipitation depth and runoff, does not differentiate between undeveloped, developed, or intensified land uses.

It is anticipated that the private properties will undergo renovation or intensification; it is during this time that the opportunity of implementing retroactive source controls should be undertaken. Similarly, roads, and town owned property will undergo reconstruction or rehabilitation at the end of the operational lifecycle; it is during this time that the town should considered implementing LID BMP source controls as a mitigation strategy.

Coronation Park Drainage Improvements Class Environmental Assessment (Amec Foster Wheeler, May 2017)

Amec Foster Wheeler (now Wood) was retained by the Town of Oakville to undertake a detailed drainage assessment (Class Environmental Assessment (EA.)) of the Coronation Park Community, an older residential area along Lake Ontario. The Coronation Park Community is serviced by a number of different systems, including rural roadways (ditches), semi-urban (ditches with storm sewers) and urban (urban roadway sections with storm sewers) and various minor watercourses. A baseline assessment was conducted to characterize the existing drainage system using a resolute hydrologic/hydraulic PCSWMM model, and to identify issues and deficiencies. The results of this assessment were used to develop a long-list of potential drainage system alternatives, which were screened to develop a short-list. The short-listed alternatives were further screened using a detailed evaluation matrix in order to develop a set of recommended drainage system alternatives. Preliminary alignments, sizing, and costings were also assessed, along with a phasing and prioritization plan. Two of the recommendations from the Coronation Park Class EA. which have been carried forward to detail design are the Coronation Park East Channel construction and the implementation of the Westminster Drive storm sewer system.

Town of Oakville Town-Wide Flood Study (Amec Foster Wheeler 2008)

The Town of Oakville retained Amec Foster Wheeler (now Wood) to assess the numerous locations within its jurisdictional area, which exhibit flood proneness. As part of this study, the whole of the community was inventoried for flood vulnerable areas. Of these, some 30 (+/-) were catalogued with site specific and legacy data. These data were compiled into an integrated ACCESS™ database for use by the Town and Conservation Halton in managing the program. The study involved developing and costing various locally-specific management strategies in each flood vulnerable area. The respective areas are systematically being addressed by way of site specific studies focussed on flood management.

1.1.2 Mapping, Drawings and Documents

Town of Oakville GIS data includes shapefiles for topography and storm water management infrastructure such as storm sewers, maintenance holes, catch basins, laterals, outfalls, as well as aerial imagery for the Study Area. Additional data provided includes various creek cross section locations, road network, land use mapping, building footprints, property parcels, Oakville property parcels, virtual lines, and virtual points.

Town of Oakville

- Town of Oakville Development Engineering Procedures and Guidelines Manual, undated
- Town of Oakville Zoning Bylaw 2014-014

1.1.3 Modelling

The following modelling data have been provided by the Town of Oakville and Conservation Halton (CH):

- HEC-2 and HEC-RAS hydraulic models for Bronte Creek, McCraney Creek and their tributaries (Conservation Halton).

- PCSWMM and HEC-RAS models developed as part of the Fourteen Mile Creek/McCraney Creek Flood Management Alternative Assessment, Town of Oakville, 2013

1.1.4 Site Reconnaissance

In addition to the afore-mentioned information from the Town and CH, information from the field reconnaissance by Amec Foster Wheeler (now Wood) staff to confirm the presence of downspout connections and basements along various sections of Lakeshore Road has been reviewed as part of the current assessment.

2.0 Existing Conditions

2.1 Existing Conditions Storm Drainage

The existing roadway drainage is split between numerous major/minor drainage outlets to Lake Ontario and three (3) watercourses: the Bronte Creek, Fourteen Mile Creek and McCraney Creek.

The existing drainage system along the urbanized sections of Lakeshore Road consists of a series of storm sewers conveying minor system flows, and a series of urban R.O.W.s (curb and gutter) conveying major system flows. The minor system conveys storm events up to the 5 year storm event, and the major system conveys storm events greater than the 5 year, up to the 100 year storm event. The rural road sections of Lakeshore Road drain to roadside ditches, which are intended to convey drainage up to the 100 year event.

The overall existing drainage boundaries, as well as storm sewers are presented in Figures 1 to 6 (ref. Appendix D). A description of the storm drainage systems, to each outlet is provided in following sections and should be read in conjunction with Drainage Figures within Appendix D. Road Stations corresponding to the drainage system boundaries have been provided for each drainage outlet.

The drainage catchments have been developed using the available background information, and additional discretization of the drainage catchments developed for the Town of Oakville Stormwater Master Plan.

2.1.1 West to Bronte Creek (0+000 to 0+310)

Drainage from stations -0+300 to 0+310 on Lakeshore Road, west of Bronte Creek undergoes a major/minor system split. The 1500 mm storm sewer outfall is at station 0+300 on the Bronte Creek west bank which conveys runoff from a drainage area of 33.45 ha (+/-) The major system splits at the intersection of Mississaga Street and Lakeshore Road; major system drainage from stations -0+300 to 0+000 is conveyed to a ditch and a remnant channel on Mississaga Street discharging to the Bronte Creek's west bank. Major system flow on Lakeshore Road between stations 0+000 and 0+310 is conveyed to West River Street where it is conveyed to Bronte Creek. East to Bronte Creek (0+310 to 0+700).

The drainage from Lakeshore Road east of Bronte Creek between stations 0+310 and 0+700 (undergoes a major/minor system split. The minor system has two (2) outlets. The first minor system between Stations 0+310 to 0+450 north of Lakeshore Road discharges to Bronte Creek's east bank at the north side the Bronte Creek crossing. The 600 mm storm sewer conveys drainage from an area of 1.018 ha (+/-) located near the outlet. The second minor system discharges on the south side of the Bronte Creek crossing and conveys drainage from Lakeshore Road between stations 0+310 to 0+700 and an external drainage area of 17.09 ha (+/-) to the Bronte Creek east bank. The minor system, 600 mm in diameter at the outfall, captures the overland flow of Bronte Road (north of Lakeshore Road) and Lakeshore Road. The overland flow is conveyed to the Lakeshore Road R.O.W. between Chris Vokes Memorial Park and the Bronte Harbour and subsequently conveyed to the Bronte Creek east bank near Bronte Harbour.

2.1.2 East to Nelson Street (0+780 to 1+090)

The major and minor system captures drainage from the Lakeshore Road at Jones Street intersection from a drainage area of 2.6 ha (+/-) and is conveyed eastward toward Nelson Street. The minor system is 750 mm in diameter in the vicinity of the Lakeshore Road and Nelson Street intersection. The major and minor systems combine with the Nelson Street major and minor systems at the intersection of Nelson Street and Lakeshore Road. The combined major and minor drainage systems are then conveyed south on Nelson Street toward Lake Ontario.

2.1.3 West to Nelson Street (1+090 to 1+400)

The Lakeshore Road major and minor systems convey drainage from the west side of East Street, westerly to the intersection of Lakeshore Road and Nelson Street. The minor system also conveys drainage on the east side of East Street with a drainage area of 0.80 ha (+/-) while the major system drainage east of East Street is conveyed southerly on East Street due to a major minor split with the major system. The storm sewer pipe diameter on Lakeshore Road at Nelson Street is 675 mm with a contributing drainage area of 10.12 ha (+/-), discharging to the Nelson Street 1.2 m x 1.9 m box storm sewer. The Nelson Street minor system south of Lakeshore Road discharges to Lake Ontario at Bronte Heritage Waterfront Park.

2.1.4 Sarah Lane (1+400 to 1+850)

The storm sewer on Lakeshore Road conveys drainage from station 1+400 eastward to Sarah Lane, while the major system from stations 1+400 to 1+700 at Solingate Drive splits to convey drainage west toward East Street. The major system east of 1+700 conveys drainage east along Lakeshore Road toward Third Line at station 2+200. The storm sewer on Lakeshore Road, ranging from 750 mm to 825 mm diameter, is combined with the storm sewer from Solingrate Drive (1650 mm diameter sewer) and the 750 mm storm sewer from Thornlea Drive prior to outletting to the 1650 mm diameter storm sewer on Sarah Lane near station 1+800. The Sarah Lane storm sewer discharges to Lake Ontario, with a drainage area at this location of approximately 151.17 ha (+/-).

2.1.5 Coronation Park West Channel (1+850 to 2+660)

There is no continual storm sewer system in place along this section of Lakeshore Road. The major system drainage on the north side of the road from station 1+700 to 2+200 is conveyed to the road-side remnant channel on the west corner of the Third Line and Lakeshore Road intersection, discharging to the a 900 mm storm sewer at the intersection. A 750 mm storm sewer on Third Line north of Lakeshore road is connected to the 900 mm storm sewer, which outlets to the road-side remnant channel on the east corner of the Third Line and Lakeshore Road intersection at Station 2+250, The major system on the south side of the road from stations 1+700 to 2+200 is conveyed to the road-side remnant channel on the east corner of the Third Line and Lakeshore Road intersection at Sir John Colborne Recreation Centre for Seniors. This remnant channel is also known as the Coronation Park West Channel. The total drainage area, including external area, conveyed to the outfall at Third Line and Lakeshore Road is 16.59 ha (+/-).

Runoff from the east bound lanes between stations 2+250 and 2+450 would sheet flow into the Coronation Park West Channel. Runoff from the west bound lanes between Stations 2+250 and 2+450 and the east bond lanes between stations 2+450 and 2+550 is conveyed to the road-side ditch on the north side of the road. The road-side ditch is conveyed to two (2) 300 mm CSP inlets at station 2+400 which are connected to a 1.2 m x 1 m box culvert. The box culvert conveys drainage under Lakeshore Road from the Venetia Drive easement, discharging to the Coronation Park West Channel. The total drainage area conveyed to this outfall is 26.08 ha (+/-).

Runoff from the east bound lanes between stations 2+550 and 2+660 is conveyed to the Coronation Park Driveway exit at station 2+660. The runoff conveyed to the driveway exit discharges into the Coronation Park West Channel. A 900 mm storm sewer that traverse Lakeshore Road at station 2+660 conveys drainage from the Watby Drive external area, discharging at the Coronation Park West Channel. Runoff from the westbound lanes between Stations 2+550 and 2+660 is conveyed to the Coronation Park East Channel (discussed in the subsequent section). The total drainage area conveyed to this outfall at the Coronation Park West Channel is 16.02 ha (+/-).

The total drainage area conveyed to the Coronation Park West Channel from Lakeshore Road and all the external areas north of Lakeshore Road is 58.09 ha, while the total drainage area conveyed to the Coronation Park West Channel including all external areas south of the channel is 73.57 ha (+/-).

2.1.6 Coronation Park East Channel (2+660 To 2+950)

There is no minor system in place along this section of Lakeshore Road. Runoff from the east bound lanes commencing near station 2+660 is conveyed eastward; there is a defined shallow ditch adjacent to the east bound lanes commencing at station 2+700 and discharges to the Coronation Park East Channel at Station 2+775. Runoff from the west bound lanes is conveyed eastward between stations 2+550 2+775 to the Coronation Park East Channel. Catch basins at the intersection of Lakeshore Road and Westminster Drive convey runoff to the 400 mm culvert that traverses Lakeshore Road at station 2+775, discharging to the Coronation Park East Channel.

Runoff from stations 2+775 to 2+950 is conveyed westward to the Coronation Park East Channel; there are no defined major system (ditch or curb/gutter) between these Stations. The total drainage area conveyed to the outfall at the Coronation Park East Channel is 14.19 ha (+/-).

The existing conditions PCSWMM model used for this study is not reflective of the east channel as construction of the channel was completed in Spring 2019. The channel was constructed following the initial Lakeshore Road SWM Report assessment submitted in March 2018.

2.1.7 Coronation Park East Parking Lot (2+950 to 3+280)

There is no minor system in place along this section of Lakeshore Road. The east bound lanes between Stations 2+950 and 3+100 would sheet flow into Coronation Park as there is no defined major system (ditch or curb/gutter). Runoff from the westbound lanes between Stations 2+950 and 3+100 is conveyed to a shallow ditch which outlets to a bird cage style catch basin; the catch basin is connected to a 600 mm storm sewer pipe that conveys runoff from north of Lakeshore Road to Lake Ontario. There is no defined major system (ditch or curb/gutter) adjacent to the westbound lane between Stations 3+100 and 3+280; the drainage between these Stations is also conveyed to the catch basin. A shallow ditch adjacent to the east bound lane conveys runoff from westward station 3+280 to 3+100 where the runoff is conveyed to a 300 CSP that is connected to the 600 mm storm sewer that traverses Lakeshore Road. The total drainage area conveyed to the storm sewer in the Coronation Park East parking lot, including all external areas, is 15.50 ha (+/-).

2.1.8 Drainage Easement (3+280 to 3+760)

There is no minor system in place along this section of Lakeshore Road. The major system conveys drainage from station 3+280 eastward to station 3+450 and from station 3+760 westward to station 3+450. There is a 1.84 x 1.22 m box culvert that traverses Lakeshore Road at Station 3+450 that conveys runoff from the Hixon Road remnant channel to Lake Ontario. There are existing shallow ditches on both sides of the road with the exception of the section of the east bound lane between Stations 3+550 to 3+760 where there is no defined major system (ditch or curb/gutter). The overall drainage area for this outlet is approximately 49.69 ha (+/-).

2.1.9 Stirling Drive Remnant Channel (3+760 to 3+900)

The 375 mm diameter storm sewer inlet in the ditch on the south side of Lakeshore Road conveys runoff from the ROW and the developed area on the north side of Lakeshore Road discharging to a remnant channel at Stirling Drive. The runoff from the north side of Lakeshore Road is conveyed to the storm sewer inlet via a 600 mm culvert under Lakeshore Road, that outlets to the road-side ditch east of the

375 mm storm sewer inlet. The storm sewer also conveys runoff from Stirling Drive and Wolfdale Avenue to the outfall at the remnant channel south of Stirling Drive. The storm sewer surcharges to the surface at the north end of the system while the south section of the storm sewer surcharged between the obvert and the rim elevation. The total drainage area from Lakeshore Road and the external area north of Lakeshore Road is conveyed to the Stirling Drive Remnant Channel is 6.85 ha (+/-). The total drainage area conveyed to the Stirling Drive Remnant Channel including all the external area south of Lakeshore Road is 11.21 ha (+/-).

2.1.10 East to Fourteen Mile Creek (3+900 to 3+980)

The existing road conveys major system flow easterly from Stations 3+900 to 3+980 where it discharges to Fourteen Mile Creek. There is no defined major system (ditch or curb/gutter) on either side of the road. The total drainage area conveyed via the major system is 0.16 ha (+/-).

There is an existing storm sewer system on Willowridge Court that discharges to the west side of Fourteen Mile Creek on the north side of the Lakeshore Road Bridge. While the 450 mm storm sewer pipe at the outfall primarily conveys drainage from Willowridge Court, there are two (2) catch basins at the intersection with Lakeshore Road on the north side of the road that convey flow to the storm sewer. The total drainage areas conveyed to this outfall is 2.60 ha (+/-).

2.1.11 West to Fourteen Mile Creek (3+980 to 4+560)

The existing road is generally conveyed in a westerly direction to Fourteen Mile Creek; there is a defined shallow ditch adjacent to the west bound lane between Stations 4+275 to 4+050 while there is no defined major system (ditch or curb/gutter) adjacent to the west bound lanes between Stations 4+275 to 4+560. There is also a defined shallow ditch, conveyed westerly, adjacent to the east bound lane between Station 4+100 to 4+050, The eastbound lane between Stations 4+100 to 4+560 conveys runoff to the side streets; runoff between Station 4+100 to 4+225 is conveyed to Westdale Road, runoff between Stations 4+225 to 4+450 is conveyed to Wilder Drive, and between Stations 4+450 to 4+560 is conveyed to West Lynn Road. There is no existing storm sewer system for this section of road, while the total drainage area discharging to the Fourteen Mile Creek via the major system is 2.89 ha (+/-), while the total drainage area conveyed to Fourteen Mile Creek and the side streets is 4.14 ha (+/-).

There is a 600 mm diameter CSP culvert that traverses Lakeshore Road at Station 4+460 to a storm sewer system on West Lynn Road. The culvert conveys drainage from the rear yards of the properties on the west side of Lakeshore Road.

2.1.12 East to McCraney Creek (4+560 to 4+930)

The existing storm sewer ranging in size from 375 mm to 525 mm is conveyed northly from Station 4+600 to 4+775 where it discharges to McCraney Creek on the west bank on the north side of the bridge. A defined shallow ditch between Stations 4+560 and 4+625 on the east side of Lakeshore Road conveys runoff to Westdale Road where it discharges to Lake Ontario. The major system on the west side of Lakeshore Road and the east side of Lakeshore Road north of Westdale Road is conveyed to McCraney Creek. The total drainage area for this outlet is approximately 1.51 ha (+/-).

2.1.13 West to McCraney Creek (4+930 to 5+090)

The 375 mm storm sewer system on Whittington Place, is connected to the Lakeshore Road 600 mm storm sewer at Station 4+925. A 525 mm storm sewer on Lakeshore Road conveys runoff from Station 5+000 westerly to the 600 mm storm sewer at Station 4+925. The 600 mm storm sewer discharges to the east side of McCraney Creek on the north side of the bridge at Station 4+800. The major system also discharges westerly to McCraney Creek. The overall drainage area at this outlet, including external drainage areas, is approximately 3.83 ha (+/-).

2.1.14 Birch Hill Lane (5+090 to 5+700)

The Lakeshore Road major and minor drainage systems convey runoff from Station 5+090 easterly to the Birch Hill Lane remnant channel at Station 5+375 while the major and minor drainage systems convey runoff from Station 5+700 westerly to the Birch Hill Lane remnant channel. The Birch Hill Lane remnant channel outlets to Lake Ontario 420 m (+/-) downstream. A 300 mm diameter storm sewer on the south side of Lakeshore Road conveys runoff from drainage collected in catch basin at the Suffolk Avenue and Lakeshore Road Intersection. The storm sewer is conveyed south easterly at Station 5+225 to the east end of The Enclave at Birch Hill (private development at 456 Lakeshore Road) where is discharges to the remnant channel 90 m (+/-) downstream of Lakeshore Road in the rear yards of the private properties on Birch Hill Lane. A storm sewer ranging from 575 mm to 650 mm is conveyed easterly from The Enclave at Birch Hill (private development at 456 Lakeshore Road), discharging to the Birch Hill Lane remnant channel at the Lakeshore Road and Birch Hill Lane (Station 5+375).

A 375 mm diameter pipe conveyed from Paliser Court outlets to a 600 mm storm sewer at the intersection with Lakeshore Road at Station 5+475. The 600 mm storm sewer is conveyed westerly on Lakeshore Road, discharging at the Birch Hill Lane remnant channel (Station 5+375). Storm sewer information has not been provided for the section of Lakeshore between Stations 5+475 and 5+700 which includes the Lambert Common private laneway. The overall drainage area to this outlet is 8.01 ha (+/-); this does not include the external drainage areas conveyed to the remnant channel of Lakeshore Road.

2.1.15 Shorewood Place (5+700 to 5+800)

There is no minor system in place along this section of the Lakeshore Road. The overland drainage from the east bound lanes is conveyed to Shorewood Place while the drainage from the west bound lanes is conveyed to the storm sewer at Tavistock Square. The Lakeshore Road drainage area to the drainage outlets is approximately 0.84 ha.

2.1.16 Remnant Channel West of Dorval Drive/ Sewer on Lakeshore Rd (5+800 to 6+100)

The drainage for this section of Lakeshore Road undergoes a major/minor system split. The minor system ranging in size from 525 mm to 600 mm diameter, commences at the intersection of Tavistock Square and Lakeshore Road at Station 5+820. The minor system discharges to the remnant channel located west of Dorval Drive and north of the Lakeshore Road near Station 6+020. The Lakeshore Road drainage area contributing for the remnant channel is approximately 6.64 ha (+/-). The remnant channel outlets to a 750 mm storm sewer, which connects to a 1200 mm storm sewer at the intersection of Lakeshore Road and Dorval Drive; the 1200 mm storm sewer also conveys drainage from an external area 27.1 ha (+/-) north of Dorval Drive. The 1200 mm storm sewer increases to 1350 mm, and conveys flow eastward on Lakeshore Road to Brock Street where the storm sewer merges with a 1350 mm storm sewer on Brock Street. The two (2) 1350 mm storm sewers outlet to a 1350 mm storm sewer conveyed southerly on Brock Street before discharging to Lake Ontario.

The Lakeshore Road major system conveys drainage to a sag point at the Lakeshore Road and Dorval Drive intersection, Should sufficient ponding occur at the intersection, it would spill over the curb into the remnant drainage channel within the St. Jude's Cemetery, where the remnant channel outlets through a 900 mm diameter culvert at Lakewood Drive to Lake Ontario.

2.2 Hydraulic Crossings

As depicted on Figures 2 to 7 and 14 and 15, there are four (4) hydraulic crossings (bridges and culverts) within the Study Area located at the following road Stations:

- Bronte Creek (0+310)
- Un-named Drainage Feature (3+450)
- Fourteen Mile Creek (3+390)
- McCraney Creek (4+790)

2.2.1 Bronte Creek

Bronte Creek Bridge (also known as 12 Mile Bridge) was built in 1970 and rehabilitated around 1999. The total deck length is 64.9m and structure width is 19.5m. The roadway width is 14.4 m. The current posted speed is 50 km/h and the roadway consists of four (4) lanes. The bridge has been assessed to be in good condition and will not require any structural modifications. Conservation Halton provided the current Bronte Creek HEC-2 hydraulic model for use in the Oakville Stormwater Master Plan. The Lakeshore Road crossing has been modelled as a bridge. Based on the HEC-2 hydraulic model the Bronte Creek crossing is capable of conveying the Regional Storm (Hurricane Hazel).

2.2.2 Un-named Drainage Feature

The second crossing is a 1.22 m x 1.84 m box culvert located at Station 3+450 that conveys runoff from north of Lakeshore Road (Hixon Street Remnant Channel) to Lake Ontario. Hydraulic modelling of the crossing has been included within the PCSWMM integrated hydrologic/hydraulic model. The crossing is capable of conveying the 100 year storm without overtopping Lakeshore Road, with approximately 0.50 m freeboard.

2.2.3 Fourteen Mile Creek

The Fourteen Mile Creek Bridge was built in 1916 and has been extended both north and south. It is a Spandrel Arch Structure. The total deck length is 17.1 m (+/-) and the structure width is 15.74 m (+/-). The roadway width is 11.54 m (+/-). The bridge has been assessed in good condition and will not require any structural modifications.

The bridge has been modelled in HEC-RAS Version 4.1 as part of the ongoing Fourteen Mile Creek and McCraney Creek Flood Mitigation Opportunities Class EA. It conveys the 100 year storm event based on a deck elevation of 81.66 m, but the Regional Storm overtops it by 0.75 m (+/-) with a flow velocity of 1.09 m/s (+/-). Further details pertaining to the WSELs for all storm events (2-100 year & Regional) are provided in Appendix 'C' while floodplain mapping has been provided on Figure 12.

At the bridge crossing, based on the simulated 0.75 m (+/-) overtopping road depth and 1.09 m/s (+/-) flow velocity, and using the Ministry of Natural Resources and Forestry's (MNRF's) vehicle ingress and egress requirements (Technical Guide – River and Stream Systems: Flooding Hazard Limit, 2002), private vehicles would not be able to drive along Lakeshore Road at the Fourteen Mile Creek crossing during the Regional Storm Event. Emergency vehicles (fire trucks) would be able to cross the bridge as the flood depth is below the 0.90 m MNRF guideline for flow depth for emergency vehicles. However, Town of Oakville staff have indicated emergency vehicles would not use the bridge under Regional Storm flooding conditions.

2.2.4 McCraney Creek

The McCraney Creek crossing is an arch culvert built in 1940 and subsequently extended with a box culvert section. The total deck length is 14 m (+/-) and the structure width is 5.4 m (+/-). The roadway width is 8.4 m (+/-). The structure has a 100 year hydraulic capacity but is overtopped by the Regional Storm by 1.36 m (+/-) with a flow velocity of 1.46 m/s (+/-) (ref. Figure 13).

In July 2017, emergency work was undertaken to temporarily stabilize the road embankment slope as a result of the north-west wingwall collapse. Erosion issues along the west creek bank will continue and will need to be addressed through creek works. Due to the structural condition and hydraulic capacity of this crossing it will require replacement as part of this project.

2.3 Physiography and Soils

Surficial soils data for the Study Area (as available from Agriculture Canada – Ontario Soil Survey Reports) is generally lacking; mapping for the Study Area indicates an urbanized land use and therefore does not provide more detailed information. Based on the soils information determined within the Coronation Park Drainage Improvements Class EA, the surficial geology within the Coronation Park area is predominantly characterized by coarse-textured glaciolacustrine deposits (sand, gravel, silt and clay).

Three geotechnical reports within the Study Area (ref. Appendix 'A' for excerpts). One report was conducted in support of the reconstruction of Third Line, another for a proposed structure within Coronation Park. A third, more extensive report provides details of the geotechnical investigation conducted in support of the Mid-Halton WWTP Effluent Sewer and Outfall Project, with deep boreholes within Coronation Park and along Lakeshore Road and Third Line. The borehole logs for these reports predominantly indicate the presence of silty sand, as well as clayey silt and silty clay within the surficial soils. Weathered shale material (Queenston formation) was generally indicated at the base of the boreholes (note that much deeper excavation and rock coring was conducted in support of the Mid-Halton WWTP Effluent Sewer and Outfall Project).

Piezometers were not installed as part of the first two geotechnical investigation, so groundwater levels cannot be reliably determined. Both reports indicated that no groundwater table was encountered during or immediately after drilling, but that soils were found to be wet at various depths. Along Third Line, wet sand was noted at depths ranging between 0.7 and 2.9 m (+/-) below ground, while within Coronation Park, wet caving was noted at depths between 1.4 and 3.1 m (+/-) below ground. In both cases, it was noted that groundwater tables fluctuate seasonally, and that the observed conditions may not reflective of long-term groundwater trends.

Piezometers were however installed at five borehole locations conducted as part of the geotechnical investigations for the Mid-Halton WWTP Effluent Sewer and Outfall Project. Reported piezometer readings taken approximately three (3) months after drilling indicated groundwater at depths of between 1.8 and 9.9 m (+/-) below ground; these piezometers were however noted to be quite deep, with the screens at much lower depths than those of the other two studies. It should be noted that artesian conditions (i.e. groundwater discharging freely to the surface) were noted at two other borehole locations, which suggests an elevated groundwater level in the area. In all cases, it was again noted that groundwater tables fluctuate seasonally and in response to precipitation, and that the observed conditions may not be reflective of long-term groundwater levels.

2.4 Existing Conditions Hydrology

An integrated hydrologic/hydraulic model of the existing conditions of the Lakeshore Road R.O.W. has been developed in PCSWMM Version 7.0. The original PCSWMM model was developed as part of the

Town of Oakville Stormwater Master Plan by Amec Foster Wheeler (now Wood) and was designed to assess the storm sewer system within southern Oakville. The PCSWMM modelling was updated for the hydrologic/hydraulic assessment within the Class EA. to be more discretized and to assess each storm sewer section and roadside ditch to determine the Lakeshore Road drainage system performance.

The PCSWMM model as developed by Amec Foster Wheeler (now Wood) has been completed, and the following items in relation to the selected parameters are important to note:

Subcatchments

- Impervious coverages as per the Stormwater Master Plan (ref. Appendix 'B')
- The Manning's 'n' value assigned to impervious surfaces is 0.013;
- The Manning's 'n' value assigned to pervious surfaces is 0.25;
- The depression storage assigned to impervious surfaces is 2 mm. and
- Based upon review of Table 24.2 within the User's guide to SWMM5, 13th Edition, the initial deficit fraction assigned for soils described herein is 0.315

Storm Sewers

- The entrance and exit loss coefficients assigned to storm sewers are 0.15 to 1 respectively (reference U.S. Department of Transportation Federal Highway Administration Hydraulic Engineering Circular 22 – Urban Drainage Design Manual, September 2009);
- The Manning's 'n' value assigned to asphalt road surfaces is 0.014. Typical industry standard for this parameter is 0.013 or 0.014; and
- The Manning's 'n' value assigned to ditches is 0.03 as they are typically manicured grass in the study area as confirmed during site reconnaissance. Typical industry standard for this parameter could be as high as 0.045 for poorly manicured grass ditches.

In keeping with these values, the storm sewers and road surfaces added to the PCSWMM model were also assigned these values. Roadside ditches were also added to the PCSWMM model based on road plan and profiles and site reconnaissance. The existing conditions drainage boundaries developed for the PCSWMM model are presented in Figures 2 to 6 (ref. Appendix D).

The PCSWMM model has been executed using the Town of Oakville 4 hour Chicago design storms for the 5 and 100 year storm events. The simulated results for existing conditions at the various minor and major system outlets for Lakeshore Road have been summarized within Tables 2.1 and 2.2.

To understand the performance of the minor system (storm sewer system) for the 5 year storm event, the level of performance has been categorized as non-surcharged, surcharged and surcharged to surface within Table 2.1. In summary most of the existing storm sewer system surcharges, with only two (2) drainage systems not surcharging. For the major system within an urban road section, level of performance has been noted as non-surcharged meaning flow below top of curb, surcharged above the curb and then surcharged more than 0.15 m above centreline of road. The Town of Oakville requires overland flow on roads to be less than 0.15 m above road centreline. For rural road sections with road-side ditches the level of performance has been assessed as non-surcharged (within the ditch) or surcharged (flooding outside of the ditch).

Site reconnaissance has been conducted to determine potential basement connections to the storm sewer system. It is not known if basements have direct or sump system connections to the minor system. The PCSWMM model has been used to determine if the minor system hydraulic grade line may be above basement levels. Documentation of the basement flood risk assessment has been provided in Appendix B.

Table 2.1. Existing Conditions Minor System Performance (5 Year)

Drainage Outlet	Road Stations	Minor System Drainage Area(ha)	Performance	Description
West to Bronte Creek	0+000 - 0+300	33.45	Non-Surcharged	The sewer system ranges in size from 1200 mm to 1500 mm diameter. There is no surcharge for the 5-year storm event throughout the 300 m sewer system.
East to Bronte Creek	0+310 - 0+700	17.58	Surcharged to Surface	The minor system along the westbound lanes ranges from 450 mm to 600 mm diameter over its 87 m length. This system is surcharged to the surface at Junction J1_1_12_R_LS with a maximum surcharge depth of 1.09 m. The minor system along the eastbound lanes ranges from 375 mm to 600 mm diameter over the total length of 432 m. This minor system is surcharged for the entire length. The system is surcharged to the surface for 150 m out of 432 m with a maximum surcharge depth of 3.62 m occurring at the junction O_0160_6712.
East to Nelson Street	0+780 - 1+060	2.6	Surcharged to Surface	The sewer system ranges in size from 300 mm to 750 mm diameter. The storm sewer surcharges for 140 m out of the 180 m total length. At Junctions O_0160_6676 and O_0160_6677, the sewer surcharges to the surface with maximum surcharge depths of 0.85 m and 1.25 m respectively.
West to Nelson Street	1+060 - 1+400	10.12	Surcharged	The sewer system ranges in size from 300 mm to 675 mm diameter. The storm sewer is surcharged for the entire 300 m length but it's not surcharged to the surface at any point.
Sarah Lane	1+400 - 1+850	151.17	Surcharged	The sewer system ranges in size from 750 mm to 1650 mm diameter. The storm sewer is surcharged for the entire length of the minor system of 450 m but it's not surcharged to the surface at any point.
Coronation Park West Channel	1+850 - 2+660	58.69	Surcharged to Surface	The 900 mm diameter sewer, collecting the overland flow conveyed through the swale (at the intersection of Third Line and Lakeshore Road) and the minor system along Third Line surcharges but not to the surface at any point over its 80 m length. At Junction O_0160_4200, water level is closest to the surface with minimum available freeboard of 0.021 m. The culvert, 1.2 m x 1 m in size, near the Station 2+400 surcharges throughout its length of 25 m. The Junction O_0160_3804 surcharges to the surface with maximum surcharge depth of 0.63 m. The 900 mm pipe at Station 2+650, connected to the minor system along the Walby Drive surcharges to the surface at both the ends with maximum surcharge depth of about 1 m.
Coronation Park East Channel	2+660 - 2+950	14.19	Surcharged to Surface	The 400 mm diameter sewer, collecting the overland flow coming along the Westminster Drive surcharges to the surface till it discharges into the open channel in the Coronation Park with maximum surcharge depth being 1.39 m at the junction O_0120_10234.
Coronation Park East Parking Lot	2+950 - 3+280	15.5	Surcharged	The 600 mm diameter sewer, collects and conveys the overland flow from Woodhaven Park Drive. The sewer surcharges until it discharges into Lake Ontario with minimum available freeboard of 0.37 m at the junction O_0120_10233 near the inlet of the pipe.
Drainage Easement	3+280 - 3+760	49.69	Non-Surcharged	The culvert is 1.84m x 1.22 m in size and does not surcharge. It discharges via a drainage easement to Lake Ontario.
Stirling Drive Remnant Channel	3+760 – 3+900	6.85	Surcharged to Surface	The 375 mm storm sewer inlet on the south side of Lakeshore Road conveys runoff from the ROW and the developed area on the north side of Lakeshore Road discharging to a remnant channel at Stirling Drive. The runoff from the north side of Lakeshore Road is conveyed to the storm sewer inlet via a 600 mm culvert under Lakeshore Road, that outlets to the road-side ditch east of the 375 mm storm sewer inlet. The storm sewer also conveys runoff from Stirling Drive and Wolfdale Avenue to the outfall at the remnant channel south of Stirling Drive. The storm sewer surcharges to the surface at the north end of the system while the south section of the storm sewer surcharged between the obvert and the rim elevation.
East to Fourteen Mile Creek	3+900 - 3+980	2.6	Surcharged	The sewer system ranges in size from 300 mm to 450 mm diameter. The minor system at this outlet is not along Lakeshore Road but instead, along Willowridge Ct. and discharges to Fourteen Mile Creek. The storm sewer is surcharged for the entire length but it's not surcharged to the surface.
West to Fourteen Mile Creek	3+980 - 4+560	2.89	-	The existing Road system is rural with the west bound lanes draining to 14 Mile Creek, and the east bound lanes, east of Westdale Drive draining (west section) to the local side Roads (Westdale Dale Drive (west section), Wilder Drive, and West Lynn Road). Hence, there is no minor system in place along Lakeshore Road for this road section.
East to McCraney Creek	4+560 - 4+780	1.51	Surcharged to Surface	The sewer system ranges in size from 375 mm to 525mm diameter. The storm sewer is non-surcharged for the entire length of the minor system of 190 m except at the outlet at McCraney Creek where it is surcharged to the surface.
West to McCraney Creek	4+780 - 5+090	3.83	Surcharged	The minor system along Lakeshore Road starts at the Station 4+925 where it is connected with the minor system coming along Whittington Place. The storm sewer 600 mm in diameter along Lakeshore Road surcharges at the outfall to McCraney Creek.
Birch Hill Lane	5+090 - 5+700	8.01	Surcharged	The sewer system ranges in size from 200 mm to 675 mm diameter east to Birch Hill Lane and from 375 mm diameter to 600 mm diameter west to Birch Hill Lane. The storm sewer is surcharged near the intersection of Lakeshore Road and Birch Hill Lane.
Remnant Channel West of Dorval Drive	5+700 - 6+100	6.64	Surcharged	The sewer system is 525 mm in diameter and 220 m in length along Lakeshore Road. The storm sewer is surcharged for the entire length but it is not surcharged to the surface at any point.

Table 2.2. Existing Conditions Major System Performance (100 Year)

Drainage Outlet	Road Stations	Drainage Area(ha)	Performance	Description
West to Bronte Creek	0+000 - 0+300	33.45	Surcharged above the centreline (>0.15 m)	The road is a 4-lane urban cross-section with curb and gutter. The major system is surcharged above the centreline of the road (> 0.15m) for 60 m out of the total length of 300 m near Station 0+175 on both the sides on Lakeshore Road. The maximum flow depth of 0.42 m is attained near Station 0+175.
East to Bronte Creek	0+310 - 0+700	17.58	Surcharged above the curb	The road is a 4-lane urban cross-section with curb and gutter until Bronte Road and 3-lane urban cross-section with curb and gutter afterwards. The major system is surcharged above the curb for 150 m out of the total length of 390 m starting at the Station near 0+400 and going along the eastbound lanes. The maximum flow depth of 0.29 m is attained near Station 0+450.
East to Nelson Creek	0+780 - 1+090	2.6	Surcharged above the centreline (>0.15 m)	The road is a 3-lane urban cross-section with curb and gutter. The major system is surcharged above the centreline of the road (> 0.15m) for 60 m out of the total length of 290 m near Station 1+020 on both the sides on Lakeshore Road. The maximum flow depth of 0.53 m is attained near Station 1+020.
West to Nelson Creek	1+090 - 1+400	10.12	Surcharged above the centreline (>0.15 m)	The road is a 3-lane urban cross-section with curb and gutter. The major system is surcharged above the centreline of the road (> 0.15m) for 80 m out of the total length of 360 m near Station 1+080 on both the sides on Lakeshore Road. The maximum flow depth of 0.31 m is attained near Station 1+075.
Sarah lane	1+400 - 1+850	151.17	Surcharged (flooding)	The road is a 2-lane rural cross-section with side ditch on either or both sides of the road. The major system is surcharged above the side ditch for 150 m out of the total length of 450 m east of Station 1+425 on Lakeshore Road. The maximum flow depth of 0.23 m is attained near Station 1+475.
Coronation Park West Channel	1+850 - 2+660	58.69	Surcharged (flooding)	The road is a 2-lane rural cross-section with side ditch on either or both sides of the road. The major system is surcharged above the side ditch for 300 m out of the total length of 800 m east of Station 2+200 on Lakeshore Road. The maximum flow depth of 0.26 m is attained near Station 2+400.
Coronation Park East Channel	2+660 - 2+950	14.19	Surcharged (flooding)	The road is a 2-lane rural cross-section with side ditch on either or both sides of the road. The major system is surcharged above the side ditch for 200 m out of the total length of 300 m east of Station 2+660 on Lakeshore Road. The maximum flow depth of 0.54 m is attained near Station 2+750.
Coronation Park East Parking Lot	2+950 - 3+280	15.5	Surcharged (flooding)	The road is a 2-lane rural cross-section with side ditch on either or both sides of the road. The major system is surcharged above the side ditch for 140 m out of the total length of 330 m east of Station 3+000 on Lakeshore Road. The maximum flow depth of 0.77 m is attained near Station 3+100.
Drainage Easement	3+280 - 3+760	49.69	Surcharged (flooding)	The road is a 2-lane rural cross-section with side ditch on either or both sides of the road. The major system is surcharged above the side ditch for 200 m out of the total length of 480 m east of Station 3+400 on Lakeshore Road. The maximum flow depth of 0.81 m is attained near Station 3+550.
Stirling Drive Remnant Channel	3+760 – 3+900	6.85	Non-Surcharged	The road is a 2-lane rural cross-section with ditches on both sides of the road. The major system maximum flow depth is below the ditch depth for the entire length of 140 m. Two (2) parallel existing ditches are located on the north side of Lakeshore Road; one (1) of the ditches is within the ROW, while the other is outside the ROW. Under existing conditions, the ditch outside the ROW surcharges to the ditch within the ROW. The major system is conveyed to a swale between Lakeshore Road and Stirling Drive, ultimately discharging to the Stirling Drive remnant channel.
East to Fourteen Mile Creek	3+760 - 3+980	2.6	Non-Surcharged	The road is a 2-lane rural cross-section with side ditch on either or both sides of the road. The major system maximum flow depth is below the side ditch depth for entire length of 220 m.
West to Fourteen Mile Creek	3+980 - 4+560	2.89	Surcharged (flooding)	The road is a 2-lane rural cross-section with side ditch on either or both sides of the road. The major system is surcharged above the side ditch for 180 m out of the total length of 570 m east of Station 4+250 on Lakeshore Road. The maximum flow depth of 0.73 m is attained near Station 4+250.
East to McCraney Creek	4+560 - 4+780	1.51	Non-Surcharged	The road is a 2-lane rural cross-section with side ditch on either or both sides of the road. The major system maximum flow depth is below the side ditch depth for entire length of 220 m.
West to McCraney Creek	4+780 - 5+090	3.83	Non-Surcharged	The road is a 2-lane rural cross-section with side ditch on either or both sides of the road. The major system maximum flow depth is below the side ditch depth for entire length of 310 m.
Birch Hill lane	5+090 - 5+700	8.01	Surcharged (flooding)	The road is a 2-lane rural cross-section with side ditch on either or both sides of the road. The major system is surcharged above the side ditch for almost 300 m out of the total length of 610 m east of Station 5+350 on Lakeshore Road. The maximum flow depth of 0.53 m is attained near Station 5+490.

Drainage Outlet	Road Stations	Drainage Area(ha)	Performance	Description
Remnant Channel West of Dorval Drive	5+700 - 6+100	6.64	Surcharged above the centreline (>0.15 m)	The road is a 2-lane rural cross-section with side ditch on either or both sides of the road until Station6+000. The road is a 2-lane urban cross-section with curb and gutter east of Station 6+000. The major system is surcharged above the centreline of the road (> 0.15m) for almost 100 m out of the total length of 400 m east of Station 6+000 on Lakeshore Road. The maximum flow depth of 0.55 m is attained near Station 6+125.

3.0 Stormwater Objectives

3.1 Stormwater Management Design Criteria

The stormwater management and hydraulic analyses of the Lakeshore Road improvements will consider stormwater management design criteria from several agencies including; the Town of Oakville, Conservation Halton, the Ministry of Transportation (MTO), the Ministry of Natural Resources and Forestry (MNRF), and the Ministry of Environment, Conservation and Parks (MECP). The stormwater management and hydraulic criteria relevant to the Lakeshore Road improvements are outlined in the following sections.

The Town of Oakville

- *Minor System:* Storm sewers are to convey the 10 year storm event, and are to be designed using Town of Oakville IDF information;
- *Major System:* R.O.W.s, including both urban and rural, are to convey flows generated by the R.O.W. itself, up to the 100 year storm event; and
- Flow depth or flooding depth on roads not to exceed 0.15 m above the road centreline.
- Implement source controls in the form of Low Impact Development Best Management Practices (LID BMPs) to capture 25 mm of precipitation to offset the reduction of hydraulic performance due to land use intensification and climate change.
- Maintain ditches and swales, where possible, along the Lakeshore Road corridor to conserve the character of the corridor and provide a stormwater quantity and quality benefit.

Conservation Halton

- *Quantity Control:* No control is required for all storm events as Lakeshore Road either directly or indirectly drains to Lake Ontario. For the road sections draining to Bronte Creek, Fourteen Mile Creek and McCraney Creek, as Lakeshore Road is at the outlet of the creek systems to Lake Ontario, no quantity controls are required;
- *Quality Control:* MECP Enhanced Level (Level 1) Water Quality Control for the increase in pavement area. A treatment train solution is recommended when feasible;
- *Erosion Control:* 25 mm for the increase in pavement area to Fourteen Mile Creek, McCraney Creek. Lakeshore Road at Bronte Creek is located at Bronte Creek Harbour, therefore no erosion control is to be provided.

The Ministry of Transportation

- Culverts crossing beneath roads classified as Urban Arterial, with a span less than 6.0 m, are to convey the peak flow generated from a 50 year storm event; and
- Culverts crossing beneath roads classified as Urban Arterial, with a span greater than 6.0 m, are to convey the peak flow generated from a 100 year storm event.
- Culverts crossing beneath roads classified as Urban Arterial are required to provide a freeboard greater than or equal to 1.0 m for the 100 year storm.

The Ministry of Natural Resources and Forestry

- Fourteen Mile Creek supports Redside Dace Habitat, and as such, thermal mitigation of stormwater discharging to Fourteen Mile Creek is required.
- MNRF's vehicle ingress and egress requirements (Technical Guide – River and Stream Systems: Flooding Hazard Limit, 2002),

The Ministry of Environment, Conservation and Parks

- *Quality Control:* MECP Enhanced Level (Level 1) Water Quality Control for the increase in pavement area. A treatment train solution is recommended when feasible;
- *Erosion Control:* 25 mm for the increase in pavement area to Fourteen Mile Creek, McCraney Creek. Lakeshore Road at Bronte Creek is located at Bronte Creek Harbour, therefore no erosion control is to be provided.

4.0 Future Conditions

4.1 Future Conditions Storm Drainage

Lakeshore Road improvements would consist of urbanization of rural road sections with curb and gutter, , revisions to intersections, adding a 3 m multi-use trail (MUT) on the south side of the road, a 1.5 m sidewalk on the north side of the road and modifications to the road profile. The MUT has not been added along the entire road section, it has been added where applicable, with no MUT through the Bronte Village as an example.

Future conditions storm drainage boundaries are presented in Figures 8 to 13 (ref. Appendix D). The roundabout shown on Figure 8, Appendix D has been removed from the preferred Third Line and Lakeshore Road intersection configuration; that said it does not impact the drainage system assessment and design. To determine the impacts of the widening works, the PCSWMM model developed for existing conditions (as per Section 2.4) has been modified to represent future conditions storm drainage. Table 4.1 presents the level of performance of each drainage system without quantity controls and without drainage system improvements. To understand the performance of the minor system (storm sewer system) for the 5 year storm event, the level of performance has been categorized as non-surcharged, surcharged and surcharged to surface within Table 4.1.

In summary most of the existing storm sewer system surcharges, with only three (3) drainage systems not surcharging. As expected, results presented in Table 4.1 indicate that under future conditions, the minor drainage system would continue to surcharge to varying degrees, with the systems that were non-surcharged under existing road conditions, remaining surcharged.

Table 4.1. Future Conditions (Without SWM and Upgrades) Minor System Performance

Drainage Outlet	Road Stations	Minor System Drainage Area(ha)	Performance	Description
West to Bronte Creek	0+000 - 0+300	33.45	Non-Surcharged	The sewer system ranges in size from 1200 mm to 1500 mm diameter. There is no surcharge for the 5-year storm event throughout the 300 m sewer length.
East to Bronte Creek	0+310 - 0+700	17.58	Surcharged to Surface	The minor system along the westbound lanes ranges from 450 mm to 600 mm in diameter over the 87 m sewer length. This system is surcharged to the surface at Junction J1_1_12_R_LS with maximum surcharge depth of 1.09 m. The minor system along the eastbound lanes ranges in size from 375 mm to 600 mm diameter over the 432 m sewer length. This minor system is surcharged for the entire length. The system is surcharged to the surface for 150 m out of 432 m with maximum surcharge depth of 3.62 m at the Junction O_0160_6712.
East to Nelson Creek	0+780 - 1+060	2.6	Surcharged to Surface	The sewer system ranges in size from 375 mm to 750 mm diameter. The storm sewer surcharges to the surface for 140 m out of 180 m of total length. At Junctions O_0160_6676 and O_0160_6677, the sewer surcharges to the surface with maximum surcharge depths of 0.83 m and 1.23 m respectively.
West to Nelson Creek	1+060 - 1+400	10.12	Surcharged	The sewer system ranges in size from 300 mm to 675 mm diameter. The storm sewer is surcharged for the entire length of the minor system of 300 m, however, the storm sewer is not surcharged to the surface at any point.
Sarah Lane	1+400 - 1+850	151.17	Surcharged to Surface	The sewer system ranges in size from 750 mm to 1650 mm diameter. The storm sewer is surcharged to the surface for 120 m out of 450 m starting at Junction O_0160_6726 which has a maximum surcharge depth of 7.84 m.
Coronation Park West Channel	1+850 - 2+660	58.69	Surcharged to Surface	The minor system ranges from 900 mm to 1050 mm diameter and commences at the Third Line. The system surcharges to surface for its entire length of 440 m with maximum the surcharge depth of 4.33 m occurring at Junction J109. The 1.2 m x 1 m culvert, near the Station 2+400 surcharges throughout its length of 25 m. The culvert captures the drainage from Venetia Drive and along Lakeshore Road. The Junction O_0160_3804 surcharges to the surface with a maximum surcharge depth of 0.26 m. The 675 mm diameter pipe at Station 2+650, connected to the minor system along Walby Drive and Lakeshore Road surcharges to the surface with maximum surcharge depth of 1.62 m.
Coronation Park East Channel	2+660 - 2+950	14.19	Surcharged to Surface	The 400 mm diameter pipe, collecting the minor system coming along the Westminster Drive and Lakeshore Road surcharges to the surface until it discharges into the channel in Coronation Park. The entire minor system coming along the Westminster drive (300 mm diameter to 375 mm diameter in size, 480 m long) also surcharges to the surface. The maximum surcharge depth at the Junction O_0160_4198 is 1.35 m.
Coronation Park East Parking Lot	2+950 - 3+280	15.5	Surcharged	The 900 mm and 975 mm diameter pipe, collecting the overland flow and the flow conveyed by the minor system coming along the Woodhaven Park Drive surcharges till it discharges into the Lake Ontario with minimum available freeboard of 0.45 m at the Junction O_0120_10233 near the inlet. The minor system on Woodhaven Park Drive surcharges to the surface for almost its entire length.
Drainage Easement	3+280 - 3+760	49.69	Non-Surcharged	The 1.84m x 1.22 m culvert does not surcharge and discharges via the drainage easement to Lake Ontario.
Stirling Drive Remnant Channel	3+760 – 3+900	5.77	Surcharged	The 375 mm storm sewer between Lakeshore Road and Stirling Drive is surcharged above the obvert at the downstream end of the system, while the upstream end is not surcharged. The 375 mm storm sewer inlet on the south side of Lakeshore Road conveys runoff from the ROW and the developed area on the north side of Lakeshore Road discharging to a remnant channel at Stirling Drive. The runoff from the north side of Lakeshore Road is conveyed to the storm sewer inlet via a 600 mm culvert under Lakeshore Road, that outlets to the roadside ditch east of the 375 mm storm sewer inlet. The storm sewer also conveys runoff from Stirling Drive and Wolfdale Avenue to the outfall at the remnant channel south of Stirling Drive.
East to Fourteen Mile Creek	3+900 - 3+980	2.6	Surcharged	The sewer system ranges in size from 300 mm to 450 mm diameter. The minor system at this outlet is located on Willowridge Court and discharges to Fourteen Mile Creek. The storm sewer is surcharged for the entire length, however, it is not surcharged to the surface.
West to Fourteen Mile Creek	3+980 - 4+560	2.89	NA-	The proposed west bound road lanes drain to 14 Mile Creek, and the east bound lanes, east of Westdale Drive drain (west section) to the local side roads (Westdale Dale Drive (west section), Wilder Drive, and West Lynn Road). There is no minor system in place along Lakeshore Road for this road section.
East to McCraney Creek	4+560 - 4+780	4.95	Surcharged to Surface	The sewer system ranges in size from 375 mm to 525mm diameter. The storm sewer is non-surcharged for the entire length of 190 m except at the outlet to McCraney Creek where it is surcharged to the surface.
West to McCraney Creek	4+780 - 5+090	1.3	Surcharged	The minor system along Lakeshore Road starts at the Station 4+925 where it is connected with the minor system coming along Whittington Place. The storm sewer, 600 mm diameter in size along Lakeshore Road surcharges at the outfall while discharging to McCraney Creek.
Birch Hill Lane	5+090 - 5+700	8.01	Surcharged	The sewer system ranges in size from 250 mm to 675 mm diameter east of Birch Hill Lane and from 375 mm to 600 mm diameter west of Birch Hill Lane. The storm sewer is surcharged near the intersection of Lakeshore Road and Birch Hill Lane.

Drainage Outlet	Road Stations	Minor System Drainage Area(ha)	Performance	Description
Remnant Channel West of Dorval Drive	5+700 - 6+100	6.64	Surcharged	The sewer system is 525 mm diameter and 220 m in length along Lakeshore Road. The storm sewer is surcharged for the entire length, however it is not surcharged to the surface at any point. The storm sewer discharges to the open channel at the Station 6+020 where it's later connected to the minor system along Lakeshore Road at Station 6+070. This minor system ranges in size from 750 mm diameter to 1350 mm diameter and surcharges to the surface for almost its entire length. The maximum surcharge depth is at Junction O_0160_5836 (at intersection of Dorval Drive and Lakeshore Road) of 2.18 m.

4.2 Future Conditions Hydraulics

The current crossing of the McCraney Creek is proposed to be replaced in order to address the deficient structural condition and the 1.36 m overtopping flow depth and 1.46 m/s flow velocity resulting from the Regional Storm (Hurricane Hazel). The proposed crossing would be a 14.6 m span by 4 m rise by 24.3 m length, with some of the bridge section skewed to accommodate a 33 m +/- long creek realignment to address the existing creek bank erosion condition on the northeast side of the structure. The proposed replacement structure would convey the Regional Storm without overtopping the road. The 24.3 m length has been minimized to accommodate the proposed 1.5 m sidewalk and 3 m MUP.

In order to determine the impacts to the water surface elevations (WSELs) upstream and downstream of the crossing, the HEC-RAS hydraulic model of the McCraney Creek has been revised to incorporate the preliminary proposed (future) crossing general arrangement. Table 4.2 below provides a comparison of the simulated WSELs under existing and proposed conditions for the Regional Storm Event; a negative value indicates a decrease in the water surface elevation from the existing conditions while a positive value indicates an increase. The existing and preliminary proposed (future) Regional Storm floodlines are presented in Figure 13.

Table 4.2. Regional Storm Flood Elevations, McCraney Creek Preliminary Crossing Replacement (m)

Cross Section I.D.	Water Level - Existing Conditions	Water Level – Future Conditions	Difference
595.382	85.92	82.30	-3.62
570.597	85.95	82.41	-3.54
544.193	85.90	81.95	-3.95
538.303	85.93	81.99	-3.94
Lakeshore Road Crossing			
510.818	81.49	81.18	-0.31
501.002	81.14	81.14	0.00
501.008	81.32	81.32	0.00
494.045	80.70	80.70	0.00

The results in Table 4.2 indicate that the proposed crossing will reduce the Regional WSEL upstream of the crossing by 3.94m. The crossing is capable of conveying the Regional Storm at an elevation of 81.99 m, which is below the soffit elevation of 82.56 m. Overtopping of Lakeshore Road will not occur during the Regional Storm. Further details pertaining to the WSELs for all storm events (2-100 year & Regional) are provided in Appendix ‘C’.

Existing crossings for Bronte Creek and Fourteen Mile Creek are to remain under future conditions and will not require lengthening to accommodate the proposed road improvements. The 1.22 m x 1.84 m box culvert at Station 3+450 will have to be extended on the north side of the road by at least 4 m and a retaining wall may be necessary. A retaining wall would be required on the south side of the road.

5.0 Stormwater Management Opportunities

5.1 General Stormwater Management Opportunities

Stormwater Management practices (SWMPs) for the management of roadway runoff generally fall into two categories: those that address stormwater quantity (including erosion) and those that manage stormwater quality of surface runoff. In addition, Low Impact Development (LID) best management practices (BMPs) are designed to provide water quality treatment and quantity control for smaller, more frequent storm events (i.e. typically the 25 mm storm event).

Stormwater quantity management issues relate to the proper sizing of minor (sewer) and major (overland flow) conveyance systems for roadway runoff. In addition, stormwater quantity management strategies can include the need for facilities to address downstream flood and erosion potential from alterations of the roadway right-of-way. Based on Lakeshore Road being immediately upstream of Lake Ontario, no quantity controls are required for the creek systems to reduce or maintain existing peak flows, instead, major and minor system improvements are required to convey the future condition peak flows. As multiple sections of Lakeshore Road have rural cross-sections, new storm sewer systems will be required. Upgrades to existing deficient storm sewer systems will also be required.

In terms of stormwater quality, the SWMPs relate to the treatment of new pavement. Typically, the treatment level is related to the standards defined in a watershed or subwatershed planning study, which are dependent on the quality and sensitivity of the receiving stream system (i.e. Type 1, Type 2, etc.). Lakeshore Road drainage discharge requires Enhanced (Level 1 – 80% average annual TSS (total suspended solids) removal) stormwater quality controls.

Erosion control to both Fourteen Mile Creek and McCraney Creek would require that the 25 mm storm event be controlled over a 24 hour duration or infiltrated for a minimum runoff volume resulting from the additional pavement. In the case of Fourteen Mile Creek, an infiltration low impact design (LID) measure would also provide thermal impact mitigation required by MNRF due the redside dace habitat.

Various best management practices or stormwater management practices are available to address both the quantity and quality of runoff from roadways. Due to the linear nature of roadway corridors however, not all stormwater management practices are considered to be appropriate.

5.1.1 Alternative Stormwater Management Practices

Quantity Management (Flood and Erosion Control)

Quantity control impacts, in this case erosion due to increased runoff from existing hard surfaces including MUTs, sidewalk and intersection improvements, can typically be mitigated by on-site storage and infiltration techniques and/or off-site mitigation measures, such as regulation or stream stabilization.

For the current project, only erosion controls are required. The expected focus is therefore on storage and infiltration based techniques.

Quality Management

There are numerous stormwater management practices which can be used to treat contaminated stormwater runoff from roadway surfaces. These include the following:

i. Wet ponds/wetlands/hybrids (generally linear facilities)
ii. Enhanced grass swales
iii. Filter strips

iv. Oil and grit separators
v. Off-site stormwater management facilities (existing, retrofitted and/or proposed)
vi. Catch basin shields
vii. LID BMPs – (Bioretention systems, permeable pavement and other infiltration systems)

The respective characteristics, advantages and disadvantages of the foregoing have been well documented in existing Municipal and Provincial literature and hence this information has not been repeated within this document. Some brief advantages and disadvantages, though, are discussed in the following.

5.1.2 General Assessment

The advantages and disadvantages of the various Best Management Practices associated with both quantity and quality control measures are as follows:

Erosion Control

Controlling runoff in stormwater management facilities requires land and future management/ maintenance by municipal staff. The advantages relate to maintaining existing sizing of drainage infrastructure or smaller infrastructure across the roadway, as well as downstream. Disadvantages include the cost of land, infrastructure and maintenance. Increasing the size of drainage infrastructure, while somewhat more costly to the municipality, reduces the need for future maintenance and eliminates the need for the dedication of stand-alone land for surface controls. Inter-subcatchment diversions can be effective on a minor scale in optimizing and/or reducing the number of crossings and are typically followed to address both major and minor runoff conditions.

For erosion control, on-site measures to reduce peak flow impacts can be highly constraining due to the general lack of properly configured land. Roadway corridors, due to their inherent linear nature, can only effectively manage relatively small volumes of increased runoff (peak flows), in the absence of stand-alone land acquisition. Combination of measures to mitigate impacts through some on-site storage, along with off-site upgrades as necessary, is often the 'best' approach, where impacts exceed allowable minimums that said, Lakeshore Road currently does not drain to any stormwater management facilities.

The following erosion controls have been screened from further consideration due to the reason provided herein:

i. Wet ponds/wetlands/hybrids

Constructing a new wet pond, wetland or hybrid pond is not feasible within the Lakeshore Road right of way based on space constraints. As such this alternative has not been considered further.

ii. Super Pipe Storage

Super pipe storage would require either upgrading existing storm sewers to a larger storm sewer, or sizing a new sewer capable of storing additional runoff to meet erosion control targets. Super pipe storage is one of the costliest methods of providing underground storage. As such this method of erosion control has been screened from further consideration.

iii. Conventional Underground Storage (Concrete Tanks)

Conventional underground storage for Lakeshore Road would require multiple concrete tanks (tanks either side of the creeks). The concrete tanks would be connected to the downstream end of the proposed storm sewers to maximize the contributing drainage area to the storage elements. Underground concrete tanks are considered costly to implement. In addition, conventional underground tanks do not filter or infiltrate captured runoff. As such conventional underground storage (concrete tanks) have been screened from further consideration.

iv. Conventional Underground Storage (Cellular Systems)

Notwithstanding the preceding, more cost effective underground storage systems could be considered to achieve erosion control requirements. This includes cellular type tank systems such as Brentwood™, Cultec™ or Triton™ systems.

v. Low Impact Development Best Management Practices (LID BMPs)

Low Impact Development Best Management Practices (LID BMPs) can address erosion control requirements by retaining and infiltrating stormwater runoff for more frequent storm events, which are typically those of concern for erosion impacts. These options have been discussed further in the subsequent section with respect to quality control, however, are considered a feasible alternative for erosion control as well.

Quality Control

i. Wet ponds, Wetlands, Hybrids

These systems generally require the dedication of land that most often is not available in linear corridors for roadway projects. Most often when applied to roadway runoff, these SWMPs are located adjacent to creek crossings of roads. Typically, these systems provide an excellent level of treatment and as end-of-pipe systems, the management and performance is more visible, hence less prone to failure. For Lakeshore Road this particular opportunity is considered impractical due to lack of available land.

ii. Enhanced Grassed Swales

Grassed swales designed with a trapezoidal geometry and flat longitudinal profiles with largely un-maintained turf can provide excellent filtration and treatment for storm runoff from roadways. It is generally conceded that treatment levels are at a minimum, Normal (formerly Level 2) 70% TSS removal water quality treatment, and combined with other practices can provide Enhanced (Level 1) 80% TSS removal stormwater quality treatment. Their application in linear corridors is also particularly appropriate and can be further enhanced through the introduction of check dams to provide additional on-line storage. Their application in urbanized roadway cross-sections (i.e. curb and gutter) often requires alternative grading and roadway configurations which can compromise the function of the roadway itself, and are therefore typically not preferred in those cases. Notwithstanding, gutter outlets along outside lanes have been demonstrated to function effectively where the right-of-way can accommodate the design. Based on the proposed Lakeshore Road ultimate urbanized road ROW and spatial constraints, enhanced grassed swales may not be considered the preferred stormwater quality treatment measure; however enhanced grass swales could be strategically placed within the corridor where sufficient area is available to provide potential attenuation and infiltration of runoff and have been carried forward for further consideration. Furthermore, existing ditches within the Lakeshore Road corridor where feasible, should be maintained or converted to enhanced grass swales to provide a water quality benefit.

iii. Filter Strips

Filter strips are typically designed for small drainage areas (less than 2 ha +\-), and are applied as part of a treatment train. Filter strips require flat areas with slopes ranging from 1 to 5% and are usually in the range of 10 to 20 m in length in the direction of flow. Flow leaving filter strips should be a maximum of 0.10 m depth, based on a 10 mm storm event. Based on the limited space within the Lakeshore Road

West ROW, filter strips are not considered a practical stormwater quality solution and have been screened from further consideration.

iv. Oil and Grit Separators (OGS)

These end-of-pipe systems tend to service smaller drainage areas (2 ha +/-) and provide varying levels of stormwater quality treatment depending on the model selected. OGS units are typically encouraged as part of a "treatment train" approach; many municipalities and regulators will not credit the full TSS removal function of OGS units accordingly (i.e. typical maximum credit of 50% to 70% TSS removal). Disadvantages include the need for frequent maintenance, as well as relatively high capital costs and the ability to service smaller drainage areas. As a pre-treatment approach for other stormwater quality measures, or for providing water quality treatment for pavement areas greater than the proposed additional paved areas, oil and grit separators have been carried forward for further consideration.

v. Off-Site Stormwater Management Facilities

While facilities can often not be constructed within roadway right-of-way lands, roadway runoff can be directed towards existing and proposed subdivisions, which would have their runoff managed by future stormwater management facilities. No sections of the Lakeshore Road minor system are currently connected to off-site stormwater management facilities, as such this alternative has been screened from further consideration.

vi. Catch Basin Shields

Catch basin (CB) shields are the application of a catch basin insert to shield accumulated sediment in the catch basin sump from resuspension and washout. The CB shields can increase TSS capture by up to 50 % as shown in Environmental Technology Verification (ETV) testing. The application of CB shields is not to be applied as a stand-alone treatment approach, however, can be combined with other treatment technologies to mitigate water quality. Implementation costs would be comparatively low to other forms of water quality treatment and frequent maintenance would be required to remove accumulated sediment from the catch basin sump to ensure acceptable long-term performance. The benefits of the TSS removal and the low cost of implementation have resulted in this alternative to be carried forward for further consideration.

vii. Low Impact Development Best Management Practices

Low Impact Development represents the application of a suite of BMPs normally related to source and conveyance storm water management controls to promote infiltration and pollutant removal on a local site by site basis. These measures rely on eliminating the direct connection between impervious surfaces such as roads and the storm drainage system, as well as the promotion of infiltration of road drainage. General design guidelines and considerations for source and conveyance controls have been advanced since the early 1990's as part of the MMAH "Making Choices" and in 1994 as part of the Ministry of the Environment's original Best Management Practices Guidelines.

Subsequent to the 1994 MOE Guidelines, technologies and standards have been developed further for the application of source and conveyance controls. These have evolved into a class of Best Management Practices (BMPs) referred to as Low Impact Development (LID) practices, which have advanced as an integrated form of site planning and storm servicing to maintain water balance and providing storm water quality control for urban developments. Initial results from studies in other settings have demonstrated that LID practices provide benefits by way of reducing the erosion potential within receiving watercourses and thereby reducing the total volume of end-of-pipe storm water erosion control requirements. In addition, due to volumetric controls afforded by LID BMP's, water quality is also improved through a reduction in mass loading. The benefits from LID storm water management practices are generally focused on the more frequent storm events (e.g. 2 year storm) of lower volumes as opposed to the less frequent storm events (e.g. 100 year storm) with higher volumes. It is also recognized that the forms of LID practices which promote infiltration or filtration through a granular medium provide thermal mitigation for storm runoff.

Guidelines regarding the application of LID practices and techniques have been developed within various jurisdictions in the United States and Canada. The Toronto and Region Conservation Authority and Credit Valley Conservation have produced the 2010 Low Impact Development Stormwater Management Manual, for the design and application of LID measures, which is used by Conservation Halton. Various LID techniques, as well as their function that are applicable to road projects, are summarized in Table 5.1, not including grassed swales and filter strips which have already been screened as appropriate SWM measures for Lakeshore Road.

Table 5.1. LID Source and Conveyance Controls

Technique	Function
Bio-retention Cell	▶ Vegetated technique for filtration of storm runoff ▶ Storm water quality control provided through filtration of runoff through soil medium and vegetation ▶ Infiltration/ evapotranspiration/ water balance maintenance and additional erosion control may be achieved if no subdrain provided
Infiltration Trenches	▶ Infiltration technique to provide storm water quality control and maintain water balance ▶ Erosion controls may be achieved depending upon soil conditions
Permeable Pavers/Pavement	▶ Infiltration technique to reduce surface runoff volume ▶ Benefits to storm water quality and erosion control are informal
Pervious Pipes	▶ Technique to reduce storm runoff through the implementation of perforated pipes as part of the storm sewer system (typically a separate lower perforated pipe, with the conventional storm sewer as the "overflow")) ▶ Promotion of infiltration maintains water balance and provides storm water quality and erosion control benefits

Bioretention Systems

Bioretention systems provide effective removal of pollutants by sedimentation, filtering, soil adsorption, microbial processes and plant uptake. Bioretention systems should be approximately 10 to 20% in size of the contributing drainage area, with typical drainage areas of 0.50 ha and a maximum drainage area of 0.8 ha. Slopes within bioretention systems are typically 1 % to 5 %. Bioretention systems are preferred in areas that have reasonable infiltration properties (15 mm/ hr, $1x10^{-6}$ cm/s), but can be implemented in all soil types as long as the water quality event can be temporarily stored (typical depths 0.15 m to 0.25 m) before infiltrating and an underdrain is provided.

Bioretention systems could be added as an infiltrative LID BMP at specific locations or as supplemental SWM control beyond requirements such as at Station 1+500 near Bronte Athletic Park. The bioretention systems should have forebays for a form of surface water pre-treatment (ref. Figure 16). Catchbasins fitted with goss traps should also be used to filter out floatable debris before directing runoff to the infiltrative component of the bioretention system. Bioretention systems have been carried forward for further consideration.

Infiltrative Trenches

Infiltrative Trenches could be implemented as they are similar to bioretention systems but could be positioned not only within the 2 m wide landscaped areas but under the proposed 3 m wide multiuse pathway. All catchbasins should be fitted with goss traps to filter floatable debris. The infiltration trench could be designed to capture the 25 mm storm event with no discharge by setting the overflow to the storm sewer system above the 25 mm storm event capture storage depth. Infiltrative Trenches have been carried forward for further consideration.

Silva Cells

Silva Cells are modular suspended paved systems with a cellular soil storage system providing structural support and allows for overland road and pavement drainage to be captured and infiltrated within the cellular soil storage system. Trees are planted within the cellular soil storage system which also use the collected drainage and provide evapotranspiration. Silva cells can be used in confined spaces within urban environments and provide additional stormwater quality benefits. Siva Cells would not be considered to be a standalone water quality measure. Silva Cells have been carried forward for further consideration.

Permeable Pavers/Pavement

Permeable pavement could be used either for the entire length or for sections of the proposed 3 m wide multi-use trail. As a standalone LID BMP, a permeable paved multiuse path would not meet either stormwater quality and/or erosion control targets as it would treat a limited area, and would not treat the roadway itself (which would be expected to generate the highest contaminant loadings). However, a permeable MUP would reduce the runoff volume from paved surfaces within the urban road ROW. This LID BMP would have to be selected by the Town to complement other SWM measures during the detailed design stage for road sections that would incur increased roadway pavement area in addition to the proposed MUT and sidewalk. Permeable Pavers/ Pavement has been carried forward for further consideration.

Pervious Pipes

Pervious pipes could be used in combination with either bioretention systems or infiltration trenches. As a standalone SWM measure, pervious pipes can be a cost-effective and relatively simple method to accomplish erosion control and infiltration requirements, while eliminating the need for surface space within the right-of-way. Pervious pipes have been carried forward for further consideration

Based on the foregoing, the following erosion, infiltration and water quality controls have been short-listed:

- Enhanced Grass Swales
- Oil and Grit Separators
- Bioretention Systems
- Infiltration Trenches
- Silva Cells
- Permeable Pavers/Pavement (For MUP)
- Pervious Pipes (used with infiltration trenches)

5.2 Managing Impacts from Land Use Intensification and Climate Change

The Town of Oakville Stormwater Master Plan Report (Wood, June 2020) noted a performance reduction within the focus area due to the increased runoff potential associated with land use intensification, and increased precipitation depth/runoff associated with climate change. The minor system upgrade recommendations provided in the town's Stormwater Master Plan address mitigating existing land use and climate hydraulic deficiencies and have not been assessed for land use intensification and climate change rainfall. The town's Stormwater Master Plan (Wood, June 2020) recommended implementing LID BMP source controls in both the private and public realm to offset the impacts due to land use intensification and climate change. Implementing further minor system upgrades and storage could be used as a method of building resiliency within the town's infrastructure, however this would be accomplished at a considerable financial cost to the town. Given that land use intensification changes are gradually being advanced by the private sector, the town's philosophy is that the private sector should finance the mitigation works at no cost/impact to the town. Similarly, infrastructure renewal of roadways, through roadway reconstruction works will require the implementation of contemporary forms of stormwater management.

The Stormwater Master Plan (Wood, June 2020) recommended a minimum capture of 25 mm of precipitation within the focus area, including the Lakeshore Road corridor, at all developed and undeveloped areas, as should be applied within the Town of Oakville, since climate change, with increased precipitation depth and runoff, does not differentiate between undeveloped, developed, and intensified land uses. As such, the 25 mm capture should be applied to existing developments and proposed developments in the private realm in addition to buildings and roadways within the public municipal realm. It is anticipated that every road and town owned property will undergo reconstruction or rehabilitation at the end of their operational lifecycle. It is during this time that town should consider implementing source controls as a mitigation strategy, such as the proposed reconstruction of Lakeshore Road.

There are limitations to the application of the 25 mm source control capture as it inherently does not address the existing hydraulic deficiencies and should be applied in addition to the recommended storm sewer upgrades (balanced approach of "grey" and "green" infrastructure). Furthermore, the source control capture has been designed to protect the municipality against impacts to land use intensification and climate change primarily to the minor system during the 5 year design storm event. Source controls, and more specifically LID BMPs, are typically used for mitigating the more frequent storm events and will not address the full impacts associates with the less frequent storm events. Lastly, while capturing 25 mm of precipitation via source controls is the objective, this may not be achievable due to various constraints, including spatial constraints, utility conflicts, and seasonal high groundwater levels. The commitment at the next stages of planning and design should be to maximize the use of LID BMP source controls where feasible to achieve the target capture of 25 mm as per the town's Stormwater Master Plan (Wood, June 2020).

While LID BMP source controls can provide a water quality benefit (ref. Section 5.1.2), the implementation of the 25 mm source controls have been recommended to offset the minor system quantity control impacts, and partially offset the major system quantity control impacts due to land use intensification and climate change. The LID BMPs identified in Section 5.1.2 for water quality control may therefore also be implemented to address the 25 mm source control targets. Based on the foregoing, the following infiltration practices have been short-listed:

- Enhanced Grass Swales
- Bioretention Systems
- Infiltration Trenches
- Silva Cells
- Permeable Pavers/Pavement (For MUP)
- Pervious Pipes (used with infiltration trenches)

The following figures illustrate typical examples of the recommended LID BMP source controls:

Figure 5.1 Enhanced Grass Swale (Low Impact Development Stormwater Management Planning and Design Guide, Version 1.0, CVC and TRCA, 2010)

Figure 5.2 Enhanced Grass Swale (Low Impact Development Stormwater Management Planning and Design Guide, Version 1.0, CVC and TRCA, 2010)

Figure 5.3 Bioretention Facility (Low Impact Development Stormwater Management Planning and Design Guide, Version 1.0, CVC and TRCA, 2010)

Figure 5.4 Bioretention Facility (Low Impact Development Stormwater Management Planning and Design Guide, Version 1.0, CVC and TRCA, 2010)

Figure 5.5 Infiltration Trench Construction (Low Impact Development Stormwater Management Planning and Design Guide, Version 1.0, CVC and TRCA, 2010)

Figure 5.6 Silva Cell Construction (www.smartcitiesdive.com, 2020)

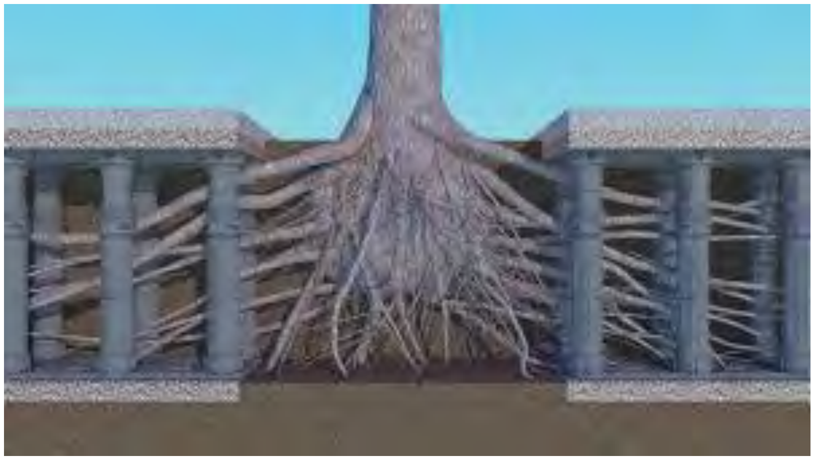


Figure 5.7 Silva Cell Cross Section (info.cambrianrisevt.com, 2020)

Figure 5.8 Permeable Pavers (Low Impact Development Stormwater Management Planning and Design Guide, Version 1.0, CVC and TRCA, 2010)

Figure 5.9 Permeable Pavement (Low Impact Development Stormwater Management Planning and Design Guide, Version 1.0, CVC and TRCA, 2010)

6.0 Short-Listed Drainage System and Stormwater Management Alternatives Assessment

The proposed road drainage and stormwater management requirements have been assessed. The drainage system assessment has included the following:

i. Resizing existing sewer systems to convey the future conditions peak flow. Storm sewers have been sized to convey the 5 year storm event unsurcharged. Where proposed upgraded Lakeshore Road R.O.W. storm sewers connect to downstream storm sewer systems located not within the Lakeshore Road R.O.W. that hydraulically constrain and impact the upstream storm sewer system, an effort has been made to reduce the hydraulic impact of the receiving downstream system to the extent possible.
ii. Downstream receiving systems have been upgraded to the extent considered feasible to remove hydraulic constraints on the Lakeshore Road storm sewer system.
iii. The Lakeshore Road R.O.W. sewer system connecting to the Nelson Road and Sarah Lane storm sewer systems has been sized using a sensitivity analysis to determine the optimized size with the existing storm sewer in place.
iv. Existing basement flood risk has been eliminated to the extent possible by upgrading the storm sewer system. Basement flood risk was determined by estimating the buildings first flood elevation, subtracting 2.59 m to determine the bottom of basement slab and requiring 0.3 m to exist from the bottom of basement slab to the 100 year hydraulic grade line. Based on the foregoing there are locations where foundation drain disconnections from the proposed storm sewer should occur as flood risk could not be entirely eliminated (ref. Appendix B).
v. The recommendations from the Coronation Park Drainage Class EA have been considered and revised based on the proposed Lakeshore Road urbanized configuration. To reduce R.O.W. flow depths the south road curb has been reduced in height and the road graded with a 1% cross-fall to Coronation Park in the vicinity of Westminster Drive.
vi. A road section of concern due to the prediction of existing flooding is the road sag located at the intersection of Dorval Drive and Lakeshore Road. To reduce flooding within the sag, a storm sewer connection to the St. Jude's Cemetery owned by the Town of Oakville would be required, in addition to twinning the existing storm sewer system going east along Lakeshore Road to its outlet at Lake Ontario.
vii. Road grades have been based on the proposed road plan.
viii. The recommendations from the town's Stormwater Master Plan (Wood 2020) have been advanced for the implementation of 25 mm source control capture in the form of LID BMPs to offset the impacts of intensification and climate change.
ix. The future studies recommended for Network's 15 (Stations 1+400 to 1+850) and 18 (Stations 1+850 to 2+660) in the town's Stormwater Master Plan (Wood 2020) have also been recommended to investigate the residual data gaps and to validate the recommended alternatives due to the extent of the recommended works; these Network's incorporate portions of Lakeshore Road.
x. The town's Stormwater Master Plan (Wood 2020) indicated that Inlet Control Devices (ICDs) should be implemented in Networks 12, 13 (Stations 0+310 to 1+400), and 29 (Stations 6+100 to 6+245) to mitigate minor system surcharging in these Networks. This should be considered at the next stages of planning and design in addition to the recommended storm sewer upgrades.

Details of minor system upgrades and revisions for each have been provided in Tables 6.1. The existing and proposed storm sewer sizes have been provided, with sewer location depicted by road Stations within the table and on Figures 7 to 11. The performance of the proposed storm sewer system has been provided in Table 6.2. Surcharging of the proposed storm sewer system does occur for some of the sewer sections, that said, most of the surcharge is considered minimal and just above the pipe obvert. Two (2) locations that will need evaluation further during detailed design are:

- The section of Lakeshore Road between Stations 1+400 and 1+850 is surcharged due to the sewer system on Sarah Lane, and further optimization of the proposed Lakeshore Road sewer system may be considered.
- The section of Lakeshore Road between Stations 1+850 and 2+660 just east of Third Line. The storm sewer system may need to be increased slightly, but due to cover constraints, a detailed plan and profile for this road section is required.

Table 6.1. Minor System Modifications and Upgrades

Drainage Outlet	Road Stations	Chainage		Conduit ID		Sewer	
		From Station	To Station	Conduit ID in Existing Model	Conduit ID in Proposed Model	Existing Sewer Diameter(mm)	Proposed Sewer Diameter(mm)
West to Bronte Creek	0+000 - 0+300	0+000	0+300	-	-	As Is	As Is**
East to Bronte Creek	0+310 - 0+700	0+340	0+360	O_0200_6614	Same as Existing	600	1050
		0+360	0+425	O_0200_400708	Same as Existing	600	1050
		0+425	0+470	O_0200_400707	Same as Existing	600	1050
		0+470	0+490	O_0200_400706	Same as Existing	600	825
		0+490	0+490	O_0200_400705	Same as Existing	525	825*
		0+490	0+580	O_0200_10	O_0200_400765_2	375	600
		0+580	0+600	O_0200_9	O_0200_400765_1	375	600
		0+600	0+650	O_0200_7357	Same as Existing	375	450
		0+700	0+780	Does not Exist	C-Prop_1	-	375
East to Nelson Creek	0+780 - 1+090	0+840	0+890	Does not Exist	C-Prop_3	-	375
		0+890	0+960	O_0200	O_0200_6477	375	450
		0+960	1+020	O_0200_6478	Same as Existing	375	900
		1+020	1+020	C6_13	Same as Existing	300	900*
		1+020	1+035	C7_13	Same as Existing	1000	900
		1+035	1+060	O_0200_6481	Same as Existing	750	900
West to Nelson Creek	1+090 - 1+400	1+060	1+075	O_0200_15	O_0200_6993_2	675	1050
		1+075	1+135	O_0200_14	O_0200_6993_1	675	1050
		1+135	1+145	O_0200_17	O_0200_7023_5	600	900
		1+145	1+155	O_0200_19	O_0200_7023_4	600	900
		1+155	1+170	O_0200_20	O_0200_7023_3	600	900
		1+170	1+180	O_0200_21	O_0200_7023_2	600	900
		1+180	1+205	O_0200_18	O_0200_7023_1	600	900
		1+205	1+215	O_0200_22	O_0200_7022_3	600	750
		1+215	1+220	O_0200_24	O_0200_7022_2	600	750
		1+220	1+280	O_0200_23	O_0200_7022_1	600	750
		1+280	1+290	O_0200_7021	O_0200_7021	525	600
		1+290	1+300	O_0200_25	O_0200_6482_2	300	450
		1+300	1+340	O_0200_16	O_0200_6482_1	300	450
Sarah Lane	1+400 - 1+850	1+415	1+435	O_0200_26	O_0200_6524_1	750	1800
		1+435	1+475	O_0200_28	O_0200_6524_2	750	1800
		1+475	1+490	O_0200_29	O_0200_6524_3	750	1800
		1+490	1+520	C1_6	O_0200_7226_1	825	1800
		1+520	1+530	C1_18	O_0200_7226_2	825	1800
		1+530	1+535	O_0200_31	O_0200_7226_4	825	1800
		1+535	1+560	O_0200_30	O_0200_7226_5	825	1800
		1+560	1+585	O_0200_33	O_0200_7226_6	825	1800
		1+585	1+640	O_0200_32	O_0200_6525_1	825	1800
		1+640	1+660	O_0200_35	O_0200_6525_2	825	1800
		1+660	1+690	O_0200_34	O_0200_6525_3	825	1800
		1+705	1+775	O_0200_36	O_0200_6525_4	825	1800
		1+775	1+795	O_0200_38	O_0200_6525_5	825	1800
Coronation Park West Channel	1+850 - 2+660	1+925	2+000	Does not Exist	C-Prop_4	-	375
		2+000	2+080	Does not Exist	C-Prop_5	-	375
		2+080	2+155	Does not Exist	C-Prop_6	-	525
		2+155	2+240	Does not Exist	C-Prop_7	-	525
		2+240	2+265	C36_CP	C36	900	1050
		2+265	2+265	O_0200_400175	Removed	900	-***
		2+265	2+400	Does not Exist	PROP-01	-	1050
		2+400	2+400	O_0200_6144	Removed	1200 x 1000 Rec	-***
		2+400	2+530	PROP-02	Same as Existing	1050	1350
		2+530	2+655	PROP-03	Same as Existing	1050	1350
		2+655	2+655	O_0200_1CP	PROP04	900	1200*
		2+655	2+655	O_0200_1CP	C614_CP	900	1200*
		2+655	2+655	O_0200_2CP	C15_CP	900	1200*
Coronation Park East Channel	2+660 - 2+950	2+655	2+665	C76	Same as Existing	975	1350
		2+665	2+775	PROP-05	Same as Existing	975	1350
		2+775	2+775	O_0200_6228	Same as Existing	400	2400 x 1500 Rec
		2+775	2+840	Does not Exist	C-Prop_8	-	525
		2+840	2+900	Does not Exist	C-Prop_9	-	450

Drainage Outlet	Road Stations	Chainage		Conduit ID		Sewer	
		From Station	To Station	Conduit ID in Existing Model	Conduit ID in Proposed Model	Existing Sewer Diameter(mm)	Proposed Sewer Diameter(mm)
Coronation Park East Parking Lot	2+950 - 3+280	3+100	3+180	Does not Exist	C-Prop_11	-	450
		3+180	3+260	Does not Exist	C-Prop_10	-	375
Drainage Easement	3+280 - 3+760	3+360	3+430	Does not Exist	C-Prop_12	-	450
		3+430	3+540	Does not Exist	C-Prop_13	-	600
		3+540	3+570	Does not Exist	C-Prop_14	-	525
		3+570	3+650	Does not Exist	C-Prop_15	-	525
		3+650	3+730	Does not Exist	C-Prop_16	-	450
East to Fourteen Mile Creek	3+760 - 3+980	3+860	3+930	Does not Exist	C-Prop_17	-	375
		3+930	3+950	Does not Exist	C-Prop_18	-	375
		3+950	3+965	O_0200_400459_1	Same as Existing	450	600
		3+965	3+980	O_0200_400459_2	Same as Existing	450	600
West to Fourteen Mile Creek	3+980 - 4+560	4+020	4+125	Does not Exist	C-Prop_19	-	600
		4+125	4+220	Does not Exist	C-Prop_20	-	600
		4+220	4+290	Does not Exist	C-Prop_21	-	525
		4+290	4+350	Does not Exist	C-Prop_22	-	450
		4+350	4+425	Does not Exist	C-Prop_23	-	450
		4+425	4+550	Does not Exist	C-Prop_24	-	375
East to McCraney Creek	4+560 - 4+780	4+560	4+780	-	-	As Is	As Is**
West to McCraney Creek	4+780 - 5+090	4+925	5+000	Does not Exist	C-Prop_25	-	375
Birch Hill Lane	5+090 - 5+700	5+475	5+550	Does not Exist	C-Prop_30	-	450
		5+550	5+630	Does not Exist	C-Prop_31	-	375
		5+630	5+675	Does not Exist	C-Prop_32	-	375
Remnant Channel West of Dorval Drive	5+700 - 6+100	5+725	5+800	Does not Exist	C-Prop_33	-	375
		5+800	5+850	Does not Exist	C-Prop_34	-	450
		5+810	5+850	O_0200_5877	Same as Existing	525	675
		5+850	5+925	O_0200_6188_1	Same as Existing	525	750
		5+925	5+935	O_0200_6188_2	Same as Existing	525	750
		5+935	6+015	O_0200_5879	Same as Existing	525	825
		6+015	6+025	O_0200_5880	Same as Existing	525	825
		6+075	6+125	O_0200_400596	Same as Existing	750	900
		6+125	6+150	O_0200_9858	Removed	750	-***
		6+125	6+150	Does not Exist	CProp_1007	-	900
South of Lakewood Dr. and St. Jude's Cemetery		~6+300	~6+300	C15_29	Same as Existing	900	1524 x 965 (Horizontal Ellipse)
Minor system modifications along the Lakeshore road for Catchbasins							
2 sets of double catchbasins added on each side of Lakeshore Road at Station 0+175.							
2 sets of double catchbasins added on each side of Lakeshore Road at Station 1+020.							
1 set of double catchbasins added on north side of Lakeshore Road at Station 1+075.							
1 set of double catchbasins added on north side of Lakeshore Road at Station 3+430.							
1 set of double catchbasins added on north side of Lakeshore Road at Station 5+375.							
1 set of double catchbasins added on north side of Lakeshore Road at Station 6+125.							
*** :** This Conduit is placed perpendicular to the eastbound and westbound lanes							
******: There are no changes in sewer pipes as the minor system is non-surcharged for the future conditions.							
***: The removed culverts/sewers are to facilitate the reduction in overland drainage for 100-year storm event to the existing drainage outlet.							

Table 6.2. Future Conditions (With SWM and Upgrades) Minor System Performance (5 Year)

Drainage Outlet	Road Stations	Minor System Drainage Area(ha)	Performance	Description
West to Bronte Creek	0+000 - 0+300	33.45	Non-Surcharged	The sewer system ranges in size from 1200 mm to 1500 mm diameter. There is no surcharge.
East to Bronte Creek	0+310 - 0+700	17.58	Non-Surcharged	The minor system along the westbound lanes ranges from 450 mm to 600 mm diameter in size over 87 m length. This system is not surcharged. The minor system along the eastbound lanes ranges from 375 mm to 1050 mm in diameter over 500 m length. The minor system is not surcharged for the entire length.
East to Nelson Creek	0+780 - 1+060	2.6	Non-Surcharged	The sewer system ranges in size from 375 mm diameter to 750 mm diameter. The storm sewer is not surcharged.
West to Nelson Creek	1+060 - 1+400	10.12	Non-Surcharged	The sewer system ranges in size from 300 mm to 1050 mm diameter. The storm sewer is not surcharged.
Sarah Lane	1+400 - 1+850	151.17	Surcharged	The sewer system ranges in size from 750 mm to 1650 mm diameter. The storm sewer is surcharged for 170 m out of 450 m length, but it is not surcharged to the surface at any point. The lowest available minimum freeboard is at the Junction O_0160_6728_4 of 1.34 m. The surcharge condition is due to the performance of the receiving sewer system.
Coronation Park West Channel	1+850 - 2+660	58.56	Surcharged	The proposed minor system ranges from 375 mm to 1350 mm in diameter. The system surcharges east of Third Line for 450 m out of the total length of 850 m with the lowest available minimum freeboard is at the Junction O_0160_3804 of 0.37 m. The 1200 mm diameter sewer at Station 2+650, connected to the sewer system on Walby Drive and Lakeshore Road surcharges at Junction O_0160_3807 with the lowest available minimum freeboard of 0.64 m. This sewer system has minimal cover and has been maximized at the downstream connection at Westminster Drive. There may be opportunities in detail design to improve upon its performance at Third Line.
Coronation Park East Channel	2+660 - 2+950	14.19	Surcharged	The box culvert, 2.4 m x 1.5 m in size, downstream of the minor system along Westminster Drive and the eastbound Lakeshore Road sewer (1350 mm in diameter) has minimal surcharge (<0.10 m) and the culvert discharges to the open channel in Coronation Park with the lowest available minimum freeboard of 0.64 m at Junction O_0160_3807 on Lakeshore Road. The storm sewer on the westbound lanes of Lakeshore Road ranges in size from 450 mm to 525 mm diameter with no surcharge over its 120 m length.
Coronation Park East Parking Lot	2+950 - 3+280	15.5	Surcharged	The 900 mm and 975 mm diameter sewers have minimum cover. The sewer system collects drainage conveyed by the minor system off Woodhaven Park Drive. The minor system on Lakeshore Road surcharges just above the sewer obvert until it discharges to Lake Ontario with the lowest available minimum freeboard of 0.44 m at Junction O_0120_10253. The storm sewer on the westbound lanes of Lakeshore Road ranges in size from 375 mm to 450 mm diameter with no surcharge over its 170 m length.
Drainage Easement	3+280 - 3+760	49.69	Non-Surcharged	The storm-sewer on the eastbound lanes of Lakeshore Road of 450 mm diameter does not surcharge over its 75 m length. The storm-sewer on the westbound lanes of Lakeshore Road ranges in size from 450 mm diameter to 600 mm diameter with no surcharge over its 320 m length. The culvert, 1.84 m x 1.22 m in size, does not surcharge and discharges via a drainage easement to Lake Ontario.
Stirling Drive Remnant Channel	3+760 – 3+900	5.77	Surcharged	The 375 mm storm sewer between Lakeshore Road and Stirling Drive is surcharged above the obvert at the downstream end of the system, while the upstream end is not surcharged. The 375 mm storm sewer inlet on the south side of Lakeshore Road conveys runoff from the ROW and the developed area on the north side of Lakeshore Road discharging to a remnant channel at Stirling Drive. The runoff from the north side of Lakeshore Road is conveyed to the storm sewer inlet via a 600 mm culvert under Lakeshore Road, that outlets to the roadside ditch east of the 375 mm storm sewer inlet. The storm sewer also conveys runoff from Stirling Drive and Wolfdale Avenue to the outfall at the remnant channel south of Stirling Drive.
East to Fourteen Mile Creek	3+900 - 3+980	2.6	Non-Surcharged	The sewer system ranges in size from 375 mm to 600 mm diameter along Lakeshore Road and discharges to Fourteen Mile Creek. The storm sewer is not surcharged over the 130 m length.
West to Fourteen Mile Creek	3+980 - 4+560	2.89	Non-Surcharged	Overland drainage from the west bound lanes drains to Fourteen Mile Creek. East bound lanes, east of Westdale Drive drains (west section) to the local side roads (Westdale Dale Drive (west section), Wilder Drive, and West Lynn Road). The proposed minor system on Lakeshore Road ranges in size from 375 mm to 600 mm diameter with no surcharge before discharging to Fourteen Mile Creek.
East to McCraney Creek	4+560 - 4+780	1.51	Non-Surcharged	The sewer system ranges in size from 375 mm to 525 mm diameter. The storm sewer is not surcharged for its 190 m length.
West to McCraney Creek	4+780 - 5+090	3.83	Non-Surcharged	The proposed minor system on Lakeshore Road commences at the Station 5+000. The storm sewer ranges in size from 375 mm to 600 mm diameter with no surcharge. The sewer discharges to McCraney Creek.
Birch Hill Lane	5+090 - 5+700	8.01	Surcharged	The sewer system ranges in size from 250 mm to 675 mm diameter, east of Birch Hill Lane and from 375 mm diameter (175 m in length) to 600 mm diameter (300 m in length) west of Birch Hill Lane. The storm sewer is surcharged just above the obvert for 60 m out of the 475 m length with the lowest available minimum freeboard of 1.92 m at Junction O_0160_400815 on Lakeshore Road.

Drainage Outlet	Road Stations	Minor System Drainage Area(ha)	Performance	Description
Remnant Channel West of Dorval Drive	5+700 - 6+100	6.64	Non-Surcharged	The sewer system ranges in size from 375 mm to 825 mm diameter over its 300 m length along Lakeshore Road with no surcharge. The storm sewer discharges to an open channel at Station 6+020 where it connects to a minor system, 900 mm in diameter, on Lakeshore Road at Station 6+070. The minor system is non-surcharged for its length of 70 m after where it would discharge to the remnant channel located in St. Jude's Cemetery.

In addition to the minor system upgrades, the major system also requires various improvements to reduce existing flooding conditions along the Lakeshore Road right-of-way. To reduce overland flooding the storm sewer system has been upgraded, localized drainage diverted, offsite channels upgraded and road sections and curb height altered at Coronation Park. A summary of the major system improvements, not including profile revisions and urbanizing the road cross-section is as per the following:

- Changes in sewer sizes have been made east of Third Line (Station 2+220) reduce the overland peak flows in the Coronation Park West Channel. The existing culverts near Stations 2+275 and 2+400 would be removed to further reduce the overland drainage through Coronation Park West Channel.
- Lakeshore Road in the vicinity of Westminster Drive would require a 1 % crossfall from the north to south side of the road and would also require a reduced curb height of 0.05 m for (Stations 2+700 to 2+840); this would allow runoff from the road to be conveyed to the constructed channel in Coronation Park during less frequent storm events.
- The Easterly Channel through Coronation Park commencing at the intersection of Westminster Drive and Lakeshore Road (Station 2+775) has been modified from Lakeshore Road to the outlet at Lake Ontario. The Coronation Park Class Environmental Assessment (EA) preliminary design is provided in the Appendix A. As of 2019 the Easterly Channel has been upgraded in accordance with the Coronation Park Class EA.
- The 900 mm diameter sewer at Station 6+100 would be connected to a sewer of the same dimension that discharges to the remnant channel located in St. Jude's Cemetery. The existing culvert crossing of Lakewood Drive will need be replaced to reduce the overland flow depth in the remnant channel in St. Jude's Cemetery.

As per the town's Stormwater Master Plan, significant surcharging was identified from the storm sewers contributing to the outlet on Sarah Lane upstream and downstream of Sarah Lane. Mitigating this section of storm sewer on Lakeshore Road (between Stations 1+400 and 1+850) will not address the surcharging of the storm sewers upstream and downstream of Lakeshore Road. Furthermore, the total drainage area contributing to Sarah Lane is 151.17 ha (+/-) from Network's 15 and 18 as identified in the town's Stormwater Master Plan. It was recommended in the town's Stormwater Masters Plan that these Networks undergo a future study with additional investigation to address residual data gaps and to validate the recommended alternatives due to the extent of the recommended works. Rather than assume that the recommended storm sewer upgrades for Lakeshore Road between 1+400 and 1+850 could be optimized at detail design, it is likely more appropriate for the whole contributing area to Sarah Lane (i.e. Networks 15 and 18) undergo a future study as per the recommendations of the Stormwater Master Plan to address the performance of the storm sewers.

The proposed storm sewers between Stations 1+850 and 2+660 on Lakeshore Road have been optimized for slope, depth, and size of storm sewer that can be accommodated within the ROW. The proposed storm sewer has also been designed to reduce the runoff to the remnant channel at the south east corner of Lakeshore Road and Third Line and to mitigate the flooding risk for the residential properties on Belvedere Drive. The slope of the storm sewer is limited by the inlet invert at the upstream end at Third Line and the outfall invert at the Coronation Park east channel south of Westminster Drive. The channel at Coronation Park has been designed and constructed in preparation for the construction of the Lakeshore Road storm sewer and the Westminster Drive storm sewer.

In addition to the proposed storm sewer on Lakeshore Road, the town's Stormwater Master Plan noted storm sewer upgrades that have been recommended for Third Line north of Lakeshore Road, and on Venetia Drive. Both storm sewers on these streets contribute to the proposed storm sewer on Lakeshore Drive and have been identified as requiring upgrades to mitigate surcharged conditions. These upgrades would also benefit the performance of the proposed storm sewers on Lakeshore Road. Venetia Drive is at the southern limit of Network 18 in the town's Stormwater Master Plan and has as previously noted, this Network has been recommended to undergo a future study to address residual data gaps and to validate the recommended alternatives which includes the recommendation of superpipe storage in this area.

In addition to the noted minor system performance improvements due to storm sewer upgrades, the town's Stormwater Master Plan also reviewed the implementation of inlet control devices (ICDs) within catch basins to limit the flow of stormwater conveyed to the minor system to improve storm sewer capacity where major system capacity was available. The ICDs were recommended to be implemented in Network's 12, 13, and 29 in the Stormwater Master Plan, which correspond to Stations 0+400 to 0+780, 0+780 to 1+390, and 5+950 to 6+245 respectively. The implementation of the ICDs should be reviewed at the next stages of planning and design as per the recommendations of the Stormwater Master Plan to identify specific locations where the ICDs should be installed.

The improved and modified major system's level of performance has been provided within Table 6.3. The level of performance has been categorized as flow/ ponding below the curb, below 0.15 m depth at road centerline and above 0.15 m at road centerline. There is currently only one (1) location that would have a flow depth > 0.15 m above the road centerline, which could be mitigated during detailed design.

Table 6.3. Proposed Conditions (With SWM and Upgrades) Major System Performance (100 Year)

Drainage Outlet	Road Stations	Minor System Drainage Area (ha)	Performance	Description
West of Bronte Creek	0+000 - 0+300	33.45	<0.15m below Road Centreline	The major system would surcharge above the curb for approximately 220 m from 0+000 to 0+220 with a maximum flow depth of 0.25 m near Station 0+175 on the north side of the road. There is a local sag in the road near this Station.
East of Bronte Creek	0+310 - 0+780	17.58	<0.15m below Road Centreline	The major system would surcharge above the curb for approximately 150 m from 0+450 to 0+600 with a maximum flow depth of 0.26 m near Station 0+450 on the north side of the road.
Jones Street to Nelson Street	0+780 - 1+060	2.6	<0.15m below Road Centreline	The major system would surcharge above the curb for approximately 50 m from 1+000 to 1+050 with a maximum flow depth of 0.25 m near Station 1+025 on the north side of the road. There would be a local sag in the road near this Station prior to connecting with the Nelson Street major system where the major system is conveyed to Lake Ontario.
East Street to Nelson Street	1+060 - 1+275	10.12	<0.15m below Road Centreline	The major system would surcharge above curb at multiple locations for approximately 70 m near Stations 1+075, 1+150, and 1+210, with a maximum flow depth of 0.25 m. There are localized low spots, such as a catch basin, along this section which cause the flow depth to be above the curb. These areas would likely be mitigated with detailed proposed road grades which could potentially raise the localized low spots allowing the major system flow to be conveyed more readily. The remainder of the section would be primarily either unsurcharged prior to draining to Nelson Street where the major system is conveyed to Lake Ontario.
Solingate Drive to East Street	1+275 - 1+700	151.17	> 0.15 m above Road Centreline	The major system would surcharge above the centreline of the road (>0.15 m) for approximately 50 m near Station 1+300 with a maximum flow depth of 0.50 m. This is likely unrealistic and a result of a localized low spots, such as a catch basin, along this section which cause the flow depth to be above the centreline of the road or above the curb. These areas would likely be mitigated with detailed proposed road grades which could potentially raise the localized low spots allowing the major system flow to be conveyed more readily. The remainder of the section would be primarily either unsurcharged or surcharged above the curb prior to draining to East Street where the major system is conveyed to Lake Ontario.
Solingate Drive to Coronation Park West Channel (Third Line)	1+700 - 2+230	58.69	<0.15m below Road Centreline	The major system would surcharge above the curb at two (2) isolated locations near Stations 1+775 and 2+230 with a maximum flow depth of 0.22 m. The major system over the curb at the south east corner of the intersection of Lakeshore Road and Third Line, where the flow enters a remnant channel, adjacent to the Sir John Colborne Recreation Centre for Seniors. The remnant channel flow is conveyed parallel to Lakeshore Road for approximately 300 m (+/-) where it is conveyed toward Lake Ontario near Belvedere Drive via the Coronation Park West Channel. Major system flow that would not enter the remnant channel at Third Line would be conveyed on Lakeshore Road to the East Channel near Station 2+775.
Third Line to Coronation Park East Channel	2+230 - 2+950	14.19	Below Curb	The major system maximum flow depth would be below the curb, with a maximum depth of 0.12 m, where the flow would be conveyed to the Coronation Park East Channel and to Lake Ontario. A roll over curb is proposed on the south side of Lakeshore Road near the East Channel to convey water off the road and into the ditch adjacent to the road. The proposed East Channel design has been included in the proposed conditions model.
Woodhaven Park Drive to Coronation Park East Parking Lot	2+950 - 3+280	15.5	Below Curb	The major system maximum flow depth would below the curb, with a maximum depth of 0.12 m, where the flow would be conveyed to Lake Ontario through the most easterly parking lot in Coronation Park near Station 3+100.
Remnant Channel Adjacent to the Wastewater Treatment Plant	3+280 - 3+760	49.69	< 0.15m above Road Centreline	The major system would surcharge above the curb for approximately 135 m from 3+400 to 3+535 with a maximum flow depth of 0.27 m near Station 3+430 on the north side of the road. There would be a local sag in the road near this Station where the major system outlets to remnant channel prior to entering Lake Ontario.
Stirling Drive Remnant Channel	3+760 – 3+900	5.77	Non-Surcharged	The roadway and the ditch on the south side of the road are not surcharged. A ditch has been maintained in the PCSWMM model on the north side of the road, outside the ROW, consistent with the existing conditions; however, it is anticipated that this ditch will not remain following the development of the area north of Lakeshore Road. A surcharge condition has been simulated in this ditch,

Drainage Outlet	Road Stations	Minor System Drainage Area (ha)	Performance	Description
				which spills onto the road ROW. The major system of the road is conveyed eastward toward the west side of Fourteen Mile Creek. The south ditch is conveyed to the Stirling Drive remnant channel, consistent with the existing conditions scenario.
Wolfdale Avenue to Fourteen Mile Creek	3+900 - 3+980	2.6	< 0.15m above Road Centreline	The major system would surcharge above the curb for approximately 45 m near Stations to 3+900 and 3+970 with a maximum flow depth of 0.22 m near Station 3+970 on the north side of the road. There would be a local sag in the road near this Station as it would be the low point of the Fourteen Mile Creek Bridge road surface.
West Lynn Road to Fourteen Mile Creek	3+980 - 4+560	2.89	Non-Surcharged	The major system maximum flow depth would be below the curb, with a maximum depth of 0.15 m, where the flow would be conveyed to Fourteen Mile Creek. A portion of the flow from the eastbound lane would be conveyed to the three (3) side streets south of Lakeshore Road, West Lynn Road, Wilder Drive, and Westdale Road as they are graded toward Lake Ontario.
Westdale Road to McCraney Creek	4+560 - 4+780	4.95	< 0.15m above Road Centreline	The major system would surcharge above the curb for approximately 120 m from Stations to 4+700 and 4+820 with a maximum flow depth of 0.22 m near Station 4+800 on the south side of the road. There would be a local sag in the road near this Station at the low point of the McCraney Creek Bridge road surface. A portion of the flow from the eastbound lane would be conveyed to Westdale Road as it is graded toward Lake Ontario.
Suffolk Avenue to McCraney Creek	4+780 - 5+090	1.3	Non-Surcharged	The major system maximum flow depth would be below the curb, with a maximum depth of 0.12 m, where the flow would be conveyed to McCraney Creek.
Suffolk Avenue to Morden Road - Outlet at Birch Hill Lane Remnant Channel	5+090 - 5+700	8.01	< 0.15m above Road Centreline	The major system would surcharge above the curb for approximately 50 m near Station 5+375 with a maximum flow depth of 0.22 m on the north side of the road. There would be a local sag in the road near this Station as it is the low point of the Birch Hill Lane remnant channel road surface.
Morden Road to St. Jude's Cemetery Remnant Channel	5+700 - 6+100	6.64	< 0.15m above Road Centreline	The major system would surcharge above the centreline of the road (>0.15 m) near Station 6+140 at the intersection of Dorval Drive and Lakeshore Road, with a maximum flow depth of 0.28 m on the north side of the road. The intersection is a low point for two major systems which spill over the curb into the remnant channel in St. Jude's Cemetery, where the flow is conveyed to Lake Ontario. A portion of the overland drainage from the eastbound lanes near Station 5+800 would be conveyed south to Shorewood Place as it is graded toward Lake Ontario. The major system would be surcharged above the curb near Station 5+900 for approximately 75 m as the flow would be conveyed to the remnant channel between Sherwood Place and Holyrood Avenue.

A preliminary volume assessment has been undertaken to size the infiltration trenches to be used for erosion control in addition to providing infiltration and water quality controls for Fourteen Mile Creek and McCraney Creek. The volume of the 25 mm design storm event has been used to size the infiltration trenches based on the increase of impervious area to each outlet to provide post to pre development erosion control. Further assessment would be required during detail design to determine discharge duration based on the configuration of the infiltration trenches.

Infiltration trench water quality control has also been selected for Birch Hill Lane, based on the contributing drainage area being less than 2 ha, allowable space within the Lakeshore Road R.O.W., and that the proposed storm sewer system would discharge to a remnant drainage channel adjacent to Birch Hill Lane. The infiltration trench as such would provide erosion control for the remnant channel.

Results in Table 6.4 show that the infiltration trenches can provide the required infiltration volume for the increase in impervious coverage for the R.O.W.

Table 6.4. 25 mm Storm Event Preliminary Infiltration Trench Volume Requirements (m^3)

Location	Infiltration Volume Required
West Side of 14 Mile Creek	0.5[1]
East Side of 14 Mile Creek	14.8[1]
West Side of McCraney Creek	7.4[2]
East Side of McCraney Creek	21.5[2]
Birch Hill Lane	9.0

Notes: 1 The West Side Fourteen Mile Creek infiltration trench can be combined with the East Side of 14 Mile Creek infiltration trench for a total volume of 15.3 m^3.
2 The West Side McCraney Creek infiltration trench can be combined with the East Side McCraney Creek infiltration trench for a total volume of 28.9 m^3.

Water quality measures to provide an Enhanced Level of water quality protection for the proposed increase in pavement to each drainage outlet have been selected with consideration to the contributing drainage area, magnitude in the increase in paved area, R.O.W. spatial constraints, effectiveness of water quality measures and input from the Town of Oakville regarding the type, number and location of LID BMPs.

In the case of OGS units, it is understood that a maximum 70% TSS removal is provided, as such OGS units are located and sized for appropriate locations, with drainage areas of approximately 2 ha or less. It is generally accepted based on MECP guidance and treatment standards that OGS units will appropriately treat up to 2 ha +/-; as the drainage area to an OGS unit increases, the peak flows will also increase and could exceed the flow capacity of the OGS unit. Should the flow capacity of the OGS unit be exceeded, the exceeded flow will by-pass the treatment function of the OGS. As such, OGS units are typically combined with another water quality measure when the drainage area to the OGS unit is greater than 2 ha, unless the OGS unit provides greater than equivalent Enhanced Level of water quality protection for the increase in paved area, by treating a larger drainage area.

Table 6.5 provides the water quality measures for the Lakeshore Road West corridor. In addition to the water quality measures, permeable pavement for the multi-use-trail should be used to reduce runoff to the major and minor drainage systems.

Table 6.5. Proposed Stormwater Quality Management

Road Stations	Drainage Outlet Station	Location	Drainage Area (ha)	Right of way Area (ha)	Existing Paved Area (ha)	Proposed Paved Area (ha)	Change in Paved Area (ha)	Percentage Change in Paved Area (%)	Stormwater Management Alternatives Discussion	SWM Alternative 1[1]	SWM Alternative 2[1]	Preferred solution
0+000 to 0+310	0+300	West of Bronte Creek	49.85	0.90	0.6362	0.6963	0.0601	9.45%	601 m^2 (+/-) of additional pavement proposed at intersections. Minor system on Lakeshore Road West is a 1500 mm dia. sewer with a nearly 50 ha contributing area, which is not conducive for retrofitting due to area and lack of space. Could do offsite improvements. Options include providing a water quality retrofit of Triller Place at 1.55 ha of drainage area using an oil/grit chamber prior to 1500 mm dia. sewer on Lakeshore Road West. Another option could be a water quality retrofit of the Bronte Harbour parking lot, which could use an oil/grit chamber and various LID measures.	Water quality retrofit of Triller Place with O/G EF4 chamber (601 m^2) $[2]	Water quality retrofit of Bronte Harbour parking area using O/G chamber and/or LID measures. $$	SWM Alternative 1
0+310 to 0+450	0+350	East of Bronte Creek	0.49	0.18	0.2932	0.2830	-0.0102	-3.48%	Stormwater quality measures not required as there is a decrease impervious area from the existing conditions to the proposed conditions.	No SWM required	No SWM required	No SWM required
0+450 to 0+700	0+350		17.09	0.91	0.5483	0.6362	0.0879	16.03%	Same minor system outlet as the road between Stations 0+310 to 0+450. The minor system contributing area is 17.09 ha to the 600 mm dia. sewer on Lakeshore Road West, as such a retrofit of the sewer outlet with an oil/grit chamber would not meet Enhanced Level water quality requirements for 879 m^2 (+/-) increase in pavement. Water quality alternatives include a retrofit of the existing 600 mm dia. sewer on the northeast side of Bronte Creek and Lakeshore Road West using an oil/grit chamber, combined with enhanced swale of 50 m (+/-) length. Another option would be a partial water quality retrofit of the east Bronte Harbour parking lot and the Chris Vokes Memorial Park parking lot (1.6 ha +/- paved) with an oil/grit chamber and could include LID measures within green spaces.	Water quality retrofit of 600mm sewer with O/G EF4 chamber (for DA=1.06 ha) (1,140 m^2), on north side of Lakeshore Road West east of Bronte Creek and an enhanced swale at the outlet. $	Water quality retrofit of the Bronte Harbour and Chris Vokes Memorial Park parking area using an O/G chamber and/or LID measures. $$	SWM Alternative 1
0+700 to 0+780	0+350			0.15	0.1660	0.1921	0.0261	15.72%	Overland drainage to Bronte Harbour, with the same minor system outlet as for the road between Stations 0+310 to 0+700. Combined increase in impervious coverage for road Stations 0+310 to 0+780 would be 1,083 m^2 (+/-).			
0+780 to 0+890	1+060	Nelson Street	41.00	0.38	0.2353	0.2717	0.0364	15.47%	There is a proposed increase in paved area of 364 m^2 draining overland to the storm sewer between road Stations 0+780 to 0+890 and	O/G EF4 Chamber (126 m^2) $	Tree Silva Cells $$	SWM Alternative 1

Road Stations	Drainage Outlet Station	Location	Drainage Area (ha)	Right of way Area (ha)	Existing Paved Area (ha)	Proposed Paved Area (ha)	Change in Paved Area (ha)	Percentage Change in Paved Area (%)	Stormwater Management Alternatives Discussion	SWM Alternative 1[1]	SWM Alternative 2[1]	Preferred solution
									then to the storm sewer system on Nelson Street which discharges to Lake Ontario.			
0+890 to 1+400	1+060	Nelson Street		1.29	1.1129	1.0891	-0.0238	-2.14%	The proposed combined change in impervious coverage from road Stations 0+890 to 1+400 is a decrease of 238 m^2 (+/-). The sewer west of Nelson Street would collect drainage from 2.6 ha (+/-) which could be treated using an oil/grit chamber.			
1+400 to 1+850	1+820	Sarah Lane	151.17	1.40	0.6998	0.7458	0.0460	6.57%	Proposed increase in paved area is 460 m^2, which would drain overland to the storm sewer within road Stations 0+890 to 1+400 and then to the storm sewer system on Nelson Street. A bioretention system on the north side of Lakeshore Road at or near Station 1+500 could be used for water quality treatment of the additional paved area.	Roadside bioretention system (460 m^2) $	Tree Silva Cells $$	Alternative 1
1+850 to 2+210	2+270	Coronation Park east channel (Proposed Condition)	7.98	1.50	0.4967	0.6495	0.1528	30.76%	The proposed increase in paved area is 1,528 m^2 (+/-) which will drain to the storm sewer to discharge at Coronation Park. The sewer west of Third Line would collect drainage from 1.63 ha (+/-) which could be treated using an oil/grit chamber.	LID BMP retrofits in Coronation Park (1883 m^2) $	Two (2) O/G chambers at west of Third Line EF4 and East of Westminster Drive EF4 (1883 m^2) $$	Combined Alternatives
2+210 to 2+270	2+270			0.18	0.1640	0.1898	0.0258	15.73%	Drainage will be conveyed easterly from Third Line within a new storm sewer to the east channel in Coronation Park as per Coronation Park Class EA. The proposed increase in pavement west of Westminster Drive would be 352 m^2 (+/-). The proposed increase in pavement east of Westminster Drive would be 3 m^2 (+/-). The sewer east of Westminster drive collects drainage from 1.22 ha which could be treated using an Oil/grit chamber. The total proposed increase in pavement to the west channel in Coronation Park would be 355 m^2 (+/-) not including the 1528 m^2 (+/-) west of Third Line. Stormwater quality could be provided through 2 oil/grit chambers, 1 west of Third Line and the other east of Westminster Drive. Alternatively, or in combination with oil/grit chambers, drainage improvements and other LID measures in Coronation Park could be used for bioretention and water quality treatment of aforementioned 352 m^2 (+/-).			
2+270 to 2+400	2+400		10.43	0.56	0.2181	0.2279	0.0098	4.49%				
2+400 to 2+660	2+660	Coronation Park east channel	16.08	1.14	0.4430	0.4426	-0.0004	-0.09%				
2+660 to 2+950	2+780	Coronation Park east channel	13.90	0.92	0.4930	0.4933	0.0003	0.06%				

Road Stations	Drainage Outlet Station	Location	Drainage Area (ha)	Right of way Area (ha)	Existing Paved Area (ha)	Proposed Paved Area (ha)	Change in Paved Area (ha)	Percentage Change in Paved Area (%)	Stormwater Management Alternatives Discussion	SWM Alternative 1[1]	SWM Alternative 2[1]	Preferred solution
2+950 to 3+280	3+100	Coronation Park East Parking Lot	15.50	1.08	0.5684	0.5593	-0.0091	-1.60%	The Coronation Park east parking lot includes both the minor and major drainage system outlets for 330 m of Lakeshore Road West and an external drainage area off Woodhaven Park Drive. The parking lot has the existing wastewater treatment plant 1800 mm dia. outlet, a 900 mm dia. abandoned wastewater outlet and a 600 mm dia. storm sewer outfall. There is a decrease in the paved are of 91 m^2 and stormwater quality treatment is not required.	No SWM required	No SWM required	No SWM required
3+280 to 3+760	3+430	Drainage Easement	49.69	1.47	0.7206	0.7992	0.0786	10.91%	This portion of the road has a rural cross-section and will become urbanized. There is an increase in paved area of 786 m^2 (+/-). 240 m^2 (+/-) of the increased paved area is conveyed to the sewer west of the Easement and the easement would collect drainage from 0.79 ha (+/-) which could be treated using an oil/grit chamber. 547 m^2 (+/-) of the increased paved area is conveyed to the sewer east of the Easement and the easement would collect drainage from 2.99 ha (+/-) which could be treated using an oil/grit chamber. Alternatively, underground infiltration and storage under the multiuse trail for the 25 mm storm event could be provided (20 m^3) and potentially combined with an oil/grit chamber.	Two (2) O/G EF4 chambers (786 m^2) $$	Tree Silva Cell $	Combined Alternatives
3+760 to 3+940	3+770	Fourteen Mile Creek west	6.80	0.49	0.3033	0.3065	0.0032	1.06%	There is increase of 20 m^2 (+/-) in pavement on the west side of Fourteen Mile Creek. Since the drainage area is too large for an Oil/Grit chamber, a combination of oil/grit chambers and erosion control infiltration trenches for the 25 mm storm event runoff response (175 m^3) have been considered to provide water quality. On the east side of Fourteen Mile Creek, the existing road is a rural cross-section with the west bound lanes draining to Fourteen Mile Creek, while the east bound lanes, between both legs of Westdale Drive drain to the local side roads (Westdale Dale Drive (west leg), Wilder Drive, and West Lynn Road). Under the proposed conditions the road will be urbanized as such the overland drainage system outlets will not change, but the minor system will	Underground Infiltration and storage trench system $	One (1) O/G EF4 Chambers (610 m^2) $$	Underground Infiltration and storage trench system
3+940 to 3+980	3+980		2.43	0.32	0.0775	0.0763	-0.0012	-1.55%				
3+980 to 4+120	4+020	Fourteen Mile Creek east	0.46	0.21	0.2167	0.2313	0.0146	6.74%				
4+120 to 4+240	4+120		0.93	0.55	0.2315	0.2363	0.0048	2.07%				
4+240 to 4+560	4+460		3.12	1.03	0.4984	0.538	0.0396	7.95%				

Road Stations	Drainage Outlet Station	Location	Drainage Area (ha)	Right of way Area (ha)	Existing Paved Area (ha)	Proposed Paved Area (ha)	Change in Paved Area (ha)	Percentage Change in Paved Area (%)	Stormwater Management Alternatives Discussion	SWM Alternative 1[1]	SWM Alternative 2[1]	Preferred solution
									convey drainage from the east bound lanes. As such 0.93 ha at 0.65 ha impervious (70% imp.) will be redirected to Fourteen Mile Creek in the minor system (5 year storm event). On the east side of Fourteen Mile Creek, the increase of 590 m^2 (+/-) in impervious cover could be addressed with an Oil/Grit chamber as the drainage area of 3.62 ha is within considerable limits for such mitigation. Note: The existing drainage outlet to the east ditch and remnant channel at Stirling Drive (3+780) will not receive drainage from the Lakeshore Road due to urbanization (addition of curb and gutter).			
4+560 to 4+780	4+770	McCraney Creek west	1.49	0.46	0.4157	0.4452	0.0295	7.10%	Similar to Fourteen Mile Creek, to provide erosion control and Enhanced water quality control for the proposed 1156 m^2 (+/-) total increase in paved area, a combination of oil/grit chambers with infiltration trenches (20 m^3) have been proposed. The infiltration trenches would provide control for the 25 mm storm event. An Oil/Grit chamber at the east outlet (drainage area = 3.82 ha (+/-)) of McCraney creek could provide quality control for the increased pervious area of 861 m^2 (+/-).	Two (2) O/G EF4 Chambers (1156 m^2) $$	Underground Infiltration and Storage Trench System (East Side) $	Combined Alternatives
4+780 to 5+090	4+770	McCraney Creek east	3.82	0.86	0.3877	0.4738	0.0861	22.21%				
5+090 to 5+270	5+375	Birch Hill Lane	3.19	0.37	0.2751	0.3046	0.0295	10.72%	One (1) Oil/Grit chamber has been recommended near Station 5+225 to treat the 295 m^2 (+/_) of additional pavement to the 300 mm storm sewer through private property. One (1) OGS unit has been recommended to treat the 250 m^2 (+/-) on additional pavement area contributing to the west side of Birch Hill Lane. Similarly, an Oil/Grit chamber has been recommended at the east outlet of Birch Hill to treat the increased pavement area of 360 m^2 (+/-). Alternatively, to address the 360 m^2 (+/-) proposed increase in paved area east of Birch Hill Lane, an underground infiltration systems (50 m^3) has been considered West on the south side of the road.	Three (3) EF4 chambers (360 m^2) $$	Underground infiltration and storage trench system (East side of Birch Hill Lane) $	Combined
5+270 to 5+375	5+375		7.75	0.84	0.3865	0.4115	0.0250	6.47%				
5+375 to 5+700	5+375		2.30	0.65	0.2011	0.2371	0.0360	17.90%				
5+700 to 5+800	6+010	Remnant Channel west of	0.84	0.42	0.1532	0.1527	-0.0005	-0.33%	The existing minor and major drainage systems at Dorval Road/ Lakeshore Road West intersection are considered inadequate with	No SWM required	No SWM required	No SWM required

Road Stations	Drainage Outlet Station	Location	Drainage Area (ha)	Right of way Area (ha)	Existing Paved Area (ha)	Proposed Paved Area (ha)	Change in Paved Area (ha)	Percentage Change in Paved Area (%)	Stormwater Management Alternatives Discussion	SWM Alternative 1[1]	SWM Alternative 2[1]	Preferred solution
		Dorval Drive							significant surcharging of the sewer system and flooding of the road during the 100 year storm. As such, the remnant channel located west of the Lakeshore Road West and Dorval has been considered to be disconnected from the existing 1200/1350 mm dia. sewer on Lakeshore Road West and connected to the existing channel within the cemetery. Twinning of the existing 1350 mm dia. sewer is being considered from Dorval to the end of the storm sewer outlet south of Brock Road. A decrease in the impervious area of 85 m^2 does not necessitate stormwater quality treatment.			
5+800 to 6+100	6+100	Remnant Channel West of Dorval Drive/ Sewer on Lakeshore	5.72	0.47	0.4796	0.4716	-0.008	-1.67%				
		TOTALS	**406.56**	**18.78**	**10.4218**	**11.1607**	**0.7389**	**7.09%**				

Notes: 1 Area in brackets represents the additional paved area requiring treatment
2 Cost estimates have not been provided for each alternative, however, the alternative with a likely lower implementation cost has been identified with a "$" while the alterative with a likely greater implementation cost has been identified with "$$".

A standard high level unitary costing rate of $100,000/unit for the implementation of the OGS units has been used to estimate the cost of the required OGS units. Thirteen (13) OGS units have been identified as being required to treat the increased impervious area as shown in Table 6.5 for a combined cost of $1,300,000; the OGS sizing reports are provided in Appendix F.

The implementation of LID BMP source controls to offset the hydraulic impact of land use intensification and climate change have been proposed based on a detailed review of the proposed increase in pavement to each drainage outlet, as well as a review of the site-specific spatial and grading constraints of constructing the LID BMPs within the ROW. This assessment has not confirmed whether the identified LID BMP measures would be sufficient to offset the 25 mm of precipitation as required by the town's Stormwater Master Plan (Wood, June 2020) for each of the sections of Lakeshore Road West; the size and level of treatment provided by each of the LID BMP units can be assessed through further investigation at the next stages of planning and design. Furthermore, this assessment has not considered the seasonally high ground water elevation and how it may impact the bottom elevation or depth of the proposed LID BMP source controls as groundwater surface elevation data has not been collected as part of this study. The Credit Valley Conservation LID Stormwater Management Planning and Design Guide indicates that the invert of stone reservoirs, for LID features such as infiltration trenches, should be located at a minimum of one (1) metre above the seasonally high water table. Groundwater monitoring data should be collected at the next stages of planning and design to confirm the feasibility of the noted LID features.

Due to the limited spatial constraints within the ROW, should the infiltration trenches or other infiltrative LID features with a stone reservoir not be suitable for the specified locations due to the seasonally high-water table, it would be advantageous if road-side ditches could be maintained where possible or converted to enhanced swales to provide a water quality benefit. The locations within the existing Lakeshore Road West ROW where road-side ditches have been identified are provided:

- Bronte Athletic Park to Solingate Drive (Stations 1+500 to 1+750)
- Solingate Drive to Third Line Belvedere Drive (Stations 1+750 to 2+500)
- Belvedere Drive to Westminster Drive (Coronation Park) (Stations 2+500 to 2+900)
- Woodhaven Park Drive to the Water Treatment Plant (Stations 2+900 to 3+300)
- Water Treatment Plant to Wolfdale Avenue (Stations 3+300 to 3+850)
- 14 Mile Creek to Spring Garden Road (Stations 4+050 to 4+300)
- Westdale Road (Stations 4+550 to 4+625)
- Birch Hill Lane to Morden Road (Stations 5+400 to 5+700)

The existing ditches at these locations should be maintained to the extent possible to provide an informal water quality benefit to treat runoff from the ROW prior to conveyance to the storm sewer system. Converting these existing ditches to enhanced swales would provide the opportunity to formalize the water quality benefits of the roadside ditches as per the recommendations of the town's Stormwater Master Plan.

The proposed LID BMP measures which have been recommended to provide 25 mm of infiltration based on spatial availability are provided in Table 6.6 for the Lakeshore Road West corridor and presented graphically on Figure 6.1. The suitable locations identified are generally dependent on the spatial area within the ROW and the road profile; LID BMPs have been recommended at low points where the road drainage can be conveyed to the source control features. To ensure the effectiveness of the LID BMPs, it is essential that there be coordination between the grading of the road profile and the location of the LID BMPs. The feasibility of implementing the LID BMP features (assessment of soil conditions, groundwater and bedrock depths, utilities configuration and depths) has not been undertaken for this study. These feasibility constraints should be reviewed at the next stages of planning and design in addition to confirming the suitable locations to maximize the use of LID BMP source controls to achieve the defined SWM targets within the town's Stormwater Master Plan. Where it is not feasible to meet the town's target of 25 mm of rainfall capture, a commitment should be made at the next stages of planning and design to maximize the use of LID BMP source controls where feasible.

Prior to the implementation of the LID BMP features, it is recommended that the town develop standards during the next stages of planning and design for all LID BMP features, or at a minimum the short-listed LID BMP features identified through this study. The standards should include conveyance and sizing requirements, construction procedures, in addition to considerations for long-term operations and maintenance of the features.

Table 6.6. Proposed LID BMP Implementation Locations

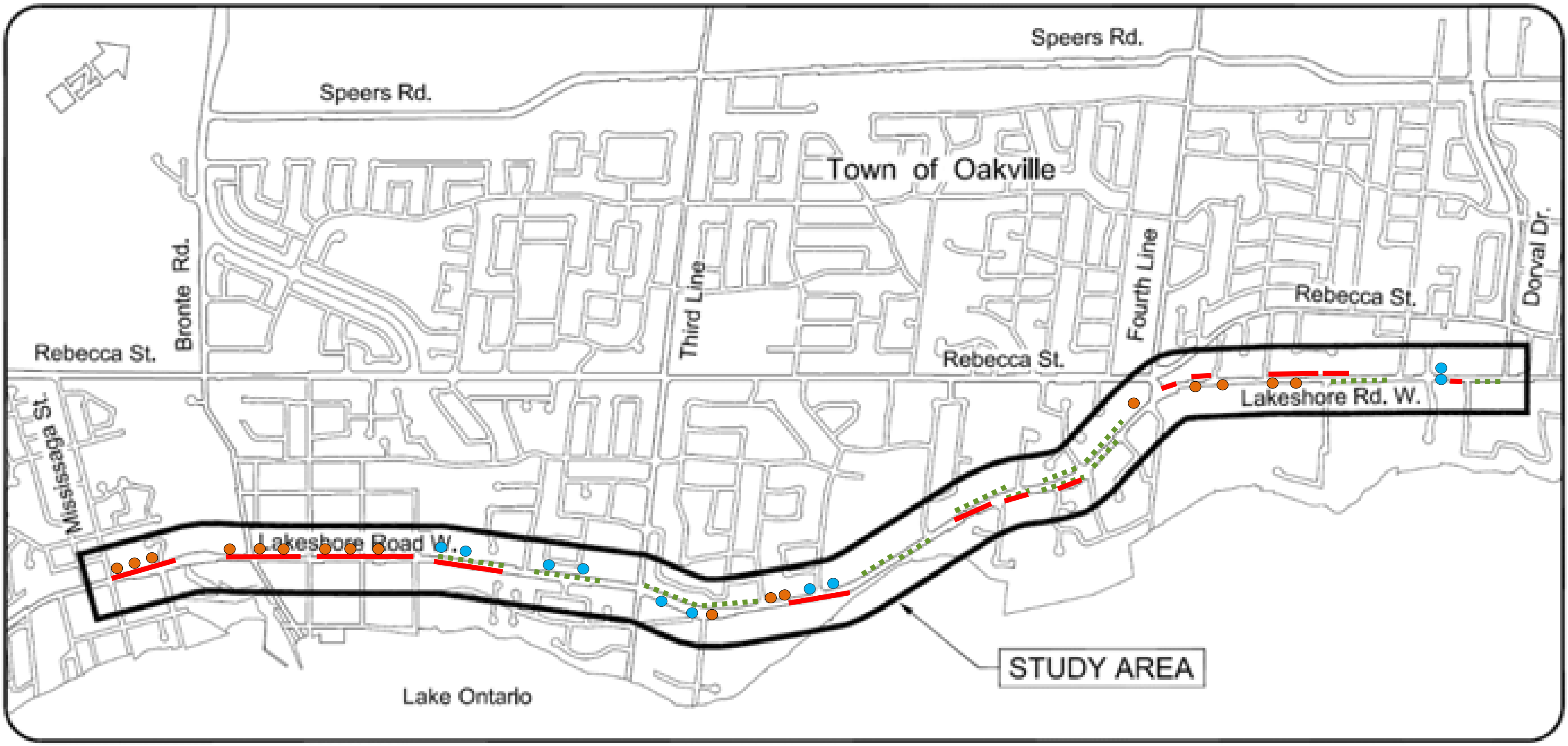
<table>
<tr><th>Road Stations</th><th>Drainage Outlet Station</th><th>Location</th><th>Drainage Area (ha)</th><th>Right of way Area (ha)</th><th>Existing Paved Area (ha)</th><th>Proposed Paved Area (ha)</th><th>Change in Paved Area (ha)</th><th>Percentage Change in Paved Area (%)</th><th>25 mm Source Control (LID BMP) Implementation Strategy</th></tr>
<tr><td>0+000 to 0+310</td><td>0+300</td><td>West Bronte Creek</td><td>49.85</td><td>0.90</td><td>0.6362</td><td>0.6963</td><td>0.0601</td><td>9.45%</td><td>There is limited area for the implementation of swales/ditches as this section of road uses curb and gutter under existing conditions. Silva cells should be considered within the area between the proposed sidewalk and the roadway on the north side of Lakeshore Road West. Drainage from the road and sidewalk could be conveyed to the silva cells where appropriate grading permits. Similarly, permeable pavers/pavement or pervious pipes with infiltration trenches could be installed in the sidewalk, however this would not likely provide substantial infiltration benefit unless the grading of the ROW in this area could be conveyed to the permeable pavers/pavement or infiltration trenches.</td></tr>
<tr><td>0+310 to 0+450</td><td>0+350</td><td rowspan="3">East Bronte Creek</td><td>0.49</td><td>0.18</td><td>0.2932</td><td>0.283</td><td>-0.0102</td><td>-3.48%</td><td rowspan="3">There is limited to no area for the implementation of swales/ditches as this section of road uses curb and gutter under existing conditions. Furthermore, the sidewalk on the south side of Lakeshore Road West extends from the back of curb to the front of the buildings. Silva cells should be considered within the area between the proposed sidewalk and the roadway on the north side of Lakeshore Road West between Station 0+600 and 0+780. Drainage from the road and sidewalk could be conveyed to the silva cells where appropriate grading permits. Similarly, permeable pavers/pavement or pervious pipes with infiltration trenches could be installed in the sidewalk on the south side of Lakeshore Road West where there is existing interlocking brick adjacent to the sidewalk. However, this would not likely provide substantial infiltration benefit unless the grading of the ROW in this area could be conveyed to the permeable pavers/pavement or infiltration trenches.
An enhanced swale has been recommended for stormwater quality treatment (ref, Table 6.5 and Figure 7) at the storm sewer outfall to Bronte Creek; these LID BMPs could be implemented to compliment the treatment of the enhanced swale.</td></tr>
<tr><td>0+450 to 0+700</td><td>0+350</td><td rowspan="2">17.09</td><td>0.91</td><td>0.5483</td><td>0.6362</td><td>0.0879</td><td>16.03%</td></tr>
<tr><td>0+700 to 0+780</td><td>0+350</td><td>0.15</td><td>0.166</td><td>0.1921</td><td>0.0261</td><td>15.72%</td></tr>
<tr><td>0+780 to 0+890</td><td>1+060</td><td>Nelson Street</td><td rowspan="2">41.00</td><td>0.38</td><td>0.2353</td><td>0.2717</td><td>0.0364</td><td>15.47%</td><td rowspan="2">Silva cells should be considered within the area between the proposed sidewalk and the roadway where green space has been proposed, on the north and south sides of Lakeshore Road West, between Stations 0+780 and 0+950 and Stations 1+100 to 1+400. Drainage from the road and sidewalk could be conveyed to the silva cells where appropriate grading permits. Silva cells have also been recommended in the area of 0+780 and 0+950 for stormwater quality treatment (ref, Table 6.5 and Figure 7). Similarly, permeable pavers/pavement or pervious pipes with infiltration trenches could be installed in the sidewalk on both sides of Lakeshore Road West, however this would not likely provide substantial infiltration benefit. unless the grading of the ROW in this area could be conveyed to the permeable pavers/pavement or infiltration trenches. Swales/ditches cannot be constructed in this area as this section of road uses curb and gutter under existing conditions and there is insufficient area to implement swales/ditches.</td></tr>
<tr><td>0+890 to 1+400</td><td>1+060</td><td>Nelson Street</td><td>1.29</td><td>1.1129</td><td>1.0891</td><td>-0.0238</td><td>-2.14%</td></tr>
</table>

Road Stations	Drainage Outlet Station	Location	Drainage Area (ha)	Right of way Area (ha)	Existing Paved Area (ha)	Proposed Paved Area (ha)	Change in Paved Area (ha)	Percentage Change in Paved Area (%)	25 mm Source Control (LID BMP) Implementation Strategy
1+400 to 1+850	1+820	Sarah Lane	151.17	1.40	0.6998	0.7458	0.046	6.57%	Shallow existing swales could be converted to enhanced swales and facilities on the north side of Lakeshore Road West between Stations 1+540 and 1+700 and bioretention facilities between Stations 1+425 and 1+525 as there is sufficient area available between the road and the property line. Drainage from the road could be conveyed to the LID BMP features through curb cuts in the curb and gutter. Catch basins are recommended to be constructed in the LID BMP features to convey excess runoff to the storm sewer system (i.e. runoff greater than the capacity of the LID BMP feature). Permeable pavers/pavement or pervious pipes with infiltration trenches could be installed in the MUP; this may provide substantial infiltration benefit as the grading of the ROW in this area could be conveyed to the permeable pavers/pavement or infiltration trenches, particularly on the south side of Lakeshore Road West.
1+850 to 2+210	2+270	Coronation Park west channel (Proposed Condition)	7.98	1.50	0.4967	0.6495	0.1528	30.76%	An existing shallow swale could be converted to an enhanced swale and/or bioretention facilities on the north side of Lakeshore Road West between Stations 1+850 and 2+075 as there is sufficient area available between the road and the property line. Drainage from the road could be conveyed to the LID BMP features through curb cuts in the curb and gutter. Catch basins are recommended to be constructed in the LID BMP features to convey excess runoff to the storm sewer system (i.e. runoff greater than the capacity of the LID-BMP feature). Permeable pavers/pavement or pervious pipes with infiltration trenches could be installed in the MUP between Station 2+125 and 2+225 on the south side of Lakeshore Road West; this may provide substantial infiltration benefit as the grading of the ROW in this area could be conveyed to the permeable pavers/pavement or infiltration trenches.
2+210 to 2+270	2+270			0.18	0.164	0.1898	0.0258	15.73%	Enhanced swales could be implemented on the north side of Lakeshore Road West between Stations 2+250 and 2+750 as there is sufficient area available between the road and the existing sidewalk; as with all the recommended LID BMPs, the feasibility of the enhanced swale will have to be reviewed for conflicts with utilities and infrastructure particularly in this location as the proposed trunk storm sewer is shown to be located on the north side of Lakeshore Road West in the boulevard. Bioretention facilities could be implemented between Station 2+300 and 2+525 on the south side of Lakeshore Road West , opposite the MUP. Drainage from the road could be conveyed to the LID BMP features through curb cuts in the curb and gutter. Catch basins are recommended to be constructed in the LID BMP features to convey excess runoff to the storm sewer system (i.e. runoff greater than the capacity of the LID-BMP feature). Silva cells could be constructed south of the MUP on the south side of Lakeshore Road Wet between Stations 2+550 and 2+650, and on the north side of Lakeshore Road West between Stations 2+800 and 2+950.
2+270 to 2+400	2+400		10.43	0.56	0.2181	0.2279	0.0098	4.49%	
2+400 to 2+660	2+660	Coronation Park west channel	16.08	1.14	0.443	0.4426	-0.0004	-0.09%	
2+660 to 2+950	2+780	Coronation Park east channel	13.9	0.92	0.493	0.4933	0.0003	0.06%	
2+950 to 3+280	3+100	Coronation Park East Parking Lot	15.5	1.08	0.5684	0.5593	-0.0091	-1.60%	Bioretention facilities could be constructed between Stations 2+970 to 3+000 and 3+025 to 3+100. The location and invert elevations of the existing sanitary sewer pipes would need to be confirmed in this area to ensure LID BMPs would not interfere with the existing infrastructure. Permeable pavers/pavement or pervious pipes with infiltration trenches could be installed in the MUP; this may provide infiltration benefit as the grading of the ROW in this area could be conveyed to the permeable

Road Stations	Drainage Outlet Station	Location	Drainage Area (ha)	Right of way Area (ha)	Existing Paved Area (ha)	Proposed Paved Area (ha)	Change in Paved Area (ha)	Percentage Change in Paved Area (%)	25 mm Source Control (LID BMP) Implementation Strategy
									pavers/pavement or infiltration trenches, particularly on the south side of Lakeshore Road West.
3+280 to 3+760	3+430	Drainage Easement	49.69	1.47	0.7206	0.7992	0.0786	10.91%	Enhanced swales could be implemented on the both the north and south sides of Lakeshore Road West between Stations 3+350 and 3+410 and 3+450 to 3+700 as there are existing swales located in these areas. The grading of the ROW between the MUP and private property on the south side of Lakeshore Road West may impact the width of the swales. Curb cuts could be implemented to convey runoff from the ROW to the swales. Should the proposed grading on the south side of the ROW not be conducive for the implementation of a swale, then permeable pavers/pavement or pervious pipes with infiltration trenches could be installed in the MUP to increase the potential for infiltration of runoff. A Silva Cell has been recommended in this area for stormwater quality treatment; the enhanced swales could compliment the treatment provided by the Silva Cell.
3+760 to 3+940	3+770	Fourteen Mile Creek west	6.80	0.49	0.3033	0.3065	0.0032	1.06%	Enhanced swales could be implemented on the both the north and south sides of Lakeshore Road West between Stations 3+870 and 3+950 and 4+000 to 4+500 as there are existing swales located in these areas. The grading of the ROW between the MUP and private property on the south side of Lakeshore Road West may impact the width of the swales. Curb cuts could be implemented to convey runoff from the ROW to the swales. Infiltration trenches have been recommended on both sides of Fourteen Mile Creek to mitigate erosion to the channel. Should the proposed grading on the south side of the ROW not be conducive for the implementation of a swale, then permeable pavers/pavement or pervious pipes with infiltration trenches could be installed in the MUP to increase the potential for infiltration of runoff in addition to the infiltration trenches recommended to mitigate erosion (ref. Table 6.4 and Figure 10).
3+940 to 3+980	3+980		2.43	0.32	0.0775	0.0763	-0.0012	-1.55%	
3+980 to 4+120	4+020	Fourteen Mile Creek east	0.46	0.21	0.2167	0.2313	0.0146	6.74%	
4+120 to 4+240	4+120		0.93	0.55	0.2315	0.2363	0.0048	2.07%	
4+240 to 4+560	4+460		3.12	1.03	0.4984	0.538	0.0396	7.95%	
4+560 to 4+780	4+770	McCraney Creek west	1.49	0.46	0.4157	0.4452	0.0295	7.10%	Silva cells could be implemented north of the sidewalk near Station 4+675 at the intersection of Fourth Line and Lakeshore Road West and on the south side of Lakeshore Road West between Stations 4+825 to 5+050 between the sidewalk and the roadway; as with all the recommended LID BMPs, the feasibility of the Silva Cells near Station 4+675 will have to be reviewed for conflicts with utilities and infrastructure particularly in this location as the existing storm sewer is shown to be located on the north side of Lakeshore Road West in the boulevard. Permeable pavers/pavement or pervious pipes with infiltration trenches could be installed in the sidewalk on the north side of Lakeshore Road West between Fourth Line and McCraney Creek (Station 4+725 and 4+760) and on the north side of Lakeshore Road West between Stations 4+825 to 4+925. The permeable pavers/pavement or pervious pipes with infiltration trenches could be implemented to compliment the infiltration trench recommended to mitigate erosion infiltration trench east of McCraney Creek (ref. Table 6.4 and Figure 10).
4+780 to 5+090	4+770	McCraney Creek east	3.82	0.86	0.3877	0.4738	0.0861	22.21%	

Road Stations	Drainage Outlet Station	Location	Drainage Area (ha)	Right of way Area (ha)	Existing Paved Area (ha)	Proposed Paved Area (ha)	Change in Paved Area (ha)	Percentage Change in Paved Area (%)	25 mm Source Control (LID BMP) Implementation Strategy
5+090 to 5+270	5+375	Birch Hill Lane	3.19	0.37	0.2751	0.3046	0.0295	10.72%	Silva cells could be implemented on the south side of the Lakeshore Road West ROW between Stations 5+150 and 5+325. Permeable pavers/pavement or pervious pipes with infiltration trenches could be constructed in the sidewalk on the north side of Lakeshore Road West between Stations 5+200 and 5+350 and Stations 5+400 and 5+5+25. The permeable pavers/pavement or pervious pipes with infiltration trenches could be implemented to compliment the infiltration trench recommended at Station 5+400 (ref. Table 6.4 and Figure 11). An existing shallow swale on the south side of Lakeshore Road West between Stations 5+400 to 5+550 could be converted to an enhanced swale with curb cuts in the curb and gutter to convey runoff from the ROW to the swale.
5+270 to 5+375	5+375		7.75	0.84	0.3865	0.4115	0.025	6.47%	
5+375 to 5+700	5+375		2.3	0.65	0.2011	0.2371	0.036	17.90%	
5+700 to 5+800	6+010	Remnant Channel west of Dorval Drive	0.84	0.42	0.1532	0.1527	-0.0005	-0.33%	Bioretention facilities could be constructed between Stations 5+800 and 5+860 on both the north and south sides of the Lakeshore Road West . Should the proposed grading on the either side of the ROW not be conducive to convey flow to the bioretention facilities, then permeable pavers/pavement could be constructed in the proposed sidewalks between Stations 5+875 and 5+925. An existing shallow swale on the south side of Lakeshore Road West between Stations 6+000 to 6+075 could be converted to an enhanced swale with curb cuts in the curb and gutter to convey runoff from the ROW to the swale.
5+800 to 6+100	6+100	Remnant Channel West of Dorval Drive/ Sewer on Lakeshore	5.72	0.47	0.4796	0.4716	-0.008	-1.67%	
		TOTALS	**412.04**	**18.72**	**10.4218**	**11.1607**	**0.7389**	**7.09%**	

Figure 6.1 LID BMP Recommended Implementation Location Plan



Recommended LID BMPs	
▪▪▪▪▪▪▪	Enhanced Grass Swales
●	Bioretention Systems
▬	Permeable Pavers/Pavement or Infiltration Trenches
●	Silva Cells

7.0 Cost Analysis

A high level supply and construction cost of implementing the recommended storm sewer upgrades has been provided in Table 7.1 while a breakdown of the cost estimates is provided in Appendix G.

Table 7.1 Storm Sewer Hydraulic Upgrades Preliminary Cost Estimate

Infrastructure	Supply and Construction Cost ($)
Storm Sewers	$7,222,000
Manholes	$1,295,000
Catch Basins	$298,000
Total	**$8,815,000**

A preliminary cost analysis for the implementation of the LID BMP source controls within the Lakeshore Road West corridor has been provided (ref. Table 7.2).

Table 7.2 Preliminary LID BMP Cost Estimate

LID BMP Feature	Unitary Rate	Unitary Rate Source	Quantity	Implementation Cost ($)
Enhanced Grass Swale	$16,500/1000 m^2 of Contributing Drainage Area	STEP LID Lifecycle Cost Tool Version 2.0, December 2019	6.2 ha	$1,023,000
Bioretention System	$26,400 per facility with 1000 m^2 of Contributing Drainage Area	STEP LID Lifecycle Cost Tool Version 2.0, December 2019	8 Units	$211,000
Permeable Pavers/Pavement or Infiltration Trench	$97,900/1000 m^2 of Contributing Drainage Area	STEP LID Lifecycle Cost Tool Version 2.0, December 2019	4.44 ha	$4,3467,000
Silva Cells	$160,000 per facility	Alternate Project	23 Units	$3,680,000
Total				**$9,261,000**

As presented in Table 7.2, the preliminary cost to implement the identified LID BMP source controls at the location identified in Figure 6.1 would be $9,260,960.

The total cost for the recommended stormwater management upgrades for the hydraulics, water quality treatment, and the LID BMP features would be $19,376,000; this includes thirteen (13) OGS units at a combined cost of $1,300,000.

8.0 Conclusions and Recommendations

8.1 Conclusions

Based on the results presented and discussed in this Stormwater Management Report, the following conclusions can be made:

i. The Class EA Study Area drains to the Bronte Creek, Fourteen Mile Creek, McCraney Creek and multiple drainage outlets to Lake Ontario, with all events up to and including the 100 year event being captured and conveyed by the existing storm sewer and roadway right-of-way.
ii. Various sections of the existing storm sewer surcharge and flood during the 100 year storm event, with basements potentially being flooded during a 100 year storm.
iii. Various sections of the road have flow depths above the curb and above the flow capacity of the roadside ditches.
iv. LID BMP source controls should be implemented within the road ROW to capture 25 mm of precipitation to offset the impacts of land use intensification and climate change as per the recommendations of the town's Stormwater Management Master Plan.
v. The existing Bronte Creek crossing conveys the Regional Storm without overtopping.
vi. The existing Fourteen Mile Creek crossing conveys the 100 year storm, but does overtop for the Regional Storm. That said, it does meet MNRF criteria for emergency vehicle ingress and egress.
vii. The existing McCraney Creek culvert conveys the 100 year storm, but does overtop by 1.36 m for the Regional Storm, and does not meet MNRF criteria for emergency vehicle ingress and egress. In addition, the culvert structural was built in 1940 and is nearing its lifespan.

8.2 Recommendations

The following recommendations have been made for drainage system improvements and stormwater management:

i. Because Lakeshore Road West is located immediately upstream of Lake Ontario, no stormwater management quantity controls are required to reduce peak flows to drainage outlets.
ii. Numerous new and upgraded storm sewers will be required to provide adequate flow conveyance. In some locations the potential basement flood risk could not be eliminated due to the basement elevations and storm system profile either on Lakeshore Road West or downstream of Lakeshore Road West. As part of the detailed design, new sump pumps, instead of gravity drains, could be added to discharge to grade and existing sump pumps retrofitted to discharge to grade could also be considered.
iii. The improved channel within Coronation Park should be connected to the proposed storm sewer system at the Westminster Drive and Lakeshore Road West intersection.
iv. To meet the water quality control, erosion infiltration trenches are recommended for the storm sewer systems draining to Fourteen Mile Creek and McCraney Creek. The infiltration trenches discharging to Fourteen Mile Creek would also provide thermal mitigation to address MNRF redside dace habitat thermal mitigation requirements.
v. An infiltration trench has been recommended for the road area draining to Birch Hill Lane.
vi. One (1) roadside bioretention system has been recommended for water quality treatment near Bronte Athletic Park.
vii. Various locations have been recommended to use Silva Cells as a water quality measure.

viii. Offsite LID BMP retrofits at Coronation Park, St. Jude's Cemetery and Bronte Creek Harbour (east side) have been recommended to provide water quality improvements.
ix. Permeable pavers and/or pavement is recommended for use for the proposed multi-use-pathway at various locations along Lakeshore Road West.
x. Oil/grit separators (OGS) have been recommended within the Lakeshore Road West R.O.W. at various locations at a combined cost of $1,300,000. Whenever possible, additional water quality measures have been recommended in addition to the OGS units.
xi. Various LID BMP measures have been proposed to be implemented in the Lakeshore Road West corridor to provide source control (infiltration) as per the recommendations of the town's Stormwater Master Plan (Wood, June 2020) to offset the hydraulic impacts of land use intensification and climate change. The LID BMP measures have not been sized based on their ability to infiltrate 25 mm of precipitation, rather they have been preliminarily sized according to the potential for implementation which has been based on spatial and grading constraints. The size and level of treatment provided by each of the LID BMP units will need to be assessed through further investigation at the next stages of planning and design. While retaining 25 mm of precipitation is the objective of the source controls, that may not be achievable due to various constraints and the implementation of LID BMP source controls should be maximized where feasible.
xii. The cost to implement the storm sewer hydraulic upgrades would be $8,815,000.
xiii. The cost to implement the LID BMP source controls has preliminarily estimated at $9,261,000.
xiv. The existing Bronte Creek and Fourteen Mile Creek structures will remain as is.
xv. The culvert at Station 3+450 needs to be extended by 4 m ± to accommodate the proposed road width. Retaining walls are required for at each side of the culvert.
xvi. The existing McCraney Creek culvert is recommended to be replaced with a 14.6 m by 4 m by 24.3 m structure that conveys the Regional Storm.

9.0 Approval and Review Requirements

The aforementioned SWM recommendations are subject to the review and approval of the Town of Oakville, Conservation Halton, Ministry of Natural Resources and Forestry, and the Ministry of Environment, Conservation and Parks.

Yours very truly,

Wood Environment & Infrastructure Solutions,
a Division of Wood Canada Limited

Per: Steve Chipps, P.Eng
Associate Water Resources Engineer

Per: Patrick MacDonald, E.I.T
Water Resources EIT

Appendix A
Background Information

GEO-CANADA LTD.
CONSULTING GEOTECHNICAL ENGINEERS

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20M-051 SD 437

GEOTECHNICAL INVESTIGATION FOR PROPOSED SUBDIVISION OAKVILLE, ONTARIO

Ref. No. G-94.1105
February 1995

Prepared for:

Marshall Macklin Monaghan Limited
80 Commerce Valley Drive East
Thornhill, Ontario
L3T 7N4

Distribution

5 Copies - Marshall Macklin Monaghan Limited
2 Copies - Geo-Canada Ltd.

Ref. No. G-94.1105

CONTENTS

APPENDIX

ENCLOSURES

REPORT
ON
GEOTECHNICAL INVESTIGATION
FOR
PROPOSED SUBDIVISION
OAKVILLE, ONTARIO

1.0 INTRODUCTION

The investigation described in this report was conducted at the request of Marshall Macklin Monaghan Limited to obtain geotechnical input for the design of a proposed residential subdivision (Lisonally Farm Property) in Oakville, Ontario. The objectives of the investigation have been to establish the subsurface stratigraphy, evaluate the soil properties, observe the groundwater conditions and to make recommendations for the design of the underground utilities, road pavement, and house foundations. In addition, the investigation was to evaluate the permeability of the site soils for the design of soak-away pits or trenches for storm water management.

2.0 SITE DESCRIPTION

The site is located between Lakeshore Road West and Lake Ontario in the Town of Oakville. It is bounded by Wilder Drive on the east and Little 14 Mile Creek on the west. It is a roughly rectangular shaped property measuring approximately 230 m by 350 m. There are some barn like structures located at the north east corner of the site, and several houses along the lake front. Other than these structures and the driveways leading to them, the rest of the site is undeveloped and is open land. Except for the areas immediately adjacent to the lake and the creek, the site is practically level. Surface vegetation is mostly grass, bushes, and some fruit trees.

The site will be developed into twenty nine (29) fully serviced lots. There will be a road connecting Lakeshore Road to Westdale Road on the east, as well as two cul-de-sac. The final grades are expected to be approximately the same as the existing grades, except along the north end, where some minor cuts could be required. The construction depth of the services will be about 3 to 4 m.

3.0 METHOD OF INVESTIGATION

The scope of the investigation was agreed with the Client to consist of drilling six (6) boreholes to 6 m depth below existing grades. The boreholes were drilled on December 12 and 13, 1994, using a truck mounted power auger drill rig working under the supervision of a technician from our office. In the boreholes, soil samples were taken at 0.76 m intervals of depth using the standard penetration test (SPT) method. The samples were visually classified in the field and brought to our laboratory where they were re-examined by a senior engineer. Representative samples were selected for laboratory analyses which included natural moisture content tests and grain size analyses. The test results are summarized on the borehole logs and the grading curves are also plotted in Figure 1.

.../...

To evaluate the permeability of the soils, both percolation tests and in-situ falling head permeability tests were performed. The percolation tests were carried out in 125 mm diameter, 0.9 m deep uncased holes drilled about 1 m away from each of the boreholes. The holes were filled with water and the rate of drop of the water level was noted for about one hour. The holes were then again filled with water and the tests were repeated, either on the same day or the next day.

For the falling head permeability tests, six (6) 1.8 m deep, approximately 75 mm diameter holes were drilled about 2 m from the boreholes. A 50 mm I.D. slotted well screen was placed in each of the holes. The holes were then filled with water to the top. The drop in the water level was recorded at 5 to 10 minute intervals for about one hour or until the water level had dropped to the bottom of the holes. These tests were also repeated to ensure that consistent results were obtained.

The results of the above tests are shown in Table 1.

Enclosure 1 attached shows the approximate borehole locations. The boreholes were laid out in the field with the assistance of a preliminary site plan provided to us by Marshall Macklin Monaghan Ltd. (MMM). The exact borehole locations and elevations were later established by the surveyors of MMM.

..../...

4.0 SUBSURFACE CONDITIONS

Under 50 to 200 mm of topsoil, the boreholes encountered 2.6 to 3.7 m of silty sand overlying shale bedrock. There is a thin veneer of clay (possibly weathered rock) above the shale in Borehole 3.

The properties of the sand and the shale will be briefly described in the following paragraphs. For details of the subsurface conditions, reference should be made to the individual borehole logs, which are attached to this report as Enclosures 2 to 7 inclusive.

4.1 Silty Sand

The overburden material encountered in every borehole is a poorly graded silty fine sand with 18 to 31% silt. Several grading curves of this deposit are shown in Figure 1 attached to this report.

The results of the percolation and in-situ permeability tests performed in the sand are shown in Table 1 below. The percolation times varied between 2.0 and 5.3 minutes/cm (average 3.7 min./cm). The coefficient of permeability (k) obtained from the falling head permeability tests range from 6.4 to 10.9 x 10^{5} cm/sec.

The natural moisture contents of the sand vary from 2 to 22%.

Standard penetration blow counts of 4 to 44 blows per 0.3 m were recorded in the sand. These indicate very loose to dense, but mostly compact to dense conditions. The compactness condition of the sand increases with depth.

TABLE 1

RESULTS OF PERCOLATION AND FALLING HEAD PERMEABILITY TESTS

Borehole	1	2	3	4	5	6
Percolation Time 1st test (min/cm) 2nd test (min/cm)	 3.6 3.7	 3.9 4.3	 2.5 3.6	 2.0 3.6	 3.6 Caved	 5.3 4.3
Coefficient of Permeability (10^{3} cm/sec) 1st test 2nd test	 8.4 6.4	 10.5 10.9	 9.5 8.6	 7.9 9.1	 8.7 7.5	 8.3 7.6

4.2 Shale Bedrock

The boreholes encountered the surface of the shale bedrock at 2.6 to 3.7 m depth (El. 77.9 to 79.7 m). The shale in the area is known to be a red and grey shale belonging to the Queenston Formation. This is a weak, closely bedded shale with generally less than 10% limestone layers. The rock was not cored, but it was possible to penetrate with the augers 3.2 and 3.4 m into the shale in Boreholes 3 and 4 without encountering refusal. The other boreholes were terminated at shallower depths as soon as the presence of the shale was positively identified.

...../.....

In Borehole 3, there is a 0.2 m thick layer of silty clay above the shale. This material contains traces of gravel and could be completely weathered shale.

4.3 Groundwater Conditions

Shortly after drilling, groundwater was at 2.1 to 3.2 m depth (El. 79.0 to 80.5 m) in Boreholes 1, 2, 4 and 5. Borehole 3 was dry, but caved in at 1.8 m depth, and Borehole 6 was dry to 4.4 m depth. In the long term, fluctuation of the water level in response to the lake level and/or precipitation is expected.

5.0 DISCUSSION OF RESULTS

5.1 Engineering Evaluation of Subsurface Conditions

The subsurface profile at the site is relatively simple. It consists of 2.6 to 3.7 m of silty sand overlying shale bedrock.

The sand is generally compact to dense and should provide good support for the underground utilities and for the houses, provided that it is not disturbed during construction. In this non-cohesive soil unsupported excavations are expected to be stable at about 30° above the water table, but below the water table caving, unstable ground conditions will prevail. Therefore, where excavations extend below the groundwater level, the water level must be temporarily lowered. Based on the results of grain size analyses, it should be possible to dewater the sand by pumping from closely spaced well points. The well points should be surrounded with a graded granular filter to prevent the removal of fine soil particles during pumping. It may be necessary to seal the top of the sand wicks surrounding the well points with clay seals to increase their effectiveness. Alternatively, the excavation could be carried out inside close sheeting extended to the surface of the relatively impervious shale.

The sand is moderately frost susceptible and is rated as a fair subgrade material.

The shale should provide excellent support for utility pipes and building foundations. The top, weathered part of the shale can possibly be excavated by a powerful excavator equipped with narrow rock buckets and hardened cutters, or with rippers. However, where the shale contains hard limestone bands and for excavations which extend deep into the shale, it may be more expedient to use explosives to break down the shale. If blasting is required, the blasts must be carefully monitored to prevent damage to nearby structures and existing utilities. The peak particle velocity at any structure or pipe should not exceed 50 mm/sec.

5.2 Road Pavement

The pavement for the new roads should be designed for the appropriate traffic and a silty sand subgrade. The sand is a fair road subgrade material. It is fairly well drained and has a moderately high load supporting strength. However, it contains up to about 30% of soil fines (materials smaller than No. 200 Sieve) and is, therefore, frost susceptible. Its CBR value, when fully drained, is estimated to be about 10%.

.../...

The Town of Oakville's standard for residential roads calls for a pavement structure consisting of 100 mm asphalt, 150 mm Granular 'A' base, and 350 mm Granular 'B' subbase. This pavement structure should be satisfactory for this site.

5.3 Pipe Support

The pipes of underground utilities can be placed on the silty sand or the shale using granular bedding. Where the pipes are founded on shale, the thickness of the granular bedding material under the pipes should be increased to 300 mm to avoid unyielding support condition.

5.4 House Foundation

Both the silty sand and the shale should provide adequate bearing capacity for single family houses. Where the foundations are placed on the sand and below the water table, the sand must be stabilized by lowering the water table before attempting the excavation. The shale is a fissile material which, when exposed to air and water, will quickly deteriorate. If the shale is exposed for a long time before the concrete for the footings is poured, it is advisable to protect the shale surface with a skim coat of lean concrete.

5.5 Excavation

Above the water table, the sand can be excavated to about 30° to the horizontal at which angle it should remain stable during construction. Below the water table the sand would not be stable and will require temporary dewatering. The rate of seepage will depend on the

.../...

depth of the trench and the drawdown, but should be moderate to small due to the proximity of the shale bedrock. We estimate that for 1 m drawdown the rate of flow should be less than 10 litres per minute for every 10 m length of trench. Alternatively, the excavation can be supported by interlocking sheet piles driven into the shale to form a seal.

5.6 Reuse of Excavated Materials for Backfilling

The excavated sand can be reused to backfill the trenches. However, it may be necessary to adjust the moisture content of the sand (add water or allow it to drain) before using to achieve an adequate degree of compaction.

The excavated shale can also be reused, but the shale must be broken down into small pieces and placed in thin lifts and a heavy compactor would be required to compact the shale to a high density.

5.7 Construction Conditions

No unusual construction conditions are expected at this site. Temporary dewatering will be required if the excavations extend below the water table. Excavation of the shale may require blasting, depending on the depth of excavation, the proportion of hard layers in the shale, and the spacing of discontinuities in the rock. If blasting is required, the vibration should be closely monitored.

6.0 RECOMMENDATIONS

6.1 Pavement

The Town of Oakville's standard pavement for residential streets (40 mm HL3, 60 mm HL8, 150 mm Granular "A" base, 350 mm Granular 'B' subbase) should be adequate for this site.

Before laying down the granular subbase materials, all topsoil should be removed. The exposed subgrades should be surface compacted to a minimum 95% standard Proctor maximum dry density (SPMDD). The subbase and base materials should be compacted to 100% SPMDD.

6.2 Pipe Bedding

Underground pipes should be placed on granular bedding in accordance with OPSS. Only well graded material (i.e. Granular 'A') should be used as the bedding material, which should have a minimum thickness of 150 mm under the pipes. This minimum thickness should be increased to 300 mm where the pipes are laid on shale.

6.3 Footings

The house footings should be bearing on undisturbed soil or rock and should be provided with a minimum of 1.2 m of earth cover for frost protection.

Footings founded on undisturbed silty sand, at depths at least 1.5 m below the existing grades, can be designed for a tentative allowable bearing pressure of 150 kPa. As variations in the bearing capacity of the soil can be expected, the soil at footing level must be inspected during construction to verify the soil bearing pressure.

6.4 Compaction of Backfill

Backfill materials placed in trenches under roadways, walkways and other areas where long term settlement is to be avoided should be compacted to a minimum 95% SPMDD.

6.5 Soil Permeability

For the design of the storm water management system, the coefficient of permeability of the site soils can be taken as 10^{-4} cm/sec and the percolation time as 4 min/cm.

6.6 Lateral Earth Pressure

The lateral earth pressure shown in Figure 2 may be used for the design of flexible shoring for the support of excavations.

7.0 STATEMENT OF LIMITATION

The Statement of Limitation, as quoted in Appendix "A", is an integral part of this report.

GEO-CANADA LTD.

James Ng, P. Eng.

Ivan P. Lieszkowszky, P. Eng.

JN/IPL:sf

APPENDIX "A"

APPENDIX
"A"
Statement of Limitation

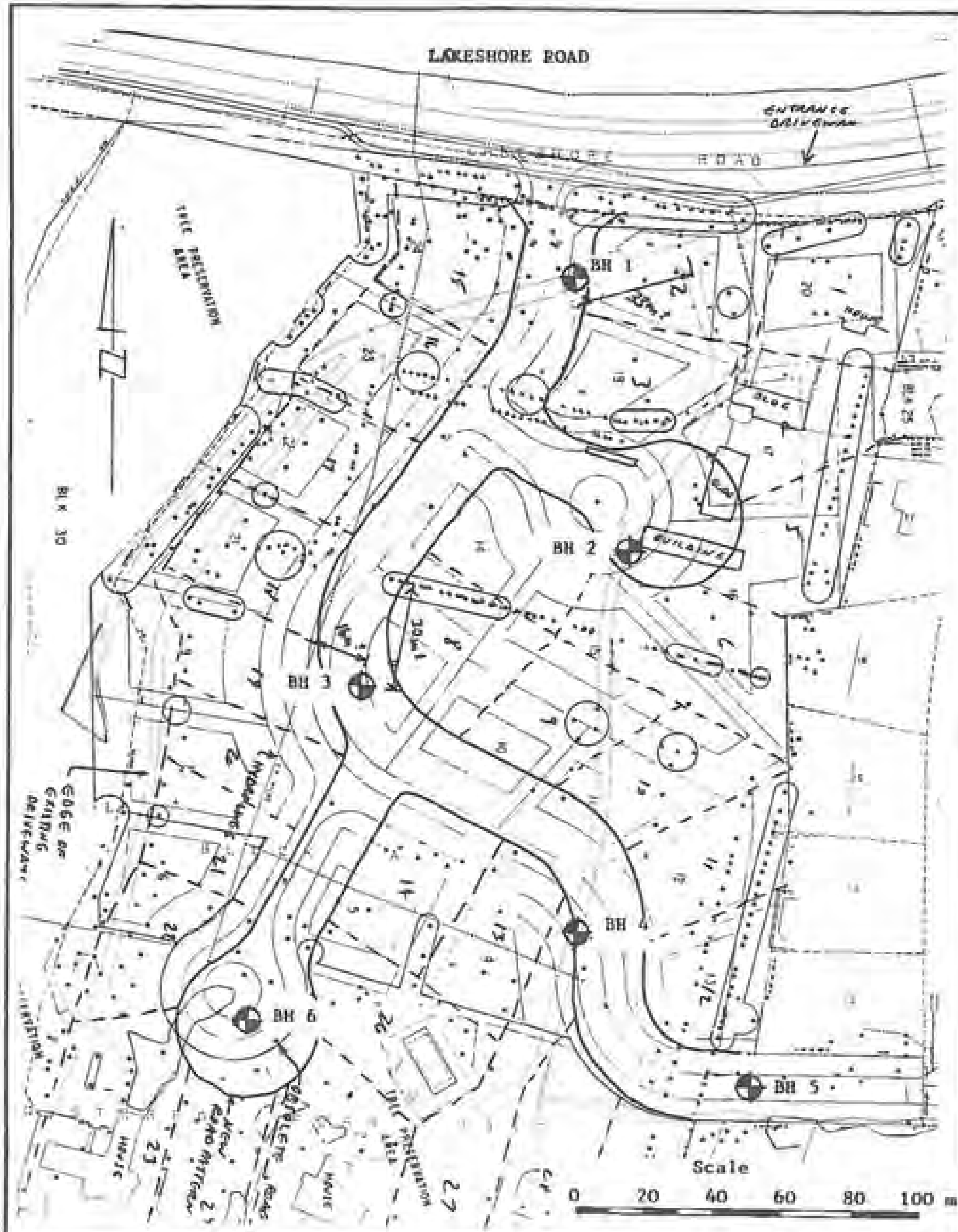
The conclusions and recommendations in this report are based on information determined at the borehole locations. Soil and groundwater conditions between and beyond the boreholes may differ from those encountered at the borehole locations, and conditions may become apparent during construction which could not be detected or anticipated at the time of the soil investigation.

The design recommendations given in this report are applicable only to the project described in the text, and then only if constructed substantially in accordance with details of alignment and elevations stated in the report. Since all details of the design may not be known to us, in our analysis certain assumptions had to be made. The actual conditions may, however, vary from those assumed, in which case changes and modifications may be required to our recommendations.

We recommend, therefore, that we be retained during the final design stage to review the design drawings and to verify that they are consistent with our recommendations or the assumptions made in our analysis. We recommend also that we be retained during construction to confirm that the subsurface conditions throughout the site do not deviate materially from those encountered in the boreholes. In cases where these recommendations are not followed, the company's responsibility is limited to interpreting accurately the information encountered at the boreholes.

The comments given in this report on potential construction problems and possible methods are intended only for the guidance of the design engineer. The number of boreholes may not be sufficient to determine all the factors that may affect construction methods and costs. The contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and draw their own conclusions as to how the subsurface conditions may affect their work.

ENCLOSURES



BOREHOLE LOCATION PLAN

G-94.1105

Encl. 1

GEO-CANADA LTD

LOG OF BOREHOLE ...1...

CLIENT: Marshall Macklin Monaghan Limited
PROJECT: Lisonally Farms Property Limited
LOCATION: Oakville
DATUM ELEVATION: Geodetic

DRILLING DATA
Method: Augering
Diameter: 100 mm
Date: December 12th, 13th, 1994

REF. NO.: G-94.1105
ENCL. NO.: 2

(m) ELEV DEPTH	SOIL PROFILE – DESCRIPTION	SAMPLE NUMBER	TYPE	'N' BLOWS/0.3 m	GROUND WATER CONDITIONS	ELEVATION SCALE	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
83.4	GROUND SURFACE						
0.0	50 mm topsoil SILTY SAND tr. of roots to 0.6 m brown loose to dense	1	SS	6		83	
		2	SS	13			0 82 18 –
		3	SS	16			
	wet	4	SS	38		81	0 69 31 –
					W.L. 80.3 m caved 94.12.13		
79.7		5	SS	40			
3.7	SHALE weathered red/grey weak	6	SS	[illegible] cm			
79.0 4.4	END OF BOREHOLE Auger Refusal						Date W.L.(m) Complet. Dry 5 hrs. later 80.3 next day 80.3

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100
SHEAR STRENGTH: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE
PLASTIC LIMIT W_P — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L
WATER CONTENT (%): 10 20 30
UNIT WEIGHT γ

GEO-CANADA LTD.

LOG OF BOREHOLE ...7...

CLIENT: Marshall Macklin Monaghan Limited
PROJECT: Lisonally Farms Property Limited
LOCATION: Oakville
DATUM ELEVATION: Geodetic

DRILLING DATA
Method: Augering
Diameter: 100 mm
Date: December 12th, 13th, 1994

REF. No.: G-94.1105
ENCL. No.: 3

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH ○UNCONFINED ●QUICK TRIAXIAL + FIELD VANE ▲ LAB VANE	PLASTIC LIMIT W_P — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L / WATER CONTENT(%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
(m) ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' BLOWS/0.3 m						
83.4	GROUND SURFACE										
0.0	100 mm topsoil SILTY SAND tr. of roots to 0.6 m brown loose to dense		1	SS	5		83				
			2	SS	19						
			3	SS	31						
			4	SS	35		81				
79.7	wet		5	SS	22	▼	W.L. 80.2 m caved 84.1 2.13				
3.7	SHALE weathered weak		6	SS	refusal						
78.8							79				
4.6	END OF BOREHOLE Auger Refusal * No change in 24 hours										

LOG OF BOREHOLE 3

CLIENT: Marshall Macklin Monaghan Limited
PROJECT: Lisonally Farms Property Limited
LOCATION: Oakville
DATUM ELEVATION: Geodetic

DRILLING DATA
Method: Augering
Diameter: 100 mm
Date: December 12th, 13th, 1994

REF. NO.: G-94.1103
ENCL. NO: 4

(m) ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' BLOWS/0.3 m	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE ▲ LAB VANE)	PLASTIC LIMIT W_P / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
82.6	GROUND SURFACE										
0.0	100 mm topsoil SILTY SAND brown very loose to compact		1	SS	4		82				
			2	SS	6						
			3	SS	27	caved 80.8 m 94.12.13					
79.9 2.7	SILTY CLAY, tr.gravel seam, weathered shale		4	SS	21		80				
79.7 2.9	SHALE weathered at surface red/grey weak		5	SS	100/8 cm						
			6	SS	100/9 cm						
			7	SS	100/6 cm		78				
			8	SS	[illegible]						
76.3			9	SS	100/3 cm						
6.3	END OF BOREHOLE										

GEO-CANADA LTD.

LOG OF BOREHOLE 4

CLIENT: Marshall Macklin Monaghan Limited
PROJECT: Lisonally Farms Property Limited
LOCATION: Oakville
DATUM ELEVATION: Geodetic

DRILLING DATA
Method: Augering
Diameter: 100 mm
Date: December 12th, 13th, 1994

REF. No: G-94.1103
ENCL. No: 5

(m) ELEV / DEPTH	SOIL PROFILE: DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: 'N' BLOWS / 0.3 m	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT W_P / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
81.9	GROUND SURFACE										
0.0	125 mm topsoil SILTY SAND some gravel to 0.6 m brown loose to dense		1	SS	9						
			2	SS	23		81				
	some coarse sand seams		3	SS	44	W.L. 79.8 m Caved 94.12.13					
79.2			4	SS	60						
2.7	SHALE weathered at surface		5	SS	100/ 14 cm		79				
	grey weak		6	SS	100/ 9 cm						
			7	SS	100/ 6 cm		77				
			8	SS	refusal						
75.8			9	SS	100/ 3 cm						
6.1	END OF BOREHOLE										Date W.L.(m) Compl. 78.4 17 hrs. 79.8 later

GEO-CANADA LTD.

LOG OF BOREHOLE 5

CLIENT: Marshall Macklin Monaghan Limited
PROJECT: Lisonally Farms Property Limited
LOCATION: Oakville
DATUM ELEVATION: Geodetic

DRILLING DATA
Method: Augering
Diameter: 100 mm
Date: December 12th, 13th, 1994

REF. NO: G-94.1105
ENCL. NO: 6

SOIL PROFILE (m) ELEV / DEPTH	DESCRIPTION	SAMPLES NUMBER	TYPE	'N' BLOWS / 0.3 m	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	WATER CONTENT (%) 10 20 30 (PLASTIC LIMIT W_P, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
81.4	GROUND SURFACE									
0.0	200 mm topsoil SILTY SAND brown loose to dense	1	SS	9		81				
		2	SS	10						
	wet	3	SS	31						0 70 30 –
					W.L. 79.0 m caved 94.1 2.34					
		4	SS	40						
77.9		5A/5B	SS	60/ 28 cm						
3.5	SHALE weathered at surface grey weak	6	SS	100/10 cm						
						77				
		7	SS	50/ 5 cm						
76.2		8	SS	100/3 cm						
5.2	END OF BOREHOLE									Date W.L.(m) Compl. 4 hrs. 79.0 later 2> hrs. 79.0 later

GEO-CANADA LTD.

LOG OF BOREHOLE 6

CLIENT: Marshall Macklin Monaghan Limited
PROJECT: Lisonally Farms Property Limited
LOCATION: Oakville
DATUM ELEVATION: Geodetic

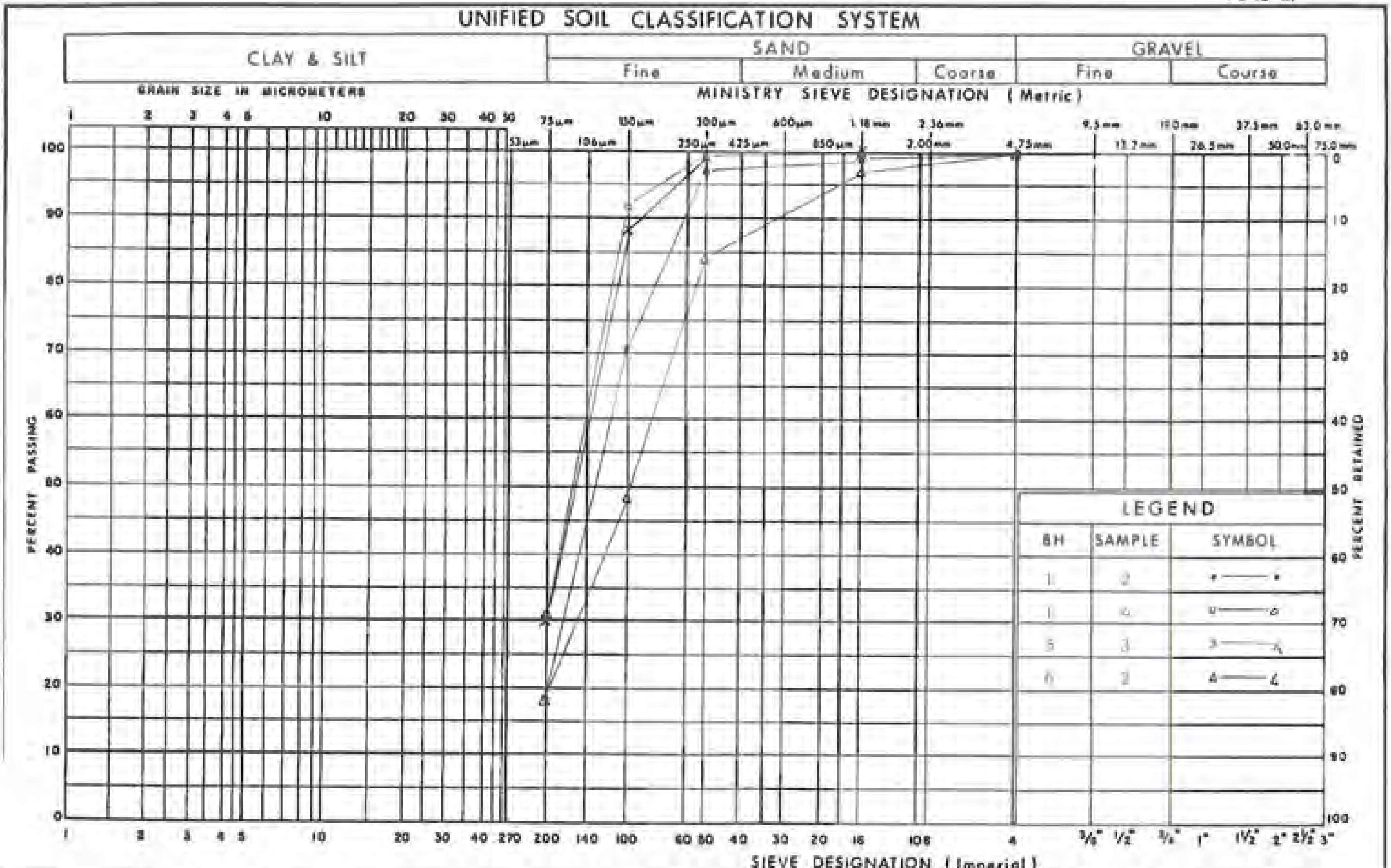
DRILLING DATA
Method: Augering
Diameter: 100 mm
Date: December 12th, 13th, 1994

REF. No.: G-94.1105
ENCL. No.: 7

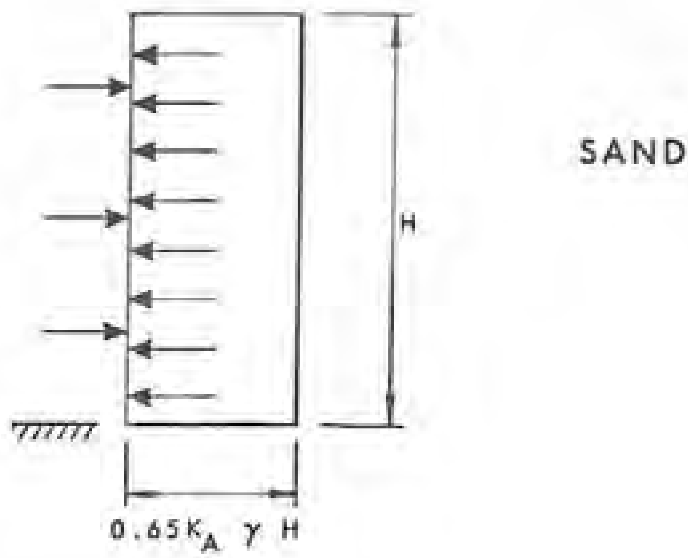
(m) ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' BLOWS/0.3 m	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH (○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE)	PLASTIC LIMIT W_P — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L / WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
82.0	GROUND SURFACE										
0.0	75 mm topsoil SILTY SAND tr. of roots to 0.6 m brown loose to dense		1	SS	5						
			2	SS	8						0 82 18 –
			3	SS	13		80				
79.4			4 A/B	SS	75						
2.6	SHALE weathered at surface grey weak		5	SS	100/	3 cm					
			6	SS	100/	4 cm	78				
							Caved 77.8 m 94.12 18				
77.4			7	SS	100/	4 cm					
4.6	END OF BOREHOLE										

GEO-CANADA LTD.

78 12 M



GEO-CANADA	GRAIN SIZE DISTRIBUTION SILTY FINE SAND	FIG No 1 G-94.1105 January 1995



$K_A = 0.3$

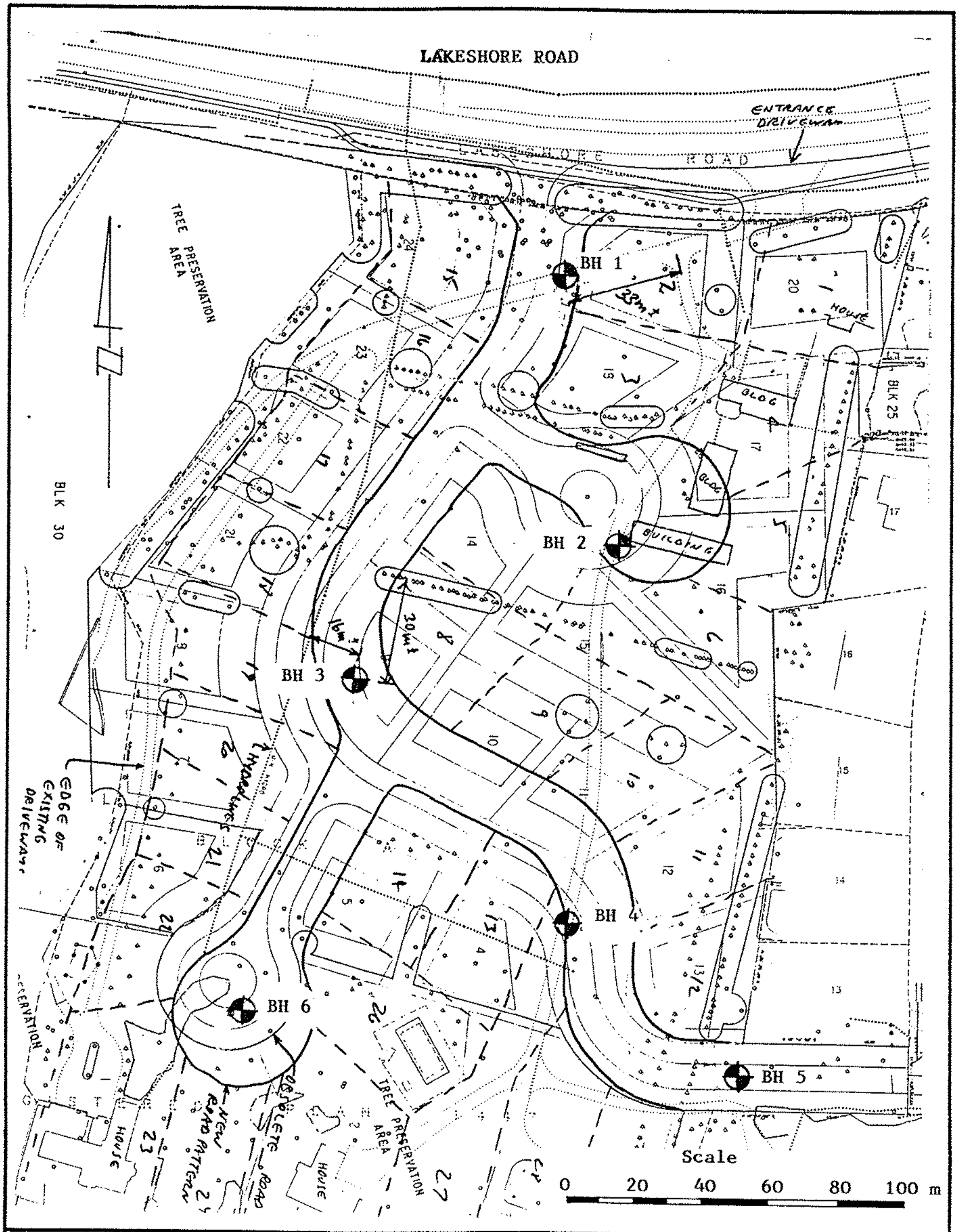
$\gamma = 20.0\ kN/m^3$

NOTES:

1. CHECK SYSTEM FOR PARTIAL EXCAVATION CONDITION
2. IF THE FREE WATER LEVEL IS ABOVE THE BASE OF THE EXCAVATION THE HYDROSTATIC PRESSURE MUST BE ADDED TO THE ABOVE PRESSURE DISTRIBUTION IN SANDS
3. IF SURCHARGE LOADINGS ARE PRESENT AT OR NEAR THE GROUND SURFACE THESE MUST BE INCLUDED IN THE LATERAL PRESSURE CALCULATION.

EARTH PRESSURE DISTRIBUTION ON BRACED SHEETING	G-94.1105 FIGURE 2

GEO-CANADA LTD.



BORHOLE LOCATION PLAN	G-94.1105 Encl. 1

GEO-CANADA LTD.

BOREHOLE LOGS

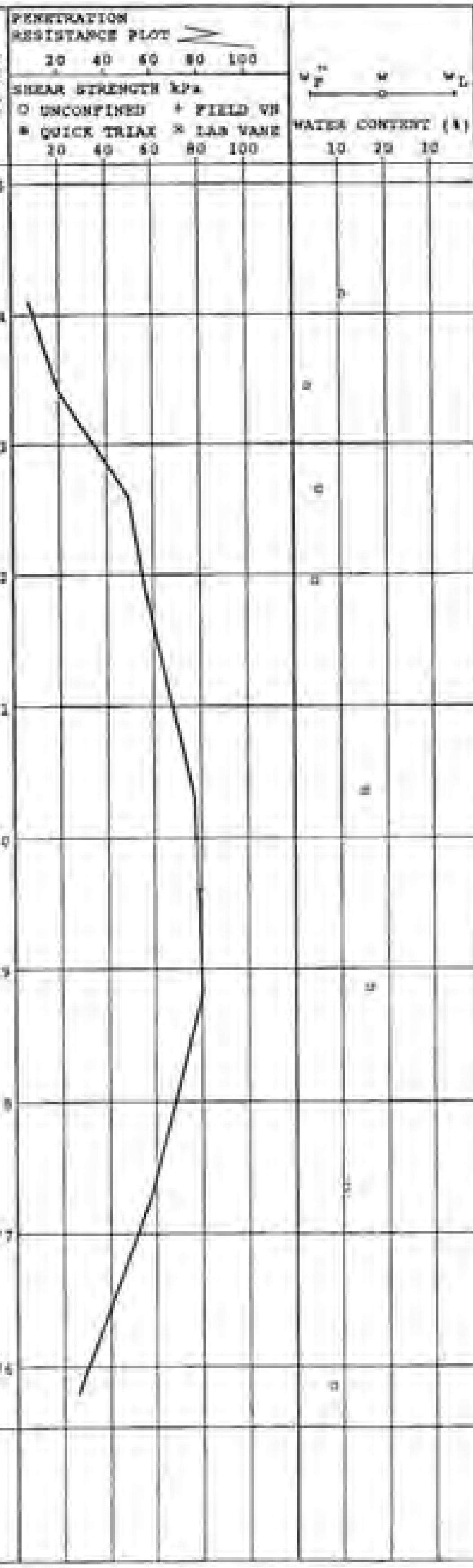
Terraprobe

Terraprobe

LOG OF BOREHOLE 1

PROJECT: Hindmarsh Estate | DATE: 95.03.14 &
LOCATION: Lakeshore Rd, Oakville | EQUIPMENT: CME 75
CLIENT: Trafalgar Engineering Ltd. | ELEVATION DATUM: Geodetic | FILE: 95134

ELEV / DEPTH	SOIL PROFILE – DESCRIPTION	SAMPLE NUMBER	TYPE	N VALUES	ELEVATION SCALE	REMARKS & GRAIN SIZE DISTR. (%) GR SA SI CL
85.2 / 0.0	250mm TOPSOIL over red-brown sand. Reddish Brown, Loose, moist SILTY SAND				85	
		1	SS	7	84	
84.0 / 1.2	Brown, Compact to Very Dense, Damp SAND, trace to some silt.	2	SS	20	83	
		3	SS	49		
		4	SS	56	82	01-79-12-08
80.9 / 4.3	Brown, Very Dense, damp SILTY SAND TO SAND AND SILT				81	
		5	SS	77	80	00-52-37-11
		6	SS	80	79	
78.2 / 7.0	Grey, Hard, moist CLAYEY SILT, trace to some gravel. -grading into a highly weathered shale.				78	
		7	SS	58	77	
		8	SS	26	76	
75.6 / 9.6	End of Borehole					



NOTES:
Borehole caving at 8.2m depth and dry on completion of drilling. Water level in standpipe at 5.2m depth on March 24, 1995.

Sheet 1 of 1

Terraprobe

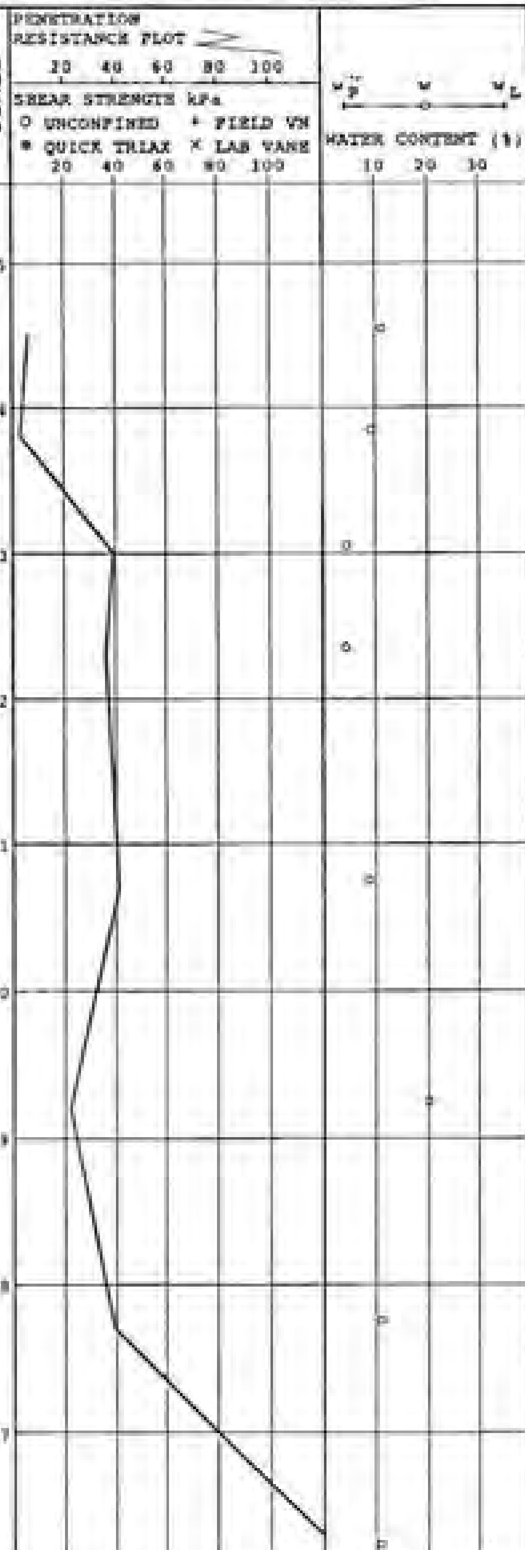
LOG OF BOREHOLE 2

PROJECT: Hindmarsh Estate — DATE: 95.03.16 &

LOCATION: Lakeshore Rd, Oakville — EQUIPMENT: CME 75

CLIENT: Trafalgar Engineering Ltd. — ELEVATION DATUM: Geodetic — FILE: 95134

SOIL PROFILE ELEV DEPTH	DESCRIPTION	SAMPLES NUMBER	TYPE	N VALUES	ELEVATION SCALE	REMARKS & GRAIN SIZE DISTR. (%) GR SA SI CL
85.6 / 0.0	220mm TOPSOIL over dark brown to reddish brown sand.				85	
	Reddish Brown, Loose to Dense, moist	1	SS	6		
		2	SS	3	84	
	SAND, trace to some silt.	3	SS	39	83	
		4	SS	36		01-78-13-08
					82	
		5	SS	41	81	04-60-27-09
					80	
	-becoming wet at 6.1m	6	SS	22	79	
78.6 / 7.0	Grey, Hard, moist				78	
	CLAYEY SILT, trace to some gravel.	7	SS	39	77	
	-grading into a highly weathered shale	8	SS	120		
76.2 / 9.4	End of Borehole					



NOTES:
Borehole caving at 5.8m and water level at 6.1m depth on completion of drilling. Water level in standpipe at 6.6m depth on March 24, 1995.

Terraprobe

LOG OF BOREHOLE 3

PROJECT: Hindmarsh Estate
LOCATION: Lakeshore Rd, Oakville
CLIENT: Trafalgar Engineering Ltd.
DATE: 95.03.16 &
EQUIPMENT: CME 75
ELEVATION DATUM: Geodetic
FILE: 95134

SOIL PROFILE			SAMPLES			WATER CONDITIONS	ELEVATION SCALE	PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE; 20 40 60 80 100)	w_P — w — w_L WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTR. (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRATA	NUMBER	TYPE	N VALUES						
87.7 / 0.0	150mm TOPSOIL over brown silty sand.										
	Reddish Brown, Dense, damp		1	SS	11		87				00-89-06-05
			2	SS	21		86				
	SAND, trace to some silt.		3	SS	28		85				00-82-13-05
			4	SS	31		84				
83.6 / 4.1	Brown, Dense, wet, SILTY SAND		5	SS	33		83				
82.7 / 5.0	End of Borehole										

NOTES:
Borehole open and water level at 4.1m depth on completion of drilling. Water level in standpipe at 4.2m depth on March 24, 1995.

Terraprobe

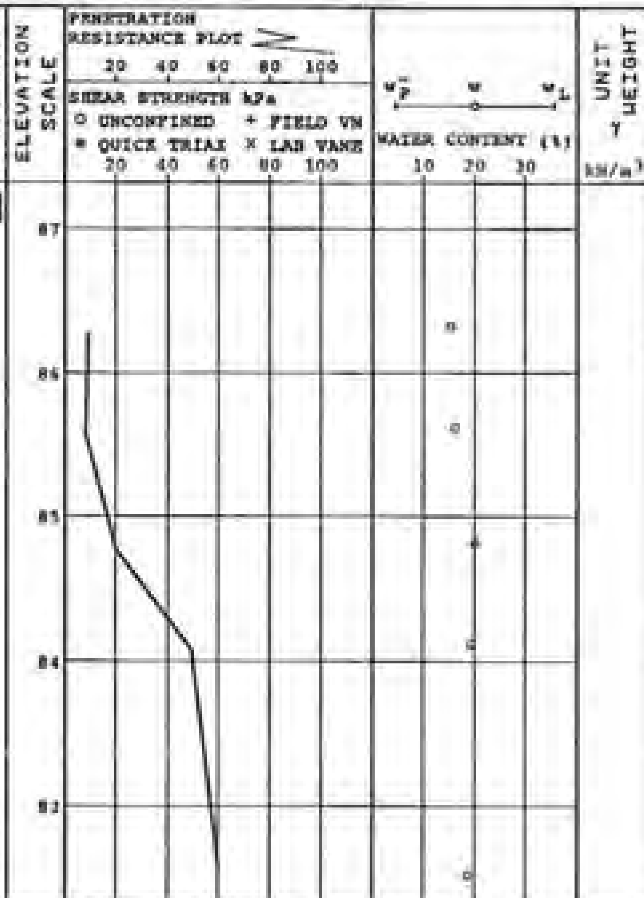
LOG OF BOREHOLE 4

PROJECT: Bindmarsh Estate
DATE: 95.03.16 &

LOCATION: Lakeshore Rd, Oakville
EQUIPMENT: CME 75

CLIENT: Trafalgar Engineering Ltd.
ELEVATION DATUM: Geodetic
FILE: 95134

ELEV DEPTH	DESCRIPTION (SOIL PROFILE)	STRATA	NUMBER (SAMPLES)	TYPE (SAMPLES)	N VALUES (SAMPLES)	WATER CONDITIONS	REMARKS & GRAIN SIZE DISTR. (%) GR SA SI CL
87.3 0.0	150mm TOPSOIL over brown silty sand						
	Reddish Brown Loose to Very Dense moist to wet		1	SS	9		00-82-10-08
	SAND		2	SS	8		
			3	SS	20		
	-changing to sand and silt with depth.		4	SS	49		
			5	SS	60		
82.3 5.0	End of Borehole						



NOTES:
Borehole caving at 3.0m and water level at 2.4m depth on completion of drilling. Water level in standpipe at 2.2m depth on March 24, 1995.

Sheet 1 of 1

Terraprobe

LOG OF BOREHOLE 5

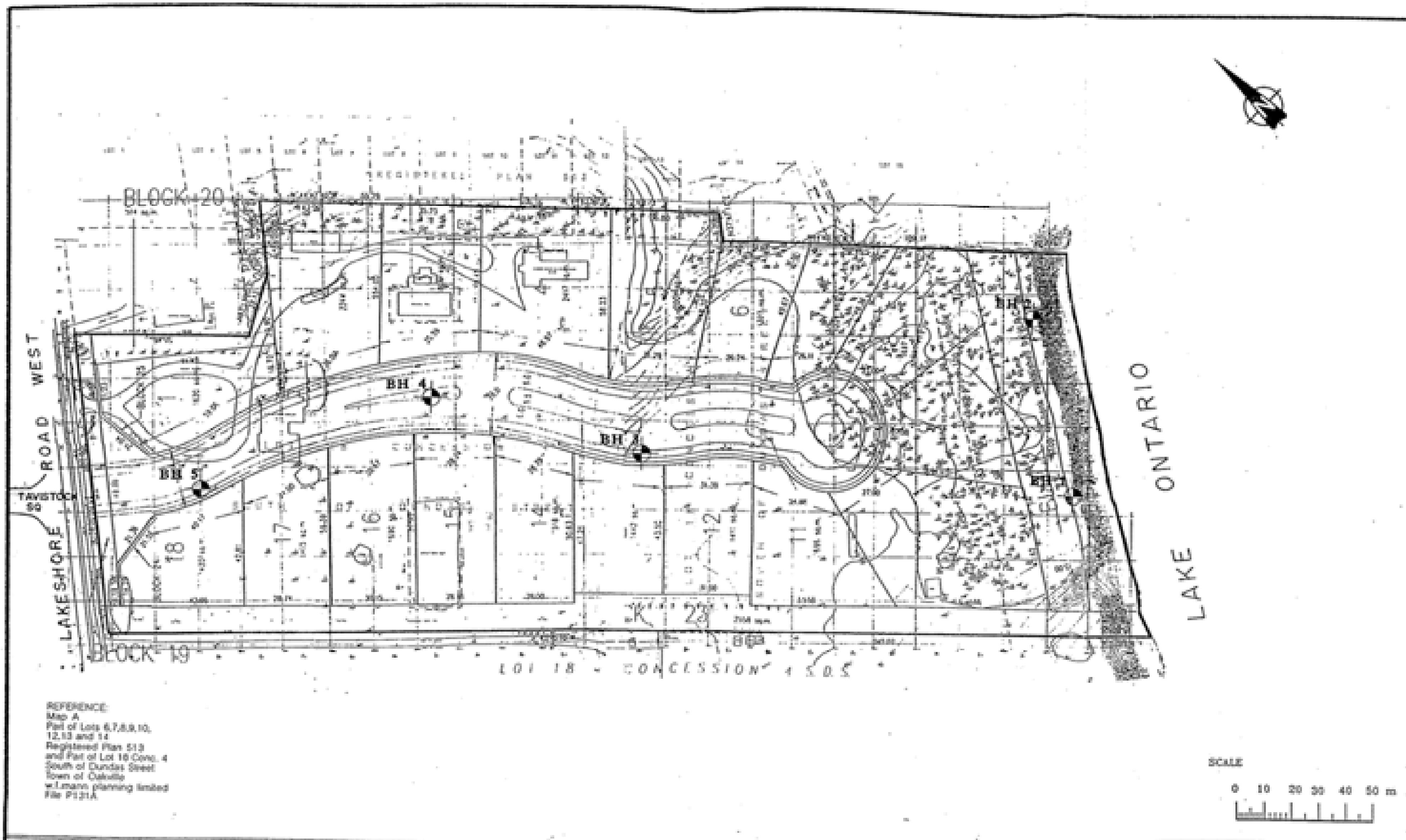
PROJECT: Hindmarsh Estate — DATE: 95.03.16 &

LOCATION: Lakeshore Rd, Oakville — EQUIPMENT: CME 75

CLIENT: Trafalgar Engineering Ltd. — ELEVATION DATUM: Geodetic — FILE: 95134

ELEV DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	N VALUES	REMARKS & GRAIN SIZE DISTR. (%) GR SA SI CL
89.5 / 0.0	TOPSOIL. SAND, trace to some silt. Reddish Brown, Compact to Dense, moist	1	SS	12	
		2	SS	41	00-90-03-07
		3	SS	45	
86.6 / 2.9	SILTY SAND. Reddish Brown, Compact to Very Dense, wet	4	SS	24	
		5	SS	61	
84.5 / 5.0	End of Borehole				

NOTES:
Borehole caving at 3.8m and water level at 3.2m depth on completion of drilling. Water level in standpipe at 3.4m depth on March 24, 1995.



BOREHOLE LOCATION PLAN

TERRAPROBE

File No. 95134

FIGURE 2

R-305-95

LAKESHORE ROAD RECONSTRUCTION
BRONTE ROAD TO RIGG ROAD
OAKVILLE, ONTARIO
(PRELIMINARY REPORT)

Prepared for
TOWN OF OAKVILLE.

Prepared by

SHAHEEN & PEAKER LIMITED

Project: SP973
July 13, 1995

250 Galaxy Boulevard
Etobicoke, Ontario
M9W 5R8
Tel: (416) 213-1255
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Table of Contents

1. Introduction

Shaheen & Peaker Limited was retained by the Corporation of the Town of Oakville to undertake a geotechnical investigation for the reconstruction of Lakeshore Road between Bronte Road and Riggs Road in Oakville, Ontario. The investigation was authorized by Mr. D.A. Bloomer of the Corporation of the Town of Oakville.

It is understood that Lakeshore Road will undergo reconstruction of the curbs, gutter, boulevards and sidewalks as well as installation of new water mains, sanitary sewers and possibly a storm sewer. Pavement in the trench areas will be reinstated and the entire roadway will be resurfaced with an asphaltic concrete overlay.

The purpose of this investigation was to determine the subsurface conditions at 7 borehole locations to a depth of about 6 m and 4 probeholes to 0.9 m. Based on the findings in the boreholes engineering recommendations were to be made for the installation of the underground services and pavement rehabilitation were to be provided.

This report is provided on the basis of the terms of reference presented above and on the assumption that the design will be in accordance with the applicable codes and standards. If there are any changes in the design features relevant to the geotechnical analyses, or if any questions arise concerning the geotechnical aspects of the codes and standards , this office should be contacted to review the design. It may then be necessary to carry out additional borings and reporting before the recommendations of this office can be relied upon.

2. Procedure

Seven boreholes were drilled to a depths ranging from 2.3 to 3.3 m and 4 probeholes to 0.9 m with solid stem continuous flight auger equipment by a drilling sub-contractor under the direction and supervision of Shaheen & Peaker Limited personnel. Samples were retrieved at regular intervals with a 50 mm O.D. split-barrel sampler driven with a hammer weighing 624 N and dropping 760 mm. The samples were logged in the field and returned to the Shaheen & Peaker Limited laboratory for detailed examination by the project engineer and testing.

Water level observations were made during drilling and in the open boreholes at the completion of the drilling operations. Piezometers were installed at the bottom of boreholes 12, 14, and 16 for long term water level observations.

The surveying of the borehole locations was undertaken by Shaheen & Peaker Limited personnel.

As well as visual examination in the laboratory, all of the soil samples were tested for moisture content and selected samples for natural unit weight determinations.

Falling weight deflectometer testing was carried out along the whole length of this section of Lakeshore Road.

3. Subsurface Conditions

The approximate borehole locations are shown on Drawing 1 and detailed subsurface conditions are presented on the borehole logs, Drawings 14 to 24. These are summarized as follows.

The pavement structure at the borehole locations consists of about 100 to 190 mm of asphaltic concrete overlying granular base materials or concrete. The concrete layer was found in all boreholes except boreholes 11, 12, PH4 and 13 and ranged in thickness from 125 to 250 mm. The granular base material was from 165 to 200 mm thick and consisted primarily of silty sand with gravel.

The actual conditions at each borehole location are summarized below:

Borehole	Asphaltic Concrete (mm)	Concrete (mm)	Granular Base (mm)
11	100	0	200
PH3	100	180	0
12	115	0	165
PH4	125	0	230
13	115	0	190
14	190	190	0
PH5	165	125	0
15	200	125	0
16	165	190	0
PH6	175	150	0
17	125	250	0

Fill, ranging in thickness from 0.5 to 1.3 m was encountered under the pavement structure in all boreholes except Borehole PH5; although a thin layer of fill is probably present under the pavement structure at this location. The fill was in a loose to compact state and consisted of a heterogeneous mixture of clayey silt to sandy silt with. The colour of the fill was brown and topsoil staining was common.

Underlying the fill was very stiff to hard clayey silt till of the Halton Formation to depths of 1.9 to 2.7 m. In borehole 16 the lower levels of the till consisted primarily of shale fragments.

The till was found to overlie very dense shale bedrock of the Queenston Formation. This rock was noted to contain occasional seams of reworked till in the upper levels of some boreholes and was red brown with olive coloured interlayers.

Water seepage was not observed during drilling and all of the boreholes were dry and open to almost their full depths at the completion of drilling.

4. Excavations

Excavation of the soil in the water main and sanitary and storm sewer trenches can be carried out with heavy hydraulic backhoes after the concrete pavement is cut and removed. It is expected that the shale encountered in the lower levels of Boreholes 2 to 6 can also be excavated with hydraulic backhoes, however, ripping teeth may be required. The bedrock may contain limestone or sandstone layers. Where these are encountered it will be necessary to use pneumatic rock hammers to break up the rock.

Clayey silt till was encountered in the boreholes. Till is a non-sorted sediment and therefore may contain boulders. Provisions must be made in the excavation contract for the removal of possible boulders. Similarly boulders and other unforeseen obstructions may be present in the fill.

Problems with groundwater are not anticipated. It is expected that water seepage which may occur during wet periods can be controlled by pumping from sumps.

All temporary excavations must be undertaken in accordance with the most recent Occupational Health and Safety Act. The fill should be classified as Type 3 soil and the till and shale are considered to be Type 1 soil.

If sheet piling is being considered to support the temporary excavation then the following design values are considered applicable:

Earth pressure	$K_a = 0.25$
Soil unit weight	$\gamma = 22\ kN/m^3$

The pressure distribution should be in accordance with the Canadian Foundation Engineering Manual, 3rd Edition (CFEM)

5. Backfill

The excavated fill, clayey silt till and shale bedrock can be used as construction backfill. Any obvious topsoil layers should be removed prior to reuse of these materials. Compaction of these materials can best be carried out with vibratory sheepsfoot type compactors. Loose lifts of fill and till which are to be compacted should not exceed 200 mm. The shale should probably be compacted in very thin lifts of about 100 mm. This is to ensure that the shale is adequately broken up. It is suggested that trial fill strips be undertaken at the start of the job to determine the optimum lift thickness and the suitability of the compaction equipment to compact the shale.

Trench backfill should be compacted to at least 95 percent standard Proctor maximum dry density to within 0.6 m of the top of the subgrade and then to 98 percent standard Proctor maximum dry density to the subgrade level.

Class B bedding should be adequate to support the pipes.

6. Pavements

The falling weight deflectometer test result were not available at the time of this preliminary report. The pavement overlay requirements will be provided in the final report.

The recommended pavement structures for reinstating the pavement at service trenches provided in Table 1 are based upon MTO guidelines for pavements assuming an AADT of 2000. An estimate of the subgrade soil properties was determined from visual examination and textural classification of the soil samples. Based on the anticipated subgrade conditions which are expected to consist of clayey silt to sandy silt, the granular base equivalency should be at least 700 mm.

TABLE 1

Recommended Pavement Structure Thicknesses

Pavement Layer	Compaction Requirements	Thickness
Asphaltic Concrete	97% Marshall Density	40 mm OPSS HL 3 80 mm OPSS HL 8
OPSS Granular A Base (Crushed Limestone)	100% SPMDD	150 mm
OPSS Granular B Sub-base	100% SPMDD	650 mm

* Denotes Standard Proctor Maximum Dry Density, ASTM-D698

The long term performance of the pavement structure is highly dependent upon the subgrade support conditions. Stringent construction control procedures should be maintained to ensure uniform subgrade moisture and density conditions are achieved. In addition, the need for adequate drainage cannot be over-emphasized. The finished pavement surface and underlying subgrade should be free of depressions and should be sloped to provide effective surface drainage toward catch basins

7. Corrosion

Soil samples are being tested for corrosion testing and the test results were not ready at the time of this preliminary report and will be included in the final report

Due to variable soil conditions as well as potential changes in the soil conductivity due to excavation and backfill and possible salt contamination, the requirement for corrosion protection cannot adequately be predicted.

It is suggested that the corrosion protection be based on the requirements of the City of Scarborough, Public Utilities. These requirements have been adopted by other municipalities

Copper piping should be protected with 5.5 kg (12 lb.) packaged zinc anodes which are installed at a spacing of 20 m. The anode should be connected to copper water service pipes with an approved clamp or soldered, and the solder should be given adequate coating of T.C. Mastic. The anodes should be parallel to the service at a minimum clearance of 400 mm.

For PVC pipes one 5.5 kg (12 lb.) packaged zinc anode should be installed on each cast iron fitting. As well one 2.7 kg (6 lb.) bare zinc anode should be installed in each valve chamber and the anode should be cad welded to the valve body and laced horizontally on the chamber floor. If the valve chambers are effectively sealed so that the chambers are free of water at all times, corrosion protection is not required.

Fire hydrants should be protected with one 10.9 kg (24 lb.) packaged zinc anode with each hydrant set. The anode should be cad welded to the gate valve and connected to the hydrant boot and tee with #8 copper bonding wire. Bonding to the tee is not required if an anchor tee is used.

8. Environmental Considerations

Three selected soil samples are being tested for MOEE Clean-up guidelines to asses the chemical characteristic of the soil for reuse and disposal purposes.

These test result were not ready at the time of this preliminary report and will be included in the final report.

9. General Comments

Shaheen & Peaker Limited should be retained for a general review of the final design and specifications to verify that this report has been properly interpreted and implemented. If not accorded the privilege of making this review, Shaheen & Peaker Limited will assume no responsibility for interpretation of the recommendations in the report.

The comments given in this report are intended only for the guidance of design engineers. The number of boreholes required to determine the localized underground conditions between boreholes affecting construction costs, techniques, sequencing, equipment, scheduling, etc., would be much greater than has been carried out for design purposes. Contractors bidding on or undertaking the works should, in this light, decide on their own investigations, as well as their own interpretations of the factual borehole results, so that they may draw their own conclusions as to how the subsurface conditions may affect them.

The information in this report in no way reflects on the environmental aspects of the soil and has not been addressed in this report, since this aspect is beyond the scope and terms of reference. Should specific information be required, additional testing may be required.

We trust that the information contained in this report is satisfactory. Should you have any questions, please do not hesitate to contact this office.

Shaheen & Peaker Limited

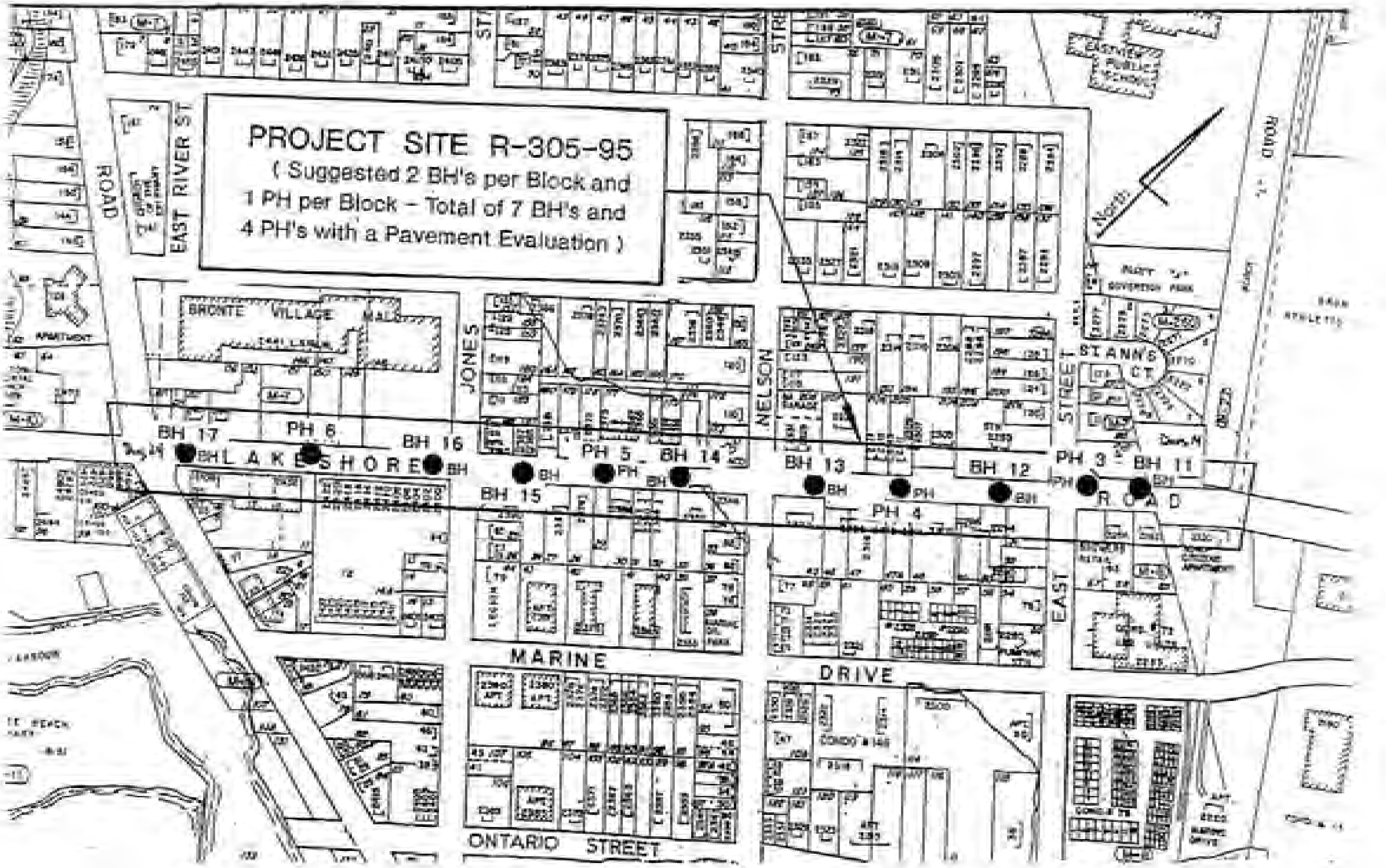
H Lohse
Holger Lohse, P.Eng.

Shaheen A. Ahmad, M.A.Sc., P.Eng

Report distribution
Corporation of the Town of Oakville (3 copies)

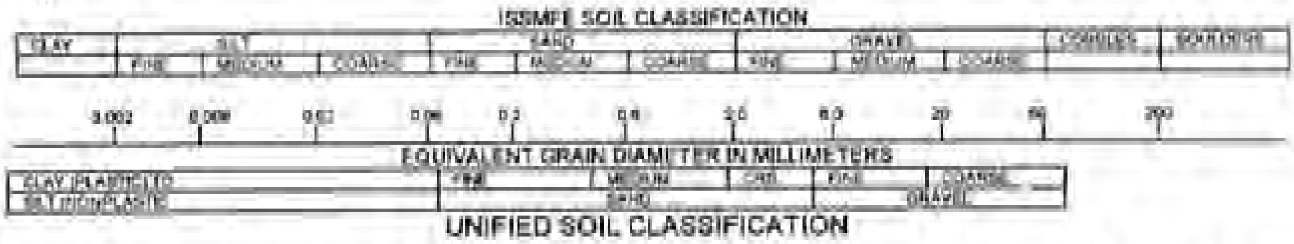
HL/M

Drawings


PROJECT SITE R-305-95
(Suggested 2 BH's per Block and
1 PH per Block - Total of 7 BH's and
4 PH's with a Pavement Evaluation)
North
EAST RIVER ST
ROAD
JONES
NELSON
STREET
EAST
LAKESHORE
ROAD
MARINE
DRIVE
ONTARIO STREET
BRONTE VILLAGE MALL
EASTVIEW PUBLIC SCHOOL
ST ANN'S CT
BH 17
PH 6
BH 16
BH 15
PH 5
BH 14
BH 13
PH 4
BH 12
PH 3
BH 11

Notes On Sample Descriptions Drawing 1A

1. All sample descriptions included in this report follow the Canadian Foundations Engineering Manual soil classification system. This system follows the standard proposed by the International Society for Soil Mechanics and Foundation Engineering. Laboratory grain size analyses provided by Shaheen & Peaker Limited also follow the same system. Different classification systems may be used by others; one such system is the Unified Soil Classification. Please note that, with the exception of those samples where a grain size analysis has been made, all samples are classified visually. Visual classification is not sufficiently accurate to provide exact grain sizing or precise differentiation between size classification systems.



2. Fill: Where fill is designated on the borehole log it is defined as indicated by the sample recovered during the boring process. The reader is cautioned that fills are heterogeneous in nature and variable in density or degree of compaction. The borehole description may therefore not be applicable as a general description of site fill materials. All fills should be expected to contain obstruction such as wood, large concrete pieces or subsurface basements, floors, tanks, etc., none of these may have been encountered in the boreholes. Since boreholes cannot accurately define the contents of the fill, test pits are recommended to provide supplementary information. Despite the use of test pits, the heterogeneous nature of fill will leave some ambiguity as to the exact composition of the fill. Most fills contain pockets, seams, or layers of organically contaminated soil. This organic material can result in the generation of methane gas and/or significant ongoing and future settlements. Fill at this site may have been monitored for the presence of methane gas and, if so, the results are given on the borehole logs. The monitoring process does not indicate the volume of gas that can be potentially generated nor does it pinpoint the source of the gas. These readings are to advise of the presence of gas only, and a detailed study is recommended for sites where any explosive gas/methane is detected. Some fill material may be contaminated by toxic/hazardous waste that renders it unacceptable for deposition in any but designated land fill sites; unless specifically stated the fill on this site has not been tested for contaminants that may be considered toxic or hazardous. This testing and a potential hazard study can be undertaken if requested. In most residential/commercial areas undergoing reconstruction, buried oil tanks are common and are generally not detected in a conventional geotechnical site investigation.

3. Till: The term till on the borehole logs indicates that the material originates from a geological process associated with glaciation. Because of this geological process the till must be considered heterogeneous in composition and as such may contain pockets and/or seams of material such as sand, gravel, silt or clay. Till often contains cobbles (60 to 200 mm) or boulders (over 200 mm). Contractors may therefore encounter cobbles and boulders during excavation, even if they are not indicated by the borings. It should be appreciated that normal sampling equipment cannot differentiate the size or type of any obstruction. Because of the horizontal and vertical variability of till, the sample description may be applicable to a very limited zone; caution is therefore essential when dealing with sensitive excavations or dewatering programs in till materials.

Project No. SP973

Log of Borehole 11

Dwg No. 14

Sheet No. 1 of 1

Project: Road Construction Program

Location: Oakville, Ontario - Lakeshore Road

Date Drilled: July 10, 1995

Drill Type:

Datum: Geodetic

Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Field Vane Test
Sensitivity
Piezometric Water Level

Combustible Vapour Reading
Natural Moisture
Plastic and Liquid Limit
Undrained Triaxial at % Strain at Failure
Penetrometer

SWL	SYMBOL	Soil Description	ELEV. m	DEPTH	N Value (20 40 60 80) / Shear Strength MPa (0.1 0.2)	Combustible Vapour Reading (ppm) 250 500 750 / Natural Moisture Content % Atterberg Limits (% Dry Weight) 10 20 30	Natural Unit Weight kN/m3
		~100 mm Asphaltic Concrete ~200 mm Granular Base: grey sand and gravel **FILL**: sandy silt to clayey silt, occasional gravel sizes, topsoil staining at 0.8 m, brown to dark brown, moist, loose	0.0 -1.3	0 1			
		CLAYEY SILT TILL: trace of gravel, shale fragments, red brown, moist, hard	-2.6	2	50/75 mm		
		SHALE: red brown with olive seams, very dense	-3.2	3	50/150 mm		
		End of Borehole					

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WATER LEVEL RECORD

Time	Water Level (m)	Depth to Cave (m)
on completion	dry	3.0

Log of Borehole PH3

Project No. SP973

Dwg No. 15

Sheet No. 1 of 1

Project: Road Construction Program

Location: Oakville, Ontario - Lakeshore Road

Date Drilled: July 10, 1995

Drill Type:

Datum: Geodetic

Auger Sample	⊠
SPT (N) Value	○ ⊠
Dynamic Cone Test	—
Shelby Tube	■
Field Vane Test	+
Sensitivity	s
Piezometric Water Level	▼
Combustible Vapour Reading	□
Natural Moisture	×
Plastic and Liquid Limit	⊢—⊙
Undrained Triaxial at % Strain at Failure	⊕
Penetrometer	▲

G.W.L.	SYMBOL	Soil Description	ELEV m	DEPTH	N Value (20, 40, 60, 80); Shear Strength MPa (0.1, 0.2)	Combustible Vapour Reading (ppm) (250, 500, 750); Natural Moisture Content %, Atterberg Limits (% Dry Weight) (10, 20, 30)	Natural Unit Weight kN/m3
			0.0	0			
		*100 mm Asphaltic Concrete *180 mm Concrete FILL: silt, some gravel trace of sand, dark brown, moist					
			-0.9				
		End of Borehole					

WATER LEVEL RECORD:

Time	Water Level (m)	Depth to Cave (m)
completion	dry on	0.9

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Project No. SP973

Log of Borehole 12

Dwg No. 16

Sheet No. 1 of 1

Project: Road Construction Program

Location: Oakville, Ontario - Lakeshore Road

Date Drilled: July 10, 1995

Drill Type:

Datum: Geodetic

Auger Sample	
SPT (N) Value	
Dynamic Cone Test	
Shelby Tube	
Field Vane Test	
Sensitivity	
Piezometric Water Level	
Combustible Vapour Reading	
Natural Moisture	
Plastic and Liquid Limit	
Undrained Triaxial at % Strain at Failure	
Penetrometer	

Soil Description	ELEV. m	DEPTH	N Value (20 40 60 80); Shear Strength MPa (0.1 0.2)	Combustible Vapour Reading (ppm) (250 500 750); Natural Moisture Content %; Atterberg Limits (% Dry Weight) (10 20 30)	Natural Unit Weight kN/m3
	0.0	0			
~115 mm Asphaltic Concrete ~165 mm Granular Base: silty fine to medium sand, occasional gravel sizes	-0.6				
FILL: silt, some sand and gravel, brown, moist		1			
CLAYEY SILT TILL: trace of gravel, numerous shale fragments at 2.3 m, brown and grey, moist, hard			72/180 mm		
	-2.5	2	50/150 mm		
SHALE: contains till-like seams, red brown with olive layers, very dense	-3.2	3	50/150 mm		
End of Borehole					

WATER LEVEL RECORD:

Time	Water Level (m)	Depth to Cave (m)
on completion	dry	3.0

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Log of Borehole PH4

Project No. SP973

Dwg No. 17

Sheet No. 1 of 1

Project: Road Construction Program

Location: Oakville, Ontario - Lakeshore Road

Date Drilled: July 10, 1995

Drill Type:

Datum: Geodetic

Auger Sample	☒	Combustible Vapour Reading	□
SPT (N) Value	○ ☒	Natural Moisture	×
Dynamic Cone Test	—	Plastic and Liquid Limit	├─○
Shelby Tube	■	Undrained Triaxial at % Strain at Failure	⊕
Field Vane Test	+	Penetrometer	▲
Sensitivity	s		
Piezometric Water Level	▼		

GWL	SYMBOL	Soil Description	ELEV. m	DEPTH	N Value 20 40 60 80 / Shear Strength MPa 0.1 0.2	Combustible Vapour Reading (ppm) 250 500 750 / Natural Moisture Content % Atterberg Limits (% Dry Weight) 10 20 30	Natural Unit Weight kN/m3
			0.0				
		*125 mm Asphaltic Concrete *230 mm Granular Base: grey sand, some gravel FILL: silty fine to medium sand, some gravel, silt and topsoil at 0.7 m, brown to dark grey, moist	-0.9				
		End of Borehole					

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WATER LEVEL RECORD:

Time	Water Level (m)	Depth to Cave (m)
completion	dry on	0.9

Project No. SP973

Log of Borehole 13

Dwg No. 18

Sheet No. 1 of 1

Project: Road Construction Program

Location: Oakville, Ontario - Lakeshore Road

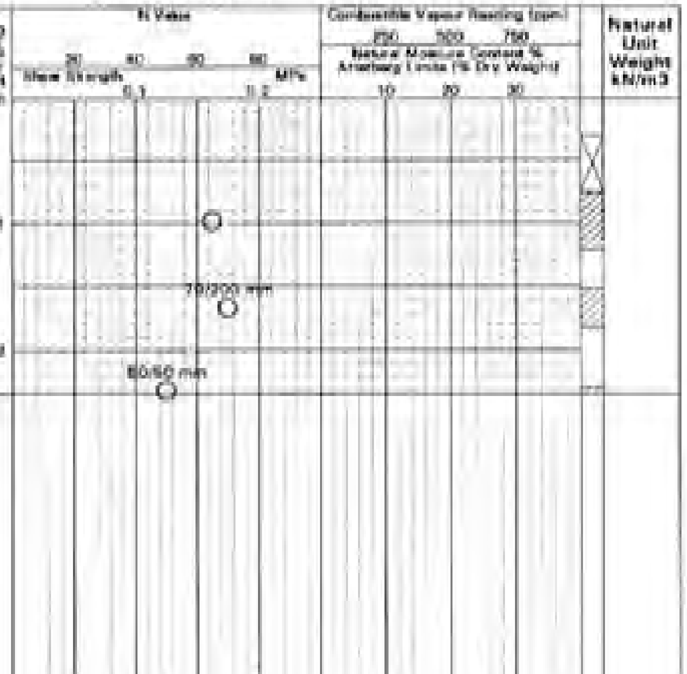
Date Drilled: July 10, 1995

Drill Type:

Datum: Geodetic

Auger Sample	☒	Combustible Vapour Reading	□
SPT (N) Value	○	Natural Moisture	×
Dynamic Cone Test	—	Plastic and Liquid Limit	├─○
Shelby Tube	■	Undrained Triaxial at % Strain at Failure	⊕
Field Vane Test	+	Penetrometer	▲
Sensitivity	S		
Piezometric Water Level	▼		

GW	Symbol	Soil Description	ELEV. m	Depth
			0.0	0
		~115 mm Asphaltic Concrete ~190 mm Granular Base: grey silty sand and gravel		
		FILL: silty sand to sandy silt, trace of gravel, brown, moist	-0.8	
		CLAYEY SILT TILL: trace of gravel, numerous shale fragments at 1.5 m, brown and grey, moist, hard		1
			-1.9	
		SHALE: red brown, very dense		2
			-2.3	
		End of Borehole		



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WATER LEVEL RECORD:

Time	Water Level (m)	Depth to Cave (m)
on completion	dry	2.2

Log of Borehole 14

Project No. SP973

Dwg No. 19

Sheet No. 1 of 1

Project: Road Construction Program

Location: Oakville, Ontario - Lakeshore Road

Date Drilled: July 10, 1995

Drill Type:

Datum: Geodetic

Auger Sample	☒	Combustible Vapour Reading	□
SPT (N) Value	○ ☒	Natural Moisture	×
Dynamic Cone Test	—	Plastic and Liquid Limit	├—○
Shelby Tube	■	Undrained Triaxial at % Strain at Failure	⊕
Field Vane Test	+	Penetrometer	▲
Sensitivity	S		
Piezometric Water Level	▼		

N Value: 20, 40, 60, 80

Shear Strength (MPa): 0.1, 0.2

Combustible Vapour Reading (ppm): 250, 500, 750

Natural Moisture Content % / Atterberg Limits (% Dry Weight): 10, 20, 30

GWL	SYMBOL	Soil Description	ELEV. m	DEPTH	Natural Unit Weight kN/m3
		~190 mm Asphaltic Concrete ~190 mm Concrete FILL: clayey silt to silt, trace of gravel, topsoil stained, brown to dark brown, moist, compact	0.0	0	
		CLAYEY SILT TILL: trace of gravel, numerous shale fragments at 2.3 m, red brown, moist, very stiff to hard	-1.3	1	
		SHALE: red brown, very dense	-2.5	2	
		End of Borehole	-3.3	3	

50/100 mm

WATER LEVEL RECORD:

Time	Water Level (m)	Depth to Cave (m)
on completion	dry	3.1

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Log of Borehole PH5

Project No. SP973

Dwg No. 20

Project: Road Construction Program

Sheet No. 1 of 1

Location: Oakville, Ontario - Lakeshore Road

Date Drilled: July 10, 1995

Drill Type:

Datum: Geodetic

Auger Sample	⊠
SPT (N) Value	○ ⊠
Dynamic Cone Test	—
Shelby Tube	■
Field Vane Test	+
Sensitivity	S
Piezometric Water Level	
Combustible Vapour Reading	□
Natural Moisture	×
Plastic and Liquid Limit	⊢—⊙
Undrained Triaxial at % Strain at Failure	⊕
Penetrometer	▲

GWL	SYMBOL	Soil Description	ELEV. m	DEPTH	N Value (20, 40, 60, 80) / Shear Strength MPa (0.1, 0.2)	Combustible Vapour Reading (ppm) (250, 500, 750) / Natural Moisture Content % / Atterberg Limits (% Dry Weight) (10, 20, 30)	Natural Unit Weight kN/m3
			0.0	0			
		~165 mm Asphaltic Concrete ~125 mm Concrete **CLAYEY SILT TILL:** trace of gravel, red brown, moist	-0.9				
		End of Borehole					

WATER LEVEL RECORD

Time	Water Level (m)	Depth to Cave (m)
completion	dry on	0.9

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Project No. SP973

Log of Borehole 15

Dwg No. 21

Project: Road Construction Program

Sheet No. 1 of 1

Location: Oakville, Ontario - Lakeshore Road

Date Drilled: July 10, 1995

Drill Type:

Datum: Geodetic

Auger Sample	⊠	Combustible Vapour Reading	▢
SPT (N) Value	○ ⊠	Natural Moisture	×
Dynamic Cone Test	—	Plastic and Liquid Limit	├—○
Shelby Tube	■	Undrained Triaxial at % Strain at Failure	⊕
Field Vane Test	+	Penetrometer	▲
Sensitivity	s		
Piezometric Water Level	▼		

GWL	SYMBOL	Soil Description	ELEV. m	DEPTH	N Value (20 40 60 80) / Shear Strength MPa (0.1 0.2)	Combustible Vapour Reading (ppm) (250 500 750) / Natural Moisture Content % Atterberg Limits (% Dry Weight) (10 20 30)	Natural Unit Weight kN/m3
		~200 mm Asphaltic Concrete ~125 mm Concrete FILL: silty sand, trace of gravel, brown, moist,	0.0	0			
		CLAYEY SILT TILL: trace of gravel, contains shale fragments, red brown, moist, hard	-0.8	1 2			
		numerous shale fragments at 2.4 m			50/50 mm		
		SHALE: olive grey, very dense	-2.5	3	50/50 mm		
		End of Borehole	-3.1				

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WATER LEVEL RECORD:

Time	Water Level (m)	Depth to Cave (m)
on completion	dry	2.9

Project No. SP973

Log of Borehole 16

Dwg No. 22

Project: Road Construction Program

Sheet No. 1 of 1

Location: Oakville, Ontario - Lakeshore Road

Date Drilled: July 10, 1995

Drill Type:

Datum: Geodetic

- Auger Sample
- SPT (N) Value
- Dynamic Cone Test
- Shelby Tube
- Field Vane Test
- Sensitivity
- Piezometric Water Level
- Combustible Vapour Reading
- Natural Moisture
- Plastic and Liquid Limit
- Undrained Triaxial at % Strain at Failure
- Penetrometer

Soil Description	ELEV. m	DEPTH	N Value (20, 40, 60, 80) / Shear Strength MPa (0.1, 0.2)	Combustible Vapour Reading (ppm) (250, 500, 750) / Natural Moisture Content % Atterberg Limits (% Dry Weight) (10, 20, 30)	Natural Unit Weight kN/m3
	0.0	0			
~165 mm Asphaltic Concrete ~190 mm Concrete **FILL:** clayey silt, trace of gravel, red brown, moist.	-0.8				
CLAYEY SILT TILL: trace of gravel, contains shale fragments, red brown, moist, hard		1			
			82/280 mm		
	-2.1	2			
SHALE TILL: mainly glacially reworked shale, red brown, slightly moist, very dense			60/150 mm		
	-2.7				
SHALE: contains reworked layers, red brown to olive, very dense		3	50/50 mm		
	-3.3				
End of Borehole					

WATER LEVEL RECORD

Time	Water Level (m)	Depth to Cave (m)
on completion	dry	2.9

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Project No. SP973

Log of Borehole PH6

Dwg No. 23

Project: Road Construction Program

Sheet No. 1 of 1

Location: Oakville, Ontario - Lakeshore Road

Date Drilled: July 10, 1995

Drill Type:

Datum: Geodetic

Auger Sample	☒
SPT (N) Value	○ ☒
Dynamic Cone Test	—
Shelby Tube	■
Field Vane Test	+
Sensitivity	S
Piezometric Water Level	▼
Combustible Vapour Reading	□
Natural Moisture	×
Plastic and Liquid Limit	⊢—⊙
Undrained Triaxial at % Strain at Failure	⊕
Penetrometer	▲

GW	SYMBOL	Soil Description	ELEV. m	DEPTH	N Value (20, 40, 60, 80) / Shear Strength MPa (0.1, 0.2)	Combustible Vapour Reading (ppm) 250, 500, 750 / Natural Moisture Content % / Atterberg Limits (% Dry Weight) 10, 20, 30	Natural Unit Weight kN/m3
			0.0	0			
		~175 mm Asphaltic Concrete ~150 mm Concrete CLAYEY SILT: trace of gravel, brown, moist (possible fill)	-0.9				
		End of Borehole					

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Consulting Geo-Environmental Engineers

WATER LEVEL RECORD:

Time	Water Level (m)	Depth to Cave (m)
completion	dry on	0.9

Project No. SP973

Log of Borehole 17

Dwg No. 24

Project: **Road Construction Program**

Sheet No. 1 of 1

Location: **Oakville, Ontario - Lakeshore Road**

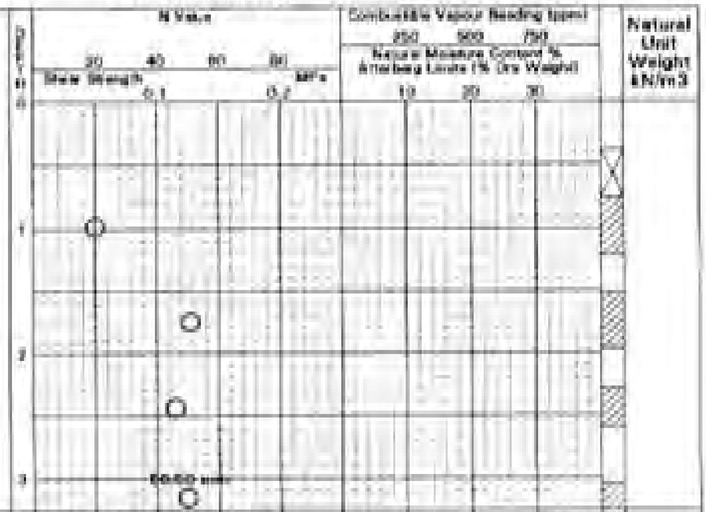
Date Drilled: **July 10, 1995**

Drill Type:

Datum: **Geodetic**

Auger Sample	☒
SPT (N) Value	○ ☒
Dynamic Cone Test	—
Shelby Tube	■
Field Vane Test	+
Sensitivity	S
Piezometric Water Level	▼
Combustible Vapour Reading	□
Natural Moisture	×
Plastic and Liquid Limit	├─○
Undrained Triaxial at % Strain at Failure	⊕
Penetrometer	▲

GWL	SYMBOL	Soil Description	ELEV. m
			0.0
		~125 mm Asphaltic Concrete ~250 mm Concrete **FILL:** clayey silt, trace of gravel, brown, moist.	-0.5
		CLAYEY SILT TILL: sand in part at 1.5 m, trace of gravel, brown to red brown, moist, hard	-2.1
		SHALE: red brown to olive, very dense	-3.3
		End of Borehole	



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Consulting Geo-Environmental Engineers

WATER LEVEL RECORD:

Time	Water Level (m)	Depth to Cave (m)
on completion	dry	2.8

LEGEND

- STUDY AREA BOUNDARY
- WATERCOURSE
- EXISTING STORM SEWER AND PIPE DIAMETER (mm)
- (600) RECOMMENDED STORM SEWER AND PIPE DIAMETER (mm)
- PROPOSED NEW STORM SEWER\CULVERT
- PROPOSED UPGRADED STORM SEWER\CULVERT
- PROPOSED ROADWAY DRAINAGE IMPROVEMENTS
- PROPOSED RE-GRADED OPEN CHANNEL

CORONATION PARK DRAINAGE ASSESSMENT

TOWN OF OAKVILLE

PREFERRED DRAINAGE ALTERNATIVES

amec foster wheeler

SCALE VALID ONLY FOR 24"x36" VERSION

Scale 1:3000 (0 25 50 100)

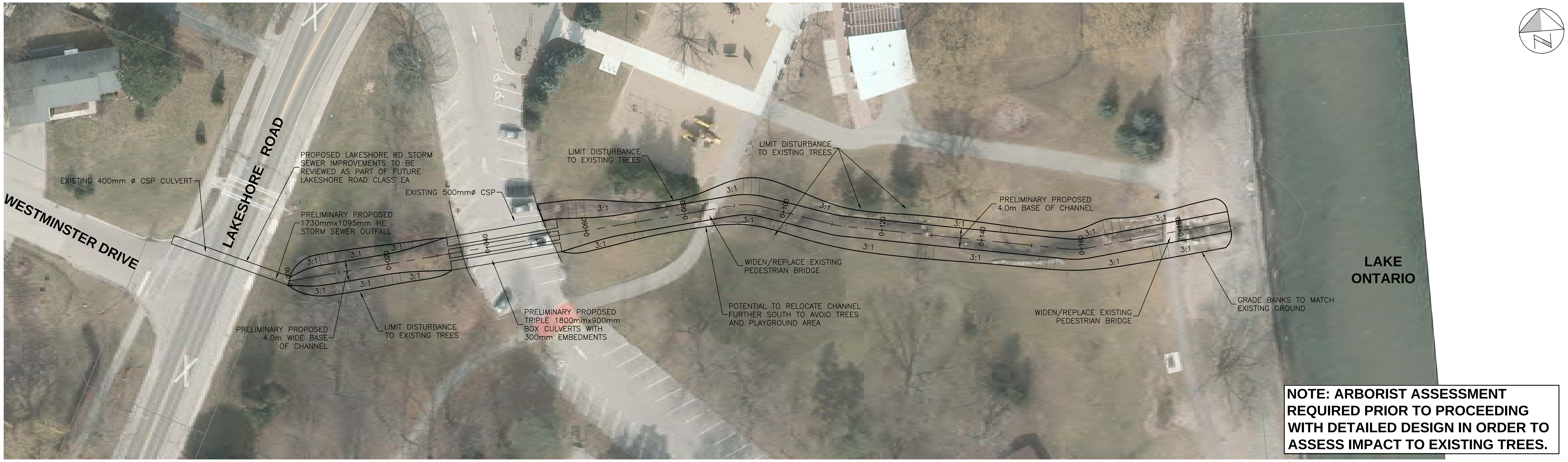
Consultant File No. TP114001

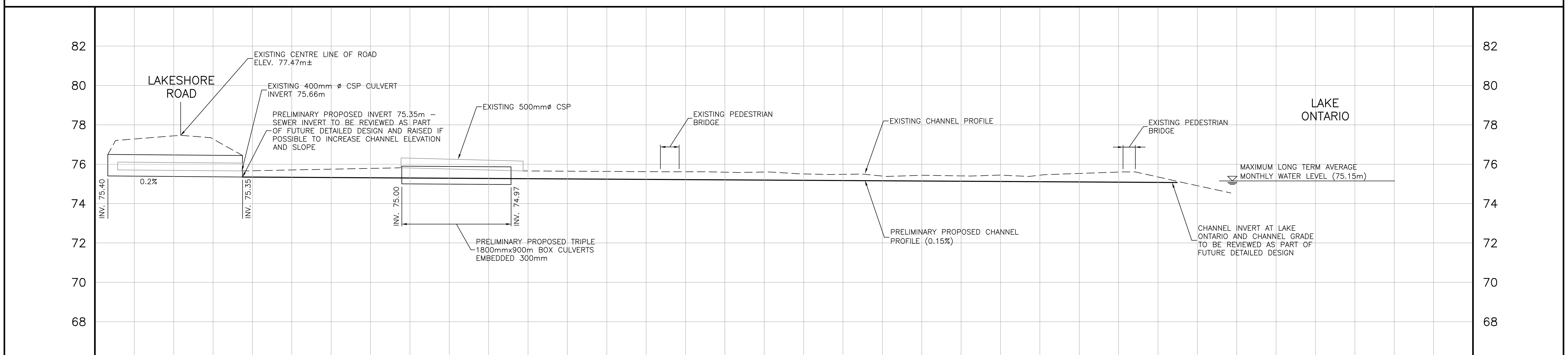
Drawing No. 12

Path: P:\Work\TP114001\water\dwg\2017-05\Dwg12 PerfrdAlt.dwg

Plotted By: j.soaresdasilva
Last Saved By: j.soaresdasilva

Plotted: 2017-05-17
Last Saved: 2017-05-17





CHAINAGE/ PROPOSED ℄ ELEVATION										
Chainage	0+000	0+020	0+040	0+060	0+080	0+100	0+120	0+140	0+160	0+180
Elevation	75.35	75.32	75.29	75.26	75.23	75.20	75.17	75.14	75.11	75.08

Path: P:\Work\TP114001\water\dwg\March2015(FinRpt)\Dwg15 Plan And Profile.dwg

Plotted By: josh.seraj
Last Saved By: josh.seraj
Plotted: 2016-02-05
Last Saved: 2016-02-05

No	Date	Drawn	Appr'd	Revisions

APPROVALS

Design	MS	Checked	MS
Drawn	MK	Checked	MS

Scale
Horiz. 1:400
Vert. 1:100

Date FEB 2016

CORONATION PARK
DRAINAGE ASSESSMENT
TOWN OF OAKVILLE

CONCEPTUAL
CORONATION PARK
CHANNEL DESIGN

amec foster wheeler

Contract No.
Consultant File No. TP114001
Drawing No. 15

Appendix B

Drainage System Assessment

Soil Conditions

The soil parameterization used for the PCSWMM modelling of the Lakehsore Road study area has been obtained from the Town of Oakville Municipal Natural Asset Initiative (MNAI) project (ref. Table 1). The study area for the MNAI project is near Maplehurst Avenue and Bridge Road, which is 500 m (+/-) north of the Lakeshore Road study area. The MNAI project PCSWMM model was calibrated with observed precipitation and flow data obtained during the spring/summer of 2017.

Table 1 - PCSWMM Soil Parameterization

PCSWMM Parameters	Calibrated
Depression Storage Imperv (mm)	1
Depression Storage Perv (mm)	5
Zero Imperviousness (%)	25
Subarea Routing	Pervious
Percent Routed (%)	40
Suction Head (mm)	50
Conductivity (mm/hr)	3.5
Initial Deficit (ratio)	0.25

Existing Conditions Imperviousness

The existing conditions subcatchment impervious values used for the PCSWMM modelling of the study area were obtained from the Town of Oakville Stormwater Master Plan project. In consultation with the Town, the existing conditions imperviousness was determined using the representative imperviousness by zoning method, which used manual measurements from aerial imagery in conjunction with the Town zoning and property ownership GIS data (ref. Appendix B). An initial approach to establishing the imperviousness had been undertaken with image processing of aerial photography and GIS screening using ArcGIS to identify hard surfaces representing total impervious coverage. However, this approach produced lower than expected values (approximately 15% +/-) and the more consistent method of impervious coverage by land use or zone classification has been used. Each land use or zone classification has been assigned an impervious value based on manual measurements.

Table 2 Impervious Coverages for Residential Zones and Municipal Rights-of-Way (%)		
Zone Classification	**Type**	**Imperviousness**
Residential Low (RL1)	ROW	60.1
	Lot	44.5
Residential Low (RL1-0)	ROW	64.0
	Lot	34.0
Residential Low (RL2)	ROW	NA[1]
	Lot	55.0
Residential Low (RL2-0)	ROW	64.1
	Lot	39.1
Residential Low (RL3)	ROW	70.8
	Lot	47.4
Residential Low (RL3-0)	ROW	58.8
	Lot	43.2
Residential Low (RL4)	ROW	NA[2]
	Lot	NA[2]
Residential Low (RL4-0)	ROW	58.4
	Lot	40.4
Residential Low (RL5)	ROW	70.8
	Lot	58.3
Residential Low (RL5-0)	ROW	70.5
	Lot	49.1
Residential Low (RL6)	ROW	63.6
	Lot	62.9
Residential Low (RL7)	ROW	65.1
	Lot	62.5
Residential Low (RL7-0)	ROW	59.0
	Lot	58.3
Residential Low (RL8)	ROW	76.1
	Lot	58.9
Residential Low (RL8-0)	ROW	73.4
	Lot	49.4
Residential Low (RL9)	ROW	76.4
	Lot	61.5
Residential Low (RL10)	ROW	NA[1]
	Lot	46.7
Residential Low (RL10-0)	ROW	NA[1]
	Lot	47.0
Residential Low (RL11)	ROW	79.0
	Lot	51.4
Residential Medium (RM1)	ROW	80.5
	Lot	61.5
Residential Medium (RM2)	ROW	NA[2]
	Lot	NA[2]
Residential Medium (RM3)	ROW	NA[2]
	Lot	NA[2]
Residential Medium (RM4)	ROW	63.9
	Lot	80.4
Residential High	ROW	60.4
	Lot	68.3
Residential Uptown Core	ROW	NA[2]
	Lot	NA[2]

Notes: [1] No road right-of-ways are associated with the residential zones based on the zoning information and property parcel data provided by the Town

[2] The residential zone or right-of way is not found within the study area based on the zoning information and property parcel data provided by the Town

Table 3 Impervious Coverages for Non-Residential Zones (%)	
Class	**Imperviousness**
Neighbourhood Commercial	82.9
Community Commercial	85.2
Core Commercial	89.3
Central Business District	100.0
Cemetery	8.7
Community Use	30.1
Office Employment	84.0
Business Employment	93.4
Industrial	77.8
Institutional	75.1
Business Commercial	87.9
Existing Development	62.7
Greenbelt	5.0
Midtown Transitional Commercial	92.2
Midtown Transitional Employment	82.8
Main Street 1	100.0
Main Street 2	95.0
Urban Centre	90.0
Urban Core	95.0
Natural Area	5.0
Park	10.0
Private Open Space	5.0
Parkway Belt Public Use	25.0
Parkway Belt Complementary Use	10.0
Utility	26.6

Potential Basement Flooding Locations for Existing and Proposed Conditions 100 Year Storm Event														
Notes	Verified/Suspected Basement	Quantity of Buildings	North or South Side of Lakeshore Road	Approximate Station of Storm Sewer Manhole	Invert Elev. (m)	Rim Elev. (m)	Depth (m)	Max 100 Year HGL (m)		Min Freeboard (m)		Approximate Required 100 Yr HGL Elevation with Building Basement (Based on Rim Elevation)	Difference from Required to Modelled (m) (- indicates insufficent depth)	
								Existing	Proposed	Existing	Proposed		Existing	Proposed
0+000 (Mississauga Street)														
House	Suspected	2	South	0+050	77.41	81.78	4.37	79.13	79.40	2.64	2.37	79.49	0.35	0.08
House	Suspected	1	North	0+100	76.27	81.16	4.89	78.29	78.68	2.87	2.48	78.79	0.50	0.11
House	Suspected	2	South	0+170	75.65	80.87	5.22	77.70	78.15	3.17	2.72	78.55	0.85	0.40
0+300 (Bronte Creek)														
Underground Parking Garage	Verified	1	North	0+450	76.00	77.91	1.91	76.25	76.25	1.66	1.66	75.60	-0.65	-0.65
Church	Verified	1	North	0+470	77.29	79.79	2.50	79.82	78.01	0.00	1.79	78.52	-1.30	0.51
Underground Parking Garage	Verified	1	South	0+580	79.27	81.44	2.17	81.58	79.63	0.00	1.81	79.12	-2.46	-0.51
0+780 (Jones Street)														
House	Verified	1	North	0+890	80.80	82.44	1.64	82.12	81.06	0.32	1.38	80.06	-2.07	-1.01
Commercial	Verified	2	North and South	0+960	80.18	81.80	1.62	81.93	80.58	0.00	1.22	78.85	-3.08	-1.73
Commercial	Verified	1	North	1+170	78.53	82.13	3.61	81.77	80.71	0.36	1.42	79.16	-2.61	-1.55
House	Suspected	1	South	1+340	81.05	82.92	1.87	82.90	81.93	0.02	0.99	80.79	-2.11	-1.14
				1+350	81.17	83.15	1.98	82.90	81.93	0.25	1.22	81.02	-1.88	-0.91
1+400 (Bronte Athletic Park)														
House	Verified	1	North	1+660	80.79	84.28	3.49	83.21	83.37	1.07	0.91	81.91	-1.30	-1.46
House	Verified	1	North	1+690	80.69	84.26	3.57	83.20	83.34	1.06	0.92	81.87	-1.32	-1.47
House	Verified	1	North	1+700	80.63	84.24	3.61	83.18	83.33	1.07	0.92	81.86	-1.32	-1.47
House	Verified	1	North	1+800	80.20	84.16	3.96	83.07	83.14	1.10	1.02	82.22	-0.84	-0.91
3+950 (Willowridge Court)														
House	Verified	1	North	3+950	79.00	82.24	3.24	80.38	79.32	1.86	2.93	79.45	-0.92	0.14
4+000 (Fourteen Mile Creek)														
House	Suspected	3	North and South	4+590	85.03	86.30	1.27	85.08	85.08	1.22	1.22	83.96	-1.12	-1.12
				4+600	84.93	86.26	1.33	85.07	85.08	1.19	1.18	83.92	-1.15	-1.16
House	Verified	1	North	4+660	83.91	85.89	1.98	84.35	84.33	1.54	1.56	83.67	-0.68	-0.66
House	Verified	1	North	4+675	83.79	85.72	1.93	84.32	84.30	1.40	1.42	83.50	-0.82	-0.79
				4+690	83.67	85.58	1.91	84.22	84.18	1.37	1.40	83.16	-1.05	-1.02
House	Suspected	2	South	4+725	83.19	85.44	2.25	83.62	83.62	1.82	1.82	83.02	-0.60	-0.60
				4+730	82.39	85.42	3.03	83.40	83.26	2.02	2.16	83.00	-0.40	-0.26
4+800 (McCraney Creek)														
House	Suspected	1	North	4+890	83.06	86.69	3.63	83.30	83.42	3.38	3.27	84.19	0.88	0.77
5+100 (Suffolk Avenue)														
House	Suspected	1	North	5+280	82.21	85.58	3.37	83.19	83.11	2.39	2.47	83.24	0.06	0.13
House	Verified	2	North	5+320	81.68	84.63	2.95	83.18	83.10	1.45	1.53	82.19	-0.99	-0.91
				5+325	81.78	84.73	2.95	83.19	83.11	1.54	1.63	82.63	-0.55	-0.47
				5+325	81.77	84.72	2.95	83.21	83.13	1.52	1.60	82.63	-0.58	-0.50
House	Verified	1	North	5+360	81.62	84.52	2.90	83.20	83.13	1.32	1.39	82.42	-0.78	-0.71
House	Verified	1	North	5+390	82.13	84.70	2.57	83.21	83.48	1.49	1.22	82.56	-0.65	-0.92
House		2	North	5+400	82.42	85.08	2.66	83.21	83.86	1.87	1.23	82.85	-0.36	-1.01
House	Verified	2	South	5+475	83.26	86.36	3.10	83.49	84.68	2.87	1.69	83.93	0.44	-0.75
				5+475	83.42	86.35	2.93	83.99	84.89	2.36	1.46	83.92	-0.07	-0.97
House	Verified	2	North	5+810	87.36	88.81	1.45	88.67	86.77	0.14	2.04	86.17	-2.50	-0.60
House				5+850	85.85	88.41	2.56	88.36	86.44	0.05	1.97	86.19	-2.18	-0.25
House	Verified	2	North	5+920	85.42	88.24	2.82	87.91	86.06	0.33	2.18	85.93	-1.98	-0.12
6+100 (Dorval Drive)														
House	Verified	2	North	6+190	82.18	85.13	2.95	86.22	84.47	0.00	0.67	83.07	-3.15	-1.39
				6+190	82.16	85.20	3.04	86.22	84.47	0.00	0.73	83.14	-3.08	-1.33
House	Suspected	1	North	6+210	82.08	85.45	3.37	86.20	84.47	0.00	0.98	83.11	-3.09	-1.36

Appendix C
Hydraulics

HEC-RAS Plan: Existing-Oct River: 14Mile Reach: MainBranch

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
MainBranch	7752.183	2Y	2.72	118.50	119.19	119.19	119.30	0.014871	1.47	1.85	8.28	0.99
MainBranch	7752.183	5Y	5.35	118.50	119.33	119.33	119.47	0.013935	1.70	3.15	10.86	1.01
MainBranch	7752.183	10Y	7.17	118.50	119.41	119.41	119.56	0.011416	1.71	4.78	26.96	0.94
MainBranch	7752.183	25Y	9.78	118.50	119.50	119.50	119.65	0.010088	1.77	7.38	32.37	0.90
MainBranch	7752.183	50Y	11.60	118.50	119.54	119.54	119.70	0.009792	1.82	8.94	34.51	0.90
MainBranch	7752.183	100Y	13.26	118.50	119.60	119.60	119.66	0.004532	1.31	22.58	74.94	0.62
MainBranch	7752.183	Regional	36.44	118.50	119.74	119.74	119.94	0.012042	2.55	32.82	75.94	1.06
MainBranch	7639.745	2Y	2.72	117.96	118.31		118.32	0.000949	0.46	8.49	34.01	0.27
MainBranch	7639.745	5Y	5.35	117.96	118.45		118.46	0.000994	0.60	13.86	47.90	0.29
MainBranch	7639.745	10Y	7.17	117.96	118.52		118.54	0.001045	0.68	17.57	61.71	0.31
MainBranch	7639.745	25Y	9.78	117.96	118.61		118.63	0.001086	0.78	23.38	65.76	0.32
MainBranch	7639.745	50Y	11.60	117.96	118.66		118.69	0.001091	0.82	26.88	67.44	0.33
MainBranch	7639.745	100Y	13.26	117.96	118.70		118.73	0.001090	0.86	29.99	68.89	0.33
MainBranch	7639.745	Regional	36.44	117.96	119.16		119.21	0.001147	1.24	64.02	79.64	0.37
MainBranch	7549.375	2Y	2.72	117.55	118.01	118.01	118.10	0.014483	1.32	2.14	13.97	0.96
MainBranch	7549.375	5Y	5.35	117.55	118.12	118.12	118.24	0.011521	1.59	4.48	27.15	0.92
MainBranch	7549.375	10Y	7.17	117.55	118.18	118.18	118.32	0.010298	1.70	6.25	30.59	0.90
MainBranch	7549.375	25Y	9.78	117.55	118.25	118.25	118.41	0.010197	1.89	8.37	34.25	0.92
MainBranch	7549.375	50Y	11.60	117.55	118.29	118.29	118.46	0.009823	1.98	9.94	36.48	0.92
MainBranch	7549.375	100Y	13.26	117.55	118.32	118.32	118.51	0.009781	2.07	11.23	38.35	0.93
MainBranch	7549.375	Regional	36.44	117.55	118.69	118.69	118.99	0.008937	2.83	27.81	53.05	0.97
MainBranch	7449.270	2Y	2.72	116.97	117.39	117.25	117.40	0.001680	0.54	5.85	32.45	0.35
MainBranch	7449.270	5Y	5.35	116.97	117.51	117.33	117.53	0.001650	0.69	10.52	47.18	0.37
MainBranch	7449.270	10Y	7.17	116.97	117.58	117.38	117.60	0.001600	0.76	13.97	54.86	0.37
MainBranch	7449.270	25Y	9.78	116.97	117.66	117.44	117.69	0.001519	0.84	18.75	58.59	0.37
MainBranch	7449.270	50Y	11.60	116.97	117.71	117.47	117.75	0.001461	0.88	22.00	60.78	0.37
MainBranch	7449.270	100Y	13.26	116.97	117.76	117.50	117.80	0.001418	0.91	24.88	62.67	0.37
MainBranch	7449.270	Regional	36.44	116.97	118.13	117.79	118.21	0.001742	1.38	56.71	103.02	0.44
MainBranch	7381.689	2Y	2.72	116.70	117.06	117.06	117.14	0.016073	1.28	2.26	14.84	0.99
MainBranch	7381.689	5Y	5.35	116.70	117.15	117.15	117.28	0.013995	1.59	3.74	16.60	1.00
MainBranch	7381.689	10Y	7.17	116.70	117.21	117.21	117.36	0.012952	1.74	4.71	17.66	0.99
MainBranch	7381.689	25Y	9.78	116.70	117.28	117.28	117.46	0.012088	1.91	6.02	19.00	0.99
MainBranch	7381.689	50Y	11.60	116.70	117.32	117.32	117.52	0.011946	2.03	6.83	19.80	1.00
MainBranch	7381.689	100Y	13.26	116.70	117.36	117.36	117.58	0.011329	2.10	7.67	20.58	0.99
MainBranch	7381.689	Regional	36.44	116.70	117.74	117.74	118.00	0.007591	2.56	32.61	103.91	0.89
MainBranch	7322.142	2Y	2.72	116.12	116.52	116.40	116.56	0.003563	0.84	3.25	11.84	0.51
MainBranch	7322.142	5Y	5.35	116.12	116.67	116.52	116.73	0.003720	1.02	5.25	14.71	0.54
MainBranch	7322.142	10Y	7.17	116.12	116.75	116.59	116.81	0.003884	1.11	6.48	16.59	0.57
MainBranch	7322.142	25Y	9.78	116.12	116.84	116.67	116.91	0.004071	1.23	7.98	19.07	0.59
MainBranch	7322.142	50Y	11.60	116.12	116.88	116.72	116.97	0.004198	1.32	8.88	20.78	0.61
MainBranch	7322.142	100Y	13.26	116.12	116.92	116.77	117.02	0.004382	1.40	9.64	22.54	0.63
MainBranch	7322.142	Regional	36.44	116.12	117.25	117.17	117.47	0.005645	2.13	23.59	50.12	0.77
MainBranch	7232.906	2Y	2.72	115.70	116.15	116.06	116.19	0.004805	0.86	3.18	14.44	0.57
MainBranch	7232.906	5Y	5.35	115.70	116.26	116.17	116.32	0.005645	1.14	4.96	20.26	0.66
MainBranch	7232.906	10Y	7.17	115.70	116.32	116.23	116.39	0.005786	1.26	6.27	23.72	0.68
MainBranch	7232.906	25Y	9.78	115.70	116.39	116.30	116.49	0.005697	1.38	8.34	30.82	0.69
MainBranch	7232.906	50Y	11.60	115.70	116.44	116.35	116.55	0.005536	1.44	10.01	35.47	0.69
MainBranch	7232.906	100Y	13.26	115.70	116.48	116.38	116.59	0.005313	1.49	11.51	39.03	0.69
MainBranch	7232.906	Regional	36.44	115.70	116.93		117.08	0.003530	1.87	36.10	74.82	0.62
MainBranch	7132.593	2Y	2.72	114.94	115.64		115.68	0.005294	0.96	2.83	11.16	0.61
MainBranch	7132.593	5Y	5.35	114.94	115.81		115.86	0.003721	1.06	5.42	18.48	0.55
MainBranch	7132.593	10Y	7.17	114.94	115.90		115.96	0.003360	1.14	7.18	21.32	0.54
MainBranch	7132.593	25Y	9.78	114.94	116.01		116.08	0.003041	1.23	9.73	24.86	0.53
MainBranch	7132.593	50Y	11.60	114.94	116.07		116.15	0.002904	1.28	11.50	27.02	0.52
MainBranch	7132.593	100Y	13.26	114.94	116.13		116.22	0.002808	1.32	13.10	28.63	0.52
MainBranch	7132.593	Regional	36.44	114.94	116.65		116.79	0.002645	1.79	31.69	49.61	0.55
MainBranch	7047.302	2Y	2.72	114.75	115.46	115.22	115.48	0.001261	0.67	4.61	15.06	0.33
MainBranch	7047.302	5Y	5.35	114.75	115.57	115.36	115.62	0.002187	1.03	6.49	18.74	0.45
MainBranch	7047.302	10Y	7.17	114.75	115.63	115.43	115.70	0.002712	1.23	7.67	20.72	0.51
MainBranch	7047.302	25Y	9.78	114.75	115.71	115.52	115.81	0.003279	1.47	9.34	23.25	0.57
MainBranch	7047.302	50Y	11.60	114.75	115.76	115.58	115.88	0.003552	1.60	10.55	24.91	0.60
MainBranch	7047.302	100Y	13.26	114.75	115.80	115.63	115.94	0.003731	1.71	11.69	26.38	0.62
MainBranch	7047.302	Regional	36.44	114.75	116.32	116.16	116.53	0.003473	2.32	37.74	66.32	0.65
MainBranch	6988.738	2Y	2.72	114.56	115.35		115.37	0.004696	0.79	7.72	55.87	0.55
MainBranch	6988.738	5Y	5.35	114.56	115.46		115.48	0.003572	0.90	13.85	58.32	0.51
MainBranch	6988.738	10Y	7.17	114.56	115.53		115.56	0.002813	0.91	18.41	60.01	0.47
MainBranch	6988.738	25Y	9.78	114.56	115.64		115.66	0.002170	0.93	24.81	62.16	0.43
MainBranch	6988.738	50Y	11.60	114.56	115.71		115.73	0.001896	0.94	29.13	63.56	0.41
MainBranch	6988.738	100Y	13.26	114.56	115.77		115.79	0.001719	0.96	32.95	64.77	0.39
MainBranch	6988.738	Regional	36.44	114.56	116.36		116.40	0.001118	1.19	74.85	74.93	0.35

HEC-RAS Plan: Existing-Oct River: 14Mile Reach: MainBranch (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
MainBranch	6894.028	2Y	2.72	114.24	114.97		115.01	0.003869	0.92	2.95	9.75	0.53
MainBranch	6894.028	5Y	5.35	114.24	115.17		115.23	0.002809	1.04	5.27	13.17	0.49
MainBranch	6894.028	10Y	7.17	114.24	115.27		115.34	0.002654	1.14	6.71	15.41	0.49
MainBranch	6894.028	25Y	9.78	114.24	115.39		115.47	0.002628	1.27	8.67	18.15	0.50
MainBranch	6894.028	50Y	11.60	114.24	115.46		115.55	0.002624	1.35	10.05	20.56	0.51
MainBranch	6894.028	100Y	13.26	114.24	115.52		115.62	0.002618	1.41	11.38	22.78	0.51
MainBranch	6894.028	Regional	36.44	114.24	116.05		116.25	0.003148	2.07	26.82	35.47	0.60
MainBranch	6846.464	2Y	2.72	114.24	114.88		114.90	0.001440	0.73	3.74	8.39	0.35
MainBranch	6846.464	5Y	5.35	114.24	115.07		115.12	0.001935	0.97	5.49	9.93	0.42
MainBranch	6846.464	10Y	7.17	114.24	115.16		115.22	0.002259	1.11	6.44	10.67	0.46
MainBranch	6846.464	25Y	9.78	114.24	115.26		115.34	0.002764	1.30	7.51	11.45	0.51
MainBranch	6846.464	50Y	11.60	114.24	115.32		115.42	0.003065	1.42	8.20	11.93	0.54
MainBranch	6846.464	100Y	13.26	114.24	115.36		115.48	0.003340	1.51	8.80	12.41	0.57
MainBranch	6846.464	Regional	36.44	114.24	115.80	115.71	116.06	0.004938	2.31	22.27	48.96	0.74
MainBranch	6772.934	2Y	2.72	114.20	114.54	114.54	114.65	0.015528	1.42	1.92	9.58	1.01
MainBranch	6772.934	5Y	5.35	114.20	114.67	114.67	114.80	0.014167	1.63	3.28	12.41	1.01
MainBranch	6772.934	10Y	7.17	114.20	114.74	114.73	114.89	0.012486	1.70	4.23	14.49	0.98
MainBranch	6772.934	25Y	9.78	114.20	114.84	114.80	114.99	0.009442	1.75	5.74	16.22	0.88
MainBranch	6772.934	50Y	11.60	114.20	114.90	114.85	115.06	0.008278	1.79	6.83	18.60	0.85
MainBranch	6772.934	100Y	13.26	114.20	114.96	114.89	115.12	0.007501	1.82	7.90	20.67	0.82
MainBranch	6772.934	Regional	36.44	114.20	115.33	115.33	115.62	0.007506	2.51	22.87	47.83	0.89
MainBranch	6662.639	2Y	2.72	113.05	113.59		113.64	0.003612	1.00	2.72	7.58	0.53
MainBranch	6662.639	5Y	5.35	113.05	113.73		113.83	0.005251	1.39	3.84	8.62	0.67
MainBranch	6662.639	10Y	7.17	113.05	113.80	113.69	113.93	0.006328	1.62	4.43	9.11	0.74
MainBranch	6662.639	25Y	9.78	113.05	113.88	113.80	114.06	0.007617	1.88	5.19	9.76	0.82
MainBranch	6662.639	50Y	11.60	113.05	113.93	113.87	114.14	0.008437	2.05	5.66	10.13	0.88
MainBranch	6662.639	100Y	13.26	113.05	113.96	113.92	114.21	0.009059	2.19	6.06	11.10	0.91
MainBranch	6662.639	Regional	36.44	113.05	114.50	114.50	114.74	0.004943	2.41	36.23	91.91	0.74
MainBranch	6565.562	2Y	2.72	112.85	113.20	113.12	113.24	0.004788	0.82	3.31	15.53	0.57
MainBranch	6565.562	5Y	5.35	112.85	113.34	113.22	113.39	0.003757	0.94	5.70	19.46	0.54
MainBranch	6565.562	10Y	7.17	112.85	113.41	113.27	113.46	0.003462	1.04	7.12	21.48	0.53
MainBranch	6565.562	25Y	9.78	112.85	113.49	113.34	113.56	0.003284	1.15	9.05	23.94	0.54
MainBranch	6565.562	50Y	11.60	112.85	113.55	113.37	113.62	0.003216	1.22	10.34	25.46	0.54
MainBranch	6565.562	100Y	13.26	112.85	113.59	113.41	113.67	0.003201	1.29	11.47	26.71	0.55
MainBranch	6565.562	Regional	36.44	112.85	113.99	113.78	114.18	0.003683	1.97	24.34	37.11	0.64
MainBranch	6478.273	2Y	2.72	112.44	112.93		112.96	0.002258	0.77	4.31	20.90	0.42
MainBranch	6478.273	5Y	5.35	112.44	113.07	112.90	113.12	0.002605	1.01	7.96	31.13	0.47
MainBranch	6478.273	10Y	7.17	112.44	113.14	112.97	113.20	0.002808	1.14	10.31	35.92	0.50
MainBranch	6478.273	25Y	9.78	112.44	113.23	113.06	113.30	0.002982	1.28	13.58	41.60	0.53
MainBranch	6478.273	50Y	11.60	112.44	113.27	113.11	113.36	0.003115	1.38	15.71	46.41	0.55
MainBranch	6478.273	100Y	13.26	112.44	113.31	113.15	113.40	0.003208	1.46	17.67	50.11	0.56
MainBranch	6478.273	Regional	36.44	112.44	113.59	113.55	113.81	0.005845	2.46	35.55	70.87	0.80
MainBranch	6435.935	2Y	2.72	112.36	112.67	112.67	112.76	0.015213	1.30	2.10	11.77	0.98
MainBranch	6435.935	5Y	5.35	112.36	112.78	112.78	112.90	0.014415	1.54	3.48	14.62	1.00
MainBranch	6435.935	10Y	7.17	112.36	112.84	112.84	112.97	0.013575	1.63	4.41	16.22	1.00
MainBranch	6435.935	25Y	9.78	112.36	112.90	112.90	113.06	0.013306	1.76	5.58	18.02	1.01
MainBranch	6435.935	50Y	11.60	112.36	112.95	112.95	113.12	0.012832	1.81	6.39	19.13	1.00
MainBranch	6435.935	100Y	13.26	112.36	112.98	112.98	113.16	0.012535	1.87	7.10	20.01	1.00
MainBranch	6435.935	Regional	36.44	112.36	113.41	113.33	113.57	0.005260	1.94	30.77	69.44	0.73
MainBranch	6358.901	2Y	2.72	111.75	112.26		112.28	0.002046	0.65	4.16	14.51	0.39
MainBranch	6358.901	5Y	5.35	111.75	112.42		112.45	0.001888	0.77	7.04	20.13	0.39
MainBranch	6358.901	10Y	7.17	111.75	112.51		112.55	0.001812	0.85	8.85	22.98	0.40
MainBranch	6358.901	25Y	9.78	111.75	112.61		112.66	0.001713	0.94	11.46	34.26	0.40
MainBranch	6358.901	50Y	11.60	111.75	112.68		112.72	0.001654	0.99	13.86	38.56	0.40
MainBranch	6358.901	100Y	13.26	111.75	112.73		112.78	0.001594	1.03	16.09	41.87	0.40
MainBranch	6358.901	Regional	36.44	111.75	113.31		113.38	0.001147	1.32	53.14	83.06	0.37
MainBranch	6301.693	2Y	2.72	111.67	112.16		112.18	0.001513	0.62	4.56	15.90	0.34
MainBranch	6301.693	5Y	5.35	111.67	112.32		112.36	0.001561	0.81	7.92	31.82	0.37
MainBranch	6301.693	10Y	7.17	111.67	112.41		112.45	0.001576	0.90	10.80	35.25	0.38
MainBranch	6301.693	25Y	9.78	111.67	112.52		112.56	0.001570	1.00	14.81	39.54	0.38
MainBranch	6301.693	50Y	11.60	111.67	112.59		112.64	0.001551	1.06	17.56	41.77	0.39
MainBranch	6301.693	100Y	13.26	111.67	112.64		112.70	0.001525	1.10	20.07	43.64	0.39
MainBranch	6301.693	Regional	36.44	111.67	113.24		113.32	0.001362	1.45	51.44	58.14	0.39
MainBranch	6233.167	2Y	2.72	111.59	112.01		112.04	0.002761	0.75	3.61	12.72	0.45
MainBranch	6233.167	5Y	5.35	111.59	112.19		112.23	0.002433	0.88	6.09	15.89	0.45
MainBranch	6233.167	10Y	7.17	111.59	112.28		112.32	0.002261	0.96	7.60	18.11	0.44
MainBranch	6233.167	25Y	9.78	111.59	112.39		112.44	0.002140	1.05	9.73	20.60	0.45
MainBranch	6233.167	50Y	11.60	111.59	112.46		112.52	0.002076	1.11	11.21	22.14	0.45
MainBranch	6233.167	100Y	13.26	111.59	112.52		112.58	0.002032	1.15	12.61	26.19	0.45

HEC-RAS Plan: Existing-Oct River: 14Mile Reach: MainBranch (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
MainBranch	6233.167	Regional	36.44	111.59	113.15	112.64	113.24	0.001422	1.40	43.48	63.93	0.41
MainBranch	6165.560	2Y	2.72	111.44	111.85	111.68	111.88	0.002069	0.75	3.64	10.34	0.40
MainBranch	6165.560	5Y	5.35	111.44	112.01	111.80	112.06	0.002460	1.01	5.31	11.36	0.46
MainBranch	6165.560	10Y	7.17	111.44	112.08	111.87	112.15	0.002816	1.18	6.13	11.91	0.51
MainBranch	6165.560	25Y	9.78	111.44	112.16	111.95	112.26	0.003392	1.42	7.08	12.51	0.57
MainBranch	6165.560	50Y	11.60	111.44	112.20	112.01	112.33	0.003772	1.56	7.66	12.86	0.60
MainBranch	6165.560	100Y	13.26	111.44	112.24	112.06	112.39	0.004119	1.69	8.15	13.15	0.64
MainBranch	6165.560	Regional	36.44	111.44	112.63	112.63	113.03	0.006667	2.88	18.08	36.85	0.87
MainBranch	6098.928	2Y	2.72	111.34	111.80		111.81	0.000632	0.44	10.21	39.21	0.23
MainBranch	6098.928	5Y	5.35	111.34	111.96		111.97	0.000722	0.58	17.45	52.88	0.26
MainBranch	6098.928	10Y	7.17	111.34	112.03		112.05	0.000782	0.65	21.47	54.59	0.27
MainBranch	6098.928	25Y	9.78	111.34	112.11		112.13	0.000883	0.74	26.01	55.13	0.29
MainBranch	6098.928	50Y	11.60	111.34	112.16		112.19	0.000936	0.80	28.88	55.47	0.31
MainBranch	6098.928	100Y	13.26	111.34	112.21		112.24	0.000962	0.84	31.40	55.85	0.31
MainBranch	6098.928	Regional	36.44	111.34	112.60		112.66	0.001503	1.40	54.91	70.06	0.42
MainBranch	6046.464	2Y	2.72	111.19	111.75		111.76	0.001294	0.59	5.33	26.05	0.32
MainBranch	6046.464	5Y	5.35	111.19	111.90		111.92	0.001355	0.74	11.14	59.79	0.34
MainBranch	6046.464	10Y	7.17	111.19	111.97		112.00	0.001374	0.81	15.90	69.27	0.35
MainBranch	6046.464	25Y	9.78	111.19	112.05		112.08	0.001427	0.91	21.43	71.94	0.37
MainBranch	6046.464	50Y	11.60	111.19	112.10		112.13	0.001427	0.96	25.13	73.67	0.37
MainBranch	6046.464	100Y	13.26	111.19	112.14		112.18	0.001407	0.99	28.54	76.03	0.38
MainBranch	6046.464	Regional	36.44	111.19	112.52		112.59	0.001745	1.47	59.21	82.40	0.45
MainBranch	5946.083	2Y	2.72	111.11	111.35	111.35	111.45	0.014320	1.42	2.32	14.20	0.98
MainBranch	5946.083	5Y	5.35	111.11	111.47	111.47	111.61	0.012275	1.73	4.22	18.27	0.97
MainBranch	5946.083	10Y	7.17	111.11	111.54	111.54	111.70	0.010646	1.84	5.92	30.95	0.93
MainBranch	5946.083	25Y	9.78	111.11	111.64	111.64	111.80	0.008738	1.91	9.46	44.57	0.88
MainBranch	5946.083	50Y	11.60	111.11	111.68	111.68	111.85	0.008965	2.04	11.29	49.35	0.90
MainBranch	5946.083	100Y	13.26	111.11	111.71	111.71	111.90	0.009038	2.14	13.16	55.55	0.91
MainBranch	5946.083	Regional	36.44	111.11	112.04	112.04	112.29	0.008310	2.80	35.03	70.90	0.94
MainBranch	5850.291	2Y	2.72	110.59	111.00		111.01	0.001899	0.64	8.55	42.22	0.38
MainBranch	5850.291	5Y	5.35	110.59	111.12		111.14	0.001957	0.82	14.05	47.46	0.41
MainBranch	5850.291	10Y	7.17	110.59	111.19		111.22	0.001975	0.92	17.42	50.35	0.42
MainBranch	5850.291	25Y	9.78	110.59	111.28		111.31	0.001962	1.02	22.04	54.05	0.43
MainBranch	5850.291	50Y	11.60	110.59	111.32		111.36	0.002093	1.11	24.43	55.78	0.45
MainBranch	5850.291	100Y	13.26	110.59	111.36		111.40	0.002209	1.18	26.46	57.18	0.47
MainBranch	5850.291	Regional	36.44	110.59	111.71		111.82	0.003336	1.94	50.61	80.17	0.62
MainBranch	5746.464	2Y	2.72	110.30	110.62		110.65	0.007656	0.99	5.38	29.20	0.71
MainBranch	5746.464	5Y	5.35	110.30	110.73	110.62	110.78	0.006798	1.23	9.48	41.53	0.72
MainBranch	5746.464	10Y	7.17	110.30	110.79	110.68	110.85	0.006968	1.38	12.10	51.37	0.74
MainBranch	5746.464	25Y	9.78	110.30	110.86	110.75	110.94	0.007307	1.57	16.87	74.13	0.78
MainBranch	5746.464	50Y	11.60	110.30	110.89	110.79	110.97	0.007175	1.64	19.34	74.35	0.78
MainBranch	5746.464	100Y	13.26	110.30	110.92	110.80	111.01	0.007080	1.70	21.45	74.54	0.79
MainBranch	5746.464	Regional	36.44	110.30	111.26		111.37	0.005395	2.13	47.26	76.77	0.75
MainBranch	5627.203	2Y	2.72	109.86	110.10		110.12	0.003032	0.64	4.26	21.88	0.45
MainBranch	5627.203	5Y	5.35	109.86	110.19		110.23	0.003546	0.88	6.37	24.88	0.52
MainBranch	5627.203	10Y	7.17	109.86	110.25		110.30	0.003527	0.98	7.83	26.41	0.53
MainBranch	5627.203	25Y	9.78	109.86	110.32		110.38	0.003410	1.09	9.90	28.47	0.54
MainBranch	5627.203	50Y	11.60	109.86	110.37		110.44	0.003291	1.16	11.34	29.80	0.54
MainBranch	5627.203	100Y	13.26	109.86	110.42		110.49	0.003181	1.20	12.66	30.91	0.54
MainBranch	5627.203	Regional	36.44	109.86	110.91		111.02	0.002079	1.53	38.53	65.53	0.48
MainBranch	5532.597	2Y	2.72	109.45	109.72		109.76	0.004931	0.81	3.56	19.46	0.57
MainBranch	5532.597	5Y	5.35	109.45	109.86		109.91	0.003297	0.93	6.52	22.84	0.51
MainBranch	5532.597	10Y	7.17	109.45	109.94		109.99	0.002972	1.01	8.37	24.72	0.50
MainBranch	5532.597	25Y	9.78	109.45	110.04		110.10	0.002693	1.10	10.93	27.11	0.49
MainBranch	5532.597	50Y	11.60	109.45	110.10		110.17	0.002604	1.16	12.58	28.56	0.49
MainBranch	5532.597	100Y	13.26	109.45	110.15		110.22	0.002604	1.22	13.97	30.29	0.50
MainBranch	5532.597	Regional	36.44	109.45	110.75		110.85	0.001611	1.50	43.38	61.96	0.43
MainBranch	5427.875	2Y	2.72	109.11	109.52		109.53	0.001183	0.58	5.84	20.72	0.31
MainBranch	5427.875	5Y	5.35	109.11	109.65		109.68	0.001543	0.82	8.83	24.50	0.37
MainBranch	5427.875	10Y	7.17	109.11	109.72		109.76	0.001728	0.95	10.64	26.52	0.40
MainBranch	5427.875	25Y	9.78	109.11	109.80		109.86	0.002034	1.13	13.23	39.83	0.45
MainBranch	5427.875	50Y	11.60	109.11	109.85		109.92	0.002204	1.23	15.30	44.36	0.47
MainBranch	5427.875	100Y	13.26	109.11	109.89		109.97	0.002316	1.31	17.12	46.78	0.49
MainBranch	5427.875	Regional	36.44	109.11	110.66		110.73	0.000937	1.34	60.71	60.73	0.35
MainBranch	5373.942	2Y	2.72	109.06	109.39	109.31	109.43	0.004009	0.80	3.91	22.94	0.53
MainBranch	5373.942	5Y	5.35	109.06	109.50	109.41	109.55	0.004377	1.06	6.66	30.34	0.58
MainBranch	5373.942	10Y	7.17	109.06	109.55	109.46	109.62	0.004553	1.19	8.53	36.04	0.61
MainBranch	5373.942	25Y	9.78	109.06	109.62	109.52	109.70	0.004723	1.34	11.26	43.50	0.64
MainBranch	5373.942	50Y	11.60	109.06	109.66	109.57	109.75	0.004930	1.44	13.01	47.99	0.66

HEC-RAS Plan: Existing-Oct River: 14Mile Reach: MainBranch (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
MainBranch	5373.942	100Y	13.26	109.06	109.69	109.60	109.80	0.005094	1.52	14.60	51.75	0.68
MainBranch	5373.942	Regional	36.44	109.06	110.64		110.68	0.000669	1.06	69.14	60.42	0.29
MainBranch	5260.950	2Y	2.72	108.28	108.54	108.54	108.61	0.016494	1.24	2.20	14.54	1.00
MainBranch	5260.950	5Y	5.35	108.28	108.63	108.63	108.74	0.014016	1.52	3.61	16.09	0.99
MainBranch	5260.950	10Y	7.17	108.28	108.68	108.68	108.82	0.013048	1.66	4.50	17.01	0.99
MainBranch	5260.950	25Y	9.78	108.28	108.75	108.75	108.92	0.011994	1.80	5.74	18.20	0.98
MainBranch	5260.950	50Y	11.60	108.28	108.80	108.79	108.98	0.011029	1.88	6.61	18.97	0.96
MainBranch	5260.950	100Y	13.26	108.28	108.84	108.83	109.03	0.010307	1.94	7.40	19.65	0.94
MainBranch	5260.950	Regional	36.44	108.28	110.62	109.22	110.64	0.000182	0.76	106.46	81.83	0.16
MainBranch	5146.464	2Y	2.72	107.53	108.03	107.86	108.05	0.001932	0.68	4.70	17.96	0.39
MainBranch	5146.464	5Y	5.35	107.53	108.18	107.97	108.22	0.002053	0.86	7.78	22.46	0.42
MainBranch	5146.464	10Y	7.17	107.53	108.26	108.04	108.30	0.002057	0.96	9.64	24.80	0.43
MainBranch	5146.464	25Y	9.78	107.53	108.36	108.12	108.41	0.002078	1.08	12.19	27.73	0.45
MainBranch	5146.464	50Y	11.60	107.53	108.42	108.16	108.48	0.002104	1.16	13.88	29.51	0.45
MainBranch	5146.464	100Y	13.26	107.53	108.47	108.19	108.54	0.002123	1.22	15.39	31.03	0.46
MainBranch	5146.464	Regional	36.44	107.53	110.62	108.59	110.63	0.000075	0.58	142.30	68.86	0.11
MainBranch	5046.464	2Y	2.72	107.45	107.84		107.86	0.001855	0.64	4.49	17.35	0.37
MainBranch	5046.464	5Y	5.35	107.45	107.98		108.01	0.002101	0.85	6.96	19.93	0.42
MainBranch	5046.464	10Y	7.17	107.45	108.05		108.09	0.002269	0.97	8.40	21.36	0.45
MainBranch	5046.464	25Y	9.78	107.45	108.12		108.18	0.002611	1.13	10.07	22.90	0.49
MainBranch	5046.464	50Y	11.60	107.45	108.14		108.22	0.003220	1.28	10.58	23.36	0.55
MainBranch	5046.464	100Y	13.26	107.45	108.21		108.29	0.002982	1.31	12.08	24.63	0.53
MainBranch	5046.464	Regional	36.44	107.45	110.62		110.62	0.000046	0.46	168.15	76.61	0.09
MainBranch	4945.903	2Y	2.72	107.12	107.36	107.36	107.44	0.016016	1.29	2.19	14.74	1.00
MainBranch	4945.903	5Y	5.35	107.12	107.46	107.46	107.58	0.012558	1.52	3.95	18.92	0.95
MainBranch	4945.903	10Y	7.17	107.12	107.53	107.52	107.66	0.011014	1.60	5.23	21.45	0.92
MainBranch	4945.903	25Y	9.78	107.12	107.63	107.58	107.76	0.008029	1.60	7.76	28.21	0.81
MainBranch	4945.903	50Y	11.60	107.12	107.74	107.63	107.84	0.004731	1.43	11.29	34.80	0.65
MainBranch	4945.903	100Y	13.26	107.12	108.13	107.67	108.15	0.000672	0.79	31.34	55.00	0.27
MainBranch	4945.903	Regional	36.44	107.12	110.61	108.04	110.62	0.000034	0.44	183.18	73.46	0.08
MainBranch	4846.464	2Y	2.72	106.47	106.92		106.94	0.002224	0.73	4.50	16.31	0.41
MainBranch	4846.464	5Y	5.35	106.47	107.08		107.12	0.002264	0.95	7.14	17.29	0.44
MainBranch	4846.464	10Y	7.17	106.47	107.18		107.23	0.002111	1.04	8.97	17.94	0.43
MainBranch	4846.464	25Y	9.78	106.47	107.26		107.33	0.002565	1.24	10.41	18.43	0.48
MainBranch	4846.464	50Y	11.60	106.47	107.62		107.66	0.000833	0.93	17.68	21.70	0.29
MainBranch	4846.464	100Y	13.26	106.47	108.09		108.11	0.000306	0.70	28.76	26.04	0.18
MainBranch	4846.464	Regional	36.44	106.47	110.61		110.61	0.000051	0.52	174.35	86.48	0.08
MainBranch	4746.464	2Y	2.72	106.12	106.55	106.47	106.60	0.005998	1.01	2.71	11.02	0.65
MainBranch	4746.464	5Y	5.35	106.12	106.66	106.60	106.75	0.006847	1.32	4.09	13.17	0.73
MainBranch	4746.464	10Y	7.17	106.12	106.68	106.66	106.82	0.010269	1.67	4.35	13.52	0.90
MainBranch	4746.464	25Y	9.78	106.12	107.08	106.74	107.13	0.001486	1.02	11.31	21.69	0.38
MainBranch	4746.464	50Y	11.60	106.12	107.59	106.79	107.61	0.000289	0.63	32.05	52.76	0.18
MainBranch	4746.464	100Y	13.26	106.12	108.08	106.83	108.09	0.000094	0.45	61.24	65.16	0.11
MainBranch	4746.464	Regional	36.44	106.12	110.61	107.35	110.61	0.000015	0.33	285.09	94.41	0.05
MainBranch	4646.464	2Y	2.72	105.73	106.13	106.01	106.16	0.003387	0.76	3.60	14.75	0.49
MainBranch	4646.464	5Y	5.35	105.73	106.29	106.12	106.33	0.002725	0.83	6.41	19.25	0.46
MainBranch	4646.464	10Y	7.17	105.73	106.42	106.18	106.45	0.001659	0.80	9.23	23.78	0.38
MainBranch	4646.464	25Y	9.78	105.73	107.08	106.25	107.09	0.000136	0.42	31.83	48.30	0.13
MainBranch	4646.464	50Y	11.60	105.73	107.59	106.29	107.60	0.000045	0.31	62.44	65.69	0.08
MainBranch	4646.464	100Y	13.26	105.73	108.08	106.33	108.08	0.000021	0.25	96.21	70.57	0.06
MainBranch	4646.464	Regional	36.44	105.73	110.61	106.68	110.61	0.000008	0.27	284.25	78.34	0.04
MainBranch	4546.464	2Y	2.72	105.40	105.76		105.79	0.003839	0.86	3.29	14.09	0.53
MainBranch	4546.464	5Y	5.35	105.40	105.83		105.92	0.006638	1.33	4.40	15.80	0.72
MainBranch	4546.464	10Y	7.17	105.40	106.35		106.37	0.000500	0.65	16.04	30.48	0.23
MainBranch	4546.464	25Y	9.78	105.40	107.07		107.08	0.000087	0.39	47.97	48.97	0.10
MainBranch	4546.464	50Y	11.60	105.40	107.59		107.59	0.000038	0.32	75.99	61.71	0.07
MainBranch	4546.464	100Y	13.26	105.40	108.08		108.08	0.000021	0.27	109.84	74.56	0.05
MainBranch	4546.464	Regional	36.44	105.40	110.61		110.61	0.000009	0.28	352.37	106.09	0.04
MainBranch	4446.464	2Y	2.72	104.63	105.02	105.01	105.13	0.013543	1.48	1.83	7.60	0.96
MainBranch	4446.464	5Y	5.35	104.63	105.78		105.79	0.000406	0.52	10.50	15.53	0.20
MainBranch	4446.464	10Y	7.17	104.63	106.34		106.35	0.000089	0.36	27.56	38.59	0.10
MainBranch	4446.464	25Y	9.78	104.63	107.07		107.07	0.000029	0.28	62.34	58.12	0.06
MainBranch	4446.464	50Y	11.60	104.63	107.59		107.59	0.000016	0.24	96.53	74.46	0.05
MainBranch	4446.464	100Y	13.26	104.63	108.08		108.08	0.000010	0.22	139.71	102.28	0.04
MainBranch	4446.464	Regional	36.44	104.63	110.61		110.61	0.000005	0.23	452.38	131.78	0.03
MainBranch	4395.415	2Y	2.72	104.50	104.93	104.74	104.94	0.001391	0.59	4.60	13.93	0.33
MainBranch	4395.415	5Y	5.35	104.50	105.78	104.84	105.78	0.000069	0.28	22.29	35.95	0.09
MainBranch	4395.415	10Y	7.17	104.50	106.34	104.89	106.34	0.000026	0.23	44.42	42.72	0.06
MainBranch	4395.415	25Y	9.78	104.50	107.07	104.97	107.07	0.000012	0.20	85.96	67.25	0.04

HEC-RAS Plan: Existing-Oct River: 14Mile Reach: MainBranch (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
MainBranch	4395.415	50Y	11.60	104.50	107.59	105.01	107.59	0.000008	0.19	137.53	146.49	0.04
MainBranch	4395.415	100Y	13.26	104.50	108.08	105.05	108.08	0.000005	0.16	211.02	153.74	0.03
MainBranch	4395.415	Regional	36.44	104.50	110.61	105.48	110.61	0.000002	0.17	676.37	204.21	0.02
MainBranch	4332.776	2Y	2.72	104.17	104.91		104.91	0.000208	0.32	8.67	16.89	0.14
MainBranch	4332.776	5Y	5.35	104.17	105.78		105.78	0.000032	0.23	25.59	22.12	0.06
MainBranch	4332.776	10Y	7.17	104.17	106.34		106.34	0.000018	0.21	40.71	32.12	0.05
MainBranch	4332.776	25Y	9.78	104.17	107.07		107.07	0.000010	0.20	70.32	47.85	0.04
MainBranch	4332.776	50Y	11.60	104.17	107.59		107.59	0.000007	0.19	96.16	51.83	0.03
MainBranch	4332.776	100Y	13.26	104.17	108.08		108.08	0.000006	0.19	122.42	55.04	0.03
MainBranch	4332.776	Regional	36.44	104.17	110.60		110.61	0.000006	0.26	278.57	67.19	0.03
MainBranch	4248.377	2Y	2.72	103.43	104.90		104.91	0.000028	0.18	15.68	16.20	0.06
MainBranch	4248.377	5Y	5.35	103.43	105.78		105.78	0.000013	0.18	36.98	35.45	0.04
MainBranch	4248.377	10Y	7.17	103.43	106.34		106.34	0.000009	0.17	57.68	37.64	0.04
MainBranch	4248.377	25Y	9.78	103.43	107.07		107.07	0.000006	0.17	86.41	41.22	0.03
MainBranch	4248.377	50Y	11.60	103.43	107.59		107.59	0.000005	0.17	108.50	44.07	0.03
MainBranch	4248.377	100Y	13.26	103.43	108.08		108.08	0.000004	0.17	130.77	46.76	0.03
MainBranch	4248.377	Regional	36.44	103.43	110.60		110.61	0.000005	0.26	268.56	66.88	0.03
MainBranch	4232.339	2Y	20.01	103.30	104.72	104.25	104.86	0.001905	1.63	12.28	15.34	0.47
MainBranch	4232.339	5Y	38.31	103.30	105.55	104.65	105.72	0.001226	1.85	20.70	27.47	0.42
MainBranch	4232.339	10Y	51.72	103.30	106.08	104.90	106.28	0.001025	1.98	26.16	36.79	0.39
MainBranch	4232.339	25Y	70.49	103.30	106.77	105.21	107.00	0.000859	2.12	33.21	40.94	0.38
MainBranch	4232.339	50Y	84.48	103.30	107.26	105.43	107.51	0.000770	2.21	38.26	44.12	0.36
MainBranch	4232.339	100Y	99.07	103.30	107.73	105.64	108.00	0.000719	2.31	42.97	47.13	0.36
MainBranch	4232.339	Regional	221.50	103.30	110.49	107.15	110.58	0.000161	1.44	275.72	76.42	0.18
MainBranch	4208.048		Culvert									
MainBranch	4100.962	2Y	20.01	102.73	103.67	103.60	103.97	0.007423	2.43	8.25	15.87	0.87
MainBranch	4100.962	5Y	38.31	102.73	104.04	103.99	104.55	0.007511	3.16	12.14	18.68	0.94
MainBranch	4100.962	10Y	51.72	102.73	104.26	104.24	104.91	0.007567	3.57	14.50	20.43	0.97
MainBranch	4100.962	25Y	70.49	102.73	104.55	104.55	105.37	0.007522	4.03	17.50	22.38	1.00
MainBranch	4100.962	50Y	84.48	102.73	104.76	104.76	105.69	0.007261	4.29	19.71	24.61	1.00
MainBranch	4100.962	100Y	99.07	102.73	104.97	104.97	106.01	0.007028	4.52	21.90	27.45	1.00
MainBranch	4100.962	Regional	221.50	102.73	106.44	106.44	108.22	0.005865	5.91	37.47	100.79	1.00
MainBranch	4067.080	2Y	20.01	102.50	103.68		103.76	0.001602	1.27	15.79	16.99	0.41
MainBranch	4067.080	5Y	38.31	102.50	104.12		104.26	0.001708	1.65	23.86	19.79	0.45
MainBranch	4067.080	10Y	51.72	102.50	104.40		104.57	0.001640	1.83	30.12	25.57	0.46
MainBranch	4067.080	25Y	70.49	102.50	104.74		104.94	0.001562	2.03	40.24	33.72	0.46
MainBranch	4067.080	50Y	84.48	102.50	104.96		105.18	0.001528	2.15	48.09	38.69	0.46
MainBranch	4067.080	100Y	99.07	102.50	105.17		105.41	0.001481	2.25	56.76	42.91	0.46
MainBranch	4067.080	Regional	221.50	102.50	106.55		106.84	0.001153	2.68	132.45	63.89	0.44
MainBranch	3946.464	2Y	20.01	102.00	103.42		103.52	0.002784	1.67	18.26	23.34	0.53
MainBranch	3946.464	5Y	38.31	102.00	103.89		104.02	0.002505	1.96	29.77	25.27	0.53
MainBranch	3946.464	10Y	51.72	102.00	104.20		104.34	0.002326	2.09	37.61	26.50	0.52
MainBranch	3946.464	25Y	70.49	102.00	104.55		104.72	0.002235	2.26	47.30	27.95	0.52
MainBranch	3946.464	50Y	84.48	102.00	104.77		104.96	0.002249	2.38	53.58	28.85	0.52
MainBranch	3946.464	100Y	99.07	102.00	104.99		105.19	0.002259	2.50	59.82	29.72	0.53
MainBranch	3946.464	Regional	221.50	102.00	106.32		106.65	0.002424	3.22	103.14	34.94	0.57
MainBranch	3846.464	2Y	20.01	101.50	103.05	102.73	103.21	0.003521	1.77	11.31	12.88	0.60
MainBranch	3846.464	5Y	38.31	101.50	103.34	103.15	103.66	0.005297	2.51	15.37	14.97	0.77
MainBranch	3846.464	10Y	51.72	101.50	103.42	103.36	103.92	0.007785	3.16	16.56	15.53	0.94
MainBranch	3846.464	25Y	70.49	101.50	103.64	103.64	104.29	0.008322	3.59	20.18	17.12	0.99
MainBranch	3846.464	50Y	84.48	101.50	103.83	103.83	104.53	0.007826	3.73	23.60	18.50	0.98
MainBranch	3846.464	100Y	99.07	101.50	104.01	104.01	104.76	0.007516	3.88	27.04	19.85	0.97
MainBranch	3846.464	Regional	221.50	101.50	105.15	105.15	106.22	0.006143	4.71	54.84	28.66	0.94
MainBranch	3770.893	2Y	20.01	101.71	102.52	102.52	102.77	0.010604	2.22	9.29	20.67	0.98
MainBranch	3770.893	5Y	38.31	101.71	102.81	102.81	103.15	0.008673	2.64	16.18	26.99	0.95
MainBranch	3770.893	10Y	51.72	101.71	103.14	102.97	103.41	0.004557	2.42	26.15	33.75	0.73
MainBranch	3770.893	25Y	70.49	101.71	103.69	103.18	103.82	0.001487	1.80	62.10	61.25	0.44
MainBranch	3770.893	50Y	84.48	101.71	104.03	103.31	104.13	0.000992	1.67	83.40	65.00	0.37
MainBranch	3770.893	100Y	99.07	101.71	103.96	103.49	104.12	0.001571	2.05	78.91	63.58	0.47
MainBranch	3770.893	Regional	221.50	101.71	104.01	104.01	104.74	0.007061	4.42	82.22	64.39	1.00
MainBranch	3717.833	2Y	20.01	100.51	102.16	101.51	102.24	0.000923	1.26	21.27	25.20	0.34
MainBranch	3717.833	5Y	38.31	100.51	102.80	101.89	102.90	0.000791	1.50	44.08	52.12	0.33
MainBranch	3717.833	10Y	51.72	100.51	103.23	102.08	103.29	0.000487	1.33	84.30	95.61	0.27
MainBranch	3717.833	25Y	70.49	100.51	103.72	102.43	103.76	0.000318	1.21	135.38	107.73	0.23
MainBranch	3717.833	50Y	84.48	100.51	104.05	102.62	104.09	0.000250	1.16	172.41	112.84	0.20
MainBranch	3717.833	100Y	99.07	100.51	104.00	102.67	104.05	0.000378	1.41	165.99	111.81	0.25
MainBranch	3717.833	Regional	221.50	100.51	104.25	103.60	104.43	0.001283	2.72	195.32	122.52	0.47
MainBranch	3709.655	2Y	20.00	100.51	102.02	101.67	102.19	0.003047	1.84	10.88	20.01	0.58

HEC-RAS Plan: Existing-Oct River: 14Mile Reach: MainBranch (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
MainBranch	3709.655	5Y	38.31	100.51	102.59	102.10	102.84	0.002518	2.22	18.47	53.50	0.56
MainBranch	3709.655	10Y	51.68	100.51	102.91	102.36	103.21	0.002397	2.45	23.16	104.41	0.57
MainBranch	3709.655	25Y	70.54	100.51	103.73	102.68	103.75	0.000181	0.81	218.88	261.97	0.16
MainBranch	3709.655	50Y	84.47	100.51	104.06	102.88	104.08	0.000114	0.70	311.08	285.65	0.13
MainBranch	3709.655	100Y	98.93	100.51	104.01	103.06	104.03	0.000177	0.86	296.09	281.73	0.17
MainBranch	3709.655	Regional	221.50	100.51	104.30	103.55	104.36	0.000484	1.52	382.45	305.38	0.28
MainBranch	3697.358		Bridge									
MainBranch	3685.955	2Y	20.00	100.20	101.46	100.86	101.53	0.001026	1.18	16.97	18.15	0.35
MainBranch	3685.955	5Y	38.31	100.20	101.99	101.18	102.12	0.001079	1.55	24.68	21.48	0.38
MainBranch	3685.955	10Y	51.68	100.20	102.31	101.38	102.46	0.001123	1.77	29.19	31.83	0.40
MainBranch	3685.955	25Y	70.54	100.20	102.88	101.63	103.06	0.000907	1.88	37.50	66.34	0.37
MainBranch	3685.955	50Y	84.47	100.20	103.19	101.80	103.39	0.000893	2.01	41.98	110.63	0.38
MainBranch	3685.955	100Y	98.93	100.20	103.31	101.97	103.57	0.001068	2.26	43.75	113.08	0.42
MainBranch	3685.955	Regional	221.50	100.20	104.11	103.17	104.16	0.000329	1.28	425.08	318.03	0.23
MainBranch	3667.068	2Y	20.00	100.00	101.35		101.48	0.003705	1.58	12.65	19.00	0.59
MainBranch	3667.068	5Y	38.31	100.00	101.97		102.09	0.001689	1.51	29.51	35.59	0.44
MainBranch	3667.068	10Y	51.68	100.00	102.31		102.42	0.001317	1.51	43.11	49.01	0.40
MainBranch	3667.068	25Y	70.54	100.00	102.92		102.99	0.000588	1.28	90.35	116.97	0.28
MainBranch	3667.068	50Y	84.47	100.00	103.26		103.31	0.000410	1.18	133.51	139.68	0.24
MainBranch	3667.068	100Y	98.93	100.00	103.40		103.46	0.000414	1.23	154.18	141.52	0.25
MainBranch	3667.068	Regional	221.50	100.00	104.02		104.13	0.000714	1.87	246.57	159.14	0.33
MainBranch	3610.812	2Y	20.00	100.00	101.31		101.36	0.000793	1.02	23.77	35.14	0.30
MainBranch	3610.812	5Y	38.31	100.00	101.97		102.01	0.000436	1.02	72.20	124.10	0.24
MainBranch	3610.812	10Y	51.68	100.00	102.32		102.35	0.000291	0.94	120.97	146.07	0.21
MainBranch	3610.812	25Y	70.54	100.00	102.94		102.95	0.000132	0.75	216.25	162.51	0.14
MainBranch	3610.812	50Y	84.47	100.00	103.27		103.28	0.000104	0.72	270.86	167.87	0.13
MainBranch	3610.812	100Y	98.93	100.00	103.41		103.43	0.000111	0.77	295.63	169.28	0.14
MainBranch	3610.812	Regional	221.50	100.00	104.04		104.08	0.000229	1.24	404.10	175.23	0.20
MainBranch	3597.283	2Y	22.52	99.97	101.19	100.75	101.32	0.001978	1.60	14.08	43.87	0.48
MainBranch	3597.283	5Y	42.68	99.97	101.73	101.12	101.95	0.001898	2.04	20.92	95.72	0.50
MainBranch	3597.283	10Y	57.48	99.97	101.96	101.36	102.26	0.002258	2.42	23.74	101.08	0.56
MainBranch	3597.283	25Y	78.22	99.97	102.93	101.65	102.95	0.000141	0.77	215.38	150.74	0.15
MainBranch	3597.283	50Y	93.10	99.97	103.26	101.84	103.28	0.000117	0.76	267.43	165.23	0.14
MainBranch	3597.283	100Y	107.30	99.97	103.41	102.02	103.42	0.000124	0.80	291.85	167.54	0.14
MainBranch	3597.283	Regional	261.10	99.97	104.02	102.50	104.07	0.000318	1.45	397.13	177.12	0.24
MainBranch	3573.439		Bridge									
MainBranch	3552.954	2Y	22.52	99.99	100.69	100.69	101.03	0.009807	2.57	8.76	40.39	0.99
MainBranch	3552.954	5Y	42.68	99.99	101.05	101.05	101.57	0.008740	3.21	13.31	75.80	1.00
MainBranch	3552.954	10Y	57.48	99.99	101.28	101.28	101.92	0.008176	3.54	16.24	81.41	1.00
MainBranch	3552.954	25Y	78.22	99.99	101.57	101.57	102.35	0.007611	3.92	19.96	88.80	1.00
MainBranch	3552.954	50Y	93.10	99.99	101.76	101.76	102.64	0.007291	4.15	22.44	102.23	1.00
MainBranch	3552.954	100Y	107.30	99.99	101.94	101.94	102.90	0.007087	4.35	24.65	122.84	1.00
MainBranch	3552.954	Regional	261.10	99.99	103.05	102.86	103.14	0.000751	1.83	284.75	168.32	0.35
MainBranch	3539.547	2Y	22.52	100.00	100.62	100.62	100.83	0.010089	2.18	13.90	37.38	0.96
MainBranch	3539.547	5Y	42.68	100.00	100.87	100.87	101.14	0.008702	2.61	23.91	45.00	0.95
MainBranch	3539.547	10Y	57.48	100.00	100.93	100.89	101.34	0.011819	3.19	26.72	56.26	1.12
MainBranch	3539.547	25Y	78.22	100.00	101.28		101.54	0.005062	2.65	51.53	73.17	0.78
MainBranch	3539.547	50Y	93.10	100.00	101.49		101.70	0.003562	2.48	67.11	76.82	0.67
MainBranch	3539.547	100Y	107.30	100.00	101.67		101.86	0.002842	2.40	81.07	80.18	0.61
MainBranch	3539.547	Regional	261.10	100.00	102.95		103.11	0.001315	2.43	224.57	152.29	0.46
MainBranch	3492.153	2Y	22.52	99.00	100.03	99.92	100.23	0.005755	1.94	12.05	20.49	0.75
MainBranch	3492.153	5Y	42.68	99.00	100.24	100.24	100.62	0.008791	2.79	16.45	23.41	0.96
MainBranch	3492.153	10Y	57.48	99.00	100.42	100.42	100.87	0.008256	3.03	21.10	26.27	0.96
MainBranch	3492.153	25Y	78.22	99.00	100.65	100.65	101.17	0.007730	3.29	27.43	29.52	0.96
MainBranch	3492.153	50Y	93.10	99.00	100.79	100.79	101.36	0.007398	3.47	31.74	31.46	0.95
MainBranch	3492.153	100Y	107.30	99.00	100.91	100.91	101.53	0.007183	3.62	35.71	33.05	0.95
MainBranch	3492.153	Regional	261.10	99.00	102.90	101.71	103.06	0.000896	2.26	224.44	127.31	0.39
MainBranch	3446.464	2Y	22.52	98.82	99.65	99.65	99.88	0.009741	2.20	11.64	29.73	0.95
MainBranch	3446.464	5Y	42.68	98.82	99.97	99.91	100.24	0.006333	2.42	22.91	38.99	0.83
MainBranch	3446.464	10Y	57.48	98.82	100.18	100.06	100.45	0.005096	2.50	31.57	43.82	0.77
MainBranch	3446.464	25Y	78.22	98.82	100.39	100.26	100.70	0.004803	2.73	41.14	48.56	0.77
MainBranch	3446.464	50Y	93.10	98.82	100.51		100.86	0.004780	2.90	47.52	52.88	0.78
MainBranch	3446.464	100Y	107.30	98.82	100.62	100.47	101.00	0.004802	3.05	53.73	59.67	0.79
MainBranch	3446.464	Regional	261.10	98.82	102.89		103.02	0.000667	2.09	237.22	98.78	0.34
MainBranch	3390.389	2Y	22.52	98.38	99.34		99.51	0.004279	1.87	14.34	24.95	0.67
MainBranch	3390.389	5Y	42.68	98.38	99.59	99.51	99.90	0.005801	2.61	21.64	34.61	0.81
MainBranch	3390.389	10Y	57.48	98.38	99.73	99.72	100.13	0.006551	3.01	26.76	39.77	0.88
MainBranch	3390.389	25Y	78.22	98.38	99.93	99.93	100.40	0.006347	3.30	35.53	44.84	0.89

HEC-RAS Plan: Existing-Oct River: 14Mile Reach: MainBranch (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
MainBranch	3390.389	50Y	93.10	98.38	100.06	100.06	100.56	0.006223	3.47	41.63	47.94	0.90
MainBranch	3390.389	100Y	107.30	98.38	100.18	100.18	100.71	0.006113	3.61	47.33	50.56	0.90
MainBranch	3390.389	Regional	261.10	98.38	102.89		102.98	0.000438	1.85	291.91	106.97	0.28
MainBranch	3322.153	2Y	22.52	98.06	98.90	98.90	99.11	0.009180	2.29	15.16	37.02	0.93
MainBranch	3322.153	5Y	42.68	98.06	99.13	99.13	99.42	0.009465	2.85	23.74	40.71	0.99
MainBranch	3322.153	10Y	57.48	98.06	99.27	99.27	99.61	0.009383	3.14	29.63	44.65	1.01
MainBranch	3322.153	25Y	78.22	98.06	99.44	99.44	99.84	0.009177	3.45	37.49	47.58	1.03
MainBranch	3322.153	50Y	93.10	98.06	99.71		100.02	0.005506	3.09	51.32	51.80	0.83
MainBranch	3322.153	100Y	107.30	98.06	100.03		100.26	0.003343	2.75	68.47	57.25	0.66
MainBranch	3322.153	Regional	261.10	98.06	102.89		102.95	0.000311	1.60	358.17	128.07	0.24
MainBranch	3246.464	2Y	22.52	97.00	97.93	97.93	98.22	0.010663	2.39	9.50	17.87	0.99
MainBranch	3246.464	5Y	42.68	97.00	98.26	98.26	98.66	0.008562	2.83	16.61	25.09	0.95
MainBranch	3246.464	10Y	57.48	97.00	98.69	98.46	98.97	0.003934	2.42	29.32	34.27	0.68
MainBranch	3246.464	25Y	78.22	97.00	99.27	98.70	99.45	0.001860	2.06	51.73	42.00	0.49
MainBranch	3246.464	50Y	93.10	97.00	99.64	98.84	99.80	0.001308	1.93	68.64	46.62	0.42
MainBranch	3246.464	100Y	107.30	97.00	99.97	99.01	100.11	0.001013	1.83	84.15	47.95	0.38
MainBranch	3246.464	Regional	261.10	97.00	102.89	99.94	102.93	0.000142	1.16	448.31	136.27	0.16
MainBranch	3150.013	2Y	22.52	96.71	97.76		97.78	0.000478	0.74	40.69	53.30	0.23
MainBranch	3150.013	5Y	42.68	96.71	98.41		98.43	0.000278	0.78	86.28	87.12	0.19
MainBranch	3150.013	10Y	57.48	96.71	98.82		98.84	0.000206	0.78	125.75	104.31	0.17
MainBranch	3150.013	25Y	78.22	96.71	99.35		99.37	0.000147	0.77	186.03	123.56	0.15
MainBranch	3150.013	50Y	93.10	96.71	99.71		99.73	0.000119	0.75	233.35	135.05	0.14
MainBranch	3150.013	100Y	107.30	96.71	100.03		100.05	0.000102	0.74	277.79	143.38	0.13
MainBranch	3150.013	Regional	261.10	96.71	102.90		102.92	0.000043	0.73	790.27	230.96	0.09
MainBranch	3105.432	2Y	22.53	96.19	97.67	97.18	97.74	0.001258	1.14	19.72	29.44	0.37
MainBranch	3105.432	5Y	42.62	96.19	98.31	97.47	98.39	0.000822	1.30	32.84	61.77	0.33
MainBranch	3105.432	10Y	57.44	96.19	98.70	97.64	98.80	0.000716	1.40	40.94	88.90	0.32
MainBranch	3105.432	25Y	78.10	96.19	99.21	97.85	99.33	0.000622	1.52	51.36	123.83	0.31
MainBranch	3105.432	50Y	93.16	96.19	99.56	97.99	99.69	0.000572	1.59	58.54	145.98	0.30
MainBranch	3105.432	100Y	107.10	96.19	99.86	98.11	100.00	0.000538	1.65	64.84	165.84	0.30
MainBranch	3105.432	Regional	256.10	96.19	102.62	99.22	102.85	0.000378	2.11	121.55	322.46	0.28
MainBranch	3085.638		Bridge									
MainBranch	3066.327	2Y	22.53	96.08	96.96	96.96	97.27	0.010538	2.47	9.12	15.33	1.00
MainBranch	3066.327	5Y	42.62	96.08	97.64	97.29	97.90	0.003177	2.22	19.16	19.85	0.62
MainBranch	3066.327	10Y	57.44	96.08	98.06	97.50	98.32	0.002280	2.27	25.31	22.88	0.55
MainBranch	3066.327	25Y	78.10	96.08	98.55	97.76	98.84	0.001839	2.41	32.47	27.05	0.52
MainBranch	3066.327	50Y	93.16	96.08	98.85	97.94	99.17	0.001702	2.52	36.94	30.26	0.51
MainBranch	3066.327	100Y	107.10	96.08	99.10	98.10	99.46	0.001631	2.63	40.67	31.35	0.51
MainBranch	3066.327	Regional	256.10	96.08	99.97	99.41	100.56	0.002577	3.54	89.56	43.64	0.62
MainBranch	3054.885	2Y	22.53	96.00	96.87	96.83	97.12	0.008861	2.20	10.27	17.62	0.91
MainBranch	3054.885	5Y	42.62	96.00	97.67		97.82	0.001795	1.74	26.28	25.31	0.47
MainBranch	3054.885	10Y	57.44	96.00	98.10		98.25	0.001242	1.74	38.71	32.13	0.41
MainBranch	3054.885	25Y	78.10	96.00	98.61		98.75	0.000926	1.77	57.00	40.02	0.37
MainBranch	3054.885	50Y	93.16	96.00	98.93		99.07	0.000803	1.80	70.85	45.02	0.35
MainBranch	3054.885	100Y	107.10	96.00	99.20		99.34	0.000719	1.81	83.16	46.19	0.34
MainBranch	3054.885	Regional	256.10	96.00	100.04		100.45	0.001526	3.13	126.00	62.74	0.51
MainBranch	2989.647	2Y	22.53	95.00	96.88	95.85	96.93	0.000556	0.98	23.06	15.70	0.26
MainBranch	2989.647	5Y	42.62	95.00	97.65	96.23	97.72	0.000554	1.18	36.14	18.20	0.27
MainBranch	2989.647	10Y	57.44	95.00	98.10	96.47	98.16	0.000425	1.15	68.33	56.20	0.24
MainBranch	2989.647	25Y	78.10	95.00	98.62	96.76	98.67	0.000349	1.17	97.65	57.23	0.22
MainBranch	2989.647	50Y	93.16	95.00	98.94	96.95	99.00	0.000321	1.19	116.23	57.80	0.22
MainBranch	2989.647	100Y	107.10	95.00	99.21	97.11	99.27	0.000305	1.21	131.97	58.27	0.21
MainBranch	2989.647	Regional	256.10	95.00	100.10	98.42	100.26	0.000681	2.08	186.97	71.68	0.33
MainBranch	2946.464	2Y	22.53	94.79	96.28	96.28	96.81	0.010632	3.23	6.97	6.55	1.00
MainBranch	2946.464	5Y	42.62	94.79	96.89	96.89	97.59	0.009907	3.71	11.48	8.23	1.00
MainBranch	2946.464	10Y	57.44	94.79	97.24	97.24	98.04	0.009640	3.95	14.54	9.27	1.01
MainBranch	2946.464	25Y	78.10	94.79	97.66	97.66	98.55	0.009256	4.18	18.70	10.66	1.01
MainBranch	2946.464	50Y	93.16	94.79	97.93	97.93	98.87	0.008970	4.30	21.66	11.54	1.00
MainBranch	2946.464	100Y	107.10	94.79	98.15	98.15	99.14	0.008775	4.41	24.29	12.28	1.00
MainBranch	2946.464	Regional	256.10	94.79	99.80	99.52	100.19	0.002666	3.40	146.72	107.99	0.60
MainBranch	2902.731	2Y	22.53	94.77	95.87		96.21	0.007111	2.57	8.76	8.76	0.82
MainBranch	2902.731	5Y	42.62	94.77	96.29	96.22	96.88	0.008641	3.38	12.60	9.30	0.93
MainBranch	2902.731	10Y	57.44	94.77	96.57	96.52	97.29	0.009076	3.78	15.21	9.69	0.96
MainBranch	2902.731	25Y	78.10	94.77	96.92	96.91	97.80	0.009411	4.16	18.75	10.50	0.99
MainBranch	2902.731	50Y	93.16	94.77	97.18	97.18	98.13	0.009293	4.30	21.68	11.55	1.00
MainBranch	2902.731	100Y	107.10	94.77	97.42	97.41	98.39	0.008936	4.36	24.56	12.51	0.99
MainBranch	2902.731	Regional	256.10	94.77	99.42	99.42	100.04	0.003476	3.77	116.13	128.59	0.68
MainBranch	2892.413	2Y	23.21	94.72	95.88	95.59	96.09	0.003952	2.00	11.59	11.21	0.63

HEC-RAS Plan: Existing-Oct River: 14Mile Reach: MainBranch (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
MainBranch	2892.413	5Y	42.81	94.72	96.37	95.99	96.68	0.004066	2.49	17.22	11.92	0.66
MainBranch	2892.413	10Y	57.68	94.72	96.68	96.25	97.06	0.004112	2.75	20.99	12.37	0.67
MainBranch	2892.413	25Y	78.40	94.72	97.07	96.58	97.53	0.004163	3.03	25.92	13.13	0.69
MainBranch	2892.413	50Y	93.45	94.72	97.33	96.79	97.84	0.004274	3.17	29.51	14.30	0.70
MainBranch	2892.413	100Y	107.50	94.72	97.58	96.98	98.11	0.004238	3.23	33.27	15.66	0.71
MainBranch	2892.413	Regional	258.40	94.72	98.96	98.93	99.45	0.002932	3.49	148.43	180.76	0.63
MainBranch	2876.495		Bridge									
MainBranch	2860.405	2Y	23.21	94.28	95.40	95.23	95.58	0.004835	1.83	12.66	17.66	0.69
MainBranch	2860.405	5Y	42.81	94.28	95.82	95.54	96.04	0.003806	2.11	20.36	19.65	0.65
MainBranch	2860.405	10Y	57.68	94.28	96.08	95.73	96.34	0.003450	2.27	25.70	21.57	0.64
MainBranch	2860.405	25Y	78.40	94.28	96.40	95.96	96.70	0.003103	2.44	33.12	24.01	0.63
MainBranch	2860.405	50Y	93.45	94.28	96.61	96.12	96.94	0.002963	2.55	38.26	25.48	0.62
MainBranch	2860.405	100Y	107.50	94.28	96.80	96.26	97.15	0.002790	2.63	43.27	26.67	0.61
MainBranch	2860.405	Regional	258.40	94.28	98.26	97.43	98.78	0.002355	3.30	90.55	39.85	0.61
MainBranch	2849.017	2Y	23.21	94.00	95.27		95.50	0.006261	2.09	11.12	15.89	0.79
MainBranch	2849.017	5Y	42.81	94.00	95.61	95.49	95.95	0.006224	2.61	16.76	17.99	0.83
MainBranch	2849.017	10Y	57.68	94.00	95.80	95.69	96.24	0.006401	2.93	20.41	19.23	0.86
MainBranch	2849.017	25Y	78.40	94.00	96.05	95.95	96.58	0.006451	3.27	25.33	20.97	0.88
MainBranch	2849.017	50Y	93.45	94.00	96.22	96.11	96.81	0.006313	3.44	29.05	22.35	0.89
MainBranch	2849.017	100Y	107.50	94.00	96.33	96.27	97.00	0.006731	3.68	31.49	23.21	0.93
MainBranch	2849.017	Regional	258.40	94.00	97.47	97.47	98.57	0.006546	4.80	62.31	30.53	0.98
MainBranch	2746.464	2Y	23.21	93.57	94.71		94.90	0.005088	1.91	12.12	16.51	0.71
MainBranch	2746.464	5Y	42.81	93.57	95.04	94.87	95.33	0.005317	2.39	17.92	18.53	0.77
MainBranch	2746.464	10Y	57.68	93.57	95.23	95.07	95.60	0.005392	2.70	21.54	19.65	0.79
MainBranch	2746.464	25Y	78.40	93.57	95.41	95.29	95.92	0.006245	3.19	25.46	27.93	0.87
MainBranch	2746.464	50Y	93.45	93.57	95.52	95.50	96.13	0.006783	3.50	28.60	29.56	0.92
MainBranch	2746.464	100Y	107.50	93.57	95.64	95.64	96.31	0.006664	3.67	32.42	30.35	0.93
MainBranch	2746.464	Regional	258.40	93.57	96.76	96.76	97.77	0.005438	4.72	71.10	38.67	0.91
MainBranch	2680.447	2Y	23.21	93.18	94.11	94.11	94.42	0.010582	2.44	9.51	15.64	1.00
MainBranch	2680.447	5Y	42.81	93.18	94.43	94.43	94.86	0.009513	2.90	14.79	17.31	1.00
MainBranch	2680.447	10Y	57.68	93.18	94.64	94.64	95.14	0.009068	3.13	18.40	18.39	1.00
MainBranch	2680.447	25Y	78.40	93.18	94.92	94.92	95.46	0.007822	3.27	25.69	34.20	0.96
MainBranch	2680.447	50Y	93.45	93.18	95.08	95.08	95.66	0.007304	3.40	31.63	40.81	0.94
MainBranch	2680.447	100Y	107.50	93.18	95.22	95.22	95.82	0.006642	3.48	37.92	44.02	0.91
MainBranch	2680.447	Regional	258.40	93.18	96.13	96.13	97.02	0.005913	4.52	95.54	60.56	0.93
MainBranch	2646.464	2Y	23.21	93.00	93.91	93.76	94.09	0.005044	1.91	13.13	22.35	0.71
MainBranch	2646.464	5Y	42.81	93.00	94.26	94.08	94.52	0.004472	2.31	22.25	27.98	0.71
MainBranch	2646.464	10Y	57.68	93.00	94.48	94.26	94.79	0.004136	2.52	28.77	29.94	0.71
MainBranch	2646.464	25Y	78.40	93.00	94.77	94.48	95.12	0.003798	2.76	37.50	31.90	0.70
MainBranch	2646.464	50Y	93.45	93.00	94.95	94.64	95.34	0.003621	2.90	43.53	32.77	0.70
MainBranch	2646.464	100Y	107.50	93.00	95.06	94.77	95.51	0.003859	3.12	47.17	33.27	0.73
MainBranch	2646.464	Regional	258.40	93.00	95.89	95.84	96.77	0.005174	4.61	104.34	65.70	0.90
MainBranch	2546.464	2Y	23.21	91.82	93.04	93.04	93.38	0.010130	2.59	8.96	12.94	0.99
MainBranch	2546.464	5Y	42.81	91.82	93.40	93.40	93.88	0.009065	3.06	14.13	15.61	0.99
MainBranch	2546.464	10Y	57.68	91.82	93.63	93.63	94.19	0.008519	3.32	17.87	17.29	0.99
MainBranch	2546.464	25Y	78.40	91.82	93.91	93.91	94.56	0.008001	3.60	23.01	19.67	0.98
MainBranch	2546.464	50Y	93.45	91.82	94.09	94.09	94.80	0.007738	3.76	26.72	21.24	0.98
MainBranch	2546.464	100Y	107.50	91.82	94.34	94.34	95.01	0.006261	3.65	36.15	46.87	0.90
MainBranch	2546.464	Regional	258.40	91.82	95.46	95.46	96.27	0.004603	4.38	118.10	92.77	0.84
MainBranch	2446.464	2Y	23.21	91.17	92.23		92.46	0.005447	2.14	10.90	13.59	0.74
MainBranch	2446.464	5Y	42.81	91.17	92.46	92.44	92.95	0.008548	3.10	14.12	14.85	0.96
MainBranch	2446.464	10Y	57.68	91.17	92.67	92.67	93.28	0.008656	3.47	17.33	16.01	0.99
MainBranch	2446.464	25Y	78.40	91.17	92.96	92.96	93.68	0.007982	3.77	22.36	17.90	0.98
MainBranch	2446.464	50Y	93.45	91.17	93.16	93.16	93.94	0.007617	3.95	26.01	19.00	0.97
MainBranch	2446.464	100Y	107.50	91.17	93.31	93.31	94.17	0.007699	4.17	28.86	19.82	0.99
MainBranch	2446.464	Regional	258.40	91.17	94.82	94.82	95.78	0.004423	4.71	106.35	74.20	0.83
MainBranch	2346.464	2Y	23.21	90.92	91.95	91.65	92.06	0.002697	1.50	20.06	51.92	0.53
MainBranch	2346.464	5Y	42.81	90.92	92.38	92.00	92.49	0.001864	1.60	44.81	62.71	0.47
MainBranch	2346.464	10Y	57.68	90.92	92.66	92.16	92.77	0.001528	1.64	63.26	67.54	0.44
MainBranch	2346.464	25Y	78.40	90.92	92.95	92.35	93.08	0.001389	1.77	83.79	72.29	0.43
MainBranch	2346.464	50Y	93.45	90.92	93.18	92.46	93.31	0.001231	1.81	100.77	75.97	0.41
MainBranch	2346.464	100Y	107.50	90.92	93.40	92.55	93.53	0.001091	1.83	117.78	79.62	0.39
MainBranch	2346.464	Regional	258.40	90.92	95.23	93.33	95.38	0.000637	2.09	292.89	117.72	0.33
MainBranch	2296.492	2Y	23.21	90.50	91.55	91.49	91.82	0.008021	2.31	10.04	14.48	0.89
MainBranch	2296.492	5Y	42.81	90.50	92.04	91.84	92.33	0.004773	2.38	19.96	29.73	0.73
MainBranch	2296.492	10Y	57.68	90.50	92.37	92.07	92.64	0.003360	2.36	32.66	48.16	0.64
MainBranch	2296.492	25Y	78.40	90.50	92.67	92.36	92.96	0.002947	2.51	48.46	58.93	0.62
MainBranch	2296.492	50Y	93.45	90.50	92.94	92.51	93.21	0.002281	2.45	66.08	67.40	0.56
MainBranch	2296.492	100Y	107.50	90.50	93.20	92.64	93.44	0.001823	2.38	83.97	70.83	0.51

HEC-RAS Plan: Existing-Oct River: 14Mile Reach: MainBranch (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
MainBranch	2296.492	Regional	258.40	90.50	95.12	93.59	95.33	0.000868	2.49	241.77	96.96	0.39
MainBranch	2224.630	2Y	23.21	90.00	91.54	90.85	91.60	0.001004	1.09	21.22	20.22	0.34
MainBranch	2224.630	5Y	42.81	90.00	92.05	91.20	92.14	0.000965	1.35	35.07	37.68	0.35
MainBranch	2224.630	10Y	57.68	90.00	92.38	91.40	92.48	0.000868	1.46	50.84	54.92	0.34
MainBranch	2224.630	25Y	78.40	90.00	92.67	91.65	92.80	0.000927	1.66	67.78	61.48	0.36
MainBranch	2224.630	50Y	93.45	90.00	92.94	91.81	93.08	0.000835	1.71	85.40	67.88	0.35
MainBranch	2224.630	100Y	107.50	90.00	93.20	91.96	93.33	0.000750	1.73	103.42	73.70	0.34
MainBranch	2224.630	Regional	258.40	90.00	95.11	93.06	95.27	0.000518	2.06	302.25	149.71	0.31
MainBranch	2213.506	2Y	24.10	90.10	91.41	91.08	91.56	0.002844	1.70	14.16	17.49	0.55
MainBranch	2213.506	5Y	42.93	90.10	91.89	91.40	92.09	0.002659	1.98	21.72	24.06	0.56
MainBranch	2213.506	10Y	57.76	90.10	92.20	91.63	92.43	0.002341	2.14	27.07	30.86	0.55
MainBranch	2213.506	25Y	78.55	90.10	92.37	91.92	92.72	0.003037	2.61	30.12	37.09	0.63
MainBranch	2213.506	50Y	93.42	90.10	92.61	92.08	92.99	0.002817	2.74	34.20	44.91	0.62
MainBranch	2213.506	100Y	107.80	90.10	92.82	92.22	93.23	0.002656	2.85	37.95	52.12	0.61
MainBranch	2213.506	Regional	260.10	90.10	95.01	93.61	95.24	0.000803	2.48	301.56	232.39	0.38
MainBranch	2199.501		Bridge									
MainBranch	2185.476	2Y	24.10	89.50	90.90	90.53	91.02	0.002284	1.53	15.78	25.16	0.50
MainBranch	2185.476	5Y	42.93	89.50	91.20	90.83	91.42	0.002852	2.06	20.88	36.65	0.59
MainBranch	2185.476	10Y	57.76	89.50	91.39	91.02	91.69	0.003238	2.41	24.02	39.17	0.64
MainBranch	2185.476	25Y	78.55	89.50	91.60	91.26	92.02	0.003797	2.85	27.53	42.08	0.71
MainBranch	2185.476	50Y	93.42	89.50	91.70	91.42	92.22	0.004429	3.20	29.17	43.10	0.77
MainBranch	2185.476	100Y	107.80	89.50	91.81	91.57	92.43	0.004827	3.48	30.98	44.02	0.81
MainBranch	2185.476	Regional	260.10	89.50	92.87	92.87	94.32	0.006234	5.34	48.67	81.03	1.00
MainBranch	2173.272	2Y	24.10	89.50	90.86	90.48	90.95	0.001879	1.35	19.70	26.91	0.45
MainBranch	2173.272	5Y	42.93	89.50	91.18	90.74	91.33	0.002244	1.76	29.03	33.03	0.51
MainBranch	2173.272	10Y	57.76	89.50	91.38	90.92	91.57	0.002426	2.01	36.08	37.21	0.54
MainBranch	2173.272	25Y	78.55	89.50	91.61	91.15	91.86	0.002642	2.30	45.34	41.87	0.58
MainBranch	2173.272	50Y	93.42	89.50	91.73	91.30	92.03	0.002945	2.53	50.40	44.71	0.62
MainBranch	2173.272	100Y	107.80	89.50	91.86	91.43	92.20	0.003031	2.68	56.61	47.98	0.63
MainBranch	2173.272	Regional	260.10	89.50	92.90	92.59	93.41	0.003058	3.54	148.79	112.26	0.68
MainBranch	2162.390	2Y	24.10	89.50	90.59		90.76	0.005757	1.82	13.33	26.05	0.74
MainBranch	2162.390	5Y	42.93	89.50	90.83	90.73	91.10	0.006160	2.31	20.26	31.76	0.80
MainBranch	2162.390	10Y	57.76	89.50	90.98	90.90	91.32	0.006578	2.62	25.14	35.84	0.85
MainBranch	2162.390	25Y	78.55	89.50	91.16	91.10	91.59	0.006811	2.96	32.01	39.52	0.89
MainBranch	2162.390	50Y	93.42	89.50	91.35	91.24	91.77	0.005766	2.97	39.70	43.27	0.83
MainBranch	2162.390	100Y	107.80	89.50	91.70		92.02	0.003304	2.61	58.66	64.67	0.65
MainBranch	2162.390	Regional	260.10	89.50	92.30	92.30	93.10	0.005783	4.26	106.68	94.03	0.91
MainBranch	2118.174	2Y	24.10	89.50	90.39		90.54	0.004362	1.77	17.59	45.37	0.66
MainBranch	2118.174	5Y	42.93	89.50	90.62	90.51	90.85	0.004843	2.25	29.44	56.16	0.73
MainBranch	2118.174	10Y	57.76	89.50	90.79	90.67	91.06	0.004600	2.45	39.78	62.32	0.74
MainBranch	2118.174	25Y	78.55	89.50	91.05		91.33	0.003847	2.57	56.72	70.33	0.70
MainBranch	2118.174	50Y	93.42	89.50	91.31		91.55	0.002734	2.43	76.30	77.38	0.60
MainBranch	2118.174	100Y	107.80	89.50	91.71		91.88	0.001563	2.12	108.84	87.47	0.47
MainBranch	2118.174	Regional	260.10	89.50	92.24		92.74	0.003605	3.76	158.63	98.12	0.75
MainBranch	2046.464	2Y	24.10	89.00	90.24		90.32	0.001876	1.34	28.54	67.24	0.45
MainBranch	2046.464	5Y	42.93	89.00	90.41		90.57	0.002980	1.90	40.60	74.37	0.59
MainBranch	2046.464	10Y	57.76	89.00	90.65		90.80	0.002355	1.93	59.59	82.40	0.54
MainBranch	2046.464	25Y	78.55	89.00	90.97		91.11	0.001806	1.96	86.97	90.82	0.49
MainBranch	2046.464	50Y	93.42	89.00	91.27		91.39	0.001281	1.85	115.96	99.42	0.42
MainBranch	2046.464	100Y	107.80	89.00	91.69		91.78	0.000776	1.64	160.49	112.15	0.34
MainBranch	2046.464	Regional	260.10	89.00	92.23		92.50	0.001924	2.96	222.81	119.13	0.56
MainBranch	1952.554	2Y	24.10	88.54	89.78	89.78	90.02	0.005781	2.28	18.98	60.71	0.77
MainBranch	1952.554	5Y	42.93	88.54	90.34	90.03	90.38	0.000981	1.26	109.90	146.79	0.34
MainBranch	1952.554	10Y	57.76	88.54	90.62	90.21	90.65	0.000744	1.24	151.16	152.67	0.30
MainBranch	1952.554	25Y	78.55	88.54	90.96	90.21	90.99	0.000591	1.25	203.70	158.56	0.28
MainBranch	1952.554	50Y	93.42	88.54	91.27	90.23	91.30	0.000438	1.18	254.65	163.50	0.25
MainBranch	1952.554	100Y	107.80	88.54	91.70	90.29	91.72	0.000283	1.06	325.62	169.16	0.20
MainBranch	1952.554	Regional	260.10	88.54	92.27	90.77	92.34	0.000761	1.97	424.40	178.30	0.34
MainBranch	1942.494	2Y	22.52	88.49	89.65	89.44	89.84	0.004979	1.90	12.07	93.10	0.71
MainBranch	1942.494	5Y	42.48	88.49	90.03	89.84	90.29	0.004453	2.30	21.35	149.59	0.71
MainBranch	1942.494	10Y	56.95	88.49	90.23	90.03	90.55	0.004409	2.56	26.86	160.28	0.73
MainBranch	1942.494	25Y	77.12	88.49	90.47	90.25	90.86	0.004377	2.87	33.59	173.23	0.74
MainBranch	1942.494	50Y	91.57	88.49	90.88	90.39	91.20	0.002658	2.62	45.01	188.78	0.60
MainBranch	1942.494	100Y	106.00	88.49	91.70	90.52	91.71	0.000174	0.85	388.67	210.57	0.16
MainBranch	1942.494	Regional	261.50	88.49	92.27	91.10	92.32	0.000483	1.61	512.22	221.68	0.28
MainBranch	1930.221		Bridge									
MainBranch	1917.479	2Y	22.52	88.48	89.26	89.15	89.41	0.005636	1.72	13.10	24.22	0.72

HEC-RAS Plan: Existing-Oct River: 14Mile Reach: MainBranch (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
MainBranch	1917.479	5Y	42.48	88.48	89.49	89.40	89.76	0.006649	2.32	18.32	31.36	0.83
MainBranch	1917.479	10Y	56.95	88.48	89.57	89.55	89.98	0.008488	2.81	20.33	88.39	0.95
MainBranch	1917.479	25Y	77.12	88.48	89.74	89.74	90.26	0.008700	3.19	24.30	92.71	0.99
MainBranch	1917.479	50Y	91.57	88.48	89.87	89.87	90.45	0.008406	3.38	27.31	96.04	1.00
MainBranch	1917.479	100Y	106.00	88.48	89.99	89.99	90.63	0.008096	3.55	30.27	98.05	0.99
MainBranch	1917.479	Regional	261.50	88.48	90.99	90.99	91.28	0.002658	2.90	200.60	130.09	0.62
MainBranch	1902.476	2Y	22.52	88.38	89.28	89.01	89.31	0.001735	1.12	50.42	111.04	0.42
MainBranch	1902.476	5Y	42.48	88.38	89.55	89.21	89.61	0.001772	1.37	83.99	131.99	0.44
MainBranch	1902.476	10Y	56.95	88.38	89.70	89.30	89.76	0.001808	1.49	102.79	133.24	0.46
MainBranch	1902.476	25Y	77.12	88.38	89.86	89.41	89.93	0.001881	1.65	124.81	134.69	0.47
MainBranch	1902.476	50Y	91.57	88.38	89.96	89.48	90.03	0.001837	1.72	147.86	150.10	0.47
MainBranch	1902.476	100Y	106.00	88.38	90.06	89.55	90.13	0.001846	1.81	162.61	150.68	0.48
MainBranch	1902.476	Regional	261.50	88.38	90.90	90.05	91.03	0.001864	2.47	292.48	157.11	0.52
MainBranch	1816.580	2Y	22.52	88.00	88.89		88.93	0.002891	1.11	40.57	105.36	0.51
MainBranch	1816.580	5Y	42.48	88.00	89.22		89.26	0.002201	1.35	82.96	140.49	0.48
MainBranch	1816.580	10Y	56.95	88.00	89.41		89.45	0.001713	1.37	111.15	152.52	0.44
MainBranch	1816.580	25Y	77.12	88.00	89.57		89.62	0.001750	1.53	136.18	158.27	0.45
MainBranch	1816.580	50Y	91.57	88.00	89.67		89.73	0.001778	1.64	152.38	160.52	0.46
MainBranch	1816.580	100Y	106.00	88.00	89.77		89.84	0.001772	1.72	168.53	162.15	0.47
MainBranch	1816.580	Regional	261.50	88.00	90.63		90.74	0.001679	2.32	314.03	175.14	0.50
MainBranch	1668.083	2Y	22.52	87.00	88.59		88.68	0.001543	1.44	31.18	72.73	0.41
MainBranch	1668.083	5Y	42.48	87.00	88.74	88.60	88.95	0.003258	2.23	42.71	80.32	0.61
MainBranch	1668.083	10Y	56.95	87.00	88.87	88.76	89.15	0.004106	2.63	55.50	114.69	0.69
MainBranch	1668.083	25Y	77.12	87.00	89.07	89.02	89.33	0.003861	2.73	79.24	121.25	0.68
MainBranch	1668.083	50Y	91.57	87.00	89.23		89.46	0.003402	2.69	98.60	124.75	0.65
MainBranch	1668.083	100Y	106.00	87.00	89.30		89.56	0.003792	2.90	106.97	126.37	0.68
MainBranch	1668.083	Regional	261.50	87.00	90.22		90.50	0.003340	3.47	236.75	174.17	0.68
MainBranch	1546.464	2Y	22.52	87.00	88.01	88.01	88.30	0.008488	2.39	11.07	29.16	0.91
MainBranch	1546.464	5Y	42.48	87.00	88.28	88.22	88.47	0.005180	2.28	44.40	86.26	0.75
MainBranch	1546.464	10Y	56.95	87.00	88.50	88.33	88.66	0.003655	2.21	64.26	89.98	0.65
MainBranch	1546.464	25Y	77.12	87.00	88.80	88.46	88.94	0.002620	2.17	91.29	94.82	0.57
MainBranch	1546.464	50Y	91.57	87.00	88.99	88.54	89.13	0.002204	2.17	110.16	97.87	0.54
MainBranch	1546.464	100Y	106.00	87.00	88.93	88.63	89.13	0.003463	2.64	103.99	96.88	0.67
MainBranch	1546.464	Regional	261.50	87.00	89.69	89.29	90.07	0.004435	3.88	181.61	107.72	0.81
MainBranch	1446.464	2Y	22.52	85.88	87.33	87.05	87.51	0.004339	1.91	11.78	14.09	0.67
MainBranch	1446.464	5Y	42.48	85.88	87.75	87.50	88.01	0.004466	2.25	18.94	19.27	0.70
MainBranch	1446.464	10Y	56.95	85.88	87.96	87.71	88.28	0.004361	2.51	23.23	21.88	0.72
MainBranch	1446.464	25Y	77.12	85.88	88.17	87.95	88.60	0.004785	2.91	27.97	24.33	0.77
MainBranch	1446.464	50Y	91.57	85.88	88.32	88.10	88.81	0.004767	3.11	31.92	26.30	0.78
MainBranch	1446.464	100Y	106.00	85.88	88.69	88.25	88.91	0.001996	2.31	106.70	129.50	0.52
MainBranch	1446.464	Regional	261.50	85.88	89.36	89.25	89.76	0.003087	3.49	226.44	209.01	0.68
MainBranch	1391.170	2Y	22.52	85.70	87.25	87.00	87.33	0.002060	1.39	32.27	58.77	0.46
MainBranch	1391.170	5Y	42.48	85.70	87.78	87.23	87.85	0.001186	1.43	65.98	67.89	0.38
MainBranch	1391.170	10Y	56.95	85.70	88.03	87.37	88.11	0.001146	1.56	83.35	71.70	0.38
MainBranch	1391.170	25Y	77.12	85.70	88.29	87.53	88.39	0.001206	1.76	102.63	75.83	0.40
MainBranch	1391.170	50Y	91.57	85.70	88.48	87.63	88.59	0.001237	1.90	117.37	83.17	0.41
MainBranch	1391.170	100Y	106.00	85.70	88.68	87.73	88.80	0.001247	2.02	135.87	99.17	0.42
MainBranch	1391.170	Regional	261.50	85.70	89.25	88.49	89.61	0.002898	3.57	259.59	226.82	0.67
MainBranch	1298.178	2Y	22.52	84.63	86.60	86.43	86.99	0.007154	2.78	8.11	6.99	0.82
MainBranch	1298.178	5Y	42.48	84.63	87.41	87.15	87.65	0.004710	2.22	20.59	29.30	0.70
MainBranch	1298.178	10Y	56.95	84.63	87.72	87.39	87.94	0.003204	2.18	33.39	52.27	0.60
MainBranch	1298.178	25Y	77.12	84.63	88.02	87.68	88.24	0.002513	2.22	51.82	70.10	0.55
MainBranch	1298.178	50Y	91.57	84.63	88.28	87.83	88.46	0.001821	2.08	73.16	88.68	0.48
MainBranch	1298.178	100Y	106.00	84.63	88.57	87.95	88.72	0.001308	1.94	103.82	142.98	0.42
MainBranch	1298.178	Regional	261.50	84.63	88.87	88.84	89.33	0.004030	3.70	147.91	159.36	0.75
MainBranch	1246.464	2Y	22.52	84.24	85.94	85.94	86.51	0.011230	3.36	6.70	5.82	1.00
MainBranch	1246.464	5Y	42.48	84.24	86.72	86.72	87.31	0.007458	3.48	14.37	17.47	0.86
MainBranch	1246.464	10Y	56.95	84.24	87.03	87.03	87.67	0.006766	3.69	21.11	26.22	0.84
MainBranch	1246.464	25Y	77.12	84.24	87.47	87.47	88.02	0.005010	3.63	36.85	46.34	0.75
MainBranch	1246.464	50Y	91.57	84.24	87.50	87.50	88.23	0.006687	4.23	38.10	47.85	0.87
MainBranch	1246.464	100Y	106.00	84.24	87.50	87.50	88.48	0.008961	4.89	38.10	47.85	1.00
MainBranch	1246.464	Regional	261.50	84.24	88.73	88.73	89.08	0.003489	4.01	200.61	219.66	0.67
MainBranch	1146.464	2Y	22.52	83.72	85.13		85.32	0.004055	1.96	11.50	12.29	0.65
MainBranch	1146.464	5Y	42.48	83.72	85.52		85.84	0.005222	2.47	17.35	17.02	0.76
MainBranch	1146.464	10Y	56.95	83.72	85.75		86.12	0.005281	2.72	21.44	18.93	0.78
MainBranch	1146.464	25Y	77.12	83.72	86.02		86.47	0.005186	2.99	26.83	20.75	0.79
MainBranch	1146.464	50Y	91.57	83.72	86.33		86.75	0.003919	2.91	33.50	24.08	0.71
MainBranch	1146.464	100Y	106.00	83.72	86.44		86.93	0.004212	3.15	36.35	25.82	0.74
MainBranch	1146.464	Regional	261.50	83.72	87.86	87.27	88.46	0.002761	3.74	129.19	144.67	0.66

HEC-RAS Plan: Existing-Oct River: 14Mile Reach: MainBranch (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
MainBranch	1093.556	2Y	22.52	83.52	85.10		85.17	0.001424	1.22	21.47	31.07	0.40
MainBranch	1093.556	5Y	42.48	83.52	85.56		85.65	0.001204	1.45	37.30	37.12	0.39
MainBranch	1093.556	10Y	56.95	83.52	85.82		85.93	0.001155	1.59	47.37	39.81	0.39
MainBranch	1093.556	25Y	77.12	83.52	86.13		86.27	0.001136	1.77	60.55	45.93	0.40
MainBranch	1093.556	50Y	91.57	83.52	86.44		86.57	0.000925	1.76	76.19	54.04	0.37
MainBranch	1093.556	100Y	106.00	83.52	86.59		86.74	0.000979	1.88	84.36	58.13	0.38
MainBranch	1093.556	Regional	261.50	83.52	88.10		88.26	0.000738	2.25	282.73	223.82	0.36
MainBranch	1060.963	2Y	22.52	83.33	85.00	84.63	85.11	0.002223	1.42	16.21	21.27	0.48
MainBranch	1060.963	5Y	42.48	83.33	85.45	84.95	85.60	0.001910	1.73	27.06	27.33	0.48
MainBranch	1060.963	10Y	56.95	83.33	85.70	85.14	85.88	0.001876	1.92	34.34	31.81	0.49
MainBranch	1060.963	25Y	77.12	83.33	86.00	85.37	86.21	0.001833	2.13	44.77	38.44	0.50
MainBranch	1060.963	50Y	91.57	83.33	86.32	85.53	86.53	0.001476	2.12	59.23	63.22	0.46
MainBranch	1060.963	100Y	106.00	83.33	86.46	85.67	86.69	0.001530	2.25	69.00	74.13	0.47
MainBranch	1060.963	Regional	261.50	83.33	88.11	87.02	88.23	0.000570	1.97	307.61	182.16	0.31
MainBranch	1027.395	2Y	22.52	83.33	84.59	84.59	84.94	0.010439	2.64	8.52	12.01	1.00
MainBranch	1027.395	5Y	42.48	83.33	85.00	85.00	85.45	0.009592	2.97	14.32	16.00	1.00
MainBranch	1027.395	10Y	56.95	83.33	85.22	85.22	85.73	0.009198	3.16	18.06	18.10	1.00
MainBranch	1027.395	25Y	77.12	83.33	85.46	85.46	86.06	0.008406	3.42	22.76	20.44	0.99
MainBranch	1027.395	50Y	91.57	83.33	86.21	85.61	86.47	0.002029	2.31	54.10	60.28	0.53
MainBranch	1027.395	100Y	106.00	83.33	86.36	85.86	86.63	0.002019	2.42	63.16	65.08	0.53
MainBranch	1027.395	Regional	261.50	83.33	88.04	86.89	88.20	0.000794	2.24	263.10	173.18	0.37
MainBranch	1012.195	2Y	24.52	83.33	84.46	84.19	84.62	0.003602	1.79	13.73	16.38	0.61
MainBranch	1012.195	5Y	42.72	83.33	84.82	84.50	85.06	0.003443	2.18	19.98	18.84	0.63
MainBranch	1012.195	10Y	57.31	83.33	85.08	84.70	85.37	0.003211	2.40	24.66	20.59	0.63
MainBranch	1012.195	25Y	77.59	83.33	85.39	84.95	85.75	0.003015	2.65	30.44	22.74	0.63
MainBranch	1012.195	50Y	91.92	83.33	86.20	85.11	86.43	0.001183	2.13	45.18	50.54	0.42
MainBranch	1012.195	100Y	106.70	83.33	86.35	85.26	86.58	0.001211	2.17	54.75	55.58	0.43
MainBranch	1012.195	Regional	266.80	83.33	88.04	86.95	88.18	0.000581	2.09	324.49	253.94	0.32
MainBranch	997.1466		Bridge									
MainBranch	982.0328	2Y	24.52	82.34	83.64	83.21	83.77	0.002305	1.58	15.49	15.10	0.50
MainBranch	982.0328	5Y	42.72	82.34	84.03	83.53	84.23	0.002533	1.97	21.74	16.98	0.54
MainBranch	982.0328	10Y	57.31	82.34	84.26	83.76	84.52	0.002745	2.25	25.54	18.14	0.58
MainBranch	982.0328	25Y	77.59	82.34	84.53	84.02	84.87	0.003019	2.58	30.09	19.50	0.62
MainBranch	982.0328	50Y	91.92	82.34	84.69	84.19	85.09	0.003253	2.81	32.76	20.14	0.65
MainBranch	982.0328	100Y	106.70	82.34	84.83	84.35	85.30	0.003504	3.04	35.22	20.58	0.68
MainBranch	982.0328	Regional	266.80	82.34	85.70	85.70	87.13	0.006741	5.30	50.71	23.37	1.00
MainBranch	966.3656	2Y	24.52	82.34	83.26	83.26	83.63	0.010552	2.69	9.12	12.63	1.01
MainBranch	966.3656	5Y	42.72	82.34	83.62	83.62	84.08	0.009706	3.00	14.23	15.68	1.01
MainBranch	966.3656	10Y	57.31	82.34	83.84	83.84	84.37	0.009133	3.21	17.87	17.58	1.00
MainBranch	966.3656	25Y	77.59	82.34	84.09	84.09	84.71	0.008626	3.50	22.49	19.72	1.00
MainBranch	966.3656	50Y	91.92	82.34	84.25	84.25	84.93	0.008179	3.66	25.82	20.94	0.99
MainBranch	966.3656	100Y	106.70	82.34	84.41	84.41	85.14	0.007877	3.81	29.15	22.09	0.99
MainBranch	966.3656	Regional	266.80	82.34	85.66	85.66	86.90	0.006402	5.02	61.59	29.61	0.98
MainBranch	895.8482	2Y	24.52	81.59	82.54	82.54	82.87	0.010402	2.57	9.56	14.25	1.00
MainBranch	895.8482	5Y	42.72	81.59	82.89	82.86	83.30	0.008803	2.83	15.10	17.12	0.96
MainBranch	895.8482	10Y	57.31	81.59	83.12	83.07	83.57	0.007892	3.00	19.17	19.03	0.94
MainBranch	895.8482	25Y	77.59	81.59	83.37	83.30	83.91	0.007291	3.25	24.27	21.18	0.93
MainBranch	895.8482	50Y	91.92	81.59	83.53	83.46	84.12	0.007115	3.41	27.65	22.49	0.93
MainBranch	895.8482	100Y	106.70	81.59	83.65	83.61	84.32	0.007352	3.63	30.47	23.52	0.96
MainBranch	895.8482	Regional	266.80	81.59	84.93	84.86	85.95	0.005222	4.56	76.21	51.35	0.89
MainBranch	846.4642	2Y	24.52	80.83	81.97	81.97	82.36	0.010323	2.74	8.94	11.68	1.00
MainBranch	846.4642	5Y	42.72	80.83	82.35	82.35	82.84	0.009617	3.10	13.78	14.10	1.00
MainBranch	846.4642	10Y	57.31	80.83	82.59	82.59	83.14	0.009231	3.30	17.36	15.63	1.00
MainBranch	846.4642	25Y	77.59	80.83	82.87	82.87	83.50	0.008917	3.50	22.15	17.82	1.00
MainBranch	846.4642	50Y	91.92	80.83	83.05	83.05	83.72	0.008803	3.63	25.31	19.13	1.01
MainBranch	846.4642	100Y	106.70	80.83	83.22	83.22	83.92	0.008508	3.72	28.71	20.45	1.00
MainBranch	846.4642	Regional	266.80	80.83	84.98	84.44	85.65	0.003146	3.67	93.55	69.33	0.69
MainBranch	794.7359	2Y	24.52	79.82	81.48	81.37	81.80	0.007218	2.53	9.67	10.77	0.85
MainBranch	794.7359	5Y	42.72	79.82	81.94		82.34	0.006365	2.80	15.28	13.34	0.83
MainBranch	794.7359	10Y	57.31	79.82	82.25		82.68	0.005649	2.93	19.59	15.04	0.81
MainBranch	794.7359	25Y	77.59	79.82	82.56		83.08	0.005306	3.20	24.65	16.77	0.80
MainBranch	794.7359	50Y	91.92	79.82	82.73	82.51	83.33	0.005476	3.42	27.52	17.69	0.83
MainBranch	794.7359	100Y	106.70	79.82	82.88	82.69	83.56	0.005735	3.66	30.19	18.49	0.85
MainBranch	794.7359	Regional	266.80	79.82	84.42	84.42	85.43	0.004261	4.60	94.34	91.02	0.81
MainBranch	746.4641	2Y	24.52	79.81	81.28		81.52	0.004100	2.15	11.43	10.30	0.65
MainBranch	746.4641	5Y	42.72	79.81	81.69		82.06	0.005083	2.69	15.90	11.96	0.74
MainBranch	746.4641	10Y	57.31	79.81	81.97	81.68	82.41	0.005827	2.93	19.56	14.49	0.80
MainBranch	746.4641	25Y	77.59	79.81	82.33	82.08	82.80	0.005748	3.06	25.40	18.09	0.81
MainBranch	746.4641	50Y	91.92	79.81	82.53	82.28	83.04	0.005267	3.16	29.29	20.16	0.80

HEC-RAS Plan: Existing-Oct River: 14Mile Reach: MainBranch (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
MainBranch	746.4641	100Y	106.70	79.81	82.70	82.45	83.26	0.005087	3.32	32.82	21.83	0.79
MainBranch	746.4641	Regional	266.80	79.81	84.30	83.81	85.14	0.003419	4.17	87.27	52.78	0.72
MainBranch	703.1630	2Y	24.52	79.56	80.83	80.83	81.23	0.010192	2.83	8.68	10.68	1.00
MainBranch	703.1630	5Y	42.72	79.56	81.22	81.22	81.75	0.009572	3.23	13.24	12.68	1.01
MainBranch	703.1630	10Y	57.31	79.56	81.47	81.47	82.08	0.009066	3.46	16.55	13.80	1.00
MainBranch	703.1630	25Y	77.59	79.56	81.75	81.75	82.48	0.008593	3.77	20.70	15.08	1.00
MainBranch	703.1630	50Y	91.92	79.56	81.95	81.95	82.73	0.008204	3.93	23.68	15.94	1.00
MainBranch	703.1630	100Y	106.70	79.56	82.18	82.13	82.98	0.007240	3.96	27.56	17.00	0.95
MainBranch	703.1630	Regional	266.80	79.56	84.08	83.67	84.99	0.003371	4.38	93.31	58.39	0.73
MainBranch	674.5680	2Y	24.52	79.40	80.44	80.41	80.82	0.009506	2.76	8.90	10.63	0.96
MainBranch	674.5680	5Y	42.72	79.40	80.95		81.38	0.006567	2.89	14.78	12.29	0.84
MainBranch	674.5680	10Y	57.31	79.40	81.35		81.76	0.005319	2.83	20.24	14.86	0.77
MainBranch	674.5680	25Y	77.59	79.40	81.79		82.20	0.004225	2.85	27.36	18.38	0.71
MainBranch	674.5680	50Y	91.92	79.40	82.04		82.47	0.003627	2.91	32.40	21.03	0.68
MainBranch	674.5680	100Y	106.70	79.40	82.29		82.74	0.003216	2.98	38.06	24.68	0.65
MainBranch	674.5680	Regional	266.80	79.40	84.48	83.52	84.75	0.001019	2.68	307.52	263.88	0.41
MainBranch	646.4641	2Y	24.52	78.57	80.28	80.05	80.59	0.005849	2.48	9.89	8.96	0.75
MainBranch	646.4641	5Y	42.72	78.57	80.64	80.53	81.16	0.007948	3.21	13.33	10.27	0.90
MainBranch	646.4641	10Y	57.31	78.57	80.85	80.83	81.54	0.009359	3.67	15.61	11.04	0.99
MainBranch	646.4641	25Y	77.59	78.57	81.19	81.19	81.99	0.009041	3.98	19.64	13.60	0.99
MainBranch	646.4641	50Y	91.92	78.57	81.40	81.40	82.28	0.008494	4.17	22.68	15.86	0.98
MainBranch	646.4641	100Y	106.70	78.57	81.60	81.60	82.55	0.007952	4.33	26.21	18.14	0.97
MainBranch	646.4641	Regional	266.80	78.57	83.26	83.26	84.59	0.005566	5.39	95.35	126.88	0.89
MainBranch	596.464*	2Y	24.52	78.05	79.77	79.77	80.20	0.010496	2.90	8.45	10.00	1.01
MainBranch	596.464*	5Y	42.72	78.05	80.19	80.19	80.72	0.009791	3.22	13.25	12.80	1.01
MainBranch	596.464*	10Y	57.31	78.05	80.46	80.46	81.04	0.009264	3.39	16.90	14.57	1.00
MainBranch	596.464*	25Y	77.59	78.05	80.76	80.76	81.42	0.008849	3.59	21.61	16.78	1.00
MainBranch	596.464*	50Y	91.92	78.05	80.94	80.94	81.65	0.008599	3.73	24.76	18.36	1.00
MainBranch	596.464*	100Y	106.70	78.05	81.10	81.10	81.86	0.008330	3.88	27.74	19.31	1.00
MainBranch	596.464*	Regional	266.80	78.05	82.44	82.44	83.72	0.006175	5.08	60.97	34.34	0.96
MainBranch	546.4642	2Y	24.52	77.52	79.00		79.27	0.005822	2.30	10.67	11.98	0.78
MainBranch	546.4642	5Y	42.72	77.52	79.37		79.75	0.006407	2.74	15.57	14.37	0.84
MainBranch	546.4642	10Y	57.31	77.52	79.60	79.47	80.06	0.006695	3.02	18.99	15.65	0.87
MainBranch	546.4642	25Y	77.59	77.52	79.83	79.76	80.42	0.007330	3.41	22.75	16.65	0.93
MainBranch	546.4642	50Y	91.92	77.52	79.96	79.93	80.65	0.007827	3.69	24.92	17.20	0.97
MainBranch	546.4642	100Y	106.70	77.52	80.09	80.09	80.87	0.008129	3.93	27.20	17.76	1.00
MainBranch	546.4642	Regional	266.80	77.52	81.94	81.42	82.89	0.003608	4.35	67.53	25.82	0.76
MainBranch	515.927*	2Y	24.52	77.39	78.75	78.65	79.06	0.007337	2.46	9.95	11.97	0.86
MainBranch	515.927*	5Y	42.72	77.39	79.17		79.55	0.006936	2.74	15.61	15.42	0.87
MainBranch	515.927*	10Y	57.31	77.39	79.40	79.30	79.84	0.007110	2.95	19.43	17.49	0.89
MainBranch	515.927*	25Y	77.59	77.39	79.65	79.57	80.18	0.007334	3.24	23.93	19.10	0.92
MainBranch	515.927*	50Y	91.92	77.39	79.79	79.73	80.39	0.007405	3.44	26.72	19.96	0.94
MainBranch	515.927*	100Y	106.70	77.39	79.93	79.87	80.60	0.007176	3.61	29.64	20.83	0.94
MainBranch	515.927*	Regional	266.80	77.39	82.08	81.11	82.71	0.002163	3.59	105.01	111.67	0.60
MainBranch	485.389*	2Y	24.52	77.26	78.54		78.84	0.006916	2.45	10.00	11.54	0.84
MainBranch	485.389*	5Y	42.72	77.26	78.94	78.84	79.33	0.007480	2.77	15.40	15.72	0.90
MainBranch	485.389*	10Y	57.31	77.26	79.19	79.09	79.62	0.007347	2.92	19.62	18.34	0.90
MainBranch	485.389*	25Y	77.59	77.26	79.44	79.37	79.94	0.007577	3.16	24.62	21.51	0.93
MainBranch	485.389*	50Y	91.92	77.26	79.65	79.52	80.16	0.006208	3.16	29.38	23.59	0.86
MainBranch	485.389*	100Y	106.70	77.26	79.84	79.65	80.36	0.005318	3.20	34.20	25.49	0.82
MainBranch	485.389*	Regional	266.80	77.26	82.23		82.58	0.001168	2.79	190.43	149.96	0.45
MainBranch	454.8528	2Y	24.52	77.12	78.43	78.20	78.64	0.004680	2.04	12.04	13.72	0.69
MainBranch	454.8528	5Y	42.72	77.12	78.83	78.56	79.12	0.004653	2.38	17.94	16.25	0.72
MainBranch	454.8528	10Y	57.31	77.12	79.08	78.80	79.42	0.004333	2.62	22.34	19.78	0.72
MainBranch	454.8528	25Y	77.59	77.12	79.26	79.06	79.75	0.005190	3.12	26.19	22.39	0.80
MainBranch	454.8528	50Y	91.92	77.12	79.44	79.22	79.98	0.005014	3.29	30.71	28.69	0.80
MainBranch	454.8528	100Y	106.70	77.12	79.58	79.39	80.20	0.005078	3.50	35.28	33.85	0.82
MainBranch	454.8528	Regional	266.80	77.12	82.28		82.52	0.000823	2.56	288.45	189.89	0.38
MainBranch	438.5957	2Y	24.66	77.12	78.14	78.14	78.52	0.010242	2.74	8.99	11.87	1.01
MainBranch	438.5957	5Y	42.70	77.12	78.50	78.50	79.00	0.009349	3.11	13.72	13.93	1.00
MainBranch	438.5957	10Y	57.30	77.12	78.75	78.74	79.31	0.008964	3.31	17.31	15.49	1.00
MainBranch	438.5957	25Y	77.60	77.12	79.16	79.10	79.64	0.007967	3.09	25.14	23.10	0.94
MainBranch	438.5957	50Y	91.98	77.12	79.45	79.32	79.84	0.007407	2.74	33.61	35.33	0.90
MainBranch	438.5957	100Y	106.70	77.12	79.72		80.02	0.004730	2.43	43.84	39.28	0.74
MainBranch	438.5957	Regional	267.80	77.12	82.42		82.45	0.000383	0.81	330.88	238.13	0.22
MainBranch	425.789*	2Y	24.66	76.81	78.27	77.63	78.35	0.001186	1.23	20.11	16.07	0.35
MainBranch	425.789*	5Y	42.70	76.81	78.68	77.91	78.81	0.001540	1.59	26.78	17.23	0.41
MainBranch	425.789*	10Y	57.30	76.81	78.98	78.11	79.14	0.001738	1.75	32.67	22.15	0.44
MainBranch	425.789*	25Y	77.60	76.81	79.32	78.35	79.52	0.001793	1.95	39.76	30.69	0.46

HEC-RAS Plan: Existing-Oct River: 14Mile Reach: MainBranch (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
MainBranch	425.789*	50Y	91.98	76.81	79.53	78.51	79.75	0.001768	2.08	44.21	35.79	0.47
MainBranch	425.789*	100Y	106.70	76.81	79.73	78.72	79.97	0.001738	2.20	48.57	37.36	0.47
MainBranch	425.789*	Regional	267.80	76.81	82.41	79.98	82.45	0.000323	0.80	333.09	211.06	0.20
MainBranch	419.9583		Bridge									
MainBranch	403.132*	2Y	24.66	76.81	78.23	77.63	78.31	0.001264	1.24	19.90	16.86	0.36
MainBranch	403.132*	5Y	42.70	76.81	78.62	77.91	78.75	0.001664	1.59	26.87	19.43	0.43
MainBranch	403.132*	10Y	57.30	76.81	78.90	78.10	79.06	0.001729	1.77	32.44	23.66	0.45
MainBranch	403.132*	25Y	77.60	76.81	79.17	78.35	79.38	0.001871	2.04	38.00	27.18	0.48
MainBranch	403.132*	50Y	91.98	76.81	79.31	78.54	79.57	0.002052	2.25	40.93	29.62	0.51
MainBranch	403.132*	100Y	106.70	76.81	79.43	78.70	79.74	0.002269	2.46	43.41	31.49	0.54
MainBranch	403.132*	Regional	267.80	76.81	79.91	79.91	81.20	0.007259	5.03	53.20	45.06	1.00
MainBranch	402.1469	2Y	24.66	76.80	78.05		78.26	0.005319	2.07	11.90	14.52	0.73
MainBranch	402.1469	5Y	42.70	76.80	78.32		78.68	0.006758	2.64	16.17	16.37	0.85
MainBranch	402.1469	10Y	57.30	76.80	78.43	78.43	78.95	0.009260	3.18	18.01	17.51	1.00
MainBranch	402.1469	25Y	77.60	76.80	78.72	78.72	79.27	0.009071	3.30	23.48	21.32	1.01
MainBranch	402.1469	50Y	91.98	76.80	78.88	78.88	79.47	0.008845	3.39	27.15	23.35	1.00
MainBranch	402.1469	100Y	106.70	76.80	79.03	79.03	79.64	0.008679	3.48	30.70	25.10	1.00
MainBranch	402.1469	Regional	267.80	76.80	80.20	80.20	80.86	0.008283	3.59	74.55	56.86	1.00
MainBranch	388.5779	2Y	24.66	76.70	78.01		78.17	0.004467	1.78	13.83	18.21	0.65
MainBranch	388.5779	5Y	42.70	76.70	78.30		78.54	0.005166	2.18	19.56	21.35	0.73
MainBranch	388.5779	10Y	57.30	76.70	78.28	78.28	78.74	0.009858	2.99	19.15	21.13	1.00
MainBranch	388.5779	25Y	77.60	76.70	78.51	78.51	79.03	0.009362	3.18	24.39	23.68	1.00
MainBranch	388.5779	50Y	91.98	76.70	78.74	78.74	79.21	0.009575	3.02	30.44	32.91	1.00
MainBranch	388.5779	100Y	106.70	76.70	78.93	78.93	79.34	0.010150	2.84	37.62	47.21	1.01
MainBranch	388.5779	Regional	267.80	76.70	79.64	79.64	80.28	0.008502	3.57	75.12	58.77	1.01
MainBranch	346.4642	2Y	24.66	76.69	77.67	77.63	77.90	0.009078	2.16	11.42	20.25	0.92
MainBranch	346.4642	5Y	42.70	76.69	77.89	77.89	78.23	0.010282	2.58	16.56	24.68	1.01
MainBranch	346.4642	10Y	57.30	76.69	78.08	78.08	78.24	0.008400	1.77	32.35	72.89	0.85
MainBranch	346.4642	25Y	77.60	76.69	78.17	78.12	78.37	0.008135	1.97	39.38	73.84	0.86
MainBranch	346.4642	50Y	91.98	76.69	78.25	78.18	78.46	0.007447	2.05	44.92	74.36	0.84
MainBranch	346.4642	100Y	106.70	76.69	78.33	78.24	78.55	0.006683	2.10	50.88	74.90	0.81
MainBranch	346.4642	Regional	267.80	76.69	79.08	78.75	79.39	0.003639	2.46	108.87	79.76	0.67
MainBranch	246.4641	2Y	24.66	75.71	76.64	76.64	76.90	0.011096	2.24	11.02	22.63	1.00
MainBranch	246.4641	5Y	42.70	75.71	76.88	76.88	77.23	0.009317	2.63	17.39	31.76	0.97
MainBranch	246.4641	10Y	57.30	75.71	77.07	77.07	77.40	0.006957	2.64	32.05	68.68	0.87
MainBranch	246.4641	25Y	77.60	75.71	77.23	77.23	77.61	0.006751	2.90	43.95	75.83	0.88
MainBranch	246.4641	50Y	91.98	75.71	77.34	77.34	77.75	0.006476	3.03	52.73	81.22	0.88
MainBranch	246.4641	100Y	106.70	75.71	77.44	77.44	77.87	0.006447	3.18	60.53	84.06	0.89
MainBranch	246.4641	Regional	267.80	75.71	78.20	78.20	78.88	0.006318	4.28	132.90	100.85	0.95
MainBranch	146.4641	2Y	24.66	74.82	76.36		76.37	0.000207	0.63	88.82	70.72	0.16
MainBranch	146.4641	5Y	42.70	74.82	76.64		76.66	0.000366	0.94	110.71	85.95	0.22
MainBranch	146.4641	10Y	57.30	74.82	76.82		76.86	0.000453	1.11	127.26	89.87	0.25
MainBranch	146.4641	25Y	77.60	74.82	77.05		77.10	0.000541	1.31	148.26	91.92	0.28
MainBranch	146.4641	50Y	91.98	74.82	77.20		77.26	0.000589	1.43	162.17	93.29	0.30
MainBranch	146.4641	100Y	106.70	74.82	77.22		77.30	0.000772	1.64	163.71	93.45	0.34
MainBranch	146.4641	Regional	267.80	74.82	78.17		78.38	0.001416	2.79	259.12	113.76	0.49
MainBranch	80.89927	2Y	24.66	75.00	76.33		76.35	0.000514	0.85	84.62	124.73	0.25
MainBranch	80.89927	5Y	42.70	75.00	76.60		76.63	0.000608	1.06	119.81	133.54	0.28
MainBranch	80.89927	10Y	57.30	75.00	76.79		76.82	0.000646	1.18	145.07	136.53	0.29
MainBranch	80.89927	25Y	77.60	75.00	77.02		77.06	0.000671	1.32	176.80	137.79	0.31
MainBranch	80.89927	50Y	91.98	75.00	77.17		77.21	0.000680	1.39	197.74	138.61	0.31
MainBranch	80.89927	100Y	106.70	75.00	77.17		77.23	0.000906	1.61	198.43	138.63	0.36
MainBranch	80.89927	Regional	267.80	75.00	78.15		78.26	0.001170	2.38	336.29	143.68	0.44
MainBranch	71.72631	2Y	24.66	75.37	76.25		76.29	0.001282	1.08	48.60	94.56	0.37
MainBranch	71.72631	5Y	42.70	75.37	76.51		76.57	0.001297	1.29	74.01	98.56	0.39
MainBranch	71.72631	10Y	57.30	75.37	76.69		76.76	0.001282	1.42	91.91	99.88	0.40
MainBranch	71.72631	25Y	77.60	75.37	76.92		76.99	0.001256	1.56	114.57	101.56	0.40
MainBranch	71.72631	50Y	91.98	75.37	77.06		77.15	0.001233	1.65	129.68	102.66	0.41
MainBranch	71.72631	100Y	106.70	75.37	77.02		77.14	0.001843	1.98	125.08	102.33	0.50
MainBranch	71.72631	Regional	267.80	75.37	77.90		78.14	0.002252	2.92	228.75	127.27	0.59
MainBranch	7.227846	2Y	24.66	75.47	75.89	75.89	76.10	0.011630	2.01	12.66	31.84	0.99
MainBranch	7.227846	5Y	42.70	75.47	76.07	76.07	76.37	0.010431	2.42	18.56	33.58	1.00
MainBranch	7.227846	10Y	57.30	75.47	76.21	76.21	76.56	0.009607	2.65	23.14	35.66	0.99
MainBranch	7.227846	25Y	77.60	75.47	76.37	76.37	76.80	0.008908	2.92	29.18	38.23	0.99
MainBranch	7.227846	50Y	91.98	75.47	76.47	76.47	76.95	0.008664	3.10	33.20	40.59	0.99
MainBranch	7.227846	100Y	106.70	75.47	76.53	76.53	76.92	0.007439	2.98	56.85	76.09	0.93
MainBranch	7.227846	Regional	267.80	75.47	77.23	77.23	77.89	0.007013	4.06	120.83	95.76	0.98

HEC-RAS Plan: Existing River: 14Mile Reach: GlenOaks

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
GlenOaks	6932.571	2Years	1.07	147.51	147.91		147.98	0.009573	1.17	0.91	4.15	0.80
GlenOaks	6932.571	5Years	2.38	147.51	148.06		148.17	0.009832	1.46	1.63	5.46	0.85
GlenOaks	6932.571	10Years	3.13	147.51	148.12	148.08	148.25	0.009826	1.58	1.99	5.99	0.87
GlenOaks	6932.571	25Years	4.14	147.51	148.18	148.15	148.34	0.010142	1.78	2.35	6.50	0.90
GlenOaks	6932.571	50Years	4.87	147.51	148.22	148.20	148.40	0.010435	1.91	2.59	6.83	0.93
GlenOaks	6932.571	100Years	5.59	147.51	148.25	148.24	148.46	0.010856	2.04	2.81	7.11	0.96
GlenOaks	6932.571	Regional	8.38	147.51	148.38	148.38	148.66	0.009977	2.33	3.87	8.36	0.96
GlenOaks	6899.999	2Years	1.07	147.05	147.47	147.47	147.58	0.015891	1.46	0.73	3.48	1.01
GlenOaks	6899.999	5Years	2.38	147.05	147.63	147.63	147.78	0.014276	1.71	1.39	4.80	1.01
GlenOaks	6899.999	10Years	3.13	147.05	147.70	147.70	147.87	0.013763	1.81	1.73	5.36	1.01
GlenOaks	6899.999	25Years	4.14	147.05	147.78	147.78	147.96	0.013235	1.91	2.17	5.99	1.01
GlenOaks	6899.999	50Years	4.87	147.05	147.83	147.83	148.02	0.012899	1.97	2.47	6.40	1.01
GlenOaks	6899.999	100Years	5.59	147.05	147.87	147.87	148.08	0.012561	2.02	2.77	6.77	1.01
GlenOaks	6899.999	Regional	8.38	147.05	148.00	148.00	148.27	0.011410	2.29	3.71	7.84	1.00
GlenOaks	6845.150	2Years	1.07	146.51	147.17		147.19	0.001875	0.67	1.59	4.85	0.37
GlenOaks	6845.150	5Years	2.38	146.51	147.35		147.39	0.002178	0.95	2.61	6.54	0.43
GlenOaks	6845.150	10Years	3.13	146.51	147.42		147.48	0.002316	1.07	3.13	7.29	0.45
GlenOaks	6845.150	25Years	4.14	146.51	147.50		147.58	0.002526	1.22	3.76	8.11	0.49
GlenOaks	6845.150	50Years	4.87	146.51	147.56		147.64	0.002631	1.32	4.21	8.64	0.50
GlenOaks	6845.150	100Years	5.59	146.51	147.61		147.70	0.002732	1.40	4.63	9.12	0.52
GlenOaks	6845.150	Regional	8.38	146.51	147.77		147.90	0.003010	1.68	6.23	10.73	0.56
GlenOaks	6800	2Years	1.07	146.51	146.93	146.91	147.01	0.012086	1.26	0.85	4.08	0.89
GlenOaks	6800	5Years	2.38	146.51	147.08	147.06	147.20	0.011487	1.51	1.58	5.62	0.91
GlenOaks	6800	10Years	3.13	146.51	147.14	147.12	147.28	0.011320	1.61	1.95	6.25	0.92
GlenOaks	6800	25Years	4.14	146.51	147.21	147.19	147.37	0.010598	1.74	2.39	6.93	0.91
GlenOaks	6800	50Years	4.87	146.51	147.25	147.23	147.42	0.010371	1.84	2.68	7.32	0.92
GlenOaks	6800	100Years	5.59	146.51	147.29	147.27	147.48	0.010215	1.94	2.95	7.68	0.93
GlenOaks	6800	Regional	8.38	146.51	147.42	147.41	147.67	0.009615	2.22	4.02	8.95	0.94
GlenOaks	6748.093	2Years	1.07	146.02	146.46	146.40	146.51	0.007675	1.05	1.02	4.65	0.72
GlenOaks	6748.093	5Years	2.38	146.02	146.60	146.54	146.69	0.008231	1.35	1.77	6.10	0.78
GlenOaks	6748.093	10Years	3.13	146.02	146.65	146.60	146.76	0.008482	1.49	2.13	6.67	0.81
GlenOaks	6748.093	25Years	4.14	146.02	146.71	146.67	146.85	0.009155	1.68	2.53	7.26	0.86
GlenOaks	6748.093	50Years	4.87	146.02	146.75	146.71	146.91	0.009346	1.78	2.83	7.68	0.88
GlenOaks	6748.093	100Years	5.59	146.02	146.79	146.76	146.96	0.009518	1.87	3.12	8.03	0.90
GlenOaks	6748.093	Regional	8.38	146.02	146.89	146.89	147.14	0.010731	2.21	4.04	9.00	0.98
GlenOaks	6700	2Years	1.07	145.51	145.89	145.89	145.99	0.016190	1.39	0.77	4.07	1.01
GlenOaks	6700	5Years	2.38	145.51	146.03	146.03	146.17	0.014561	1.63	1.46	5.60	1.01
GlenOaks	6700	10Years	3.13	145.51	146.09	146.09	146.24	0.014007	1.72	1.82	6.24	1.01
GlenOaks	6700	25Years	4.14	145.51	146.16	146.16	146.33	0.013024	1.81	2.29	7.01	1.00
GlenOaks	6700	50Years	4.87	145.51	146.20	146.20	146.39	0.012761	1.90	2.58	7.45	1.00
GlenOaks	6700	100Years	5.59	145.51	146.24	146.24	146.44	0.012507	1.97	2.86	7.85	1.01
GlenOaks	6700	Regional	8.38	145.51	146.38	146.38	146.61	0.011020	2.15	4.04	9.34	0.98
GlenOaks	6651.313	2Years	1.07	145.00	145.42		145.44	0.002640	0.62	1.74	7.99	0.42
GlenOaks	6651.313	5Years	2.38	145.00	145.57		145.60	0.002705	0.76	3.14	10.84	0.45
GlenOaks	6651.313	10Years	3.13	145.00	145.66		145.69	0.002327	0.76	4.10	12.44	0.42
GlenOaks	6651.313	25Years	4.14	145.00	145.76		145.79	0.001823	0.74	5.57	14.68	0.39
GlenOaks	6651.313	50Years	4.87	145.00	145.84		145.87	0.001507	0.72	6.75	16.24	0.36
GlenOaks	6651.313	100Years	5.59	145.00	145.91		145.94	0.001201	0.70	7.97	17.48	0.32
GlenOaks	6651.313	Regional	8.38	145.00	146.17		146.20	0.000617	0.68	12.98	20.44	0.25
GlenOaks	6621.406	2Years	1.07	145.00	145.34		145.36	0.002896	0.57	1.87	10.38	0.43
GlenOaks	6621.406	5Years	2.38	145.00	145.53		145.54	0.001361	0.60	4.19	15.17	0.33
GlenOaks	6621.406	10Years	3.13	145.00	145.62		145.64	0.001010	0.61	5.67	16.32	0.29
GlenOaks	6621.406	25Years	4.14	145.00	145.74		145.76	0.000761	0.62	7.67	17.69	0.27
GlenOaks	6621.406	50Years	4.87	145.00	145.82		145.84	0.000652	0.63	9.12	18.52	0.25
GlenOaks	6621.406	100Years	5.59	145.00	145.89		145.91	0.000575	0.63	10.55	19.30	0.24
GlenOaks	6621.406	Regional	8.38	145.00	146.16		146.18	0.000407	0.66	16.10	22.02	0.21
GlenOaks	6599.053	2Years	1.07	145.00	145.30	145.17	145.31	0.001542	0.49	2.23	10.44	0.33
GlenOaks	6599.053	5Years	2.38	145.00	145.50	145.26	145.52	0.000927	0.54	4.68	13.67	0.28
GlenOaks	6599.053	10Years	3.13	145.00	145.60	145.29	145.62	0.000752	0.56	6.10	15.21	0.26
GlenOaks	6599.053	25Years	4.14	145.00	145.72	145.34	145.74	0.000602	0.58	7.96	16.44	0.24
GlenOaks	6599.053	50Years	4.87	145.00	145.81	145.37	145.82	0.000535	0.60	9.25	17.14	0.23
GlenOaks	6599.053	100Years	5.59	145.00	145.88	145.40	145.90	0.000487	0.61	10.50	17.80	0.22
GlenOaks	6599.053	Regional	8.38	145.00	146.15	145.50	146.17	0.000376	0.66	15.11	20.10	0.21
GlenOaks	6568.916		Culvert									
GlenOaks	6538.791	2Years	1.07	144.01	144.37	144.16	144.38	0.000677	0.37	2.88	10.14	0.22
GlenOaks	6538.791	5Years	2.38	144.01	144.48	144.26	144.50	0.001192	0.58	4.09	11.22	0.31

HEC-RAS Plan: Existing River: 14Mile Reach: GlenOaks (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
GlenOaks	6538.791	10Years	3.13	144.01	144.53	144.30	144.56	0.001406	0.67	4.67	11.71	0.34
GlenOaks	6538.791	25Years	4.14	144.01	144.59	144.36	144.62	0.001594	0.77	5.38	12.10	0.37
GlenOaks	6538.791	50Years	4.87	144.01	144.63	144.37	144.67	0.001707	0.84	5.82	12.27	0.38
GlenOaks	6538.791	100Years	5.59	144.01	144.66	144.40	144.71	0.001795	0.90	6.25	12.44	0.40
GlenOaks	6538.791	Regional	8.38	144.01	144.78	144.51	144.84	0.002038	1.10	7.74	13.12	0.44
GlenOaks	6518.760	2Years	1.07	144.03	144.35		144.36	0.001192	0.38	2.81	14.85	0.28
GlenOaks	6518.760	5Years	2.38	144.03	144.46		144.47	0.001327	0.54	4.47	15.92	0.32
GlenOaks	6518.760	10Years	3.13	144.03	144.51		144.53	0.001375	0.61	5.25	16.41	0.33
GlenOaks	6518.760	25Years	4.14	144.03	144.57		144.59	0.001421	0.68	6.22	16.99	0.34
GlenOaks	6518.760	50Years	4.87	144.03	144.60		144.63	0.001469	0.74	6.84	17.35	0.36
GlenOaks	6518.760	100Years	5.59	144.03	144.64		144.67	0.001502	0.78	7.44	17.69	0.36
GlenOaks	6518.760	Regional	8.38	144.03	144.75		144.80	0.001582	0.93	9.58	18.85	0.39
GlenOaks	6455.909	2Years	1.07	143.99	144.11	144.11	144.16	0.019250	0.96	1.12	11.88	1.00
GlenOaks	6455.909	5Years	2.38	143.99	144.18	144.18	144.26	0.016678	1.23	1.95	13.00	1.00
GlenOaks	6455.909	10Years	3.13	143.99	144.21	144.21	144.30	0.015748	1.33	2.38	13.54	1.00
GlenOaks	6455.909	25Years	4.14	143.99	144.25	144.25	144.35	0.014805	1.45	2.90	14.14	1.00
GlenOaks	6455.909	50Years	4.87	143.99	144.27	144.27	144.39	0.014189	1.53	3.25	14.37	1.00
GlenOaks	6455.909	100Years	5.59	143.99	144.30	144.30	144.43	0.013647	1.60	3.59	14.59	0.99
GlenOaks	6455.909	Regional	8.38	143.99	144.38	144.38	144.54	0.012478	1.82	4.79	15.34	0.99
GlenOaks	6400	2Years	1.07	143.00	143.38		143.39	0.001706	0.49	2.19	10.44	0.34
GlenOaks	6400	5Years	2.38	143.00	143.50		143.52	0.001871	0.67	3.57	11.48	0.38
GlenOaks	6400	10Years	3.13	143.00	143.56		143.58	0.001963	0.75	4.21	11.94	0.40
GlenOaks	6400	25Years	4.14	143.00	143.62		143.66	0.002045	0.84	5.01	12.48	0.41
GlenOaks	6400	50Years	4.87	143.00	143.66		143.70	0.002097	0.90	5.55	12.83	0.43
GlenOaks	6400	100Years	5.59	143.00	143.70		143.75	0.002144	0.95	6.05	13.15	0.43
GlenOaks	6400	Regional	8.38	143.00	143.83		143.89	0.002197	1.12	7.81	14.42	0.46
GlenOaks	6352.562	2Years	1.07	142.93	143.13	143.13	143.19	0.017808	1.14	0.94	7.21	1.01
GlenOaks	6352.562	5Years	2.38	142.93	143.22	143.22	143.32	0.015661	1.37	1.73	9.10	1.01
GlenOaks	6352.562	10Years	3.13	142.93	143.27	143.27	143.38	0.015176	1.48	2.12	9.83	1.01
GlenOaks	6352.562	25Years	4.14	142.93	143.31	143.31	143.44	0.014074	1.62	2.57	10.22	1.01
GlenOaks	6352.562	50Years	4.87	142.93	143.34	143.34	143.49	0.013451	1.70	2.89	10.51	1.00
GlenOaks	6352.562	100Years	5.59	142.93	143.37	143.37	143.53	0.012926	1.78	3.20	10.78	1.00
GlenOaks	6352.562	Regional	8.38	142.93	143.47	143.47	143.68	0.011503	2.01	4.34	11.72	0.99
GlenOaks	6300	2Years	1.07	142.00	142.39		142.42	0.005162	0.81	1.32	6.71	0.58
GlenOaks	6300	5Years	2.38	142.00	142.52		142.57	0.005218	1.03	2.32	8.51	0.62
GlenOaks	6300	10Years	3.13	142.00	142.57		142.64	0.005237	1.14	2.79	9.04	0.64
GlenOaks	6300	25Years	4.14	142.00	142.64		142.72	0.005277	1.25	3.38	9.66	0.65
GlenOaks	6300	50Years	4.87	142.00	142.68		142.77	0.005304	1.32	3.78	10.06	0.66
GlenOaks	6300	100Years	5.59	142.00	142.71		142.81	0.005357	1.39	4.15	10.42	0.67
GlenOaks	6300	Regional	8.38	142.00	142.84		142.97	0.005506	1.60	5.51	11.62	0.70
GlenOaks	6242.021	2Years	1.07	141.50	141.84	141.84	141.92	0.016663	1.32	0.81	4.68	1.01
GlenOaks	6242.021	5Years	2.38	141.50	141.96	141.96	142.09	0.014717	1.58	1.50	6.15	1.01
GlenOaks	6242.021	10Years	3.13	141.50	142.02	142.02	142.16	0.013902	1.68	1.87	6.90	1.01
GlenOaks	6242.021	25Years	4.14	141.50	142.09	142.09	142.25	0.013128	1.79	2.36	7.78	1.00
GlenOaks	6242.021	50Years	4.87	141.50	142.13	142.13	142.30	0.012747	1.85	2.70	8.34	1.00
GlenOaks	6242.021	100Years	5.59	141.50	142.17	142.17	142.35	0.012353	1.90	3.03	8.86	0.99
GlenOaks	6242.021	Regional	8.38	141.50	142.29	142.29	142.51	0.011383	2.09	4.24	10.58	0.99
GlenOaks	6200	2Years	1.07	141.00	141.58		141.60	0.001716	0.60	1.78	6.09	0.35
GlenOaks	6200	5Years	2.38	141.00	141.76		141.79	0.002142	0.80	2.99	7.89	0.41
GlenOaks	6200	10Years	3.13	141.00	141.82		141.86	0.002311	0.88	3.55	8.60	0.44
GlenOaks	6200	25Years	4.14	141.00	141.90		141.95	0.002408	0.99	4.19	9.35	0.46
GlenOaks	6200	50Years	4.87	141.00	141.94		142.00	0.002474	1.07	4.62	9.82	0.47
GlenOaks	6200	100Years	5.59	141.00	141.98		142.05	0.002547	1.14	5.02	10.24	0.48
GlenOaks	6200	Regional	8.38	141.00	142.11	141.87	142.21	0.002791	1.37	6.47	11.64	0.52
GlenOaks	6152.898	2Years	1.07	141.00	141.33	141.33	141.41	0.016936	1.29	0.83	5.03	1.02
GlenOaks	6152.898	5Years	2.38	141.00	141.45	141.45	141.57	0.015082	1.51	1.58	6.94	1.01
GlenOaks	6152.898	10Years	3.13	141.00	141.50	141.50	141.63	0.014458	1.59	1.97	7.75	1.01
GlenOaks	6152.898	25Years	4.14	141.00	141.56	141.56	141.71	0.013963	1.72	2.41	8.52	1.02
GlenOaks	6152.898	50Years	4.87	141.00	141.59	141.59	141.76	0.013374	1.80	2.72	8.98	1.01
GlenOaks	6152.898	100Years	5.59	141.00	141.63	141.63	141.80	0.012656	1.86	3.05	9.44	1.00
GlenOaks	6152.898	Regional	8.38	141.00	141.74	141.74	141.96	0.010996	2.08	4.22	10.89	0.97
GlenOaks	6121.368	2Years	1.07	140.50	140.99		141.01	0.002159	0.61	1.75	7.01	0.39
GlenOaks	6121.368	5Years	2.38	140.50	141.16		141.19	0.002121	0.74	3.20	9.37	0.41
GlenOaks	6121.368	10Years	3.13	140.50	141.25		141.28	0.001999	0.78	4.01	10.46	0.40
GlenOaks	6121.368	25Years	4.14	140.50	141.34		141.37	0.001751	0.82	5.06	11.89	0.39
GlenOaks	6121.368	50Years	4.87	140.50	141.40		141.44	0.001627	0.85	5.82	12.81	0.38
GlenOaks	6121.368	100Years	5.59	140.50	141.46		141.50	0.001509	0.87	6.62	13.71	0.37

HEC-RAS Plan: Existing River: 14Mile Reach: GlenOaks (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
GlenOaks	6121.368	Regional	8.38	140.50	141.74		141.78	0.000836	0.85	11.02	17.67	0.30
GlenOaks	6106.137	2Years	1.07	140.50	140.95	140.81	140.97	0.002000	0.62	1.76	7.21	0.38
GlenOaks	6106.137	5Years	2.38	140.50	141.13	140.93	141.16	0.001898	0.81	3.19	9.30	0.40
GlenOaks	6106.137	10Years	3.13	140.50	141.21	140.98	141.25	0.001791	0.88	3.97	10.33	0.40
GlenOaks	6106.137	25Years	4.14	140.50	141.30	141.04	141.34	0.001733	0.97	4.97	11.49	0.40
GlenOaks	6106.137	50Years	4.87	140.50	141.36	141.08	141.41	0.001675	1.02	5.68	12.19	0.40
GlenOaks	6106.137	100Years	5.59	140.50	141.42	141.12	141.47	0.001601	1.06	6.40	12.69	0.40
GlenOaks	6106.137	Regional	8.38	140.50	141.71	141.24	141.76	0.001035	1.06	10.07	15.15	0.34
GlenOaks	6080.772		Culvert									
GlenOaks	6055.417	2Years	1.07	140.50	140.95	140.77	140.97	0.001064	0.50	2.15	9.56	0.29
GlenOaks	6055.417	5Years	2.38	140.50	141.11	140.87	141.14	0.001380	0.74	3.21	11.06	0.35
GlenOaks	6055.417	10Years	3.13	140.50	141.17	140.92	141.21	0.001543	0.86	3.65	11.69	0.38
GlenOaks	6055.417	25Years	4.14	140.50	141.24	140.97	141.29	0.001810	1.01	4.12	12.35	0.41
GlenOaks	6055.417	50Years	4.87	140.50	141.28	141.01	141.34	0.002015	1.11	4.40	12.72	0.44
GlenOaks	6055.417	100Years	5.59	140.50	141.31	141.05	141.39	0.002246	1.21	4.62	12.95	0.47
GlenOaks	6055.417	Regional	8.38	140.50	141.55	141.18	141.60	0.001131	1.01	9.69	14.66	0.35
GlenOaks	6040.300	2Years	1.07	140.50	140.85	140.83	140.91	0.011359	1.11	0.97	5.49	0.84
GlenOaks	6040.300	5Years	2.38	140.50	140.96	140.95	141.07	0.013230	1.43	1.66	7.21	0.95
GlenOaks	6040.300	10Years	3.13	140.50	141.00	141.00	141.13	0.014370	1.58	1.98	7.87	1.01
GlenOaks	6040.300	25Years	4.14	140.50	141.06	141.06	141.20	0.014038	1.68	2.46	8.77	1.01
GlenOaks	6040.300	50Years	4.87	140.50	141.10	141.10	141.25	0.013765	1.74	2.80	9.36	1.01
GlenOaks	6040.300	100Years	5.59	140.50	141.14	141.14	141.29	0.013131	1.77	3.16	9.94	1.00
GlenOaks	6040.300	Regional	8.38	140.50	141.53		141.57	0.001859	0.94	9.12	19.71	0.41
GlenOaks	6000	2Years	1.07	140.00	140.28	140.28	140.35	0.017464	1.18	0.90	6.48	1.01
GlenOaks	6000	5Years	2.38	140.00	140.39	140.39	140.48	0.015470	1.38	1.73	8.97	1.00
GlenOaks	6000	10Years	3.13	140.00	140.61	140.43	140.64	0.002270	0.72	4.35	14.35	0.42
GlenOaks	6000	25Years	4.14	140.00	140.85	140.48	140.87	0.000587	0.51	8.46	19.94	0.23
GlenOaks	6000	50Years	4.87	140.00	141.01	140.51	141.02	0.000315	0.45	11.94	23.95	0.18
GlenOaks	6000	100Years	5.59	140.00	141.16	140.54	141.17	0.000203	0.41	15.88	29.59	0.15
GlenOaks	6000	Regional	8.38	140.00	141.55	140.64	141.55	0.000014	0.14	105.55	96.62	0.04
GlenOaks	5942.698	2Years	1.07	139.51	140.05	139.71	140.05	0.000063	0.14	9.67	40.12	0.07
GlenOaks	5942.698	5Years	2.38	139.51	140.44	139.77	140.44	0.000022	0.13	29.47	62.36	0.05
GlenOaks	5942.698	10Years	3.13	139.51	140.63	139.80	140.63	0.000015	0.13	42.13	70.61	0.04
GlenOaks	5942.698	25Years	4.14	139.51	140.86	139.84	140.86	0.000011	0.13	59.63	79.44	0.04
GlenOaks	5942.698	50Years	4.87	139.51	141.02	139.86	141.02	0.000003	0.07	148.49	140.13	0.02
GlenOaks	5942.698	100Years	5.59	139.51	141.17	139.88	141.17	0.000002	0.07	169.36	141.55	0.02
GlenOaks	5942.698	Regional	8.38	139.51	141.55	139.95	141.55	0.000002	0.07	224.28	144.86	0.02
GlenOaks	5899.999	2Years	1.07	139.50	140.05		140.05	0.000046	0.13	9.64	31.85	0.06
GlenOaks	5899.999	5Years	2.38	139.50	140.44		140.44	0.000021	0.14	24.58	45.15	0.05
GlenOaks	5899.999	10Years	3.13	139.50	140.63		140.63	0.000017	0.14	33.72	50.31	0.04
GlenOaks	5899.999	25Years	4.14	139.50	140.86		140.86	0.000013	0.14	46.06	55.66	0.04
GlenOaks	5899.999	50Years	4.87	139.50	141.02		141.02	0.000011	0.14	55.13	59.25	0.04
GlenOaks	5899.999	100Years	5.59	139.50	141.16		141.17	0.000011	0.15	65.36	80.95	0.04
GlenOaks	5899.999	Regional	8.38	139.50	141.55		141.55	0.000009	0.16	107.10	123.10	0.04
GlenOaks	5869.256	2Years	1.07	139.41	140.05		140.05	0.000049	0.15	10.49	30.78	0.07
GlenOaks	5869.256	5Years	2.38	139.41	140.43		140.44	0.000027	0.16	24.60	41.02	0.05
GlenOaks	5869.256	10Years	3.13	139.41	140.62		140.63	0.000022	0.17	33.01	46.10	0.05
GlenOaks	5869.256	25Years	4.14	139.41	140.86		140.86	0.000018	0.17	44.18	50.37	0.05
GlenOaks	5869.256	50Years	4.87	139.41	141.02		141.02	0.000016	0.18	52.67	57.71	0.05
GlenOaks	5869.256	100Years	5.59	139.41	141.16		141.16	0.000015	0.18	61.92	65.06	0.04
GlenOaks	5869.256	Regional	8.38	139.41	141.55		141.55	0.000013	0.19	89.91	77.73	0.04
GlenOaks	5839.625	2Years	1.07	139.50	140.04	139.74	140.05	0.000226	0.24	4.65	16.78	0.13
GlenOaks	5839.625	5Years	2.38	139.50	140.43	139.84	140.43	0.000063	0.21	16.00	38.43	0.08
GlenOaks	5839.625	10Years	3.13	139.50	140.62	139.88	140.62	0.000041	0.20	23.63	41.36	0.07
GlenOaks	5839.625	25Years	4.14	139.50	140.86	139.92	140.86	0.000029	0.20	33.70	45.07	0.06
GlenOaks	5839.625	50Years	4.87	139.50	141.01	139.95	141.02	0.000024	0.19	41.03	47.59	0.05
GlenOaks	5839.625	100Years	5.59	139.50	141.16	139.97	141.16	0.000020	0.19	48.26	49.91	0.05
GlenOaks	5839.625	Regional	8.38	139.50	141.55	140.06	141.55	0.000019	0.22	71.80	73.00	0.05
GlenOaks	5816.245	2Years	1.07	139.47	140.01	139.82	140.03	0.001508	0.61	1.87	6.73	0.34
GlenOaks	5816.245	5Years	2.38	139.47	140.41	139.96	140.43	0.000462	0.52	5.44	10.67	0.21
GlenOaks	5816.245	10Years	3.13	139.47	140.61	140.02	140.62	0.000315	0.52	7.52	12.23	0.18
GlenOaks	5816.245	25Years	4.14	139.47	140.84	140.09	140.85	0.000223	0.51	10.22	14.13	0.16
GlenOaks	5816.245	50Years	4.87	139.47	141.00	140.13	141.01	0.000186	0.51	12.05	15.41	0.15
GlenOaks	5816.245	100Years	5.59	139.47	141.15	140.18	141.16	0.000163	0.52	13.76	16.75	0.14
GlenOaks	5816.245	Regional	8.38	139.47	141.53	140.31	141.54	0.000141	0.57	22.54	20.00	0.14

HEC-RAS Plan: Existing River: 14Mile Reach: GlenOaks (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
GlenOaks	5740.884		Culvert									
GlenOaks	5705.508	2Years	6.71	138.00	139.00	139.00	139.35	0.010901	2.59	2.59	6.42	1.00
GlenOaks	5705.508	5Years	10.30	138.00	139.23	139.23	139.68	0.009790	2.98	3.46	7.90	1.00
GlenOaks	5705.508	10Years	12.80	138.00	139.37	139.37	139.90	0.009393	3.21	3.99	8.80	1.00
GlenOaks	5705.508	25Years	16.30	138.00	139.56	139.56	140.17	0.008860	3.48	4.69	10.00	1.00
GlenOaks	5705.508	50Years	18.91	138.00	139.68	139.68	140.36	0.008598	3.66	5.17	10.98	1.00
GlenOaks	5705.508	100Years	21.49	138.00	139.81	139.81	140.55	0.008300	3.81	5.65	12.09	1.00
GlenOaks	5705.508	Regional	21.66	138.00	139.81	139.81	140.56	0.008368	3.83	5.66	12.12	1.00
GlenOaks	5660.181	2Years	6.71	138.00	138.99		139.02	0.000983	0.83	9.22	17.39	0.31
GlenOaks	5660.181	5Years	10.30	138.00	139.15		139.19	0.001135	1.01	12.11	19.63	0.35
GlenOaks	5660.181	10Years	12.80	138.00	139.23		139.29	0.001240	1.13	13.87	20.87	0.37
GlenOaks	5660.181	25Years	16.30	138.00	139.34		139.41	0.001363	1.27	16.18	22.47	0.39
GlenOaks	5660.181	50Years	18.91	138.00	139.41		139.50	0.001446	1.37	17.80	23.59	0.41
GlenOaks	5660.181	100Years	21.49	138.00	139.47		139.57	0.001547	1.46	19.21	24.54	0.43
GlenOaks	5660.181	Regional	21.66	138.00	139.47		139.57	0.001546	1.47	19.34	24.63	0.43
GlenOaks	5600	2Years	6.71	138.00	138.66	138.66	138.83	0.013019	1.85	3.64	11.66	1.01
GlenOaks	5600	5Years	10.30	138.00	138.79	138.79	138.99	0.010561	2.01	5.54	17.15	0.95
GlenOaks	5600	10Years	12.80	138.00	138.87	138.87	139.08	0.009615	2.09	6.95	19.48	0.93
GlenOaks	5600	25Years	16.30	138.00	138.95	138.95	139.19	0.009228	2.23	8.74	22.08	0.93
GlenOaks	5600	50Years	18.91	138.00	139.01	139.01	139.27	0.009114	2.33	10.01	23.83	0.93
GlenOaks	5600	100Years	21.49	138.00	139.07	139.07	139.33	0.008651	2.37	11.48	26.09	0.92
GlenOaks	5600	Regional	21.66	138.00	139.07	139.07	139.34	0.008768	2.39	11.50	26.11	0.93
GlenOaks	5500	2Years	6.71	136.35	137.31	137.31	137.54	0.012410	2.14	3.14	6.90	1.01
GlenOaks	5500	5Years	10.30	136.35	137.48	137.48	137.75	0.011731	2.32	4.44	8.30	1.01
GlenOaks	5500	10Years	12.80	136.35	137.58	137.58	137.87	0.011156	2.40	5.34	9.14	1.00
GlenOaks	5500	25Years	16.30	136.35	137.70	137.70	138.02	0.010798	2.51	6.49	10.12	1.00
GlenOaks	5500	50Years	18.91	136.35	137.78	137.78	138.12	0.010576	2.59	7.31	10.77	1.00
GlenOaks	5500	100Years	21.49	136.35	137.85	137.85	138.21	0.010422	2.65	8.10	11.34	1.00
GlenOaks	5500	Regional	21.66	136.35	137.86	137.86	138.22	0.010411	2.66	8.15	11.37	1.00
GlenOaks	5400	2Years	6.71	135.00	135.85		135.97	0.006872	1.55	4.34	10.21	0.76
GlenOaks	5400	5Years	10.30	135.00	135.99		136.15	0.006996	1.76	5.89	12.59	0.79
GlenOaks	5400	10Years	12.80	135.00	136.07	135.98	136.25	0.007012	1.88	6.95	14.44	0.80
GlenOaks	5400	25Years	16.30	135.00	136.16	136.08	136.37	0.006956	2.03	8.43	16.72	0.81
GlenOaks	5400	50Years	18.91	135.00	136.16	136.15	136.44	0.009305	2.35	8.45	16.75	0.94
GlenOaks	5400	100Years	21.49	135.00	136.21	136.21	136.52	0.009464	2.48	9.23	17.87	0.96
GlenOaks	5400	Regional	21.66	135.00	136.21	136.21	136.52	0.009428	2.48	9.30	18.01	0.96
GlenOaks	5300	2Years	6.71	134.00	134.84	134.84	135.06	0.012512	2.05	3.28	7.86	1.01
GlenOaks	5300	5Years	10.30	134.00	135.00	135.00	135.25	0.011571	2.21	4.66	9.37	1.00
GlenOaks	5300	10Years	12.80	134.00	135.09	135.09	135.37	0.011209	2.31	5.55	10.23	1.00
GlenOaks	5300	25Years	16.30	134.00	135.20	135.20	135.50	0.010862	2.42	6.73	11.28	1.00
GlenOaks	5300	50Years	18.91	134.00	135.36	135.28	135.61	0.007351	2.19	8.64	13.46	0.84
GlenOaks	5300	100Years	21.49	134.00	135.45	135.34	135.70	0.006426	2.19	10.00	16.30	0.80
GlenOaks	5300	Regional	21.66	134.00	135.46	135.35	135.70	0.006453	2.20	10.04	16.34	0.80
GlenOaks	5246.372	2Years	6.71	133.00	134.21		134.31	0.003714	1.42	4.74	7.78	0.58
GlenOaks	5246.372	5Years	10.30	133.00	134.62		134.69	0.001889	1.22	8.42	10.37	0.43
GlenOaks	5246.372	10Years	12.80	133.00	134.87		134.94	0.001278	1.13	11.39	13.31	0.37
GlenOaks	5246.372	25Years	16.30	133.00	135.21		135.27	0.000808	1.04	16.80	18.93	0.30
GlenOaks	5246.372	50Years	18.91	133.00	135.42		135.47	0.000630	1.02	21.21	24.15	0.27
GlenOaks	5246.372	100Years	21.49	133.00	135.50		135.56	0.000653	1.08	23.41	26.51	0.28
GlenOaks	5246.372	Regional	21.66	133.00	135.51		135.56	0.000658	1.08	23.50	26.60	0.28
GlenOaks	5226.563	2Years	6.71	133.00	134.11	133.86	134.24	0.003011	1.68	5.07	8.31	0.56
GlenOaks	5226.563	5Years	10.30	133.00	134.54	134.07	134.65	0.001645	1.61	9.24	11.72	0.44
GlenOaks	5226.563	10Years	12.80	133.00	134.80	134.19	134.90	0.001220	1.56	12.26	17.41	0.39
GlenOaks	5226.563	25Years	16.30	133.00	135.14	134.34	135.24	0.000921	1.54	16.33	23.88	0.35
GlenOaks	5226.563	50Years	18.91	133.00	135.35	134.44	135.44	0.000833	1.57	18.90	28.61	0.34
GlenOaks	5226.563	100Years	21.49	133.00	135.46	134.56	135.54	0.000770	1.56	28.51	31.95	0.33
GlenOaks	5226.563	Regional	21.66	133.00	135.46	134.57	135.54	0.000777	1.56	28.61	32.04	0.33
GlenOaks	5195.237		Culvert									
GlenOaks	5162.059	2Years	6.71	131.68	132.40	132.40	132.67	0.010579	2.33	3.01	13.81	0.99
GlenOaks	5162.059	5Years	10.30	131.68	132.58	132.58	132.94	0.009776	2.70	4.02	16.05	1.00
GlenOaks	5162.059	10Years	12.80	131.68	132.69	132.69	133.11	0.009421	2.91	4.65	17.22	1.00
GlenOaks	5162.059	25Years	16.30	131.68	132.84	132.84	133.34	0.008952	3.15	5.48	18.77	1.00
GlenOaks	5162.059	50Years	18.91	131.68	132.95	132.95	133.49	0.008571	3.30	6.08	19.86	1.00
GlenOaks	5162.059	100Years	21.49	131.68	133.04	133.04	133.64	0.008468	3.46	6.60	21.23	1.00
GlenOaks	5162.059	Regional	21.66	131.68	133.07	133.07	133.30	0.003923	2.35	16.76	21.51	0.68

HEC-RAS Plan: Existing River: 14Mile Reach: GlenOaks (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
GlenOaks	5143.615	2Years	6.71	131.50	132.24		132.27	0.001299	0.74	11.14	25.28	0.34
GlenOaks	5143.615	5Years	10.30	131.50	132.38		132.42	0.001320	0.87	14.62	25.92	0.35
GlenOaks	5143.615	10Years	12.80	131.50	132.46		132.51	0.001320	0.95	16.83	26.32	0.36
GlenOaks	5143.615	25Years	16.30	131.50	132.57		132.62	0.001331	1.05	19.64	26.84	0.37
GlenOaks	5143.615	50Years	18.91	131.50	132.64		132.70	0.001341	1.11	21.60	27.18	0.38
GlenOaks	5143.615	100Years	21.49	131.50	132.71		132.78	0.001340	1.17	23.49	27.52	0.38
GlenOaks	5143.615	Regional	21.66	131.50	132.72		132.78	0.001341	1.18	23.61	27.54	0.38
GlenOaks	5118.131	2Years	6.71	131.43	132.14		132.20	0.005248	1.34	9.21	23.61	0.66
GlenOaks	5118.131	5Years	10.30	131.43	132.25		132.34	0.005738	1.63	11.83	24.91	0.72
GlenOaks	5118.131	10Years	12.80	131.43	132.32		132.43	0.005730	1.77	13.63	25.52	0.73
GlenOaks	5118.131	25Years	16.30	131.43	132.40		132.54	0.005851	1.96	15.86	26.17	0.75
GlenOaks	5118.131	50Years	18.91	131.43	132.46		132.61	0.006003	2.09	17.34	26.60	0.77
GlenOaks	5118.131	100Years	21.49	131.43	132.52		132.68	0.005998	2.19	18.88	27.03	0.78
GlenOaks	5118.131	Regional	21.66	131.43	132.52		132.69	0.006005	2.20	18.97	27.06	0.79
GlenOaks	5096.349	2Years	6.71	131.07	131.74	131.74	131.90	0.012514	1.79	4.41	17.42	0.99
GlenOaks	5096.349	5Years	10.30	131.07	131.86	131.86	132.05	0.010071	1.97	6.81	22.44	0.93
GlenOaks	5096.349	10Years	12.80	131.07	131.92	131.92	132.13	0.010122	2.14	8.10	22.77	0.95
GlenOaks	5096.349	25Years	16.30	131.07	131.99	131.99	132.24	0.009914	2.32	9.85	23.22	0.97
GlenOaks	5096.349	50Years	18.91	131.07	132.05	132.05	132.32	0.009500	2.42	11.20	23.56	0.96
GlenOaks	5096.349	100Years	21.49	131.07	132.09	132.09	132.39	0.009591	2.54	12.28	23.83	0.98
GlenOaks	5096.349	Regional	21.66	131.07	132.10	132.10	132.39	0.009576	2.55	12.36	23.85	0.98
GlenOaks	5078.876	2Years	6.71	130.74	131.22	131.22	131.36	0.013650	1.72	4.70	18.25	1.01
GlenOaks	5078.876	5Years	10.30	130.74	131.31	131.31	131.49	0.012538	1.98	6.44	19.12	1.01
GlenOaks	5078.876	10Years	12.80	130.74	131.37	131.37	131.58	0.012023	2.12	7.56	19.67	1.02
GlenOaks	5078.876	25Years	16.30	130.74	131.44	131.44	131.69	0.011428	2.30	9.06	20.38	1.02
GlenOaks	5078.876	50Years	18.91	130.74	131.49	131.49	131.77	0.011091	2.41	10.14	20.86	1.02
GlenOaks	5078.876	100Years	21.49	130.74	131.54	131.54	131.84	0.010781	2.51	11.18	21.32	1.02
GlenOaks	5078.876	Regional	21.66	130.74	131.55	131.55	131.84	0.010758	2.52	11.25	21.35	1.02
GlenOaks	5000	2Years	6.71	129.50	129.99	129.99	130.14	0.013583	1.70	3.99	14.27	1.01
GlenOaks	5000	5Years	10.30	129.50	130.10	130.10	130.27	0.012557	1.88	5.59	16.33	1.00
GlenOaks	5000	10Years	12.80	129.50	130.15	130.15	130.36	0.012229	2.01	6.55	17.23	1.01
GlenOaks	5000	25Years	16.30	129.50	130.22	130.22	130.46	0.011478	2.17	7.80	17.87	1.00
GlenOaks	5000	50Years	18.91	129.50	130.27	130.27	130.53	0.011097	2.28	8.69	18.31	1.00
GlenOaks	5000	100Years	21.49	129.50	130.32	130.32	130.60	0.010718	2.37	9.56	18.73	1.00
GlenOaks	5000	Regional	21.66	129.50	130.32	130.32	130.61	0.010692	2.37	9.62	18.76	1.00
GlenOaks	4900	2Years	6.71	128.00	128.57		128.64	0.005044	1.18	5.85	18.64	0.63
GlenOaks	4900	5Years	10.30	128.00	128.66	128.56	128.76	0.005520	1.41	7.76	21.25	0.69
GlenOaks	4900	10Years	12.80	128.00	128.72	128.62	128.84	0.005745	1.56	8.92	22.57	0.71
GlenOaks	4900	25Years	16.30	128.00	128.78	128.69	128.93	0.006124	1.74	10.38	23.55	0.75
GlenOaks	4900	50Years	18.91	128.00	128.83	128.74	129.00	0.006198	1.85	11.50	24.05	0.77
GlenOaks	4900	100Years	21.49	128.00	128.86	128.79	129.06	0.006498	1.98	12.40	24.43	0.79
GlenOaks	4900	Regional	21.66	128.00	128.87	128.79	129.06	0.006458	1.98	12.50	24.48	0.79
GlenOaks	4800	2Years	6.71	127.45	127.71	127.71	127.81	0.016445	1.56	6.63	33.83	1.06
GlenOaks	4800	5Years	10.30	127.45	127.78	127.78	127.91	0.015250	1.79	8.93	34.12	1.07
GlenOaks	4800	10Years	12.80	127.45	127.82	127.82	127.97	0.014900	1.94	10.33	34.29	1.08
GlenOaks	4800	25Years	16.30	127.45	127.88	127.88	128.06	0.014101	2.09	12.26	34.53	1.08
GlenOaks	4800	50Years	18.91	127.45	127.91	127.91	128.11	0.014210	2.22	13.43	34.67	1.10
GlenOaks	4800	100Years	21.49	127.45	127.95	127.95	128.16	0.013537	2.30	14.79	34.84	1.09
GlenOaks	4800	Regional	21.66	127.45	127.95	127.95	128.17	0.013692	2.32	14.81	34.84	1.09
GlenOaks	4741.451	2Years	6.71	126.00	126.56	126.48	126.64	0.005709	1.26	5.90	20.30	0.68
GlenOaks	4741.451	5Years	10.30	126.00	126.84	126.57	126.89	0.001864	1.06	12.34	27.07	0.42
GlenOaks	4741.451	10Years	12.80	126.00	127.10	126.63	127.14	0.000849	0.90	21.42	46.16	0.30
GlenOaks	4741.451	25Years	16.30	126.00	127.46	126.70	127.48	0.000341	0.71	43.99	62.00	0.20
GlenOaks	4741.451	50Years	18.91	126.00	127.71	126.75	127.73	0.000215	0.64	59.88	63.17	0.17
GlenOaks	4741.451	100Years	21.49	126.00	127.95	126.80	127.97	0.000153	0.60	75.19	64.28	0.14
GlenOaks	4741.451	Regional	21.66	126.00	127.97	126.80	127.98	0.000150	0.60	76.19	64.35	0.14
GlenOaks	4668.109	2Years	6.71	125.49	126.35		126.39	0.002116	0.90	7.51	18.54	0.43
GlenOaks	4668.109	5Years	10.30	125.49	126.80		126.82	0.000429	0.65	22.21	37.97	0.22
GlenOaks	4668.109	10Years	12.80	125.49	127.08		127.10	0.000244	0.58	33.22	40.14	0.17
GlenOaks	4668.109	25Years	16.30	125.49	127.45		127.46	0.000148	0.54	48.44	43.14	0.14
GlenOaks	4668.109	50Years	18.91	125.49	127.71		127.72	0.000114	0.53	59.73	45.13	0.13
GlenOaks	4668.109	100Years	21.49	125.49	127.95		127.96	0.000093	0.52	70.81	46.77	0.12
GlenOaks	4668.109	Regional	21.66	125.49	127.96		127.97	0.000092	0.52	71.54	46.88	0.11
GlenOaks	4608.320	2Years	6.71	125.00	126.35		126.36	0.000133	0.38	23.09	37.28	0.12
GlenOaks	4608.320	5Years	10.30	125.00	126.80		126.81	0.000079	0.38	42.32	44.92	0.10
GlenOaks	4608.320	10Years	12.80	125.00	127.08		127.09	0.000063	0.38	55.28	47.51	0.09
GlenOaks	4608.320	25Years	16.30	125.00	127.45		127.46	0.000050	0.38	73.34	50.55	0.08

HEC-RAS Plan: Existing River: 14Mile Reach: GlenOaks (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
GlenOaks	4608.320	50Years	18.91	125.00	127.71		127.71	0.000043	0.39	86.43	51.92	0.08
GlenOaks	4608.320	100Years	21.49	125.00	127.95		127.95	0.000039	0.39	99.12	53.22	0.08
GlenOaks	4608.320	Regional	21.66	125.00	127.96		127.97	0.000039	0.39	99.94	53.30	0.08
GlenOaks	4596.187	2Years	6.71	125.00	126.35	125.55	126.36	0.000146	0.41	16.56	29.03	0.13
GlenOaks	4596.187	5Years	10.30	125.00	126.80	125.66	126.81	0.000102	0.43	23.88	32.13	0.11
GlenOaks	4596.187	10Years	12.80	125.00	127.08	125.73	127.09	0.000087	0.45	28.47	35.28	0.11
GlenOaks	4596.187	25Years	16.30	125.00	127.44	125.80	127.45	0.000075	0.47	34.42	37.90	0.10
GlenOaks	4596.187	50Years	18.91	125.00	127.70	125.85	127.71	0.000069	0.49	38.58	39.50	0.10
GlenOaks	4596.187	100Years	21.49	125.00	127.94	125.90	127.95	0.000065	0.51	42.50	41.00	0.10
GlenOaks	4596.187	Regional	21.66	125.00	127.95	125.90	127.97	0.000064	0.51	42.76	41.10	0.10
GlenOaks	4567.342		Culvert									
GlenOaks	4541.851	2Years	6.71	124.08	125.29	125.07	125.44	0.003794	1.69	3.96	7.03	0.61
GlenOaks	4541.851	5Years	10.30	124.08	125.45	125.26	125.69	0.004941	2.18	4.74	8.59	0.71
GlenOaks	4541.851	10Years	12.80	124.08	125.53	125.37	125.84	0.005853	2.50	5.13	9.16	0.79
GlenOaks	4541.851	25Years	16.30	124.08	125.60	125.53	126.05	0.007452	2.96	5.51	9.71	0.90
GlenOaks	4541.851	50Years	18.91	124.08	125.75	125.63	126.06	0.005321	2.46	8.50	10.89	0.76
GlenOaks	4541.851	100Years	21.49	124.08	125.81	125.74	126.16	0.005698	2.64	9.18	11.53	0.79
GlenOaks	4541.851	Regional	21.66	124.08	125.82	125.74	126.17	0.005723	2.65	9.22	11.57	0.79
GlenOaks	4524.948	2Years	6.71	124.00	125.26		125.35	0.003053	1.31	5.13	8.16	0.53
GlenOaks	4524.948	5Years	10.30	124.00	125.44		125.56	0.003376	1.56	6.84	11.54	0.57
GlenOaks	4524.948	10Years	12.80	124.00	125.53		125.68	0.003572	1.71	8.03	13.20	0.60
GlenOaks	4524.948	25Years	16.30	124.00	125.65	125.39	125.83	0.003878	1.90	9.63	15.15	0.63
GlenOaks	4524.948	50Years	18.91	124.00	125.72	125.47	125.93	0.004020	2.01	10.87	16.52	0.65
GlenOaks	4524.948	100Years	21.49	124.00	125.79	125.55	126.02	0.004200	2.13	12.02	17.70	0.67
GlenOaks	4524.948	Regional	21.66	124.00	125.80	125.55	126.02	0.004212	2.14	12.10	17.78	0.67
GlenOaks	4469.732	2Years	6.71	124.00	124.80	124.80	125.01	0.012492	2.03	3.30	8.03	1.01
GlenOaks	4469.732	5Years	10.30	124.00	124.96	124.96	125.21	0.011798	2.22	4.65	9.50	1.01
GlenOaks	4469.732	10Years	12.80	124.00	125.04	125.04	125.32	0.011436	2.32	5.51	10.26	1.01
GlenOaks	4469.732	25Years	16.30	124.00	125.15	125.15	125.46	0.010852	2.43	6.71	11.23	1.00
GlenOaks	4469.732	50Years	18.91	124.00	125.22	125.22	125.55	0.010827	2.52	7.49	11.82	1.01
GlenOaks	4469.732	100Years	21.49	124.00	125.29	125.29	125.63	0.010601	2.59	8.30	12.39	1.01
GlenOaks	4469.732	Regional	21.66	124.00	125.29	125.29	125.64	0.010587	2.59	8.35	12.43	1.01
GlenOaks	4400	2Years	6.71	123.00	124.09		124.15	0.002462	1.12	6.14	13.81	0.47
GlenOaks	4400	5Years	10.30	123.00	124.23		124.33	0.002778	1.35	8.46	18.33	0.52
GlenOaks	4400	10Years	12.80	123.00	124.31		124.42	0.003054	1.50	9.84	18.72	0.55
GlenOaks	4400	25Years	16.30	123.00	124.39		124.54	0.003460	1.70	11.46	19.17	0.59
GlenOaks	4400	50Years	18.91	123.00	124.44		124.61	0.003933	1.87	12.29	19.40	0.64
GlenOaks	4400	100Years	21.49	123.00	124.49		124.68	0.004091	1.97	13.43	19.70	0.65
GlenOaks	4400	Regional	21.66	123.00	124.50		124.69	0.004091	1.98	13.52	19.73	0.65
GlenOaks	4347.009	2Years	6.71	123.00	123.70	123.70	123.89	0.011992	1.94	3.66	13.21	0.98
GlenOaks	4347.009	5Years	10.30	123.00	123.86	123.84	124.07	0.009009	2.06	6.25	19.65	0.89
GlenOaks	4347.009	10Years	12.80	123.00	123.98	123.92	124.18	0.006885	2.03	9.00	26.70	0.80
GlenOaks	4347.009	25Years	16.30	123.00	124.11	123.99	124.30	0.005598	2.03	13.76	39.73	0.74
GlenOaks	4347.009	50Years	18.91	123.00	124.20	124.13	124.37	0.004840	2.01	17.25	40.08	0.70
GlenOaks	4347.009	100Years	21.49	123.00	124.22	124.18	124.43	0.005591	2.20	18.19	40.17	0.76
GlenOaks	4347.009	Regional	21.66	123.00	124.22	124.18	124.43	0.005678	2.21	18.19	40.17	0.76
GlenOaks	4300	2Years	6.71	122.10	123.33	123.12	123.45	0.004661	1.58	4.26	6.95	0.64
GlenOaks	4300	5Years	10.30	122.10	123.36	123.31	123.63	0.009635	2.30	4.47	7.13	0.93
GlenOaks	4300	10Years	12.80	122.10	123.43	123.43	123.76	0.010994	2.56	5.01	7.55	1.00
GlenOaks	4300	25Years	16.30	122.10	123.56	123.56	123.93	0.010684	2.68	6.08	8.36	1.00
GlenOaks	4300	50Years	18.91	122.10	123.66	123.66	124.04	0.009880	2.74	7.09	13.43	0.98
GlenOaks	4300	100Years	21.49	122.10	123.88	123.75	124.16	0.005782	2.37	11.18	23.75	0.77
GlenOaks	4300	Regional	21.66	122.10	123.90	123.76	124.17	0.005456	2.33	11.70	24.39	0.75
GlenOaks	4200	2Years	6.71	122.10	122.58	122.58	122.72	0.013015	1.70	4.17	17.33	0.99
GlenOaks	4200	5Years	10.30	122.10	122.78		122.89	0.005186	1.51	8.34	22.78	0.68
GlenOaks	4200	10Years	12.80	122.10	123.09		123.15	0.001413	1.09	15.92	25.19	0.39
GlenOaks	4200	25Years	16.30	122.10	123.47		123.51	0.000600	0.92	25.94	28.06	0.27
GlenOaks	4200	50Years	18.91	122.10	123.73		123.76	0.000403	0.86	33.48	30.04	0.23
GlenOaks	4200	100Years	21.49	122.10	123.97		124.00	0.000300	0.82	41.04	31.92	0.20
GlenOaks	4200	Regional	21.66	122.10	123.99		124.02	0.000295	0.82	41.55	32.04	0.20
GlenOaks	4153.677	2Years	6.71	121.00	122.38		122.39	0.000188	0.45	17.65	26.01	0.14
GlenOaks	4153.677	5Years	10.30	121.00	122.83		122.84	0.000116	0.45	30.70	31.76	0.12
GlenOaks	4153.677	10Years	12.80	121.00	123.11		123.12	0.000093	0.46	40.12	34.90	0.11
GlenOaks	4153.677	25Years	16.30	121.00	123.48		123.49	0.000074	0.47	53.68	38.97	0.10
GlenOaks	4153.677	50Years	18.91	121.00	123.74		123.75	0.000065	0.47	64.07	42.00	0.10
GlenOaks	4153.677	100Years	21.49	121.00	123.98		123.99	0.000059	0.48	74.72	45.53	0.10

HEC-RAS Plan: Existing River: 14Mile Reach: GlenOaks (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
GlenOaks	4153.677	Regional	21.66	121.00	124.00		124.01	0.000059	0.48	75.43	45.73	0.09
GlenOaks	4112.991	2Years	6.71	121.00	122.36	121.66	122.38	0.000302	0.58	12.62	15.13	0.18
GlenOaks	4112.991	5Years	10.30	121.00	122.81	121.79	122.83	0.000202	0.61	19.85	23.07	0.16
GlenOaks	4112.991	10Years	12.80	121.00	123.10	121.86	123.12	0.000170	0.63	24.64	35.40	0.15
GlenOaks	4112.991	25Years	16.30	121.00	123.46	121.95	123.48	0.000142	0.65	31.00	43.39	0.14
GlenOaks	4112.991	50Years	18.91	121.00	123.72	122.01	123.74	0.000128	0.67	35.45	46.91	0.14
GlenOaks	4112.991	100Years	21.49	121.00	123.96	122.08	123.98	0.000118	0.68	39.65	49.75	0.13
GlenOaks	4112.991	Regional	21.66	121.00	123.98	122.08	124.00	0.000118	0.68	39.92	49.93	0.13
GlenOaks	4088.661		Culvert									
GlenOaks	4065.910	2Years	6.71	121.00	121.75	121.75	122.04	0.010944	2.37	2.83	9.06	1.00
GlenOaks	4065.910	5Years	10.30	121.00	121.94	121.94	122.32	0.009860	2.72	3.78	11.16	1.00
GlenOaks	4065.910	10Years	12.80	121.00	122.06	122.06	122.50	0.009422	2.93	4.37	12.46	1.00
GlenOaks	4065.910	25Years	16.30	121.00	122.21	122.21	122.73	0.008968	3.18	5.13	13.86	1.00
GlenOaks	4065.910	50Years	18.91	121.00	122.32	122.32	122.89	0.008566	3.33	5.68	14.83	1.00
GlenOaks	4065.910	100Years	21.49	121.00	122.42	122.42	122.59	0.003831	1.82	11.98	15.41	0.63
GlenOaks	4065.910	Regional	21.66	121.00	122.42	122.42	122.59	0.003891	1.84	11.98	15.41	0.64
GlenOaks	4045.227	2Years	6.71	120.50	121.29		121.33	0.001918	0.93	7.49	15.98	0.41
GlenOaks	4045.227	5Years	10.30	120.50	121.43		121.49	0.001932	1.10	9.92	17.30	0.43
GlenOaks	4045.227	10Years	12.80	120.50	121.52		121.59	0.001979	1.21	11.42	18.07	0.45
GlenOaks	4045.227	25Years	16.30	120.50	121.62		121.71	0.002062	1.35	13.33	19.00	0.47
GlenOaks	4045.227	50Years	18.91	120.50	121.69		121.79	0.002121	1.44	14.67	19.62	0.48
GlenOaks	4045.227	100Years	21.49	120.50	121.75		121.87	0.002177	1.53	15.93	20.20	0.49
GlenOaks	4045.227	Regional	21.66	120.50	121.76		121.87	0.002180	1.53	16.01	20.23	0.49
GlenOaks	4000	2Years	6.71	120.50	120.99	120.97	121.13	0.010944	1.63	4.15	13.37	0.92
GlenOaks	4000	5Years	10.30	120.50	121.08	121.08	121.28	0.011993	1.95	5.36	14.26	0.99
GlenOaks	4000	10Years	12.80	120.50	121.14	121.14	121.37	0.011768	2.09	6.26	14.89	1.00
GlenOaks	4000	25Years	16.30	120.50	121.23	121.23	121.48	0.011205	2.24	7.52	15.73	1.00
GlenOaks	4000	50Years	18.91	120.50	121.28	121.28	121.56	0.010905	2.33	8.42	16.30	1.00
GlenOaks	4000	100Years	21.49	120.50	121.33	121.33	121.63	0.010655	2.41	9.29	16.84	1.00
GlenOaks	4000	Regional	21.66	120.50	121.34	121.34	121.63	0.010656	2.42	9.34	16.87	1.00
GlenOaks	3962.377	2Years	6.71	119.97	120.53	120.53	120.68	0.013089	1.73	3.97	14.56	1.00
GlenOaks	3962.377	5Years	10.30	119.97	120.64	120.64	120.83	0.011901	1.93	5.67	17.06	0.99
GlenOaks	3962.377	10Years	12.80	119.97	120.70	120.70	120.91	0.011515	2.05	6.77	18.08	0.99
GlenOaks	3962.377	25Years	16.30	119.97	120.78	120.78	121.02	0.011156	2.19	8.23	19.37	1.00
GlenOaks	3962.377	50Years	18.91	119.97	120.84	120.84	121.09	0.010619	2.26	9.40	20.33	0.99
GlenOaks	3962.377	100Years	21.49	119.97	120.89	120.89	121.16	0.010449	2.34	10.42	20.84	0.99
GlenOaks	3962.377	Regional	21.66	119.97	120.89	120.89	121.16	0.010430	2.34	10.48	20.88	0.99
GlenOaks	3938.663	2Years	6.71	119.50	120.15	120.13	120.30	0.012147	1.76	3.81	11.36	0.97
GlenOaks	3938.663	5Years	10.30	119.50	120.28	120.26	120.46	0.010178	1.86	5.53	13.63	0.92
GlenOaks	3938.663	10Years	12.80	119.50	120.36	120.33	120.55	0.009448	1.96	6.59	14.92	0.91
GlenOaks	3938.663	25Years	16.30	119.50	120.44	120.41	120.67	0.009210	2.10	7.93	16.47	0.92
GlenOaks	3938.663	50Years	18.91	119.50	120.51	120.47	120.75	0.008814	2.17	9.02	17.63	0.91
GlenOaks	3938.663	100Years	21.49	119.50	120.56	120.53	120.82	0.008748	2.26	9.98	18.59	0.91
GlenOaks	3938.663	Regional	21.66	119.50	120.56	120.53	120.82	0.008731	2.26	10.05	18.66	0.91
GlenOaks	3899.999	2Years	6.71	119.00	119.73	119.70	119.88	0.009765	1.72	3.91	10.69	0.89
GlenOaks	3899.999	5Years	10.30	119.00	119.83	119.82	120.05	0.010724	2.08	5.08	12.16	0.96
GlenOaks	3899.999	10Years	12.80	119.00	119.90	119.90	120.16	0.010810	2.25	5.95	13.55	0.98
GlenOaks	3899.999	25Years	16.30	119.00	120.00	120.00	120.29	0.010121	2.40	7.37	15.00	0.98
GlenOaks	3899.999	50Years	18.91	119.00	120.06	120.06	120.38	0.009943	2.52	8.30	15.73	0.98
GlenOaks	3899.999	100Years	21.49	119.00	120.12	120.12	120.46	0.009378	2.60	9.34	16.90	0.97
GlenOaks	3899.999	Regional	21.66	119.00	120.13	120.13	120.46	0.009355	2.60	9.41	16.97	0.97
GlenOaks	3843.650	2Years	6.71	118.50	119.07	119.07	119.24	0.013261	1.82	3.69	11.21	1.01
GlenOaks	3843.650	5Years	10.30	118.50	119.19	119.19	119.40	0.012325	2.03	5.08	12.38	1.01
GlenOaks	3843.650	10Years	12.80	118.50	119.26	119.26	119.50	0.011876	2.14	5.98	13.10	1.01
GlenOaks	3843.650	25Years	16.30	118.50	119.35	119.35	119.61	0.011401	2.27	7.17	13.87	1.01
GlenOaks	3843.650	50Years	18.91	118.50	119.41	119.41	119.69	0.010905	2.35	8.05	14.38	1.00
GlenOaks	3843.650	100Years	21.49	118.50	119.46	119.46	119.77	0.010831	2.45	8.78	14.78	1.01
GlenOaks	3843.650	Regional	21.66	118.50	119.47	119.47	119.77	0.010806	2.45	8.84	14.80	1.01
GlenOaks	3800	2Years	6.71	117.58	118.75	118.11	118.76	0.000244	0.48	23.25	45.04	0.16
GlenOaks	3800	5Years	10.30	117.58	119.27	118.22	119.28	0.000093	0.40	50.46	56.36	0.11
GlenOaks	3800	10Years	12.80	117.58	119.33	118.28	119.34	0.000122	0.48	53.91	57.49	0.13
GlenOaks	3800	25Years	16.30	117.58	119.44	118.36	119.45	0.000154	0.56	59.82	59.52	0.14
GlenOaks	3800	50Years	18.91	117.58	119.49	118.41	119.51	0.000180	0.62	63.35	60.81	0.15
GlenOaks	3800	100Years	21.49	117.58	119.60	118.46	119.62	0.000183	0.65	69.93	63.42	0.16
GlenOaks	3800	Regional	21.66	117.58	119.60	118.46	119.62	0.000186	0.65	69.92	63.42	0.16

HEC-RAS Plan: Existing River: 14Mile Reach: GlenOaks (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
GlenOaks	3742.784	2Years	13.42	117.00	118.75		118.75	0.000071	0.37	83.90	93.62	0.10
GlenOaks	3742.784	5Years	20.88	117.00	119.27		119.28	0.000050	0.38	135.25	100.85	0.08
GlenOaks	3742.784	10Years	26.29	117.00	119.33		119.34	0.000071	0.46	141.29	101.51	0.10
GlenOaks	3742.784	25Years	32.80	117.00	119.43		119.44	0.000091	0.54	151.52	102.80	0.12
GlenOaks	3742.784	50Years	36.25	117.00	119.49		119.50	0.000101	0.58	157.61	104.61	0.12
GlenOaks	3742.784	100Years	44.70	117.00	119.59		119.61	0.000128	0.67	168.53	106.41	0.14
GlenOaks	3742.784	Regional	44.70	117.00	119.59		119.61	0.000128	0.67	168.53	106.41	0.14
GlenOaks	3699.999	2Years	13.42	117.00	118.74		118.75	0.000042	0.29	125.86	124.14	0.07
GlenOaks	3699.999	5Years	20.88	117.00	119.27		119.27	0.000030	0.30	192.29	128.04	0.07
GlenOaks	3699.999	10Years	26.29	117.00	119.33		119.33	0.000042	0.36	199.95	128.48	0.08
GlenOaks	3699.999	25Years	32.80	117.00	119.43		119.44	0.000055	0.42	212.89	129.24	0.09
GlenOaks	3699.999	50Years	36.25	117.00	119.49		119.50	0.000060	0.45	220.53	129.68	0.09
GlenOaks	3699.999	100Years	44.70	117.00	119.59		119.60	0.000077	0.52	234.01	130.45	0.11
GlenOaks	3699.999	Regional	44.70	117.00	119.59		119.60	0.000077	0.52	234.01	130.45	0.11
GlenOaks	3651.369	2Years	13.42	116.50	118.74		118.75	0.000014	0.21	150.26	101.96	0.05
GlenOaks	3651.369	5Years	20.88	116.50	119.27		119.27	0.000015	0.24	205.72	108.71	0.05
GlenOaks	3651.369	10Years	26.29	116.50	119.33		119.33	0.000021	0.30	212.21	109.51	0.06
GlenOaks	3651.369	25Years	32.80	116.50	119.43		119.43	0.000029	0.36	223.22	110.84	0.07
GlenOaks	3651.369	50Years	36.25	116.50	119.49		119.49	0.000033	0.38	229.76	111.64	0.07
GlenOaks	3651.369	100Years	44.70	116.50	119.59		119.60	0.000044	0.45	241.33	113.05	0.08
GlenOaks	3651.369	Regional	44.70	116.50	119.59		119.60	0.000044	0.45	241.33	113.05	0.08
GlenOaks	3635.031	2Years	13.42	116.53	118.72	117.31	118.74	0.000152	0.64	21.22	59.82	0.15
GlenOaks	3635.031	5Years	20.88	116.53	119.26	117.49	119.27	0.000069	0.50	95.17	81.82	0.10
GlenOaks	3635.031	10Years	26.29	116.53	119.31	117.61	119.33	0.000099	0.61	99.66	82.98	0.12
GlenOaks	3635.031	25Years	32.80	116.53	119.41	117.75	119.43	0.000131	0.72	107.59	85.03	0.14
GlenOaks	3635.031	50Years	36.25	116.53	119.47	117.82	119.49	0.000145	0.77	112.39	86.25	0.15
GlenOaks	3635.031	100Years	44.70	116.53	119.56	117.97	119.59	0.000189	0.90	120.69	88.31	0.17
GlenOaks	3635.031	Regional	44.70	116.53	119.56	117.97	119.59	0.000189	0.90	120.69	88.31	0.17
GlenOaks	3610.515		Culvert									
GlenOaks	3580.966	2Years	13.42	115.00	116.78	116.14	116.93	0.001565	1.72	7.79	18.07	0.45
GlenOaks	3580.966	5Years	20.88	115.00	117.09	116.45	117.34	0.002049	2.23	9.36	22.43	0.53
GlenOaks	3580.966	10Years	26.29	115.00	117.27	116.64	117.60	0.002383	2.56	10.27	27.80	0.58
GlenOaks	3580.966	25Years	32.80	115.00	117.45	116.86	117.89	0.002754	2.92	11.23	38.16	0.63
GlenOaks	3580.966	50Years	36.25	115.00	117.75	116.98	117.82	0.000557	1.31	43.85	44.90	0.28
GlenOaks	3580.966	100Years	44.70	115.00	118.01	117.24	118.09	0.000510	1.35	57.24	53.32	0.28
GlenOaks	3580.966	Regional	44.70	115.00	118.01	117.24	118.09	0.000510	1.35	57.24	53.32	0.28
GlenOaks	3570.062	2Years	13.42	115.00	116.82		116.86	0.000678	0.87	15.75	17.01	0.27
GlenOaks	3570.062	5Years	20.88	115.00	117.18		117.23	0.000641	0.98	22.35	20.21	0.28
GlenOaks	3570.062	10Years	26.29	115.00	117.39		117.45	0.000598	1.05	27.03	27.13	0.27
GlenOaks	3570.062	25Years	32.80	115.00	117.63		117.69	0.000550	1.11	35.60	47.64	0.27
GlenOaks	3570.062	50Years	36.25	115.00	117.75		117.81	0.000518	1.13	41.34	49.81	0.26
GlenOaks	3570.062	100Years	44.70	115.00	118.02		118.08	0.000449	1.15	55.22	53.10	0.25
GlenOaks	3570.062	Regional	44.70	115.00	118.02		118.08	0.000449	1.15	55.22	53.10	0.25
GlenOaks	3500	2Years	13.42	115.00	116.78	116.06	116.81	0.000643	0.87	16.77	18.84	0.27
GlenOaks	3500	5Years	20.88	115.00	117.14	116.25	117.18	0.000586	0.98	24.16	22.40	0.27
GlenOaks	3500	10Years	26.29	115.00	117.35	116.37	117.41	0.000550	1.05	29.29	24.57	0.27
GlenOaks	3500	25Years	32.80	115.00	117.59	116.51	117.65	0.000520	1.12	35.43	27.10	0.26
GlenOaks	3500	50Years	36.25	115.00	117.71	116.58	117.77	0.000507	1.15	39.96	43.00	0.26
GlenOaks	3500	100Years	44.70	115.00	117.98	116.72	118.04	0.000462	1.20	52.56	50.72	0.26
GlenOaks	3500	Regional	44.70	115.00	117.98	116.72	118.04	0.000462	1.20	52.56	50.72	0.26
GlenOaks	3453.308	2Years	13.42	115.00	116.78		116.80	0.000137	0.53	30.97	25.19	0.13
GlenOaks	3453.308	5Years	20.88	115.00	117.14		117.16	0.000161	0.66	40.46	27.48	0.15
GlenOaks	3453.308	10Years	26.29	115.00	117.36		117.38	0.000174	0.74	46.61	28.74	0.16
GlenOaks	3453.308	25Years	32.80	115.00	117.60		117.63	0.000187	0.82	53.70	30.70	0.17
GlenOaks	3453.308	50Years	36.25	115.00	117.72		117.75	0.000193	0.86	57.35	31.71	0.17
GlenOaks	3453.308	100Years	44.70	115.00	117.98		118.02	0.000204	0.94	66.12	34.15	0.18
GlenOaks	3453.308	Regional	44.70	115.00	117.98		118.02	0.000204	0.94	66.12	34.15	0.18
GlenOaks	3427.268	2Years	13.42	115.00	116.38	116.38	116.75	0.010295	2.68	5.12	7.41	0.99
GlenOaks	3427.268	5Years	20.88	115.00	116.66	116.66	117.11	0.009448	2.98	7.35	8.77	0.98
GlenOaks	3427.268	10Years	26.29	115.00	116.82	116.82	117.32	0.009038	3.18	8.81	9.67	0.98
GlenOaks	3427.268	25Years	32.80	115.00	116.99	116.99	117.56	0.008530	3.40	10.50	10.49	0.98
GlenOaks	3427.268	50Years	36.25	115.00	117.07	117.07	117.68	0.008211	3.49	11.44	10.92	0.97
GlenOaks	3427.268	100Years	44.70	115.00	117.27	117.27	117.94	0.007682	3.71	13.69	11.94	0.96
GlenOaks	3427.268	Regional	44.70	115.00	117.27	117.27	117.94	0.007682	3.71	13.69	11.94	0.96
GlenOaks	3407.117	2Years	13.42	114.21	115.44	115.44	115.74	0.010668	2.44	5.54	10.11	0.99
GlenOaks	3407.117	5Years	20.88	114.21	115.68	115.68	116.03	0.008394	2.66	8.70	15.59	0.92

HEC-RAS Plan: Existing River: 14Mile Reach: GlenOaks (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
GlenOaks	3407.117	10Years	26.29	114.21	115.81	115.81	116.20	0.007829	2.83	10.84	16.75	0.91
GlenOaks	3407.117	25Years	32.80	114.21	115.95	115.95	116.38	0.007502	3.03	13.21	17.95	0.92
GlenOaks	3407.117	50Years	36.25	114.21	116.02	116.02	116.47	0.007342	3.11	14.45	18.55	0.91
GlenOaks	3407.117	100Years	44.70	114.21	116.17	116.17	116.67	0.007030	3.31	17.43	19.91	0.91
GlenOaks	3407.117	Regional	44.70	114.21	116.17	116.17	116.67	0.007030	3.31	17.43	19.91	0.91
GlenOaks	3388.007	2Years	13.42	113.50	114.81	114.81	115.04	0.011605	2.12	6.34	14.80	0.99
GlenOaks	3388.007	5Years	20.88	113.50	114.99	114.99	115.27	0.009186	2.33	9.82	22.92	0.93
GlenOaks	3388.007	10Years	26.29	113.50	115.10	115.10	115.40	0.008497	2.48	12.32	25.89	0.92
GlenOaks	3388.007	25Years	32.80	113.50	115.21	115.21	115.36	0.004563	1.99	26.11	48.56	0.69
GlenOaks	3388.007	50Years	36.25	113.50	115.21	115.21	115.40	0.005573	2.20	26.11	48.56	0.76
GlenOaks	3388.007	100Years	44.70	113.50	115.21	115.21	115.49	0.008473	2.72	26.11	48.56	0.94
GlenOaks	3388.007	Regional	44.70	113.50	115.21	115.21	115.49	0.008473	2.72	26.11	48.56	0.94
GlenOaks	3338.702	2Years	13.42	112.61	113.72	113.72	113.97	0.010617	2.24	6.15	13.59	0.97
GlenOaks	3338.702	5Years	20.88	112.61	113.91	113.91	114.22	0.009439	2.51	8.98	15.94	0.96
GlenOaks	3338.702	10Years	26.29	112.61	114.04	114.04	114.37	0.008269	2.59	11.38	28.23	0.92
GlenOaks	3338.702	25Years	32.80	112.61	114.15	114.15	114.27	0.003746	1.90	34.21	84.91	0.63
GlenOaks	3338.702	50Years	36.25	112.61	114.15	114.15	114.30	0.004576	2.09	34.21	84.91	0.70
GlenOaks	3338.702	100Years	44.70	112.61	114.16	114.16	114.38	0.006449	2.51	35.40	85.80	0.83
GlenOaks	3338.702	Regional	44.70	112.61	114.16	114.16	114.38	0.006449	2.51	35.40	85.80	0.83
GlenOaks	3300	2Years	13.42	112.00	112.89	112.89	113.12	0.011028	2.12	6.58	15.45	0.98
GlenOaks	3300	5Years	20.88	112.00	113.05	113.05	113.35	0.009885	2.44	9.21	17.13	0.97
GlenOaks	3300	10Years	26.29	112.00	113.16	113.16	113.49	0.009222	2.61	11.09	18.25	0.96
GlenOaks	3300	25Years	32.80	112.00	113.27	113.27	113.66	0.008916	2.81	13.18	19.91	0.97
GlenOaks	3300	50Years	36.25	112.00	113.33	113.33	113.73	0.008604	2.88	14.40	20.89	0.96
GlenOaks	3300	100Years	44.70	112.00	113.47	113.47	113.91	0.007964	3.05	17.42	23.14	0.95
GlenOaks	3300	Regional	44.70	112.00	113.47	113.47	113.91	0.007964	3.05	17.42	23.14	0.95
GlenOaks	3244.446	2Years	13.42	110.92	112.01	112.01	112.27	0.011014	2.29	5.94	12.11	0.99
GlenOaks	3244.446	5Years	20.88	110.92	112.20	112.20	112.53	0.009635	2.56	8.60	14.80	0.97
GlenOaks	3244.446	10Years	26.29	110.92	112.32	112.32	112.69	0.009233	2.73	10.46	16.53	0.97
GlenOaks	3244.446	25Years	32.80	110.92	112.46	112.46	112.86	0.008409	2.86	12.94	20.30	0.95
GlenOaks	3244.446	50Years	36.25	110.92	112.54	112.54	112.94	0.007768	2.89	14.66	25.60	0.92
GlenOaks	3244.446	100Years	44.70	110.92	112.70	112.70	113.11	0.006700	2.97	19.51	33.72	0.88
GlenOaks	3244.446	Regional	44.70	110.92	112.70	112.70	113.11	0.006700	2.97	19.51	33.72	0.88
GlenOaks	3218.863	2Years	13.42	110.00	111.70		111.80	0.002283	1.39	10.15	14.48	0.48
GlenOaks	3218.863	5Years	20.88	110.00	112.23		112.31	0.000994	1.27	19.04	18.82	0.35
GlenOaks	3218.863	10Years	26.29	110.00	112.37		112.47	0.001117	1.44	21.73	20.02	0.37
GlenOaks	3218.863	25Years	32.80	110.00	112.44		112.58	0.001560	1.74	23.28	40.46	0.44
GlenOaks	3218.863	50Years	36.25	110.00	112.47		112.64	0.001730	1.87	24.85	41.98	0.47
GlenOaks	3218.863	100Years	44.70	110.00	112.55	112.03	112.77	0.002152	2.15	28.33	45.14	0.53
GlenOaks	3218.863	Regional	44.70	110.00	112.55	112.03	112.77	0.002152	2.15	28.33	45.14	0.53
GlenOaks	3202.874	2Years	13.42	110.00	111.64	111.25	111.75	0.002594	1.48	9.08	10.68	0.51
GlenOaks	3202.874	5Years	20.88	110.00	112.20	111.50	112.29	0.001261	1.36	15.77	13.45	0.38
GlenOaks	3202.874	10Years	26.29	110.00	112.32	111.64	112.44	0.001501	1.55	17.50	14.09	0.42
GlenOaks	3202.874	25Years	32.80	110.00	112.37	111.79	112.55	0.002110	1.87	18.18	14.52	0.50
GlenOaks	3202.874	50Years	36.25	110.00	112.38	111.86	112.60	0.002505	2.05	18.38	14.64	0.54
GlenOaks	3202.874	100Years	44.70	110.00	112.35	112.03	112.69	0.004061	2.58	17.94	14.37	0.69
GlenOaks	3202.874	Regional	44.70	110.00	112.35	112.03	112.69	0.004061	2.58	17.94	14.37	0.69
GlenOaks	3156.948		Culvert									
GlenOaks	3099.031	2Years	13.42	109.00	109.92	109.92	110.31	0.009586	2.75	4.88	28.86	1.00
GlenOaks	3099.031	5Years	20.88	109.00	110.18	110.18	110.71	0.008764	3.20	6.53	105.24	1.00
GlenOaks	3099.031	10Years	26.29	109.00	110.36	110.36	110.96	0.008313	3.45	7.62	117.50	1.00
GlenOaks	3099.031	25Years	32.80	109.00	110.55	110.55	111.25	0.007904	3.71	8.83	138.26	1.00
GlenOaks	3099.031	50Years	36.25	109.00	110.65	110.65	111.40	0.007733	3.84	9.44	174.76	1.00
GlenOaks	3099.031	100Years	44.70	109.00	110.87	110.87	111.74	0.007420	4.12	10.84	184.49	1.00
GlenOaks	3099.031	Regional	44.70	109.00	110.87	110.87	111.74	0.007420	4.12	10.84	184.49	1.00
GlenOaks	3073.705	2Years	13.42	108.71	109.53		109.56	0.001149	0.83	27.17	83.23	0.33
GlenOaks	3073.705	5Years	20.88	108.71	109.56		109.61	0.002365	1.22	29.08	84.12	0.48
GlenOaks	3073.705	10Years	26.29	108.71	109.62		109.69	0.002380	1.30	34.97	86.91	0.49
GlenOaks	3073.705	25Years	32.80	108.71	109.70		109.77	0.002371	1.39	41.69	90.13	0.50
GlenOaks	3073.705	50Years	36.25	108.71	109.72		109.80	0.002569	1.47	43.65	90.86	0.52
GlenOaks	3073.705	100Years	44.70	108.71	109.79		109.87	0.002805	1.62	49.48	93.00	0.55
GlenOaks	3073.705	Regional	44.70	108.71	109.79		109.87	0.002805	1.62	49.48	93.00	0.55
GlenOaks	3045	2Years	13.42	107.85	108.94	108.94	109.44	0.013313	3.12	4.31	4.33	1.00
GlenOaks	3045	5Years	20.88	107.85	109.37	109.37	109.52	0.004503	2.12	23.57	75.68	0.58
GlenOaks	3045	10Years	26.29	107.85	109.43	109.43	109.59	0.005018	2.30	28.32	84.71	0.62
GlenOaks	3045	25Years	32.80	107.85	109.48	109.48	109.66	0.005825	2.54	33.17	101.52	0.67

HEC-RAS Plan: Existing   River: 14Mile   Reach: GlenOaks (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
GlenOaks	3045	50Years	36.25	107.85	109.54	109.54	109.70	0.005170	2.45	39.54	115.07	0.63
GlenOaks	3045	100Years	44.70	107.85	109.60	109.60	109.76	0.005723	2.65	46.29	123.87	0.67
GlenOaks	3045	Regional	44.70	107.85	109.60	109.60	109.76	0.005723	2.65	46.29	123.87	0.67
GlenOaks	3040		Culvert									
GlenOaks	3035	2Years	13.42	107.55	108.64	108.64	109.14	0.013298	3.12	4.31	4.33	1.00
GlenOaks	3035	5Years	20.88	107.55	109.19	109.19	109.36	0.004036	2.12	22.53	73.22	0.56
GlenOaks	3035	10Years	26.29	107.55	109.26	109.26	109.43	0.004491	2.31	27.51	79.50	0.59
GlenOaks	3035	25Years	32.80	107.55	109.34	109.34	109.51	0.004630	2.42	34.79	101.07	0.61
GlenOaks	3035	50Years	36.25	107.55	109.37	109.37	109.55	0.004809	2.50	37.98	105.91	0.62
GlenOaks	3035	100Years	44.70	107.55	109.44	109.44	109.62	0.005212	2.67	45.30	116.18	0.65
GlenOaks	3035	Regional	44.70	107.55	109.44	109.44	109.62	0.005212	2.67	45.30	116.18	0.65
GlenOaks	2999.999	2Years	13.42	106.50	107.56	107.56	107.83	0.011142	2.30	5.83	10.81	1.00
GlenOaks	2999.999	5Years	20.88	106.50	107.77	107.77	108.09	0.010759	2.54	8.23	12.83	1.01
GlenOaks	2999.999	10Years	26.29	106.50	107.88	107.88	108.25	0.010229	2.69	9.82	14.18	1.01
GlenOaks	2999.999	25Years	32.80	106.50	108.01	108.01	108.42	0.009800	2.85	11.67	15.63	1.01
GlenOaks	2999.999	50Years	36.25	106.50	108.09	108.09	108.50	0.008900	2.84	13.17	20.51	0.97
GlenOaks	2999.999	100Years	44.70	106.50	108.25	108.25	108.68	0.007838	2.91	16.96	26.80	0.93
GlenOaks	2999.999	Regional	44.70	106.50	108.25	108.25	108.68	0.007838	2.91	16.96	26.80	0.93
GlenOaks	2908.990	2Years	13.42	105.17	106.77	106.20	106.83	0.001360	1.17	11.49	11.71	0.38
GlenOaks	2908.990	5Years	20.88	105.17	106.83	106.42	106.98	0.002720	1.70	12.29	11.99	0.54
GlenOaks	2908.990	10Years	26.29	105.17	106.95	106.56	107.02	0.001629	1.38	30.04	43.17	0.42
GlenOaks	2908.990	25Years	32.80	105.17	106.94	106.71	107.06	0.002643	1.75	29.57	42.47	0.53
GlenOaks	2908.990	50Years	36.25	105.17	106.95	106.78	107.09	0.003145	1.92	29.87	42.90	0.58
GlenOaks	2908.990	100Years	44.70	105.17	106.97	106.92	107.17	0.004339	2.29	31.02	44.57	0.69
GlenOaks	2908.990	Regional	44.70	105.17	106.97	106.92	107.17	0.004339	2.29	31.02	44.57	0.69
GlenOaks	2888.560	2Years	13.42	104.86	106.78	105.88	106.80	0.000364	0.69	29.94	117.98	0.20
GlenOaks	2888.560	5Years	20.88	104.86	106.86	106.07	106.90	0.000595	0.92	41.22	136.94	0.26
GlenOaks	2888.560	10Years	26.29	104.86	106.95	106.20	106.99	0.000577	0.95	61.04	175.50	0.26
GlenOaks	2888.560	25Years	32.80	104.86	106.94	106.34	107.00	0.000955	1.21	58.83	173.44	0.34
GlenOaks	2888.560	50Years	36.25	104.86	106.95	106.40	107.01	0.001124	1.32	60.18	174.70	0.36
GlenOaks	2888.560	100Years	44.70	104.86	106.98	106.77	107.07	0.001459	1.53	66.06	180.08	0.42
GlenOaks	2888.560	Regional	44.70	104.86	106.98	106.77	107.07	0.001459	1.53	66.06	180.08	0.42
GlenOaks	2876.394		Culvert									
GlenOaks	2864.348	2Years	13.42	104.95	106.36	105.97	106.52	0.003311	1.77	7.62	24.89	0.54
GlenOaks	2864.348	5Years	20.88	104.95	106.44	106.24	106.78	0.006531	2.56	8.20	46.73	0.76
GlenOaks	2864.348	10Years	26.29	104.95	106.47	106.41	106.97	0.009616	3.15	8.43	47.90	0.92
GlenOaks	2864.348	25Years	32.80	104.95	106.79	106.61	106.88	0.002093	1.72	54.79	163.25	0.45
GlenOaks	2864.348	50Years	36.25	104.95	106.85	106.69	106.92	0.001816	1.65	64.02	165.44	0.42
GlenOaks	2864.348	100Years	44.70	104.95	106.95	106.81	107.01	0.001592	1.61	80.67	169.31	0.40
GlenOaks	2864.348	Regional	44.70	104.95	106.95	106.81	107.01	0.001592	1.61	80.67	169.31	0.40
GlenOaks	2843.745	2Years	13.42	104.70	106.03	106.03	106.36	0.011198	2.53	5.30	8.14	1.00
GlenOaks	2843.745	5Years	20.88	104.70	106.38	106.38	106.59	0.005370	2.17	15.56	52.51	0.73
GlenOaks	2843.745	10Years	26.29	104.70	106.48	106.48	106.68	0.005003	2.24	21.31	64.94	0.72
GlenOaks	2843.745	25Years	32.80	104.70	106.57	106.57	106.78	0.004975	2.36	27.51	80.40	0.73
GlenOaks	2843.745	50Years	36.25	104.70	106.61	106.61	106.82	0.004949	2.41	30.95	89.01	0.73
GlenOaks	2843.745	100Years	44.70	104.70	106.69	106.69	106.91	0.004869	2.52	39.19	98.13	0.73
GlenOaks	2843.745	Regional	44.70	104.70	106.69	106.69	106.91	0.004869	2.52	39.19	98.13	0.73
GlenOaks	2799.999	2Years	13.42	104.50	105.77	105.63	105.93	0.004939	1.79	8.48	21.19	0.69
GlenOaks	2799.999	5Years	20.88	104.50	105.98	105.87	106.17	0.004742	2.01	14.21	38.79	0.70
GlenOaks	2799.999	10Years	26.29	104.50	106.10	105.98	106.29	0.004378	2.07	19.66	48.87	0.68
GlenOaks	2799.999	25Years	32.80	104.50	106.23	106.14	106.41	0.003966	2.09	26.42	57.25	0.66
GlenOaks	2799.999	50Years	36.25	104.50	106.29		106.47	0.003767	2.09	30.07	60.90	0.65
GlenOaks	2799.999	100Years	44.70	104.50	106.44		106.60	0.003303	2.08	39.67	71.29	0.62
GlenOaks	2799.999	Regional	44.70	104.50	106.44		106.60	0.003303	2.08	39.67	71.29	0.62
GlenOaks	2699.999	2Years	13.42	103.92	104.97	104.96	105.23	0.010730	2.26	5.93	10.94	0.98
GlenOaks	2699.999	5Years	20.88	103.92	105.17	105.17	105.49	0.010361	2.52	8.30	12.71	0.99
GlenOaks	2699.999	10Years	26.29	103.92	105.28	105.28	105.65	0.009992	2.67	9.88	14.35	1.00
GlenOaks	2699.999	25Years	32.80	103.92	105.41	105.41	105.82	0.009122	2.83	11.85	16.93	0.98
GlenOaks	2699.999	50Years	36.25	103.92	105.47	105.47	105.90	0.008781	2.91	12.94	18.11	0.97
GlenOaks	2699.999	100Years	44.70	103.92	105.62	105.62	106.09	0.008012	3.07	15.79	21.19	0.95
GlenOaks	2699.999	Regional	44.70	103.92	105.62	105.62	106.09	0.008012	3.07	15.79	21.19	0.95
GlenOaks	2593.551	2Years	13.42	103.00	103.87	103.87	104.12	0.010011	2.23	6.64	15.58	0.95
GlenOaks	2593.551	5Years	20.88	103.00	104.06	104.06	104.36	0.008773	2.53	9.78	18.42	0.94
GlenOaks	2593.551	10Years	26.29	103.00	104.17	104.17	104.51	0.008384	2.71	11.90	19.95	0.94
GlenOaks	2593.551	25Years	32.80	103.00	104.30	104.30	104.67	0.007542	2.84	14.74	21.54	0.91

HEC-RAS Plan: Existing River: 14Mile Reach: GlenOaks (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
GlenOaks	2593.551	50Years	36.25	103.00	104.36	104.36	104.75	0.007495	2.93	15.93	21.76	0.92
GlenOaks	2593.551	100Years	44.70	103.00	104.48	104.48	104.92	0.007511	3.16	18.60	22.24	0.93
GlenOaks	2593.551	Regional	44.70	103.00	104.48	104.48	104.92	0.007511	3.16	18.60	22.24	0.93
GlenOaks	2532.899	2Years	13.42	102.68	103.91	103.41	103.93	0.000515	0.71	30.45	62.45	0.24
GlenOaks	2532.899	5Years	20.88	102.68	104.09	103.57	104.12	0.000566	0.84	42.29	68.01	0.26
GlenOaks	2532.899	10Years	26.29	102.68	104.18	103.64	104.21	0.000635	0.94	48.64	70.84	0.28
GlenOaks	2532.899	25Years	32.80	102.68	104.43	103.72	104.45	0.000293	0.73	104.31	171.68	0.19
GlenOaks	2532.899	50Years	36.25	102.68	104.46	103.76	104.48	0.000315	0.76	109.95	172.08	0.20
GlenOaks	2532.899	100Years	44.70	102.68	104.53	103.76	104.55	0.000370	0.85	121.89	172.91	0.22
GlenOaks	2532.899	Regional	44.70	102.68	104.53	103.76	104.55	0.000370	0.85	121.89	172.91	0.22
GlenOaks	2477.264	2Years	13.42	102.67	103.65	103.65	103.84	0.007738	2.16	10.28	31.59	0.86
GlenOaks	2477.264	5Years	20.88	102.67	103.79	103.79	104.02	0.008180	2.52	15.20	53.87	0.91
GlenOaks	2477.264	10Years	26.29	102.67	103.92	103.79	104.12	0.006066	2.42	23.38	62.11	0.81
GlenOaks	2477.264	25Years	32.80	102.67	104.41	103.79	104.43	0.000504	0.93	104.13	182.66	0.25
GlenOaks	2477.264	50Years	36.25	102.67	104.44	103.79	104.46	0.000530	0.96	109.98	184.24	0.26
GlenOaks	2477.264	100Years	44.70	102.67	104.51	104.10	104.53	0.000599	1.06	122.36	187.66	0.28
GlenOaks	2477.264	Regional	44.70	102.67	104.51	104.10	104.53	0.000599	1.06	122.36	187.66	0.28
GlenOaks	2337	2Years	13.42	101.17	102.75		102.87	0.004260	1.95	14.51	35.33	0.56
GlenOaks	2337	5Years	20.88	101.17	103.47		103.49	0.000628	0.99	50.56	67.61	0.23
GlenOaks	2337	10Years	26.29	101.17	103.92		103.93	0.000266	0.74	88.35	96.58	0.15
GlenOaks	2337	25Years	32.80	101.17	104.37		104.38	0.000122	0.56	134.64	105.71	0.11
GlenOaks	2337	50Years	36.25	101.17	104.40		104.41	0.000140	0.61	137.47	105.71	0.11
GlenOaks	2337	100Years	44.70	101.17	104.45		104.46	0.000189	0.71	143.08	105.71	0.13
GlenOaks	2337	Regional	44.70	101.17	104.45		104.46	0.000189	0.71	143.08	105.71	0.13
GlenOaks	2320.843	2Years	13.42	100.95	102.78	101.70	102.81	0.000341	0.83	19.03	123.19	0.20
GlenOaks	2320.843	5Years	20.88	100.95	103.44	101.94	103.48	0.000256	0.89	27.79	168.17	0.18
GlenOaks	2320.843	10Years	26.29	100.95	103.87	102.08	103.91	0.000226	0.93	33.48	204.30	0.18
GlenOaks	2320.843	25Years	32.80	100.95	104.38	102.23	104.38	0.000011	0.23	382.71	267.05	0.04
GlenOaks	2320.843	50Years	36.25	100.95	104.40	102.31	104.40	0.000014	0.26	389.91	267.25	0.05
GlenOaks	2320.843	100Years	44.70	100.95	104.46	102.46	104.46	0.000019	0.30	404.28	267.25	0.05
GlenOaks	2320.843	Regional	44.70	100.95	104.46	102.46	104.46	0.000019	0.30	404.28	267.25	0.05
GlenOaks	2307.157		Culvert									
GlenOaks	2295.416	2Years	13.42	100.69	101.64	101.64	102.07	0.009456	2.93	4.73	83.17	1.01
GlenOaks	2295.416	5Years	20.88	100.69	101.93	101.93	102.51	0.008635	3.41	6.34	138.94	1.01
GlenOaks	2295.416	10Years	26.29	100.69	102.12	102.12	102.79	0.008167	3.67	7.40	235.21	1.01
GlenOaks	2295.416	25Years	32.80	100.69	102.34	102.34	103.12	0.007779	3.95	8.58	250.45	1.01
GlenOaks	2295.416	50Years	36.25	100.69	102.44	102.44	103.28	0.007631	4.09	9.16	250.81	1.01
GlenOaks	2295.416	100Years	44.70	100.69	102.69	102.69	103.65	0.007283	4.39	10.54	251.66	1.01
GlenOaks	2295.416	Regional	44.70	100.69	102.69	102.69	103.65	0.007283	4.39	10.54	251.66	1.01
GlenOaks	2281.974	2Years	13.42	100.28	101.42	101.42	101.66	0.007227	2.34	8.29	22.29	0.83
GlenOaks	2281.974	5Years	20.88	100.28	101.62	101.62	101.89	0.006634	2.60	13.62	30.62	0.83
GlenOaks	2281.974	10Years	26.29	100.28	101.73	101.73	102.02	0.006368	2.74	17.48	35.53	0.82
GlenOaks	2281.974	25Years	32.80	100.28	101.84	101.84	102.15	0.006398	2.92	21.66	40.37	0.84
GlenOaks	2281.974	50Years	36.25	100.28	101.91	101.91	102.06	0.003755	2.32	42.69	107.01	0.65
GlenOaks	2281.974	100Years	44.70	100.28	101.99	101.95	102.13	0.003770	2.41	50.77	108.42	0.66
GlenOaks	2281.974	Regional	44.70	100.28	101.99	101.95	102.13	0.003770	2.41	50.77	108.42	0.66
GlenOaks	2246.37	2Years	13.42	99.68	101.19	101.19	101.47	0.001496	2.73	13.99	32.37	0.79
GlenOaks	2246.37	5Years	20.88	99.68	101.52	101.52	101.71	0.000941	2.54	37.97	93.63	0.65
GlenOaks	2246.37	10Years	26.29	99.68	101.59	101.59	101.80	0.001043	2.77	45.31	97.44	0.69
GlenOaks	2246.37	25Years	32.80	99.68	101.66	101.66	101.89	0.001198	3.05	52.28	101.44	0.75
GlenOaks	2246.37	50Years	36.25	99.68	101.70	101.70	101.94	0.001244	3.16	56.42	104.98	0.76
GlenOaks	2246.37	100Years	44.70	99.68	101.79	101.79	102.04	0.001346	3.39	65.99	112.72	0.80
GlenOaks	2246.37	Regional	44.70	99.68	101.79	101.79	102.04	0.001346	3.39	65.99	112.72	0.80
GlenOaks	2230.806	2Years	13.42	100.00	101.15	101.15	101.31	0.005901	1.92	11.84	51.57	0.75
GlenOaks	2230.806	5Years	20.88	100.00	101.29	101.29	101.46	0.005642	2.13	20.74	80.27	0.76
GlenOaks	2230.806	10Years	26.29	100.00	101.37	101.37	101.53	0.005440	2.22	27.62	97.79	0.76
GlenOaks	2230.806	25Years	32.80	100.00	101.57		101.65	0.002544	1.75	52.75	154.17	0.53
GlenOaks	2230.806	50Years	36.25	100.00	101.44	101.44	101.64	0.006460	2.56	35.57	114.73	0.83
GlenOaks	2230.806	100Years	44.70	100.00	101.54	101.54	101.72	0.005464	2.52	49.03	147.38	0.78
GlenOaks	2230.806	Regional	44.70	100.00	101.54	101.54	101.72	0.005464	2.52	49.03	147.38	0.78
GlenOaks	2167	2Years	13.42	98.77	99.93	99.93	100.41	0.002171	3.13	5.62	7.44	0.98
GlenOaks	2167	5Years	20.88	98.77	100.27	100.27	100.88	0.001928	3.57	8.42	8.83	0.97
GlenOaks	2167	10Years	26.29	98.77	100.45	100.45	101.18	0.002017	3.95	10.00	9.53	1.01
GlenOaks	2167	25Years	32.80	98.77	100.77	100.77	101.47	0.001536	3.92	17.86	38.39	0.91
GlenOaks	2167	50Years	36.25	98.77	101.17	101.17	101.46	0.000622	2.84	53.00	100.49	0.60
GlenOaks	2167	100Years	44.70	98.77	101.28	101.28	101.59	0.000684	3.07	63.52	100.49	0.63

HEC-RAS Plan: Existing River: 14Mile Reach: GlenOaks (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
GlenOaks	2167	Regional	44.70	98.77	101.28	101.28	101.59	0.000684	3.07	63.52	100.49	0.63
GlenOaks	2155.5	2Years	13.42	98.45	99.58	99.58	99.91	0.009901	2.56	5.46	8.87	0.98
GlenOaks	2155.5	5Years	20.88	98.45	100.03	99.81	100.31	0.004448	2.38	9.42	10.50	0.71
GlenOaks	2155.5	10Years	26.29	98.45	100.44	99.96	100.67	0.002447	2.17	13.17	12.06	0.56
GlenOaks	2155.5	25Years	32.80	98.45	100.92	100.13	101.12	0.001528	2.05	17.50	21.05	0.46
GlenOaks	2155.5	50Years	36.25	98.45	100.97	100.21	101.20	0.001725	2.21	17.93	48.38	0.49
GlenOaks	2155.5	100Years	44.70	98.45	100.99	100.40	101.34	0.002516	2.69	18.16	49.91	0.59
GlenOaks	2155.5	Regional	44.70	98.45	100.99	100.40	101.34	0.002516	2.69	18.16	49.91	0.59
GlenOaks	2141.697		Culvert									
GlenOaks	2126.4	2Years	13.42	97.48	99.44	98.48	99.52	0.000898	1.21	11.31	9.58	0.30
GlenOaks	2126.4	5Years	20.88	97.48	99.70	98.75	99.84	0.001339	1.63	13.19	10.70	0.37
GlenOaks	2126.4	10Years	26.29	97.48	99.88	98.93	100.05	0.001592	1.88	14.44	11.45	0.41
GlenOaks	2126.4	25Years	32.80	97.48	100.07	99.13	100.30	0.001846	2.14	15.83	12.29	0.45
GlenOaks	2126.4	50Years	36.25	97.48	100.19	99.23	100.44	0.001898	2.24	16.70	12.81	0.46
GlenOaks	2126.4	100Years	44.70	97.48	100.45	99.45	100.76	0.002038	2.49	18.60	13.95	0.48
GlenOaks	2126.4	Regional	44.70	97.48	100.45	99.45	100.76	0.002038	2.49	18.60	13.95	0.48
GlenOaks	2120.26	2Years	13.42	97.71	99.39	98.82	99.50	0.001984	1.47	9.13	8.41	0.45
GlenOaks	2120.26	5Years	20.88	97.71	99.64	99.11	99.81	0.002645	1.84	11.38	9.28	0.53
GlenOaks	2120.26	10Years	26.29	97.71	99.83	99.29	100.03	0.002817	1.99	13.19	9.93	0.55
GlenOaks	2120.26	25Years	32.80	97.71	100.06	99.47	100.28	0.002828	2.11	15.52	10.71	0.56
GlenOaks	2120.26	50Years	36.25	97.71	100.19	99.56	100.42	0.002733	2.14	16.93	11.15	0.55
GlenOaks	2120.26	100Years	44.70	97.71	100.47	99.76	100.72	0.002571	2.21	20.25	12.13	0.55
GlenOaks	2120.26	Regional	44.70	97.71	100.47	99.76	100.72	0.002571	2.21	20.25	12.13	0.55
GlenOaks	2106.268	2Years	13.42	97.84	99.11	99.11	99.42	0.010885	2.49	5.40	8.56	1.00
GlenOaks	2106.268	5Years	20.88	97.84	99.46	99.35	99.74	0.007010	2.35	8.87	10.98	0.84
GlenOaks	2106.268	10Years	26.29	97.84	99.74	99.49	99.98	0.004445	2.18	12.15	12.82	0.69
GlenOaks	2106.268	25Years	32.80	97.84	100.01	99.64	100.24	0.003058	2.12	15.94	14.58	0.60
GlenOaks	2106.268	50Years	36.25	97.84	100.15	99.71	100.38	0.002625	2.11	18.05	15.46	0.56
GlenOaks	2106.268	100Years	44.70	97.84	100.45	99.86	100.68	0.002064	2.12	22.97	19.81	0.51
GlenOaks	2106.268	Regional	44.70	97.84	100.45	99.86	100.68	0.002064	2.12	22.97	19.81	0.51
GlenOaks	2098.17*	2Years	13.42	97.66	99.06		99.28	0.006240	2.08	6.45	8.93	0.77
GlenOaks	2098.17*	5Years	20.88	97.66	99.48		99.69	0.003297	2.02	10.80	11.66	0.60
GlenOaks	2098.17*	10Years	26.29	97.66	99.73		99.94	0.002639	2.07	14.28	22.02	0.56
GlenOaks	2098.17*	25Years	32.80	97.66	100.02		100.21	0.001926	2.01	22.91	35.67	0.49
GlenOaks	2098.17*	50Years	36.25	97.66	100.18		100.35	0.001612	1.94	28.96	43.64	0.46
GlenOaks	2098.17*	100Years	44.70	97.66	100.51		100.64	0.001117	1.81	46.25	61.33	0.39
GlenOaks	2098.17*	Regional	44.70	97.66	100.51		100.64	0.001117	1.81	46.25	61.33	0.39
GlenOaks	2090.07*	2Years	13.42	97.48	99.04	98.76	99.23	0.003401	1.97	8.23	16.91	0.60
GlenOaks	2090.07*	5Years	20.88	97.48	99.50	99.11	99.65	0.001862	1.85	17.98	25.42	0.47
GlenOaks	2090.07*	10Years	26.29	97.48	99.78		99.90	0.001421	1.80	25.68	30.79	0.43
GlenOaks	2090.07*	25Years	32.80	97.48	100.07		100.18	0.001121	1.76	35.40	36.57	0.39
GlenOaks	2090.07*	50Years	36.25	97.48	100.21		100.32	0.001015	1.76	40.97	40.94	0.37
GlenOaks	2090.07*	100Years	44.70	97.48	100.52		100.62	0.000846	1.75	55.81	55.00	0.35
GlenOaks	2090.07*	Regional	44.70	97.48	100.52		100.62	0.000846	1.75	55.81	55.00	0.35
GlenOaks	2081.98	2Years	13.42	97.30	98.75	98.75	99.17	0.008035	3.10	6.03	8.11	0.91
GlenOaks	2081.98	5Years	20.88	97.30	99.06	99.06	99.58	0.007718	3.56	8.80	9.42	0.92
GlenOaks	2081.98	10Years	26.29	97.30	99.26	99.26	99.84	0.007546	3.81	10.70	10.19	0.93
GlenOaks	2081.98	25Years	32.80	97.30	99.47	99.47	100.11	0.007406	4.08	12.91	11.02	0.94
GlenOaks	2081.98	50Years	36.25	97.30	99.54	99.54	100.24	0.007836	4.30	13.69	11.34	0.98
GlenOaks	2081.98	100Years	44.70	97.30	99.80	99.80	100.54	0.007246	4.49	16.90	13.00	0.96
GlenOaks	2081.98	Regional	44.70	97.30	99.80	99.80	100.54	0.007246	4.49	16.90	13.00	0.96
GlenOaks	2061.48*	2Years	13.42	97.23	98.79	98.57	98.99	0.003482	2.12	9.31	18.22	0.62
GlenOaks	2061.48*	5Years	20.88	97.23	99.18		99.35	0.002323	2.09	18.03	25.93	0.53
GlenOaks	2061.48*	10Years	26.29	97.23	99.33		99.51	0.002415	2.26	22.07	28.75	0.55
GlenOaks	2061.48*	25Years	32.80	97.23	99.41		99.65	0.002971	2.59	24.65	30.37	0.61
GlenOaks	2061.48*	50Years	36.25	97.23	99.45		99.72	0.003312	2.77	25.76	31.20	0.65
GlenOaks	2061.48*	100Years	44.70	97.23	99.51	99.39	99.87	0.004377	3.25	27.63	32.94	0.75
GlenOaks	2061.48*	Regional	44.70	97.23	99.51	99.39	99.87	0.004377	3.25	27.63	32.94	0.75
GlenOaks	2040.99*	2Years	13.42	97.15	98.75	98.39	98.91	0.002771	1.84	8.62	19.29	0.55
GlenOaks	2040.99*	5Years	20.88	97.15	99.16		99.30	0.001758	1.80	19.65	34.95	0.46
GlenOaks	2040.99*	10Years	26.29	97.15	99.31		99.46	0.001756	1.92	25.60	41.98	0.47
GlenOaks	2040.99*	25Years	32.80	97.15	99.40		99.59	0.002132	2.18	29.47	46.65	0.52
GlenOaks	2040.99*	50Years	36.25	97.15	99.44		99.64	0.002353	2.32	31.26	49.09	0.55
GlenOaks	2040.99*	100Years	44.70	97.15	99.50	99.34	99.77	0.003006	2.69	34.58	53.42	0.62
GlenOaks	2040.99*	Regional	44.70	97.15	99.50	99.34	99.77	0.003006	2.69	34.58	53.42	0.62

HEC-RAS Plan: Existing River: 14Mile Reach: GlenOaks (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
GlenOaks	2020.49*	2Years	13.42	97.08	98.73		98.85	0.002055	1.55	9.08	10.25	0.47
GlenOaks	2020.49*	5Years	20.88	97.08	99.14		99.26	0.001522	1.64	18.75	44.69	0.43
GlenOaks	2020.49*	10Years	26.29	97.08	99.29		99.42	0.001463	1.72	26.67	54.68	0.43
GlenOaks	2020.49*	25Years	32.80	97.08	99.38		99.54	0.001757	1.95	31.67	61.92	0.47
GlenOaks	2020.49*	50Years	36.25	97.08	99.42		99.59	0.001919	2.07	34.05	65.31	0.50
GlenOaks	2020.49*	100Years	44.70	97.08	99.48		99.70	0.002383	2.36	38.51	69.69	0.56
GlenOaks	2020.49*	Regional	44.70	97.08	99.48		99.70	0.002383	2.36	38.51	69.69	0.56
GlenOaks	2000	2Years	13.42	97.00	98.71	98.21	98.81	0.001652	1.35	10.12	11.07	0.42
GlenOaks	2000	5Years	20.88	97.00	99.12	98.46	99.23	0.001300	1.49	16.05	41.14	0.40
GlenOaks	2000	10Years	26.29	97.00	99.27	98.60	99.39	0.001332	1.61	24.85	71.51	0.41
GlenOaks	2000	25Years	32.80	97.00	99.35	98.75	99.50	0.001612	1.84	31.25	86.42	0.45
GlenOaks	2000	50Years	36.25	97.00	99.39	98.83	99.55	0.001739	1.93	34.46	89.11	0.47
GlenOaks	2000	100Years	44.70	97.00	99.45	99.01	99.65	0.002143	2.20	40.06	93.09	0.53
GlenOaks	2000	Regional	44.70	97.00	99.45	99.01	99.65	0.002143	2.20	40.06	93.09	0.53
GlenOaks	1982.66*	2Years	13.42	96.83	98.67	98.26	98.77	0.002501	1.42	9.48	12.08	0.49
GlenOaks	1982.66*	5Years	20.88	96.83	99.10	98.52	99.20	0.001470	1.44	17.22	50.27	0.40
GlenOaks	1982.66*	10Years	26.29	96.83	99.26	98.65	99.37	0.001366	1.50	28.33	87.20	0.40
GlenOaks	1982.66*	25Years	32.80	96.83	99.35	98.79	99.47	0.001534	1.65	36.30	95.03	0.43
GlenOaks	1982.66*	50Years	36.25	96.83	99.39	98.86	99.51	0.001619	1.72	40.03	97.69	0.44
GlenOaks	1982.66*	100Years	44.70	96.83	99.45	99.28	99.60	0.001925	1.93	46.62	101.70	0.48
GlenOaks	1982.66*	Regional	44.70	96.83	99.45	99.28	99.60	0.001925	1.93	46.62	101.70	0.48
GlenOaks	1965.32*	2Years	13.42	96.66	98.52	98.21	98.70	0.005904	1.86	7.23	10.28	0.71
GlenOaks	1965.32*	5Years	20.88	96.66	99.07	98.60	99.17	0.001948	1.46	17.30	56.50	0.44
GlenOaks	1965.32*	10Years	26.29	96.66	99.25	98.73	99.34	0.001508	1.42	31.73	97.60	0.40
GlenOaks	1965.32*	25Years	32.80	96.66	99.34	98.86	99.43	0.001588	1.52	41.07	106.83	0.42
GlenOaks	1965.32*	50Years	36.25	96.66	99.38	98.92	99.48	0.001648	1.58	45.39	111.89	0.43
GlenOaks	1965.32*	100Years	44.70	96.66	99.44	99.26	99.56	0.001912	1.76	53.21	120.88	0.46
GlenOaks	1965.32*	Regional	44.70	96.66	99.44	99.26	99.56	0.001912	1.76	53.21	120.88	0.46
GlenOaks	1947.99*	2Years	13.42	96.48	98.15	97.96	98.54	0.010549	2.77	4.85	4.69	0.87
GlenOaks	1947.99*	5Years	20.88	96.48	98.92	98.48	99.12	0.003712	2.01	11.98	24.70	0.58
GlenOaks	1947.99*	10Years	26.29	96.48	99.12	98.71	99.29	0.002964	1.98	23.59	97.58	0.53
GlenOaks	1947.99*	25Years	32.80	96.48	99.23	99.17	99.39	0.002797	2.02	36.05	125.05	0.52
GlenOaks	1947.99*	50Years	36.25	96.48	99.22	99.22	99.43	0.003515	2.26	35.29	123.58	0.58
GlenOaks	1947.99*	100Years	44.70	96.48	99.31	99.31	99.51	0.003535	2.35	47.18	144.97	0.59
GlenOaks	1947.99*	Regional	44.70	96.48	99.31	99.31	99.51	0.003535	2.35	47.18	144.97	0.59
GlenOaks	1930.658	2Years	13.42	96.31	98.02	97.70	98.38	0.007791	2.63	5.10	3.61	0.71
GlenOaks	1930.658	5Years	20.88	96.31	98.75	98.13	99.03	0.006061	2.36	8.86	7.44	0.69
GlenOaks	1930.658	10Years	26.29	96.31	99.08	98.57	99.23	0.003312	1.89	31.31	197.10	0.53
GlenOaks	1930.658	25Years	32.80	96.31	99.28	99.16	99.33	0.001309	1.31	72.14	217.16	0.34
GlenOaks	1930.658	50Years	36.25	96.31	99.27	99.18	99.33	0.001691	1.48	70.25	215.96	0.39
GlenOaks	1930.658	100Years	44.70	96.31	99.32	99.23	99.39	0.001857	1.59	81.82	224.51	0.41
GlenOaks	1930.658	Regional	44.70	96.31	99.32	99.23	99.39	0.001857	1.59	81.82	224.51	0.41
GlenOaks	1921.384	2Years	13.42	96.19	97.62	97.62	98.21	0.014618	3.40	3.95	3.52	1.01
GlenOaks	1921.384	5Years	20.88	96.19	98.04	98.04	98.80	0.013989	3.87	5.39	3.93	1.00
GlenOaks	1921.384	10Years	26.29	96.19	98.91	98.91	99.17	0.003609	2.46	21.19	69.93	0.53
GlenOaks	1921.384	25Years	32.80	96.19	99.06	99.06	99.26	0.003086	2.37	38.83	194.08	0.49
GlenOaks	1921.384	50Years	36.25	96.19	99.18	99.18	99.30	0.002087	2.02	63.60	224.36	0.41
GlenOaks	1921.384	100Years	44.70	96.19	99.22	99.22	99.35	0.002408	2.19	73.72	231.59	0.44
GlenOaks	1921.384	Regional	44.70	96.19	99.22	99.22	99.35	0.002408	2.19	73.72	231.59	0.44
GlenOaks	1910.213		Culvert									
GlenOaks	1897.719	2Years	13.42	95.65	97.51	97.06	97.79	0.003915	2.37	5.66	4.53	0.60
GlenOaks	1897.719	5Years	20.88	95.65	97.54	97.44	98.21	0.008827	3.61	5.78	4.57	0.91
GlenOaks	1897.719	10Years	26.29	95.65	97.74	97.70	98.58	0.009550	4.06	6.48	4.80	0.96
GlenOaks	1897.719	25Years	32.80	95.65	98.87	98.72	99.02	0.001714	1.94	39.61	104.61	0.39
GlenOaks	1897.719	50Years	36.25	95.65	98.99	98.79	99.10	0.001386	1.80	53.45	132.71	0.35
GlenOaks	1897.719	100Years	44.70	95.65	98.90	98.90	99.14	0.002871	2.53	42.68	108.30	0.51
GlenOaks	1897.719	Regional	44.70	95.65	98.90	98.90	99.14	0.002871	2.53	42.68	108.30	0.51
GlenOaks	1889.709	2Years	13.42	95.58	97.08	97.08	97.60	0.012978	3.19	4.20	4.04	1.00
GlenOaks	1889.709	5Years	20.88	95.58	97.47	97.47	98.11	0.012793	3.56	5.87	4.59	1.00
GlenOaks	1889.709	10Years	26.29	95.58	97.71	97.71	98.43	0.012496	3.74	7.03	4.93	1.00
GlenOaks	1889.709	25Years	32.80	95.58	98.21	98.21	98.75	0.011624	3.26	10.05	9.25	1.00
GlenOaks	1889.709	50Years	36.25	95.58	98.36	98.36	98.85	0.011302	3.10	11.70	11.93	1.00
GlenOaks	1889.709	100Years	44.70	95.58	98.70	98.70	98.92	0.005024	2.23	33.39	96.65	0.69
GlenOaks	1889.709	Regional	44.70	95.58	98.70	98.70	98.92	0.005024	2.23	33.39	96.65	0.69
GlenOaks	1799.999	2Years	13.42	94.57	96.02	95.79	96.14	0.004060	1.52	8.92	15.88	0.61
GlenOaks	1799.999	5Years	20.88	94.57	96.34	96.00	96.44	0.002468	1.47	16.09	29.79	0.50

HEC-RAS Plan: Existing River: 14Mile Reach: GlenOaks (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
GlenOaks	1799.999	10Years	26.29	94.57	96.47	96.13	96.59	0.002281	1.56	20.53	35.56	0.50
GlenOaks	1799.999	25Years	32.80	94.57	96.83	96.25	96.90	0.001085	1.31	35.28	46.98	0.36
GlenOaks	1799.999	50Years	36.25	94.57	96.67	96.31	96.81	0.002158	1.71	28.33	42.46	0.50
GlenOaks	1799.999	100Years	44.70	94.57	96.74	96.42	96.91	0.002672	1.97	31.08	44.31	0.56
GlenOaks	1799.999	Regional	44.70	94.57	97.40	96.42	97.45	0.000481	1.11	73.08	97.74	0.25
GlenOaks	1742.723	2Years	18.58	93.99	95.60	95.33	95.77	0.004377	1.85	10.09	13.18	0.65
GlenOaks	1742.723	5Years	28.32	93.99	96.16	95.60	96.28	0.001674	1.58	22.00	38.84	0.44
GlenOaks	1742.723	10Years	34.73	93.99	96.29	95.73	96.43	0.001675	1.69	27.61	41.99	0.45
GlenOaks	1742.723	25Years	42.77	93.99	96.75	95.88	96.83	0.000800	1.39	49.09	53.75	0.32
GlenOaks	1742.723	50Years	48.86	93.99	96.34	96.00	96.58	0.002885	2.26	29.70	43.10	0.59
GlenOaks	1742.723	100Years	54.24	93.99	96.35	96.15	96.64	0.003479	2.49	30.04	43.27	0.65
GlenOaks	1742.723	Regional	105.80	93.99	96.71	96.71	97.24	0.005305	3.55	47.23	52.77	0.83
GlenOaks	1715.436	2Years	18.58	93.87	95.31	94.96	95.62	0.003410	2.48	7.49	6.94	0.66
GlenOaks	1715.436	5Years	28.32	93.87	95.50	95.32	96.07	0.005217	3.34	8.49	9.99	0.83
GlenOaks	1715.436	10Years	34.73	93.87	96.31	95.92	96.35	0.000901	1.16	65.43	137.53	0.30
GlenOaks	1715.436	25Years	42.77	93.87	96.77	96.03	96.78	0.000258	0.74	144.13	202.89	0.17
GlenOaks	1715.436	50Years	48.86	93.87	96.38	96.09	96.44	0.001346	1.46	75.41	147.40	0.37
GlenOaks	1715.436	100Years	54.24	93.87	96.40	96.13	96.47	0.001535	1.57	78.37	150.20	0.40
GlenOaks	1715.436	Regional	105.80	93.87	96.43	96.43	96.69	0.005089	2.91	83.83	155.24	0.73
GlenOaks	1702.377		Bridge									
GlenOaks	1687.450	2Years	18.58	93.62	94.90	94.72	95.31	0.005191	2.82	6.60	8.58	0.80
GlenOaks	1687.450	5Years	28.32	93.62	95.08	95.08	95.80	0.007770	3.76	7.53	9.25	1.00
GlenOaks	1687.450	10Years	34.73	93.62	95.29	95.29	96.12	0.007428	4.03	8.63	10.06	1.00
GlenOaks	1687.450	25Years	42.77	93.62	95.54	95.54	96.49	0.007110	4.32	9.90	11.01	1.00
GlenOaks	1687.450	50Years	48.86	93.62	95.71	95.71	96.22	0.005090	3.16	15.58	21.16	0.80
GlenOaks	1687.450	100Years	54.24	93.62	95.95	95.95	96.28	0.003714	2.62	29.48	89.73	0.65
GlenOaks	1687.450	Regional	105.80	93.62	96.39	96.39	96.69	0.003319	2.90	86.30	161.23	0.64
GlenOaks	1660.15	2Years	18.58	93.32	94.84	94.84	95.08	0.005391	2.43	13.93	37.95	0.72
GlenOaks	1660.15	5Years	28.32	93.32	95.07	95.07	95.28	0.004530	2.51	25.13	58.76	0.68
GlenOaks	1660.15	10Years	34.73	93.32	95.14	95.14	95.37	0.004879	2.69	29.49	61.87	0.71
GlenOaks	1660.15	25Years	42.77	93.32	95.22	95.22	95.46	0.005250	2.89	34.49	65.26	0.74
GlenOaks	1660.15	50Years	48.86	93.32	95.27	95.27	95.53	0.005511	3.03	37.99	67.52	0.77
GlenOaks	1660.15	100Years	54.24	93.32	95.31	95.31	95.58	0.005704	3.14	40.99	69.41	0.78
GlenOaks	1660.15	Regional	105.80	93.32	95.72	95.63	96.00	0.005396	3.54	73.20	87.11	0.79
GlenOaks	1626.345	2Years	18.58	93.00	94.28	94.28	94.52	0.007179	2.24	10.17	29.89	0.84
GlenOaks	1626.345	5Years	28.32	93.00	94.47	94.47	94.74	0.006304	2.46	16.49	35.36	0.82
GlenOaks	1626.345	10Years	34.73	93.00	94.56	94.56	94.86	0.006316	2.62	19.77	36.49	0.83
GlenOaks	1626.345	25Years	42.77	93.00	94.66	94.66	94.99	0.006444	2.82	23.39	37.60	0.86
GlenOaks	1626.345	50Years	48.86	93.00	94.73	94.73	95.08	0.006483	2.94	26.02	38.29	0.87
GlenOaks	1626.345	100Years	54.24	93.00	94.78	94.78	95.16	0.006635	3.07	28.04	38.81	0.88
GlenOaks	1626.345	Regional	105.80	93.00	95.22	95.22	95.77	0.007130	3.90	46.54	46.26	0.96
GlenOaks	1602.427	2Years	18.58	93.00	94.10	94.05	94.29	0.005663	2.06	12.29	31.97	0.76
GlenOaks	1602.427	5Years	28.32	93.00	94.23	94.23	94.50	0.006669	2.49	17.03	37.83	0.85
GlenOaks	1602.427	10Years	34.73	93.00	94.33	94.33	94.61	0.006280	2.60	20.91	39.16	0.84
GlenOaks	1602.427	25Years	42.77	93.00	94.42	94.42	94.73	0.006470	2.80	24.50	39.83	0.86
GlenOaks	1602.427	50Years	48.86	93.00	94.49	94.49	94.82	0.006569	2.93	27.07	40.30	0.88
GlenOaks	1602.427	100Years	54.24	93.00	94.54	94.54	94.89	0.006666	3.04	29.20	40.68	0.89
GlenOaks	1602.427	Regional	105.80	93.00	94.95	94.95	95.47	0.007209	3.86	46.71	43.67	0.97
GlenOaks	1518.067	2Years	18.58	92.00	93.31	93.31	93.64	0.010455	2.57	7.24	10.72	1.00
GlenOaks	1518.067	5Years	28.32	92.00	93.44	93.44	93.67	0.008150	2.42	18.16	37.95	0.89
GlenOaks	1518.067	10Years	34.73	92.00	93.52	93.52	93.77	0.008418	2.59	20.98	38.69	0.92
GlenOaks	1518.067	25Years	42.77	92.00	93.60	93.60	93.89	0.008773	2.79	24.16	39.57	0.95
GlenOaks	1518.067	50Years	48.86	92.00	93.65	93.65	93.97	0.009078	2.93	26.34	40.21	0.98
GlenOaks	1518.067	100Years	54.24	92.00	93.70	93.70	94.03	0.009394	3.06	28.07	40.71	1.00
GlenOaks	1518.067	Regional	105.80	92.00	93.97	93.97	94.61	0.013322	4.32	39.74	44.01	1.24
GlenOaks	1400	2Years	18.58	91.00	92.23	92.23	92.36	0.007071	2.05	19.08	60.91	0.81
GlenOaks	1400	5Years	28.32	91.00	92.37	92.32	92.49	0.006085	2.10	27.93	63.26	0.77
GlenOaks	1400	10Years	34.73	91.00	92.37	92.37	92.55	0.009204	2.58	27.87	63.25	0.95
GlenOaks	1400	25Years	42.77	91.00	92.43	92.43	92.63	0.009911	2.77	31.57	64.21	0.99
GlenOaks	1400	50Years	48.86	91.00	92.47	92.47	92.69	0.010531	2.92	33.99	64.83	1.03
GlenOaks	1400	100Years	54.24	91.00	92.53	92.50	92.73	0.009645	2.88	37.77	65.78	0.99
GlenOaks	1400	Regional	105.80	91.00	92.91	92.76	93.18	0.008594	3.44	65.33	85.44	0.99
GlenOaks	1299.999	2Years	18.58	90.14	91.26	91.26	91.55	0.008176	2.48	9.39	20.37	0.91
GlenOaks	1299.999	5Years	28.32	90.14	91.48	91.48	91.82	0.007144	2.75	14.47	25.65	0.89
GlenOaks	1299.999	10Years	34.73	90.14	91.58	91.58	91.73	0.003913	2.17	32.44	61.89	0.67
GlenOaks	1299.999	25Years	42.77	90.14	91.58	91.58	91.81	0.005933	2.68	32.44	61.89	0.82

HEC-RAS Plan: Existing   River: 14Mile   Reach: GlenOaks (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
GlenOaks	1299.999	50Years	48.86	90.14	91.63	91.63	91.88	0.006180	2.81	35.44	62.32	0.85
GlenOaks	1299.999	100Years	54.24	90.14	91.66	91.66	91.93	0.006676	2.97	37.29	62.60	0.88
GlenOaks	1299.999	Regional	105.80	90.14	91.99	91.99	92.37	0.007536	3.74	59.14	69.92	0.98
GlenOaks	1200	2Years	18.58	88.27	89.76	89.76	89.89	0.006129	2.14	21.15	66.77	0.75
GlenOaks	1200	5Years	28.32	88.27	89.84	89.84	90.01	0.008162	2.60	26.51	70.29	0.88
GlenOaks	1200	10Years	34.73	88.27	89.89	89.89	90.08	0.008750	2.80	30.29	73.00	0.92
GlenOaks	1200	25Years	42.77	88.27	89.95	89.95	90.15	0.009141	2.99	35.00	76.25	0.95
GlenOaks	1200	50Years	48.86	88.27	89.98	89.98	90.21	0.010202	3.22	37.19	77.81	1.01
GlenOaks	1200	100Years	54.24	88.27	90.05	90.05	90.27	0.009247	3.20	42.88	87.01	0.97
GlenOaks	1200	Regional	105.80	88.27	90.38	90.29	90.61	0.008408	3.62	74.04	105.42	0.97
GlenOaks	1144.426	2Years	18.58	86.82	88.77	88.61	88.88	0.003602	1.59	16.94	52.65	0.59
GlenOaks	1144.426	5Years	28.32	86.82	89.03	88.79	89.11	0.002147	1.50	34.82	83.13	0.47
GlenOaks	1144.426	10Years	34.73	86.82	89.18	88.86	89.25	0.001585	1.41	48.21	91.28	0.42
GlenOaks	1144.426	25Years	42.77	86.82	89.36	88.99	89.42	0.001207	1.35	65.49	104.59	0.37
GlenOaks	1144.426	50Years	48.86	86.82	89.49		89.54	0.001016	1.32	79.37	115.05	0.35
GlenOaks	1144.426	100Years	54.24	86.82	89.59		89.64	0.000936	1.33	92.99	138.61	0.34
GlenOaks	1144.426	Regional	105.80	86.82	90.45		90.48	0.000358	1.10	231.88	186.93	0.22
GlenOaks	1100	2Years	18.58	86.78	88.28	88.28	88.60	0.010679	2.50	7.42	11.49	1.00
GlenOaks	1100	5Years	28.32	86.78	88.51	88.51	88.90	0.009723	2.78	10.36	14.24	0.99
GlenOaks	1100	10Years	34.73	86.78	88.64	88.64	89.06	0.009229	2.90	12.35	15.83	0.98
GlenOaks	1100	25Years	42.77	86.78	88.77	88.77	89.25	0.008672	3.08	14.61	17.21	0.97
GlenOaks	1100	50Years	48.86	86.78	88.87	88.87	89.38	0.008332	3.20	16.30	18.11	0.97
GlenOaks	1100	100Years	54.24	86.78	88.95	88.95	89.49	0.008024	3.30	17.82	18.86	0.96
GlenOaks	1100	Regional	105.80	86.78	89.60	89.60	90.36	0.006674	4.00	31.83	24.68	0.94
GlenOaks	999.9999	2Years	18.58	85.00	86.68		86.84	0.004063	1.81	10.31	14.17	0.64
GlenOaks	999.9999	5Years	28.32	85.00	86.79	86.66	87.08	0.006117	2.40	12.35	21.62	0.80
GlenOaks	999.9999	10Years	34.73	85.00	86.95	86.82	87.25	0.005100	2.44	16.39	26.64	0.75
GlenOaks	999.9999	25Years	42.77	85.00	87.16	86.98	87.44	0.003917	2.41	22.31	29.88	0.68
GlenOaks	999.9999	50Years	48.86	85.00	87.32		87.58	0.003239	2.37	27.27	32.64	0.63
GlenOaks	999.9999	100Years	54.24	85.00	87.15	87.15	87.61	0.006606	3.11	21.84	29.59	0.88
GlenOaks	999.9999	Regional	105.80	85.00	87.70	87.70	88.31	0.005970	3.76	40.93	39.29	0.89
GlenOaks	937.8583	2Years	18.58	85.00	85.96	85.96	86.23	0.009910	2.32	8.65	17.97	0.96
GlenOaks	937.8583	5Years	28.32	85.00	86.10	86.10	86.34	0.008479	2.40	17.18	39.40	0.92
GlenOaks	937.8583	10Years	34.73	85.00	86.10	86.10	86.47	0.012751	2.94	17.18	39.40	1.12
GlenOaks	937.8583	25Years	42.77	85.00	86.10	86.10	86.66	0.019338	3.62	17.18	39.40	1.39
GlenOaks	937.8583	50Years	48.86	85.00	86.10	86.10	86.83	0.025237	4.14	17.18	39.40	1.58
GlenOaks	937.8583	100Years	54.24	85.00	86.37	86.37	86.70	0.008238	2.94	28.07	41.21	0.95
GlenOaks	937.8583	Regional	105.80	85.00	86.75	86.75	87.25	0.008426	3.72	44.46	43.79	1.02
GlenOaks	899.9999	2Years	18.58	84.00	84.75	84.73	85.00	0.009389	2.19	8.71	16.47	0.93
GlenOaks	899.9999	5Years	28.32	84.00	84.96	84.90	85.25	0.007657	2.43	12.25	17.92	0.89
GlenOaks	899.9999	10Years	34.73	84.00	85.07	85.01	85.40	0.007123	2.57	14.37	18.74	0.87
GlenOaks	899.9999	25Years	42.77	84.00	85.20	85.13	85.58	0.006764	2.74	16.85	19.65	0.87
GlenOaks	899.9999	50Years	48.86	84.00	85.29	85.21	85.70	0.006572	2.86	18.65	20.29	0.87
GlenOaks	899.9999	100Years	54.24	84.00	85.37	85.28	85.80	0.006426	2.96	20.22	20.83	0.87
GlenOaks	899.9999	Regional	105.80	84.00	86.12	85.88	86.66	0.004346	3.38	37.83	26.82	0.78
GlenOaks	799.9999	2Years	18.58	83.00	84.41		84.52	0.002520	1.46	12.85	16.57	0.51
GlenOaks	799.9999	5Years	28.32	83.00	84.63		84.79	0.002682	1.73	16.79	18.36	0.55
GlenOaks	799.9999	10Years	34.73	83.00	84.76		84.94	0.002787	1.89	19.08	19.32	0.57
GlenOaks	799.9999	25Years	42.77	83.00	84.89		85.11	0.002887	2.07	21.75	20.43	0.59
GlenOaks	799.9999	50Years	48.86	83.00	84.98		85.23	0.002954	2.20	23.69	21.20	0.60
GlenOaks	799.9999	100Years	54.24	83.00	85.06		85.33	0.003029	2.31	25.32	22.25	0.61
GlenOaks	799.9999	Regional	105.80	83.00	86.06		86.33	0.001619	2.40	59.72	41.36	0.49
GlenOaks	738.7840	2Years	18.58	83.02	83.96	83.96	84.24	0.009124	2.43	9.46	18.59	0.94
GlenOaks	738.7840	5Years	28.32	83.02	84.15	84.15	84.49	0.009027	2.77	13.13	20.56	0.97
GlenOaks	738.7840	10Years	34.73	83.02	84.26	84.26	84.64	0.008802	2.93	15.51	21.74	0.97
GlenOaks	738.7840	25Years	42.77	83.02	84.39	84.39	84.80	0.008673	3.11	18.30	23.04	0.98
GlenOaks	738.7840	50Years	48.86	83.02	84.47	84.47	84.92	0.008701	3.24	20.24	23.91	0.99
GlenOaks	738.7840	100Years	54.24	83.02	84.54	84.54	85.01	0.008678	3.34	21.96	24.65	0.99
GlenOaks	738.7840	Regional	105.80	83.02	86.01		86.21	0.001701	2.26	69.35	39.77	0.49
GlenOaks	667.8976	2Years	18.58	82.00	82.84	82.84	83.09	0.009140	2.27	9.78	23.62	0.93
GlenOaks	667.8976	5Years	28.32	82.00	83.01	83.01	83.32	0.008300	2.56	14.38	28.76	0.92
GlenOaks	667.8976	10Years	34.73	82.00	83.04	83.04	83.46	0.011185	3.04	15.14	31.01	1.08
GlenOaks	667.8976	25Years	42.77	82.00	83.27	83.27	83.57	0.006215	2.67	24.78	44.84	0.84
GlenOaks	667.8976	50Years	48.86	82.00	83.33	83.33	83.65	0.006183	2.78	27.78	45.51	0.84
GlenOaks	667.8976	100Years	54.24	82.00	83.50	83.38	83.74	0.004118	2.49	35.57	47.24	0.71
GlenOaks	667.8976	Regional	105.80	82.00	86.10	83.77	86.13	0.000180	1.09	201.63	92.35	0.18

HEC-RAS Plan: Existing River: 14Mile Reach: GlenOaks (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
GlenOaks	651.4387	2Years	18.58	81.00	82.35	81.74	82.39	0.000792	0.89	20.88	22.72	0.29
GlenOaks	651.4387	5Years	28.32	81.00	82.73	81.90	82.78	0.000611	0.96	29.88	25.12	0.27
GlenOaks	651.4387	10Years	34.73	81.00	82.96	82.00	83.01	0.000544	0.99	35.48	26.56	0.26
GlenOaks	651.4387	25Years	42.77	81.00	83.24	82.12	83.29	0.000471	1.03	42.21	29.86	0.25
GlenOaks	651.4387	50Years	48.86	81.00	83.43	82.19	83.49	0.000430	1.06	47.09	34.68	0.24
GlenOaks	651.4387	100Years	54.24	81.00	83.57	82.26	83.63	0.000417	1.09	50.74	37.82	0.24
GlenOaks	651.4387	Regional	105.80	81.00	86.10	82.75	86.13	0.000089	0.86	207.00	118.88	0.13
GlenOaks	631.6630		Bridge									
GlenOaks	612.3046	2Years	18.58	80.52	81.53	81.53	81.89	0.010168	2.65	7.00	11.63	1.00
GlenOaks	612.3046	5Years	28.32	80.52	81.77	81.77	82.23	0.009494	3.02	9.38	12.83	1.00
GlenOaks	612.3046	10Years	34.73	80.52	81.91	81.91	82.44	0.009122	3.20	10.85	13.58	1.00
GlenOaks	612.3046	25Years	42.77	80.52	82.08	82.08	82.67	0.008790	3.40	12.59	14.44	1.00
GlenOaks	612.3046	50Years	48.86	80.52	82.40	82.20	82.87	0.005427	3.04	16.08	16.00	0.81
GlenOaks	612.3046	100Years	54.24	80.52	82.85	82.29	83.18	0.002700	2.57	21.11	18.91	0.60
GlenOaks	612.3046	Regional	105.80	80.52	85.91	83.05	85.97	0.000173	1.19	150.88	62.33	0.18
GlenOaks	595.3819	2Years	18.58	80.00	81.06	81.06	81.36	0.010097	2.41	8.24	17.20	0.98
GlenOaks	595.3819	5Years	28.32	80.00	81.36	81.27	81.65	0.006104	2.43	14.13	21.59	0.81
GlenOaks	595.3819	10Years	34.73	80.00	81.74	81.38	81.93	0.002689	2.03	23.65	28.75	0.57
GlenOaks	595.3819	25Years	42.77	80.00	82.20	81.50	82.34	0.001337	1.75	38.04	33.93	0.42
GlenOaks	595.3819	50Years	48.86	80.00	82.54	81.59	82.66	0.000903	1.63	50.73	40.13	0.36
GlenOaks	595.3819	100Years	54.24	80.00	82.95	81.70	83.04	0.000563	1.45	68.60	46.49	0.29
GlenOaks	595.3819	Regional	105.80	80.00	85.92	82.30	85.96	0.000116	1.10	254.22	104.18	0.15
GlenOaks	570.5971	2Years	18.58	80.00	81.07		81.12	0.001508	1.09	26.82	33.68	0.39
GlenOaks	570.5971	5Years	28.32	80.00	81.48		81.52	0.000920	1.08	41.32	37.17	0.33
GlenOaks	570.5971	10Years	34.73	80.00	81.82		81.86	0.000579	1.02	54.46	40.19	0.27
GlenOaks	570.5971	25Years	42.77	80.00	82.25		82.29	0.000368	0.97	72.67	43.61	0.23
GlenOaks	570.5971	50Years	48.86	80.00	82.59		82.62	0.000277	0.94	87.96	47.57	0.20
GlenOaks	570.5971	100Years	54.24	80.00	82.99		83.02	0.000194	0.88	107.86	52.52	0.17
GlenOaks	570.5971	Regional	105.80	80.00	85.93		85.95	0.000059	0.80	338.00	163.16	0.11
GlenOaks	544.1928	2Years	18.12	79.76	80.62	80.62	80.95	0.010577	2.55	7.10	10.73	1.00
GlenOaks	544.1928	5Years	28.72	79.76	81.24	80.87	81.44	0.003279	1.99	14.53	14.32	0.60
GlenOaks	544.1928	10Years	35.45	79.76	81.64	81.01	81.80	0.001853	1.77	21.96	21.47	0.47
GlenOaks	544.1928	25Years	43.77	79.76	82.12	81.17	82.25	0.001040	1.60	33.10	24.77	0.37
GlenOaks	544.1928	50Years	49.99	79.76	82.48	81.28	82.59	0.000743	1.51	42.43	30.36	0.32
GlenOaks	544.1928	100Years	55.87	79.76	82.90	81.38	82.99	0.000502	1.39	58.11	41.78	0.27
GlenOaks	544.1928	Regional	108.70	79.76	85.90	82.08	85.94	0.000110	1.07	275.32	160.81	0.14
GlenOaks	538.434*	2Years	18.12	79.06	80.66	80.06	80.77	0.001650	1.46	12.40	11.65	0.42
GlenOaks	538.434*	5Years	28.72	79.06	81.29	80.35	81.40	0.001119	1.51	19.03	18.93	0.37
GlenOaks	538.434*	10Years	35.45	79.06	81.66	80.50	81.78	0.000886	1.53	23.16	23.26	0.34
GlenOaks	538.434*	25Years	43.77	79.06	82.12	80.67	82.24	0.000704	1.55	28.16	26.50	0.31
GlenOaks	538.434*	50Years	49.99	79.06	82.46	80.79	82.58	0.000608	1.57	31.87	30.11	0.29
GlenOaks	538.434*	100Years	55.87	79.06	82.86	80.90	82.98	0.000492	1.54	36.30	40.90	0.27
GlenOaks	538.434*	Regional	108.70	79.06	85.93	81.71	85.93	0.000029	0.42	306.46	164.33	0.07
GlenOaks	531.5748		Bridge									
GlenOaks	512.519*	2Years	18.12	78.90	79.85	79.83	80.21	0.009836	2.65	6.84	9.96	0.97
GlenOaks	512.519*	5Years	28.72	78.90	80.14	80.14	80.59	0.009850	2.95	9.72	13.24	1.00
GlenOaks	512.519*	10Years	35.45	78.90	80.28	80.28	80.79	0.009415	3.17	11.20	14.30	1.00
GlenOaks	512.519*	25Years	43.77	78.90	80.43	80.43	81.02	0.008994	3.40	12.89	15.57	1.00
GlenOaks	512.519*	50Years	49.99	78.90	80.54	80.54	81.18	0.008762	3.55	14.07	19.67	1.00
GlenOaks	512.519*	100Years	55.87	78.90	80.64	80.64	81.33	0.008567	3.69	15.14	21.68	1.00
GlenOaks	512.519*	Regional	108.70	78.90	81.49	81.31	81.81	0.004878	2.51	43.23	37.59	0.75
GlenOaks	501.0021	2Years	18.12	78.53	79.76	79.76	80.07	0.010703	2.47	7.32	11.78	1.00
GlenOaks	501.0021	5Years	28.72	78.53	80.01	80.01	80.38	0.010123	2.69	10.69	14.90	1.00
GlenOaks	501.0021	10Years	35.45	78.53	80.14	80.14	80.54	0.009718	2.82	12.65	16.59	1.00
GlenOaks	501.0021	25Years	43.77	78.53	80.28	80.28	80.72	0.009281	2.95	15.18	20.81	0.99
GlenOaks	501.0021	50Years	49.99	78.53	80.37	80.37	80.84	0.008638	3.03	17.43	24.92	0.97
GlenOaks	501.0021	100Years	55.87	78.53	80.46	80.46	80.95	0.008216	3.12	19.61	29.76	0.96
GlenOaks	501.0021	Regional	108.70	78.53	81.14	81.04	81.68	0.005069	3.41	47.59	48.27	0.82
GlenOaks	500.008*	2Years	18.12	78.50	79.69	79.21	79.77	0.001568	1.27	14.25	14.34	0.41
GlenOaks	500.008*	5Years	28.72	78.50	79.92	79.42	80.06	0.002124	1.62	17.68	15.37	0.48
GlenOaks	500.008*	10Years	35.45	78.50	80.03	79.54	80.20	0.002480	1.83	19.35	16.23	0.53
GlenOaks	500.008*	25Years	43.77	78.50	80.19	79.68	80.39	0.002549	2.00	22.06	17.50	0.54
GlenOaks	500.008*	50Years	49.99	78.50	80.34	79.78	80.55	0.002485	2.06	24.91	24.02	0.54
GlenOaks	500.008*	100Years	55.87	78.50	80.48	79.87	80.70	0.002238	2.08	28.00	32.37	0.52
GlenOaks	500.008*	Regional	108.70	78.50	81.32	80.57	81.60	0.001816	2.47	65.12	51.50	0.51

HEC-RAS Plan: Existing River: 14Mile Reach: GlenOaks (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
GlenOaks	500		Bridge									
GlenOaks	494.045*	2Years	18.12	78.45	79.69	79.16	79.76	0.001384	1.22	14.82	14.34	0.38
GlenOaks	494.045*	5Years	28.72	78.45	79.91	79.38	80.04	0.001945	1.58	18.22	15.80	0.46
GlenOaks	494.045*	10Years	35.45	78.45	80.01	79.49	80.18	0.002277	1.79	19.86	16.69	0.51
GlenOaks	494.045*	25Years	43.77	78.45	80.13	79.63	80.34	0.002631	2.03	21.85	18.81	0.55
GlenOaks	494.045*	50Years	49.99	78.45	80.21	79.73	80.45	0.002866	2.19	23.48	22.20	0.58
GlenOaks	494.045*	100Years	55.87	78.45	80.28	79.82	80.55	0.003119	2.32	25.18	24.87	0.61
GlenOaks	494.045*	Regional	108.70	78.45	80.70	80.55	81.28	0.004953	3.41	39.71	40.58	0.80
GlenOaks	448.3297	2Years	18.12	77.93	79.60		79.69	0.001681	1.35	15.56	27.78	0.43
GlenOaks	448.3297	5Years	28.72	77.93	79.78		79.93	0.002372	1.75	21.68	36.48	0.52
GlenOaks	448.3297	10Years	35.45	77.93	79.85		80.05	0.002990	2.02	24.18	39.08	0.59
GlenOaks	448.3297	25Years	43.77	77.93	79.93	79.67	80.18	0.003701	2.32	27.23	42.05	0.66
GlenOaks	448.3297	50Years	49.99	77.93	79.98	79.79	80.28	0.004120	2.50	29.77	44.21	0.70
GlenOaks	448.3297	100Years	55.87	77.93	80.04	79.88	80.37	0.004503	2.66	32.05	45.87	0.73
GlenOaks	448.3297	Regional	108.70	77.93	80.45	80.45	81.01	0.006300	3.59	53.94	58.19	0.90
GlenOaks	396.6188	2Years	18.12	78.16	79.29	79.29	79.52	0.006678	2.24	12.13	35.47	0.81
GlenOaks	396.6188	5Years	28.72	78.16	79.48	79.48	79.73	0.006635	2.50	19.80	46.48	0.83
GlenOaks	396.6188	10Years	35.45	78.16	79.60	79.60	79.83	0.006004	2.52	25.38	50.90	0.80
GlenOaks	396.6188	25Years	43.77	78.16	79.68	79.68	79.93	0.006406	2.70	29.50	51.66	0.84
GlenOaks	396.6188	50Years	49.99	78.16	79.73	79.73	80.00	0.006776	2.84	32.11	52.14	0.87
GlenOaks	396.6188	100Years	55.87	78.16	79.77	79.77	80.07	0.007042	2.95	34.55	52.59	0.89
GlenOaks	396.6188	Regional	108.70	78.16	80.12	80.12	80.52	0.008490	3.67	53.14	55.85	1.01
GlenOaks	327.0741	2Years	18.12	76.50	77.95		78.03	0.001699	1.29	14.39	17.13	0.43
GlenOaks	327.0741	5Years	28.72	76.50	78.06		78.22	0.003113	1.82	16.48	27.95	0.58
GlenOaks	327.0741	10Years	35.45	76.50	78.11	77.82	78.34	0.003949	2.12	18.09	36.62	0.66
GlenOaks	327.0741	25Years	43.77	76.50	78.16	77.98	78.47	0.005065	2.48	20.10	42.24	0.76
GlenOaks	327.0741	50Years	49.99	76.50	78.19	78.11	78.56	0.005979	2.74	21.40	45.71	0.83
GlenOaks	327.0741	100Years	55.87	76.50	78.24	78.24	78.65	0.006341	2.90	23.76	51.45	0.86
GlenOaks	327.0741	Regional	108.70	76.50	78.75	78.75	79.14	0.004541	3.13	63.20	88.94	0.77
GlenOaks	271.7621	2Years	18.12	76.60	77.76	77.76	77.88	0.004491	1.70	18.69	99.12	0.66
GlenOaks	271.7621	5Years	28.72	76.60	77.86	77.86	78.01	0.005130	1.96	29.22	102.29	0.72
GlenOaks	271.7621	10Years	35.45	76.60	77.91	77.91	78.07	0.005558	2.10	34.32	103.80	0.75
GlenOaks	271.7621	25Years	43.77	76.60	77.96	77.96	78.13	0.006067	2.27	39.78	105.38	0.79
GlenOaks	271.7621	50Years	49.99	76.60	78.00	78.00	78.18	0.006430	2.38	43.42	106.42	0.82
GlenOaks	271.7621	100Years	55.87	76.60	78.03	78.03	78.22	0.006712	2.48	46.75	107.36	0.84
GlenOaks	271.7621	Regional	108.70	76.60	78.25	78.25	78.51	0.008335	3.09	71.35	111.30	0.97
GlenOaks	200	2Years	18.12	76.00	76.90	76.82	77.02	0.004700	1.81	18.22	48.74	0.67
GlenOaks	200	5Years	28.72	76.00	77.00	76.98	77.18	0.006704	2.32	23.26	53.39	0.82
GlenOaks	200	10Years	35.45	76.00	77.04	77.00	77.28	0.008360	2.68	26.30	80.97	0.92
GlenOaks	200	25Years	43.77	76.00	77.03	77.03	77.40	0.012801	3.30	25.66	72.40	1.14
GlenOaks	200	50Years	49.99	76.00	77.14	77.00	77.46	0.010616	3.21	35.35	95.24	1.05
GlenOaks	200	100Years	55.87	76.00	77.23	77.01	77.47	0.008070	2.94	43.56	98.12	0.93
GlenOaks	200	Regional	108.70	76.00	77.73		77.86	0.003692	2.49	96.58	112.27	0.66
GlenOaks	148.0308	2Years	18.12	75.89	76.67	76.55	76.73	0.006273	1.63	26.94	56.11	0.74
GlenOaks	148.0308	5Years	28.72	75.89	76.83	76.62	76.88	0.004317	1.58	48.59	118.15	0.64
GlenOaks	148.0308	10Years	35.45	75.89	76.92	76.68	76.97	0.003563	1.57	59.89	120.70	0.59
GlenOaks	148.0308	25Years	43.77	75.89	77.03	76.75	77.08	0.003010	1.59	72.85	123.55	0.56
GlenOaks	148.0308	50Years	49.99	75.89	77.10	76.80	77.15	0.002730	1.60	81.97	125.01	0.54
GlenOaks	148.0308	100Years	55.87	75.89	77.17	76.83	77.21	0.002522	1.61	90.25	125.82	0.52
GlenOaks	148.0308	Regional	108.70	75.89	77.68	77.04	77.73	0.001701	1.76	155.74	132.55	0.46
GlenOaks	80.68134	2Years	18.12	75.50	76.61		76.62	0.000586	0.78	66.45	116.91	0.25
GlenOaks	80.68134	5Years	28.72	75.50	76.74		76.77	0.000793	0.99	82.88	121.07	0.30
GlenOaks	80.68134	10Years	35.45	75.50	76.84		76.86	0.000834	1.08	94.35	123.83	0.31
GlenOaks	80.68134	25Years	43.77	75.50	76.94		76.97	0.000870	1.16	107.67	126.95	0.32
GlenOaks	80.68134	50Years	49.99	75.50	77.02		77.05	0.000889	1.22	117.10	129.12	0.33
GlenOaks	80.68134	100Years	55.87	75.50	77.08		77.12	0.000901	1.27	125.80	130.82	0.34
GlenOaks	80.68134	Regional	108.70	75.50	77.60		77.64	0.000908	1.56	195.57	139.79	0.35
GlenOaks	27.45592	2Years	18.12	75.99	76.57	76.57	76.58	0.001247	0.69	57.35	92.78	0.33
GlenOaks	27.45592	5Years	28.72	75.99	76.69	76.57	76.71	0.001664	0.93	68.92	94.32	0.39
GlenOaks	27.45592	10Years	35.45	75.99	76.78	76.57	76.81	0.001698	1.04	77.49	95.43	0.41
GlenOaks	27.45592	25Years	43.77	75.99	76.89	76.57	76.91	0.001724	1.15	87.38	96.57	0.42
GlenOaks	27.45592	50Years	49.99	75.99	76.96	76.57	76.99	0.001741	1.23	94.31	97.45	0.43
GlenOaks	27.45592	100Years	55.87	75.99	77.02	76.57	77.06	0.001752	1.30	100.62	98.26	0.44
GlenOaks	27.45592	Regional	108.70	75.99	77.52	76.57	77.58	0.001753	1.74	150.85	104.06	0.47
GlenOaks	7.899100	2Years	18.12	75.67	76.22	76.22	76.41	0.011795	2.23	16.33	48.05	1.02
GlenOaks	7.899100	5Years	28.72	75.67	76.37	76.37	76.62	0.011236	2.60	24.27	64.63	1.04

HEC-RAS Plan: Existing   River: 14Mile   Reach: GlenOaks (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
GlenOaks	7.899100	10Years	35.45	75.67	76.48	76.48	76.72	0.009137	2.60	31.46	66.14	0.96
GlenOaks	7.899100	25Years	43.77	75.67	76.56	76.56	76.82	0.009408	2.81	36.38	66.77	0.99
GlenOaks	7.899100	50Years	49.99	75.67	76.61	76.61	76.89	0.009552	2.95	39.86	67.20	1.01
GlenOaks	7.899100	100Years	55.87	75.67	76.65	76.65	76.96	0.009743	3.08	42.87	67.58	1.03
GlenOaks	7.899100	Regional	108.70	75.67	77.08	77.08	77.48	0.008371	3.69	78.42	90.82	1.01

HEC-RAS Plan: realigned River: 14Mile Reach: GlenOaks

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
GlenOaks	6932.571	2Years	1.07	147.51	147.91		147.98	0.009573	1.17	0.91	4.15	0.80
GlenOaks	6932.571	5Years	2.38	147.51	148.06		148.17	0.009832	1.46	1.63	5.46	0.85
GlenOaks	6932.571	10Years	3.13	147.51	148.12	148.08	148.25	0.009826	1.58	1.99	5.99	0.87
GlenOaks	6932.571	25Years	4.14	147.51	148.18	148.15	148.34	0.010142	1.78	2.35	6.50	0.90
GlenOaks	6932.571	50Years	4.87	147.51	148.22	148.20	148.40	0.010435	1.91	2.59	6.83	0.93
GlenOaks	6932.571	100Years	5.59	147.51	148.25	148.24	148.46	0.010856	2.04	2.81	7.11	0.96
GlenOaks	6932.571	Regional	8.38	147.51	148.38	148.38	148.66	0.009977	2.33	3.87	8.36	0.96
GlenOaks	6899.999	2Years	1.07	147.05	147.47	147.47	147.58	0.015891	1.46	0.73	3.48	1.01
GlenOaks	6899.999	5Years	2.38	147.05	147.63	147.63	147.78	0.014276	1.71	1.39	4.80	1.01
GlenOaks	6899.999	10Years	3.13	147.05	147.70	147.70	147.87	0.013763	1.81	1.73	5.36	1.01
GlenOaks	6899.999	25Years	4.14	147.05	147.78	147.78	147.96	0.013235	1.91	2.17	5.99	1.01
GlenOaks	6899.999	50Years	4.87	147.05	147.83	147.83	148.02	0.012899	1.97	2.47	6.40	1.01
GlenOaks	6899.999	100Years	5.59	147.05	147.87	147.87	148.08	0.012561	2.02	2.77	6.77	1.01
GlenOaks	6899.999	Regional	8.38	147.05	148.00	148.00	148.27	0.011410	2.29	3.71	7.84	1.00
GlenOaks	6845.150	2Years	1.07	146.51	147.17		147.19	0.001875	0.67	1.59	4.85	0.37
GlenOaks	6845.150	5Years	2.38	146.51	147.35		147.39	0.002178	0.95	2.61	6.54	0.43
GlenOaks	6845.150	10Years	3.13	146.51	147.42		147.48	0.002316	1.07	3.13	7.29	0.45
GlenOaks	6845.150	25Years	4.14	146.51	147.50		147.58	0.002526	1.22	3.76	8.11	0.49
GlenOaks	6845.150	50Years	4.87	146.51	147.56		147.64	0.002631	1.32	4.21	8.64	0.50
GlenOaks	6845.150	100Years	5.59	146.51	147.61		147.70	0.002732	1.40	4.63	9.12	0.52
GlenOaks	6845.150	Regional	8.38	146.51	147.77		147.90	0.003010	1.68	6.23	10.73	0.56
GlenOaks	6800	2Years	1.07	146.51	146.93	146.91	147.01	0.012086	1.26	0.85	4.08	0.89
GlenOaks	6800	5Years	2.38	146.51	147.08	147.06	147.20	0.011487	1.51	1.58	5.62	0.91
GlenOaks	6800	10Years	3.13	146.51	147.14	147.12	147.28	0.011320	1.61	1.95	6.25	0.92
GlenOaks	6800	25Years	4.14	146.51	147.21	147.19	147.37	0.010598	1.74	2.39	6.93	0.91
GlenOaks	6800	50Years	4.87	146.51	147.25	147.23	147.42	0.010371	1.84	2.68	7.32	0.92
GlenOaks	6800	100Years	5.59	146.51	147.29	147.27	147.48	0.010215	1.94	2.95	7.68	0.93
GlenOaks	6800	Regional	8.38	146.51	147.42	147.41	147.67	0.009615	2.22	4.02	8.95	0.94
GlenOaks	6748.093	2Years	1.07	146.02	146.46	146.40	146.51	0.007675	1.05	1.02	4.65	0.72
GlenOaks	6748.093	5Years	2.38	146.02	146.60	146.54	146.69	0.008231	1.35	1.77	6.10	0.78
GlenOaks	6748.093	10Years	3.13	146.02	146.65	146.60	146.76	0.008482	1.49	2.13	6.67	0.81
GlenOaks	6748.093	25Years	4.14	146.02	146.71	146.67	146.85	0.009155	1.68	2.53	7.26	0.86
GlenOaks	6748.093	50Years	4.87	146.02	146.75	146.71	146.91	0.009346	1.78	2.83	7.68	0.88
GlenOaks	6748.093	100Years	5.59	146.02	146.79	146.76	146.96	0.009518	1.87	3.12	8.03	0.90
GlenOaks	6748.093	Regional	8.38	146.02	146.89	146.89	147.14	0.010731	2.21	4.04	9.00	0.98
GlenOaks	6700	2Years	1.07	145.51	145.89	145.89	145.99	0.016190	1.39	0.77	4.07	1.01
GlenOaks	6700	5Years	2.38	145.51	146.03	146.03	146.17	0.014561	1.63	1.46	5.60	1.01
GlenOaks	6700	10Years	3.13	145.51	146.09	146.09	146.24	0.014007	1.72	1.82	6.24	1.01
GlenOaks	6700	25Years	4.14	145.51	146.16	146.16	146.33	0.013024	1.81	2.29	7.01	1.00
GlenOaks	6700	50Years	4.87	145.51	146.20	146.20	146.39	0.012761	1.90	2.58	7.45	1.00
GlenOaks	6700	100Years	5.59	145.51	146.24	146.24	146.44	0.012507	1.97	2.86	7.85	1.01
GlenOaks	6700	Regional	8.38	145.51	146.38	146.38	146.61	0.011020	2.15	4.04	9.34	0.98
GlenOaks	6651.313	2Years	1.07	145.00	145.42		145.44	0.002640	0.62	1.74	7.99	0.42
GlenOaks	6651.313	5Years	2.38	145.00	145.57		145.60	0.002705	0.76	3.14	10.84	0.45
GlenOaks	6651.313	10Years	3.13	145.00	145.66		145.69	0.002327	0.76	4.10	12.44	0.42
GlenOaks	6651.313	25Years	4.14	145.00	145.76		145.79	0.001823	0.74	5.57	14.68	0.39
GlenOaks	6651.313	50Years	4.87	145.00	145.84		145.87	0.001507	0.72	6.75	16.24	0.36
GlenOaks	6651.313	100Years	5.59	145.00	145.91		145.94	0.001201	0.70	7.97	17.48	0.32
GlenOaks	6651.313	Regional	8.38	145.00	146.17		146.20	0.000617	0.68	12.98	20.44	0.25
GlenOaks	6621.406	2Years	1.07	145.00	145.34		145.36	0.002896	0.57	1.87	10.38	0.43
GlenOaks	6621.406	5Years	2.38	145.00	145.53		145.54	0.001361	0.60	4.19	15.17	0.33
GlenOaks	6621.406	10Years	3.13	145.00	145.62		145.64	0.001010	0.61	5.67	16.32	0.29
GlenOaks	6621.406	25Years	4.14	145.00	145.74		145.76	0.000761	0.62	7.67	17.69	0.27
GlenOaks	6621.406	50Years	4.87	145.00	145.82		145.84	0.000652	0.63	9.12	18.52	0.25
GlenOaks	6621.406	100Years	5.59	145.00	145.89		145.91	0.000575	0.63	10.55	19.30	0.24
GlenOaks	6621.406	Regional	8.38	145.00	146.16		146.18	0.000407	0.66	16.10	22.02	0.21
GlenOaks	6599.053	2Years	1.07	145.00	145.30	145.17	145.31	0.001542	0.49	2.23	10.44	0.33
GlenOaks	6599.053	5Years	2.38	145.00	145.50	145.26	145.52	0.000927	0.54	4.68	13.67	0.28
GlenOaks	6599.053	10Years	3.13	145.00	145.60	145.29	145.62	0.000752	0.56	6.10	15.21	0.26
GlenOaks	6599.053	25Years	4.14	145.00	145.72	145.34	145.74	0.000602	0.58	7.96	16.44	0.24
GlenOaks	6599.053	50Years	4.87	145.00	145.81	145.37	145.82	0.000535	0.60	9.25	17.14	0.23
GlenOaks	6599.053	100Years	5.59	145.00	145.88	145.40	145.90	0.000487	0.61	10.50	17.80	0.22
GlenOaks	6599.053	Regional	8.38	145.00	146.15	145.50	146.17	0.000376	0.66	15.11	20.10	0.21
GlenOaks	6568.916		Culvert									
GlenOaks	6538.791	2Years	1.07	144.01	144.37	144.16	144.38	0.000677	0.37	2.88	10.14	0.22
GlenOaks	6538.791	5Years	2.38	144.01	144.48	144.26	144.50	0.001192	0.58	4.09	11.22	0.31

HEC-RAS Plan: realigned River: 14Mile Reach: GlenOaks (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
GlenOaks	6538.791	10Years	3.13	144.01	144.53	144.30	144.56	0.001406	0.67	4.67	11.71	0.34
GlenOaks	6538.791	25Years	4.14	144.01	144.59	144.36	144.62	0.001594	0.77	5.38	12.10	0.37
GlenOaks	6538.791	50Years	4.87	144.01	144.63	144.37	144.67	0.001707	0.84	5.82	12.27	0.38
GlenOaks	6538.791	100Years	5.59	144.01	144.66	144.40	144.71	0.001795	0.90	6.25	12.44	0.40
GlenOaks	6538.791	Regional	8.38	144.01	144.78	144.51	144.84	0.002038	1.10	7.74	13.12	0.44
GlenOaks	6518.760	2Years	1.07	144.03	144.35		144.36	0.001192	0.38	2.81	14.85	0.28
GlenOaks	6518.760	5Years	2.38	144.03	144.46		144.47	0.001327	0.54	4.47	15.92	0.32
GlenOaks	6518.760	10Years	3.13	144.03	144.51		144.53	0.001375	0.61	5.25	16.41	0.33
GlenOaks	6518.760	25Years	4.14	144.03	144.57		144.59	0.001421	0.68	6.22	16.99	0.34
GlenOaks	6518.760	50Years	4.87	144.03	144.60		144.63	0.001469	0.74	6.84	17.35	0.36
GlenOaks	6518.760	100Years	5.59	144.03	144.64		144.67	0.001502	0.78	7.44	17.69	0.36
GlenOaks	6518.760	Regional	8.38	144.03	144.75		144.80	0.001582	0.93	9.58	18.85	0.39
GlenOaks	6455.909	2Years	1.07	143.99	144.11	144.11	144.16	0.019250	0.96	1.12	11.88	1.00
GlenOaks	6455.909	5Years	2.38	143.99	144.18	144.18	144.26	0.016678	1.23	1.95	13.00	1.00
GlenOaks	6455.909	10Years	3.13	143.99	144.21	144.21	144.30	0.015748	1.33	2.38	13.54	1.00
GlenOaks	6455.909	25Years	4.14	143.99	144.25	144.25	144.35	0.014805	1.45	2.90	14.14	1.00
GlenOaks	6455.909	50Years	4.87	143.99	144.27	144.27	144.39	0.014189	1.53	3.25	14.37	1.00
GlenOaks	6455.909	100Years	5.59	143.99	144.30	144.30	144.43	0.013647	1.60	3.59	14.59	0.99
GlenOaks	6455.909	Regional	8.38	143.99	144.38	144.38	144.54	0.012478	1.82	4.79	15.34	0.99
GlenOaks	6400	2Years	1.07	143.00	143.38		143.39	0.001706	0.49	2.19	10.44	0.34
GlenOaks	6400	5Years	2.38	143.00	143.50		143.52	0.001871	0.67	3.57	11.48	0.38
GlenOaks	6400	10Years	3.13	143.00	143.56		143.58	0.001963	0.75	4.21	11.94	0.40
GlenOaks	6400	25Years	4.14	143.00	143.62		143.66	0.002045	0.84	5.01	12.48	0.41
GlenOaks	6400	50Years	4.87	143.00	143.66		143.70	0.002097	0.90	5.55	12.83	0.43
GlenOaks	6400	100Years	5.59	143.00	143.70		143.75	0.002144	0.95	6.05	13.15	0.43
GlenOaks	6400	Regional	8.38	143.00	143.83		143.89	0.002197	1.12	7.81	14.42	0.46
GlenOaks	6352.562	2Years	1.07	142.93	143.13	143.13	143.19	0.017808	1.14	0.94	7.21	1.01
GlenOaks	6352.562	5Years	2.38	142.93	143.22	143.22	143.32	0.015661	1.37	1.73	9.10	1.01
GlenOaks	6352.562	10Years	3.13	142.93	143.27	143.27	143.38	0.015176	1.48	2.12	9.83	1.01
GlenOaks	6352.562	25Years	4.14	142.93	143.31	143.31	143.44	0.014074	1.62	2.57	10.22	1.01
GlenOaks	6352.562	50Years	4.87	142.93	143.34	143.34	143.49	0.013451	1.70	2.89	10.51	1.00
GlenOaks	6352.562	100Years	5.59	142.93	143.37	143.37	143.53	0.012926	1.78	3.20	10.78	1.00
GlenOaks	6352.562	Regional	8.38	142.93	143.47	143.47	143.68	0.011503	2.01	4.34	11.72	0.99
GlenOaks	6300	2Years	1.07	142.00	142.39		142.42	0.005162	0.81	1.32	6.71	0.58
GlenOaks	6300	5Years	2.38	142.00	142.52		142.57	0.005218	1.03	2.32	8.51	0.62
GlenOaks	6300	10Years	3.13	142.00	142.57		142.64	0.005237	1.14	2.79	9.04	0.64
GlenOaks	6300	25Years	4.14	142.00	142.64		142.72	0.005277	1.25	3.38	9.66	0.65
GlenOaks	6300	50Years	4.87	142.00	142.68		142.77	0.005304	1.32	3.78	10.06	0.66
GlenOaks	6300	100Years	5.59	142.00	142.71		142.81	0.005357	1.39	4.15	10.42	0.67
GlenOaks	6300	Regional	8.38	142.00	142.84		142.97	0.005506	1.60	5.51	11.62	0.70
GlenOaks	6242.021	2Years	1.07	141.50	141.84	141.84	141.92	0.016663	1.32	0.81	4.68	1.01
GlenOaks	6242.021	5Years	2.38	141.50	141.96	141.96	142.09	0.014717	1.58	1.50	6.15	1.01
GlenOaks	6242.021	10Years	3.13	141.50	142.02	142.02	142.16	0.013902	1.68	1.87	6.90	1.01
GlenOaks	6242.021	25Years	4.14	141.50	142.09	142.09	142.25	0.013128	1.79	2.36	7.78	1.00
GlenOaks	6242.021	50Years	4.87	141.50	142.13	142.13	142.30	0.012747	1.85	2.70	8.34	1.00
GlenOaks	6242.021	100Years	5.59	141.50	142.17	142.17	142.35	0.012353	1.90	3.03	8.86	0.99
GlenOaks	6242.021	Regional	8.38	141.50	142.29	142.29	142.51	0.011383	2.09	4.24	10.58	0.99
GlenOaks	6200	2Years	1.07	141.00	141.58		141.60	0.001716	0.60	1.78	6.09	0.35
GlenOaks	6200	5Years	2.38	141.00	141.76		141.79	0.002142	0.80	2.99	7.89	0.41
GlenOaks	6200	10Years	3.13	141.00	141.82		141.86	0.002311	0.88	3.55	8.60	0.44
GlenOaks	6200	25Years	4.14	141.00	141.90		141.95	0.002408	0.99	4.19	9.35	0.46
GlenOaks	6200	50Years	4.87	141.00	141.94		142.00	0.002474	1.07	4.62	9.82	0.47
GlenOaks	6200	100Years	5.59	141.00	141.98		142.05	0.002547	1.14	5.02	10.24	0.48
GlenOaks	6200	Regional	8.38	141.00	142.11	141.87	142.21	0.002791	1.37	6.47	11.64	0.52
GlenOaks	6152.898	2Years	1.07	141.00	141.33	141.33	141.41	0.016936	1.29	0.83	5.03	1.02
GlenOaks	6152.898	5Years	2.38	141.00	141.45	141.45	141.57	0.015082	1.51	1.58	6.94	1.01
GlenOaks	6152.898	10Years	3.13	141.00	141.50	141.50	141.63	0.014458	1.59	1.97	7.75	1.01
GlenOaks	6152.898	25Years	4.14	141.00	141.56	141.56	141.71	0.013963	1.72	2.41	8.52	1.02
GlenOaks	6152.898	50Years	4.87	141.00	141.59	141.59	141.76	0.013374	1.80	2.72	8.98	1.01
GlenOaks	6152.898	100Years	5.59	141.00	141.63	141.63	141.80	0.012656	1.86	3.05	9.44	1.00
GlenOaks	6152.898	Regional	8.38	141.00	141.74	141.74	141.96	0.010996	2.08	4.22	10.89	0.97
GlenOaks	6121.368	2Years	1.07	140.50	140.99		141.01	0.002159	0.61	1.75	7.01	0.39
GlenOaks	6121.368	5Years	2.38	140.50	141.16		141.19	0.002121	0.74	3.20	9.37	0.41
GlenOaks	6121.368	10Years	3.13	140.50	141.25		141.28	0.001999	0.78	4.01	10.46	0.40
GlenOaks	6121.368	25Years	4.14	140.50	141.34		141.37	0.001751	0.82	5.06	11.89	0.39
GlenOaks	6121.368	50Years	4.87	140.50	141.40		141.44	0.001627	0.85	5.82	12.81	0.38
GlenOaks	6121.368	100Years	5.59	140.50	141.46		141.50	0.001509	0.87	6.62	13.71	0.37

HEC-RAS Plan: realigned River: 14Mile Reach: GlenOaks (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
GlenOaks	6121.368	Regional	8.38	140.50	141.74		141.78	0.000836	0.85	11.02	17.67	0.30
GlenOaks	6106.137	2Years	1.07	140.50	140.95	140.81	140.97	0.002000	0.62	1.76	7.21	0.38
GlenOaks	6106.137	5Years	2.38	140.50	141.13	140.93	141.16	0.001898	0.81	3.19	9.30	0.40
GlenOaks	6106.137	10Years	3.13	140.50	141.21	140.98	141.25	0.001791	0.88	3.97	10.33	0.40
GlenOaks	6106.137	25Years	4.14	140.50	141.30	141.04	141.34	0.001733	0.97	4.97	11.49	0.40
GlenOaks	6106.137	50Years	4.87	140.50	141.36	141.08	141.41	0.001675	1.02	5.68	12.19	0.40
GlenOaks	6106.137	100Years	5.59	140.50	141.42	141.12	141.47	0.001601	1.06	6.40	12.69	0.40
GlenOaks	6106.137	Regional	8.38	140.50	141.71	141.24	141.76	0.001035	1.06	10.07	15.15	0.34
GlenOaks	6080.772		Culvert									
GlenOaks	6055.417	2Years	1.07	140.50	140.95	140.77	140.97	0.001064	0.50	2.15	9.56	0.29
GlenOaks	6055.417	5Years	2.38	140.50	141.11	140.87	141.14	0.001380	0.74	3.21	11.06	0.35
GlenOaks	6055.417	10Years	3.13	140.50	141.17	140.92	141.21	0.001543	0.86	3.65	11.69	0.38
GlenOaks	6055.417	25Years	4.14	140.50	141.24	140.97	141.29	0.001810	1.01	4.12	12.35	0.41
GlenOaks	6055.417	50Years	4.87	140.50	141.28	141.01	141.34	0.002015	1.11	4.40	12.72	0.44
GlenOaks	6055.417	100Years	5.59	140.50	141.31	141.05	141.39	0.002246	1.21	4.62	12.95	0.47
GlenOaks	6055.417	Regional	8.38	140.50	141.55	141.18	141.60	0.001131	1.01	9.69	14.66	0.35
GlenOaks	6040.300	2Years	1.07	140.50	140.85	140.83	140.91	0.011359	1.11	0.97	5.49	0.84
GlenOaks	6040.300	5Years	2.38	140.50	140.96	140.95	141.07	0.013230	1.43	1.66	7.21	0.95
GlenOaks	6040.300	10Years	3.13	140.50	141.00	141.00	141.13	0.014370	1.58	1.98	7.87	1.01
GlenOaks	6040.300	25Years	4.14	140.50	141.06	141.06	141.20	0.014038	1.68	2.46	8.77	1.01
GlenOaks	6040.300	50Years	4.87	140.50	141.10	141.10	141.25	0.013765	1.74	2.80	9.36	1.01
GlenOaks	6040.300	100Years	5.59	140.50	141.14	141.14	141.29	0.013131	1.77	3.16	9.94	1.00
GlenOaks	6040.300	Regional	8.38	140.50	141.53		141.57	0.001859	0.94	9.12	19.71	0.41
GlenOaks	6000	2Years	1.07	140.00	140.28	140.28	140.35	0.017464	1.18	0.90	6.48	1.01
GlenOaks	6000	5Years	2.38	140.00	140.39	140.39	140.48	0.015470	1.38	1.73	8.97	1.00
GlenOaks	6000	10Years	3.13	140.00	140.61	140.43	140.64	0.002270	0.72	4.35	14.35	0.42
GlenOaks	6000	25Years	4.14	140.00	140.85	140.48	140.87	0.000587	0.51	8.46	19.94	0.23
GlenOaks	6000	50Years	4.87	140.00	141.01	140.51	141.02	0.000315	0.45	11.94	23.95	0.18
GlenOaks	6000	100Years	5.59	140.00	141.16	140.54	141.17	0.000203	0.41	15.88	29.59	0.15
GlenOaks	6000	Regional	8.38	140.00	141.55	140.64	141.55	0.000014	0.14	105.55	96.62	0.04
GlenOaks	5942.698	2Years	1.07	139.51	140.05	139.71	140.05	0.000063	0.14	9.67	40.12	0.07
GlenOaks	5942.698	5Years	2.38	139.51	140.44	139.77	140.44	0.000022	0.13	29.47	62.36	0.05
GlenOaks	5942.698	10Years	3.13	139.51	140.63	139.80	140.63	0.000015	0.13	42.13	70.61	0.04
GlenOaks	5942.698	25Years	4.14	139.51	140.86	139.84	140.86	0.000011	0.13	59.63	79.44	0.04
GlenOaks	5942.698	50Years	4.87	139.51	141.02	139.86	141.02	0.000003	0.07	148.49	140.13	0.02
GlenOaks	5942.698	100Years	5.59	139.51	141.17	139.88	141.17	0.000002	0.07	169.36	141.55	0.02
GlenOaks	5942.698	Regional	8.38	139.51	141.55	139.95	141.55	0.000002	0.07	224.28	144.86	0.02
GlenOaks	5899.999	2Years	1.07	139.50	140.05		140.05	0.000046	0.13	9.64	31.85	0.06
GlenOaks	5899.999	5Years	2.38	139.50	140.44		140.44	0.000021	0.14	24.58	45.15	0.05
GlenOaks	5899.999	10Years	3.13	139.50	140.63		140.63	0.000017	0.14	33.72	50.31	0.04
GlenOaks	5899.999	25Years	4.14	139.50	140.86		140.86	0.000013	0.14	46.06	55.66	0.04
GlenOaks	5899.999	50Years	4.87	139.50	141.02		141.02	0.000011	0.14	55.13	59.25	0.04
GlenOaks	5899.999	100Years	5.59	139.50	141.16		141.17	0.000011	0.15	65.36	80.95	0.04
GlenOaks	5899.999	Regional	8.38	139.50	141.55		141.55	0.000009	0.16	107.10	123.10	0.04
GlenOaks	5869.256	2Years	1.07	139.41	140.05		140.05	0.000049	0.15	10.49	30.78	0.07
GlenOaks	5869.256	5Years	2.38	139.41	140.43		140.44	0.000027	0.16	24.60	41.02	0.05
GlenOaks	5869.256	10Years	3.13	139.41	140.62		140.63	0.000022	0.17	33.01	46.10	0.05
GlenOaks	5869.256	25Years	4.14	139.41	140.86		140.86	0.000018	0.17	44.18	50.37	0.05
GlenOaks	5869.256	50Years	4.87	139.41	141.02		141.02	0.000016	0.18	52.67	57.71	0.05
GlenOaks	5869.256	100Years	5.59	139.41	141.16		141.16	0.000015	0.18	61.92	65.06	0.04
GlenOaks	5869.256	Regional	8.38	139.41	141.55		141.55	0.000013	0.19	89.91	77.73	0.04
GlenOaks	5839.625	2Years	1.07	139.50	140.04	139.74	140.05	0.000226	0.24	4.65	16.78	0.13
GlenOaks	5839.625	5Years	2.38	139.50	140.43	139.84	140.43	0.000063	0.21	16.00	38.43	0.08
GlenOaks	5839.625	10Years	3.13	139.50	140.62	139.88	140.62	0.000041	0.20	23.63	41.36	0.07
GlenOaks	5839.625	25Years	4.14	139.50	140.86	139.92	140.86	0.000029	0.20	33.70	45.07	0.06
GlenOaks	5839.625	50Years	4.87	139.50	141.01	139.95	141.02	0.000024	0.19	41.03	47.59	0.05
GlenOaks	5839.625	100Years	5.59	139.50	141.16	139.97	141.16	0.000020	0.19	48.26	49.91	0.05
GlenOaks	5839.625	Regional	8.38	139.50	141.55	140.06	141.55	0.000019	0.22	71.80	73.00	0.05
GlenOaks	5816.245	2Years	1.07	139.47	140.01	139.82	140.03	0.001508	0.61	1.87	6.73	0.34
GlenOaks	5816.245	5Years	2.38	139.47	140.41	139.96	140.43	0.000462	0.52	5.44	10.67	0.21
GlenOaks	5816.245	10Years	3.13	139.47	140.61	140.02	140.62	0.000315	0.52	7.52	12.23	0.18
GlenOaks	5816.245	25Years	4.14	139.47	140.84	140.09	140.85	0.000223	0.51	10.22	14.13	0.16
GlenOaks	5816.245	50Years	4.87	139.47	141.00	140.13	141.01	0.000186	0.51	12.05	15.41	0.15
GlenOaks	5816.245	100Years	5.59	139.47	141.15	140.18	141.16	0.000163	0.52	13.76	16.75	0.14
GlenOaks	5816.245	Regional	8.38	139.47	141.53	140.31	141.54	0.000141	0.57	22.54	20.00	0.14

HEC-RAS Plan: realigned River: 14Mile Reach: GlenOaks (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
GlenOaks	5740.884		Culvert									
GlenOaks	5705.508	2Years	6.71	138.00	139.00	139.00	139.35	0.010901	2.59	2.59	6.42	1.00
GlenOaks	5705.508	5Years	10.30	138.00	139.23	139.23	139.68	0.009790	2.98	3.46	7.90	1.00
GlenOaks	5705.508	10Years	12.80	138.00	139.37	139.37	139.90	0.009393	3.21	3.99	8.80	1.00
GlenOaks	5705.508	25Years	16.30	138.00	139.56	139.56	140.17	0.008860	3.48	4.69	10.00	1.00
GlenOaks	5705.508	50Years	18.91	138.00	139.68	139.68	140.36	0.008598	3.66	5.17	10.98	1.00
GlenOaks	5705.508	100Years	21.49	138.00	139.81	139.81	140.55	0.008300	3.81	5.65	12.09	1.00
GlenOaks	5705.508	Regional	21.66	138.00	139.81	139.81	140.56	0.008368	3.83	5.66	12.12	1.00
GlenOaks	5660.181	2Years	6.71	138.00	138.99		139.02	0.000983	0.83	9.22	17.39	0.31
GlenOaks	5660.181	5Years	10.30	138.00	139.15		139.19	0.001135	1.01	12.11	19.63	0.35
GlenOaks	5660.181	10Years	12.80	138.00	139.23		139.29	0.001240	1.13	13.87	20.87	0.37
GlenOaks	5660.181	25Years	16.30	138.00	139.34		139.41	0.001363	1.27	16.18	22.47	0.39
GlenOaks	5660.181	50Years	18.91	138.00	139.41		139.50	0.001446	1.37	17.80	23.59	0.41
GlenOaks	5660.181	100Years	21.49	138.00	139.47		139.57	0.001547	1.46	19.21	24.54	0.43
GlenOaks	5660.181	Regional	21.66	138.00	139.47		139.57	0.001546	1.47	19.34	24.63	0.43
GlenOaks	5600	2Years	6.71	138.00	138.66	138.66	138.83	0.013019	1.85	3.64	11.66	1.01
GlenOaks	5600	5Years	10.30	138.00	138.79	138.79	138.99	0.010561	2.01	5.54	17.15	0.95
GlenOaks	5600	10Years	12.80	138.00	138.87	138.87	139.08	0.009615	2.09	6.95	19.48	0.93
GlenOaks	5600	25Years	16.30	138.00	138.95	138.95	139.19	0.009228	2.23	8.74	22.08	0.93
GlenOaks	5600	50Years	18.91	138.00	139.01	139.01	139.27	0.009114	2.33	10.01	23.83	0.93
GlenOaks	5600	100Years	21.49	138.00	139.07	139.07	139.33	0.008651	2.37	11.48	26.09	0.92
GlenOaks	5600	Regional	21.66	138.00	139.07	139.07	139.34	0.008768	2.39	11.50	26.11	0.93
GlenOaks	5500	2Years	6.71	136.35	137.31	137.31	137.54	0.012410	2.14	3.14	6.90	1.01
GlenOaks	5500	5Years	10.30	136.35	137.48	137.48	137.75	0.011731	2.32	4.44	8.30	1.01
GlenOaks	5500	10Years	12.80	136.35	137.58	137.58	137.87	0.011156	2.40	5.34	9.14	1.00
GlenOaks	5500	25Years	16.30	136.35	137.70	137.70	138.02	0.010798	2.51	6.49	10.12	1.00
GlenOaks	5500	50Years	18.91	136.35	137.78	137.78	138.12	0.010576	2.59	7.31	10.77	1.00
GlenOaks	5500	100Years	21.49	136.35	137.85	137.85	138.21	0.010422	2.65	8.10	11.34	1.00
GlenOaks	5500	Regional	21.66	136.35	137.86	137.86	138.22	0.010411	2.66	8.15	11.37	1.00
GlenOaks	5400	2Years	6.71	135.00	135.85		135.97	0.006872	1.55	4.34	10.21	0.76
GlenOaks	5400	5Years	10.30	135.00	135.99		136.15	0.006996	1.76	5.89	12.59	0.79
GlenOaks	5400	10Years	12.80	135.00	136.07	135.98	136.25	0.007012	1.88	6.95	14.44	0.80
GlenOaks	5400	25Years	16.30	135.00	136.16	136.08	136.37	0.006956	2.03	8.43	16.72	0.81
GlenOaks	5400	50Years	18.91	135.00	136.16	136.15	136.44	0.009305	2.35	8.45	16.75	0.94
GlenOaks	5400	100Years	21.49	135.00	136.21	136.21	136.52	0.009464	2.48	9.23	17.87	0.96
GlenOaks	5400	Regional	21.66	135.00	136.21	136.21	136.52	0.009428	2.48	9.30	18.01	0.96
GlenOaks	5300	2Years	6.71	134.00	134.84	134.84	135.06	0.012512	2.05	3.28	7.86	1.01
GlenOaks	5300	5Years	10.30	134.00	135.00	135.00	135.25	0.011571	2.21	4.66	9.37	1.00
GlenOaks	5300	10Years	12.80	134.00	135.09	135.09	135.37	0.011209	2.31	5.55	10.23	1.00
GlenOaks	5300	25Years	16.30	134.00	135.20	135.20	135.50	0.010862	2.42	6.73	11.28	1.00
GlenOaks	5300	50Years	18.91	134.00	135.36	135.28	135.61	0.007351	2.19	8.64	13.46	0.84
GlenOaks	5300	100Years	21.49	134.00	135.45	135.34	135.70	0.006426	2.19	10.00	16.30	0.80
GlenOaks	5300	Regional	21.66	134.00	135.46	135.35	135.70	0.006453	2.20	10.04	16.34	0.80
GlenOaks	5246.372	2Years	6.71	133.00	134.21		134.31	0.003714	1.42	4.74	7.78	0.58
GlenOaks	5246.372	5Years	10.30	133.00	134.62		134.69	0.001889	1.22	8.42	10.37	0.43
GlenOaks	5246.372	10Years	12.80	133.00	134.87		134.94	0.001278	1.13	11.39	13.31	0.37
GlenOaks	5246.372	25Years	16.30	133.00	135.21		135.27	0.000808	1.04	16.80	18.93	0.30
GlenOaks	5246.372	50Years	18.91	133.00	135.42		135.47	0.000630	1.02	21.21	24.15	0.27
GlenOaks	5246.372	100Years	21.49	133.00	135.50		135.56	0.000653	1.08	23.41	26.51	0.28
GlenOaks	5246.372	Regional	21.66	133.00	135.51		135.56	0.000658	1.08	23.50	26.60	0.28
GlenOaks	5226.563	2Years	6.71	133.00	134.11	133.86	134.24	0.003011	1.68	5.07	8.31	0.56
GlenOaks	5226.563	5Years	10.30	133.00	134.54	134.07	134.65	0.001645	1.61	9.24	11.72	0.44
GlenOaks	5226.563	10Years	12.80	133.00	134.80	134.19	134.90	0.001220	1.56	12.26	17.41	0.39
GlenOaks	5226.563	25Years	16.30	133.00	135.14	134.34	135.24	0.000921	1.54	16.33	23.88	0.35
GlenOaks	5226.563	50Years	18.91	133.00	135.35	134.44	135.44	0.000833	1.57	18.90	28.61	0.34
GlenOaks	5226.563	100Years	21.49	133.00	135.46	134.56	135.54	0.000770	1.56	28.51	31.95	0.33
GlenOaks	5226.563	Regional	21.66	133.00	135.46	134.57	135.54	0.000777	1.56	28.61	32.04	0.33
GlenOaks	5195.237		Culvert									
GlenOaks	5162.059	2Years	6.71	131.68	132.40	132.40	132.67	0.010579	2.33	3.01	13.81	0.99
GlenOaks	5162.059	5Years	10.30	131.68	132.58	132.58	132.94	0.009776	2.70	4.02	16.05	1.00
GlenOaks	5162.059	10Years	12.80	131.68	132.69	132.69	133.11	0.009421	2.91	4.65	17.22	1.00
GlenOaks	5162.059	25Years	16.30	131.68	132.84	132.84	133.34	0.008952	3.15	5.48	18.77	1.00
GlenOaks	5162.059	50Years	18.91	131.68	132.95	132.95	133.49	0.008571	3.30	6.08	19.86	1.00
GlenOaks	5162.059	100Years	21.49	131.68	133.04	133.04	133.64	0.008468	3.46	6.60	21.23	1.00
GlenOaks	5162.059	Regional	21.66	131.68	133.07	133.07	133.30	0.003923	2.35	16.76	21.51	0.68

HEC-RAS Plan: realigned River: 14Mile Reach: GlenOaks (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
GlenOaks	5143.615	2Years	6.71	131.50	132.24		132.27	0.001299	0.74	11.14	25.28	0.34
GlenOaks	5143.615	5Years	10.30	131.50	132.38		132.42	0.001320	0.87	14.62	25.92	0.35
GlenOaks	5143.615	10Years	12.80	131.50	132.46		132.51	0.001320	0.95	16.83	26.32	0.36
GlenOaks	5143.615	25Years	16.30	131.50	132.57		132.62	0.001331	1.05	19.64	26.84	0.37
GlenOaks	5143.615	50Years	18.91	131.50	132.64		132.70	0.001341	1.11	21.60	27.18	0.38
GlenOaks	5143.615	100Years	21.49	131.50	132.71		132.78	0.001340	1.17	23.49	27.52	0.38
GlenOaks	5143.615	Regional	21.66	131.50	132.72		132.78	0.001341	1.18	23.61	27.54	0.38
GlenOaks	5118.131	2Years	6.71	131.43	132.14		132.20	0.005248	1.34	9.21	23.61	0.66
GlenOaks	5118.131	5Years	10.30	131.43	132.25		132.34	0.005738	1.63	11.83	24.91	0.72
GlenOaks	5118.131	10Years	12.80	131.43	132.32		132.43	0.005730	1.77	13.63	25.52	0.73
GlenOaks	5118.131	25Years	16.30	131.43	132.40		132.54	0.005851	1.96	15.86	26.17	0.75
GlenOaks	5118.131	50Years	18.91	131.43	132.46		132.61	0.006003	2.09	17.34	26.60	0.77
GlenOaks	5118.131	100Years	21.49	131.43	132.52		132.68	0.005998	2.19	18.88	27.03	0.78
GlenOaks	5118.131	Regional	21.66	131.43	132.52		132.69	0.006005	2.20	18.97	27.06	0.79
GlenOaks	5096.349	2Years	6.71	131.07	131.74	131.74	131.90	0.012514	1.79	4.41	17.42	0.99
GlenOaks	5096.349	5Years	10.30	131.07	131.86	131.86	132.05	0.010071	1.97	6.81	22.44	0.93
GlenOaks	5096.349	10Years	12.80	131.07	131.92	131.92	132.13	0.010122	2.14	8.10	22.77	0.95
GlenOaks	5096.349	25Years	16.30	131.07	131.99	131.99	132.24	0.009914	2.32	9.85	23.22	0.97
GlenOaks	5096.349	50Years	18.91	131.07	132.05	132.05	132.32	0.009500	2.42	11.20	23.56	0.96
GlenOaks	5096.349	100Years	21.49	131.07	132.09	132.09	132.39	0.009591	2.54	12.28	23.83	0.98
GlenOaks	5096.349	Regional	21.66	131.07	132.10	132.10	132.39	0.009576	2.55	12.36	23.85	0.98
GlenOaks	5078.876	2Years	6.71	130.74	131.22	131.22	131.36	0.013650	1.72	4.70	18.25	1.01
GlenOaks	5078.876	5Years	10.30	130.74	131.31	131.31	131.49	0.012538	1.98	6.44	19.12	1.01
GlenOaks	5078.876	10Years	12.80	130.74	131.37	131.37	131.58	0.012023	2.12	7.56	19.67	1.02
GlenOaks	5078.876	25Years	16.30	130.74	131.44	131.44	131.69	0.011428	2.30	9.06	20.38	1.02
GlenOaks	5078.876	50Years	18.91	130.74	131.49	131.49	131.77	0.011091	2.41	10.14	20.86	1.02
GlenOaks	5078.876	100Years	21.49	130.74	131.54	131.54	131.84	0.010781	2.51	11.18	21.32	1.02
GlenOaks	5078.876	Regional	21.66	130.74	131.55	131.55	131.84	0.010758	2.52	11.25	21.35	1.02
GlenOaks	5000	2Years	6.71	129.50	129.99	129.99	130.14	0.013583	1.70	3.99	14.27	1.01
GlenOaks	5000	5Years	10.30	129.50	130.10	130.10	130.27	0.012557	1.88	5.59	16.33	1.00
GlenOaks	5000	10Years	12.80	129.50	130.15	130.15	130.36	0.012229	2.01	6.55	17.23	1.01
GlenOaks	5000	25Years	16.30	129.50	130.22	130.22	130.46	0.011478	2.17	7.80	17.87	1.00
GlenOaks	5000	50Years	18.91	129.50	130.27	130.27	130.53	0.011097	2.28	8.69	18.31	1.00
GlenOaks	5000	100Years	21.49	129.50	130.32	130.32	130.60	0.010718	2.37	9.56	18.73	1.00
GlenOaks	5000	Regional	21.66	129.50	130.32	130.32	130.61	0.010692	2.37	9.62	18.76	1.00
GlenOaks	4900	2Years	6.71	128.00	128.57		128.64	0.005044	1.18	5.85	18.64	0.63
GlenOaks	4900	5Years	10.30	128.00	128.66	128.56	128.76	0.005520	1.41	7.76	21.25	0.69
GlenOaks	4900	10Years	12.80	128.00	128.72	128.62	128.84	0.005745	1.56	8.92	22.57	0.71
GlenOaks	4900	25Years	16.30	128.00	128.78	128.69	128.93	0.006124	1.74	10.38	23.55	0.75
GlenOaks	4900	50Years	18.91	128.00	128.83	128.74	129.00	0.006198	1.85	11.50	24.05	0.77
GlenOaks	4900	100Years	21.49	128.00	128.86	128.79	129.06	0.006498	1.98	12.40	24.43	0.79
GlenOaks	4900	Regional	21.66	128.00	128.87	128.79	129.06	0.006458	1.98	12.50	24.48	0.79
GlenOaks	4800	2Years	6.71	127.45	127.71	127.71	127.81	0.016445	1.56	6.63	33.83	1.06
GlenOaks	4800	5Years	10.30	127.45	127.78	127.78	127.91	0.015250	1.79	8.93	34.12	1.07
GlenOaks	4800	10Years	12.80	127.45	127.82	127.82	127.97	0.014900	1.94	10.33	34.29	1.08
GlenOaks	4800	25Years	16.30	127.45	127.88	127.88	128.06	0.014101	2.09	12.26	34.53	1.08
GlenOaks	4800	50Years	18.91	127.45	127.91	127.91	128.11	0.014210	2.22	13.43	34.67	1.10
GlenOaks	4800	100Years	21.49	127.45	127.95	127.95	128.16	0.013537	2.30	14.79	34.84	1.09
GlenOaks	4800	Regional	21.66	127.45	127.95	127.95	128.17	0.013692	2.32	14.81	34.84	1.09
GlenOaks	4741.451	2Years	6.71	126.00	126.56	126.48	126.64	0.005709	1.26	5.90	20.30	0.68
GlenOaks	4741.451	5Years	10.30	126.00	126.84	126.57	126.89	0.001864	1.06	12.34	27.07	0.42
GlenOaks	4741.451	10Years	12.80	126.00	127.10	126.63	127.14	0.000849	0.90	21.42	46.16	0.30
GlenOaks	4741.451	25Years	16.30	126.00	127.46	126.70	127.48	0.000341	0.71	43.99	62.00	0.20
GlenOaks	4741.451	50Years	18.91	126.00	127.71	126.75	127.73	0.000215	0.64	59.88	63.17	0.17
GlenOaks	4741.451	100Years	21.49	126.00	127.95	126.80	127.97	0.000153	0.60	75.19	64.28	0.14
GlenOaks	4741.451	Regional	21.66	126.00	127.97	126.80	127.98	0.000150	0.60	76.19	64.35	0.14
GlenOaks	4668.109	2Years	6.71	125.49	126.35		126.39	0.002116	0.90	7.51	18.54	0.43
GlenOaks	4668.109	5Years	10.30	125.49	126.80		126.82	0.000429	0.65	22.21	37.97	0.22
GlenOaks	4668.109	10Years	12.80	125.49	127.08		127.10	0.000244	0.58	33.22	40.14	0.17
GlenOaks	4668.109	25Years	16.30	125.49	127.45		127.46	0.000148	0.54	48.44	43.14	0.14
GlenOaks	4668.109	50Years	18.91	125.49	127.71		127.72	0.000114	0.53	59.73	45.13	0.13
GlenOaks	4668.109	100Years	21.49	125.49	127.95		127.96	0.000093	0.52	70.81	46.77	0.12
GlenOaks	4668.109	Regional	21.66	125.49	127.96		127.97	0.000092	0.52	71.54	46.88	0.11
GlenOaks	4608.320	2Years	6.71	125.00	126.35		126.36	0.000133	0.38	23.09	37.28	0.12
GlenOaks	4608.320	5Years	10.30	125.00	126.80		126.81	0.000079	0.38	42.32	44.92	0.10
GlenOaks	4608.320	10Years	12.80	125.00	127.08		127.09	0.000063	0.38	55.28	47.51	0.09
GlenOaks	4608.320	25Years	16.30	125.00	127.45		127.46	0.000050	0.38	73.34	50.55	0.08

HEC-RAS Plan: realigned River: 14Mile Reach: GlenOaks (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
GlenOaks	4608.320	50Years	18.91	125.00	127.71		127.71	0.000043	0.39	86.43	51.92	0.08
GlenOaks	4608.320	100Years	21.49	125.00	127.95		127.95	0.000039	0.39	99.12	53.22	0.08
GlenOaks	4608.320	Regional	21.66	125.00	127.96		127.97	0.000039	0.39	99.94	53.30	0.08
GlenOaks	4596.187	2Years	6.71	125.00	126.35	125.55	126.36	0.000146	0.41	16.56	29.03	0.13
GlenOaks	4596.187	5Years	10.30	125.00	126.80	125.66	126.81	0.000102	0.43	23.88	32.13	0.11
GlenOaks	4596.187	10Years	12.80	125.00	127.08	125.73	127.09	0.000087	0.45	28.47	35.28	0.11
GlenOaks	4596.187	25Years	16.30	125.00	127.44	125.80	127.45	0.000075	0.47	34.42	37.90	0.10
GlenOaks	4596.187	50Years	18.91	125.00	127.70	125.85	127.71	0.000069	0.49	38.58	39.50	0.10
GlenOaks	4596.187	100Years	21.49	125.00	127.94	125.90	127.95	0.000065	0.51	42.50	41.00	0.10
GlenOaks	4596.187	Regional	21.66	125.00	127.95	125.90	127.97	0.000064	0.51	42.76	41.10	0.10
GlenOaks	4567.342		Culvert									
GlenOaks	4541.851	2Years	6.71	124.08	125.29	125.07	125.44	0.003794	1.69	3.96	7.03	0.61
GlenOaks	4541.851	5Years	10.30	124.08	125.45	125.26	125.69	0.004941	2.18	4.74	8.59	0.71
GlenOaks	4541.851	10Years	12.80	124.08	125.53	125.37	125.84	0.005853	2.50	5.13	9.16	0.79
GlenOaks	4541.851	25Years	16.30	124.08	125.60	125.53	126.05	0.007452	2.96	5.51	9.71	0.90
GlenOaks	4541.851	50Years	18.91	124.08	125.75	125.63	126.06	0.005321	2.46	8.50	10.89	0.76
GlenOaks	4541.851	100Years	21.49	124.08	125.81	125.74	126.16	0.005698	2.64	9.18	11.53	0.79
GlenOaks	4541.851	Regional	21.66	124.08	125.82	125.74	126.17	0.005723	2.65	9.22	11.57	0.79
GlenOaks	4524.948	2Years	6.71	124.00	125.26		125.35	0.003053	1.31	5.13	8.16	0.53
GlenOaks	4524.948	5Years	10.30	124.00	125.44		125.56	0.003376	1.56	6.84	11.54	0.57
GlenOaks	4524.948	10Years	12.80	124.00	125.53		125.68	0.003572	1.71	8.03	13.20	0.60
GlenOaks	4524.948	25Years	16.30	124.00	125.65	125.39	125.83	0.003878	1.90	9.63	15.15	0.63
GlenOaks	4524.948	50Years	18.91	124.00	125.72	125.47	125.93	0.004020	2.01	10.87	16.52	0.65
GlenOaks	4524.948	100Years	21.49	124.00	125.79	125.55	126.02	0.004200	2.13	12.02	17.70	0.67
GlenOaks	4524.948	Regional	21.66	124.00	125.80	125.55	126.02	0.004212	2.14	12.10	17.78	0.67
GlenOaks	4469.732	2Years	6.71	124.00	124.80	124.80	125.01	0.012492	2.03	3.30	8.03	1.01
GlenOaks	4469.732	5Years	10.30	124.00	124.96	124.96	125.21	0.011798	2.22	4.65	9.50	1.01
GlenOaks	4469.732	10Years	12.80	124.00	125.04	125.04	125.32	0.011436	2.32	5.51	10.26	1.01
GlenOaks	4469.732	25Years	16.30	124.00	125.15	125.15	125.46	0.010852	2.43	6.71	11.23	1.00
GlenOaks	4469.732	50Years	18.91	124.00	125.22	125.22	125.55	0.010827	2.52	7.49	11.82	1.01
GlenOaks	4469.732	100Years	21.49	124.00	125.29	125.29	125.63	0.010601	2.59	8.30	12.39	1.01
GlenOaks	4469.732	Regional	21.66	124.00	125.29	125.29	125.64	0.010587	2.59	8.35	12.43	1.01
GlenOaks	4400	2Years	6.71	123.00	124.09		124.15	0.002462	1.12	6.14	13.81	0.47
GlenOaks	4400	5Years	10.30	123.00	124.23		124.33	0.002778	1.35	8.46	18.33	0.52
GlenOaks	4400	10Years	12.80	123.00	124.31		124.42	0.003054	1.50	9.84	18.72	0.55
GlenOaks	4400	25Years	16.30	123.00	124.39		124.54	0.003460	1.70	11.46	19.17	0.59
GlenOaks	4400	50Years	18.91	123.00	124.44		124.61	0.003933	1.87	12.29	19.40	0.64
GlenOaks	4400	100Years	21.49	123.00	124.49		124.68	0.004091	1.97	13.43	19.70	0.65
GlenOaks	4400	Regional	21.66	123.00	124.50		124.69	0.004091	1.98	13.52	19.73	0.65
GlenOaks	4347.009	2Years	6.71	123.00	123.70	123.70	123.89	0.011992	1.94	3.66	13.21	0.98
GlenOaks	4347.009	5Years	10.30	123.00	123.86	123.84	124.07	0.009009	2.06	6.25	19.65	0.89
GlenOaks	4347.009	10Years	12.80	123.00	123.98	123.92	124.18	0.006885	2.03	9.00	26.70	0.80
GlenOaks	4347.009	25Years	16.30	123.00	124.11	123.99	124.30	0.005598	2.03	13.76	39.73	0.74
GlenOaks	4347.009	50Years	18.91	123.00	124.20	124.13	124.37	0.004840	2.01	17.25	40.08	0.70
GlenOaks	4347.009	100Years	21.49	123.00	124.22	124.18	124.43	0.005591	2.20	18.19	40.17	0.76
GlenOaks	4347.009	Regional	21.66	123.00	124.22	124.18	124.43	0.005678	2.21	18.19	40.17	0.76
GlenOaks	4300	2Years	6.71	122.10	123.33	123.12	123.45	0.004661	1.58	4.26	6.95	0.64
GlenOaks	4300	5Years	10.30	122.10	123.36	123.31	123.63	0.009635	2.30	4.47	7.13	0.93
GlenOaks	4300	10Years	12.80	122.10	123.43	123.43	123.76	0.010994	2.56	5.01	7.55	1.00
GlenOaks	4300	25Years	16.30	122.10	123.56	123.56	123.93	0.010684	2.68	6.08	8.36	1.00
GlenOaks	4300	50Years	18.91	122.10	123.66	123.66	124.04	0.009880	2.74	7.09	13.43	0.98
GlenOaks	4300	100Years	21.49	122.10	123.88	123.75	124.16	0.005782	2.37	11.18	23.75	0.77
GlenOaks	4300	Regional	21.66	122.10	123.90	123.76	124.17	0.005456	2.33	11.70	24.39	0.75
GlenOaks	4200	2Years	6.71	122.10	122.58	122.58	122.72	0.013015	1.70	4.17	17.33	0.99
GlenOaks	4200	5Years	10.30	122.10	122.78		122.89	0.005186	1.51	8.34	22.78	0.68
GlenOaks	4200	10Years	12.80	122.10	123.09		123.15	0.001413	1.09	15.92	25.19	0.39
GlenOaks	4200	25Years	16.30	122.10	123.47		123.51	0.000600	0.92	25.94	28.06	0.27
GlenOaks	4200	50Years	18.91	122.10	123.73		123.76	0.000403	0.86	33.48	30.04	0.23
GlenOaks	4200	100Years	21.49	122.10	123.97		124.00	0.000300	0.82	41.04	31.92	0.20
GlenOaks	4200	Regional	21.66	122.10	123.99		124.02	0.000295	0.82	41.55	32.04	0.20
GlenOaks	4153.677	2Years	6.71	121.00	122.38		122.39	0.000188	0.45	17.65	26.01	0.14
GlenOaks	4153.677	5Years	10.30	121.00	122.83		122.84	0.000116	0.45	30.70	31.76	0.12
GlenOaks	4153.677	10Years	12.80	121.00	123.11		123.12	0.000093	0.46	40.12	34.90	0.11
GlenOaks	4153.677	25Years	16.30	121.00	123.48		123.49	0.000074	0.47	53.68	38.97	0.10
GlenOaks	4153.677	50Years	18.91	121.00	123.74		123.75	0.000065	0.47	64.07	42.00	0.10
GlenOaks	4153.677	100Years	21.49	121.00	123.98		123.99	0.000059	0.48	74.72	45.53	0.10

HEC-RAS Plan: realigned River: 14Mile Reach: GlenOaks (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
GlenOaks	4153.677	Regional	21.66	121.00	124.00		124.01	0.000059	0.48	75.43	45.73	0.09
GlenOaks	4112.991	2Years	6.71	121.00	122.36	121.66	122.38	0.000302	0.58	12.62	15.13	0.18
GlenOaks	4112.991	5Years	10.30	121.00	122.81	121.79	122.83	0.000202	0.61	19.85	23.07	0.16
GlenOaks	4112.991	10Years	12.80	121.00	123.10	121.86	123.12	0.000170	0.63	24.64	35.40	0.15
GlenOaks	4112.991	25Years	16.30	121.00	123.46	121.95	123.48	0.000142	0.65	31.00	43.39	0.14
GlenOaks	4112.991	50Years	18.91	121.00	123.72	122.01	123.74	0.000128	0.67	35.45	46.91	0.14
GlenOaks	4112.991	100Years	21.49	121.00	123.96	122.08	123.98	0.000118	0.68	39.65	49.75	0.13
GlenOaks	4112.991	Regional	21.66	121.00	123.98	122.08	124.00	0.000118	0.68	39.92	49.93	0.13
GlenOaks	4088.661		Culvert									
GlenOaks	4065.910	2Years	6.71	121.00	121.75	121.75	122.04	0.010944	2.37	2.83	9.06	1.00
GlenOaks	4065.910	5Years	10.30	121.00	121.94	121.94	122.32	0.009860	2.72	3.78	11.16	1.00
GlenOaks	4065.910	10Years	12.80	121.00	122.06	122.06	122.50	0.009422	2.93	4.37	12.46	1.00
GlenOaks	4065.910	25Years	16.30	121.00	122.21	122.21	122.73	0.008968	3.18	5.13	13.86	1.00
GlenOaks	4065.910	50Years	18.91	121.00	122.32	122.32	122.89	0.008566	3.33	5.68	14.83	1.00
GlenOaks	4065.910	100Years	21.49	121.00	122.42	122.42	122.59	0.003831	1.82	11.98	15.41	0.63
GlenOaks	4065.910	Regional	21.66	121.00	122.42	122.42	122.59	0.003891	1.84	11.98	15.41	0.64
GlenOaks	4045.227	2Years	6.71	120.50	121.29		121.33	0.001918	0.93	7.49	15.98	0.41
GlenOaks	4045.227	5Years	10.30	120.50	121.43		121.49	0.001932	1.10	9.92	17.30	0.43
GlenOaks	4045.227	10Years	12.80	120.50	121.52		121.59	0.001979	1.21	11.42	18.07	0.45
GlenOaks	4045.227	25Years	16.30	120.50	121.62		121.71	0.002062	1.35	13.33	19.00	0.47
GlenOaks	4045.227	50Years	18.91	120.50	121.69		121.79	0.002121	1.44	14.67	19.62	0.48
GlenOaks	4045.227	100Years	21.49	120.50	121.75		121.87	0.002177	1.53	15.93	20.20	0.49
GlenOaks	4045.227	Regional	21.66	120.50	121.76		121.87	0.002180	1.53	16.01	20.23	0.49
GlenOaks	4000	2Years	6.71	120.50	120.99	120.97	121.13	0.010944	1.63	4.15	13.37	0.92
GlenOaks	4000	5Years	10.30	120.50	121.08	121.08	121.28	0.011993	1.95	5.36	14.26	0.99
GlenOaks	4000	10Years	12.80	120.50	121.14	121.14	121.37	0.011768	2.09	6.26	14.89	1.00
GlenOaks	4000	25Years	16.30	120.50	121.23	121.23	121.48	0.011205	2.24	7.52	15.73	1.00
GlenOaks	4000	50Years	18.91	120.50	121.28	121.28	121.56	0.010905	2.33	8.42	16.30	1.00
GlenOaks	4000	100Years	21.49	120.50	121.33	121.33	121.63	0.010655	2.41	9.29	16.84	1.00
GlenOaks	4000	Regional	21.66	120.50	121.34	121.34	121.63	0.010656	2.42	9.34	16.87	1.00
GlenOaks	3962.377	2Years	6.71	119.97	120.53	120.53	120.68	0.013089	1.73	3.97	14.56	1.00
GlenOaks	3962.377	5Years	10.30	119.97	120.64	120.64	120.83	0.011901	1.93	5.67	17.06	0.99
GlenOaks	3962.377	10Years	12.80	119.97	120.70	120.70	120.91	0.011515	2.05	6.77	18.08	0.99
GlenOaks	3962.377	25Years	16.30	119.97	120.78	120.78	121.02	0.011156	2.19	8.23	19.37	1.00
GlenOaks	3962.377	50Years	18.91	119.97	120.84	120.84	121.09	0.010619	2.26	9.40	20.33	0.99
GlenOaks	3962.377	100Years	21.49	119.97	120.89	120.89	121.16	0.010449	2.34	10.42	20.84	0.99
GlenOaks	3962.377	Regional	21.66	119.97	120.89	120.89	121.16	0.010430	2.34	10.48	20.88	0.99
GlenOaks	3938.663	2Years	6.71	119.50	120.15	120.13	120.30	0.012147	1.76	3.81	11.36	0.97
GlenOaks	3938.663	5Years	10.30	119.50	120.28	120.26	120.46	0.010178	1.86	5.53	13.63	0.92
GlenOaks	3938.663	10Years	12.80	119.50	120.36	120.33	120.55	0.009448	1.96	6.59	14.92	0.91
GlenOaks	3938.663	25Years	16.30	119.50	120.44	120.41	120.67	0.009210	2.10	7.93	16.47	0.92
GlenOaks	3938.663	50Years	18.91	119.50	120.51	120.47	120.75	0.008814	2.17	9.02	17.63	0.91
GlenOaks	3938.663	100Years	21.49	119.50	120.56	120.53	120.82	0.008748	2.26	9.98	18.59	0.91
GlenOaks	3938.663	Regional	21.66	119.50	120.56	120.53	120.82	0.008731	2.26	10.05	18.66	0.91
GlenOaks	3899.999	2Years	6.71	119.00	119.73	119.70	119.88	0.009765	1.72	3.91	10.69	0.89
GlenOaks	3899.999	5Years	10.30	119.00	119.83	119.82	120.05	0.010724	2.08	5.08	12.16	0.96
GlenOaks	3899.999	10Years	12.80	119.00	119.90	119.90	120.16	0.010810	2.25	5.95	13.55	0.98
GlenOaks	3899.999	25Years	16.30	119.00	120.00	120.00	120.29	0.010121	2.40	7.37	15.00	0.98
GlenOaks	3899.999	50Years	18.91	119.00	120.06	120.06	120.38	0.009943	2.52	8.30	15.73	0.98
GlenOaks	3899.999	100Years	21.49	119.00	120.12	120.12	120.46	0.009378	2.60	9.34	16.90	0.97
GlenOaks	3899.999	Regional	21.66	119.00	120.13	120.13	120.46	0.009355	2.60	9.41	16.97	0.97
GlenOaks	3843.650	2Years	6.71	118.50	119.07	119.07	119.24	0.013261	1.82	3.69	11.21	1.01
GlenOaks	3843.650	5Years	10.30	118.50	119.19	119.19	119.40	0.012325	2.03	5.08	12.38	1.01
GlenOaks	3843.650	10Years	12.80	118.50	119.26	119.26	119.50	0.011876	2.14	5.98	13.10	1.01
GlenOaks	3843.650	25Years	16.30	118.50	119.35	119.35	119.61	0.011401	2.27	7.17	13.87	1.01
GlenOaks	3843.650	50Years	18.91	118.50	119.41	119.41	119.69	0.010905	2.35	8.05	14.38	1.00
GlenOaks	3843.650	100Years	21.49	118.50	119.46	119.46	119.77	0.010831	2.45	8.78	14.78	1.01
GlenOaks	3843.650	Regional	21.66	118.50	119.47	119.47	119.77	0.010806	2.45	8.84	14.80	1.01
GlenOaks	3800	2Years	6.71	117.58	118.75	118.11	118.76	0.000244	0.48	23.25	45.04	0.16
GlenOaks	3800	5Years	10.30	117.58	119.27	118.22	119.28	0.000093	0.40	50.46	56.36	0.11
GlenOaks	3800	10Years	12.80	117.58	119.33	118.28	119.34	0.000122	0.48	53.91	57.49	0.13
GlenOaks	3800	25Years	16.30	117.58	119.44	118.36	119.45	0.000154	0.56	59.82	59.52	0.14
GlenOaks	3800	50Years	18.91	117.58	119.49	118.41	119.51	0.000180	0.62	63.35	60.81	0.15
GlenOaks	3800	100Years	21.49	117.58	119.60	118.46	119.62	0.000183	0.65	69.93	63.42	0.16
GlenOaks	3800	Regional	21.66	117.58	119.60	118.46	119.62	0.000186	0.65	69.92	63.42	0.16

HEC-RAS Plan: realigned River: 14Mile Reach: GlenOaks (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
GlenOaks	3742.784	2Years	13.42	117.00	118.75		118.75	0.000071	0.37	83.90	93.62	0.10
GlenOaks	3742.784	5Years	20.88	117.00	119.27		119.28	0.000050	0.38	135.25	100.85	0.08
GlenOaks	3742.784	10Years	26.29	117.00	119.33		119.34	0.000071	0.46	141.29	101.51	0.10
GlenOaks	3742.784	25Years	32.80	117.00	119.43		119.44	0.000091	0.54	151.52	102.80	0.12
GlenOaks	3742.784	50Years	36.25	117.00	119.49		119.50	0.000101	0.58	157.61	104.61	0.12
GlenOaks	3742.784	100Years	44.70	117.00	119.59		119.61	0.000128	0.67	168.53	106.41	0.14
GlenOaks	3742.784	Regional	44.70	117.00	119.59		119.61	0.000128	0.67	168.53	106.41	0.14
GlenOaks	3699.999	2Years	13.42	117.00	118.74		118.75	0.000042	0.29	125.86	124.14	0.07
GlenOaks	3699.999	5Years	20.88	117.00	119.27		119.27	0.000030	0.30	192.29	128.04	0.07
GlenOaks	3699.999	10Years	26.29	117.00	119.33		119.33	0.000042	0.36	199.95	128.48	0.08
GlenOaks	3699.999	25Years	32.80	117.00	119.43		119.44	0.000055	0.42	212.89	129.24	0.09
GlenOaks	3699.999	50Years	36.25	117.00	119.49		119.50	0.000060	0.45	220.53	129.68	0.09
GlenOaks	3699.999	100Years	44.70	117.00	119.59		119.60	0.000077	0.52	234.01	130.45	0.11
GlenOaks	3699.999	Regional	44.70	117.00	119.59		119.60	0.000077	0.52	234.01	130.45	0.11
GlenOaks	3651.369	2Years	13.42	116.50	118.74		118.75	0.000014	0.21	150.26	101.96	0.05
GlenOaks	3651.369	5Years	20.88	116.50	119.27		119.27	0.000015	0.24	205.72	108.71	0.05
GlenOaks	3651.369	10Years	26.29	116.50	119.33		119.33	0.000021	0.30	212.21	109.51	0.06
GlenOaks	3651.369	25Years	32.80	116.50	119.43		119.43	0.000029	0.36	223.22	110.84	0.07
GlenOaks	3651.369	50Years	36.25	116.50	119.49		119.49	0.000033	0.38	229.76	111.64	0.07
GlenOaks	3651.369	100Years	44.70	116.50	119.59		119.60	0.000044	0.45	241.33	113.05	0.08
GlenOaks	3651.369	Regional	44.70	116.50	119.59		119.60	0.000044	0.45	241.33	113.05	0.08
GlenOaks	3635.031	2Years	13.42	116.53	118.72	117.31	118.74	0.000152	0.64	21.22	59.82	0.15
GlenOaks	3635.031	5Years	20.88	116.53	119.26	117.49	119.27	0.000069	0.50	95.17	81.82	0.10
GlenOaks	3635.031	10Years	26.29	116.53	119.31	117.61	119.33	0.000099	0.61	99.66	82.98	0.12
GlenOaks	3635.031	25Years	32.80	116.53	119.41	117.75	119.43	0.000131	0.72	107.59	85.03	0.14
GlenOaks	3635.031	50Years	36.25	116.53	119.47	117.82	119.49	0.000145	0.77	112.39	86.25	0.15
GlenOaks	3635.031	100Years	44.70	116.53	119.56	117.97	119.59	0.000189	0.90	120.69	88.31	0.17
GlenOaks	3635.031	Regional	44.70	116.53	119.56	117.97	119.59	0.000189	0.90	120.69	88.31	0.17
GlenOaks	3610.515		Culvert									
GlenOaks	3580.966	2Years	13.42	115.00	116.78	116.14	116.93	0.001565	1.72	7.79	18.07	0.45
GlenOaks	3580.966	5Years	20.88	115.00	117.09	116.45	117.34	0.002049	2.23	9.36	22.43	0.53
GlenOaks	3580.966	10Years	26.29	115.00	117.27	116.64	117.60	0.002383	2.56	10.27	27.80	0.58
GlenOaks	3580.966	25Years	32.80	115.00	117.45	116.86	117.89	0.002754	2.92	11.23	38.16	0.63
GlenOaks	3580.966	50Years	36.25	115.00	117.75	116.98	117.82	0.000557	1.31	43.85	44.90	0.28
GlenOaks	3580.966	100Years	44.70	115.00	118.01	117.24	118.09	0.000510	1.35	57.24	53.32	0.28
GlenOaks	3580.966	Regional	44.70	115.00	118.01	117.24	118.09	0.000510	1.35	57.24	53.32	0.28
GlenOaks	3570.062	2Years	13.42	115.00	116.82		116.86	0.000678	0.87	15.75	17.01	0.27
GlenOaks	3570.062	5Years	20.88	115.00	117.18		117.23	0.000641	0.98	22.35	20.21	0.28
GlenOaks	3570.062	10Years	26.29	115.00	117.39		117.45	0.000598	1.05	27.03	27.13	0.27
GlenOaks	3570.062	25Years	32.80	115.00	117.63		117.69	0.000550	1.11	35.60	47.64	0.27
GlenOaks	3570.062	50Years	36.25	115.00	117.75		117.81	0.000518	1.13	41.34	49.81	0.26
GlenOaks	3570.062	100Years	44.70	115.00	118.02		118.08	0.000449	1.15	55.22	53.10	0.25
GlenOaks	3570.062	Regional	44.70	115.00	118.02		118.08	0.000449	1.15	55.22	53.10	0.25
GlenOaks	3500	2Years	13.42	115.00	116.78	116.06	116.81	0.000643	0.87	16.77	18.84	0.27
GlenOaks	3500	5Years	20.88	115.00	117.14	116.25	117.18	0.000586	0.98	24.16	22.40	0.27
GlenOaks	3500	10Years	26.29	115.00	117.35	116.37	117.41	0.000550	1.05	29.29	24.57	0.27
GlenOaks	3500	25Years	32.80	115.00	117.59	116.51	117.65	0.000520	1.12	35.43	27.10	0.26
GlenOaks	3500	50Years	36.25	115.00	117.71	116.58	117.77	0.000507	1.15	39.96	43.00	0.26
GlenOaks	3500	100Years	44.70	115.00	117.98	116.72	118.04	0.000462	1.20	52.56	50.72	0.26
GlenOaks	3500	Regional	44.70	115.00	117.98	116.72	118.04	0.000462	1.20	52.56	50.72	0.26
GlenOaks	3453.308	2Years	13.42	115.00	116.78		116.80	0.000137	0.53	30.97	25.19	0.13
GlenOaks	3453.308	5Years	20.88	115.00	117.14		117.16	0.000161	0.66	40.46	27.48	0.15
GlenOaks	3453.308	10Years	26.29	115.00	117.36		117.38	0.000174	0.74	46.61	28.74	0.16
GlenOaks	3453.308	25Years	32.80	115.00	117.60		117.63	0.000187	0.82	53.70	30.70	0.17
GlenOaks	3453.308	50Years	36.25	115.00	117.72		117.75	0.000193	0.86	57.35	31.71	0.17
GlenOaks	3453.308	100Years	44.70	115.00	117.98		118.02	0.000204	0.94	66.12	34.15	0.18
GlenOaks	3453.308	Regional	44.70	115.00	117.98		118.02	0.000204	0.94	66.12	34.15	0.18
GlenOaks	3427.268	2Years	13.42	115.00	116.38	116.38	116.75	0.010295	2.68	5.12	7.41	0.99
GlenOaks	3427.268	5Years	20.88	115.00	116.66	116.66	117.11	0.009448	2.98	7.35	8.77	0.98
GlenOaks	3427.268	10Years	26.29	115.00	116.82	116.82	117.32	0.009038	3.18	8.81	9.67	0.98
GlenOaks	3427.268	25Years	32.80	115.00	116.99	116.99	117.56	0.008530	3.40	10.50	10.49	0.98
GlenOaks	3427.268	50Years	36.25	115.00	117.07	117.07	117.68	0.008211	3.49	11.44	10.92	0.97
GlenOaks	3427.268	100Years	44.70	115.00	117.27	117.27	117.94	0.007682	3.71	13.69	11.94	0.96
GlenOaks	3427.268	Regional	44.70	115.00	117.27	117.27	117.94	0.007682	3.71	13.69	11.94	0.96
GlenOaks	3407.117	2Years	13.42	114.21	115.44	115.44	115.74	0.010668	2.44	5.54	10.11	0.99
GlenOaks	3407.117	5Years	20.88	114.21	115.68	115.68	116.03	0.008394	2.66	8.70	15.59	0.92

HEC-RAS Plan: realigned River: 14Mile Reach: GlenOaks (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
GlenOaks	3407.117	10Years	26.29	114.21	115.81	115.81	116.20	0.007829	2.83	10.84	16.75	0.91
GlenOaks	3407.117	25Years	32.80	114.21	115.95	115.95	116.38	0.007502	3.03	13.21	17.95	0.92
GlenOaks	3407.117	50Years	36.25	114.21	116.02	116.02	116.47	0.007342	3.11	14.45	18.55	0.91
GlenOaks	3407.117	100Years	44.70	114.21	116.17	116.17	116.67	0.007030	3.31	17.43	19.91	0.91
GlenOaks	3407.117	Regional	44.70	114.21	116.17	116.17	116.67	0.007030	3.31	17.43	19.91	0.91
GlenOaks	3388.007	2Years	13.42	113.50	114.81	114.81	115.04	0.011605	2.12	6.34	14.80	0.99
GlenOaks	3388.007	5Years	20.88	113.50	114.99	114.99	115.27	0.009186	2.33	9.82	22.92	0.93
GlenOaks	3388.007	10Years	26.29	113.50	115.10	115.10	115.40	0.008497	2.48	12.32	25.89	0.92
GlenOaks	3388.007	25Years	32.80	113.50	115.21	115.21	115.36	0.004563	1.99	26.11	48.56	0.69
GlenOaks	3388.007	50Years	36.25	113.50	115.21	115.21	115.40	0.005573	2.20	26.11	48.56	0.76
GlenOaks	3388.007	100Years	44.70	113.50	115.21	115.21	115.49	0.008473	2.72	26.11	48.56	0.94
GlenOaks	3388.007	Regional	44.70	113.50	115.21	115.21	115.49	0.008473	2.72	26.11	48.56	0.94
GlenOaks	3338.702	2Years	13.42	112.61	113.72	113.72	113.97	0.010617	2.24	6.15	13.59	0.97
GlenOaks	3338.702	5Years	20.88	112.61	113.91	113.91	114.22	0.009439	2.51	8.98	15.94	0.96
GlenOaks	3338.702	10Years	26.29	112.61	114.04	114.04	114.37	0.008269	2.59	11.38	28.23	0.92
GlenOaks	3338.702	25Years	32.80	112.61	114.15	114.15	114.27	0.003746	1.90	34.21	84.91	0.63
GlenOaks	3338.702	50Years	36.25	112.61	114.15	114.15	114.30	0.004576	2.09	34.21	84.91	0.70
GlenOaks	3338.702	100Years	44.70	112.61	114.16	114.16	114.38	0.006449	2.51	35.40	85.80	0.83
GlenOaks	3338.702	Regional	44.70	112.61	114.16	114.16	114.38	0.006449	2.51	35.40	85.80	0.83
GlenOaks	3300	2Years	13.42	112.00	112.89	112.89	113.12	0.011028	2.12	6.58	15.45	0.98
GlenOaks	3300	5Years	20.88	112.00	113.05	113.05	113.35	0.009885	2.44	9.21	17.13	0.97
GlenOaks	3300	10Years	26.29	112.00	113.16	113.16	113.49	0.009222	2.61	11.09	18.25	0.96
GlenOaks	3300	25Years	32.80	112.00	113.27	113.27	113.66	0.008916	2.81	13.18	19.91	0.97
GlenOaks	3300	50Years	36.25	112.00	113.33	113.33	113.73	0.008604	2.88	14.40	20.89	0.96
GlenOaks	3300	100Years	44.70	112.00	113.47	113.47	113.91	0.007964	3.05	17.42	23.14	0.95
GlenOaks	3300	Regional	44.70	112.00	113.47	113.47	113.91	0.007964	3.05	17.42	23.14	0.95
GlenOaks	3244.446	2Years	13.42	110.92	112.01	112.01	112.27	0.011014	2.29	5.94	12.11	0.99
GlenOaks	3244.446	5Years	20.88	110.92	112.20	112.20	112.53	0.009635	2.56	8.60	14.80	0.97
GlenOaks	3244.446	10Years	26.29	110.92	112.32	112.32	112.69	0.009233	2.73	10.46	16.53	0.97
GlenOaks	3244.446	25Years	32.80	110.92	112.46	112.46	112.86	0.008409	2.86	12.94	20.30	0.95
GlenOaks	3244.446	50Years	36.25	110.92	112.54	112.54	112.94	0.007768	2.89	14.66	25.60	0.92
GlenOaks	3244.446	100Years	44.70	110.92	112.70	112.70	113.11	0.006700	2.97	19.51	33.72	0.88
GlenOaks	3244.446	Regional	44.70	110.92	112.70	112.70	113.11	0.006700	2.97	19.51	33.72	0.88
GlenOaks	3218.863	2Years	13.42	110.00	111.70		111.80	0.002283	1.39	10.15	14.48	0.48
GlenOaks	3218.863	5Years	20.88	110.00	112.23		112.31	0.000994	1.27	19.04	18.82	0.35
GlenOaks	3218.863	10Years	26.29	110.00	112.37		112.47	0.001117	1.44	21.73	20.02	0.37
GlenOaks	3218.863	25Years	32.80	110.00	112.44		112.58	0.001560	1.74	23.28	40.46	0.44
GlenOaks	3218.863	50Years	36.25	110.00	112.47		112.64	0.001730	1.87	24.85	41.98	0.47
GlenOaks	3218.863	100Years	44.70	110.00	112.55	112.03	112.77	0.002152	2.15	28.33	45.14	0.53
GlenOaks	3218.863	Regional	44.70	110.00	112.55	112.03	112.77	0.002152	2.15	28.33	45.14	0.53
GlenOaks	3202.874	2Years	13.42	110.00	111.64	111.25	111.75	0.002594	1.48	9.08	10.68	0.51
GlenOaks	3202.874	5Years	20.88	110.00	112.20	111.50	112.29	0.001261	1.36	15.77	13.45	0.38
GlenOaks	3202.874	10Years	26.29	110.00	112.32	111.64	112.44	0.001501	1.55	17.50	14.09	0.42
GlenOaks	3202.874	25Years	32.80	110.00	112.37	111.79	112.55	0.002110	1.87	18.18	14.52	0.50
GlenOaks	3202.874	50Years	36.25	110.00	112.38	111.86	112.60	0.002505	2.05	18.38	14.64	0.54
GlenOaks	3202.874	100Years	44.70	110.00	112.35	112.03	112.69	0.004061	2.58	17.94	14.37	0.69
GlenOaks	3202.874	Regional	44.70	110.00	112.35	112.03	112.69	0.004061	2.58	17.94	14.37	0.69
GlenOaks	3156.948		Culvert									
GlenOaks	3099.031	2Years	13.42	109.00	109.92	109.92	110.31	0.009586	2.75	4.88	28.86	1.00
GlenOaks	3099.031	5Years	20.88	109.00	110.18	110.18	110.71	0.008764	3.20	6.53	105.24	1.00
GlenOaks	3099.031	10Years	26.29	109.00	110.36	110.36	110.96	0.008313	3.45	7.62	117.50	1.00
GlenOaks	3099.031	25Years	32.80	109.00	110.55	110.55	111.25	0.007904	3.71	8.83	138.26	1.00
GlenOaks	3099.031	50Years	36.25	109.00	110.65	110.65	111.40	0.007733	3.84	9.44	174.76	1.00
GlenOaks	3099.031	100Years	44.70	109.00	110.87	110.87	111.74	0.007420	4.12	10.84	184.49	1.00
GlenOaks	3099.031	Regional	44.70	109.00	110.87	110.87	111.74	0.007420	4.12	10.84	184.49	1.00
GlenOaks	3073.705	2Years	13.42	108.71	109.53		109.56	0.001149	0.83	27.17	83.23	0.33
GlenOaks	3073.705	5Years	20.88	108.71	109.56		109.61	0.002365	1.22	29.08	84.12	0.48
GlenOaks	3073.705	10Years	26.29	108.71	109.62		109.69	0.002380	1.30	34.97	86.91	0.49
GlenOaks	3073.705	25Years	32.80	108.71	109.70		109.77	0.002371	1.39	41.69	90.13	0.50
GlenOaks	3073.705	50Years	36.25	108.71	109.72		109.80	0.002569	1.47	43.65	90.86	0.52
GlenOaks	3073.705	100Years	44.70	108.71	109.79		109.87	0.002805	1.62	49.48	93.00	0.55
GlenOaks	3073.705	Regional	44.70	108.71	109.79		109.87	0.002805	1.62	49.48	93.00	0.55
GlenOaks	3045	2Years	13.42	107.85	108.94	108.94	109.44	0.013313	3.12	4.31	4.33	1.00
GlenOaks	3045	5Years	20.88	107.85	109.37	109.37	109.52	0.004503	2.12	23.57	75.68	0.58
GlenOaks	3045	10Years	26.29	107.85	109.43	109.43	109.59	0.005018	2.30	28.32	84.71	0.62
GlenOaks	3045	25Years	32.80	107.85	109.48	109.48	109.66	0.005825	2.54	33.17	101.52	0.67

HEC-RAS Plan: realigned River: 14Mile Reach: GlenOaks (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
GlenOaks	3045	50Years	36.25	107.85	109.54	109.54	109.70	0.005170	2.45	39.54	115.07	0.63
GlenOaks	3045	100Years	44.70	107.85	109.60	109.60	109.76	0.005723	2.65	46.29	123.87	0.67
GlenOaks	3045	Regional	44.70	107.85	109.60	109.60	109.76	0.005723	2.65	46.29	123.87	0.67
GlenOaks	3040		Culvert									
GlenOaks	3035	2Years	13.42	107.55	108.64	108.64	109.14	0.013298	3.12	4.31	4.33	1.00
GlenOaks	3035	5Years	20.88	107.55	109.19	109.19	109.36	0.004036	2.12	22.53	73.22	0.56
GlenOaks	3035	10Years	26.29	107.55	109.26	109.26	109.43	0.004491	2.31	27.51	79.50	0.59
GlenOaks	3035	25Years	32.80	107.55	109.34	109.34	109.51	0.004630	2.42	34.79	101.07	0.61
GlenOaks	3035	50Years	36.25	107.55	109.37	109.37	109.55	0.004809	2.50	37.98	105.91	0.62
GlenOaks	3035	100Years	44.70	107.55	109.44	109.44	109.62	0.005212	2.67	45.30	116.18	0.65
GlenOaks	3035	Regional	44.70	107.55	109.44	109.44	109.62	0.005212	2.67	45.30	116.18	0.65
GlenOaks	2999.999	2Years	13.42	106.50	107.56	107.56	107.83	0.011142	2.30	5.83	10.81	1.00
GlenOaks	2999.999	5Years	20.88	106.50	107.77	107.77	108.09	0.010759	2.54	8.23	12.83	1.01
GlenOaks	2999.999	10Years	26.29	106.50	107.88	107.88	108.25	0.010229	2.69	9.82	14.18	1.01
GlenOaks	2999.999	25Years	32.80	106.50	108.01	108.01	108.42	0.009800	2.85	11.67	15.63	1.01
GlenOaks	2999.999	50Years	36.25	106.50	108.09	108.09	108.50	0.008900	2.84	13.17	20.51	0.97
GlenOaks	2999.999	100Years	44.70	106.50	108.25	108.25	108.68	0.007838	2.91	16.96	26.80	0.93
GlenOaks	2999.999	Regional	44.70	106.50	108.25	108.25	108.68	0.007838	2.91	16.96	26.80	0.93
GlenOaks	2908.990	2Years	13.42	105.17	106.77	106.20	106.83	0.001360	1.17	11.49	11.71	0.38
GlenOaks	2908.990	5Years	20.88	105.17	106.83	106.42	106.98	0.002720	1.70	12.29	11.99	0.54
GlenOaks	2908.990	10Years	26.29	105.17	106.95	106.56	107.02	0.001629	1.38	30.04	43.17	0.42
GlenOaks	2908.990	25Years	32.80	105.17	106.94	106.71	107.06	0.002643	1.75	29.57	42.47	0.53
GlenOaks	2908.990	50Years	36.25	105.17	106.95	106.78	107.09	0.003145	1.92	29.87	42.90	0.58
GlenOaks	2908.990	100Years	44.70	105.17	106.97	106.92	107.17	0.004339	2.29	31.02	44.57	0.69
GlenOaks	2908.990	Regional	44.70	105.17	106.97	106.92	107.17	0.004339	2.29	31.02	44.57	0.69
GlenOaks	2888.560	2Years	13.42	104.86	106.78	105.88	106.80	0.000364	0.69	29.94	117.98	0.20
GlenOaks	2888.560	5Years	20.88	104.86	106.86	106.07	106.90	0.000595	0.92	41.22	136.94	0.26
GlenOaks	2888.560	10Years	26.29	104.86	106.95	106.20	106.99	0.000577	0.95	61.04	175.50	0.26
GlenOaks	2888.560	25Years	32.80	104.86	106.94	106.34	107.00	0.000955	1.21	58.83	173.44	0.34
GlenOaks	2888.560	50Years	36.25	104.86	106.95	106.40	107.01	0.001124	1.32	60.18	174.70	0.36
GlenOaks	2888.560	100Years	44.70	104.86	106.98	106.77	107.07	0.001459	1.53	66.06	180.08	0.42
GlenOaks	2888.560	Regional	44.70	104.86	106.98	106.77	107.07	0.001459	1.53	66.06	180.08	0.42
GlenOaks	2876.394		Culvert									
GlenOaks	2864.348	2Years	13.42	104.95	106.36	105.97	106.52	0.003311	1.77	7.62	24.89	0.54
GlenOaks	2864.348	5Years	20.88	104.95	106.44	106.24	106.78	0.006531	2.56	8.20	46.73	0.76
GlenOaks	2864.348	10Years	26.29	104.95	106.47	106.41	106.97	0.009616	3.15	8.43	47.90	0.92
GlenOaks	2864.348	25Years	32.80	104.95	106.79	106.61	106.88	0.002093	1.72	54.79	163.25	0.45
GlenOaks	2864.348	50Years	36.25	104.95	106.85	106.69	106.92	0.001816	1.65	64.02	165.44	0.42
GlenOaks	2864.348	100Years	44.70	104.95	106.95	106.81	107.01	0.001592	1.61	80.67	169.31	0.40
GlenOaks	2864.348	Regional	44.70	104.95	106.95	106.81	107.01	0.001592	1.61	80.67	169.31	0.40
GlenOaks	2843.745	2Years	13.42	104.70	106.03	106.03	106.36	0.011198	2.53	5.30	8.14	1.00
GlenOaks	2843.745	5Years	20.88	104.70	106.38	106.38	106.59	0.005370	2.17	15.56	52.51	0.73
GlenOaks	2843.745	10Years	26.29	104.70	106.48	106.48	106.68	0.005003	2.24	21.31	64.94	0.72
GlenOaks	2843.745	25Years	32.80	104.70	106.57	106.57	106.78	0.004975	2.36	27.51	80.40	0.73
GlenOaks	2843.745	50Years	36.25	104.70	106.61	106.61	106.82	0.004949	2.41	30.95	89.01	0.73
GlenOaks	2843.745	100Years	44.70	104.70	106.69	106.69	106.91	0.004869	2.52	39.19	98.13	0.73
GlenOaks	2843.745	Regional	44.70	104.70	106.69	106.69	106.91	0.004869	2.52	39.19	98.13	0.73
GlenOaks	2799.999	2Years	13.42	104.50	105.77	105.63	105.93	0.004939	1.79	8.48	21.19	0.69
GlenOaks	2799.999	5Years	20.88	104.50	105.98	105.87	106.17	0.004742	2.01	14.21	38.79	0.70
GlenOaks	2799.999	10Years	26.29	104.50	106.10	105.98	106.29	0.004378	2.07	19.66	48.87	0.68
GlenOaks	2799.999	25Years	32.80	104.50	106.23	106.14	106.41	0.003966	2.09	26.42	57.25	0.66
GlenOaks	2799.999	50Years	36.25	104.50	106.29		106.47	0.003767	2.09	30.07	60.90	0.65
GlenOaks	2799.999	100Years	44.70	104.50	106.44		106.60	0.003303	2.08	39.67	71.29	0.62
GlenOaks	2799.999	Regional	44.70	104.50	106.44		106.60	0.003303	2.08	39.67	71.29	0.62
GlenOaks	2699.999	2Years	13.42	103.92	104.97	104.96	105.23	0.010730	2.26	5.93	10.94	0.98
GlenOaks	2699.999	5Years	20.88	103.92	105.17	105.17	105.49	0.010361	2.52	8.30	12.71	0.99
GlenOaks	2699.999	10Years	26.29	103.92	105.28	105.28	105.65	0.009992	2.67	9.88	14.35	1.00
GlenOaks	2699.999	25Years	32.80	103.92	105.41	105.41	105.82	0.009122	2.83	11.85	16.93	0.98
GlenOaks	2699.999	50Years	36.25	103.92	105.47	105.47	105.90	0.008781	2.91	12.94	18.11	0.97
GlenOaks	2699.999	100Years	44.70	103.92	105.62	105.62	106.09	0.008012	3.07	15.79	21.19	0.95
GlenOaks	2699.999	Regional	44.70	103.92	105.62	105.62	106.09	0.008012	3.07	15.79	21.19	0.95
GlenOaks	2593.551	2Years	13.42	103.00	103.87	103.87	104.12	0.010011	2.23	6.64	15.58	0.95
GlenOaks	2593.551	5Years	20.88	103.00	104.06	104.06	104.36	0.008773	2.53	9.78	18.42	0.94
GlenOaks	2593.551	10Years	26.29	103.00	104.17	104.17	104.51	0.008384	2.71	11.90	19.95	0.94
GlenOaks	2593.551	25Years	32.80	103.00	104.30	104.30	104.67	0.007542	2.84	14.74	21.54	0.91

HEC-RAS Plan: realigned River: 14Mile Reach: GlenOaks (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
GlenOaks	2593.551	50Years	36.25	103.00	104.36	104.36	104.75	0.007495	2.93	15.93	21.76	0.92
GlenOaks	2593.551	100Years	44.70	103.00	104.48	104.48	104.92	0.007511	3.16	18.60	22.24	0.93
GlenOaks	2593.551	Regional	44.70	103.00	104.48	104.48	104.92	0.007511	3.16	18.60	22.24	0.93
GlenOaks	2532.899	2Years	13.42	102.68	103.91	103.41	103.93	0.000515	0.71	30.45	62.45	0.24
GlenOaks	2532.899	5Years	20.88	102.68	104.09	103.57	104.12	0.000566	0.84	42.29	68.01	0.26
GlenOaks	2532.899	10Years	26.29	102.68	104.18	103.64	104.21	0.000635	0.94	48.64	70.84	0.28
GlenOaks	2532.899	25Years	32.80	102.68	104.43	103.72	104.45	0.000293	0.73	104.31	171.68	0.19
GlenOaks	2532.899	50Years	36.25	102.68	104.46	103.76	104.48	0.000315	0.76	109.95	172.08	0.20
GlenOaks	2532.899	100Years	44.70	102.68	104.53	103.76	104.55	0.000370	0.85	121.89	172.91	0.22
GlenOaks	2532.899	Regional	44.70	102.68	104.53	103.76	104.55	0.000370	0.85	121.89	172.91	0.22
GlenOaks	2477.264	2Years	13.42	102.67	103.65	103.65	103.84	0.007738	2.16	10.28	31.59	0.86
GlenOaks	2477.264	5Years	20.88	102.67	103.79	103.79	104.02	0.008180	2.52	15.20	53.87	0.91
GlenOaks	2477.264	10Years	26.29	102.67	103.92	103.79	104.12	0.006066	2.42	23.38	62.11	0.81
GlenOaks	2477.264	25Years	32.80	102.67	104.41	103.79	104.43	0.000504	0.93	104.13	182.66	0.25
GlenOaks	2477.264	50Years	36.25	102.67	104.44	103.79	104.46	0.000530	0.96	109.98	184.24	0.26
GlenOaks	2477.264	100Years	44.70	102.67	104.51	104.10	104.53	0.000599	1.06	122.36	187.66	0.28
GlenOaks	2477.264	Regional	44.70	102.67	104.51	104.10	104.53	0.000599	1.06	122.36	187.66	0.28
GlenOaks	2337	2Years	13.42	101.17	102.75		102.87	0.004260	1.95	14.51	35.33	0.56
GlenOaks	2337	5Years	20.88	101.17	103.47		103.49	0.000628	0.99	50.56	67.61	0.23
GlenOaks	2337	10Years	26.29	101.17	103.92		103.93	0.000266	0.74	88.35	96.58	0.15
GlenOaks	2337	25Years	32.80	101.17	104.37		104.38	0.000122	0.56	134.64	105.71	0.11
GlenOaks	2337	50Years	36.25	101.17	104.40		104.41	0.000140	0.61	137.47	105.71	0.11
GlenOaks	2337	100Years	44.70	101.17	104.45		104.46	0.000189	0.71	143.08	105.71	0.13
GlenOaks	2337	Regional	44.70	101.17	104.45		104.46	0.000189	0.71	143.08	105.71	0.13
GlenOaks	2320.843	2Years	13.42	100.95	102.78	101.70	102.81	0.000341	0.83	19.03	123.19	0.20
GlenOaks	2320.843	5Years	20.88	100.95	103.44	101.94	103.48	0.000256	0.89	27.79	168.17	0.18
GlenOaks	2320.843	10Years	26.29	100.95	103.87	102.08	103.91	0.000226	0.93	33.48	204.30	0.18
GlenOaks	2320.843	25Years	32.80	100.95	104.38	102.23	104.38	0.000011	0.23	382.71	267.05	0.04
GlenOaks	2320.843	50Years	36.25	100.95	104.40	102.31	104.40	0.000014	0.26	389.91	267.25	0.05
GlenOaks	2320.843	100Years	44.70	100.95	104.46	102.46	104.46	0.000019	0.30	404.28	267.25	0.05
GlenOaks	2320.843	Regional	44.70	100.95	104.46	102.46	104.46	0.000019	0.30	404.28	267.25	0.05
GlenOaks	2307.157		Culvert									
GlenOaks	2295.416	2Years	13.42	100.69	101.64	101.64	102.07	0.009456	2.93	4.73	83.17	1.01
GlenOaks	2295.416	5Years	20.88	100.69	101.93	101.93	102.51	0.008635	3.41	6.34	138.94	1.01
GlenOaks	2295.416	10Years	26.29	100.69	102.12	102.12	102.79	0.008167	3.67	7.40	235.21	1.01
GlenOaks	2295.416	25Years	32.80	100.69	102.34	102.34	103.12	0.007779	3.95	8.58	250.45	1.01
GlenOaks	2295.416	50Years	36.25	100.69	102.44	102.44	103.28	0.007631	4.09	9.16	250.81	1.01
GlenOaks	2295.416	100Years	44.70	100.69	102.69	102.69	103.65	0.007283	4.39	10.54	251.66	1.01
GlenOaks	2295.416	Regional	44.70	100.69	102.69	102.69	103.65	0.007283	4.39	10.54	251.66	1.01
GlenOaks	2281.974	2Years	13.42	100.28	101.42	101.42	101.66	0.007227	2.34	8.29	22.29	0.83
GlenOaks	2281.974	5Years	20.88	100.28	101.62	101.62	101.89	0.006634	2.60	13.62	30.62	0.83
GlenOaks	2281.974	10Years	26.29	100.28	101.73	101.73	102.02	0.006368	2.74	17.48	35.53	0.82
GlenOaks	2281.974	25Years	32.80	100.28	101.84	101.84	102.15	0.006398	2.92	21.66	40.37	0.84
GlenOaks	2281.974	50Years	36.25	100.28	101.91	101.91	102.06	0.003755	2.32	42.69	107.01	0.65
GlenOaks	2281.974	100Years	44.70	100.28	101.99	101.95	102.13	0.003770	2.41	50.77	108.42	0.66
GlenOaks	2281.974	Regional	44.70	100.28	101.99	101.95	102.13	0.003770	2.41	50.77	108.42	0.66
GlenOaks	2246.37	2Years	13.42	99.68	101.19	101.19	101.47	0.001496	2.73	13.99	32.37	0.79
GlenOaks	2246.37	5Years	20.88	99.68	101.52	101.52	101.71	0.000941	2.54	37.97	93.63	0.65
GlenOaks	2246.37	10Years	26.29	99.68	101.59	101.59	101.80	0.001043	2.77	45.31	97.44	0.69
GlenOaks	2246.37	25Years	32.80	99.68	101.66	101.66	101.89	0.001198	3.05	52.28	101.44	0.75
GlenOaks	2246.37	50Years	36.25	99.68	101.70	101.70	101.94	0.001244	3.16	56.42	104.98	0.76
GlenOaks	2246.37	100Years	44.70	99.68	101.79	101.79	102.04	0.001346	3.39	65.99	112.72	0.80
GlenOaks	2246.37	Regional	44.70	99.68	101.79	101.79	102.04	0.001346	3.39	65.99	112.72	0.80
GlenOaks	2230.806	2Years	13.42	100.00	101.15	101.15	101.31	0.005901	1.92	11.84	51.57	0.75
GlenOaks	2230.806	5Years	20.88	100.00	101.29	101.29	101.46	0.005642	2.13	20.74	80.27	0.76
GlenOaks	2230.806	10Years	26.29	100.00	101.37	101.37	101.53	0.005440	2.22	27.62	97.79	0.76
GlenOaks	2230.806	25Years	32.80	100.00	101.57		101.65	0.002544	1.75	52.75	154.17	0.53
GlenOaks	2230.806	50Years	36.25	100.00	101.44	101.44	101.64	0.006460	2.56	35.57	114.73	0.83
GlenOaks	2230.806	100Years	44.70	100.00	101.54	101.54	101.72	0.005464	2.52	49.03	147.38	0.78
GlenOaks	2230.806	Regional	44.70	100.00	101.54	101.54	101.72	0.005464	2.52	49.03	147.38	0.78
GlenOaks	2167	2Years	13.42	98.77	99.93	99.93	100.41	0.002171	3.13	5.62	7.44	0.98
GlenOaks	2167	5Years	20.88	98.77	100.27	100.27	100.88	0.001928	3.57	8.42	8.83	0.97
GlenOaks	2167	10Years	26.29	98.77	100.45	100.45	101.18	0.002017	3.95	10.00	9.53	1.01
GlenOaks	2167	25Years	32.80	98.77	100.77	100.77	101.47	0.001536	3.92	17.86	38.39	0.91
GlenOaks	2167	50Years	36.25	98.77	101.17	101.17	101.46	0.000622	2.84	53.00	100.49	0.60
GlenOaks	2167	100Years	44.70	98.77	101.28	101.28	101.59	0.000684	3.07	63.52	100.49	0.63

HEC-RAS Plan: realigned   River: 14Mile   Reach: GlenOaks (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
GlenOaks	2167	Regional	44.70	98.77	101.28	101.28	101.59	0.000684	3.07	63.52	100.49	0.63
GlenOaks	2155.5	2Years	13.42	98.45	99.58	99.58	99.91	0.009901	2.56	5.46	8.87	0.98
GlenOaks	2155.5	5Years	20.88	98.45	100.03	99.81	100.31	0.004448	2.38	9.42	10.50	0.71
GlenOaks	2155.5	10Years	26.29	98.45	100.44	99.96	100.67	0.002447	2.17	13.17	12.06	0.56
GlenOaks	2155.5	25Years	32.80	98.45	100.92	100.13	101.12	0.001528	2.05	17.50	21.05	0.46
GlenOaks	2155.5	50Years	36.25	98.45	100.97	100.21	101.20	0.001725	2.21	17.93	48.38	0.49
GlenOaks	2155.5	100Years	44.70	98.45	100.99	100.40	101.34	0.002516	2.69	18.16	49.91	0.59
GlenOaks	2155.5	Regional	44.70	98.45	100.99	100.40	101.34	0.002516	2.69	18.16	49.91	0.59
GlenOaks	2141.697		Culvert									
GlenOaks	2126.4	2Years	13.42	97.48	99.44	98.48	99.52	0.000898	1.21	11.31	9.58	0.30
GlenOaks	2126.4	5Years	20.88	97.48	99.70	98.75	99.84	0.001339	1.63	13.19	10.70	0.37
GlenOaks	2126.4	10Years	26.29	97.48	99.88	98.93	100.05	0.001592	1.88	14.44	11.45	0.41
GlenOaks	2126.4	25Years	32.80	97.48	100.07	99.13	100.30	0.001846	2.14	15.83	12.29	0.45
GlenOaks	2126.4	50Years	36.25	97.48	100.19	99.23	100.44	0.001898	2.24	16.70	12.81	0.46
GlenOaks	2126.4	100Years	44.70	97.48	100.45	99.45	100.76	0.002038	2.49	18.60	13.95	0.48
GlenOaks	2126.4	Regional	44.70	97.48	100.45	99.45	100.76	0.002038	2.49	18.60	13.95	0.48
GlenOaks	2120.26	2Years	13.42	97.71	99.39	98.82	99.50	0.001984	1.47	9.13	8.41	0.45
GlenOaks	2120.26	5Years	20.88	97.71	99.64	99.11	99.81	0.002645	1.84	11.38	9.28	0.53
GlenOaks	2120.26	10Years	26.29	97.71	99.83	99.29	100.03	0.002817	1.99	13.19	9.93	0.55
GlenOaks	2120.26	25Years	32.80	97.71	100.06	99.47	100.28	0.002828	2.11	15.52	10.71	0.56
GlenOaks	2120.26	50Years	36.25	97.71	100.19	99.56	100.42	0.002733	2.14	16.93	11.15	0.55
GlenOaks	2120.26	100Years	44.70	97.71	100.47	99.76	100.72	0.002571	2.21	20.25	12.13	0.55
GlenOaks	2120.26	Regional	44.70	97.71	100.47	99.76	100.72	0.002571	2.21	20.25	12.13	0.55
GlenOaks	2106.268	2Years	13.42	97.84	99.11	99.11	99.42	0.010885	2.49	5.40	8.56	1.00
GlenOaks	2106.268	5Years	20.88	97.84	99.46	99.35	99.74	0.007010	2.35	8.87	10.98	0.84
GlenOaks	2106.268	10Years	26.29	97.84	99.74	99.49	99.98	0.004445	2.18	12.15	12.82	0.69
GlenOaks	2106.268	25Years	32.80	97.84	100.01	99.64	100.24	0.003058	2.12	15.94	14.58	0.60
GlenOaks	2106.268	50Years	36.25	97.84	100.15	99.71	100.38	0.002625	2.11	18.05	15.46	0.56
GlenOaks	2106.268	100Years	44.70	97.84	100.45	99.86	100.68	0.002064	2.12	22.97	19.81	0.51
GlenOaks	2106.268	Regional	44.70	97.84	100.45	99.86	100.68	0.002064	2.12	22.97	19.81	0.51
GlenOaks	2098.17*	2Years	13.42	97.66	99.06		99.28	0.006240	2.08	6.45	8.93	0.77
GlenOaks	2098.17*	5Years	20.88	97.66	99.48		99.69	0.003297	2.02	10.80	11.66	0.60
GlenOaks	2098.17*	10Years	26.29	97.66	99.73		99.94	0.002639	2.07	14.28	22.02	0.56
GlenOaks	2098.17*	25Years	32.80	97.66	100.02		100.21	0.001926	2.01	22.91	35.67	0.49
GlenOaks	2098.17*	50Years	36.25	97.66	100.18		100.35	0.001612	1.94	28.96	43.64	0.46
GlenOaks	2098.17*	100Years	44.70	97.66	100.51		100.64	0.001117	1.81	46.25	61.33	0.39
GlenOaks	2098.17*	Regional	44.70	97.66	100.51		100.64	0.001117	1.81	46.25	61.33	0.39
GlenOaks	2090.07*	2Years	13.42	97.48	99.04	98.76	99.23	0.003401	1.97	8.23	16.91	0.60
GlenOaks	2090.07*	5Years	20.88	97.48	99.50	99.11	99.65	0.001862	1.85	17.98	25.42	0.47
GlenOaks	2090.07*	10Years	26.29	97.48	99.78		99.90	0.001421	1.80	25.68	30.79	0.43
GlenOaks	2090.07*	25Years	32.80	97.48	100.07		100.18	0.001121	1.76	35.40	36.57	0.39
GlenOaks	2090.07*	50Years	36.25	97.48	100.21		100.32	0.001015	1.76	40.97	40.94	0.37
GlenOaks	2090.07*	100Years	44.70	97.48	100.52		100.62	0.000846	1.75	55.81	55.00	0.35
GlenOaks	2090.07*	Regional	44.70	97.48	100.52		100.62	0.000846	1.75	55.81	55.00	0.35
GlenOaks	2081.98	2Years	13.42	97.30	98.75	98.75	99.17	0.008035	3.10	6.03	8.11	0.91
GlenOaks	2081.98	5Years	20.88	97.30	99.06	99.06	99.58	0.007718	3.56	8.80	9.42	0.92
GlenOaks	2081.98	10Years	26.29	97.30	99.26	99.26	99.84	0.007546	3.81	10.70	10.19	0.93
GlenOaks	2081.98	25Years	32.80	97.30	99.47	99.47	100.11	0.007406	4.08	12.91	11.02	0.94
GlenOaks	2081.98	50Years	36.25	97.30	99.54	99.54	100.24	0.007836	4.30	13.69	11.34	0.98
GlenOaks	2081.98	100Years	44.70	97.30	99.80	99.80	100.54	0.007246	4.49	16.90	13.00	0.96
GlenOaks	2081.98	Regional	44.70	97.30	99.80	99.80	100.54	0.007246	4.49	16.90	13.00	0.96
GlenOaks	2061.48*	2Years	13.42	97.23	98.79	98.57	98.99	0.003482	2.12	9.31	18.22	0.62
GlenOaks	2061.48*	5Years	20.88	97.23	99.18		99.35	0.002323	2.09	18.03	25.93	0.53
GlenOaks	2061.48*	10Years	26.29	97.23	99.33		99.51	0.002415	2.26	22.07	28.75	0.55
GlenOaks	2061.48*	25Years	32.80	97.23	99.41		99.65	0.002971	2.59	24.65	30.37	0.61
GlenOaks	2061.48*	50Years	36.25	97.23	99.45		99.72	0.003312	2.77	25.76	31.20	0.65
GlenOaks	2061.48*	100Years	44.70	97.23	99.51	99.39	99.87	0.004377	3.25	27.63	32.94	0.75
GlenOaks	2061.48*	Regional	44.70	97.23	99.51	99.39	99.87	0.004377	3.25	27.63	32.94	0.75
GlenOaks	2040.99*	2Years	13.42	97.15	98.75	98.39	98.91	0.002771	1.84	8.62	19.29	0.55
GlenOaks	2040.99*	5Years	20.88	97.15	99.16		99.30	0.001758	1.80	19.65	34.95	0.46
GlenOaks	2040.99*	10Years	26.29	97.15	99.31		99.46	0.001756	1.92	25.60	41.98	0.47
GlenOaks	2040.99*	25Years	32.80	97.15	99.40		99.59	0.002132	2.18	29.47	46.65	0.52
GlenOaks	2040.99*	50Years	36.25	97.15	99.44		99.64	0.002353	2.32	31.26	49.09	0.55
GlenOaks	2040.99*	100Years	44.70	97.15	99.50	99.34	99.77	0.003006	2.69	34.58	53.42	0.62
GlenOaks	2040.99*	Regional	44.70	97.15	99.50	99.34	99.77	0.003006	2.69	34.58	53.42	0.62

HEC-RAS Plan: realigned River: 14Mile Reach: GlenOaks (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
GlenOaks	2020.49*	2Years	13.42	97.08	98.73		98.85	0.002055	1.55	9.08	10.25	0.47
GlenOaks	2020.49*	5Years	20.88	97.08	99.14		99.26	0.001522	1.64	18.75	44.69	0.43
GlenOaks	2020.49*	10Years	26.29	97.08	99.29		99.42	0.001463	1.72	26.67	54.68	0.43
GlenOaks	2020.49*	25Years	32.80	97.08	99.38		99.54	0.001757	1.95	31.67	61.92	0.47
GlenOaks	2020.49*	50Years	36.25	97.08	99.42		99.59	0.001919	2.07	34.05	65.31	0.50
GlenOaks	2020.49*	100Years	44.70	97.08	99.48		99.70	0.002383	2.36	38.51	69.69	0.56
GlenOaks	2020.49*	Regional	44.70	97.08	99.48		99.70	0.002383	2.36	38.51	69.69	0.56
GlenOaks	2000	2Years	13.42	97.00	98.71	98.21	98.81	0.001652	1.35	10.12	11.07	0.42
GlenOaks	2000	5Years	20.88	97.00	99.12	98.46	99.23	0.001300	1.49	16.05	41.14	0.40
GlenOaks	2000	10Years	26.29	97.00	99.27	98.60	99.39	0.001332	1.61	24.85	71.51	0.41
GlenOaks	2000	25Years	32.80	97.00	99.35	98.75	99.50	0.001612	1.84	31.25	86.42	0.45
GlenOaks	2000	50Years	36.25	97.00	99.39	98.83	99.55	0.001739	1.93	34.46	89.11	0.47
GlenOaks	2000	100Years	44.70	97.00	99.45	99.01	99.65	0.002143	2.20	40.06	93.09	0.53
GlenOaks	2000	Regional	44.70	97.00	99.45	99.01	99.65	0.002143	2.20	40.06	93.09	0.53
GlenOaks	1982.66*	2Years	13.42	96.83	98.67	98.26	98.77	0.002501	1.42	9.48	12.08	0.49
GlenOaks	1982.66*	5Years	20.88	96.83	99.10	98.52	99.20	0.001470	1.44	17.22	50.27	0.40
GlenOaks	1982.66*	10Years	26.29	96.83	99.26	98.65	99.37	0.001366	1.50	28.33	87.20	0.40
GlenOaks	1982.66*	25Years	32.80	96.83	99.35	98.79	99.47	0.001534	1.65	36.30	95.03	0.43
GlenOaks	1982.66*	50Years	36.25	96.83	99.39	98.86	99.51	0.001619	1.72	40.03	97.69	0.44
GlenOaks	1982.66*	100Years	44.70	96.83	99.45	99.28	99.60	0.001925	1.93	46.62	101.70	0.48
GlenOaks	1982.66*	Regional	44.70	96.83	99.45	99.28	99.60	0.001925	1.93	46.62	101.70	0.48
GlenOaks	1965.32*	2Years	13.42	96.66	98.52	98.21	98.70	0.005904	1.86	7.23	10.28	0.71
GlenOaks	1965.32*	5Years	20.88	96.66	99.07	98.60	99.17	0.001948	1.46	17.30	56.50	0.44
GlenOaks	1965.32*	10Years	26.29	96.66	99.25	98.73	99.34	0.001508	1.42	31.73	97.60	0.40
GlenOaks	1965.32*	25Years	32.80	96.66	99.34	98.86	99.43	0.001588	1.52	41.07	106.83	0.42
GlenOaks	1965.32*	50Years	36.25	96.66	99.38	98.92	99.48	0.001648	1.58	45.39	111.89	0.43
GlenOaks	1965.32*	100Years	44.70	96.66	99.44	99.26	99.56	0.001912	1.76	53.21	120.88	0.46
GlenOaks	1965.32*	Regional	44.70	96.66	99.44	99.26	99.56	0.001912	1.76	53.21	120.88	0.46
GlenOaks	1947.99*	2Years	13.42	96.48	98.15	97.96	98.54	0.010549	2.77	4.85	4.69	0.87
GlenOaks	1947.99*	5Years	20.88	96.48	98.92	98.48	99.12	0.003712	2.01	11.98	24.70	0.58
GlenOaks	1947.99*	10Years	26.29	96.48	99.12	98.71	99.29	0.002964	1.98	23.59	97.58	0.53
GlenOaks	1947.99*	25Years	32.80	96.48	99.23	99.17	99.39	0.002797	2.02	36.05	125.05	0.52
GlenOaks	1947.99*	50Years	36.25	96.48	99.22	99.22	99.43	0.003515	2.26	35.29	123.58	0.58
GlenOaks	1947.99*	100Years	44.70	96.48	99.31	99.31	99.51	0.003535	2.35	47.18	144.97	0.59
GlenOaks	1947.99*	Regional	44.70	96.48	99.31	99.31	99.51	0.003535	2.35	47.18	144.97	0.59
GlenOaks	1930.658	2Years	13.42	96.31	98.02	97.70	98.38	0.007791	2.63	5.10	3.61	0.71
GlenOaks	1930.658	5Years	20.88	96.31	98.75	98.13	99.03	0.006061	2.36	8.86	7.44	0.69
GlenOaks	1930.658	10Years	26.29	96.31	99.08	98.57	99.23	0.003312	1.89	31.31	197.10	0.53
GlenOaks	1930.658	25Years	32.80	96.31	99.28	99.16	99.33	0.001309	1.31	72.14	217.16	0.34
GlenOaks	1930.658	50Years	36.25	96.31	99.27	99.18	99.33	0.001691	1.48	70.25	215.96	0.39
GlenOaks	1930.658	100Years	44.70	96.31	99.32	99.23	99.39	0.001857	1.59	81.82	224.51	0.41
GlenOaks	1930.658	Regional	44.70	96.31	99.32	99.23	99.39	0.001857	1.59	81.82	224.51	0.41
GlenOaks	1921.384	2Years	13.42	96.19	97.62	97.62	98.21	0.014618	3.40	3.95	3.52	1.01
GlenOaks	1921.384	5Years	20.88	96.19	98.04	98.04	98.80	0.013989	3.87	5.39	3.93	1.00
GlenOaks	1921.384	10Years	26.29	96.19	98.91	98.91	99.17	0.003609	2.46	21.19	69.93	0.53
GlenOaks	1921.384	25Years	32.80	96.19	99.06	99.06	99.26	0.003086	2.37	38.83	194.08	0.49
GlenOaks	1921.384	50Years	36.25	96.19	99.18	99.18	99.30	0.002087	2.02	63.60	224.36	0.41
GlenOaks	1921.384	100Years	44.70	96.19	99.22	99.22	99.35	0.002408	2.19	73.72	231.59	0.44
GlenOaks	1921.384	Regional	44.70	96.19	99.22	99.22	99.35	0.002408	2.19	73.72	231.59	0.44
GlenOaks	1910.213		Culvert									
GlenOaks	1897.719	2Years	13.42	95.65	97.51	97.06	97.79	0.003915	2.37	5.66	4.53	0.60
GlenOaks	1897.719	5Years	20.88	95.65	97.54	97.44	98.21	0.008827	3.61	5.78	4.57	0.91
GlenOaks	1897.719	10Years	26.29	95.65	97.74	97.70	98.58	0.009550	4.06	6.48	4.80	0.96
GlenOaks	1897.719	25Years	32.80	95.65	98.87	98.72	99.02	0.001714	1.94	39.61	104.61	0.39
GlenOaks	1897.719	50Years	36.25	95.65	98.99	98.79	99.10	0.001386	1.80	53.45	132.71	0.35
GlenOaks	1897.719	100Years	44.70	95.65	98.90	98.90	99.14	0.002871	2.53	42.68	108.30	0.51
GlenOaks	1897.719	Regional	44.70	95.65	98.90	98.90	99.14	0.002871	2.53	42.68	108.30	0.51
GlenOaks	1889.709	2Years	13.42	95.58	97.08	97.08	97.60	0.012978	3.19	4.20	4.04	1.00
GlenOaks	1889.709	5Years	20.88	95.58	97.47	97.47	98.11	0.012793	3.56	5.87	4.59	1.00
GlenOaks	1889.709	10Years	26.29	95.58	97.71	97.71	98.43	0.012496	3.74	7.03	4.93	1.00
GlenOaks	1889.709	25Years	32.80	95.58	98.21	98.21	98.75	0.011624	3.26	10.05	9.25	1.00
GlenOaks	1889.709	50Years	36.25	95.58	98.36	98.36	98.85	0.011302	3.10	11.70	11.93	1.00
GlenOaks	1889.709	100Years	44.70	95.58	98.70	98.70	98.92	0.005024	2.23	33.39	96.65	0.69
GlenOaks	1889.709	Regional	44.70	95.58	98.70	98.70	98.92	0.005024	2.23	33.39	96.65	0.69
GlenOaks	1799.999	2Years	13.42	94.57	96.02	95.79	96.14	0.004060	1.52	8.92	15.88	0.61
GlenOaks	1799.999	5Years	20.88	94.57	96.34	96.00	96.44	0.002468	1.47	16.09	29.79	0.50

HEC-RAS Plan: realigned River: 14Mile Reach: GlenOaks (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
GlenOaks	1799.999	10Years	26.29	94.57	96.47	96.13	96.59	0.002281	1.56	20.53	35.56	0.50
GlenOaks	1799.999	25Years	32.80	94.57	96.83	96.25	96.90	0.001085	1.31	35.28	46.98	0.36
GlenOaks	1799.999	50Years	36.25	94.57	96.67	96.31	96.81	0.002158	1.71	28.33	42.46	0.50
GlenOaks	1799.999	100Years	44.70	94.57	96.74	96.42	96.91	0.002672	1.97	31.08	44.31	0.56
GlenOaks	1799.999	Regional	44.70	94.57	97.40	96.42	97.45	0.000481	1.11	73.08	97.74	0.25
GlenOaks	1742.723	2Years	18.58	93.99	95.60	95.33	95.77	0.004377	1.85	10.09	13.18	0.65
GlenOaks	1742.723	5Years	28.32	93.99	96.16	95.60	96.28	0.001674	1.58	22.00	38.84	0.44
GlenOaks	1742.723	10Years	34.73	93.99	96.29	95.73	96.43	0.001675	1.69	27.61	41.99	0.45
GlenOaks	1742.723	25Years	42.77	93.99	96.75	95.88	96.83	0.000800	1.39	49.09	53.75	0.32
GlenOaks	1742.723	50Years	48.86	93.99	96.34	96.00	96.58	0.002885	2.26	29.70	43.10	0.59
GlenOaks	1742.723	100Years	54.24	93.99	96.35	96.15	96.64	0.003479	2.49	30.04	43.27	0.65
GlenOaks	1742.723	Regional	105.80	93.99	96.71	96.71	97.24	0.005305	3.55	47.23	52.77	0.83
GlenOaks	1715.436	2Years	18.58	93.87	95.31	94.96	95.62	0.003410	2.48	7.49	6.94	0.66
GlenOaks	1715.436	5Years	28.32	93.87	95.50	95.32	96.07	0.005217	3.34	8.49	9.99	0.83
GlenOaks	1715.436	10Years	34.73	93.87	96.31	95.92	96.35	0.000901	1.16	65.43	137.53	0.30
GlenOaks	1715.436	25Years	42.77	93.87	96.77	96.03	96.78	0.000258	0.74	144.13	202.89	0.17
GlenOaks	1715.436	50Years	48.86	93.87	96.38	96.09	96.44	0.001346	1.46	75.41	147.40	0.37
GlenOaks	1715.436	100Years	54.24	93.87	96.40	96.13	96.47	0.001535	1.57	78.37	150.20	0.40
GlenOaks	1715.436	Regional	105.80	93.87	96.43	96.43	96.69	0.005089	2.91	83.83	155.24	0.73
GlenOaks	1702.377		Bridge									
GlenOaks	1687.450	2Years	18.58	93.62	94.90	94.72	95.31	0.005191	2.82	6.60	8.58	0.80
GlenOaks	1687.450	5Years	28.32	93.62	95.08	95.08	95.80	0.007770	3.76	7.53	9.25	1.00
GlenOaks	1687.450	10Years	34.73	93.62	95.29	95.29	96.12	0.007428	4.03	8.63	10.06	1.00
GlenOaks	1687.450	25Years	42.77	93.62	95.54	95.54	96.49	0.007110	4.32	9.90	11.01	1.00
GlenOaks	1687.450	50Years	48.86	93.62	95.71	95.71	96.22	0.005090	3.16	15.58	21.16	0.80
GlenOaks	1687.450	100Years	54.24	93.62	95.95	95.95	96.28	0.003714	2.62	29.48	89.73	0.65
GlenOaks	1687.450	Regional	105.80	93.62	96.39	96.39	96.69	0.003319	2.90	86.30	161.23	0.64
GlenOaks	1660.15	2Years	18.58	93.32	94.84	94.84	95.08	0.005391	2.43	13.93	37.95	0.72
GlenOaks	1660.15	5Years	28.32	93.32	95.07	95.07	95.28	0.004530	2.51	25.13	58.76	0.68
GlenOaks	1660.15	10Years	34.73	93.32	95.14	95.14	95.37	0.004879	2.69	29.49	61.87	0.71
GlenOaks	1660.15	25Years	42.77	93.32	95.22	95.22	95.46	0.005250	2.89	34.49	65.26	0.74
GlenOaks	1660.15	50Years	48.86	93.32	95.27	95.27	95.53	0.005511	3.03	37.99	67.52	0.77
GlenOaks	1660.15	100Years	54.24	93.32	95.31	95.31	95.58	0.005704	3.14	40.99	69.41	0.78
GlenOaks	1660.15	Regional	105.80	93.32	95.72	95.63	96.00	0.005396	3.54	73.20	87.11	0.79
GlenOaks	1626.345	2Years	18.58	93.00	94.28	94.28	94.52	0.007179	2.24	10.17	29.89	0.84
GlenOaks	1626.345	5Years	28.32	93.00	94.47	94.47	94.74	0.006304	2.46	16.49	35.36	0.82
GlenOaks	1626.345	10Years	34.73	93.00	94.56	94.56	94.86	0.006316	2.62	19.77	36.49	0.83
GlenOaks	1626.345	25Years	42.77	93.00	94.66	94.66	94.99	0.006444	2.82	23.39	37.60	0.86
GlenOaks	1626.345	50Years	48.86	93.00	94.73	94.73	95.08	0.006483	2.94	26.02	38.29	0.87
GlenOaks	1626.345	100Years	54.24	93.00	94.78	94.78	95.16	0.006635	3.07	28.04	38.81	0.88
GlenOaks	1626.345	Regional	105.80	93.00	95.22	95.22	95.77	0.007130	3.90	46.54	46.26	0.96
GlenOaks	1602.427	2Years	18.58	93.00	94.10	94.05	94.29	0.005663	2.06	12.29	31.97	0.76
GlenOaks	1602.427	5Years	28.32	93.00	94.23	94.23	94.50	0.006669	2.49	17.03	37.83	0.85
GlenOaks	1602.427	10Years	34.73	93.00	94.33	94.33	94.61	0.006280	2.60	20.91	39.16	0.84
GlenOaks	1602.427	25Years	42.77	93.00	94.42	94.42	94.73	0.006470	2.80	24.50	39.83	0.86
GlenOaks	1602.427	50Years	48.86	93.00	94.49	94.49	94.82	0.006569	2.93	27.07	40.30	0.88
GlenOaks	1602.427	100Years	54.24	93.00	94.54	94.54	94.89	0.006666	3.04	29.20	40.68	0.89
GlenOaks	1602.427	Regional	105.80	93.00	94.95	94.95	95.47	0.007209	3.86	46.71	43.67	0.97
GlenOaks	1518.067	2Years	18.58	92.00	93.31	93.31	93.64	0.010455	2.57	7.24	10.72	1.00
GlenOaks	1518.067	5Years	28.32	92.00	93.44	93.44	93.67	0.008150	2.42	18.16	37.95	0.89
GlenOaks	1518.067	10Years	34.73	92.00	93.52	93.52	93.77	0.008418	2.59	20.98	38.69	0.92
GlenOaks	1518.067	25Years	42.77	92.00	93.60	93.60	93.89	0.008773	2.79	24.16	39.57	0.95
GlenOaks	1518.067	50Years	48.86	92.00	93.65	93.65	93.97	0.009078	2.93	26.34	40.21	0.98
GlenOaks	1518.067	100Years	54.24	92.00	93.70	93.70	94.03	0.009394	3.06	28.07	40.71	1.00
GlenOaks	1518.067	Regional	105.80	92.00	93.97	93.97	94.61	0.013322	4.32	39.74	44.01	1.24
GlenOaks	1400	2Years	18.58	91.00	92.23	92.23	92.36	0.007071	2.05	19.08	60.91	0.81
GlenOaks	1400	5Years	28.32	91.00	92.37	92.32	92.49	0.006085	2.10	27.93	63.26	0.77
GlenOaks	1400	10Years	34.73	91.00	92.37	92.37	92.55	0.009204	2.58	27.87	63.25	0.95
GlenOaks	1400	25Years	42.77	91.00	92.43	92.43	92.63	0.009911	2.77	31.57	64.21	0.99
GlenOaks	1400	50Years	48.86	91.00	92.47	92.47	92.69	0.010531	2.92	33.99	64.83	1.03
GlenOaks	1400	100Years	54.24	91.00	92.53	92.50	92.73	0.009645	2.88	37.77	65.78	0.99
GlenOaks	1400	Regional	105.80	91.00	92.91	92.76	93.18	0.008594	3.44	65.33	85.44	0.99
GlenOaks	1299.999	2Years	18.58	90.14	91.26	91.26	91.55	0.008176	2.48	9.39	20.37	0.91
GlenOaks	1299.999	5Years	28.32	90.14	91.48	91.48	91.82	0.007144	2.75	14.47	25.65	0.89
GlenOaks	1299.999	10Years	34.73	90.14	91.58	91.58	91.73	0.003913	2.17	32.44	61.89	0.67
GlenOaks	1299.999	25Years	42.77	90.14	91.58	91.58	91.81	0.005933	2.68	32.44	61.89	0.82

HEC-RAS Plan: realigned River: 14Mile Reach: GlenOaks (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
GlenOaks	1299.999	50Years	48.86	90.14	91.63	91.63	91.88	0.006180	2.81	35.44	62.32	0.85
GlenOaks	1299.999	100Years	54.24	90.14	91.66	91.66	91.93	0.006676	2.97	37.29	62.60	0.88
GlenOaks	1299.999	Regional	105.80	90.14	91.99	91.99	92.37	0.007536	3.74	59.14	69.92	0.98
GlenOaks	1200	2Years	18.58	88.27	89.76	89.76	89.89	0.006129	2.14	21.15	66.77	0.75
GlenOaks	1200	5Years	28.32	88.27	89.84	89.84	90.01	0.008162	2.60	26.51	70.29	0.88
GlenOaks	1200	10Years	34.73	88.27	89.89	89.89	90.08	0.008750	2.80	30.29	73.00	0.92
GlenOaks	1200	25Years	42.77	88.27	89.95	89.95	90.15	0.009141	2.99	35.00	76.25	0.95
GlenOaks	1200	50Years	48.86	88.27	89.98	89.98	90.21	0.010202	3.22	37.19	77.81	1.01
GlenOaks	1200	100Years	54.24	88.27	90.05	90.05	90.27	0.009247	3.20	42.88	87.01	0.97
GlenOaks	1200	Regional	105.80	88.27	90.38	90.29	90.61	0.008408	3.62	74.04	105.42	0.97
GlenOaks	1144.426	2Years	18.58	86.82	88.77	88.61	88.88	0.003602	1.59	16.94	52.65	0.59
GlenOaks	1144.426	5Years	28.32	86.82	89.03	88.79	89.11	0.002147	1.50	34.82	83.13	0.47
GlenOaks	1144.426	10Years	34.73	86.82	89.18	88.86	89.25	0.001585	1.41	48.21	91.28	0.42
GlenOaks	1144.426	25Years	42.77	86.82	89.36	88.99	89.42	0.001207	1.35	65.49	104.59	0.37
GlenOaks	1144.426	50Years	48.86	86.82	89.49		89.54	0.001016	1.32	79.37	115.05	0.35
GlenOaks	1144.426	100Years	54.24	86.82	89.59		89.64	0.000936	1.33	92.99	138.61	0.34
GlenOaks	1144.426	Regional	105.80	86.82	90.45		90.48	0.000358	1.10	231.88	186.93	0.22
GlenOaks	1100	2Years	18.58	86.78	88.28	88.28	88.60	0.010679	2.50	7.42	11.49	1.00
GlenOaks	1100	5Years	28.32	86.78	88.51	88.51	88.90	0.009723	2.78	10.36	14.24	0.99
GlenOaks	1100	10Years	34.73	86.78	88.64	88.64	89.06	0.009229	2.90	12.35	15.83	0.98
GlenOaks	1100	25Years	42.77	86.78	88.77	88.77	89.25	0.008672	3.08	14.61	17.21	0.97
GlenOaks	1100	50Years	48.86	86.78	88.87	88.87	89.38	0.008332	3.20	16.30	18.11	0.97
GlenOaks	1100	100Years	54.24	86.78	88.95	88.95	89.49	0.008024	3.30	17.82	18.86	0.96
GlenOaks	1100	Regional	105.80	86.78	89.60	89.60	90.36	0.006674	4.00	31.83	24.68	0.94
GlenOaks	999.9999	2Years	18.58	85.00	86.68		86.84	0.004063	1.81	10.31	14.17	0.64
GlenOaks	999.9999	5Years	28.32	85.00	86.79	86.66	87.08	0.006117	2.40	12.35	21.62	0.80
GlenOaks	999.9999	10Years	34.73	85.00	86.95	86.82	87.25	0.005100	2.44	16.39	26.64	0.75
GlenOaks	999.9999	25Years	42.77	85.00	87.16	86.98	87.44	0.003917	2.41	22.31	29.88	0.68
GlenOaks	999.9999	50Years	48.86	85.00	87.32		87.58	0.003239	2.37	27.27	32.64	0.63
GlenOaks	999.9999	100Years	54.24	85.00	87.15	87.15	87.61	0.006606	3.11	21.84	29.59	0.88
GlenOaks	999.9999	Regional	105.80	85.00	87.70	87.70	88.31	0.005970	3.76	40.93	39.29	0.89
GlenOaks	937.8583	2Years	18.58	85.00	85.96	85.96	86.23	0.009910	2.32	8.65	17.97	0.96
GlenOaks	937.8583	5Years	28.32	85.00	86.10	86.10	86.34	0.008479	2.40	17.18	39.40	0.92
GlenOaks	937.8583	10Years	34.73	85.00	86.10	86.10	86.47	0.012751	2.94	17.18	39.40	1.12
GlenOaks	937.8583	25Years	42.77	85.00	86.10	86.10	86.66	0.019338	3.62	17.18	39.40	1.39
GlenOaks	937.8583	50Years	48.86	85.00	86.10	86.10	86.83	0.025237	4.14	17.18	39.40	1.58
GlenOaks	937.8583	100Years	54.24	85.00	86.37	86.37	86.70	0.008238	2.94	28.07	41.21	0.95
GlenOaks	937.8583	Regional	105.80	85.00	86.75	86.75	87.25	0.008426	3.72	44.46	43.79	1.02
GlenOaks	899.9999	2Years	18.58	84.00	84.75	84.73	85.00	0.009389	2.19	8.71	16.47	0.93
GlenOaks	899.9999	5Years	28.32	84.00	84.96	84.90	85.25	0.007657	2.43	12.25	17.92	0.89
GlenOaks	899.9999	10Years	34.73	84.00	85.07	85.01	85.40	0.007123	2.57	14.37	18.74	0.87
GlenOaks	899.9999	25Years	42.77	84.00	85.20	85.13	85.58	0.006764	2.74	16.85	19.65	0.87
GlenOaks	899.9999	50Years	48.86	84.00	85.29	85.21	85.70	0.006572	2.86	18.65	20.29	0.87
GlenOaks	899.9999	100Years	54.24	84.00	85.37	85.28	85.80	0.006426	2.96	20.22	20.83	0.87
GlenOaks	899.9999	Regional	105.80	84.00	85.92	85.88	86.61	0.006327	3.80	32.85	24.72	0.92
GlenOaks	799.9999	2Years	18.58	83.00	84.41		84.52	0.002520	1.46	12.85	16.57	0.51
GlenOaks	799.9999	5Years	28.32	83.00	84.63		84.79	0.002682	1.73	16.79	18.36	0.55
GlenOaks	799.9999	10Years	34.73	83.00	84.76		84.94	0.002787	1.89	19.08	19.32	0.57
GlenOaks	799.9999	25Years	42.77	83.00	84.89		85.11	0.002887	2.07	21.75	20.43	0.59
GlenOaks	799.9999	50Years	48.86	83.00	84.98		85.23	0.002954	2.20	23.69	21.20	0.60
GlenOaks	799.9999	100Years	54.24	83.00	85.06		85.33	0.003029	2.31	25.32	22.25	0.61
GlenOaks	799.9999	Regional	105.80	83.00	85.60	85.26	86.08	0.003651	3.14	41.77	36.79	0.71
GlenOaks	738.7840	2Years	18.58	83.02	83.96	83.96	84.24	0.009124	2.43	9.46	18.59	0.94
GlenOaks	738.7840	5Years	28.32	83.02	84.15	84.15	84.49	0.009027	2.77	13.13	20.56	0.97
GlenOaks	738.7840	10Years	34.73	83.02	84.26	84.26	84.64	0.008802	2.93	15.51	21.74	0.97
GlenOaks	738.7840	25Years	42.77	83.02	84.39	84.39	84.80	0.008673	3.11	18.30	23.04	0.98
GlenOaks	738.7840	50Years	48.86	83.02	84.47	84.47	84.92	0.008701	3.24	20.24	23.91	0.99
GlenOaks	738.7840	100Years	54.24	83.02	84.54	84.54	85.01	0.008678	3.34	21.96	24.65	0.99
GlenOaks	738.7840	Regional	105.80	83.02	85.11	85.11	85.74	0.008210	3.99	37.55	30.40	1.02
GlenOaks	667.8976	2Years	18.58	82.00	82.84	82.84	83.09	0.009140	2.27	9.78	23.62	0.93
GlenOaks	667.8976	5Years	28.32	82.00	83.01	83.01	83.32	0.008300	2.56	14.38	28.76	0.92
GlenOaks	667.8976	10Years	34.73	82.00	83.04	83.04	83.46	0.011185	3.04	15.14	31.01	1.08
GlenOaks	667.8976	25Years	42.77	82.00	83.27	83.27	83.57	0.006215	2.67	24.78	44.84	0.84
GlenOaks	667.8976	50Years	48.86	82.00	83.33	83.33	83.65	0.006183	2.78	27.78	45.51	0.84
GlenOaks	667.8976	100Years	54.24	82.00	83.53	83.38	83.75	0.003745	2.41	36.91	47.53	0.67
GlenOaks	667.8976	Regional	105.80	82.00	84.98	83.77	85.06	0.000642	1.64	117.88	63.87	0.32

HEC-RAS Plan: realigned River: 14Mile Reach: GlenOaks (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
GlenOaks	651.4387	2Years	18.58	81.00	82.35	81.74	82.39	0.000792	0.89	20.88	22.72	0.29
GlenOaks	651.4387	5Years	28.32	81.00	82.73	81.90	82.78	0.000611	0.96	29.88	25.12	0.27
GlenOaks	651.4387	10Years	34.73	81.00	82.96	82.00	83.01	0.000544	0.99	35.48	26.56	0.26
GlenOaks	651.4387	25Years	42.77	81.00	83.24	82.12	83.29	0.000471	1.03	42.21	29.86	0.25
GlenOaks	651.4387	50Years	48.86	81.00	83.43	82.19	83.49	0.000430	1.06	47.09	34.68	0.24
GlenOaks	651.4387	100Years	54.24	81.00	83.59	82.26	83.65	0.000403	1.08	51.28	38.28	0.24
GlenOaks	651.4387	Regional	105.80	81.00	84.97	82.75	85.05	0.000279	1.26	88.88	61.43	0.22
GlenOaks	631.6630		Bridge									
GlenOaks	612.3046	2Years	18.58	80.52	81.53	81.53	81.89	0.010168	2.65	7.00	11.63	1.00
GlenOaks	612.3046	5Years	28.32	80.52	81.77	81.77	82.23	0.009494	3.02	9.38	12.83	1.00
GlenOaks	612.3046	10Years	34.73	80.52	81.91	81.91	82.44	0.009122	3.20	10.85	13.58	1.00
GlenOaks	612.3046	25Years	42.77	80.52	82.08	82.08	82.67	0.008790	3.40	12.59	14.44	1.00
GlenOaks	612.3046	50Years	48.86	80.52	82.20	82.20	82.83	0.008577	3.53	13.86	15.06	1.00
GlenOaks	612.3046	100Years	54.24	80.52	82.29	82.29	82.97	0.008440	3.63	14.94	15.56	1.00
GlenOaks	612.3046	Regional	105.80	80.52	83.05	83.05	84.09	0.007331	4.53	23.36	20.16	1.00
GlenOaks	595.3819	2Years	18.58	80.00	81.39	81.06	81.51	0.002279	1.53	14.95	21.97	0.50
GlenOaks	595.3819	5Years	28.32	80.00	81.73	81.27	81.86	0.001821	1.67	23.47	28.68	0.47
GlenOaks	595.3819	10Years	34.73	80.00	81.89	81.38	82.04	0.001805	1.79	28.06	30.39	0.48
GlenOaks	595.3819	25Years	42.77	80.00	82.04	81.50	82.22	0.001874	1.95	32.96	32.11	0.49
GlenOaks	595.3819	50Years	48.86	80.00	82.15	81.59	82.34	0.001947	2.08	36.30	33.24	0.51
GlenOaks	595.3819	100Years	54.24	80.00	82.24	81.70	82.45	0.001967	2.16	39.51	34.53	0.51
GlenOaks	595.3819	Regional	105.80	80.00	82.91	82.30	83.26	0.002310	2.89	66.38	45.83	0.59
GlenOaks	570.5971	2Years	18.58	80.07	81.44		81.46	0.000354	0.60	31.00	32.67	0.20
GlenOaks	570.5971	5Years	28.32	80.07	81.79		81.81	0.000330	0.65	43.37	38.17	0.20
GlenOaks	570.5971	10Years	34.73	80.07	81.96		81.98	0.000340	0.70	49.89	40.78	0.20
GlenOaks	570.5971	25Years	42.77	80.07	82.13		82.16	0.000350	0.75	57.06	42.64	0.21
GlenOaks	570.5971	50Years	48.86	80.07	82.24		82.27	0.000357	0.79	61.97	43.53	0.21
GlenOaks	570.5971	100Years	54.24	80.07	82.35		82.38	0.000358	0.82	66.53	44.58	0.21
GlenOaks	570.5971	Regional	105.80	80.07	83.10		83.15	0.000401	1.02	103.37	53.63	0.24
GlenOaks	544.1928	2Years	18.12	79.76	80.99	80.99	81.34	0.010561	2.61	6.93	9.98	1.00
GlenOaks	544.1928	5Years	28.72	79.76	81.30	81.30	81.68	0.010262	2.75	10.46	13.62	1.00
GlenOaks	544.1928	10Years	35.45	79.76	81.45	81.45	81.84	0.010161	2.79	12.70	15.99	1.00
GlenOaks	544.1928	25Years	43.77	79.76	81.60	81.60	82.02	0.009998	2.85	15.36	18.54	1.00
GlenOaks	544.1928	50Years	49.99	79.76	81.70	81.70	82.13	0.009856	2.91	17.17	19.85	1.00
GlenOaks	544.1928	100Years	55.87	79.76	81.77	81.77	82.23	0.009677	2.99	18.66	20.40	1.00
GlenOaks	544.1928	Regional	108.70	79.76	82.31	82.31	82.95	0.008708	3.52	30.86	24.46	1.00
GlenOaks	538.303*	2Years	18.12	79.39	80.45	80.26	80.58	0.004144	1.60	11.36	17.47	0.62
GlenOaks	538.303*	5Years	28.72	79.39	80.72	80.44	80.88	0.003365	1.79	16.08	19.17	0.59
GlenOaks	538.303*	10Years	35.45	79.39	80.88	80.54	81.06	0.003079	1.88	18.83	20.15	0.58
GlenOaks	538.303*	25Years	43.77	79.39	81.06	80.66	81.26	0.002824	1.99	22.05	21.29	0.57
GlenOaks	538.303*	50Years	49.99	79.39	81.19	80.74	81.40	0.002699	2.06	24.30	22.08	0.56
GlenOaks	538.303*	100Years	55.87	79.39	81.31	80.81	81.53	0.002576	2.11	26.43	22.73	0.56
GlenOaks	538.303*	Regional	108.70	79.39	82.24	81.39	82.56	0.001970	2.49	43.60	26.17	0.52
GlenOaks	531.5748		Bridge									
GlenOaks	510.818*	2Years	18.12	78.88	80.09	79.70	80.17	0.001915	1.28	14.13	16.25	0.44
GlenOaks	510.818*	5Years	28.72	78.88	80.37	79.89	80.49	0.001985	1.53	18.82	16.92	0.46
GlenOaks	510.818*	10Years	35.45	78.88	80.52	80.00	80.66	0.002069	1.67	21.29	17.26	0.48
GlenOaks	510.818*	25Years	43.77	78.88	80.67	80.13	80.84	0.002164	1.83	23.92	18.02	0.50
GlenOaks	510.818*	50Years	49.99	78.88	80.76	80.21	80.96	0.002276	1.95	25.58	18.61	0.51
GlenOaks	510.818*	100Years	55.87	78.88	80.85	80.29	81.07	0.002368	2.06	27.07	19.59	0.53
GlenOaks	510.818*	Regional	108.70	78.88	81.18	80.88	81.74	0.004755	3.31	33.03	25.30	0.77
GlenOaks	501.0021	2Years	18.12	78.53	79.76	79.76	80.07	0.010703	2.47	7.32	11.78	1.00
GlenOaks	501.0021	5Years	28.72	78.53	80.01	80.01	80.38	0.010123	2.69	10.69	14.90	1.00
GlenOaks	501.0021	10Years	35.45	78.53	80.14	80.14	80.54	0.009718	2.82	12.65	16.59	1.00
GlenOaks	501.0021	25Years	43.77	78.53	80.28	80.28	80.72	0.009281	2.95	15.18	20.81	0.99
GlenOaks	501.0021	50Years	49.99	78.53	80.37	80.37	80.84	0.008638	3.03	17.43	24.92	0.97
GlenOaks	501.0021	100Years	55.87	78.53	80.46	80.46	80.95	0.008216	3.12	19.61	29.76	0.96
GlenOaks	501.0021	Regional	108.70	78.53	81.14	81.04	81.68	0.005069	3.41	47.59	48.27	0.82
GlenOaks	500.008*	2Years	18.12	78.50	79.69	79.21	79.77	0.001568	1.27	14.25	14.34	0.41
GlenOaks	500.008*	5Years	28.72	78.50	79.92	79.42	80.06	0.002124	1.62	17.68	15.37	0.48
GlenOaks	500.008*	10Years	35.45	78.50	80.03	79.54	80.20	0.002480	1.83	19.35	16.23	0.53
GlenOaks	500.008*	25Years	43.77	78.50	80.19	79.68	80.39	0.002549	2.00	22.06	17.50	0.54
GlenOaks	500.008*	50Years	49.99	78.50	80.34	79.78	80.55	0.002485	2.06	24.91	24.02	0.54
GlenOaks	500.008*	100Years	55.87	78.50	80.48	79.87	80.70	0.002238	2.08	28.00	32.37	0.52
GlenOaks	500.008*	Regional	108.70	78.50	81.32	80.57	81.60	0.001816	2.47	65.12	51.50	0.51

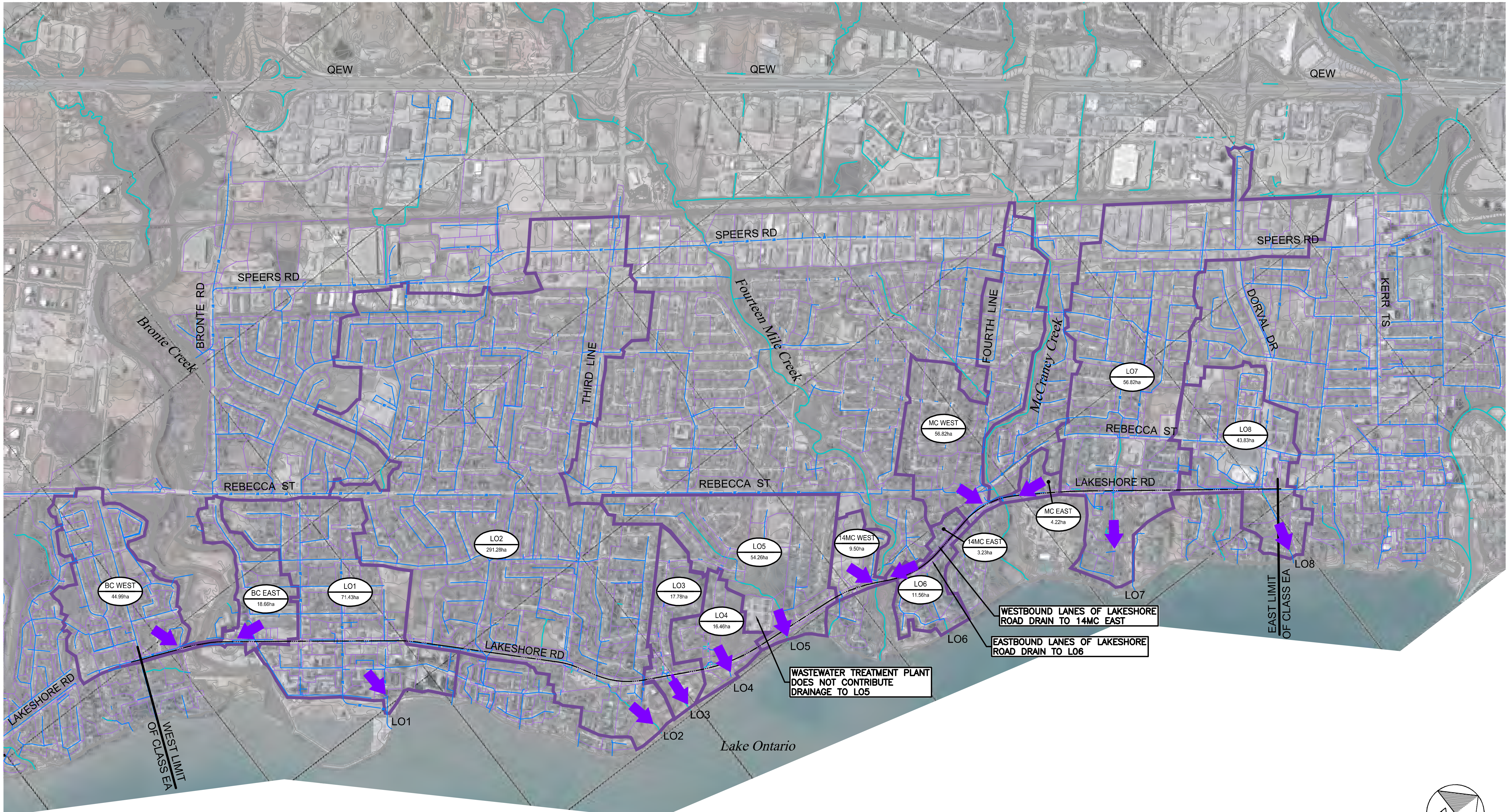
HEC-RAS Plan: realigned River: 14Mile Reach: GlenOaks (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
GlenOaks	500		Bridge									
GlenOaks	494.045*	2Years	18.12	78.45	79.69	79.16	79.76	0.001384	1.22	14.82	14.34	0.38
GlenOaks	494.045*	5Years	28.72	78.45	79.91	79.38	80.04	0.001945	1.58	18.22	15.80	0.46
GlenOaks	494.045*	10Years	35.45	78.45	80.01	79.49	80.18	0.002277	1.79	19.86	16.69	0.51
GlenOaks	494.045*	25Years	43.77	78.45	80.13	79.63	80.34	0.002631	2.03	21.85	18.81	0.55
GlenOaks	494.045*	50Years	49.99	78.45	80.21	79.73	80.45	0.002866	2.19	23.48	22.20	0.58
GlenOaks	494.045*	100Years	55.87	78.45	80.28	79.82	80.55	0.003119	2.32	25.18	24.87	0.61
GlenOaks	494.045*	Regional	108.70	78.45	80.70	80.55	81.28	0.004953	3.41	39.71	40.58	0.80
GlenOaks	448.3297	2Years	18.12	77.93	79.60		79.69	0.001681	1.35	15.56	27.78	0.43
GlenOaks	448.3297	5Years	28.72	77.93	79.78		79.93	0.002372	1.75	21.68	36.48	0.52
GlenOaks	448.3297	10Years	35.45	77.93	79.85		80.05	0.002990	2.02	24.18	39.08	0.59
GlenOaks	448.3297	25Years	43.77	77.93	79.93	79.67	80.18	0.003701	2.32	27.23	42.05	0.66
GlenOaks	448.3297	50Years	49.99	77.93	79.98	79.79	80.28	0.004120	2.50	29.77	44.21	0.70
GlenOaks	448.3297	100Years	55.87	77.93	80.04	79.88	80.37	0.004503	2.66	32.05	45.87	0.73
GlenOaks	448.3297	Regional	108.70	77.93	80.45	80.45	81.01	0.006300	3.59	53.94	58.19	0.90
GlenOaks	396.6188	2Years	18.12	78.16	79.29	79.29	79.52	0.006678	2.24	12.13	35.47	0.81
GlenOaks	396.6188	5Years	28.72	78.16	79.48	79.48	79.73	0.006635	2.50	19.80	46.48	0.83
GlenOaks	396.6188	10Years	35.45	78.16	79.60	79.60	79.83	0.006004	2.52	25.38	50.90	0.80
GlenOaks	396.6188	25Years	43.77	78.16	79.68	79.68	79.93	0.006406	2.70	29.50	51.66	0.84
GlenOaks	396.6188	50Years	49.99	78.16	79.73	79.73	80.00	0.006776	2.84	32.11	52.14	0.87
GlenOaks	396.6188	100Years	55.87	78.16	79.77	79.77	80.07	0.007042	2.95	34.55	52.59	0.89
GlenOaks	396.6188	Regional	108.70	78.16	80.12	80.12	80.52	0.008490	3.67	53.14	55.85	1.01
GlenOaks	327.0741	2Years	18.12	76.50	77.95		78.03	0.001699	1.29	14.39	17.13	0.43
GlenOaks	327.0741	5Years	28.72	76.50	78.06		78.22	0.003113	1.82	16.48	27.95	0.58
GlenOaks	327.0741	10Years	35.45	76.50	78.11	77.82	78.34	0.003949	2.12	18.09	36.62	0.66
GlenOaks	327.0741	25Years	43.77	76.50	78.16	77.98	78.47	0.005065	2.48	20.10	42.24	0.76
GlenOaks	327.0741	50Years	49.99	76.50	78.19	78.11	78.56	0.005979	2.74	21.40	45.71	0.83
GlenOaks	327.0741	100Years	55.87	76.50	78.24	78.24	78.65	0.006341	2.90	23.76	51.45	0.86
GlenOaks	327.0741	Regional	108.70	76.50	78.75	78.75	79.14	0.004541	3.13	63.20	88.94	0.77
GlenOaks	271.7621	2Years	18.12	76.60	77.76	77.76	77.88	0.004491	1.70	18.69	99.12	0.66
GlenOaks	271.7621	5Years	28.72	76.60	77.86	77.86	78.01	0.005130	1.96	29.22	102.29	0.72
GlenOaks	271.7621	10Years	35.45	76.60	77.91	77.91	78.07	0.005558	2.10	34.32	103.80	0.75
GlenOaks	271.7621	25Years	43.77	76.60	77.96	77.96	78.13	0.006067	2.27	39.78	105.38	0.79
GlenOaks	271.7621	50Years	49.99	76.60	78.00	78.00	78.18	0.006430	2.38	43.42	106.42	0.82
GlenOaks	271.7621	100Years	55.87	76.60	78.03	78.03	78.22	0.006712	2.48	46.75	107.36	0.84
GlenOaks	271.7621	Regional	108.70	76.60	78.25	78.25	78.51	0.008335	3.09	71.35	111.30	0.97
GlenOaks	200	2Years	18.12	76.00	76.90	76.82	77.02	0.004700	1.81	18.22	48.74	0.67
GlenOaks	200	5Years	28.72	76.00	77.00	76.98	77.18	0.006704	2.32	23.26	53.39	0.82
GlenOaks	200	10Years	35.45	76.00	77.04	77.00	77.28	0.008360	2.68	26.30	80.97	0.92
GlenOaks	200	25Years	43.77	76.00	77.03	77.03	77.40	0.012801	3.30	25.66	72.40	1.14
GlenOaks	200	50Years	49.99	76.00	77.14	77.00	77.46	0.010616	3.21	35.35	95.24	1.05
GlenOaks	200	100Years	55.87	76.00	77.23	77.01	77.47	0.008070	2.94	43.56	98.12	0.93
GlenOaks	200	Regional	108.70	76.00	77.73		77.86	0.003692	2.49	96.58	112.27	0.66
GlenOaks	148.0308	2Years	18.12	75.89	76.67	76.55	76.73	0.006273	1.63	26.94	56.11	0.74
GlenOaks	148.0308	5Years	28.72	75.89	76.83	76.62	76.88	0.004317	1.58	48.59	118.15	0.64
GlenOaks	148.0308	10Years	35.45	75.89	76.92	76.68	76.97	0.003563	1.57	59.89	120.70	0.59
GlenOaks	148.0308	25Years	43.77	75.89	77.03	76.75	77.08	0.003010	1.59	72.85	123.55	0.56
GlenOaks	148.0308	50Years	49.99	75.89	77.10	76.80	77.15	0.002730	1.60	81.97	125.01	0.54
GlenOaks	148.0308	100Years	55.87	75.89	77.17	76.83	77.21	0.002522	1.61	90.25	125.82	0.52
GlenOaks	148.0308	Regional	108.70	75.89	77.68	77.04	77.73	0.001701	1.76	155.74	132.55	0.46
GlenOaks	80.68134	2Years	18.12	75.50	76.61		76.62	0.000586	0.78	66.45	116.91	0.25
GlenOaks	80.68134	5Years	28.72	75.50	76.74		76.77	0.000793	0.99	82.88	121.07	0.30
GlenOaks	80.68134	10Years	35.45	75.50	76.84		76.86	0.000834	1.08	94.35	123.83	0.31
GlenOaks	80.68134	25Years	43.77	75.50	76.94		76.97	0.000870	1.16	107.67	126.95	0.32
GlenOaks	80.68134	50Years	49.99	75.50	77.02		77.05	0.000889	1.22	117.10	129.12	0.33
GlenOaks	80.68134	100Years	55.87	75.50	77.08		77.12	0.000901	1.27	125.80	130.82	0.34
GlenOaks	80.68134	Regional	108.70	75.50	77.60		77.64	0.000908	1.56	195.57	139.79	0.35
GlenOaks	27.45592	2Years	18.12	75.99	76.57	76.57	76.58	0.001247	0.69	57.35	92.78	0.33
GlenOaks	27.45592	5Years	28.72	75.99	76.69	76.57	76.71	0.001664	0.93	68.92	94.32	0.39
GlenOaks	27.45592	10Years	35.45	75.99	76.78	76.57	76.81	0.001698	1.04	77.49	95.43	0.41
GlenOaks	27.45592	25Years	43.77	75.99	76.89	76.57	76.91	0.001724	1.15	87.38	96.57	0.42
GlenOaks	27.45592	50Years	49.99	75.99	76.96	76.57	76.99	0.001741	1.23	94.31	97.45	0.43
GlenOaks	27.45592	100Years	55.87	75.99	77.02	76.57	77.06	0.001752	1.30	100.62	98.26	0.44
GlenOaks	27.45592	Regional	108.70	75.99	77.52	76.57	77.58	0.001753	1.74	150.85	104.06	0.47
GlenOaks	7.899100	2Years	18.12	75.67	76.22	76.22	76.41	0.011795	2.23	16.33	48.05	1.02
GlenOaks	7.899100	5Years	28.72	75.67	76.37	76.37	76.62	0.011236	2.60	24.27	64.63	1.04

HEC-RAS Plan: realigned   River: 14Mile   Reach: GlenOaks (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
GlenOaks	7.899100	10Years	35.45	75.67	76.48	76.48	76.72	0.009137	2.60	31.46	66.14	0.96
GlenOaks	7.899100	25Years	43.77	75.67	76.56	76.56	76.82	0.009408	2.81	36.38	66.77	0.99
GlenOaks	7.899100	50Years	49.99	75.67	76.61	76.61	76.89	0.009552	2.95	39.86	67.20	1.01
GlenOaks	7.899100	100Years	55.87	75.67	76.65	76.65	76.96	0.009743	3.08	42.87	67.58	1.03
GlenOaks	7.899100	Regional	108.70	75.67	77.08	77.08	77.48	0.008371	3.69	78.42	90.82	1.01

Appendix D
Drainage Figures



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Plotted: 2020-11-19 Plotted By: richard.bartolo
Last Saved: 2020-10-15 Last Saved By: mary.kelly

LEGEND

PROPERTY BOUNDARY	
WATERCOURSE	
CONTOUR (1m)	
EXISTING CULVERT	
EXISTING STORM SEWER SYSTEM	
DRAINAGE BOUNDARY	
M114	DRAINAGE OUTLET ID#
0.75ha	SUBCATCHMENT AREA (TO MAJOR SYSTEM OUTLET)
	MAJOR SYSTEM FLOW DIRECTION

BC	BRONTE CREEK
14MC	FOURTEEN MILE CREEK
MC	McCRANEY CREEK
LO	LAKE ONTARIO

SCALE VALID ONLY FOR 24"x36" VERSION

LAKESHORE ROAD CLASS EA

TOWN OF OAKVILLE

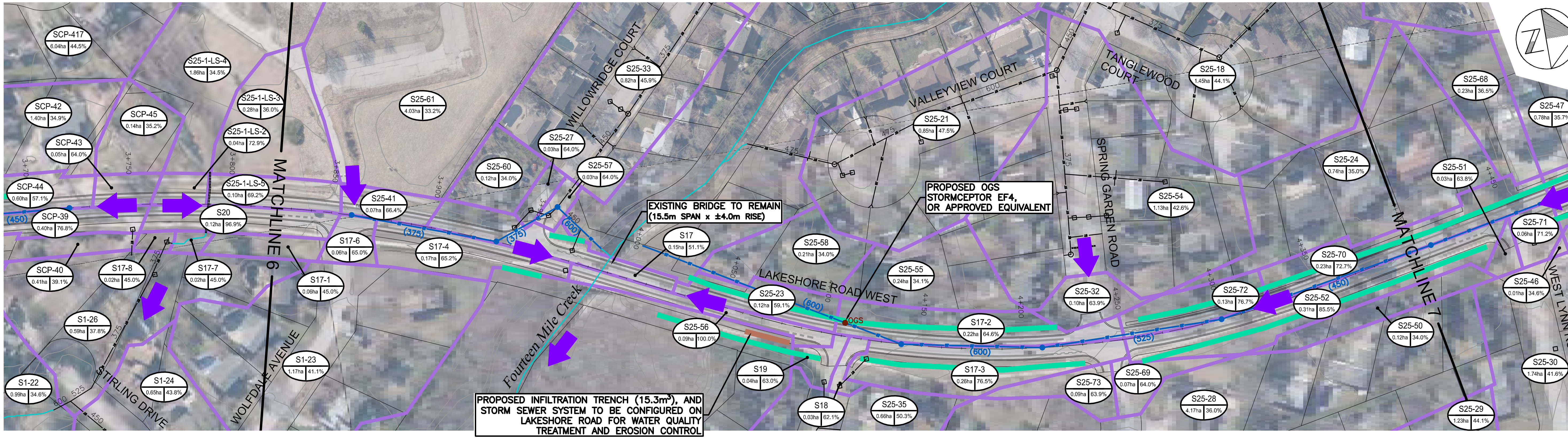
STORM DRAINAGE BOUNDARIES

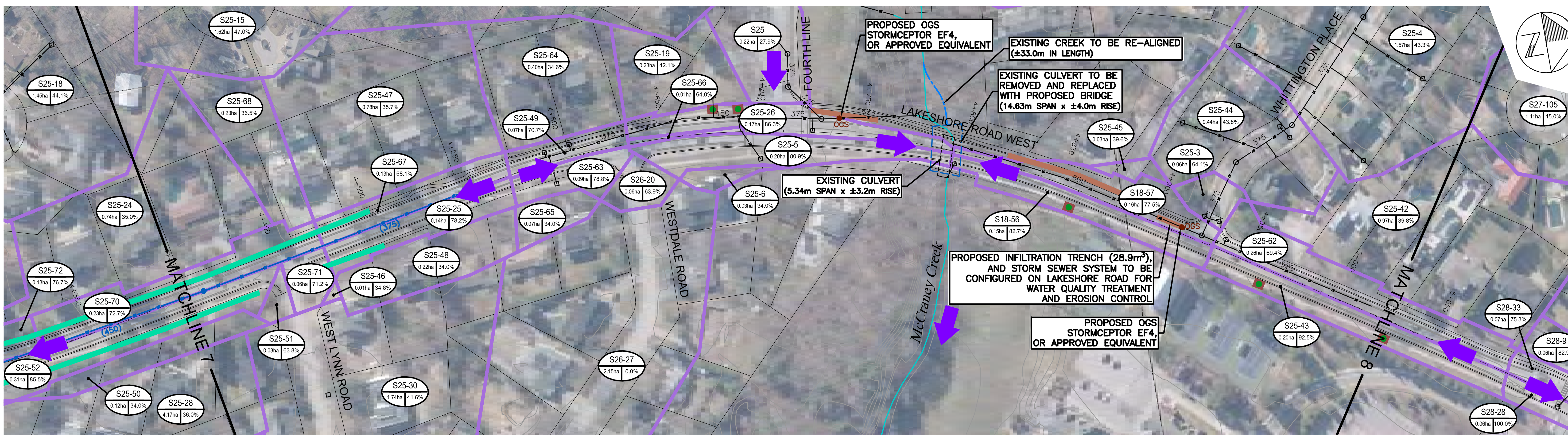
wood.

Scale 1:10000
0 100 200 400

Consultant File No. TPB166147

Figure No. 1





LEGEND

- PROPERTY BOUNDARY
- WATERCOURSE
- CONTOUR (1m)
- EXISTING CULVERT
- EXISTING STORM SEWER AND PIPE SIZE (450)
- FUTURE STORM SEWER AND PIPE SIZE ((450))
- OGS — FUTURE OIL/GRIT SEPARATOR
- SUBCATCHMENT BOUNDARY
- S13-3-LS — SUBCATCHMENT ID#
- 73.4% — PERCENTAGE OF IMPERVIOUS AREA
- 0.75ha — SUBCATCHMENT AREA
- MAJOR SYSTEM FLOW DIRECTION
- MINOR SYSTEM FLOW DIRECTION

25mm SOURCE CONTROL

- SILVA CELL
- BIO-RETENTION FACILITY
- ENHANCED GRASS SWALE
- INFILTRATION TRENCH/PERMEABLE PAVERS

SCALE VALID ONLY FOR 24"x36" VERSION

LAKESHORE ROAD CLASS EA TOWN OF OAKVILLE	STORM DRAINAGE BOUNDARIES (FUTURE CONDITION)	wood.	Scale 1:1000 (0 10 20 40) Consultant File No. TPB166147 Figure No. 10

Path: I:\LakeshoreEA\Plates\Fig7-11 FuturePlates.dwg
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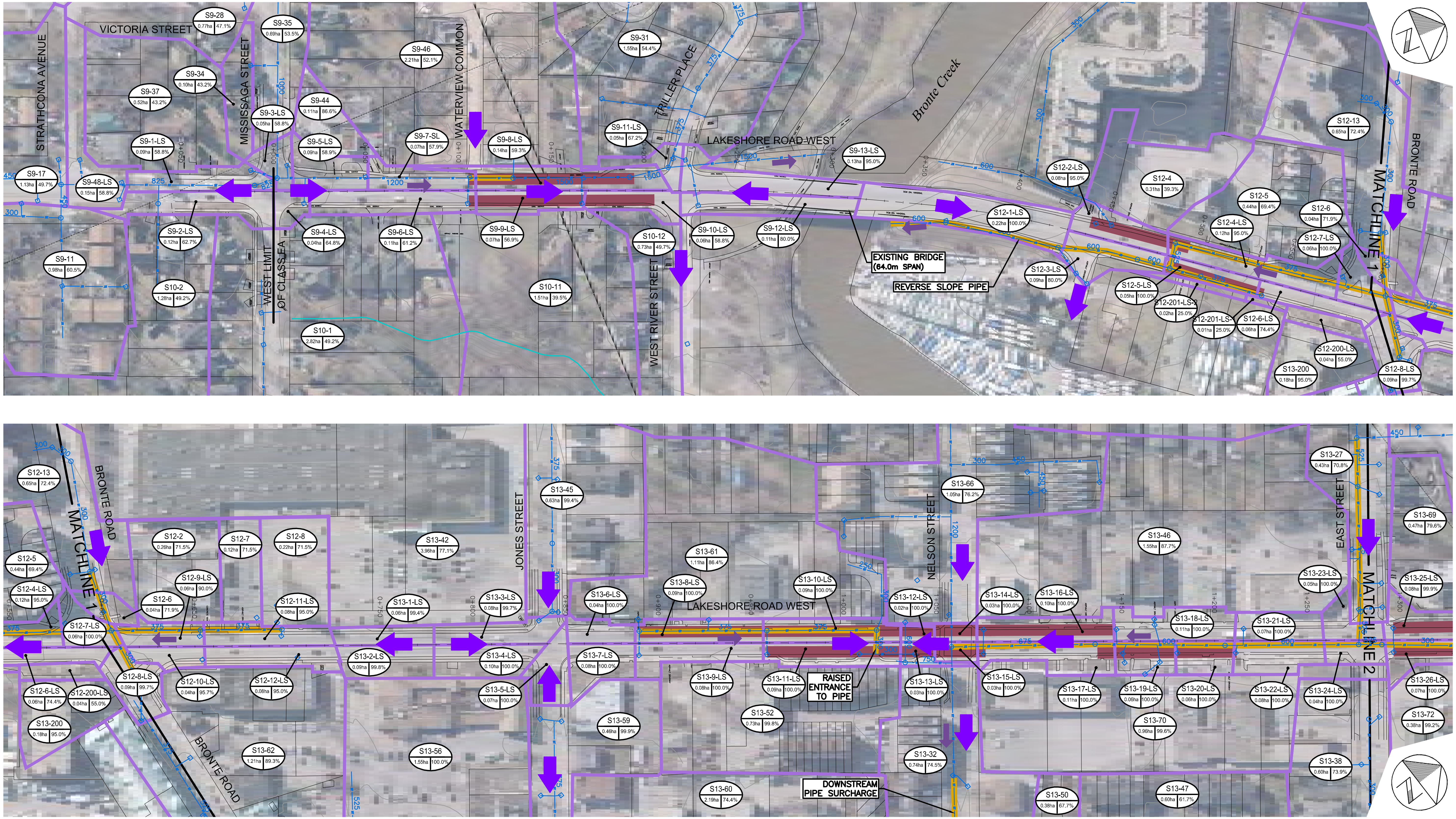

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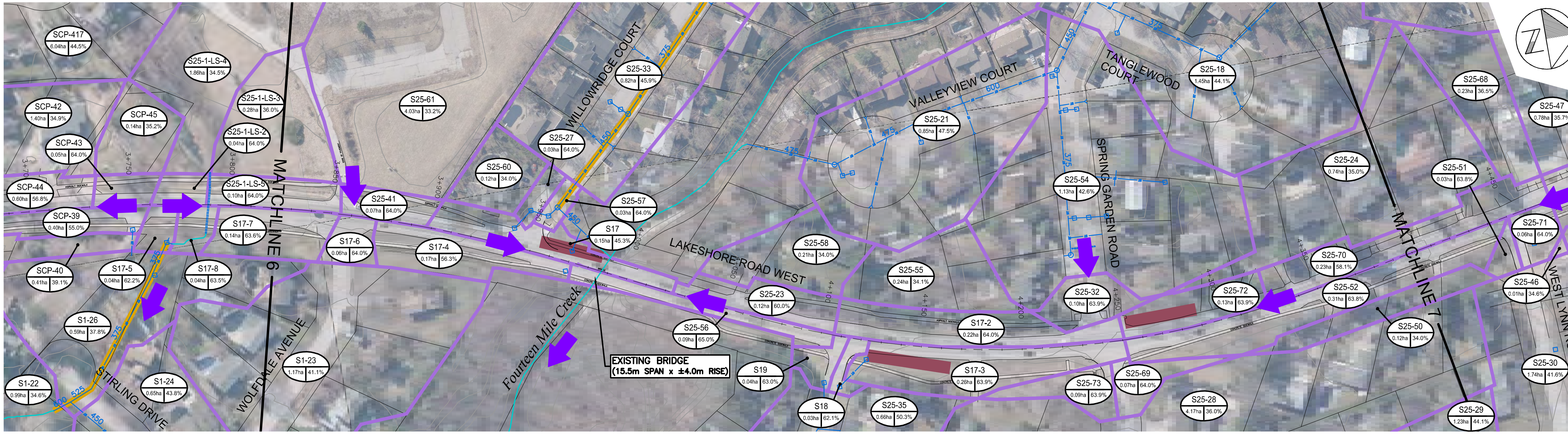
Plotted: 2020-11-19
Last Saved: 2020-10-27

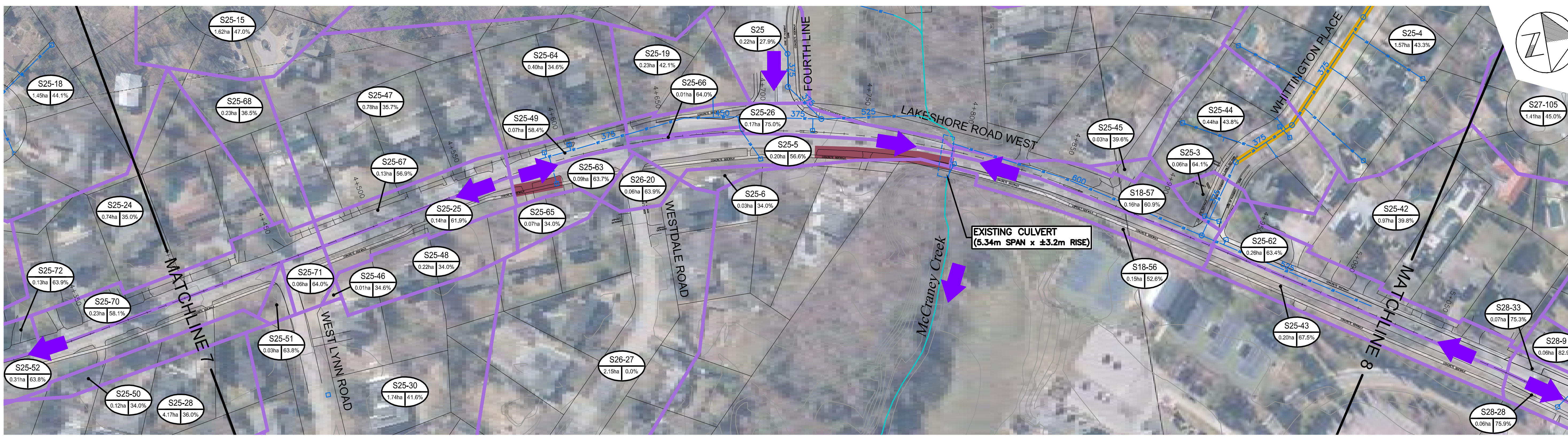
LEGEND

PROPERTY BOUNDARY	
WATERCOURSE	
CONTOUR (1m)	
EXISTING CULVERT	
450	EXISTING STORM SEWER AND PIPE SIZE
SUBCATCHMENT BOUNDARY	
S13-3-LS / 0.75ha / 73.4%	SUBCATCHMENT ID# / PERCENTAGE OF IMPERVIOUS AREA / SUBCATCHMENT AREA
MAJOR SYSTEM FLOW DIRECTION	
MINOR SYSTEM FLOW DIRECTION	
MINOR 5 YEAR PIPE SURCHARGE	
MAJOR 100 YEAR SYSTEM SURCHARGE	

SCALE VALID ONLY FOR 24"x36" VERSION

LAKESHORE ROAD CLASS EA TOWN OF OAKVILLE	STORM DRAINAGE BOUNDARIES (EXISTING CONDITION)	wood.	Scale 1:1000 (0 10 20 40) Consultant File No. TPB166147 Figure No. 2



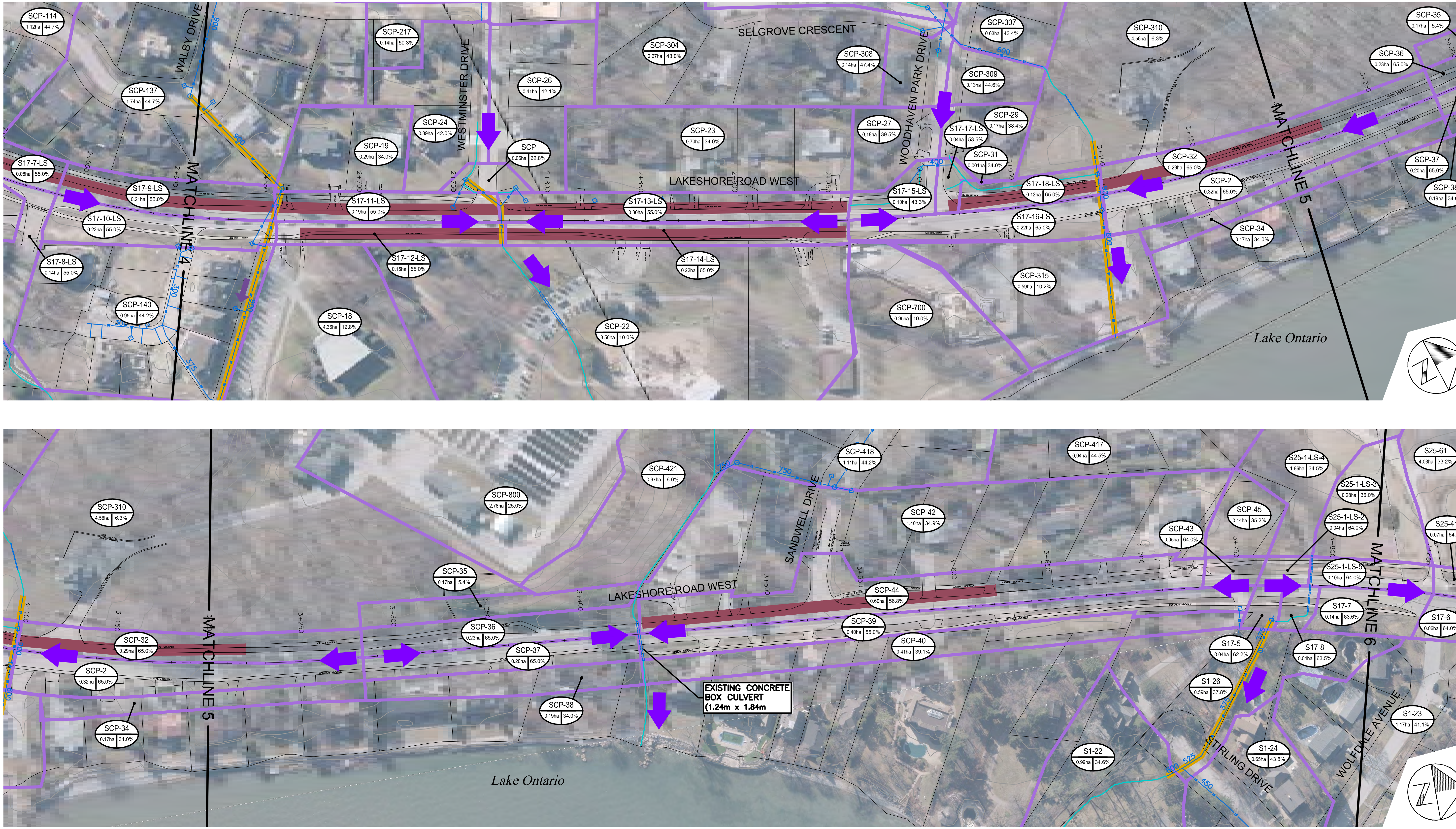


LEGEND

PROPERTY BOUNDARY
WATERCOURSE
CONTOUR (1m)
EXISTING CULVERT
450 EXISTING STORM SEWER AND PIPE SIZE
SUBCATCHMENT BOUNDARY
S13-3-LS SUBCATCHMENT ID#
73.4% PERCENTAGE OF IMPERVIOUS AREA
0.75ha SUBCATCHMENT AREA
MAJOR SYSTEM FLOW DIRECTION
MINOR SYSTEM FLOW DIRECTION
MINOR 5 YEAR PIPE SURCHARGE
MAJOR 100 YEAR SYSTEM SURCHARGE

SCALE VALID ONLY FOR 24"x36" VERSION

LAKESHORE ROAD CLASS EA TOWN OF OAKVILLE	STORM DRAINAGE BOUNDARIES (EXISTING CONDITION)	wood.	Scale 1:1000 (0 10 20 40) Consultant File No. TPB166147 Figure No. 5



LEGEND

	PROPERTY BOUNDARY		SUBCATCHMENT BOUNDARY		MINOR 5 YEAR PIPE SURCHARGE
	WATERCOURSE	S13-3-LS	SUBCATCHMENT ID#		MAJOR 100 YEAR SYSTEM SURCHARGE
	CONTOUR (1m)	0.75ha	PERCENTAGE OF IMPERVIOUS AREA		
	EXISTING CULVERT	73.4%	SUBCATCHMENT AREA		
450	EXISTING STORM SEWER AND PIPE SIZE		MAJOR SYSTEM FLOW DIRECTION		
			MINOR SYSTEM FLOW DIRECTION		

SCALE VALID ONLY FOR 24"x36" VERSION

LAKESHORE ROAD CLASS EA TOWN OF OAKVILLE	STORM DRAINAGE BOUNDARIES (EXISTING CONDITION)	wood.	Scale 1:1000 (0 10 20 40) Consultant File No. TPB166147 Figure No. 4

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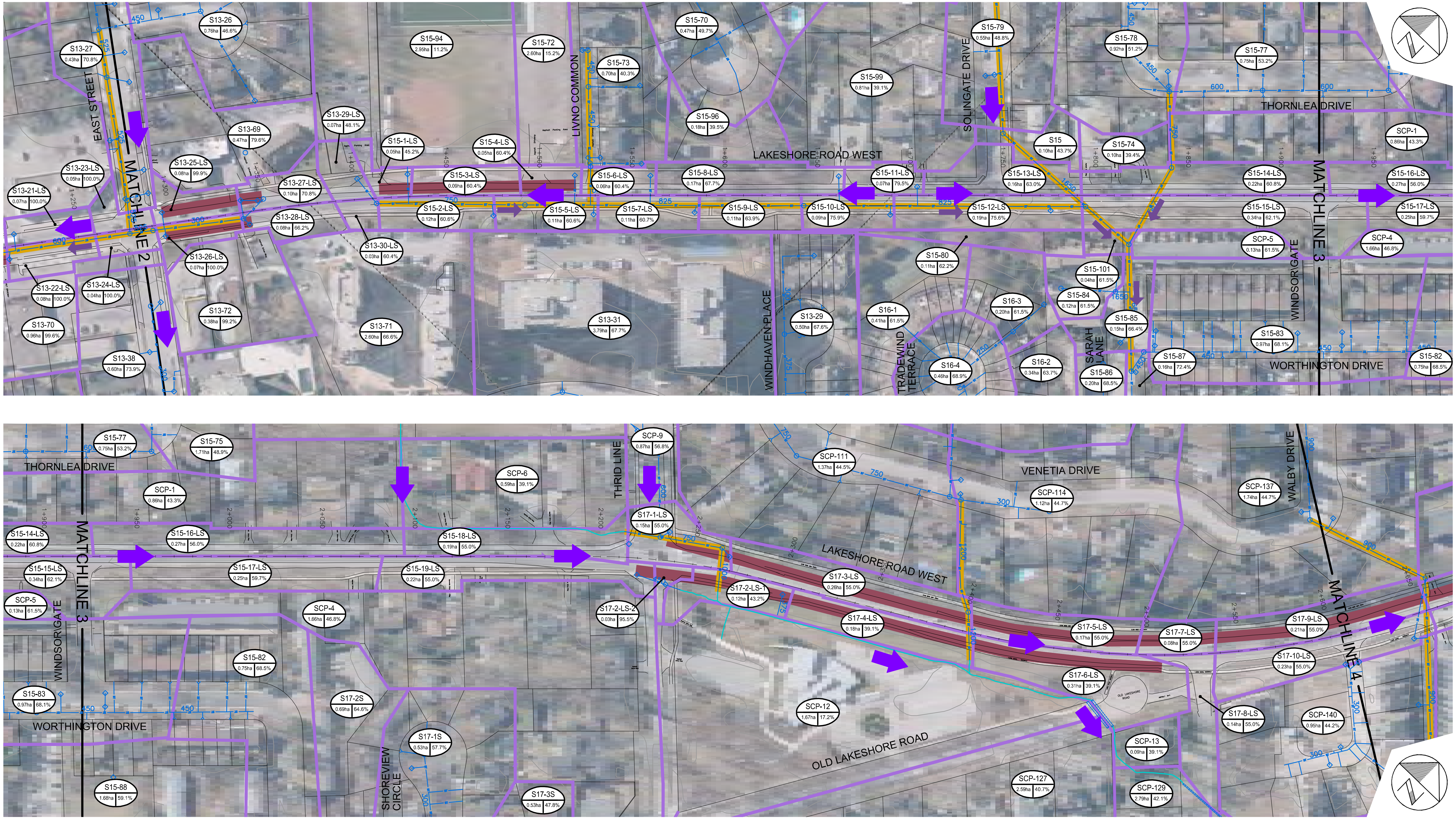

LEGEND

- PROPERTY BOUNDARY
- WATERCOURSE
- CONTOUR (1m)
- EXISTING CULVERT
- 450 EXISTING STORM SEWER AND PIPE SIZE
- SUBCATCHMENT BOUNDARY
- S13-3-LS / 0.75ha / 73.4%: SUBCATCHMENT ID#; PERCENTAGE OF IMPERVIOUS AREA; SUBCATCHMENT AREA
- MAJOR SYSTEM FLOW DIRECTION
- MINOR SYSTEM FLOW DIRECTION
- MINOR 5 YEAR PIPE SURCHARGE
- MAJOR 100 YEAR SYSTEM SURCHARGE

SCALE VALID ONLY FOR 24"x36" VERSION

LAKESHORE ROAD CLASS EA TOWN OF OAKVILLE	STORM DRAINAGE BOUNDARIES (EXISTING CONDITION)	wood.	Scale 1:1000 (0 10 20 40) Consultant File No. TPB166147 Figure No. 3

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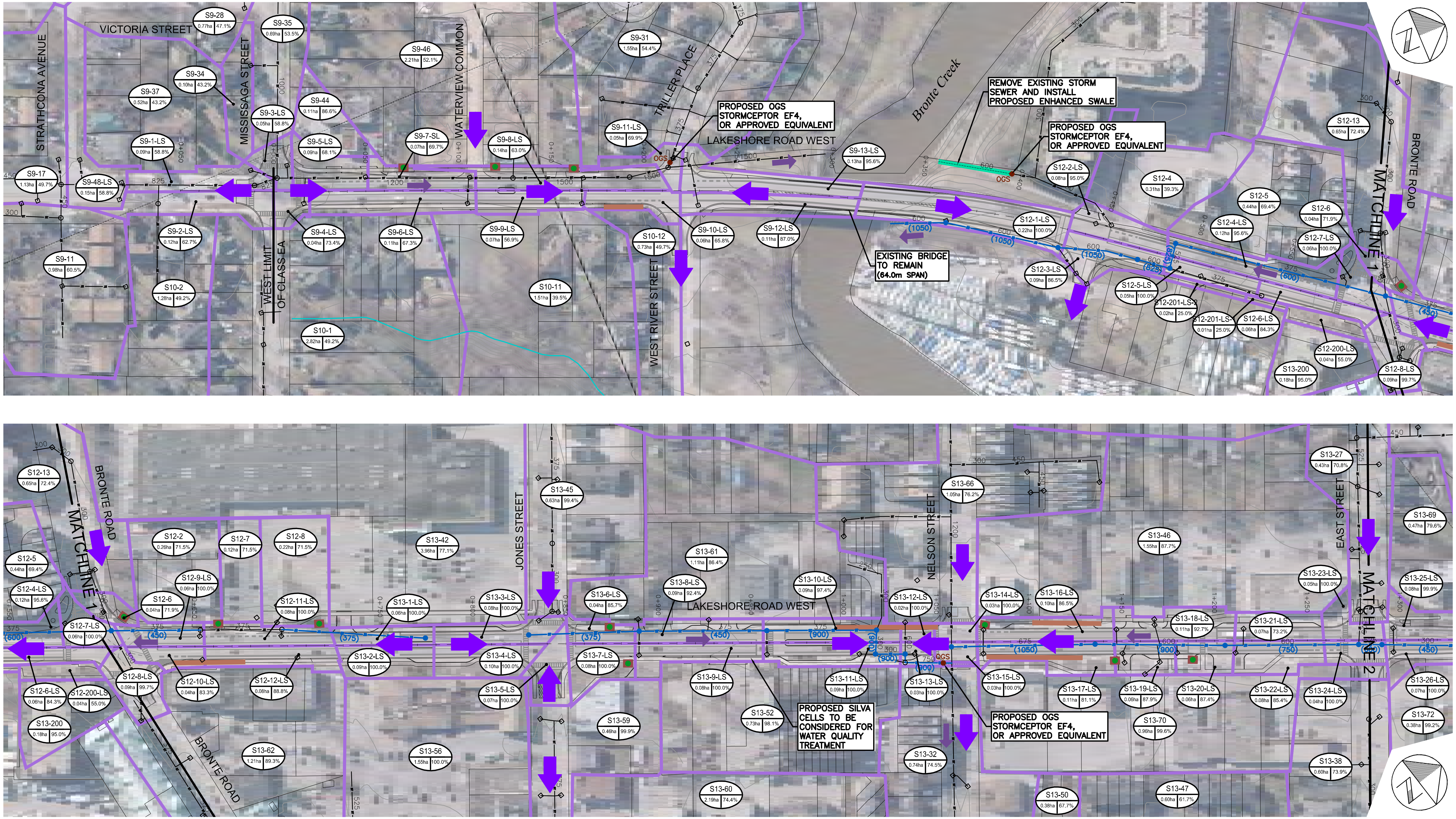
Plotted: 2020-11-19
Last Saved: 2020-10-27



LEGEND

PROPERTY BOUNDARY	FUTURE OIL/GRIT SEPARATOR
WATERCOURSE	SUBCATCHMENT BOUNDARY
CONTOUR (1m)	SUBCATCHMENT ID#
EXISTING CULVERT	PERCENTAGE OF IMPERVIOUS AREA
EXISTING STORM SEWER AND PIPE SIZE	SUBCATCHMENT AREA
FUTURE STORM SEWER AND PIPE SIZE	MAJOR SYSTEM FLOW DIRECTION
	MINOR SYSTEM FLOW DIRECTION

25mm SOURCE CONTROL

- SILVA CELL
- BIO-RETENTION FACILITY
- ENHANCED GRASS SWALE
- INFILTRATION TRENCH/PERMEABLE PAVERS

SCALE VALID ONLY FOR 24"x36" VERSION

LAKESHORE ROAD CLASS EA TOWN OF OAKVILLE	STORM DRAINAGE BOUNDARIES (FUTURE CONDITION)	wood.	Scale 1:1000 Consultant File No. TPB166147 Figure No. 7

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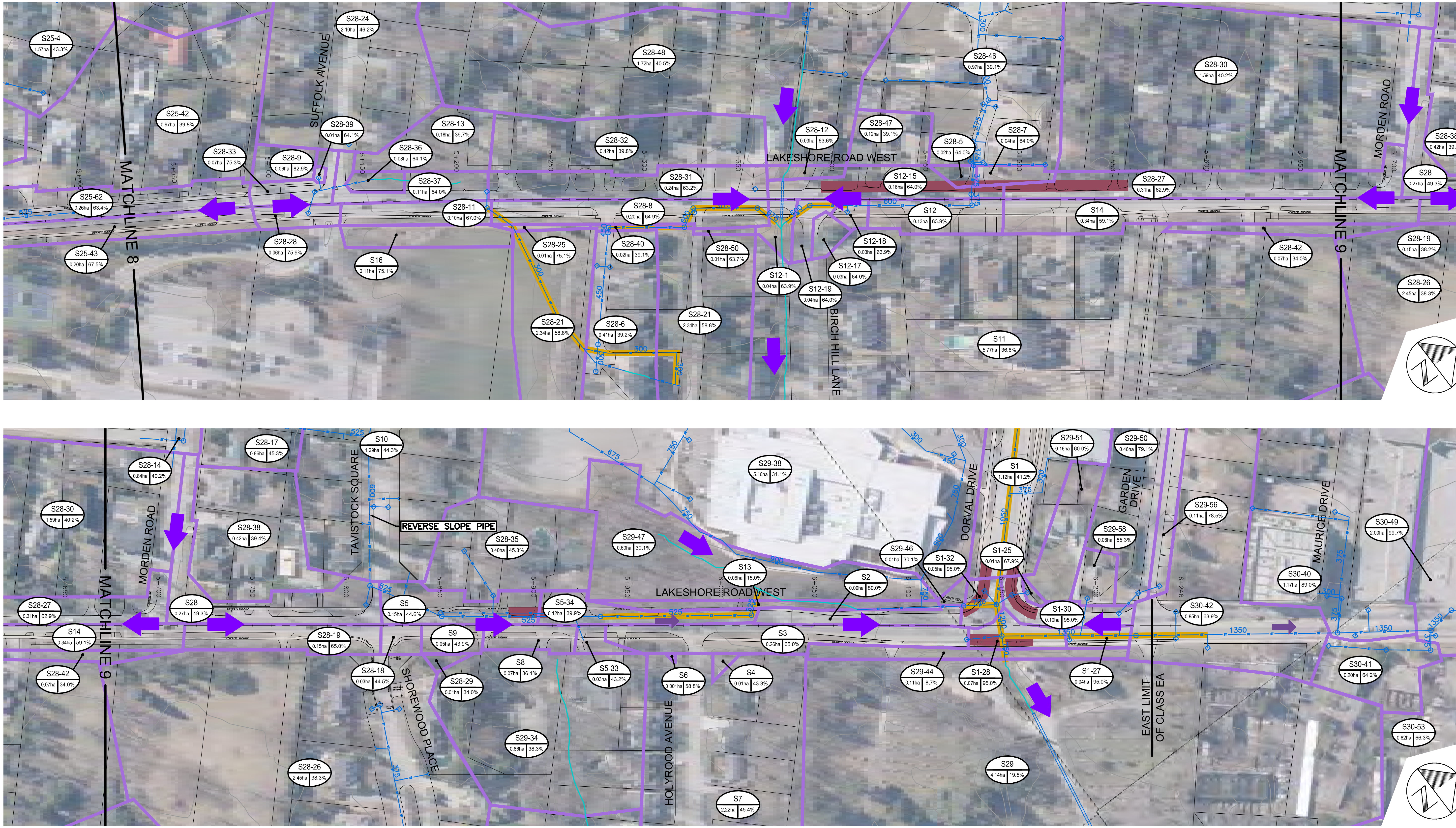

LEGEND

PROPERTY BOUNDARY

WATERCOURSE

CONTOUR (1m)

EXISTING CULVERT

450 EXISTING STORM SEWER AND PIPE SIZE

SUBCATCHMENT BOUNDARY

S13-3-LS SUBCATCHMENT ID#

73.4% PERCENTAGE OF IMPERVIOUS AREA

0.75ha SUBCATCHMENT AREA

MAJOR SYSTEM FLOW DIRECTION

MINOR SYSTEM FLOW DIRECTION

MINOR 5 YEAR PIPE SURCHARGE

MAJOR 100 YEAR SYSTEM SURCHARGE

SCALE VALID ONLY FOR 24"x36" VERSION

LAKESHORE ROAD CLASS EA

TOWN OF OAKVILLE

STORM DRAINAGE BOUNDARIES (EXISTING CONDITION)

wood.

Scale 1:1000

0 10 20 40

Consultant File No. TPB166147

Figure No. 6

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Plotted: 2020-11-19 Last Saved: 2020-10-27

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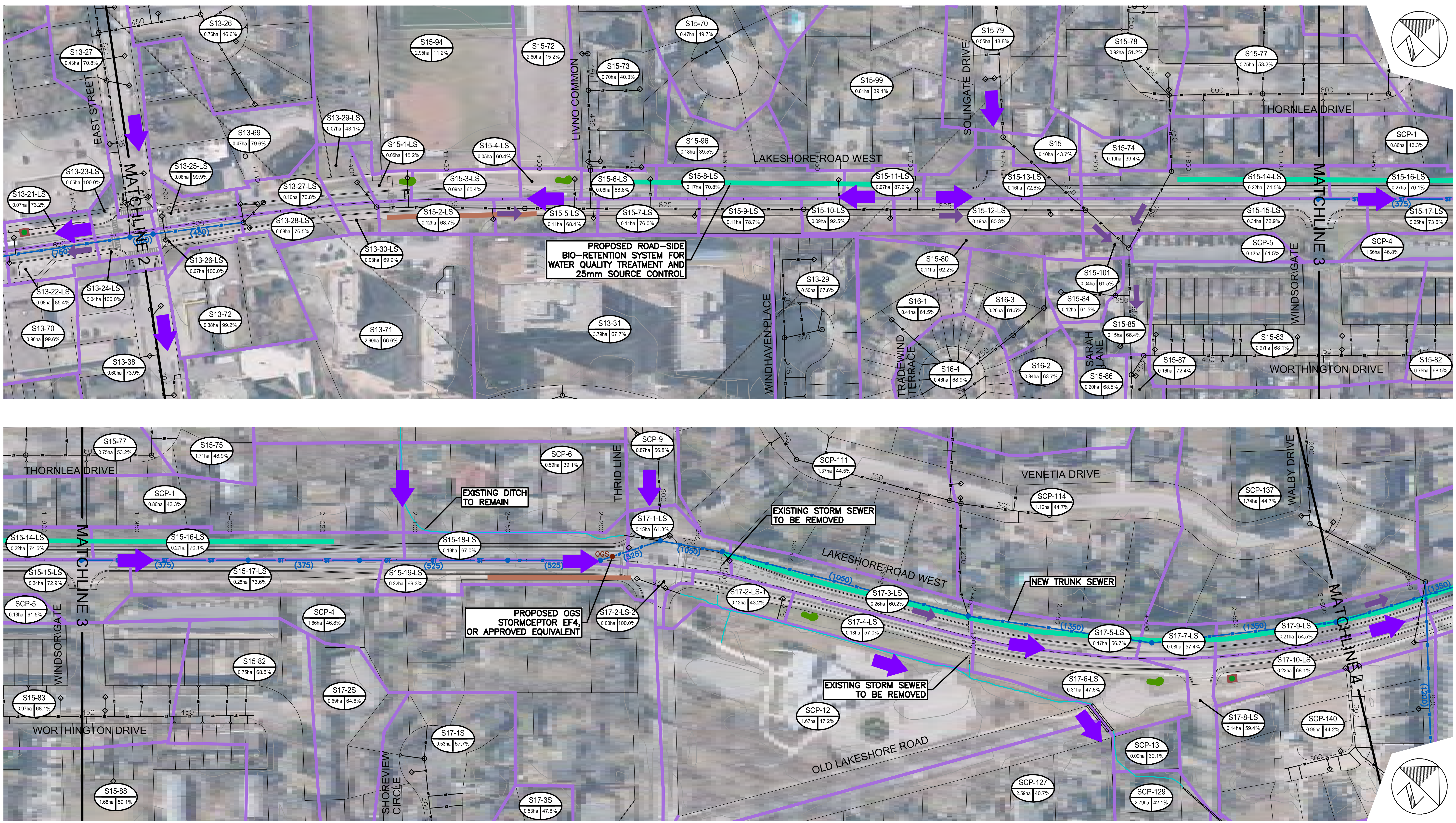

LEGEND

- PROPERTY BOUNDARY
- WATERCOURSE
- CONTOUR (1m)
- EXISTING CULVERT
- 450 EXISTING STORM SEWER AND PIPE SIZE
- (450) FUTURE STORM SEWER AND PIPE SIZE
- OGS FUTURE OIL/GRIT SEPARATOR
- SUBCATCHMENT BOUNDARY
- S13-3-LS SUBCATCHMENT ID#
- 73.4% PERCENTAGE OF IMPERVIOUS AREA
- 0.75ha SUBCATCHMENT AREA
- MAJOR SYSTEM FLOW DIRECTION
- MINOR SYSTEM FLOW DIRECTION

25mm SOURCE CONTROL

- SILVA CELL
- BIO–RETENTION FACILITY
- ENHANCED GRASS SWALE
- INFILTRATION TRENCH/PERMEABLE PAVERS

SCALE VALID ONLY FOR 24"x36" VERSION

LAKESHORE ROAD CLASS EA TOWN OF OAKVILLE	STORM DRAINAGE BOUNDARIES (FUTURE CONDITION)	wood.	Scale 1:1000 (0 10 20 40) Consultant File No. TPB166147 Figure No. 8

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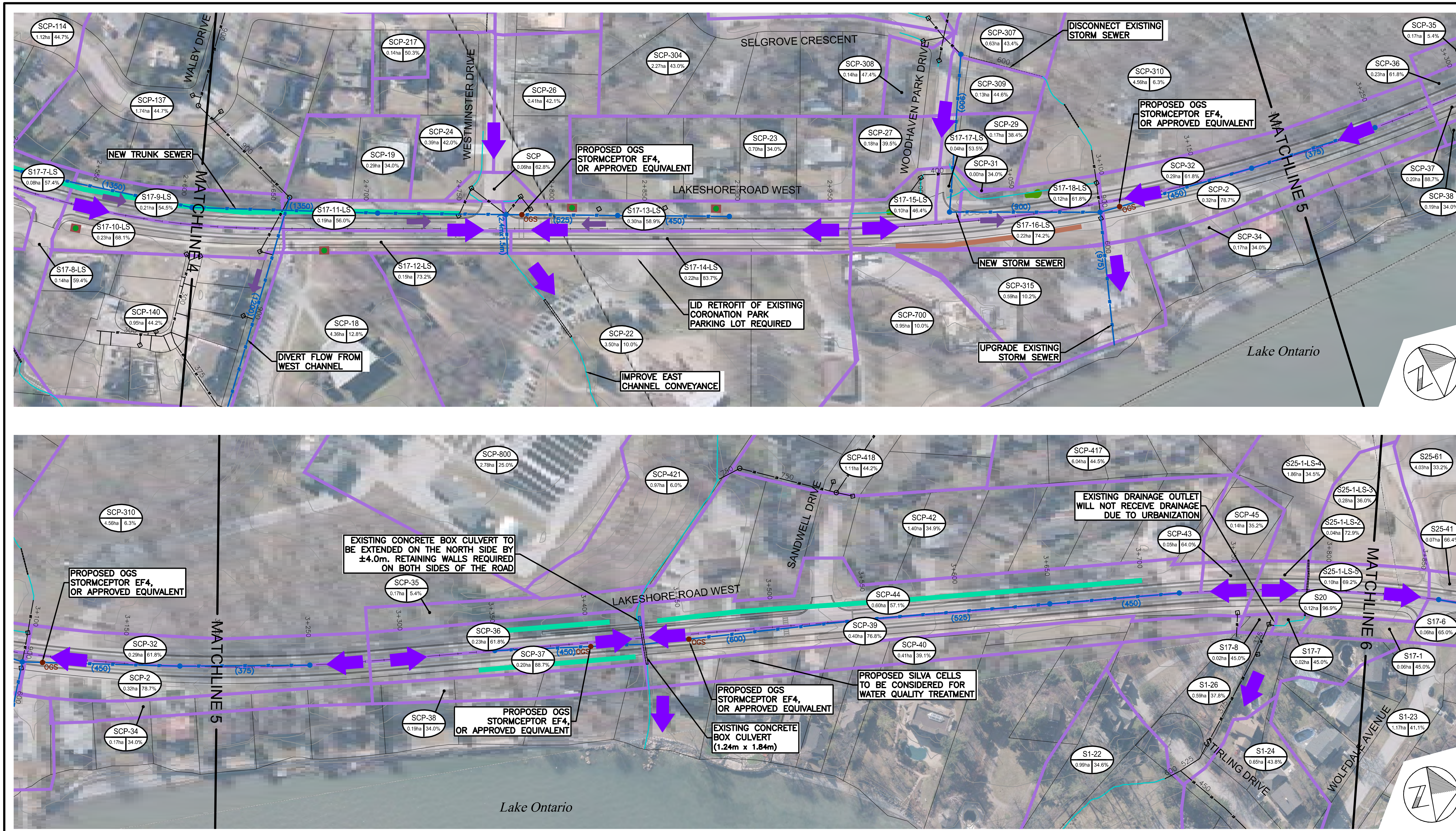

LEGEND

	PROPERTY BOUNDARY
	WATERCOURSE
	CONTOUR (1m)
	EXISTING CULVERT
450	EXISTING STORM SEWER AND PIPE SIZE
(450)	FUTURE STORM SEWER AND PIPE SIZE
OGS	FUTURE OIL/GRIT SEPARATOR
	SUBCATCHMENT BOUNDARY
S13-3-LS	SUBCATCHMENT ID#
73.4%	PERCENTAGE OF IMPERVIOUS AREA
0.75ha	SUBCATCHMENT AREA
	MAJOR SYSTEM FLOW DIRECTION
	MINOR SYSTEM FLOW DIRECTION

25mm SOURCE CONTROL

	SILVA CELL
	BIO-RETENTION FACILITY
	ENHANCED GRASS SWALE
	INFILTRATION TRENCH/PERMEABLE PAVERS

SCALE VALID ONLY FOR 24"x36" VERSION

LAKESHORE ROAD CLASS EA
TOWN OF OAKVILLE

STORM DRAINAGE BOUNDARIES (FUTURE CONDITION)

wood.

Scale 1:1000
0 10 20 40

Consultant File No. TPB166147

Figure No. 9

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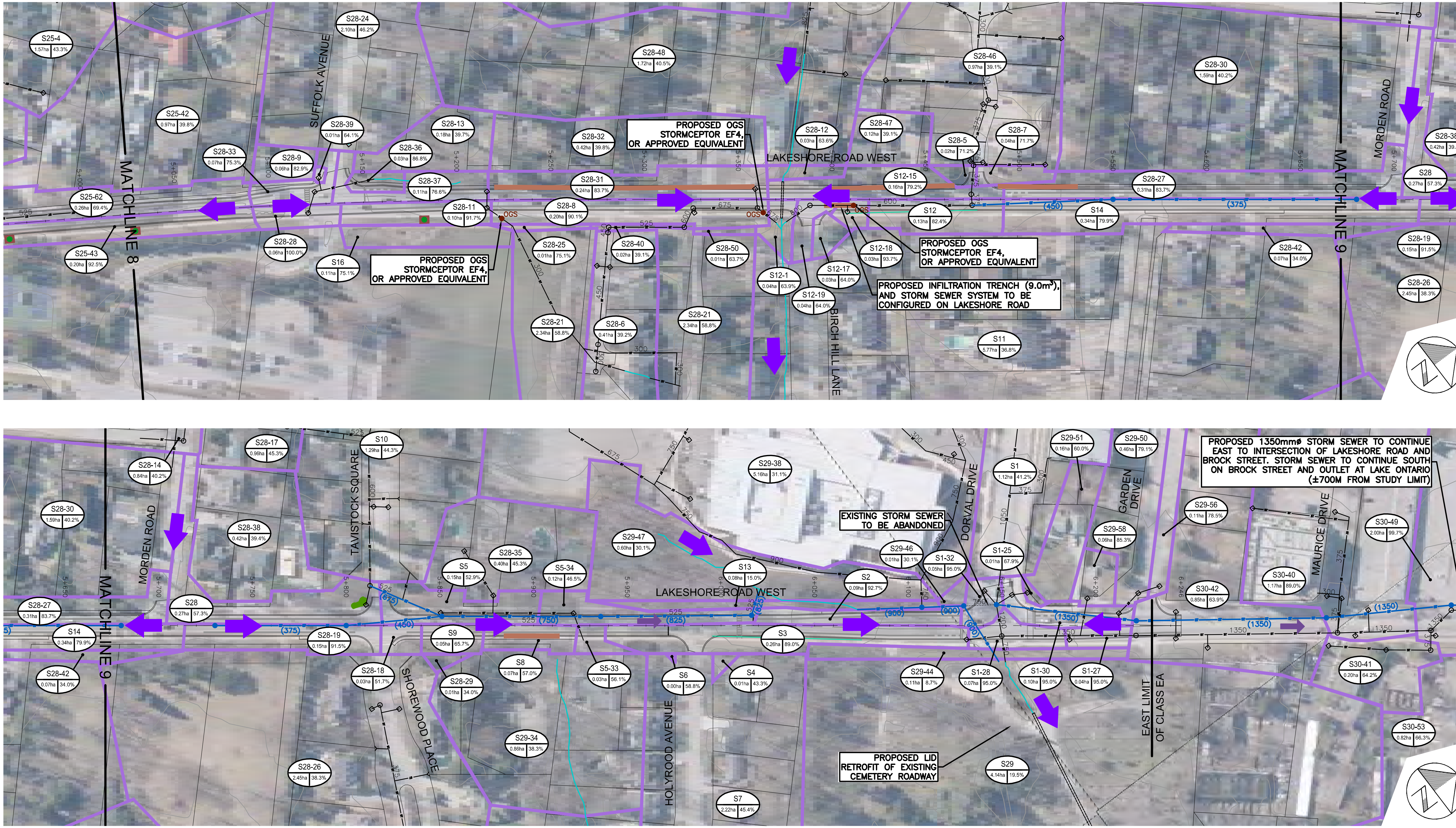

LEGEND

- PROPERTY BOUNDARY
- WATERCOURSE
- CONTOUR (1m)
- EXISTING CULVERT
- 450 EXISTING STORM SEWER AND PIPE SIZE
- (450) FUTURE STORM SEWER AND PIPE SIZE
- OGS FUTURE OIL/GRIT SEPARATOR
- SUBCATCHMENT BOUNDARY
- S13-3-LS SUBCATCHMENT ID#
- 73.4% PERCENTAGE OF IMPERVIOUS AREA
- 0.75ha SUBCATCHMENT AREA
- MAJOR SYSTEM FLOW DIRECTION
- MINOR SYSTEM FLOW DIRECTION

25mm SOURCE CONTROL

- SILVA CELL
- BIO-RETENTION FACILITY
- ENHANCED GRASS SWALE
- INFILTRATION TRENCH/PERMEABLE PAVERS

LAKESHORE ROAD CLASS EA TOWN OF OAKVILLE	STORM DRAINAGE BOUNDARIES (FUTURE CONDITION)	wood.	SCALE VALID ONLY FOR 24"x36" VERSION Scale 1:1000 (0 10 20 40) Consultant File No. TPB166147 Figure No. 11

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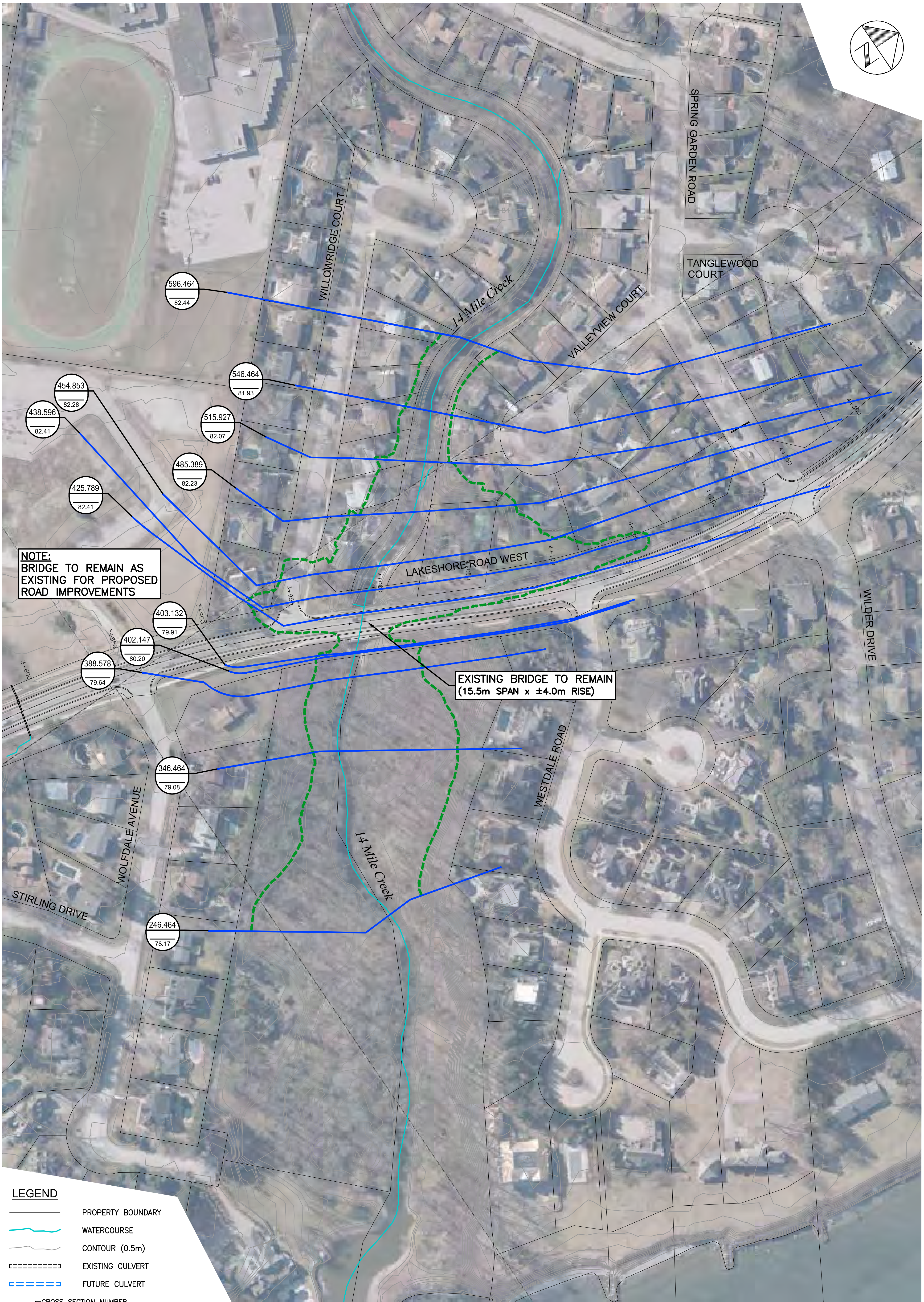

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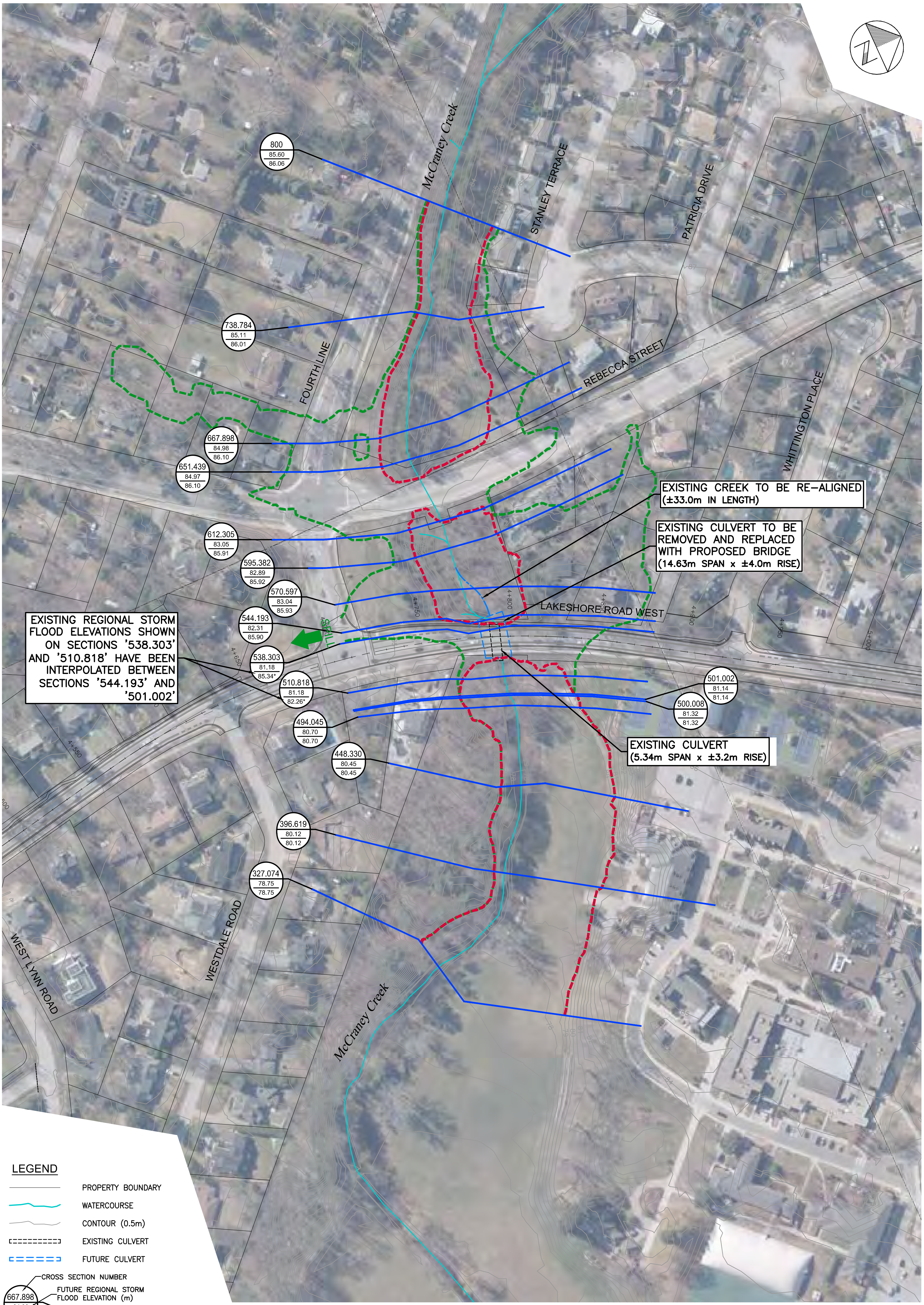
Last Saved By: richard.bartolo
Last Saved: 2020-11-06

SCALE VALID ONLY FOR 24"x36" VERSION

LAKESHORE ROAD CLASS EA TOWN OF OAKVILLE	REGIONAL STORM FLOODPLAIN MAPPING 14 MILE CREEK	wood.	Scale 1:1000 (0 10 20 40) Consultant File No. TPB166147 Figure No. 12



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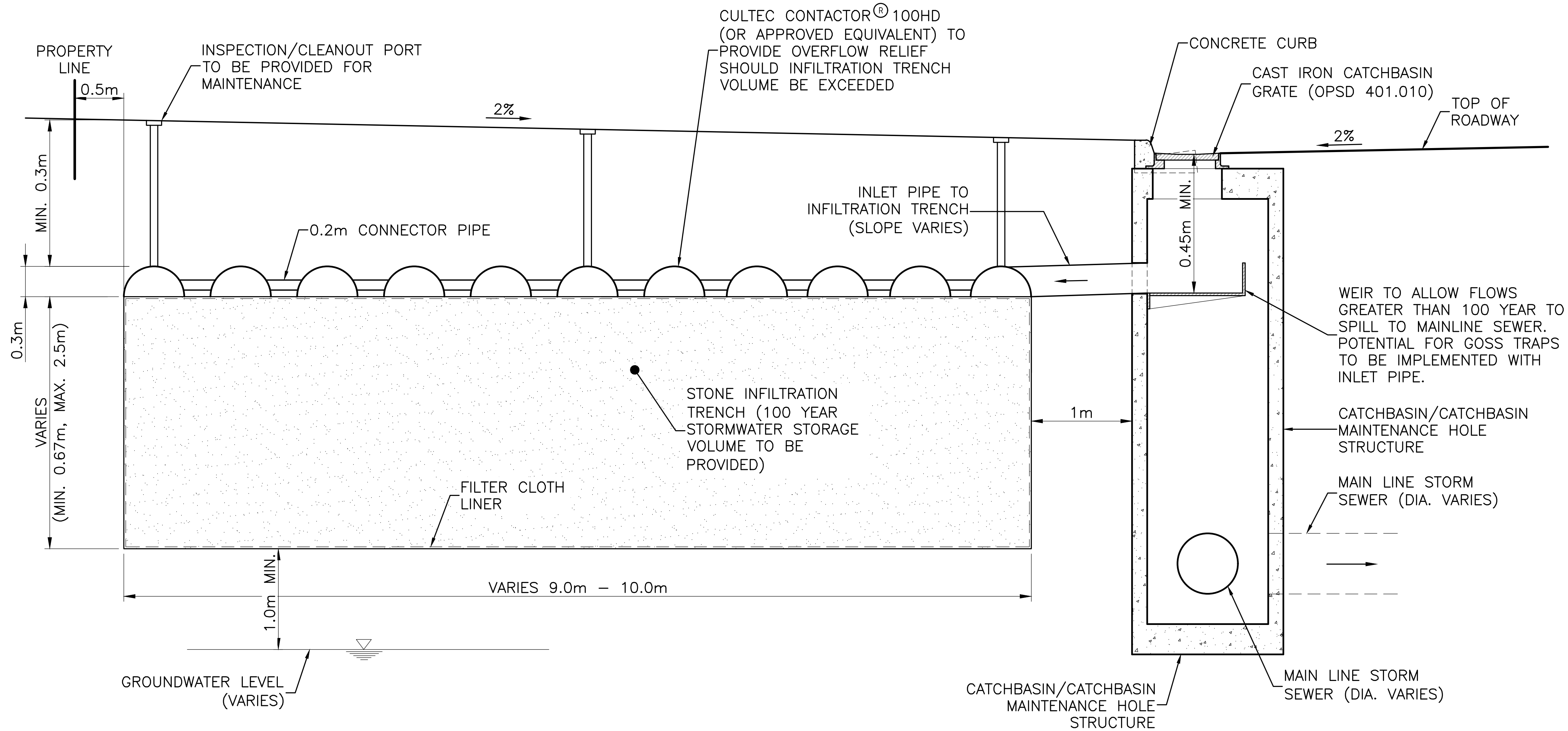
Last Saved: 2020-11-06 Last Saved By: richard.bartolo Plotted: 2020-11-19 Plotted By: richard.bartolo

SCALE VALID ONLY FOR 24"x36" VERSION

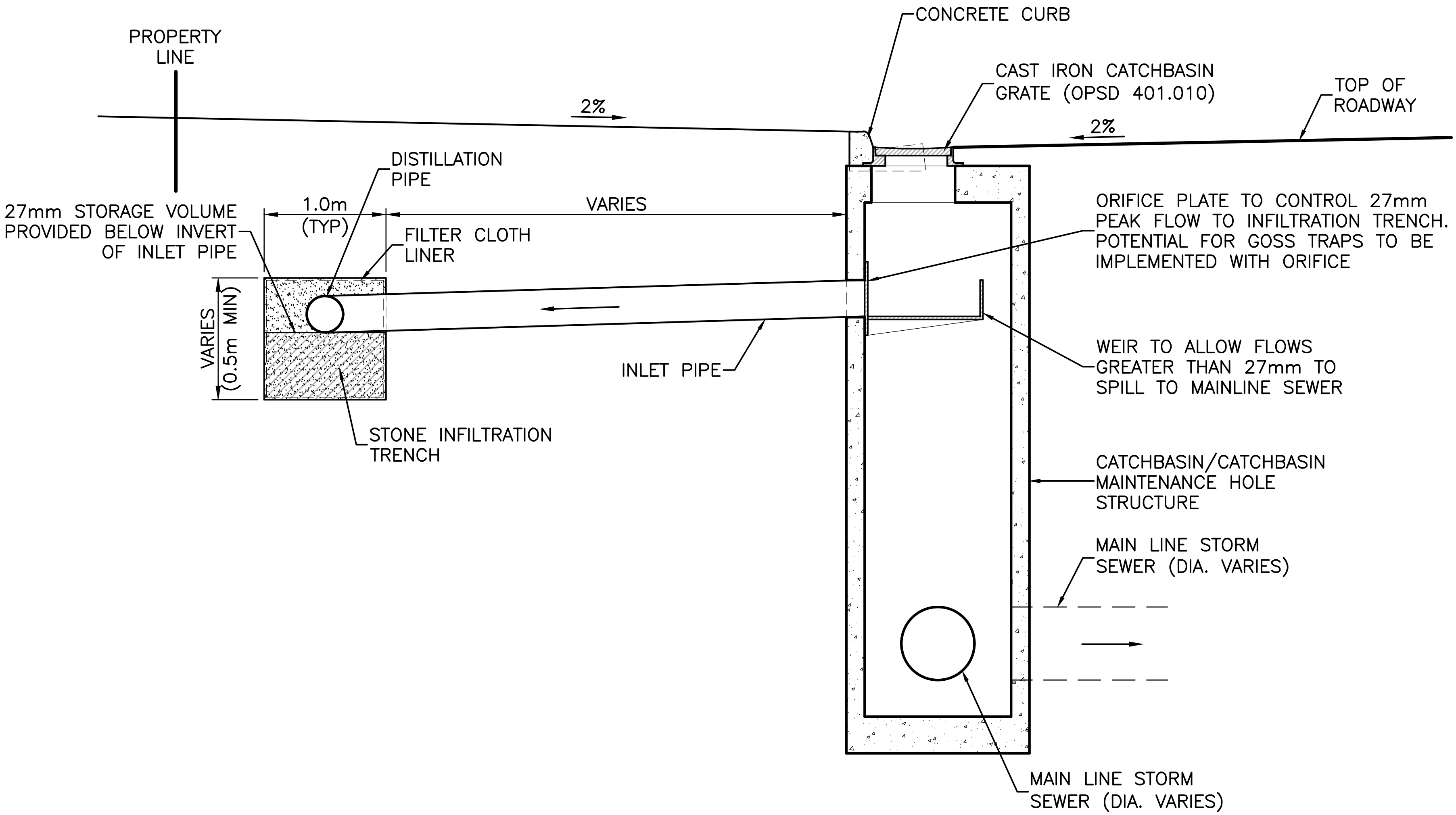
LAKESHORE ROAD CLASS EA TOWN OF OAKVILLE	REGIONAL STORM FLOODPLAIN MAPPING McCRANEY CREEK	wood.	Scale 1:1000 (0 10 20 40) Consultant File No. TPB166147 Figure No. 13



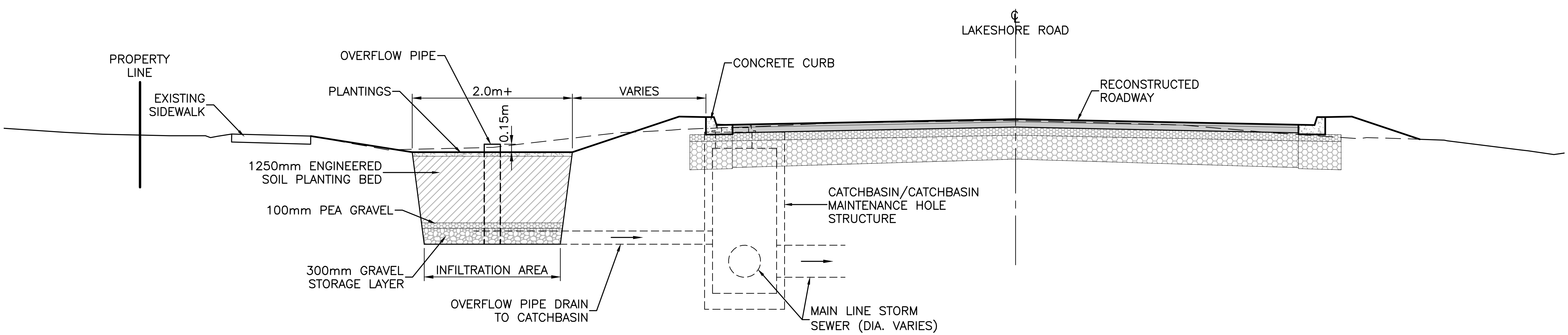
NOTE:

1. DOWNSTREAM ORIFICE PLATE BACKS–UP STORMWATER INTO STORAGE TANK.

LAKESHORE ROAD CLASS EA TOWN OF OAKVILLE	INFILTRATION STORAGE TRENCH TYPICAL CROSS-SECTION CONFIGURATION	wood.	Scale 1:50 Consultant File No. TPB166147 Figure No. 14



LAKESHORE ROAD CLASS EA TOWN OF OAKVILLE	INFILTRATION TRENCH CONFIGURATION	wood.	Scale 1:50 Consultant File No. TPB166147 Figure No. 15



Path: I:\LakeshoreEA\Plates\Fig16 Bioretention.dwg

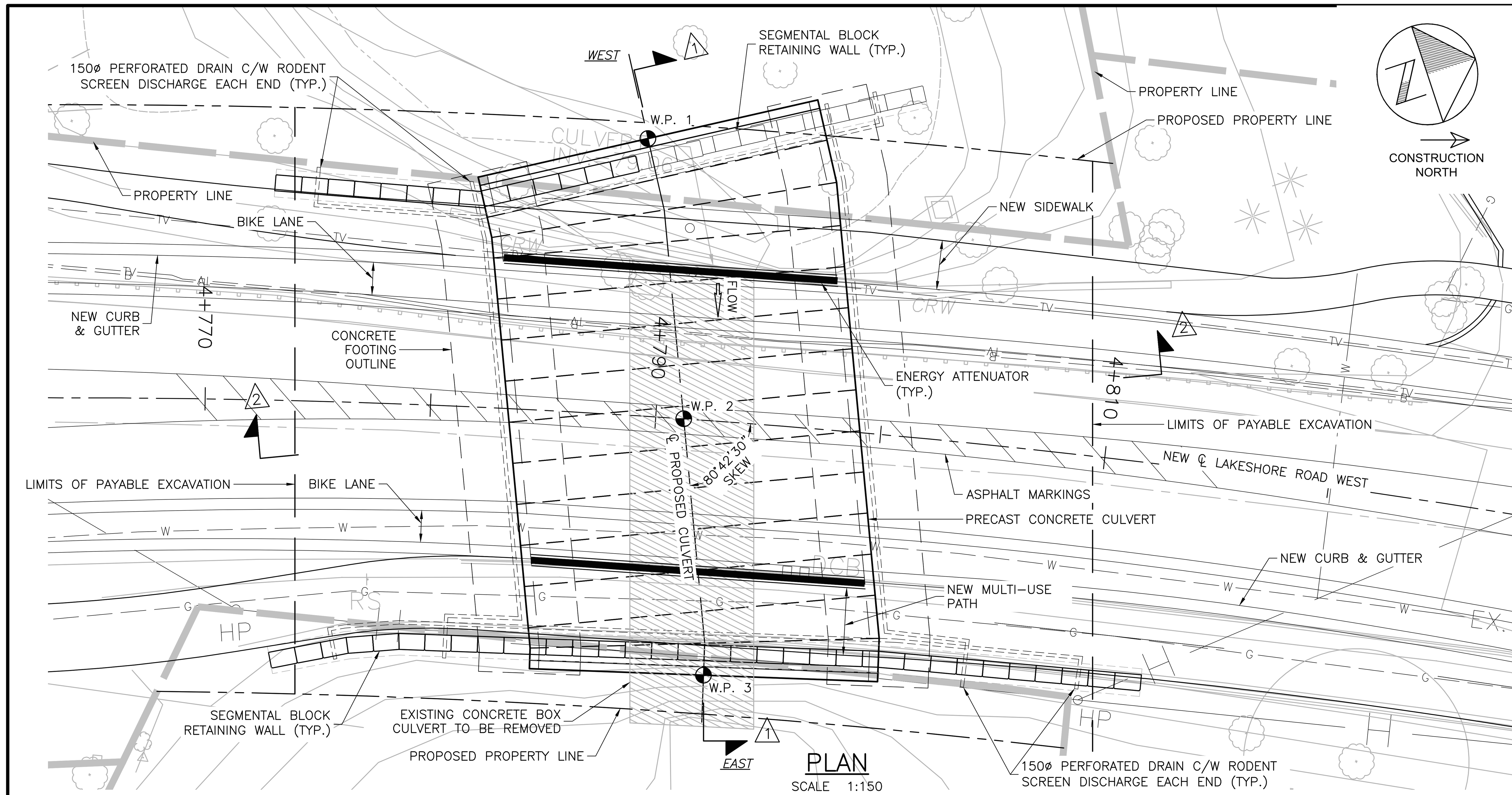
Plotted: 2020-11-19 Plotted By: richard.bartolo
Last Saved: 2020-11-10 Last Saved By: richard.bartolo

LAKESHORE ROAD CLASS EA TOWN OF OAKVILLE	BIORETENTION CELL CONFIGURATION	wood.	Scale 1:75 Consultant File No. TPB166147 Figure No. 16

Appendix E
McCraney Creek Realignment

amec foster wheeler

GA Drawing for McCraney Creek Structure



PLAN
SCALE 1:150

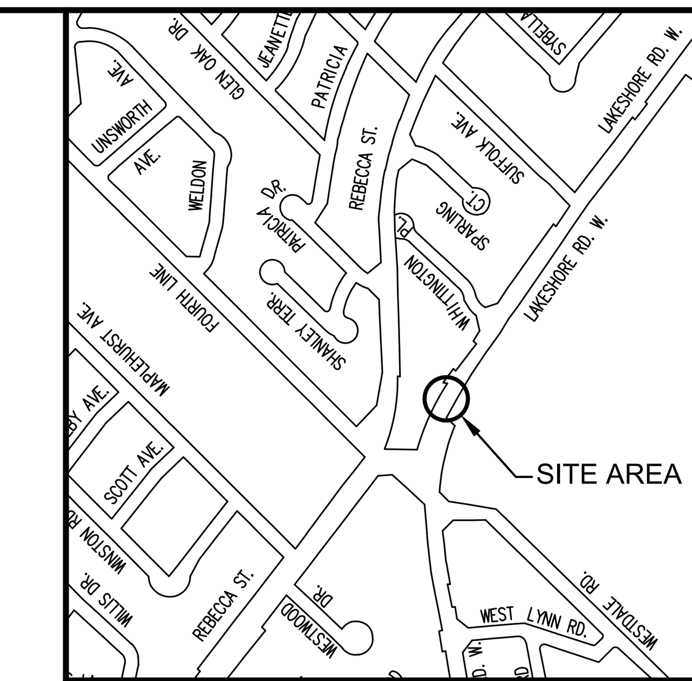
COORDINATE TABLE

CONTROL	NORTHING	EASTING	ELEVATION*	℄ ROAD OFFSET	STATION
W.P. 1	4808919.523	606085.073	82.825	12.302 (WEST)	4+788.885
W.P. 2	4808917.182	606096.999	82.825	0.00	4+791.263
W.P. 3	4808914.463	606108.075	82.825	11.280 (EAST)	4+792.942

* ELEVATION IS MEASURED TO TOP OF CULVERT SLAB AT APEX.

NOTES:

1. DESIGN SHALL CONFORM TO THE CANADIAN HIGHWAY BRIDGE DESIGN CODE, CAN/CSA–S6–14, DESIGN LIVE LOADING IS CL–625–ONT.
2. THE CONTRACTOR SHALL VERIFY ALL DIMENSIONS OF THE EXISTING AND PROPOSED WORK AND ALL DETAILS ON SITE AND REPORT DISCREPANCIES TO THE CONTRACT ADMINISTRATOR BEFORE PROCEEDING WITH THE WORK.
3. ALL SERVICES ARE TO BE ACCURATELY LOCATED PRIOR TO CONSTRUCTION AND ADEQUATE PROTECTION PROVIDED AT ALL TIMES. ANY INTERFERENCE OF EXISTING SERVICES OR UTILITIES WITH PROPOSED STRUCTURE OR CONSTRUCTION OPERATIONS IS TO BE REPORTED TO THE ENGINEER PRIOR TO THE COMMENCING OF CONSTRUCTION.
4. THE SPECIFIED COMPRESSIVE CONCRETE STRENGTH (AT 28 DAYS) SHALL BE:
   FOR PRECAST UNITS: 40MPa CLASS C–1
   FOR CAST–IN–PLACE: 30MPa CLASS F–1
5. CLEAR COVER TO REINFORCING STEEL IN CONCRETE SHALL BE:
   PRECAST CONCRETE
   – BOTTOM OF CULVERT TOP SLAB 40mm ±10mm
   – REMAINDER 50mm ±10mm
   CAST–IN–PLACE CONCRETE
   – 100mm ±25mm – CONCRETE AGAINST OR PERMANENTLY EXPOSED TO EARTH
   – 70mm ±20mm – REMAINDER, UNLESS OTHERWISE NOTED.
6. DETAIL, BEND, PLACE AND SUPPORT REINFORCING STEEL TO CONFORM TO THE REINFORCING STEEL MANUAL OF STANDARD PRACTICE AND CSA A23.1–09, UNLESS NOTED OTHERWISE.
7. EXPOSED EDGES TO BE CHAMFERED 20x20 EXCEPT AS NOTED.
8. REINFORCING SHALL BE DEFORMED WELDED WIRE FABRIC TO ASTM A497M (Fy=500 MPa.) AND DEFORMED BARS CONFORMING TO CSA STANDARD G30.18–09m, GRADE 400W.
9. CONTRACTOR TO DESIGN, SUPPLY AND INSTALL PRECAST REINFORCED CONCRETE UNITS FOR THE SIZE, DEPTH AND LOADS INDICATED ON THE DRAWINGS, DETAILS FOR HEADER WALLS TO BE AS SHOWN.
10. PROVIDE WATER TIGHT JOINTS BETWEEN ALL PRECAST CONCRETE SEGMENTS AS PER MANUFACTURER SPECIFICATIONS.
11. DIMENSIONS AND ELEVATION SHOWN TO EXISTING CONDITIONS ARE TO BE FIELD VERIFIED.
12. THIS DRAWING TO BE READ IN CONJUNCTION WITH ALL OTHER STRUCTURAL DETAIL DRAWINGS.
13. SOIL BEARING CAPACITY:
    SERVICEABILITY LIMIT STATE: 150 KPa (UNFACTORED)
    ULTIMATE LIMIT STATE 200 KPa (FACTORED)
    THE GEOTECHNICAL ENGINEER TO VERIFY THIS REQUIREMENT PRIOR TO PLACING BOX CULVERT AND CONCRETE.
14. DO NOT SCALE THESE DRAWINGS.



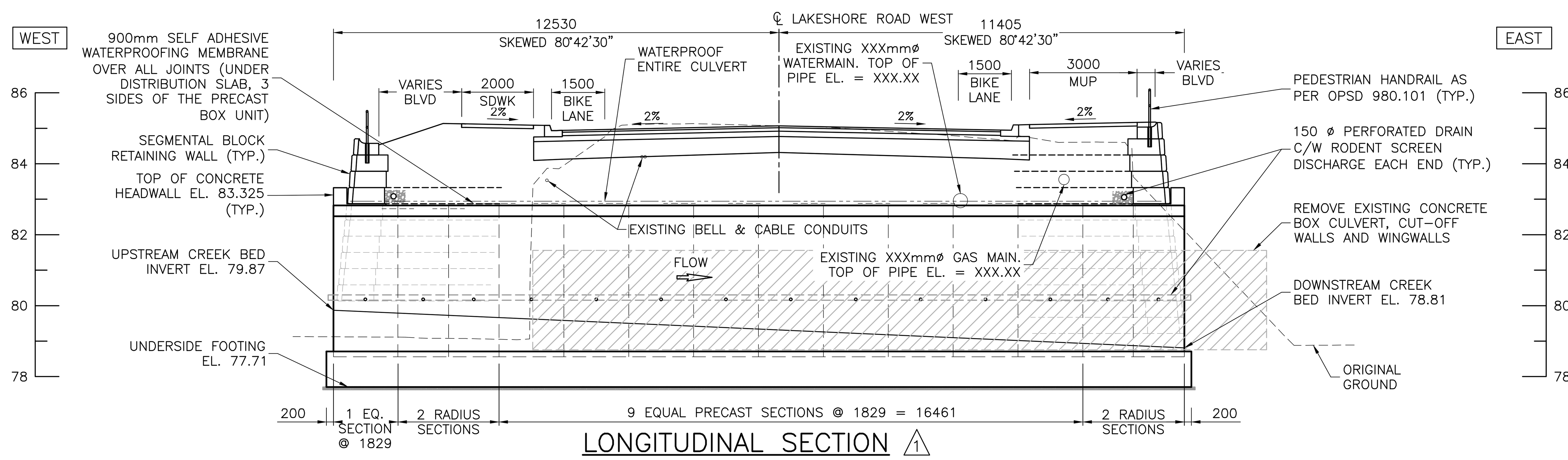
KEY PLAN

CONSTRUCTION NOTES:

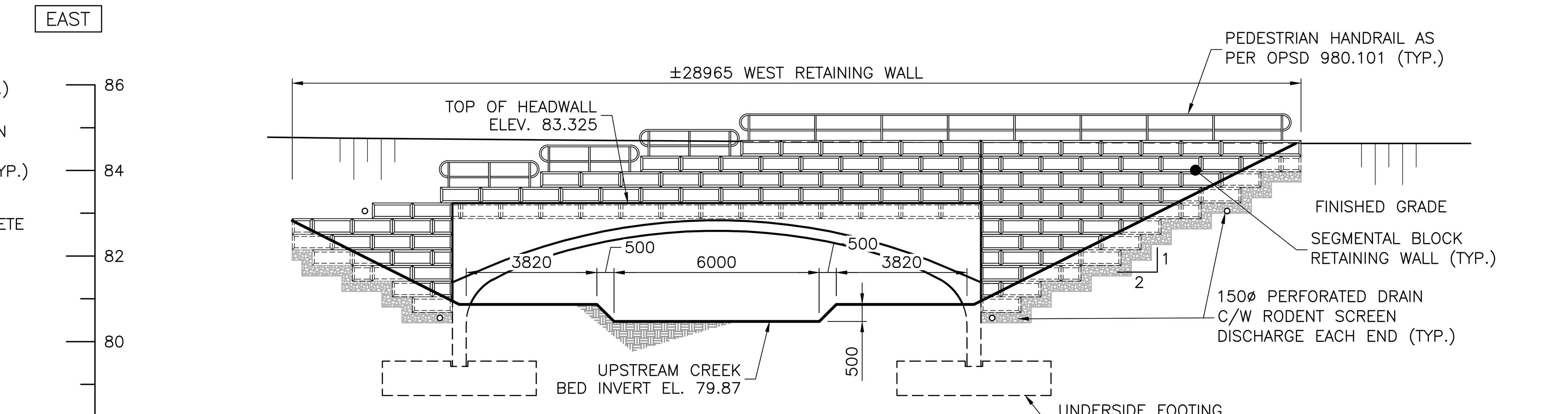
1. BACKFILL SHALL BE PLACED SIMULTANEOUSLY BEHIND BOTH SIDES OF CULVERT KEEPING THE HEIGHT OF THE BACKFILL APPROXIMATELY THE SAME. AT NO TIME SHALL THE DIFFERENCE IN ELEVATION BE GREATER THAN 500mm.
2. THE SUB-BASE SHALL BE FREE FROM FROZEN MATERIAL AND SHALL BE COMPACTED TO SPECIFICATIONS. FROZEN AND SOFTENED MATERIALS SHALL BE REMOVED AND REPLACED WITH SUITABLE COMPACTED MATERIALS. OBTAIN ACCEPTANCE REGARDING SUB-BASE MATERIAL AND COMPACTION FROM THE OWNER'S REPRESENTATIVE PRIOR TO PLACING CONCRETE.

APPLICABLE STANDARDS:

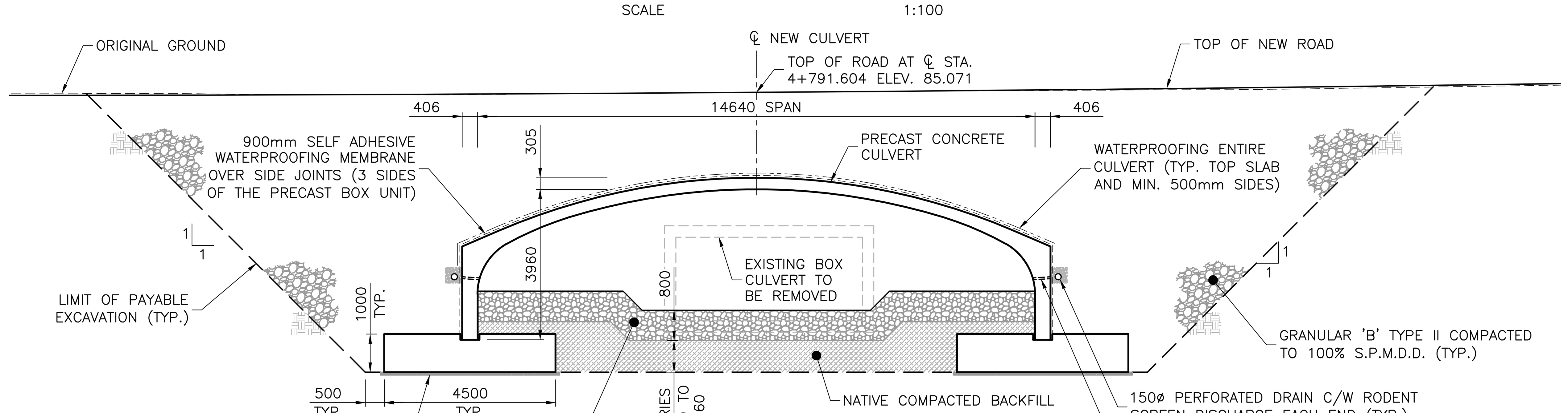
OPSD 3190.100WALLS RETAINING AND ABUTMENT WALL DRAIN



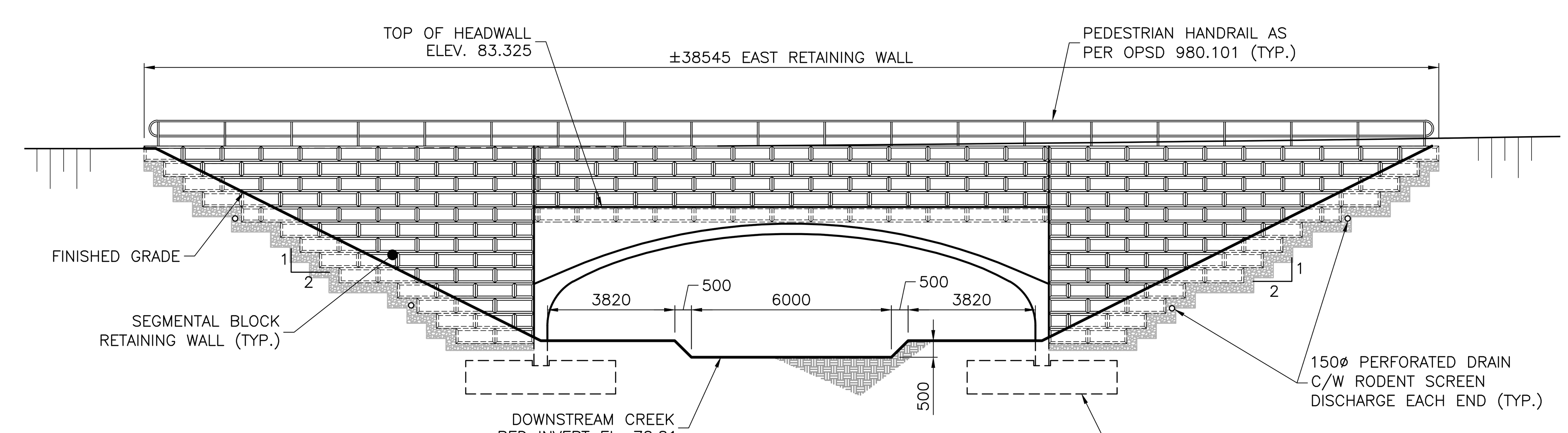
LONGITUDINAL SECTION 1
SCALE 1:100



CULVERT WEST ELEVATION
SCALE 1:125



SECTION 2
SCALE 1:100



CULVERT EAST ELEVATION
SCALE 1:125

No	Date	Drawn	Appr'd	Revisions

APPROVALS

Design	PA	Checked	
Drawn	MEM	Checked	PA
Scale	AS SHOWN		
Date	OCTOBER 2017		

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

LAKESHORE ROAD WEST IMPROVEMENTS - McCRANEY CREEK CULVERT REPLACEMENT
TOWN OF OAKVILLE

GENERAL ARRANGEMENT

amec foster wheeler

Contract No.
Consultant File No. TPB166147
Drawing No. SHEET S01 OF

Path: P:\2016\Projects\TPB166147 – Oakville Lakeshore EA\06_DES-ENG\01_CAD\02_DWGS\03_STRUC\02_CONT\TPB166147-S01 GA.dwg
Plotted By: mariusz.eizenbart Last Saved By: mariusz.eizenbart
Plotted: 2018-03-23 Last Saved: 2018-03-23

17-232 Wood Oakville Lakeshore Rd W - UFI Tree Inventory

Tree	Tag	Common Name	Scientific Name	DBH (cm)	TPZ (m)
1	1937	Manitoba Maple	*Acer negundo*	35	3.0
2	1936	Black Walnut	*Juglans nigra*	25	2.4
3	1935	White Spruce	*Picea glauca*	21	2.4
4	1934	Norway Maple	*Acer platanoides*	12	2.4
5	1933	Manitoba Maple	*Acer negundo*	16	2.4
6		Manitoba Maple	*Acer negundo*	9	1.8
7	1932	Norway Maple	*Acer platanoides*	13	2.4
8	1931	Manitoba Maple	*Acer negundo*	25,17	2.4
9	1930	Manitoba Maple	*Acer negundo*	13,13	2.4
10		Norway Maple	*Acer platanoides*	9	1.8
11	1929	Black Walnut	*Juglans nigra*	25	2.4
12		Eastern White Cedar	*Thuja occidentalis*	7	1.8
13	1928	White Mulberry	*Morus alba*	15	2.4
14	1927	Norway Spruce	*Picea abies*	27	2.4
15		Manitoba Maple	*Acer negundo*	5	1.8
16		Manitoba Maple	*Acer negundo*	9	1.8
17		Black Walnut	*Juglans nigra*	5	1.8
18	1926	Norway Maple	*Acer platanoides*	13	2.4
19	1925	Manitoba Maple	*Acer negundo*	15	2.4
20	1924	Black Walnut	*Juglans nigra*	25	2.4
21	1923	Green Ash	*Fraxinus pennsylvanica*	25,23,19	2.4
22	1922	White Willow	*Salix alba*	43	3.0
23	1921	Green Ash	*Fraxinus pennsylvanica*	30	2.4
24	1920	Green Ash	*Fraxinus pennsylvanica*	18	2.4
25	1919	Norway Maple	*Acer platanoides*	28,22	2.4
26		Black Walnut	*Juglans nigra*	8	1.8
27		Green Ash	*Fraxinus pennsylvanica*	7	1.8
28		Norway Maple	*Acer platanoides*	6	1.8
29	1918	Manitoba Maple	*Acer negundo*	19	2.4
30	1917	Green Ash	*Fraxinus pennsylvanica*	22	2.4
31	1915	Green Ash	*Fraxinus pennsylvanica*	15	2.4
32	1914	Norway Maple	*Acer platanoides*	18	2.4
33	1916	Green Ash	*Fraxinus pennsylvanica*	29	2.4
34	1913	Manitoba Maple	*Acer negundo*	13	2.4
35	1912	Green Ash	*Fraxinus pennsylvanica*	21	2.4
36	1911	Norway Maple	*Acer platanoides*	19	2.4
37	1910	Green Ash	*Fraxinus pennsylvanica*	40	3.0
38	1909	Norway Maple	*Acer platanoides*	51	3.6
39	1908	Green Ash	*Fraxinus pennsylvanica*	21	2.4
40	1907	Green Ash	*Fraxinus pennsylvanica*	17	2.4
41	1906	Green Ash	*Fraxinus pennsylvanica*	27	2.4
42		Green Ash	*Fraxinus pennsylvanica*	9	1.8
43		Green Ash	*Fraxinus pennsylvanica*	9	1.8
44		Green Ash	*Fraxinus pennsylvanica*	7	1.8
45		Norway Maple	*Acer platanoides*	7	1.8
46	1905	Norway Maple	*Acer platanoides*	11	2.4

47	1904	Green Ash	*Fraxinus pennsylvanica*	13	2.4
48	1903	Green Ash	*Fraxinus pennsylvanica*	26	2.4
49	1902	Green Ash	*Fraxinus pennsylvanica*	20	2.4
50	1901	Black Walnut	*Juglans nigra*	19	2.4
51	1969	Black Walnut	*Juglans nigra*	29	2.4
52	1968	Black Walnut	*Juglans nigra*	24,11	2.4
53	1967	White Willow	*Salix alba*	37	3.0
54	1966	Norway Maple	*Acer platanoides*	36	3.0
55	1965	Green Ash	*Fraxinus pennsylvanica*	13	2.4
56	1964	Norway Maple	*Acer platanoides*	23	2.4
57		Sugar Maple	*Acer saccharum*	9	1.8
58	1963	Green Ash	*Fraxinus pennsylvanica*	49	3.0
59	1962	Norway Maple	*Acer platanoides*	17	2.4
60		American Elm	*Ulmus americana*	8	1.8
61	1961	Black Walnut	*Juglans nigra*	13	2.4
62		Norway Maple	*Acer platanoides*	7	1.8
63	1960	Green Ash	*Fraxinus pennsylvanica*	43,33	3.0
64	1959	Green Ash	*Fraxinus pennsylvanica*	17	2.4
65	1958	Green Ash	*Fraxinus pennsylvanica*	31	3.0
66	1957	Norway Maple	*Acer platanoides*	17	2.4
67	1956	Norway Maple	*Acer platanoides*	21	2.4
68	2000	Norway Maple	*Acer platanoides*	15	2.4
69	1999	Black Walnut	*Juglans nigra*	47	3.0
70	1998	Green Ash	*Fraxinus pennsylvanica*	13	2.4
71	1997	American Elm	*Ulmus americana*	12	2.4
72	1955	Norway Maple	*Acer platanoides*	23	2.4
73	1954	Green Ash	*Fraxinus pennsylvanica*	22,15	2.4
74	1953	White Willow	*Salix alba*	27	2.4
75		Basswood	*Tilia americana*	9	1.8
76	1951	Norway Maple	*Acer platanoides*	18	2.4
77		Sugar Maple	*Acer saccharum*	5	1.8
78	1952	Manitoba Maple	*Acer negundo*	50	3.0
79		Norway Maple	*Acer platanoides*	6	1.8
80	1950	White Willow	*Salix alba*	39	3.0
81	1949	Cherry Species	*Prunus* sp.	14	2.4
82	1947	Norway Maple	*Acer platanoides*	36	3.0
83		Green Ash	*Fraxinus pennsylvanica*	9	1.8
84	1944	Norway Maple	*Acer platanoides*	13	2.4
85	1943	Norway Maple	*Acer platanoides*	22	2.4
86	1942	Norway Maple	*Acer platanoides*	23	2.4
87	1945	Green Ash	*Fraxinus pennsylvanica*	38	3.0
88	1946	White Willow	*Salix alba*	45	3.0
89	1996	Green Ash	*Fraxinus pennsylvanica*	25	2.4
90	1939	Silver Maple	*Acer saccharinum*	15	2.4
91	1938	Silver Maple	*Acer saccharinum*	27	2.4
92	1970	White Willow	*Salix alba*	43	3.0
93	1941	Green Ash	*Fraxinus pennsylvanica*	35	3.0

94	1940	Norway Maple	*Acer platanoides*	39	3.0
95	1973	Green Ash	*Fraxinus pennsylvanica*	11	2.4
96	1972	White Willow	*Salix alba*	52	3.6
97	1971	Black Walnut	*Juglans nigra*	60	3.6
98	1993	Black Walnut	*Juglans nigra*	19	2.4
99		Manitoba Maple	*Acer negundo*	7	1.8
100	1992	American Elm	*Ulmus americana*	17,16,10	2.4
101		Black Walnut	*Juglans nigra*	15	2.4
102	1991	Manitoba Maple	*Acer negundo*	10	2.4
103		American Elm	*Ulmus americana*	8,7	1.8
104		Manitoba Maple	*Acer negundo*	9	1.8
105		Green Ash	*Fraxinus pennsylvanica*	25	2.4
106		Norway Maple	*Acer platanoides*	15	2.4
107		American Elm	*Ulmus americana*	6	1.8
108		Green Ash	*Fraxinus pennsylvanica*	6	1.8
109	1990	Green Ash	*Fraxinus pennsylvanica*	10	2.4
110	1989	Green Ash	*Fraxinus pennsylvanica*	10	2.4
111	1995	White Willow	*Salix alba*	29	2.4
112	1994	Black Walnut	*Juglans nigra*	20	2.4
113		Green Ash	*Fraxinus pennsylvanica*	7	1.8
114	1988	Norway Maple	*Acer platanoides*	24	2.4
115		Green Ash	*Fraxinus pennsylvanica*	9	1.8
116		Sugar Maple	*Acer saccharum*	8	1.8
117	1980	Green Ash	*Fraxinus pennsylvanica*	11	2.4
118	1979	Manitoba Maple	*Acer negundo*	17	2.4
119	1981	Norway Maple	*Acer platanoides*	17	2.4
120	1982	Sugar Maple	*Acer saccharum*	21	2.4
121	1985	White Willow	*Salix alba*	52,46,41,47	3.6
122		Green Ash	*Fraxinus pennsylvanica*	7	1.8
123	1984	Green Ash	*Fraxinus pennsylvanica*	10	2.4
124		Green Ash	*Fraxinus pennsylvanica*	6	1.8
125	1983	Norway Maple	*Acer platanoides*	23	2.4
126	1986	Green Ash	*Fraxinus pennsylvanica*	12	2.4
127		Norway Maple	*Acer platanoides*	8	1.8
128		Norway Maple	*Acer platanoides*	5	1.8
129		Green Ash	*Fraxinus pennsylvanica*	5	1.8
130	1987	Norway Maple	*Acer platanoides*	11	2.4
131		Norway Maple	*Acer platanoides*	7	1.8
132		Green Ash	*Fraxinus pennsylvanica*	9	1.8
133	1978	Green Ash	*Fraxinus pennsylvanica*	16	2.4
134		Green Ash	*Fraxinus pennsylvanica*	6	1.8
135		Green Ash	*Fraxinus pennsylvanica*	9	1.8
136		Green Ash	*Fraxinus pennsylvanica*	5	1.8
137	1977	Green Ash	*Fraxinus pennsylvanica*	23	2.4
138	962	Norway Maple	*Acer platanoides*	23	2.4
139		Norway Maple	*Acer platanoides*	5	1.8
140	960	Colorado Spruce	*Picea pungens*	32,29	3.0

141	961	Buckthorn Species	*Rhamnus* sp.	20	2.4
142	963	Colorado Spruce	*Picea pungens*	38	3.0
143	964	Colorado Spruce	*Picea pungens*	53	3.6
144	959	Silver Maple	*Acer saccharinum*	22	2.4
145	966	Norway Maple	*Acer platanoides*	15	2.4
146		Norway Maple	*Acer platanoides*	8	1.8
147		Green Ash	*Fraxinus pennsylvanica*	5	1.8
148	967	Black Walnut	*Juglans nigra*	14	2.4
149		Black Walnut	*Juglans nigra*	5	1.8
150	968	Green Ash	*Fraxinus pennsylvanica*	27	2.4
151		Green Ash	*Fraxinus pennsylvanica*	9	1.8
152		Norway Maple	*Acer platanoides*	6	1.8
153		Norway Maple	*Acer platanoides*	5	1.8
154		Norway Maple	*Acer platanoides*	5	1.8
155	972	Green Ash	*Fraxinus pennsylvanica*	25	2.4
156	971	Pussy Willow	*Salix discolor*	21,20,12,12	2.4
157		Manitoba Maple	*Acer negundo*	7	1.8
158		Green Ash	*Fraxinus pennsylvanica*	8	1.8
159		Green Ash	*Fraxinus pennsylvanica*	5	1.8
160		Green Ash	*Fraxinus pennsylvanica*	5	1.8
161	1975	Norway Maple	*Acer platanoides*	13	2.4
162		Green Ash	*Fraxinus pennsylvanica*	6	1.8
163	1976	White Willow	*Salix alba*	36	3.0
164	1974	Green Ash	*Fraxinus pennsylvanica*	18	2.4
165	969	Green Ash	*Fraxinus pennsylvanica*	19	2.4
166	965	Silver Maple	*Acer saccharinum*	29	2.4
167		Black Walnut	*Juglans nigra*	9	1.8
168	958	Black Walnut	*Juglans nigra*	23	2.4
169		Black Walnut	*Juglans nigra*	7	1.8
170	957	Colorado Spruce	*Picea pungens*	53	3.6
171	956	Staghorn Sumac	*Rhus typhina*	13	2.4
172	955	Black Walnut	*Juglans nigra*	27	2.4
173	954	Colorado Spruce	*Picea pungens*	31	3.0
174	1000	Silver Maple	*Acer saccharinum*	20,18	2.4
175	999	Colorado Spruce	*Picea pungens*	36	3.0
176	997	Norway Maple	*Acer platanoides*	10	2.4
177	996	Norway Maple	*Acer platanoides*	17	2.4
178	995	Norway Maple	*Acer platanoides*	10	2.4
179		Norway Maple	*Acer platanoides*	7	1.8
180	994	Green Ash	*Fraxinus pennsylvanica*	17	2.4
181	992	Green Ash	*Fraxinus pennsylvanica*	13	2.4
182	991	Green Ash	*Fraxinus pennsylvanica*	17	2.4
183	983	Manitoba Maple	*Acer negundo*	22	2.4
184	990	Manitoba Maple	*Acer negundo*	15	2.4
185	988	Manitoba Maple	*Acer negundo*	12	2.4
186	989	Black Walnut	*Juglans nigra*	14	2.4
187	998	Black Locust	*Robinia pseudoacacia*	26	2.4

188		Manitoba Maple	*Acer negundo*	5	1.8
189	887	Manitoba Maple	*Acer negundo*	12	2.4
190	886	Black Locust	*Robinia pseudoacacia*	50,45,43,21	3.0
191		Norway Maple	*Acer platanoides*	7	1.8
192		Norway Maple	*Acer platanoides*	7	1.8
193	985	Manitoba Maple	*Acer negundo*	21	2.4
194		Norway Maple	*Acer platanoides*	6	1.8
195	984	Manitoba Maple	*Acer negundo*	11	2.4
196	982	Manitoba Maple	*Acer negundo*	42	3.0
197	981	Black Walnut	*Juglans nigra*	40	3.0
198	980	Norway Maple	*Acer platanoides*	11	2.4
199	979	Manitoba Maple	*Acer negundo*	12	2.4
200		Green Ash	*Fraxinus pennsylvanica*	7	1.8
201		Basswood	*Tilia americana*	9	1.8
202	978	Black Walnut	*Juglans nigra*	33,23	3.0
203		Manitoba Maple	*Acer negundo*	8	1.8
204		Green Ash	*Fraxinus pennsylvanica*	5	1.8
205		Green Ash	*Fraxinus pennsylvanica*	5	1.8
206		Manitoba Maple	*Acer negundo*	5	1.8
207		Black Walnut	*Juglans nigra*	30	2.4
208	977	Manitoba Maple	*Acer negundo*	27	2.4
209		Green Ash	*Fraxinus pennsylvanica*	6	1.8
210		Green Ash	*Fraxinus pennsylvanica*	5	1.8
211	976	Norway Maple	*Acer platanoides*	25	2.4
212	975	Norway Maple	*Acer platanoides*	22,8	2.4
213	974	Norway Maple	*Acer platanoides*	34	3.0
214	973	Norway Maple	*Acer platanoides*	31	3.0
215	972	Norway Maple	*Acer platanoides*	27	2.4
216	971	Norway Maple	*Acer platanoides*	21	2.4
217	970	Norway Maple	*Acer platanoides*	22	2.4
218		Green Ash	*Fraxinus pennsylvanica*	8	1.8
219		Green Ash	*Fraxinus pennsylvanica*	5	1.8
220		Green Ash	*Fraxinus pennsylvanica*	5	1.8
221		Green Ash	*Fraxinus pennsylvanica*	5	1.8
222		Green Ash	*Fraxinus pennsylvanica*	6	1.8
223		Green Ash	*Fraxinus pennsylvanica*	5	1.8
224		Green Ash	*Fraxinus pennsylvanica*	5	1.8
225	967	Norway Maple	*Acer platanoides*	20	2.4
226	965	Norway Maple	*Acer platanoides*	21	2.4
227	966	Black Walnut	*Juglans nigra*	50	3.0
228	964	Basswood	*Tilia americana*	13	2.4
229	963	Norway Maple	*Acer platanoides*	20	2.4
230	962	Red Oak	*Quercus rubra*	46	3.0
231	961	Norway Maple	*Acer platanoides*	16	2.4
232	960	Green Ash	*Fraxinus pennsylvanica*	17	2.4
233	095X	Norway Maple	*Acer platanoides*	10	2.4
234	959	Basswood	*Tilia americana*	53	3.6

235	957	Norway Maple	*Acer platanoides*	24	2.4
236	956	Norway Maple	*Acer platanoides*	16	2.4
237		Norway Maple	*Acer platanoides*	5	1.8
238	955	Norway Maple	*Acer platanoides*	27	2.4
239	954	Green Ash	*Fraxinus pennsylvanica*	46	3.0
240		Norway Maple	*Acer platanoides*	7	1.8
241	953	Green Ash	*Fraxinus pennsylvanica*	15	2.4
242	952	Norway Maple	*Acer platanoides*	22	2.4
243		Norway Maple	*Acer platanoides*	9	1.8
244	951	Silver Maple	*Acer saccharinum*	87	5.4
245		Black Walnut	*Juglans nigra*	5	1.8
246		Black Walnut	*Juglans nigra*	9	1.8
247		Green Ash	*Fraxinus pennsylvanica*	5	1.8
248	968	Norway Maple	*Acer platanoides*	89	5.4
249	969	Norway Maple	*Acer platanoides*	28	2.4
250		Green Ash	*Fraxinus pennsylvanica*	5	1.8
251		Manitoba Maple	*Acer negundo*	8	1.8
252		Manitoba Maple	*Acer negundo*	8	1.8
253		Manitoba Maple	*Acer negundo*	6	1.8
254		American Elm	*Ulmus americana*	8	1.8
255		American Elm	*Ulmus americana*	9	1.8
256		American Elm	*Ulmus americana*	7	1.8
257		American Elm	*Ulmus americana*	5	1.8
258		Manitoba Maple	*Acer negundo*	5	1.8
259		Green Ash	*Fraxinus pennsylvanica*	5	1.8
260		Manitoba Maple	*Acer negundo*	9	1.8
261		American Elm	*Ulmus americana*	8	1.8
262		American Elm	*Ulmus americana*	5	1.8
263		Manitoba Maple	*Acer negundo*	7	1.8
264		Manitoba Maple	*Acer negundo*	8	1.8
265		Manitoba Maple	*Acer negundo*	9	1.8
266		Norway Maple	*Acer platanoides*	7	1.8
267	950	American Elm	*Ulmus americana*	20	2.4
268	946	Norway Maple	*Acer platanoides*	56	3.6
269	945	Norway Maple	*Acer platanoides*	44	3.0
270	949	Basswood	*Tilia americana*	30	2.4
271	948	Basswood	*Tilia americana*	26	2.4
272	947	Black Walnut	*Juglans nigra*	43	3.0

Fluvial Geomorphology FINAL v2
Lakeshore West EA - AquaLogic March.19.2018

Fluvial Geomorphology Review and Preliminary Channel Design
Fourteen Mile Creek & McCraney Creek
Lakeshore Road West Improvements
Class Environmental Assessment
Town of Oakville

Submitted to:

Wood PLC
3450 Harvester Road, Suite 100
Burlington, ON L7N 3W5

DRAFT April 4, 2017 / 2nd DRAFT May 19, 2017 / FINAL March 19, 2018

AquaLogic

AquaLogic Consulting • 324 St. Paul Street, Burlington, ON L7R 3J9 • (905) 637-1862 • bill.degeus@sympatico.ca

Fluvial Geomorphology Review and Preliminary Channel Design
Fourteen Mile Creek & McCraney Creek
Lakeshore Road West Improvements Class Environmental Assessment
Town of Oakville

Fourteen Mile Creek and McCraney Creek have been investigated based on fluvial geomorphic requirements for Lakeshore Road improvements in the Town of Oakville. Scoping level characterization review including rapid assessments, summary of meander belt and erosion limits leading to recommendations for crossing geometry, and guidance recommendations for scour treatment and erosion control, have been undertaken.

Proposed preliminary channel design analysis and plotting has been undertaken specifically for McCraney Creek. Existing conditions include a valley wall contact erosion site coincident with the Lakeshore Road embankment on the upstream west side of the crossing. Emergency protection treatment has been installed but a long term solution is required for integration with proposed road widening and other improvements.

Watershed and Watercourse Characterization

Fourteen Mile Creek

Fourteen Mile Creek is a 3rd order watercourse with an upstream drainage area of approximately 25.8km^2 to the study area. The site falls within the Iroquois Plain physiographic region. Upstream catchment land use consists of low and some mixed density residential, industrial and commercial, protected valley, golf course, rural, and highway corridor. Several stormwater management ponds are seen in the residential catchment areas of the watershed.

The local watercourse from upstream to downstream of the Lakeshore Road crossing (~18m long open bottom span) consists of three distinct sub-reach types. Upstream of the crossing, two block high embedded armourstone bank treatment and armourstone grade control steps (three) have been installed with additional riverstone fill and shaping, over a length of 50m. Tree and shrub planting has been done along the top of bank behind armourstone with shrubs also colonizing the intervening riverstone treatment. A local storm sewer outlet is accommodated through the face of armourstone on the upstream left side just above the crossing wall. The armoured banks transition flush to the existing crossing width of approximately 15m. The alignment of the channel into the crossing biases flow against the westerly wall with depositional material biased easterly and extending slightly downstream. The downstream east side also shows distinct sedimentary bedrock layers exposed at and slightly above the elevation of the low flow. Downstream of the crossing, natural wooded flood plain conditions occur along the riparian zone with a single low head armourstone grade control, and additional riverstone bank treatment, installed in and along the channel.

Bankfull channel width in proximity to Lakeshore Road varies from approximately 8-11m on the downstream side of the crossing where natural indicators can be identified. Bankfull depth ranges broadly between approximately 0.5m to 1.5m downstream of the crossing, but is highly variable under the crossing to the upstream side due to deep scour pools, as noted below. Armourstone channelization on the upstream side precludes good definition of the bankfull channel. Bedform development is influenced by the presence of the armourstone step structures both upstream and downstream of the crossing. Below the sequence of three steps upstream of the crossing, a distinct scour pool has formed with a maximum low flow depth of 1.7m. This pool has incised through a clay till layer and sedimentary shale and limestone under the till. A subsequent deep pool exists under the crossing biased to the westerly downstream side. Similar till and bedrock geology is seen in this pool, which has a low flow depth of 1.4m. Below the end of the pool outside of the crossing the next armourstone step weir is drowned out by backwater from the crest of deposits further downstream.

Native channel bed geology consists of a wide gradation of shale dominant sand to cobble and boulder sized material mixed with imported gravel to cobble sized riverstone used within channelization geometry. Block shaped limestone cobble to boulder material also mixes with the shale. Much of the large cobble and small boulder sized material appears relatively stable under frequent flow conditions with algae and mineralization stains on water contact faces. Degradation and incision nonetheless indicates that weathering breakdown and scour occurs under peak events. Some erosion of banks above both sides of the step weir downstream of the crossing is evident. The pool under the crossing biased to the west side has scoured its deepest thalweg point against the crossing wall and some bank erosion naturally extends down the west side bank immediately from the crossing face.

McCraney Creek

McCraney Creek is a 2nd order watercourse with an upstream drainage area of approximately 10km^2 to the study area. The site falls within the Iroquois Plain physiographic region. The upstream catchment area is dominated by mixed density residential, with protected valley, institutional, commercial and industrial, vacant rural, and highway corridor land uses. There is a lack of stormwater management ponds in the catchment.

The watercourse upstream of Lakeshore Road turns sharply west and is fully confined against the roadside embankment before turning northerly up the valley corridor. The corridor is a relatively mature forest feature that results in high levels of shading and reduced groundcover density. Rooting density is thus lower than optimum for channel protection. The roadside embankment confinement is a distinct vertical eroding slope at a maximum height of 4.5m which tapers down to approximately 1m high over 40m of meander arc (see report cover picture of pre emergency works installation conditions). Recent emergency treatment stone works have been installed (by early 2018) to partially address the pre-existing erosion scar. The former vertical erosion scar transitioned to be an undercut channel edge scar which can still be seen moving upstream past the limits of recent work. A local storm sewer outlet set back from the eroding bank also results in an entrenched gully that cuts through the channel bank. This erosion reach is identified as the top ranking *Priority Localized Area of Concern* in the Town of Oakville's "Creek Inventory and Assessment Study" (Aquafor Beech 2016).

The channel enters the crossing in a sharp turn that is characterized by a distinct outcrop mound of sedimentary limestone bedrock at the crossing face that splits the low flow and that appears to extend under the crossing footings. The bedrock transitions to a cast concrete channel bed apron that is in a failed condition with dislodged elements downstream. The lip of the failed concrete results in a drop to a scour pool and widened flow from wall to wall that is approximately 0.9m deep. A distinct clay till layer also emerges at the face of the drop under which are further layers of shale and limestone. The pool extends several metres to approximately two thirds of the length of the crossing. The crossing structure itself is actually two structures of different age and geometry, butted together. The north half is a cast concrete open bottom arch with vertical lower walls and the south half is an open bottom precast box. The opening width is approximately 5.4m.

Through the downstream face of the crossing and southerly towards Lake Ontario the channel is relatively straight, over widened, and lined with dual armourstone rows on the west from the crossing. The channel passes under an approximate 10m span of a pedestrian bridge on the Appleby College property, 20m downstream. Similar forested conditions as upstream exist downstream and similar lack of rooting density is evident.

Bankfull channel width varies from approximately 5-8m where natural indicators can be identified. Bankfull depth varies from approximately 0.5-1m. Bedform development is influenced by the presence of sedimentary shale and limestone layers in various states of weathering and breakdown. Deposits of gravel to boulder sized bedrock fragments are distinct upstream and downstream of the crossing and weathered layers are seen in toe erosion above low flow. The embankment slope erosion site upstream of the crossing has a deep sand face layer above bedrock up to the height of topsoil cover.

The downstream easterly bank below the crossing also shows moderate erosion down through the piles supporting the pedestrian bridge. A small amount of ad hoc stone and concrete debris protection appears to be placed along this bank. Bed material beyond the crossing limits appears to be a mix of stable and mobile sizes, above and below medium cobble range respectively. Channel evolution conditions appear to be a legacy of past incision evolving into more current widening dominant processes. The level of bedrock exposure and stone pavement bed cover is generally more resistant than channel bank soils and this has resulted in the noted erosion scars resulting from channel widening.

Rapid Assessment Protocols

Three rapid assessment protocols were undertaken for the upstream and downstream sub-reaches and for a sub-reach directly under each crossing. Field observations were used to score relative geomorphic and environmental attributes. Rapid Geomorphic Assessment (RGA) was used to rate channel stability and infrastructure impact. Rapid Habitat Assessment (RHA) was used to define in-stream and riparian habitat. Rapid Stream Assessment Technique (RSAT) was used to test broad indicators of channel stability, aquatic habitat, and water quality. A weighted score out of 100 was transposed from the results of each protocol and a combined average score was determined from the three tests. Four qualifying ranges of poor, fair, good, and optimal are maintained in the RHA and RSAT protocols, between the original scoring and the weighted scoring out of 100, while the three original ranges in RGA scoring are reflected as fair, good, and optimal (urban vs. natural conditions considered). The combined average score is qualified by poor to optimal ranges designed as a best fit of the individual protocol ranges. The upstream sub-reach for McCraney Creek was specifically assessed based on pre-existing conditions before recent emergency works were installed. The detailed results are appended and included with each are photographs of typical reach conditions. Scoring results are summarized in **Table 1**.

Table1: Rapid Assessment Protocol Summary Scoring Results

	RGA	RHA	RSAT	Combined
Fourteen Mile u/s of Lakeshore Road	86.4	68.5	72.0	75.6
Fourteen Mile crossing	72.1	62.5	60.0	64.0
Fourteen Mile d/s of Lakeshore Road	64.3	75.0	70.0	69.8
McCraney u/s of Lakeshore Road	58.2	61.0	52.0	57.1
McCraney Crossing	69.3	57.5	56.0	60.9
McCraney d/s of Lakeshore Road	73.2	65.5	56.0	64.9

The results of rapid assessment confirm generally fair to good channel conditions given the urban context. Stability is highest in the armoured reach of Fourteen Mile Creek and lowest through the significant erosion site on McCraney Creek upstream of the crossing. Habitat assessment generally scores in the fair to lower range of good, based on reasonable riparian and bed conditions, with lowest scores reflecting the short sub-reaches within each crossing structure. Each structure nonetheless provides large pool habitat, as described in the characterization discussion. The rapid assessments do not necessarily reflect positive habitat benefits from manmade structures, or specific functions of specific individual features.

Meander Belt Analysis

Fourteen Mile Creek

The Fourteen Mile Creek crossing creates a fixed horizontal control to the watercourse due to the existing structure walls and the upstream erosion control transition into the structure. Constraints between historical abutting land uses and legal property boundaries also contribute to limited opportunity to consider crossing relocation or very large span increases. As a result, detailed pre-development historic channel planform conditions are not deemed necessary for meander belt or amplitude screening, and a review of relatively recent conditions was deemed appropriate.

Comparisons of digital air photos (Town of Oakville, 2015) spanning 1995 to 2015 (1995, 1999, 2002, 2006, 2008, 2010, 2012, 2015) was done. Using the 1999 (better clarity than 1995) and 2015 photos a side by side comparison and digital centre line trace was made of natural channel patterns downstream of the crossing. The detailed results are appended.

The comparison shows essentially identical planform patterns at both intervals. As a result, there is no evidence of expansive amplitude or expansive meander belt development. Likewise there is no evidence of reach or meander based up or down valley translation of aggressive erosion patterns. Based on this summary there is a lack of opportunity, and no explicit need, to make recommendations for meander pattern related requirements for crossing sizing.

The existing planform based point of crossing is not explicitly perpendicular to a straight section of the watercourse. The upstream channelization creates the equivalent of a large radius westerly meander arc which results in the existing low flow bias against the westerly wall within the crossing. This also results in the bar formation within and downstream of the crossing, as biased to the east side. The best fit cross-section within the crossing under future conditions would thus be an asymmetrical pool with the thalweg biased westerly.

Requirements of OMNRF permitting regarding Redside Dace habitat dictate meander belt identification, plus additional setback, to define permit limits.

Cross-reference to topographic and GIS mapping contour patterns shows evidence of past meander development downstream of the crossing. This planform pattern may have existed well before the original construction of Lakeshore Road. Appended schematics show the pattern and a hypothetical meander belt width of approximately 75m. For comparison, meander belt limits were also defined by an empirical data approach. The appended regional regression analysis shows Southern Ontario meander belt measurement as a function of drainage area. The calculated meander belt width was determined to be 64.2m using this approach. The measured limits of 75m are seen to fall within the data scatter in the regime relationship but are more conservative than the best fit, and are thus recommended for implementation.

The bias in downstream valley bottom definition and the resultant bias in the measured belt limits are to the east of the crossing. For implementation ease it is suggested that a one third westerly to two thirds easterly split in the belt limits be applied in the work zone for road improvements. This results in 25m west of centre and 50m east of centre of the crossing defining the belt limit habitat zone, measured on the centre line of Lakeshore Road. An appended air photo schematic shows the proposed alignment of the belt limits and the additional 30m Redside Dace habitat zone setbacks required by Ontario Regulation 242/08 of the Endangered Species Act (OMNRF 2016).

McCraney Creek

The McCraney Creek crossing creates a 5.4m wide fixed horizontal control to the watercourse due to the existing structure walls. Constraints between historical abutting land uses and legal property boundaries also contribute to limited opportunity to consider crossing relocation or very large span increases. As a result, detailed pre-development historic channel planform conditions are not deemed necessary for meander belt or amplitude screening, and a review of relatively recent conditions was deemed appropriate.

Comparisons of digital air photos (Town of Oakville, 2015) spanning 1995 to 2015 (1995, 1999, 2002, 2006, 2008, 2010, 2012, 2015) was done. Using the 1999 (better clarity than 1995) and 2015 photos a side by side comparison and digital centre line trace was made of natural channel patterns downstream of the crossing. The detailed results are appended.

The comparison shows essentially identical planform patterns at both intervals with possible reflection of some down valley movement in the eroding bend leading directly into the crossing. There is no evidence of widespread expansive amplitude or expansive meander belt development. Based on this summary there is a lack of opportunity, and no explicit need, to make recommendations for meander pattern related requirements for crossing sizing. Addressing the erosion site upstream of the crossing will involve in-situ adjustment of the channel that will likely result in some adjustment of the planform leading to the crossing.

100yr Erosion Limits

The results of meander belt analysis identify a lack of need to consider opening widths in terms of planform patterning. The shift in focus therefore turns to localized channel stability using standard criteria from existing guidelines. From a geomorphic perspective, opening width and protection requirements are based on a combination of bankfull channel width plus appropriate 100yr erosion contingency integrated with scour treatment requirements. A lower standard can be used when constraints are identified. Scour treatments are shaped to define bankfull channel geometry and are enhanced with appropriate substrate for fish habitat and barrier free fish passage (details discussed further below).

The crossing locations are targeted for channel stability based on the 100yr scour protection requirements of MTO Guidelines WC-1/WC-3 for collector roads (MTO 2008). A Provincial Guideline criterion for 100yr erosion limits (MNR 2002) in turn applies for stable channel definition given the installation of scour treatments. Five field measurements were made of bankfull channel width in proximity to each crossing and the appropriate channel setback is deemed to be the equivalent of stable conditions. Appended is a summary of bankfull measurements combined with the recommended setbacks based on Provincial Guidelines. The diverse channel bed sediment conditions ranging from weathered shale and limestone to clay till would suggest the median criteria from the guideline range. An average setback of 3.5m satisfies integrated consideration of bedrock with evidence of erosion and stable heterogeneous soils, for channels over 5m wide. Using average bankfull widths of 9.5m and 6.5m for Fourteen Mile and McCraney respectively, the recommended opening widths of 16.5m and 13.5m would apply, subject to implementation of scour protection treatment. The existing crossing opening of Fourteen Mile Creek is moderately smaller (15m) than recommended (16.5m) and the existing crossing of McCraney Creek is significantly smaller (5.4m) than recommended (13.5m). The existing opening width for Fourteen Mile Creek is deemed acceptable because the relative difference to recommended is minor from a geomorphic perspective, and because related hydraulic and structural analysis confirms the structure to be acceptable. Consideration for widening and related channel and corridor integration can be done when the structure requires replacement due to life cycle structural deficiencies.

McCraney Creek Preliminary Channel Design Analysis

Design Rationale

The existing slope toe contact erosion site on the upstream west side of the crossing dictates that either a protect in place strategy or a channel realignment strategy be used to address the hazard and risk, in association with road widening and other road improvements. The recently installed emergency works only partially resolve the problem. The widening proposal for Lakeshore Road necessitates crossing width enlargement and crossing length increases to the upstream side. These geometry changes need to adjust the creek alignment regardless of existing conditions and clearly it would be unreasonable to only move the creek insofar to realign it along the new slope/abutment toe when a better solution exists.

Existing conditions are also impacted by the full confinement of the two existing old crossing structures, the presence of a low flow bedrock encroachment on the upstream side of the existing crossing, and the lack of bedform sequencing that matches upstream and downstream. The full confinement impacts terrestrial corridors for small mammal movement, with the westerly slope toe confinement completely closing off corridor continuity on this side. The existing crossing width confinement also results in a lack of conveyance capacity from an engineering perspective.

Channel realignment achieves a better integrated corridor solution by providing channel integrity and symmetrical terrestrial function on both sides instead of just one. Realignment eliminates the slope contact hazard and replaces it specifically with a new slope at better angle with reinforcing vegetation. Based on this summary the realignment channel design solution was pursued for detailed analysis as the preferred option.

The design rationale advocated for the upstream to downstream realignment and the McCraney Creek crossing is rehabilitation of reference conditions that result in improved channel performance and corridor function. Accommodation of bankfull channel width with overbank setbacks is intended to achieve stable geomorphic form with fish passage and habitat improvement, and terrestrial linkage.

Flow Regime

Flow regime conditions for the proposed channel design are based on field survey of existing active flow or bankfull conditions. Field survey was done at two representative locations, upstream and downstream of the existing crossing, to determine a target bankfull flow.

Channel bed and bank geometry and bankfull flow geomorphic indicators were measured at each cross-section for use in geomorphic modeling. Channel bed substrates were measured through random-step Wolman pebble counts and recorded using the Wentworth sediment distribution scale. Cross-section locations were selected on evidence of active channel processes and defined bankfull shape and stage. Points of significant organic debris blockage that create localized backwater conditions were avoided. Observable tailwater flow indicators such as matted or flattened vegetation edges and root structures were located along banks and within encroaching vegetation for demarcation of cross-section limits.

Geomorphic open channel flow models were created for each cross-section location. Each model required input of channel bed substrate data, cross-section dimensions, gradient, and bank geometry. Modeling tests were done for each cross-section to determine hydraulic geometry, erosion thresholds, and bankfull flow. The detailed modeling results for existing bankfull conditions are appended. The proposed design bankfull flow rate was determined to be $3.65m^3\ s^{-1}$. Based on the urbanized watershed context and lack of known upstream stormwater management facilities it is expected that bankfull or channel forming flows occur potentially several times a year and that peak events have flashy timing. Erosion threshold indicators from proposed design sections are not extreme, with velocity ranging from $1.1\text{-}1.4m\ s^{-1}$ and shear stress ranging from $30\text{-}80N\ m^{-2}$/. Indicators are moderately high enough however that sympathetic design treatments are warranted, given the specific consideration that shading will impact vegetative reinforcement.

Cross-Section Design

Based on the results of opening width recommendations and the surveys of existing bankfull conditions, proposed design cross-section models were produced for riffle and pool features that mimic the existing channel type at channel forming flow. The sections were designed at the average bankfull width noted in erosion limits discussion. Detailed results are appended showing the proposed bankfull channel forming geometry. Channel forming slope used in section models was adjusted to match the combination of proposed planform requirements and hydraulic analysis. Riffle slope was modeled at feature face slope to be conservative for stability design and to not constrain fish passage.

In daylight areas it is recommended that low bank height vegetated stone revetments be used along outside pool banks that transition to intervening riffles. This will fix the new realignment in place while vegetation establishes over time. As noted, the corridor shading will impact some vegetative growth but using vegetation within stone protects rooting development from the potential impact of frequent bankfull flow events. It is further recommended to construct pools as symmetrical instead of asymmetrical cross-sections. This will initially shift the thalweg or deepest point away from the bank apex and allow the thalweg to adjust over time. In weathered shale bedrock and forested conditions this is preferred as it initially shifts the highest shear and to a degree the highest velocity away from newly installed vegetation, seeding, and topsoil placement. The intent is to maximize the opportunity for vegetation to establish as much as possible in the constrained geologic and canopy shade environment.

Within the crossing the proposed bankfull cross-section and overbanks will be shaped within the recommended scour treatment minus cover cap depth for overbank terraces and bed cover depth for fish habitat, as described further below. The overbanks from the bankfull limits should be essentially flat to the crossing wall limits. The upstream and downstream crossing tie-ins will need to have overbank grading that blends from existing. These areas are recommended for integrated erosion protection treatment as needed in the contraction and expansion zones.

An additional consideration in detailed cross-section design and implementation is the identified deep pool that currently exists specifically within the existing crossing. This pool has incised into bedrock and provides a unique feature that is uncommon otherwise within the general reach from further downstream to further upstream. Based on the distinct form and function of this pool it is recommended that it be preserved as best as possible with new channel construction. Demolition of the existing structure may impact the lateral limits of this pool therefore it is imperative to specifically include adequate restoration with stable treatment that restores the feature morphology. It is assumed that it will be necessary to inspect the feature in post demolition conditions to adjust any detailed design plans. Regardless of selection of scour treatment typology a more specific treatment may be needed for the pool.

Scour Treatment

Scour treatment design was undertaken using proposed conditions indicators from HEC-RAS modeling. Typically the 100yr event design standard is used for analysis, subject to site specific conditions. A lower standard is used when constraints are identified and understood. Using 'collector road' criteria, a 1.15 factor of safety is applied to scour treatment analysis to meet the intent of MTO Highway Drainage Design Standards (MTO 2008). HEC-RAS review shows that velocity supersedes shear stress with regard to stability of channel materials therefore velocity was used for analysis. The maximum 100yr event velocity of 3.34m s^{-1} through the proposed structure was used as input for a treatment sizing model and the FS=1.15 was applied. Detailed results of modeling are appended. Given the high relative velocity and high factor of safety, the recommended stone size treatment is excessive with the D_{100} equal to 1.1m and a D_{50} of 0.8m diameter for rounded stone. Layer thickness would be onerous and potentially deeper than proposed footing depth. As a result, an alternate best fit solution was iteratively checked for the maximum realistic solution.

Review of upstream and downstream conditions shows that velocities are generally lower in the wider flood plain conditions than within the crossing, as expected. Specifically, as flows drop to and below the 25yr event, velocities drop to be within a realistic range for vegetative reinforcement and typical levels of stability for cobble to boulder gradation of bed materials. There is still risk to exposed and unprotected banks where vegetation is lacking due to shading of groundcover growth but the 25yr event appears practical as a continuum target for the crossing. An additional stone size treatment test was done at the 25yr event velocity, in the crossing, of 3.09m s^{-1} with FS=1. Detailed results are appended. This velocity is moderately lower than the 100yr and with lower FS results in a more realistic stone treatment gradation. Representative D_{100} and D_{50} sizes are 70cm and 55cm respectively for riverstone. Given that weathered sedimentary shale bedrock is expected within excavations, and potentially more resistant limestone layers, it is recommended that angular stone is better suited to both the geologic environment and from a stability perspective in both engineering and geomorphic terms. This will provide a better level of surface contact and thus resistance to movement. A summary sheet is appended, after stone size modeling sheets, showing the recommended treatment details.

Installation of stone treatment in the clear span crossing will have overbanks in-filled with cohesive soil to a balance line 20cm above the installed stone depth to match upstream and downstream daylight grades and to mimic bare native soil that would exist under shaded crossing conditions. The fill cap should be compacted in place to a level natural surface that allows movement of small mammals along the created overbank terrace. Within the bankfull channel limits, re-used native creek bed substrate material will be used as void fill of the scour treatment. The void fill will define the constructed bankfull and low flow geometry to mimic physical stream bed conditions for fish habitat and barrier free passage per the intent of MTO WC-12 guidelines (MTO 2008), MTO fish habitat mitigation (MTO 2009), and CH requirements.

The lack of groundcover and forest shading under future conditions is expected to persist therefore an extension zone of treatment that helps create defined channel entry and exit, and a buffer around the ends of the crossing walls, is recommended. Vegetated stone revetment treatments of the bankfull channel can be sized similarly to scour protection stone and a fully integrated solution can be achieved.

The preferred scour treatment approach is influenced by alternate options that follow current practice and requirements of Conservation Halton and the Ontario Ministry of Natural Resources and Forestry. Appended schematics show the MTO Guideline approach followed by CH and OMNRF approaches. Summary annotations are provided regarding the treatments and summary discussion is provided of the risk levels and functional values of each option. The MTO Guideline approach is the preferred approach recommended for municipal design. Potential channel reconstruction and restoration is deemed to be a risk at less than the highest standard possible. Maintenance costs and practical feasibility of restoring channels in constrained access crossings are current issues that characterize historic lack of due diligence with original design and construction. The best long term scour protection design therefore helps ensure the anticipated long term life cycle concurrently provided by structure design. Further discussion of the alternate approaches may be required at detailed design.

Planform Design

Planform plotting of the proposed preliminary channel design was done to show the bankfull channel limits through the crossing and upstream in the realigned footprint. A schematic plan view of the proposed realignment with new crossing is appended.

Starting on the downstream side, the new widened opening of the crossing will require grade blending and adjustment adjacent to the channel. Existing armourstone on the west side will require resetting to new westerly definition along the valley toe. This stone will transition to existing stone that protects the westerly piles of an existing pedestrian bridge on the Appleby College property. The grading on the east side will facilitate channel protection installation in the form of vegetated stone that should be extended to protect the easterly piles supporting the pedestrian bridge. The proposed planform will tie-in with the existing channel just below the crossing. A riffle transition is appropriate using the existing bed as a foundation with augmented stone placement to define low flow backwater upstream. The low flow backwater will help define and maintain the alignment through the existing deep pool. Removal of the bedrock barrier just upstream of the deep pool will be replaced with a riffle bedform that transitions to the upstream face of the new structure. The alignment will then deviate from the existing channel footprint in a mirrored reflection of the current channel against the slope toe. The existing point bar to terrace transition that exists opposite the erosion site meander is proposed to be excavated for the new alignment. This will take advantage of a slight bank face that currently exists on the east side of this terrace, which will define part of the upstream right bank of the new channel. A pool to riffle pattern is proposed using standard geomorphic sequencing design through the upstream realignment. This pattern will tie-in at the upstream end with tailwater conditions in the existing channel. Augmented riffle stone placement is possible at the tie-in zone to help define this transition.

The overall realignment footprint is also intended to allow the full restoration of the westerly slope erosion, with removal or burial of emergency works. The new slope and road embankment will be graded with a stable slope angle and be treated with integrated seeding, planting, and bioengineering. The slope toe to channel transition area will be characterized by the backfilled old channel and a new riparian edge that transitions into the overbank through the new crossing, which in combination will establish the new westerly terrestrial corridor.

Profile Design

Preliminary design of the proposed realignment channel profile was done using the planform plotting of relative distance between key bedform points and using field surveyed upstream and downstream existing channel tie-in elevations. The proposed low flow depth variation between riffles and pools was iteratively adjusted and the deep pool invert under the crossing was set based on field measurement of existing conditions. The profile plot is appended showing bedform sequencing and the bankfull flow profile under proposed conditions.

Fish Passage Analysis

Fish passage confirmation was undertaken using a velocity nomograph to assess the size of fish capable of moving upstream against specific nose velocities. Bankfull event velocities under proposed design riffle and pool cross-section conditions were used to check the preliminary design. Detailed results are appended. The results show that fish as small as approximately 2-3cm long range can use burst speed to move up the channel boundary and fish as small as 3-4cm range can use burst speed to move suspended through the water column. Burst speed distances are theoretically 90m or more before velocity shelter is required. Based on the proposed length of the crossing and the intervening shelter from bedform sequencing in the realignment, there are no constraints foreseen to the size range of typical fish that will pass the design during high flows. These results are conservative because they represent the peak of freshet or infrequent storm events when fish are more likely to only be active during the rise or upon the recession of flows to levels less than bankfull

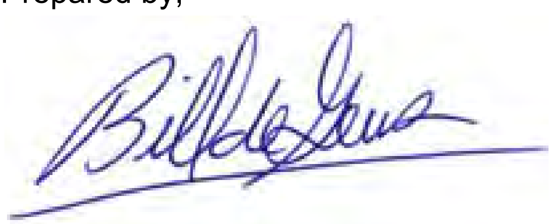
Conclusions

Fourteen Mile Creek and McCraney Creek have been investigated based on fluvial geomorphic requirements for Lakeshore Road improvements in the Town of Oakville. Characterization rapid assessments, summary of meander belt and erosion limits, crossing geometry sizing, and guidance recommendations for scour treatment and erosion control, have been undertaken.

The recommended meander belt limits for delineation of Fourteen Mile Creek related Redside Dace habitat are 75m, with 25m measured westerly and 50m measured easterly from the creek centreline along Lakeshore Road. The existing crossing opening width for Fourteen Mile Creek is considered acceptable and the minimum crossing opening width recommended for McCraney Creek is 13.5m which encompass bankfull width of 6.5m with 3.5m overbanks on both sides. Larger crossing opening width would also be suitable, with overbank width adjusted accordingly. Opening sizing is conditional on implementation of scour protection to feasible levels.

Analysis of preliminary realignment channel design for McCraney Creek has been done to address new crossing geometry and to address a valley wall contact erosion site coincident with the Lakeshore Road embankment on the upstream west side. Flow regime, cross-section, scour treatment, planform, profile, and fish passage characterization for the realignment have been done and the results are recommended for implementation and finalization during detailed design.

Prepared by,



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GEO-RAP v.1.2 Rapid Assessment Protocol Model

B. de Geus 03.12

Project: **Fourteen Mile Creek**
Lakeshore Road West Improvements Class Environmental Assessment
Upstream of Crossing

1) Rapid Geomorphic Assessment (RGA)

Aggradation	
Lobate bar	
Coarse material in riffles embedded	1
Siltation in pools	
Medial bars	
Accretion on point bars	
Poor longitudinal sorting of bed materials	
Deposition in the overbank zone	
n/7 =	0.14

Degradation	
Exposed bridge footing(s)	
Exposed sanitary/storm sewer/pipeline etc.	
Elevated stormsewer outfall(s)	1
Undermined gabion baskets/concrete aprons etc.	
Scour pools d/s of culverts/stormsewer outlets	1
Cut face on bar forms	
Head cutting due to knick point migration	1
Terrace cut through older bar material	
Suspended armour layer visible in bank	
Channel worn into undisturbed overburden/bedrock	1
n/10 =	0.40

Widening	
Fallen/leaning trees/fence posts etc.	
Occurrence of Large Organic Debris	
Exposed tree roots	
Basal scour on inside meander bends	
Basal scour on both sides of channel through riffle	
Gabion baskets/concrete walls etc. out flanked	
Length of basal scour >50% through subject reach	
Exposed length of previously buried pipe/cable etc.	
Fracture lines along top of bank	
Exposed building foundation	
n/10 =	0.00

Planimetric Form	
Formation of chute(s)	
Single thread channel to multiple channel	
Evolution of pool-riffle form to low bed relief form	
Cut-off channel(s)	
Formation of island(s)	
Thalweg alignment out of phase meander form	
Bar forms poorly formed/reworked/removed	
n/7 =	0.00

STABILITY INDEX (SI) = (A + D + W + P) / 4 =	0.14
SI < 0.2	In Regime
0.2 < SI < 0.4	Transitional
SI > 0.4	In Adjustment
100 - (100*SI) =	86.4

2) Rapid Habitat Assessmemt (RHA)

Riffle Run Channel Type

		Optimal	Good	Fair	Poor
Epifaunal Substrate / Available Cover	16	20--16	15-11	10-6	5-0
Embeddedness	12	20--16	15-11	10-6	5-0
Velocity / Depth Regime	17	20--16	15-11	10-6	5-0
Sediment Deposition	13	20--16	15-11	10-6	5-0
Channel Flow Status	18	20--16	15-11	10-6	5-0
Channel Alteration	5	20--16	15-11	10-6	5-0
Frequency of Riffles	14	20--16	15-11	10-6	5-0
Bank Stability u/s L	9	10-8	7-6	5-3	2-0
u/s R	9	10-8	7-6	5-3	2-0
Vegetative Protection u/s L	6	10-8	7-6	5-3	2-0
u/s R	6	10-8	7-6	5-3	2-0
Riparian Vegetation Zone Width u/s L	6	10-8	7-6	5-3	2-0
u/s R	6	10-8	7-6	5-3	2-0
/200	137				
/100	68.5	Optimal	Good	Fair	Poor
		100-78	77-53	52-28	27-0

Glide Pool Channel Type

		Optimal	Good	Fair	Poor
Epifaunal Substrate / Available Cover		20--16	15-11	10-6	5-0
Pool Substrate Characterization		20--16	15-11	10-6	5-0
Pool Variability		20--16	15-11	10-6	5-0
Sediment Deposition		20--16	15-11	10-6	5-0
Channel Flow Status		20--16	15-11	10-6	5-0
Channel Alteration		20--16	15-11	10-6	5-0
Channel Sinuosity		20--16	15-11	10-6	5-0
Bank Stability u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
Vegetative Protection u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
Riparian Vegetation Zone Width u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
/200					
/100		Optimal	Good	Fair	Poor
		100-78	77-53	52-28	27-0

3) Rapid Stream Assessment Technique (RSAT)

		Optimal	Good	Fair	Poor
Channel Stability	9	11-9	8-6	5-3	2-0
Channel Scouring/Deposition	6	8-7	6-5	4-3	2-0
Physical Instream Habitat	6	8-7	6-5	4-3	2-0
Water Quality	4	8-7	6-5	4-3	2-0
Riparian Habitat Conditions	4	7-6	5-4	3-2	1-0
Biological Indicators	7	8-7	6-5	4-3	2-0
/50	36				
/100	72.0	Optimal	Good	Fair	Poor
		100-83	82-59	58-31	30-0

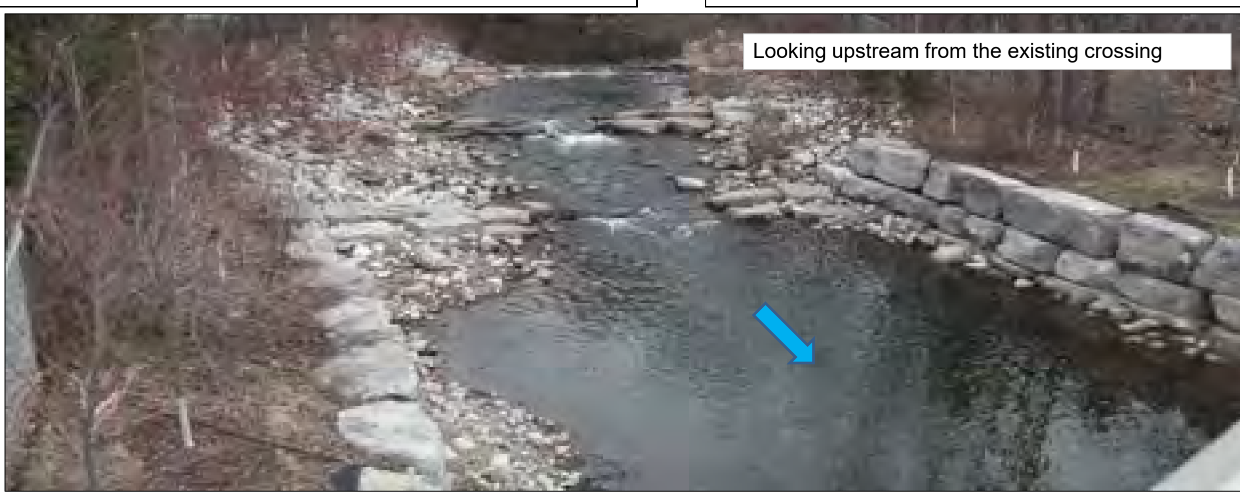
Combined Assessment

Riffle Run Channel Type

		Optimal	Good	Fair	Poor
(RGA + RHA + RSAT) / 3 =	75.6	Optimal	Good	Fair	Poor
		100-80	80-56	55-30	29-0

Glide Pool Channel Type

		Optimal	Good	Fair	Poor
(RGA + RHA + RSAT) / 3 =		Optimal	Good	Fair	Poor
		100-80	80-56	55-30	29-0



References
1) Ontario Ministry of Environment and Energy. 2003. Stormwater Management Planning and Design Manual. Appendix C.
2) USEPA. 2004. Wadeable Stream Assessment: Field Operations Manual. EPA841-B-04-004. U.S. Environmental Protection Agency, Office of Water and Office of Research and Development, Washington, DC.
3) Galli, J., 1996. Rapid stream assessment technique, field methods. Metropolitan Washington Council of Governments.

GEO-RAP v.1.2 Rapid Assessment Protocol Model

AquaLogic

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Project: Fourteen Mile Creek
Lakeshore Road West Improvements Class Environmental Assessment
Inside Crossing

1) Rapid Geomorphic Assessment (RGA)

Aggradation	Lobate bar	1
	Coarse material in riffles embedded	
	Siltation in pools	
	Medial bars	
	Accretion on point bars	1
	Poor longitudinal sorting of bed materials	
	Deposition in the overbank zone	1
	n/7 =	0.43
Degradation	Exposed bridge footing(s)	1
	Exposed sanitary/storm sewer/pipeline etc.	
	Elevated stormsewer outfall(s)	
	Undermined gabion baskets/concrete aprons etc.	
	Scour pools d/s of culverts/stormsewer outlets	1
	Cut face on bar forms	
	Head cutting due to knick point migration	1
	Terrace cut through older bar material	
	Suspended armour layer visible in bank	
	Channel worn into undisturbed overburden/bedrock	1
	n/10 =	0.40

Widening	Fallen/leaning trees/fence posts etc.	
	Occurrence of Large Organic Debris	
	Exposed tree roots	
	Basal scour on inside meander bends	
	Basal scour on both sides of channel through riffle	
	Gabion baskets/concrete walls etc. out flanked	
	Length of basal scour >50% through subject reach	
	Exposed length of previously buried pipe/cable etc.	
	Fracture lines along top of bank	
	Exposed building foundation	
	n/10 =	0.00
Planimetric Form	Formation of chute(s)	
	Single thread channel to multiple channel	
	Evolution of pool-riffle form to low bed relief form	
	Cut-off channel(s)	
	Formation of island(s)	
	Thalweg alignment out of phase meander form	1
	Bar forms poorly formed/reworked/removed	1
	n/7 =	0.29

STABILITY INDEX (SI) = (A + D + W + P) / 4 = **0.28**

SI < 0.2	In Regime
0.2 < SI < 0.4	Transitional
SI > 0.4	In Adjustment

100 - (100*SI) = **72.1**

2) Rapid Habitat Assessmemt (RHA)

Riffle Run Channel Type

		Optimal	Good	Fair	Poor
Epifaunal Substrate / Available Cover	16	20--16	15-11	10-6	5-0
Embeddedness	12	20--16	15-11	10-6	5-0
Velocity / Depth Regime	17	20--16	15-11	10-6	5-0
Sediment Deposition	8	20--16	15-11	10-6	5-0
Channel Flow Status	18	20--16	15-11	10-6	5-0
Channel Alteration	4	20--16	15-11	10-6	5-0
Frequency of Riffles	8	20--16	15-11	10-6	5-0
Bank Stability u/s L	7	10-8	7-6	5-3	2-0
u/s R	7	10-8	7-6	5-3	2-0
Vegetative Protection u/s L	7	10-8	7-6	5-3	2-0
u/s R	7	10-8	7-6	5-3	2-0
Riparian Vegetation Zone Width u/s L	7	10-8	7-6	5-3	2-0
u/s R	7	10-8	7-6	5-3	2-0
/200	125				
/100	62.5	Optimal	Good	Fair	Poor
		100-78	77-53	52-28	27-0

Glide Pool Channel Type

		Optimal	Good	Fair	Poor
Epifaunal Substrate / Available Cover		20--16	15-11	10-6	5-0
Pool Substrate Characterization		20--16	15-11	10-6	5-0
Pool Variability		20--16	15-11	10-6	5-0
Sediment Deposition		20--16	15-11	10-6	5-0
Channel Flow Status		20--16	15-11	10-6	5-0
Channel Alteration		20--16	15-11	10-6	5-0
Channel Sinuosity		20--16	15-11	10-6	5-0
Bank Stability u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
Vegetative Protection u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
Riparian Vegetation Zone Width u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
/200					
/100		Optimal	Good	Fair	Poor
		100-78	77-53	52-28	27-0

3) Rapid Stream Assessment Technique (RSAT)

		Optimal	Good	Fair	Poor
Channel Stability	7	11-9	8-6	5-3	2-0
Channel Scouring/Deposition	6	8-7	6-5	4-3	2-0
Physical Instream Habitat	6	8-7	6-5	4-3	2-0
Water Quality	4	8-7	6-5	4-3	2-0
Riparian Habitat Conditions	0	7-6	5-4	3-2	1-0
Biological Indicators	7	8-7	6-5	4-3	2-0
/50	30				
/100	60.0	Optimal	Good	Fair	Poor
		100-83	82-59	58-31	30-0

Combined Assessment

Riffle Run Channel Type

		Optimal	Good	Fair	Poor
(RGA + RHA + RSAT) / 3 =	64.9	100-80	80-56	55-30	29-0

Glide Pool Channel Type

		Optimal	Good	Fair	Poor
(RGA + RHA + RSAT) / 3 =		100-80	80-56	55-30	29-0

References

1) Ontario Ministry of Environment and Energy. 2003. Stormwater Management Planning and Design Manual. Appendix C.

2) USEPA. 2004. Wadeable Stream Assessment: Field Operations Manual. EPA841-B-04-004. U.S. Environmental Protection Agency, Office of Water and Office of Research and Development, Washington, DC.

3) Galli, J., 1996. Rapid stream assessment technique, field methods. Metropolitan Washington Council of Governments.

GEO-RAP v.1.2 Rapid Assessment Protocol Model

AquaLogic

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Project: Fourteen Mile Creek
Lakeshore Road West Improvements Class Environmental Assessment
Downstream of Crossing

1) Rapid Geomorphic Assessment (RGA)

Aggradation	Lobate bar	
	Coarse material in riffles embedded	1
	Siltation in pools	
	Medial bars	
	Accretion on point bars	1
	Poor longitudinal sorting of bed materials	
	Deposition in the overbank zone	
	n/7 =	0.29
Degradation	Exposed bridge footing(s)	
	Exposed sanitary/storm sewer/pipeline etc.	
	Elevated stormsewer outfall(s)	
	Undermined gabion baskets/concrete aprons etc.	
	Scour pools d/s of culverts/stormsewer outlets	
	Cut face on bar forms	1
	Head cutting due to knick point migration	1
	Terrace cut through older bar material	1
	Suspended armour layer visible in bank	1
	Channel worn into undisturbed overburden/bedrock	1
	n/10 =	0.50
Widening	Fallen/leaning trees/fence posts etc.	1
	Occurrence of Large Organic Debris	1
	Exposed tree roots	1
	Basal scour on inside meander bends	
	Basal scour on both sides of channel through riffle	
	Gabion baskets/concrete walls etc. out flanked	1
	Length of basal scour >50% through subject reach	1
	Exposed length of previously buried pipe/cable etc.	
	Fracture lines along top of bank	
	Exposed building foundation	
	n/10 =	0.50
Planimetric Form	Formation of chute(s)	
	Single thread channel to multiple channel	
	Evolution of pool-riffle form to low bed relief form	
	Cut-off channel(s)	
	Formation of island(s)	
	Thalweg alignment out of phase meander form	
	Bar forms poorly formed/reworked/removed	1
	n/7 =	0.14

STABILITY INDEX (SI) = (A + D + W + P) / 4 =	**0.36**
SI < 0.2	In Regime
0.2 < SI < 0.4	Transitional
SI > 0.4	In Adjustment
100 - (100*SI) =	**64.3**

2) Rapid Habitat Assessmemt (RHA)

Riffle Run Channel Type

		Optimal	Good	Fair	Poor
Epifaunal Substrate / Available Cover	15	20--16	15-11	10-6	5-0
Embeddedness	12	20--16	15-11	10-6	5-0
Velocity / Depth Regime	17	20--16	15-11	10-6	5-0
Sediment Deposition	13	20--16	15-11	10-6	5-0
Channel Flow Status	18	20--16	15-11	10-6	5-0
Channel Alteration	15	20--16	15-11	10-6	5-0
Frequency of Riffles	14	20--16	15-11	10-6	5-0
Bank Stability u/s L	7	10-8	7-6	5-3	2-0
u/s R	7	10-8	7-6	5-3	2-0
Vegetative Protection u/s L	7	10-8	7-6	5-3	2-0
u/s R	7	10-8	7-6	5-3	2-0
Riparian Vegetation Zone Width u/s L	9	10-8	7-6	5-3	2-0
u/s R	9	10-8	7-6	5-3	2-0
/200	150				
/100	**75.0**	Optimal	Good	Fair	Poor
		100-78	77-53	52-28	27-0

Glide Pool Channel Type

		Optimal	Good	Fair	Poor
Epifaunal Substrate / Available Cover		20--16	15-11	10-6	5-0
Pool Substrate Characterization		20--16	15-11	10-6	5-0
Pool Variability		20--16	15-11	10-6	5-0
Sediment Deposition		20--16	15-11	10-6	5-0
Channel Flow Status		20--16	15-11	10-6	5-0
Channel Alteration		20--16	15-11	10-6	5-0
Channel Sinuosity		20--16	15-11	10-6	5-0
Bank Stability u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
Vegetative Protection u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
Riparian Vegetation Zone Width u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
/200					
/100		Optimal	Good	Fair	Poor
		100-78	77-53	52-28	27-0

3) Rapid Stream Assessment Technique (RSAT)

		Optimal	Good	Fair	Poor
Channel Stability	7	11-9	8-6	5-3	2-0
Channel Scouring/Deposition	6	8-7	6-5	4-3	2-0
Physical Instream Habitat	6	8-7	6-5	4-3	2-0
Water Quality	4	8-7	6-5	4-3	2-0
Riparian Habitat Conditions	5	7-6	5-4	3-2	1-0
Biological Indicators	7	8-7	6-5	4-3	2-0
/50	35				
/100	**70.0**	Optimal	Good	Fair	Poor
		100-83	82-59	58-31	30-0

Combined Assessment

Riffle Run Channel Type

		Optimal	Good	Fair	Poor
(RGA + RHA + RSAT) / 3 =	**69.8**	100-80	80-56	55-30	29-0

Glide Pool Channel Type

		Optimal	Good	Fair	Poor
(RGA + RHA + RSAT) / 3 =		100-80	80-56	55-30	29-0

Looking downstream from the existing crossing

References

1) Ontario Ministry of Environment and Energy. 2003. Stormwater Management Planning and Design Manual. Appendix C.

2) USEPA. 2004. Wadeable Stream Assessment: Field Operations Manual. EPA841-B-04-004. U.S. Environmental Protection Agency, Office of Water and Office of Research and Development, Washington, DC.

3) Galli, J., 1996. Rapid stream assessment technique, field methods. Metropolitan Washington Council of Governments.

GEO-RAP v.1.2 Rapid Assessment Protocol Model

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Project: McCraney Creek
Lakeshore Road West Improvements Class Environmental Assessment
Upstream of Crossing

1) Rapid Geomorphic Assessment (RGA)

Aggradation	
Lobate bar	1
Coarse material in riffles embedded	1
Siltation in pools	
Medial bars	
Accretion on point bars	1
Poor longitudinal sorting of bed materials	
Deposition in the overbank zone	
n/7 =	0.43

Degradation	
Exposed bridge footing(s)	1
Exposed sanitary/storm sewer/pipeline etc.	
Elevated stormsewer outfall(s)	1
Undermined gabion baskets/concrete aprons etc.	
Scour pools d/s of culverts/stormsewer outlets	1
Cut face on bar forms	
Head cutting due to knick point migration	
Terrace cut through older bar material	
Suspended armour layer visible in bank	1
Channel worn into undisturbed overburden/bedrock	1
n/10 =	0.50

Widening	
Fallen/leaning trees/fence posts etc.	1
Occurrence of Large Organic Debris	1
Exposed tree roots	1
Basal scour on inside meander bends	1
Basal scour on both sides of channel through riffle	1
Gabion baskets/concrete walls etc. out flanked	
Length of basal scour >50% through subject reach	1
Exposed length of previously buried pipe/cable etc.	
Fracture lines along top of bank	
Exposed building foundation	
n/10 =	0.60

Planimetric Form	
Formation of chute(s)	
Single thread channel to multiple channel	
Evolution of pool-riffle form to low bed relief form	
Cut-off channel(s)	
Formation of island(s)	
Thalweg alignment out of phase meander form	
Bar forms poorly formed/reworked/removed	1
n/7 =	0.14

STABILITY INDEX (SI) = (A + D + W + P) / 4 =	0.42
SI < 0.2	In Regime
0.2 < SI < 0.4	Transitional
SI > 0.4	In Adjustment
100 - (100*SI) =	58.2

2) Rapid Habitat Assessmemt (RHA)

Riffle Run Channel Type

	Score	Optimal	Good	Fair	Poor
Epifaunal Substrate / Available Cover	15	20--16	15-11	10-6	5-0
Embeddedness	12	20--16	15-11	10-6	5-0
Velocity / Depth Regime	11	20--16	15-11	10-6	5-0
Sediment Deposition	11	20--16	15-11	10-6	5-0
Channel Flow Status	13	20--16	15-11	10-6	5-0
Channel Alteration	10	20--16	15-11	10-6	5-0
Frequency of Riffles	14	20--16	15-11	10-6	5-0
Bank Stability u/s L	5	10-8	7-6	5-3	2-0
u/s R	6	10-8	7-6	5-3	2-0
Vegetative Protection u/s L	4	10-8	7-6	5-3	2-0
u/s R	7	10-8	7-6	5-3	2-0
Riparian Vegetation Zone Width u/s L	7	10-8	7-6	5-3	2-0
u/s R	7	10-8	7-6	5-3	2-0
/200	122				
/100	61.0	Optimal	Good	Fair	Poor
		100-78	77-53	52-28	27-0

Glide Pool Channel Type

	Score	Optimal	Good	Fair	Poor
Epifaunal Substrate / Available Cover		20--16	15-11	10-6	5-0
Pool Substrate Characterization		20--16	15-11	10-6	5-0
Pool Variability		20--16	15-11	10-6	5-0
Sediment Deposition		20--16	15-11	10-6	5-0
Channel Flow Status		20--16	15-11	10-6	5-0
Channel Alteration		20--16	15-11	10-6	5-0
Channel Sinuosity		20--16	15-11	10-6	5-0
Bank Stability u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
Vegetative Protection u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
Riparian Vegetation Zone Width u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
/200					
/100		Optimal	Good	Fair	Poor
		100-78	77-53	52-28	27-0

3) Rapid Stream Assessment Technique (RSAT)

	Score	Optimal	Good	Fair	Poor
Channel Stability	6	11-9	8-6	5-3	2-0
Channel Scouring/Deposition	4	8-7	6-5	4-3	2-0
Physical Instream Habitat	6	8-7	6-5	4-3	2-0
Water Quality	4	8-7	6-5	4-3	2-0
Riparian Habitat Conditions	4	7-6	5-4	3-2	1-0
Biological Indicators	2	8-7	6-5	4-3	2-0
/50	26				
/100	52.0	Optimal	Good	Fair	Poor
		100-83	82-59	58-31	30-0

Combined Assessment

Riffle Run Channel Type

	Score	Optimal	Good	Fair	Poor
(RGA + RHA + RSAT) / 3 =	57.1	Optimal	Good	Fair	Poor
		100-80	80-56	55-30	29-0

Glide Pool Channel Type

	Score	Optimal	Good	Fair	Poor
(RGA + RHA + RSAT) / 3 =		Optimal	Good	Fair	Poor
		100-80	80-56	55-30	29-0

Looking upstream over typical conditions above erosion site

Looking downstream over erosion site leading to the crossing

References

1) Ontario Ministry of Environment and Energy. 2003. Stormwater Management Planning and Design Manual. Appendix C.

2) USEPA. 2004. Wadeable Stream Assessment: Field Operations Manual. EPA841-B-04-004. U.S. Environmental Protection Agency, Office of Water and Office of Research and Development, Washington, DC.

3) Galli, J., 1996. Rapid stream assessment technique, field methods. Metropolitan Washington Council of Governments.

GEO-RAP v.1.2 Rapid Assessment Protocol Model

AquaLogic
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Project: McCraney Creek
Lakeshore Road West Improvements Class Environmental Assessment
Inside Crossing

1) Rapid Geomorphic Assessment (RGA)

Aggradation	Lobate bar	1
	Coarse material in riffles embedded	
	Siltation in pools	
	Medial bars	
	Accretion on point bars	
	Poor longitudinal sorting of bed materials	
	Deposition in the overbank zone	
	n/7 =	0.14
Degradation	Exposed bridge footing(s)	1
	Exposed sanitary/storm sewer/pipeline etc.	
	Elevated stormsewer outfall(s)	
	Undermined gabion baskets/concrete aprons etc.	1
	Scour pools d/s of culverts/stormsewer outlets	1
	Cut face on bar forms	
	Head cutting due to knick point migration	1
	Terrace cut through older bar material	
	Suspended armour layer visible in bank	1
	Channel worn into undisturbed overburden/bedrock	1
	n/10 =	0.60
Widening	Fallen/leaning trees/fence posts etc.	
	Occurrence of Large Organic Debris	
	Exposed tree roots	
	Basal scour on inside meander bends	
	Basal scour on both sides of channel through riffle	
	Gabion baskets/concrete walls etc. out flanked	
	Length of basal scour >50% through subject reach	1
	Exposed length of previously buried pipe/cable etc.	
	Fracture lines along top of bank	
	Exposed building foundation	1
	n/10 =	0.20
Planimetric Form	Formation of chute(s)	
	Single thread channel to multiple channel	
	Evolution of pool-riffle form to low bed relief form	
	Cut-off channel(s)	
	Formation of island(s)	
	Thalweg alignment out of phase meander form	1
	Bar forms poorly formed/reworked/removed	1
	n/7 =	0.29

STABILITY INDEX (SI) = (A + D + W + P) / 4 = **0.31**

SI < 0.2	In Regime
0.2 < SI < 0.4	Transitional
SI > 0.4	In Adjustment
100 - (100*SI) =	**69.3**

2) Rapid Habitat Assessmemt (RHA)

Riffle Run Channel Type

Parameter	Score	Optimal	Good	Fair	Poor
Epifaunal Substrate / Available Cover	13	20--16	15-11	10-6	5-0
Embeddedness	6	20--16	15-11	10-6	5-0
Velocity / Depth Regime	18	20--16	15-11	10-6	5-0
Sediment Deposition	11	20--16	15-11	10-6	5-0
Channel Flow Status	13	20--16	15-11	10-6	5-0
Channel Alteration	4	20--16	15-11	10-6	5-0
Frequency of Riffles	8	20--16	15-11	10-6	5-0
Bank Stability u/s L	7	10-8	7-6	5-3	2-0
u/s R	7	10-8	7-6	5-3	2-0
Vegetative Protection u/s L	7	10-8	7-6	5-3	2-0
u/s R	7	10-8	7-6	5-3	2-0
Riparian Vegetation Zone Width u/s L	7	10-8	7-6	5-3	2-0
u/s R	7	10-8	7-6	5-3	2-0
/200	115				
/100	**57.5**	Optimal	Good	Fair	Poor
		100-78	77-53	52-28	27-0

Glide Pool Channel Type

Parameter	Score	Optimal	Good	Fair	Poor
Epifaunal Substrate / Available Cover		20--16	15-11	10-6	5-0
Pool Substrate Characterization		20--16	15-11	10-6	5-0
Pool Variability		20--16	15-11	10-6	5-0
Sediment Deposition		20--16	15-11	10-6	5-0
Channel Flow Status		20--16	15-11	10-6	5-0
Channel Alteration		20--16	15-11	10-6	5-0
Channel Sinuosity		20--16	15-11	10-6	5-0
Bank Stability u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
Vegetative Protection u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
Riparian Vegetation Zone Width u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
/200					
/100		Optimal	Good	Fair	Poor
		100-78	77-53	52-28	27-0

3) Rapid Stream Assessment Technique (RSAT)

Parameter	Score	Optimal	Good	Fair	Poor
Channel Stability	7	11-9	8-6	5-3	2-0
Channel Scouring/Deposition	4	8-7	6-5	4-3	2-0
Physical Instream Habitat	7	8-7	6-5	4-3	2-0
Water Quality	4	8-7	6-5	4-3	2-0
Riparian Habitat Conditions	4	7-6	5-4	3-2	1-0
Biological Indicators	2	8-7	6-5	4-3	2-0
/50	28				
/100	**56.0**	Optimal	Good	Fair	Poor
		100-83	82-59	58-31	30-0

Combined Assessment

Riffle Run Channel Type

	Score	Optimal	Good	Fair	Poor
(RGA + RHA + RSAT) / 3 =	**60.9**	Optimal	Good	Fair	Poor
		100-80	80-56	55-30	29-0

Glide Pool Channel Type

	Score	Optimal	Good	Fair	Poor
(RGA + RHA + RSAT) / 3 =		Optimal	Good	Fair	Poor
		100-80	80-56	55-30	29-0

References

1) Ontario Ministry of Environment and Energy. 2003. Stormwater Management Planning and Design Manual. Appendix C.
2) USEPA. 2004. Wadeable Stream Assessment: Field Operations Manual. EPA841-B-04-004. U.S. Environmental Protection Agency, Office of Water and Office of Research and Development, Washington, DC.
3) Galli, J., 1996. Rapid stream assessment technique, field methods. Metropolitan Washington Council of Governments.

GEO-RAP v.1.2 **Rapid Assessment Protocol Model**

B. de Geus 03.12

Project: **McCraney Creek**
Lakeshore Road West Improvements Class Environmental Assessment
Downstream of Crossing

1) Rapid Geomorphic Assessment (RGA)

Aggradation	
Lobate bar	1
Coarse material in riffles embedded	1
Siltation in pools	
Medial bars	
Accretion on point bars	1
Poor longitudinal sorting of bed materials	
Deposition in the overbank zone	
n/7 =	0.43

Degradation	
Exposed bridge footing(s)	
Exposed sanitary/storm sewer/pipeline etc.	
Elevated stormsewer outfall(s)	
Undermined gabion baskets/concrete aprons etc.	
Scour pools d/s of culverts/stormsewer outlets	
Cut face on bar forms	
Head cutting due to knick point migration	
Terrace cut through older bar material	
Suspended armour layer visible in bank	1
Channel worn into undisturbed overburden/bedrock	1
n/10 =	0.20

Widening	
Fallen/leaning trees/fence posts etc.	
Occurrence of Large Organic Debris	1
Exposed tree roots	1
Basal scour on inside meander bends	
Basal scour on both sides of channel through riffle	
Gabion baskets/concrete walls etc. out flanked	
Length of basal scour >50% through subject reach	1
Exposed length of previously buried pipe/cable etc.	
Fracture lines along top of bank	
Exposed building foundation	
n/10 =	0.30

Planimetric Form	
Formation of chute(s)	
Single thread channel to multiple channel	
Evolution of pool-riffle form to low bed relief form	
Cut-off channel(s)	
Formation of island(s)	
Thalweg alignment out of phase meander form	1
Bar forms poorly formed/reworked/removed	
n/7 =	0.14

STABILITY INDEX (SI) = (A + D + W + P) / 4 =	0.27
SI < 0.2	In Regime
0.2 < SI < 0.4	Transitional
SI > 0.4	In Adjustment
100 - (100*SI) =	73.2

2) Rapid Habitat Assessmemt (RHA)

Riffle Run Channel Type

	Score	Optimal	Good	Fair	Poor
Epifaunal Substrate / Available Cover	15	20--16	15-11	10-6	5-0
Embeddedness	12	20--16	15-11	10-6	5-0
Velocity / Depth Regime	13	20--16	15-11	10-6	5-0
Sediment Deposition	13	20--16	15-11	10-6	5-0
Channel Flow Status	13	20--16	15-11	10-6	5-0
Channel Alteration	10	20--16	15-11	10-6	5-0
Frequency of Riffles	14	20--16	15-11	10-6	5-0
Bank Stability u/s L	7	10-8	7-6	5-3	2-0
u/s R	7	10-8	7-6	5-3	2-0
Vegetative Protection u/s L	7	10-8	7-6	5-3	2-0
u/s R	7	10-8	7-6	5-3	2-0
Riparian Vegetation Zone Width u/s L	7	10-8	7-6	5-3	2-0
u/s R	6	10-8	7-6	5-3	2-0
/200	131				
/100	65.5	Optimal	Good	Fair	Poor
		100-78	77-53	52-28	27-0

Glide Pool Channel Type

	Score	Optimal	Good	Fair	Poor
Epifaunal Substrate / Available Cover		20--16	15-11	10-6	5-0
Pool Substrate Characterization		20--16	15-11	10-6	5-0
Pool Variability		20--16	15-11	10-6	5-0
Sediment Deposition		20--16	15-11	10-6	5-0
Channel Flow Status		20--16	15-11	10-6	5-0
Channel Alteration		20--16	15-11	10-6	5-0
Channel Sinuosity		20--16	15-11	10-6	5-0
Bank Stability u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
Vegetative Protection u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
Riparian Vegetation Zone Width u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
/200					
/100		Optimal	Good	Fair	Poor
		100-78	77-53	52-28	27-0

3) Rapid Stream Assessment Technique (RSAT)

	Score	Optimal	Good	Fair	Poor
Channel Stability	7	11-9	8-6	5-3	2-0
Channel Scouring/Deposition	4	8-7	6-5	4-3	2-0
Physical Instream Habitat	6	8-7	6-5	4-3	2-0
Water Quality	4	8-7	6-5	4-3	2-0
Riparian Habitat Conditions	5	7-6	5-4	3-2	1-0
Biological Indicators	2	8-7	6-5	4-3	2-0
/50	28				
/100	56.0	Optimal	Good	Fair	Poor
		100-83	82-59	58-31	30-0

Combined Assessment

Riffle Run Channel Type

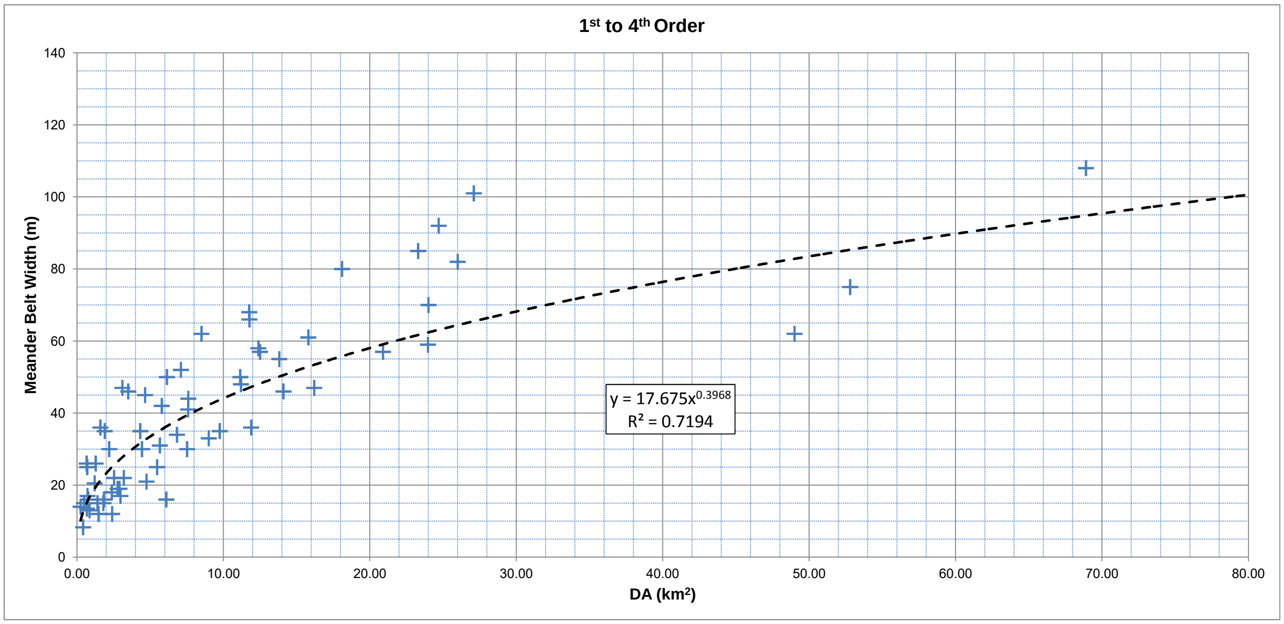
	Score	Optimal	Good	Fair	Poor
(RGA + RHA + RSAT) / 3 =	64.9	Optimal	Good	Fair	Poor
		100-80	80-56	55-30	29-0

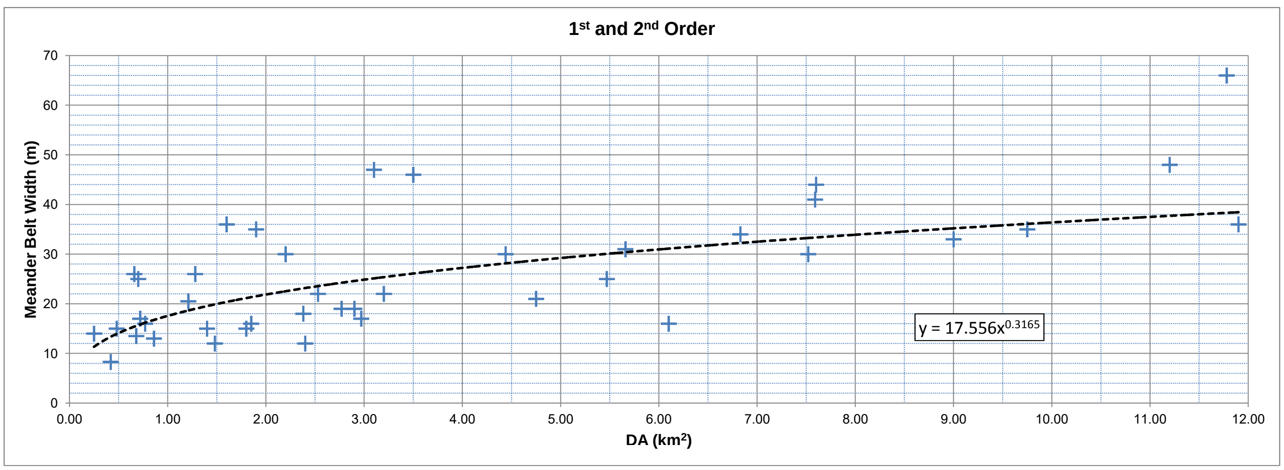
Glide Pool Channel Type

	Score	Optimal	Good	Fair	Poor
(RGA + RHA + RSAT) / 3 =		Optimal	Good	Fair	Poor
		100-80	80-56	55-30	29-0

References
1) Ontario Ministry of Environment and Energy. 2003. Stormwater Management Planning and Design Manual. Appendix C.
2) USEPA. 2004. Wadeable Stream Assessment: Field Operations Manual. EPA841-B-04-004. U.S. Environmental Protection Agency, Office of Water and Office of Research and Development, Washington, DC.
3) Galli, J., 1996. Rapid stream assessment technique, field methods. Metropolitan Washington Council of Governments.

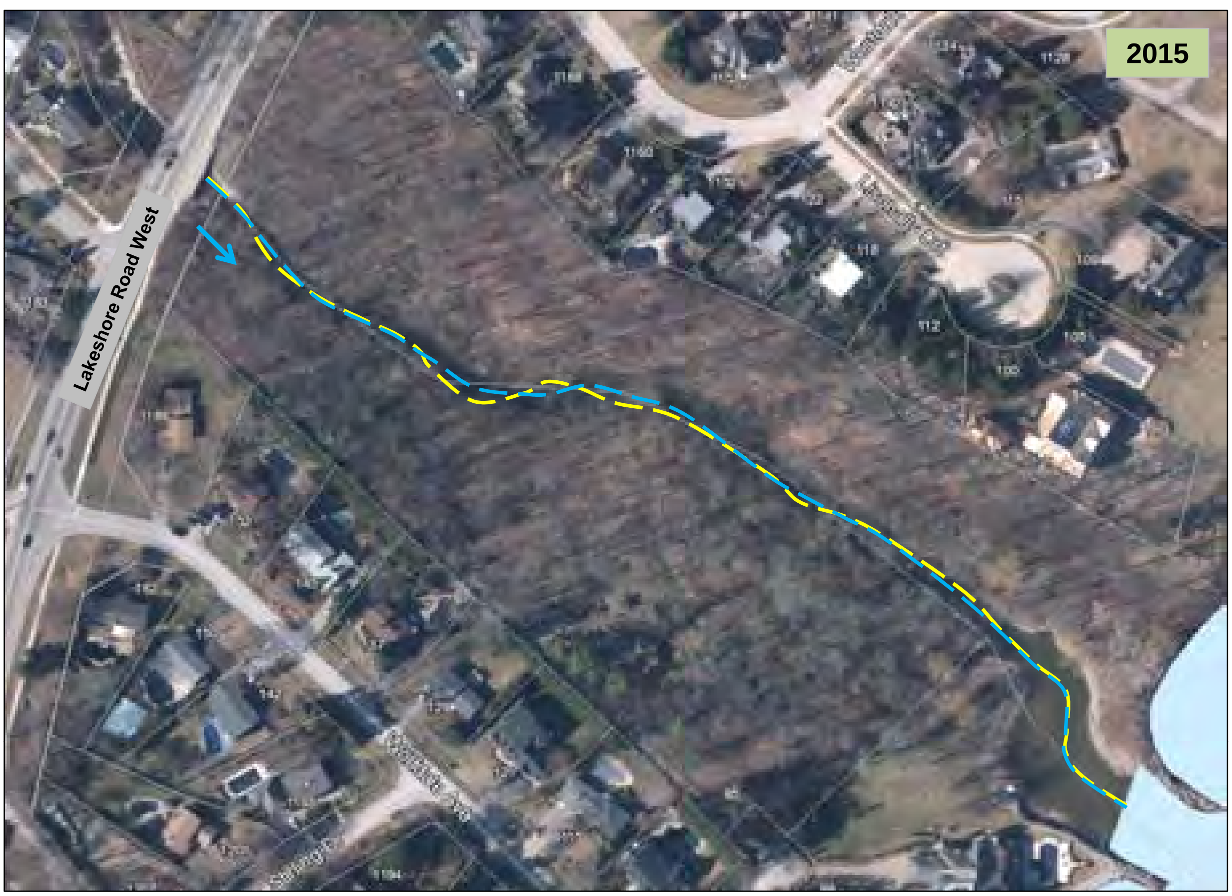
Regional Regression Curves for Meander Belt Width - Southern Ontario Data





Using 1st to 4th Order Equation, Solve for:	DA (km^2)	meander belt width (m)
Fourteen Mile Creek @ Lakeshore Road	25.8	64.2

Fourteen Mile Creek - Planform Comparison
Lakeshore Road West Improvements Class Environmental Assessment



Fourteen Mile Creek - Meander Belt Width
Lakeshore Road West Improvements Class Environmental Assessment

AquaLogic

McCraney Creek - Planform Comparison
Lakeshore Road West Improvements Class Environmental Assessment

Fourteen Mile Creek
McCraney Creek
Lakeshore Road West Improvements Class Environmental Assessment
Crossing Width Opening Sizing

	bankfull width field measurements (m)
Fourteen Mile Creek	(10.8+10.7+9.1+8.2+8.6)/5=9.5
McCraney Creek	(5.4+7.3+6.5+6.0+7.5)/5=6.5

	bankfull width (m)		erosion allowance (m)		recommended minimum opening width (m)	existing opening width (m)
Fourteen Mile Creek	9.5	+	(2 x 3.5m)	=	**16.5**	15.0
McCraney Creek	6.5	+	(2 x 3.5m)	=	**13.5**	5.4

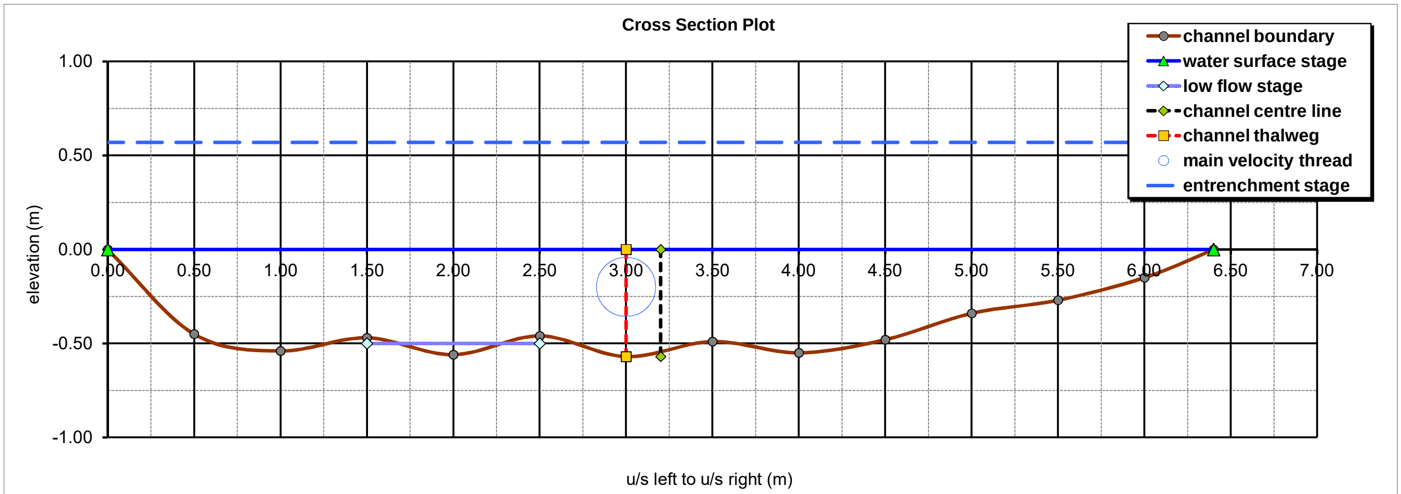
	Range of Suggested Toe Erosion Allowances			
	Evidence of Active Erosion or Bankfull Flow Velocity > Competent Flow Velocity	No Evidence of Active Erosion or Bankfull Flow Velocity < Competent Flow Velocity		
		Bankfull Width		
Native Soil Structure		<5m	5-30m	>30m
Hard Rock (granite)	0-2m	0m	0m	1m
Soft Rock (shale, limestone), Cobbles, Boulders	2-5m	0m	1m	2m
Stiff/Hard Cohesive Soil (clays, clay silt), Coarse Granular (gravels), Till	5-8m	1m	2m	4m
Soft/Firm Cohesive Soil, Loose Granular (sand, silt), Fill	8-15m	1-2m	5m	7m

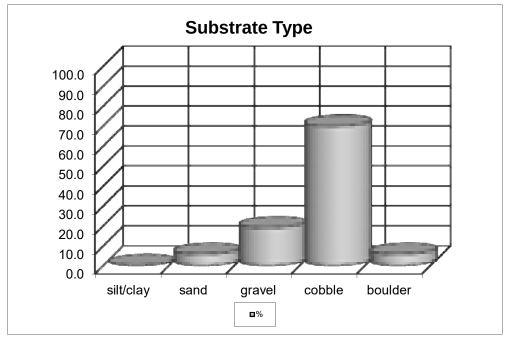
i) Where a combination of different native soil structures occurs, the greater or largest range of applicable to erosion allowances for the materials found at the site should be applied
ii) Active Erosion is defined as: bank material is exposed directly to stream flow under normal or flood flow conditions where undercutting, over-steepening, slumping of a bank or down stream sediment loading is occurring. An area may have erosion but there may not be evidence of 'active erosion' either as a result of well rooted vegetation or as a result of a condition of net sediment deposition. The area may still suffer erosion at some point in the future as a result of shifting of the channel
iii) Competent Flow Velocity is the flow velocity that the bed material in the stream can support without resulting in erosion or scour (OMNR 2002)

GEO-X v.5.1 Geomorphic Cross-section Analysis Model

B. de Geus 05.11

Project: McCraney Creek Preliminary Channel Design
Lakeshore Road Crossing
Existing Conditions Active Channel - Section 1 upstream





Morphology Type	
cascade	
step	
riffle	●
run	
glide	
pool	
thalweg out of phase	

Hydraulic Geometry	
A (m^2)	2.66
R (m)	0.40
TW (m)	6.40
WP (m)	6.70
max d (m)	0.57
mean d (m)	0.42
$E_{s\ (Limerinos)}$ (m) [+]	
$E_{s\ (Strickler)}$ (m) [+]	

Hydraulic Roughness	
rr R/D_{84}	2.15
ff V mean/V*	5.32
ff D_{84}	4.83
ff mean	5.07
ROUGH BED	

Hydraulic Ratios	
ER max d	1.48
r_c / TW	
TW / Lf_w	6.40
TW/max d	11.2
TW/mean d	15.4

Sediment Transport Mode

			w_s (m s^{-1})	P	wash load	high sus. load	low sus. load	bedload
k	0.41	D_{30}	1.353	29.28	NO	NO	NO	NO
V_* (m s^{-1})	0.113	D_{50}	1.574	34.06	NO	NO	NO	NO
		D_{84}	1.997	43.20	NO	NO	NO	NO

Section Data

ER_e (m)	0.57	ER stations L / R	-0.50	9.00	TW ck
WS_e (m)	0.000	WS stations L / R	0.00	6.40	6.40
Lf_e (m)	-0.500	Lf stations L / R	1.50	2.50	
W_{fp} (m)	9.50	E_s sta. (Limerinos) L / R			
r_c (m)		E_s sta. (Strickler) L / R			
z		T_e (m) $T_{o/s}$ (m)	-0.57	3.00	
E_g (m m^{-1})	0.0160				

Bedload Transport Data

Rosgen type	Strickler Q Q_{sb} (kg sec^{-1})	Limerinos Q Q_{sb} (kg sec^{-1})	T_*	D_{30}	D_{50}	D_{84}
				0.8	0.6	0.3
B3	0.0028	0.0027	saltation	NO	NO	NO
C3	0.0037	0.0033	rolling	NO	NO	NO
C4	0.0119	0.0116	Ø	YES	YES	YES

Substrate Gradation

	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
Existing Conditions (mm)	30.00	85.00	115.00	185.00	330.00
Stability Design Targets (mm)					
τ_{cr} (N m^{-2})	29.10	82.45	111.55	179.45	320.10
high turbulence - angular (mm)					
high turbulence - rounded (mm)					
low turbulence - angular (mm)					
low turbulence - rounded (mm)					

Flow Regime Strickler method		Flow Regime Limerinos method	
Q (cms)	3.620	Q (cms)	
V (m s^{-1})	1.36	V (m s^{-1})	
n	0.050	n	
Fr	0.68	*Fr*	
D_c rectangular (m)	0.32	D_c rectangular (m)	
D_c trapezoidal (m)	0.54	D_c trapezoidal (m)	
D_c triangular (m)	0.78	D_c triangular (m)	
D_c parabolic (m)	0.51	D_c parabolic (m)	
D_c mean (m)	0.54	D_c mean (m)	
flow type	SUBCRITICAL	flow type	
Ω (watts m^{-1})	567.57	Ω (watts m^{-1})	
ω_a (watts m^{-2})	84.76	ω_a (watts m^{-2})	
ω_a/TW (watts m^{-1})	13.24	ω_a/TW (watts m^{-1})	
*Re**	215.3	*Re**	
Re	474202	*Re*	
turbulence	HIGH	turbulence	

Erosion Thresholds

		V_c / V_b Strickler	Limerinos
τ_{calc} (kg m^{-2})	6.35		
τ_{calc} (N m^{-2})	62.23		
τ D_{crit} (gr-co) (mm)	64.16		
D_{50} V_c (vcs +) (m s^{-1})	1.66	1.74	
D_{84} V_c (vcs +) (m s^{-1})	2.11	2.21	

Bank Data

	u/s L	u/s R
H_b (m)		
Bf_d (m)		
RDp (m)		
H_b/Bf_d		
RDp/H_b		
RDn (%)		
BA (°)		
BFP (%)		

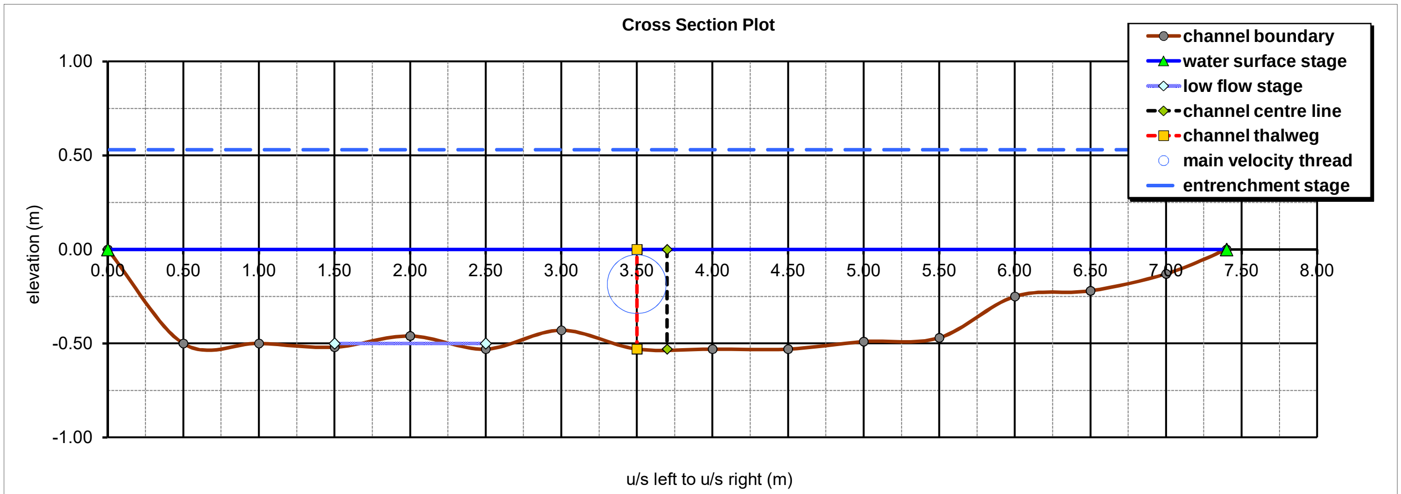
Substrate Type (%)

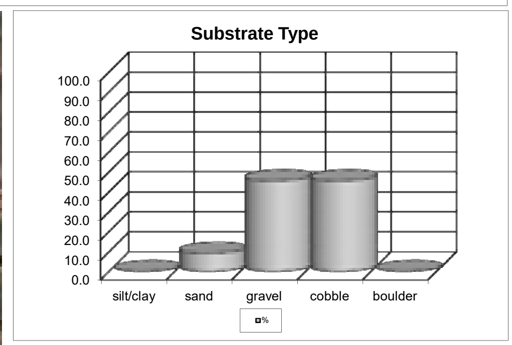
silt/clay	sand	gravel	cobble	boulder
0.0	5.7	18.9	69.8	5.7

GEO-X v.5.1 Geomorphic Cross-section Analysis Model

Project: McCraney Creek Preliminary Channel Design
Lakeshore Road Crossing
Existing Conditions Active Channel - Section 2 downstream

B. de Geus 05.11





Morphology Type		Hydraulic Geometry	
cascade		A (m^2)	3.04
step		R (m)	0.39
riffle		TW (m)	7.40
run	●	WP (m)	7.71
glide		max d (m)	0.53
pool		mean d (m)	0.41
thalweg out of phase		$E_{s\ (Limerinos)}$ (m) [+]	
		$E_{s\ (Strickler)}$ (m) [+]	

Hydraulic Roughness		Hydraulic Ratios	
rr R/D_{84}	2.63	ER max d	1.55
ff V mean/V*	5.55	r_c / TW	
ff D_{84}	5.32	TW / Lf_w	7.40
ff mean	5.44	TW/max d	14.0
ROUGH BED		TW/mean d	18.0

Sediment Transport Mode

			w_s ($m\ s^{-1}$)	P	wash load	high sus. load	low sus. load	bedload
k	0.41	D_{30}	0.567	13.66	NO	NO	NO	NO
V_* ($m\ s^{-1}$)	0.101	D_{50}	0.928	22.36	NO	NO	NO	NO
		D_{84}	1.798	43.32	NO	NO	NO	NO

Section Data

					TW ck
ER_e (m)	0.53	ER stations L / R	-0.50	11.00	
WS_e (m)	0.000	WS stations L / R	0.00	7.40	7.40
Lf_e (m)	-0.500	Lf stations L / R	1.50	2.50	
W_{fp} (m)	11.50	E_s sta. $_{(Limerinos)}$ L / R			
r_c (m)		E_s sta. $_{(Strickler)}$ L / R			
z		T_e (m) $T_{o/s}$ (m)	-0.53	3.50	
E_g ($m\ m^{-1}$)	0.0130				

Bedload Transport Data

Rosgen type	Strickler Q Q_{sb} ($kg\ sec^{-1}$)	Limerinos Q Q_{sb} ($kg\ sec^{-1}$)		D_{30}	D_{50}	D_{84}
			T_*	3.4	1.3	0.3
B3	0.0028	0.0028	saltation	YES	NO	NO
C3	0.0039	0.0041	rolling	YES	YES	NO
C4	0.0121	0.0123	Ø	NO	NO	YES

Substrate Gradation

	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
Existing Conditions (mm)	4.00	15.00	40.00	150.00	220.00
Stability Design Targets (mm)					
τ_{cr} ($N\ m^{-2}$)	3.88	14.55	38.80	145.50	213.40
high turbulence - angular (mm)					
high turbulence - rounded (mm)					
low turbulence - angular (mm)					
low turbulence - rounded (mm)					

Flow Regime

Strickler method		Limerinos method	
Q (cms)	3.712	Q (cms)	
V ($m\ s^{-1}$)	1.22	V ($m\ s^{-1}$)	
n	0.050	n	
Fr	0.61	*Fr*	
D_c rectangular (m)	0.30	D_c rectangular (m)	
D_c trapezoidal (m)	0.53	D_c trapezoidal (m)	
D_c triangular (m)	0.79	D_c triangular (m)	
D_c parabolic (m)	0.51	D_c parabolic (m)	
D_c mean (m)	0.53	D_c mean (m)	
flow type	SUBCRITICAL	flow type	
Ω ($watts\ m^{-1}$)	472.88	Ω ($watts\ m^{-1}$)	
ω_a ($watts\ m^{-2}$)	61.31	ω_a ($watts\ m^{-2}$)	
ω_a/TW ($watts\ m^{-1}$)	8.28	ω_a/TW ($watts\ m^{-1}$)	
*Re**	74.9	*Re**	
Re	422107	*Re*	
turbulence	HIGH	turbulence	

Erosion Thresholds

		V_c / V_b Strickler	V_c / V_b Limerinos
τ_{calc} ($kg\ m^{-2}$)	5.12		
τ_{calc} ($N\ m^{-2}$)	50.18		
τ D_{crit} (gr-co) (mm)	51.74		
D_{50} V_c (vcs +) ($m\ s^{-1}$)	0.98	1.15	2.22
D_{84} V_c (vcs +) ($m\ s^{-1}$)	1.90		

Bank Data

	u/s L	u/s R
H_b (m)		
Bf_d (m)		
RDp (m)		
H_b/Bf_d		
RDp/H_b		
RDn (%)		
BA (°)		
BFP (%)		

Substrate Type (%)

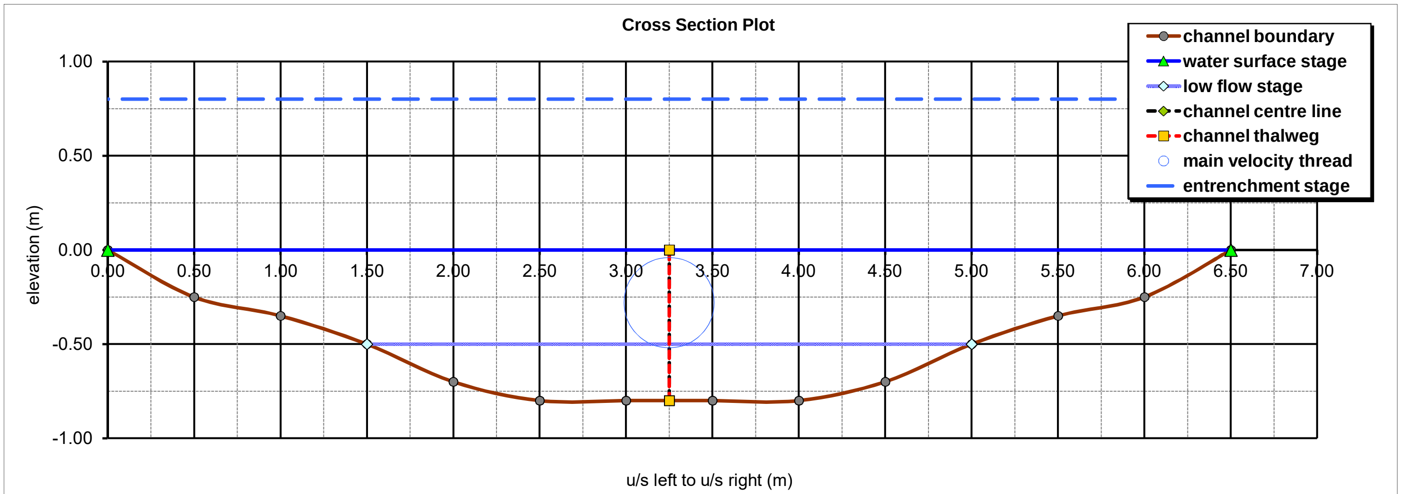
silt/clay	sand	gravel	cobble	boulder
0.0	9.1	45.5	45.5	0.0

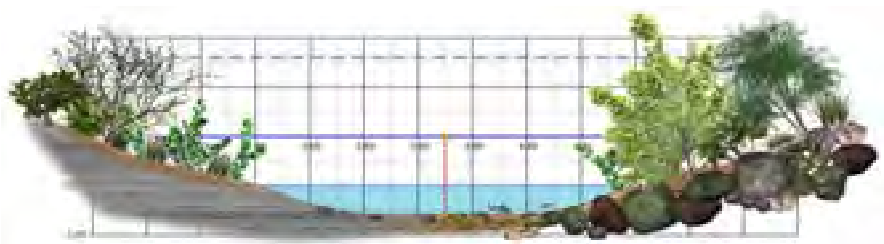
GEO-X v.5.1 Geomorphic Cross-section Analysis Model

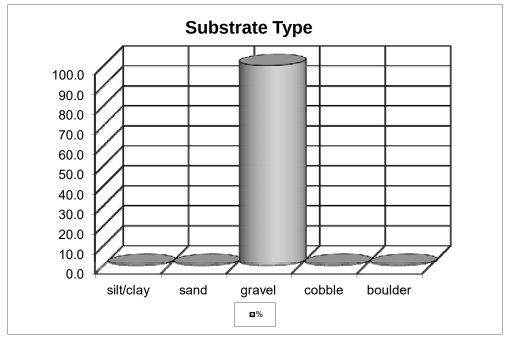
AquaLogic

B. de Geus 05.11

Project: McCraney Creek Preliminary Channel Design
Lakeshore Road Crossing
Proposed Pool Section







Morphology Type

cascade	
step	
riffle	
run	
glide	
pool	●
thalweg out of phase	

Hydraulic Geometry

A (m^2)	3.40
R (m)	0.50
TW (m)	6.50
WP (m)	6.78
max d (m)	0.80
mean d (m)	0.52
$E_{s\ (Limerinos)}$ (m) [+]	
$E_{s\ (Strickler)}$ (m) [+]	

Hydraulic Roughness

rr R/D_{84}	11.15
ff V mean/V*	7.74
ff D_{84}	8.90
ff mean	8.32
SMOOTH BED	

Hydraulic Ratios

ER max d	3.85
r_c / TW	
TW / Lf_w	1.86
TW/max d	8.1
TW/mean d	12.4

Sediment Transport Mode

			w_s (m s^{-1})	P	wash load	high sus. load	low sus. load	bedload
k	0.41	D_{30}	0.655	20.60	NO	NO	NO	NO
V_* (m s^{-1})	0.078	D_{50}	0.868	27.27	NO	NO	NO	NO
		D_{84}	0.984	30.93	NO	NO	NO	NO

Section Data

ER_e (m)	0.80	ER stations L / R	-10.00	15.00	TW ck
WS_e (m)	0.000	WS stations L / R	0.00	6.50	6.50
Lf_e (m)	-0.500	Lf stations L / R	1.50	5.00	
W_{fp} (m)	25.00	E_s sta. $_{(Limerinos)}$ L / R			
r_c (m)		E_s sta. $_{(Strickler)}$ L / R			
z		T_e (m) $T_{o/s}$ (m)	-0.80	3.25	
E_g (m m^{-1})	0.0060				

Bedload Transport Data

Rosgen type	Strickler Q Q_{sb} (kg sec^{-1})	Limerinos Q Q_{sb} (kg sec^{-1})		D_{30}	D_{50}	D_{84}
			T_*	1.5	0.9	0.7
B3	0.0028	0.0031	saltation	NO	NO	NO
C3	0.0038	0.0079	rolling	YES	NO	NO
C4	0.0120	0.0144	Ø	NO	YES	YES

Substrate Gradation

	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
Existing Conditions (mm)	15	20	35	45	50
Stability Design Targets (mm)	15	20	35	45	50
τ_{cr} (N m^{-2})	14.55	19.40	33.95	43.65	48.50
high turbulence - angular (mm)	10.5	14.7	31.5	37.8	42.0
high turbulence - rounded (mm)	11.7	16.3	35.0	42.0	46.7
low turbulence - angular (mm)	6.3	12.6	21.0	27.3	31.5
low turbulence - rounded (mm)	7.0	14.0	23.3	30.3	35.0

Flow Regime

Strickler method		Limerinos method	
Q (cms)	3.686	Q (cms)	
V (m s^{-1})	1.08	V (m s^{-1})	
n	0.045	n	
Fr	0.48	Fr	
D_c rectangular (m)	0.32	D_c rectangular (m)	
D_c trapezoidal (m)	0.53	D_c trapezoidal (m)	
D_c triangular (m)	0.79	D_c triangular (m)	
D_c parabolic (m)	0.48	D_c parabolic (m)	
D_c mean (m)	0.53	D_c mean (m)	
flow type	SUBCRITICAL	flow type	
Ω (watts m^{-1})	216.74	Ω (watts m^{-1})	
ω_a (watts m^{-2})	31.97	ω_a (watts m^{-2})	
ω_a/TW (watts m^{-1})	4.92	ω_a/TW (watts m^{-1})	
$Re*$	56.6	$Re*$	
Re	476994	Re	
turbulence	HIGH	turbulence	

Erosion Thresholds

		V_c / V_b Strickler	Limerinos
τ_{calc} (kg m^{-2})	3.01		
τ_{calc} (N m^{-2})	29.49		
τ D_{crit} (gr-co) (mm)	30.40		
D_{50} V_c (vcs +) (m s^{-1})	0.92	1.21	
D_{84} V_c (vcs +) (m s^{-1})	1.04	1.37	

Substrate Type (%)

silt/clay	sand	gravel	cobble	boulder
0.0	0.0	100.0	0.0	0.0

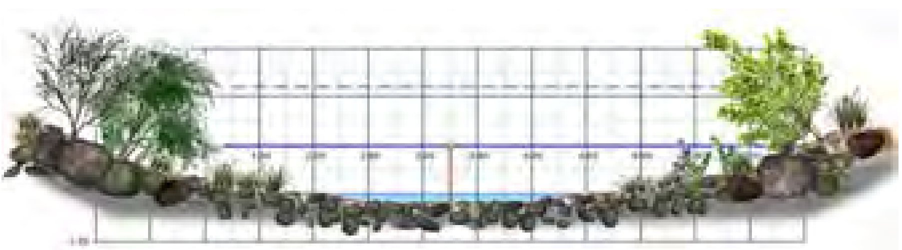
Bank Data

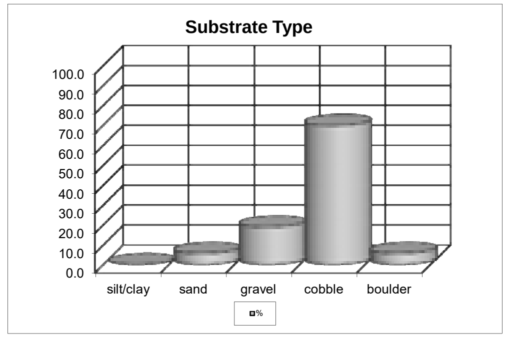
	u/s L	u/s R
H_b (m)		
Bf_d (m)		
RDp (m)		
H_b/Bf_d		
RDp/H_b		
RDn (%)		
BA (°)		
BFP (%)		

GEO-X v.5.1 Geomorphic Cross-section Analysis Model

B. de Geus 05.11

Project: McCraney Creek Preliminary Channel Design
Lakeshore Road Crossing
Proposed Riffle Section





Morphology Type	
cascade	
step	
riffle	●
run	
glide	
pool	
thalweg out of phase	

Hydraulic Geometry	
A (m^2)	2.70
R (m)	0.41
TW (m)	6.44
WP (m)	6.63
max d (m)	0.59
mean d (m)	0.42
$E_{s\ (Limerinos)}$ (m) [+]	
$E_{s\ (Strickler)}$ (m) [+]	

Hydraulic Roughness	
rr R/D_{84}	6.27
ff V mean/V*	6.28
ff D_{84}	7.45
ff mean	6.86
ROUGH BED	

Hydraulic Ratios	
ER max d	3.88
r_c / TW	
TW / Lf_w	2.58
TW/max d	11.0
TW/mean d	15.3

Sediment Transport Mode

			w_s ($m\ s^{-1}$)	P	wash load	high sus. load	low sus. load	bedload
k	0.41	D_{30}	0.803	15.34	NO	NO	NO	NO
V_* ($m\ s^{-1}$)	0.128	D_{50}	1.038	19.82	NO	NO	NO	NO
		D_{84}	1.183	22.60	NO	NO	NO	NO

Section Data

ER_e (m)	0.57	ER stations L / R	-10.00	15.00	TW ck
WS_e (m)	-0.015	WS stations L / R	0.00	6.50	6.50
Lf_e (m)	-0.500	Lf stations L / R	2.00	4.50	
W_{fp} (m)	25.00	E_s sta. $_{(Limerinos)}$ L / R			
r_c (m)		E_s sta. $_{(Strickler)}$ L / R			
z		T_e (m) $T_{o/s}$ (m)	-0.60	3.25	
E_g ($m\ m^{-1}$)	0.0200				

Bedload Transport Data

Rosgen type	Strickler Q Q_{sb} ($kg\ sec^{-1}$)	Limerinos Q Q_{sb} ($kg\ sec^{-1}$)	T_*	D_{30}	D_{50}	D_{84}
				2.7	1.6	1.3
B3	0.0028	0.0032	saltation	YES	NO	NO
C3	0.0038	0.0096	rolling	YES	YES	YES
C4	0.0120	0.0151	Ø	NO	NO	NO

Substrate Gradation	D_{15}	D_{30}	D_{50}	D_{84}	D_{100}
Existing Conditions (mm)	25	30	50	65	75
Stability Design Targets (mm)	25	30	50	65	75
τ_{cr} ($N\ m^{-2}$)	24.25	29.10	48.50	63.05	72.75
high turbulence - angular (mm)	15.0	21.0	45.0	54.0	60.0
high turbulence - rounded (mm)	16.7	23.3	50.0	60.0	66.7
low turbulence - angular (mm)	9.0	18.0	30.0	39.0	45.0
low turbulence - rounded (mm)	10.0	20.0	33.3	43.3	50.0

Flow Regime Strickler method		Flow Regime Limerinos method	
Q (cms)	3.674	Q (cms)	
V ($m\ s^{-1}$)	1.36	V ($m\ s^{-1}$)	
n	0.057	n	
Fr	0.67	*Fr*	
D_c rectangular (m)	0.32	D_c rectangular (m)	
D_c trapezoidal (m)	0.54	D_c trapezoidal (m)	
D_c triangular (m)	0.79	D_c triangular (m)	
D_c parabolic (m)	0.51	D_c parabolic (m)	
D_c mean (m)	0.54	D_c mean (m)	
flow type	SUBCRITICAL	flow type	
Ω ($watts\ m^{-1}$)	720.20	Ω ($watts\ m^{-1}$)	
ω_a ($watts\ m^{-2}$)	108.55	ω_a ($watts\ m^{-2}$)	
ω_a/TW ($watts\ m^{-1}$)	16.86	ω_a/TW ($watts\ m^{-1}$)	
*Re**	105.4	*Re**	
Re	485820	*Re*	
turbulence	HIGH	turbulence	

Erosion Thresholds

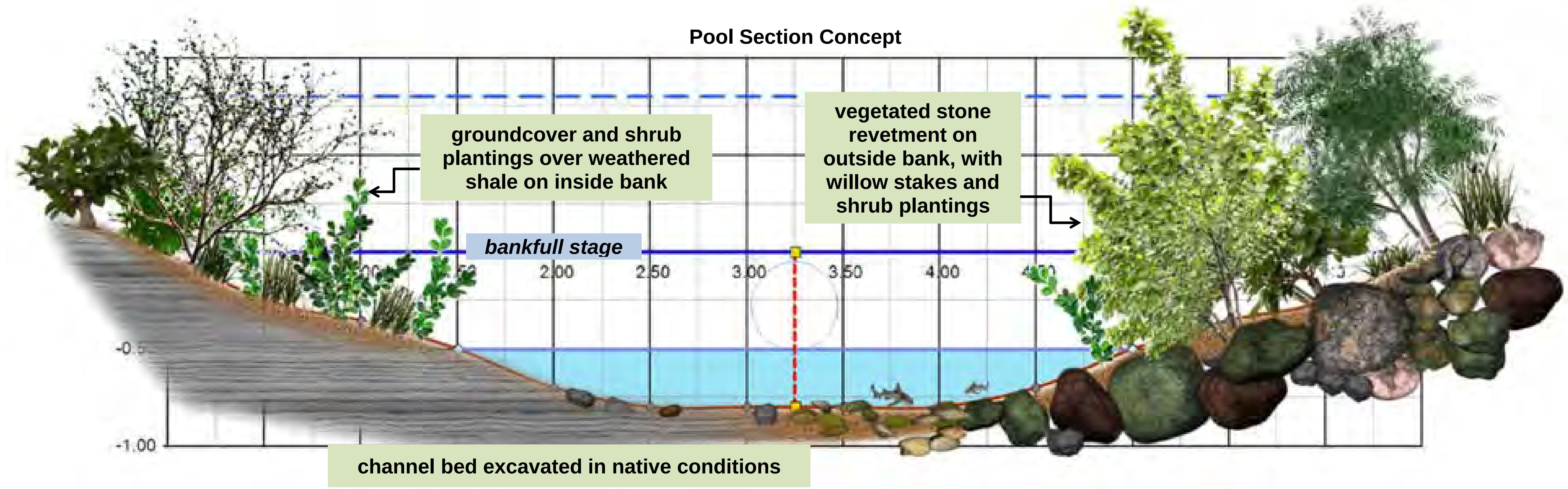
		V_c / V_b Strickler	Limerinos
τ_{calc} ($kg\ m^{-2}$)	8.15		
τ_{calc} ($N\ m^{-2}$)	79.85		
τ D_{crit} (gr-co) (mm)	82.32		
D_{50} V_c (vcs +) ($m\ s^{-1}$)	1.10	1.15	
D_{84} V_c (vcs +) ($m\ s^{-1}$)	1.25	1.31	

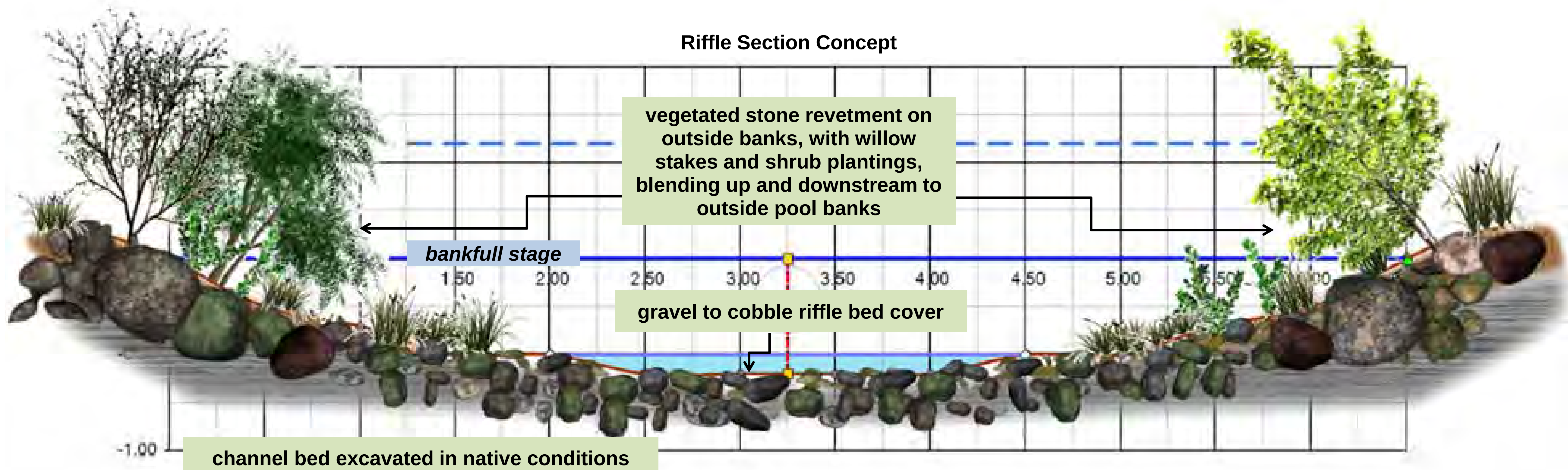
Substrate Type (%)

silt/clay	sand	gravel	cobble	boulder
0.0	5.7	18.9	69.8	5.7

Bank Data	u/s L	u/s R
H_b (m)		
Bf_d (m)		
RDp (m)		
H_b/Bf_d		
RDp/H_b		
RDn (%)		
BA (°)		
BFP (%)		

McCraney Creek
Preliminary Channel Design
Lakeshore Road Crossing





McCraney Creek Preliminary Channel Design
HEC-RAS Summary

River Sta	Profile	Q Tot (m3/s)	Top W (m)	E.G. Sl (m/m)	V Left (m/s)	V Chnl (m/s)	V Rght (m/s)	Shear L (N/m2)	Shear Ch (N/m2)	Shear R (N/m2)	Froude # Chl	Powr Chn (N/m s)
631.663		Bridge	Rebecca									
612.3046	2Years	18.58	11.63	0.01017		2.65			69.95		1	185.61
612.3046	5Years	28.32	12.83	0.00949		3.02			83.48		1	252.13
612.3046	10Years	34.73	13.58	0.00912		3.2			90.19		1	288.71
612.3046	25Years	42.77	14.44	0.00879		3.4			97.69		1	331.85
612.3046	50Years	48.86	15.06	0.00858		3.53			102.63		1	361.79
612.3046	100Years	54.24	15.56	0.00844		3.63			106.89		1	388.17
595.3819	2Years	18.58	22.04	0.00222	0.23	1.51	0.14	7.61	20.58	3.44	0.49	31.14
595.3819	5Years	28.32	28.72	0.0018	0.26	1.66	0.19	8.42	22.49	5.38	0.47	37.37
595.3819	10Years	34.73	30.41	0.00179	0.3	1.79	0.22	10.25	25.05	6.54	0.47	44.75
595.3819	25Years	42.77	32.13	0.00187	0.34	1.95	0.25	12.55	28.86	8.05	0.49	56.3
595.3819	50Years	48.86	33.27	0.00194	0.36	2.07	0.27	14.28	31.9	9.16	0.51	66.12
595.3819	100Years	54.24	34.54	0.00196	0.38	2.16	0.29	15.43	34.06	9.98	0.51	73.61
570.5971	2Years	18.58	36.86	0.00044	0.22	0.73	0.02	4.72	4.59	0.09	0.22	3.34
570.5971	5Years	28.32	39.91	0.00041	0.25	0.85	0.07	5.46	5.7	0.77	0.23	4.85
570.5971	10Years	34.73	41.32	0.00044	0.27	0.94	0.09	6.24	6.69	1.16	0.24	6.27
570.5971	25Years	42.77	42.55	0.00047	0.29	1.05	0.11	7.31	8.03	1.73	0.25	8.4
570.5971	50Years	48.86	43.4	0.0005	0.31	1.12	0.13	8.14	9.09	2.13	0.26	10.2
570.5971	100Years	54.24	44.33	0.00052	0.33	1.18	0.14	8.76	9.9	2.39	0.27	11.71
544.1928	2Years	18.12	9.98	0.01056		2.61			69.02		1	180.41
544.1928	5Years	28.72	13.62	0.01026		2.75			73.79		1	202.62
544.1928	10Years	35.45	15.99	0.01016		2.79			75.46		1	210.65
544.1928	25Years	43.77	18.54	0.01		2.85			77.49		1	220.77
544.1928	50Years	49.99	19.85	0.00986		2.91			79.73		1	232.08
544.1928	100Years	55.87	20.4	0.00968		2.99			82.79		1	247.85
538.303*	2Years	18.12	17.47	0.00414		1.6			26.05		0.62	41.55
538.303*	5Years	28.72	19.17	0.00337		1.79			29.3		0.59	52.34
538.303*	10Years	35.45	20.15	0.00308		1.88			31.01		0.58	58.39
538.303*	25Years	43.77	21.29	0.00282		1.99			32.85		0.57	65.22
538.303*	50Years	49.99	22.08	0.0027		2.06			34.28		0.56	70.53
538.303*	100Years	55.87	22.73	0.00258		2.11			35.28		0.56	74.56
531.5748		Bridge	Lakeshore									
531.5748BR U	2Years	18.12	14.65	0.01186		2.3			58.71		0.79	135.13
531.5748BR U	5Years	28.72	14.65	0.01104		2.68			72.55		0.83	194.59
531.5748BR U	10Years	35.45	14.65	0.01071		2.88			79.94		0.85	229.87
531.5748BR U	25Years	43.77	14.65	0.01047		3.09			88.49		0.87	273.31
531.5748BR U	50Years	49.99	14.64	0.01024		3.22			93.73		0.87	301.92
531.5748BR U	100Years	55.87	14.64	0.01011		3.34			98.67		0.88	329.67
531.5748BR D	2Years	18.12	14.65	0.00205		1.33			16.7		0.39	22.28
531.5748BR D	5Years	28.72	14.64	0.00224		1.63			23.01		0.43	37.44
531.5748BR D	10Years	35.45	14.64	0.00242		1.8			27.23		0.45	48.96
531.5748BR D	25Years	43.77	14.64	0.00267		2			32.75		0.48	65.51
531.5748BR D	50Years	49.99	14.64	0.00289		2.15			37.31		0.5	80.32
531.5748BR D	100Years	55.87	14.64	0.00309		2.29			41.56		0.52	95.05

River Sta	Profile	Q Tot (m3/s)	Top W (m)	E.G. Sl (m/m)	V Left (m/s)	V Chnl (m/s)	V Rght (m/s)	Shear L (N/m2)	Shear Ch (N/m2)	Shear R (N/m2)	Froude # Chl	Powr Chn (N/m s)
510.818*	2Years	18.12	16.25	0.00192		1.28			15.48		0.44	19.85
510.818*	5Years	28.72	16.92	0.00199		1.53			20.28		0.46	30.95
510.818*	10Years	35.45	17.26	0.00207		1.67			23.36		0.48	38.9
510.818*	25Years	43.77	18.02	0.00216		1.83			27.2		0.5	49.77
510.818*	50Years	49.99	18.61	0.00228		1.95			30.41		0.51	59.45
510.818*	100Years	55.87	19.59	0.00237		2.06			33.32		0.53	68.77
501.0021	2Years	18.12	11.78	0.0107		2.47			63.8		1	157.89
501.0021	5Years	28.72	14.9	0.01012	0.08	2.69		2.09	71.2		1	191.34
501.0021	10Years	35.45	16.59	0.00972	0.19	2.82		8	75.86		1	214.11
501.0021	25Years	43.77	20.81	0.00928	0.19	2.95		8.02	80.26		0.99	237.02
501.0021	50Years	49.99	24.92	0.00864	0.24	3.03	0.1	10.88	81.96	3.09	0.97	248.38
501.0021	100Years	55.87	29.76	0.00822	0.25	3.12	0.16	11.72	84.42	6.21	0.96	263.15
500.008*	2Years	18.12	14.34	0.00157		1.27			14.53		0.41	18.47
500.008*	5Years	28.72	15.37	0.00212		1.62			22.65		0.48	36.81
500.008*	10Years	35.45	16.23	0.00248	0.06	1.83		0.92	28.25		0.53	51.81
500.008*	25Years	43.77	17.5	0.00255	0.12	2		2.94	32.41		0.54	64.84
500.008*	50Years	49.99	24.02	0.00249	0.16	2.06	0.03	4.53	33.54	0.38	0.54	68.95
500.008*	100Years	55.87	32.37	0.00224	0.23	2.08	0.1	7.3	33.26	2.17	0.52	69.21
500		Bridge	pedestrian									
500 BR U	2Years	18.12	14.18	0.00158		1.28			14.66		0.41	18.72
500 BR U	5Years	28.72	14.71	0.00215		1.64			23.15		0.48	38.08
500 BR U	10Years	35.45	15.53	0.00262	0.05	1.87		0.8	29.43		0.53	55
500 BR U	25Years	43.77		0.00775	0.1	2.16		2.79	48.09		0.54	103.99
500 BR U	50Years	49.99	0.76	0.01011	0.11	2.47		3.5	62.72		0.6	154.9
500 BR U	100Years	55.87	3.62	0.01262	0.14	2.76		5.43	78.29		0.66	216.03
500 BR D	2Years	18.12	14.09	0.00137		1.22			13.23		0.38	16.16
500 BR D	5Years	28.72	15.23	0.00196	0.03	1.58		0.38	21.38		0.46	33.88
500 BR D	10Years	35.45	16.12	0.00235	0.08	1.81		1.65	27.21		0.5	49.12
500 BR D	25Years	43.77	1.55	0.00698	0.12	2.1		3.04	44.69		0.52	93.65
500 BR D	50Years	49.99	4.68	0.0091	0.13	2.39		4.65	58.23		0.58	139.29
500 BR D	100Years	55.87	6.61	0.01133	0.19	2.67		7.98	72.54		0.64	193.7
494.045*	2Years	18.12	14.34	0.00138		1.22			13.29		0.38	16.26
494.045*	5Years	28.72	15.8	0.00195	0.03	1.58		0.34	21.19		0.46	33.42
494.045*	10Years	35.45	16.69	0.00228	0.08	1.79		1.56	26.7		0.51	47.85
494.045*	25Years	43.77	18.81	0.00263	0.1	2.03		2.24	33.31		0.55	67.54
494.045*	50Years	49.99	22.2	0.00287	0.12	2.19		2.88	38.13		0.58	83.38
494.045*	100Years	55.87	24.87	0.00312	0.15	2.32		4.21	42.63		0.61	99.03
448.3297	2Years	18.12	27.78	0.00168	0.12	1.35		2.64	16.2		0.43	21.89
448.3297	5Years	28.72	36.48	0.00237	0.2	1.75		6.06	26.08		0.52	45.71
448.3297	10Years	35.45	39.08	0.00299	0.24	2.02		8.75	34.27		0.59	69.31
448.3297	25Years	43.77	42.05	0.0037	0.3	2.32		12.37	44.35		0.66	102.81
448.3297	50Years	49.99	44.21	0.00412	0.33	2.5		15.16	51.05		0.7	127.64
448.3297	100Years	55.87	45.87	0.0045	0.37	2.66		17.96	57.36		0.73	152.74
396.6188	2Years	18.12	35.47	0.00668	0.45	2.24		12.61	48.81		0.81	109.29
396.6188	5Years	28.72	46.48	0.00664	0.61	2.5		19.38	57.38		0.83	143.28
396.6188	10Years	35.45	50.9	0.006	0.67	2.52		22.19	56.61		0.8	142.44
396.6188	25Years	43.77	51.66	0.00641	0.79	2.7		28.37	63.88		0.84	172.35
396.6188	50Years	49.99	52.14	0.00678	0.86	2.84		33.1	69.86		0.87	198.17
396.6188	100Years	55.87	52.59	0.00704	0.93	2.95		37.33	74.77		0.89	220.54

GEO-ROX v.1.6 Rock Size Treatment Model

B. de Geus 01.11

Project: **McCraney Creek Preliminary Channel Design**
Lakeshore Road Crossing
100yr Event with FS=1.15 Scour Protection Treatment

Threshold Velocity
USDA Isbash Method

Notation:

V_i = Isbash velocity
W = average rock weight

	g (kg m^{-3})
dolomite	2900
granite	2800
limestone	2650
pure shale	2400
calcareous shale	2600
sandstone	2500

Input:

design storm frequency	100yr	
mean channel velocity (V_{mean})	3.34	m s^{-1}
Isbash adjustment factor (F_v)	1.15	
density of rock (g)	2650	kg m^{-3}

V_i	W required
3.84 m s^{-1}	214.6 kg

Equivalent average diameters:

D_{50} cube	43.3 cm	17.0 inches
D_{50} river stone	53.7 cm	21.1 inches
D_{50} angular	48.5 cm	19.1 inches

River stone gradation and sub-pavement depth:

	low turbulence Q lower limit (cm)	high turbulence Q upper limit (cm)
D_{100}	80.5	107.4
D_{85}	69.8	96.6
D_{50}	53.7	80.5
D_{30}	32.2	37.6
D_{15}	16.1	26.8
sub-pavement depth	107.4	161.0

Angular gradation and sub-pavement depth:

	low turbulence Q lower limit (cm)	high turbulence Q upper limit (cm)
D_{100}	72.7	96.9
D_{85}	63.0	87.3
D_{50}	48.5	72.7
D_{30}	29.1	33.9
D_{15}	14.5	24.2
sub-pavement depth	96.9	145.4

Threshold Shear Stress
Newbury-Fischenich Method

Input:

τ_{calc} (N m^{-2})	99.0
Shear pulse adjustment factor (F_s)	2.0
τ D_{crit} (gr-co) (cm)	19.404

River stone gradation and sub-pavement depth:

	low turbulence Q lower limit (cm)	high turbulence Q upper limit (cm)
D_{100}	19.4	38.8
D_{85}	16.8	34.9
D_{50}	12.9	19.4
D_{30}	7.8	13.6
D_{15}	3.9	9.7
sub-pavement depth	25.9	38.8

Angular gradation and sub-pavement depth:

	low turbulence Q lower limit (cm)	high turbulence Q upper limit (cm)
D_{100}	17.5	34.9
D_{85}	15.1	31.4
D_{50}	11.6	17.5
D_{30}	7.0	12.2
D_{15}	3.5	8.7
sub-pavement depth	23.3	34.9

Dimensionless Shear
Shields-Rosgen Method (C3-C4 channel type)

River stone gradation and sub-pavement depth:

	low turbulence Q lower limit (cm)	high turbulence Q upper limit (cm)
D_{100}	52.1	69.4
D_{85}	45.1	62.5
D_{50}	34.7	52.1
D_{30}	20.8	24.3
D_{15}	10.4	17.4
sub-pavement depth	69.4	104.2

Angular gradation and sub-pavement depth:

	low turbulence Q lower limit (cm)	high turbulence Q upper limit (cm)
D_{100}	47.0	62.7
D_{85}	40.8	56.4
D_{50}	31.4	47.0
D_{30}	18.8	21.9
D_{15}	9.4	15.7
sub-pavement depth	62.7	94.1

GEO-ROX v.1.6 Rock Size Treatment Model

B. de Geus 01.11

Project: **McCraney Creek Preliminary Channel Design**
Lakeshore Road Crossing
25yr Event with FS=1.0 Scour Protection Treatment

Threshold Velocity
USDA Isbash Method

Notation:

V_i = Isbash velocity
W = average rock weight

	g (kg m^{-3})
dolomite	2900
granite	2800
limestone	2650
pure shale	2400
calcareous shale	2600
sandstone	2500

Input:

design storm frequency	25yr	
mean channel velocity (V_{mean})	3.09	m s^{-1}
Isbash adjustment factor (F_v)	1.0	
density of rock (g)	2650	kg m^{-3}

V_i
3.09 m s^{-1}

W required
58.2 kg

Equivalent average diameters:

D_{50} cube	28.0 cm	11.0 inches
D_{50} river stone	34.7 cm	13.7 inches
D_{50} angular	31.4 cm	12.4 inches

River stone gradation and sub-pavement depth:

	low turbulence Q lower limit (cm)	high turbulence Q upper limit (cm)
D_{100}	52.1	69.5
D_{85}	45.2	62.5
D_{50}	34.7	52.1
D_{30}	20.8	24.3
D_{15}	10.4	17.4
sub-pavement depth	69.5	104.2

Angular gradation and sub-pavement depth:

	low turbulence Q lower limit (cm)	high turbulence Q upper limit (cm)
D_{100}	47.1	62.7
D_{85}	40.8	56.5
D_{50}	31.4	47.1
D_{30}	18.8	22.0
D_{15}	9.4	15.7
sub-pavement depth	62.7	94.1

Threshold Shear Stress
Newbury-Fischenich Method

Input:

τ_{calc} (N m^{-2})	90.0
Shear pulse adjustment factor (F_s)	2.0
τ D_{crit} (gr-co) (cm)	17.64

River stone gradation and sub-pavement depth:

	low turbulence Q lower limit (cm)	high turbulence Q upper limit (cm)
D_{100}	17.6	35.3
D_{85}	15.3	31.8
D_{50}	11.8	17.6
D_{30}	7.1	12.3
D_{15}	3.5	8.8
sub-pavement depth	23.5	35.3

Angular gradation and sub-pavement depth:

	low turbulence Q lower limit (cm)	high turbulence Q upper limit (cm)
D_{100}	15.9	31.8
D_{85}	13.8	28.6
D_{50}	10.6	15.9
D_{30}	6.4	11.1
D_{15}	3.2	7.9
sub-pavement depth	21.2	31.8

Dimensionless Shear
Shields-Rosgen Method (C3-C4 channel type)

River stone gradation and sub-pavement depth:

	low turbulence Q lower limit (cm)	high turbulence Q upper limit (cm)
D_{100}	33.7	44.9
D_{85}	29.2	40.4
D_{50}	22.5	33.7
D_{30}	13.5	15.7
D_{15}	6.7	11.2
sub-pavement depth	44.9	67.4

Angular gradation and sub-pavement depth:

	low turbulence Q lower limit (cm)	high turbulence Q upper limit (cm)
D_{100}	30.4	40.6
D_{85}	26.4	36.5
D_{50}	20.3	30.4
D_{30}	12.2	14.2
D_{15}	6.1	10.1
sub-pavement depth	40.6	60.9

McCraney Creek Preliminary Channel Design
Lakeshore Road Crossing

Scour Treatment Summary

Standard Approach

Velocity from HECRAS
($m\ s^{-1}$)
3.34 (100yr)

MTO multiplier = 1.15
(FS to satisy intent)

Final Design Velocity
($m\ s^{-1}$)
3.84 (100yr)

Design Flow Return Period for Bridges and Culverts - Standard Road Classifications

Functional Road Classification	Return Period of Design Flows (Years) [1,2,3]		Check Flow for Scour
	Total Span less than or equal to 6.0 m	Total Span greater than 6.0 m	
Freeway, Urban Arterial	50	100	130% of 100 year
Rural Arterial, Collector Road	25	50	115% of 100 year
Local Road	10	25	100% of 100 year

Note:
1. The listed design flows apply to roads under the jurisdiction of the Ministry of Transportation
2. The Fish Passage Design Flow for culverts is defined in Standard WC-12 Fish Passage Requirements Through Culverts
3. Sometimes referred to as Normal Design Flow

Alternate Approach

Velocity from HECRAS
($m\ s^{-1}$)
3.09 (25yr)

design multiplier = 1.0
(recommended)

Final Design Velocity
($m\ s^{-1}$)
3.09 (25yr)

	D_{15} (cm)	D_{30} (cm)	D_{50} (cm)	D_{84} (cm)	D_{100} (cm)	
Angular Stone	15.0	25.0	50.0	55.0	65.0	(i)
River Stone	20.0	30.0	55.0	65.0	70.0	

(i) - satisfied by OPSS 1004 R-50 rip-rap up to D_{30}

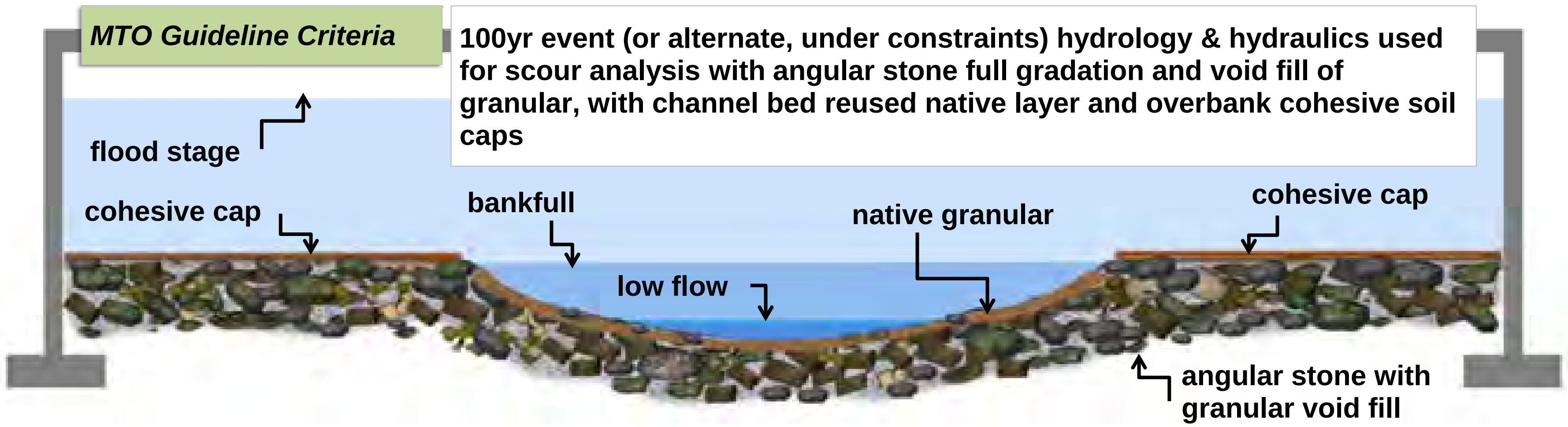
stone treatment layer thickness (cm)	overbank treatment layer thickness (ii) (cm)	bed treatment layer thickness (iii) (cm)
100	20	10

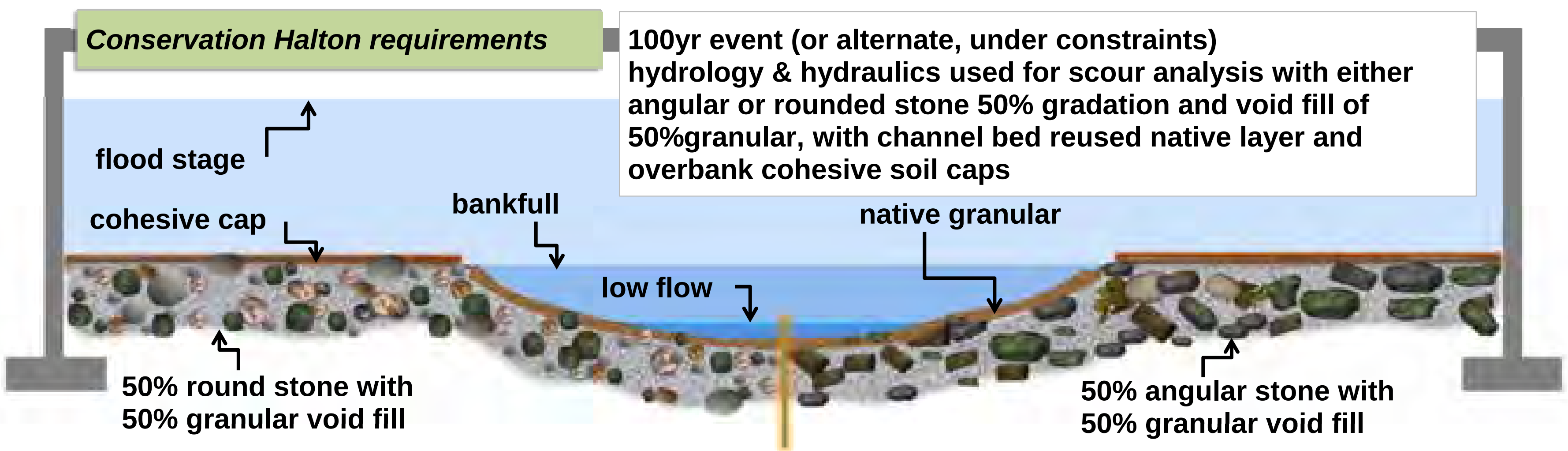
(ii) - satisfied by native excavation clay-silt with some granular material
(iii) - satisfied by native granular with some fines and some gravel-cobble

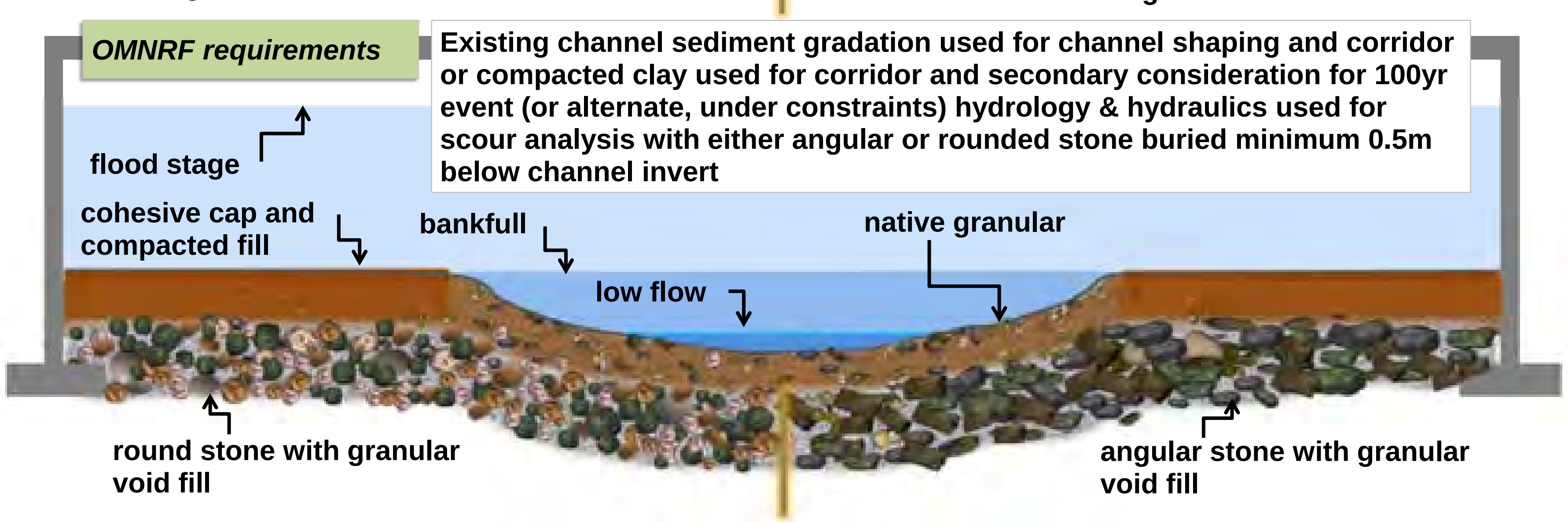
McCraney Creek Preliminary Channel Design
Lakeshore Road Crossing

AquaLogic

Scour Treatment Options

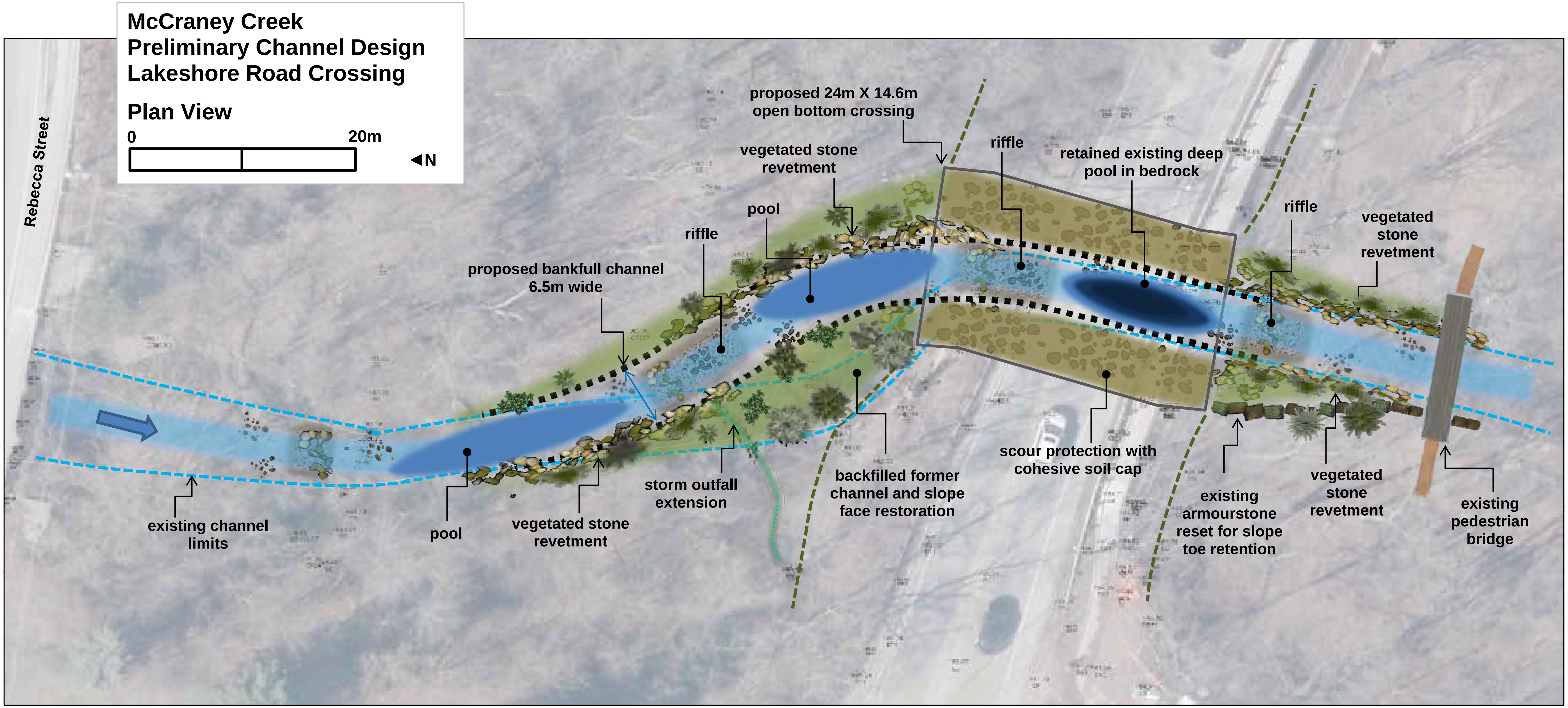






Risk and Value Summary

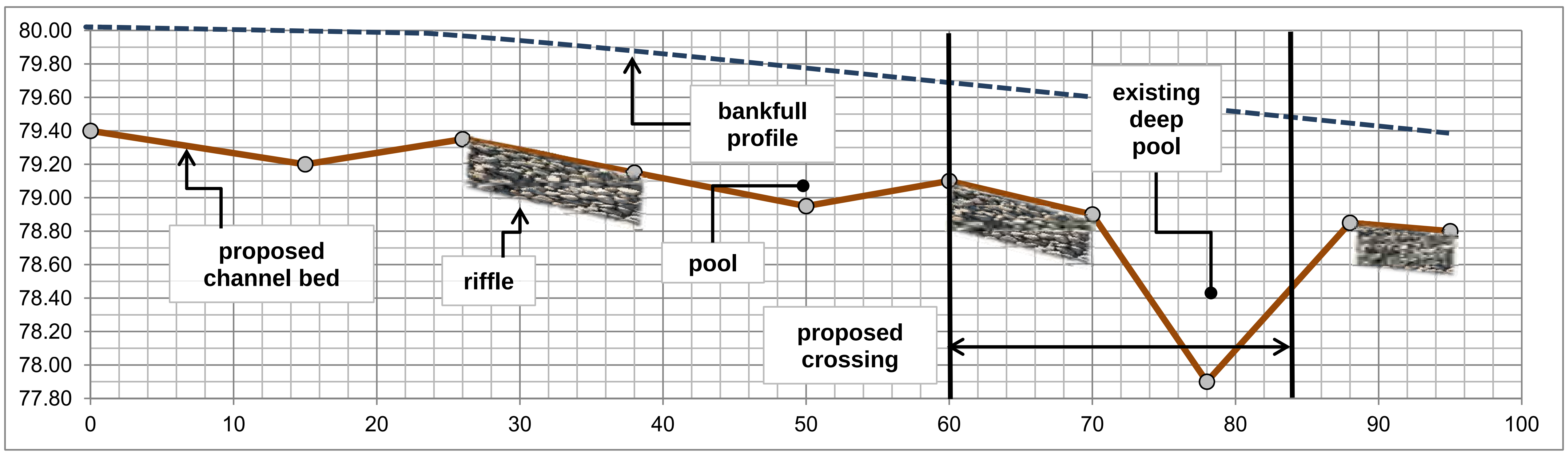
Scour Protection	*Channel Morphology*	*Fish Habitat*	*Terrestrial Corridor*
Low Risk High Value - designed specifically for long term structural integrity	Low Risk High Value - designed specifically for long term channel maintenance - stone effectively replaces biotechnical reinforcement with structural reinforcement	Medium Risk Medium Value - designed specifically for long term channel maintenance - not as heterogeneous as native conditions	Medium Risk Medium Value - designed specifically for long term corridor integrity - not as heterogeneous as native conditions, some stone will likely be exposed
Medium Risk Medium Value - compromise on long term structural integrity for sake of more heterogeneous conditions	Medium Risk Medium Value - compromise on long term channel maintenance for sake of more heterogeneous conditions - compromise on reinforcement	Medium Risk Medium Value - compromise on long term channel maintenance for sake of more heterogeneous conditions	Medium Risk Medium Value - compromise on long term corridor integrity for sake of more heterogeneous conditions
High Risk Low-Med Value - compromise on long term structural integrity for sake of more heterogeneous conditions - channel will erode deeply at infrequent events but footings likely protected	Medium Risk Medium Value - compromise on long term channel maintenance for sake of more heterogeneous conditions - lack of long term channel reinforcement means channel will erode deeply with unpredictable replacement by aggradation	Medium Risk Med-High Value - compromise on long term channel maintenance for sake of more heterogeneous conditions - short term conditions ultimately replaced by erosion with unpredictable replacement by aggradation but likely evolution to a large pool feature	High Risk Low-Med Value - compromise on long term corridor integrity for sake of more heterogeneous conditions - short term conditions ultimately replaced by erosion with potential corridor cut off by wall to wall low flow


McCraney Creek
Preliminary Channel Design
Lakeshore Road Crossing
Plan View
0
20m
N
Rebecca Street
proposed 24m X 14.6m open bottom crossing
vegetated stone revetment
riffle
retained existing deep pool in bedrock
pool
riffle
vegetated stone revetment
riffle
proposed bankfull channel 6.5m wide
scour protection with cohesive soil cap
backfilled former channel and slope face restoration
storm outfall extension
existing armourstone reset for slope toe retention
vegetated stone revetment
existing pedestrian bridge
existing channel limits
pool
vegetated stone revetment

McCraney Creek
Preliminary Channel Design
Lakeshore Road Crossing

Channel Profile

elev. m	distance m	ID
79.40	0	bottom of riffle / upstream tie-in
79.20	15	max depth pool
79.35	26	top of riffle
79.15	38	bottom of riffle
78.95	50	max depth pool
79.10	60	top of riffle
78.90	70	bottom of riffle
77.90	78	max depth existing deep pool
78.85	88	top of riffle
78.80	95	bottom of riffle / downstream tie-in



FSH-PASS v.2.2 Fish Passage Channel Velocity Analysis Model

B. de Geus 07.12

Project: **McCraney Creek Preliminary Channel Design**
Lakeshore Road Crossing
Proposed Bankfull

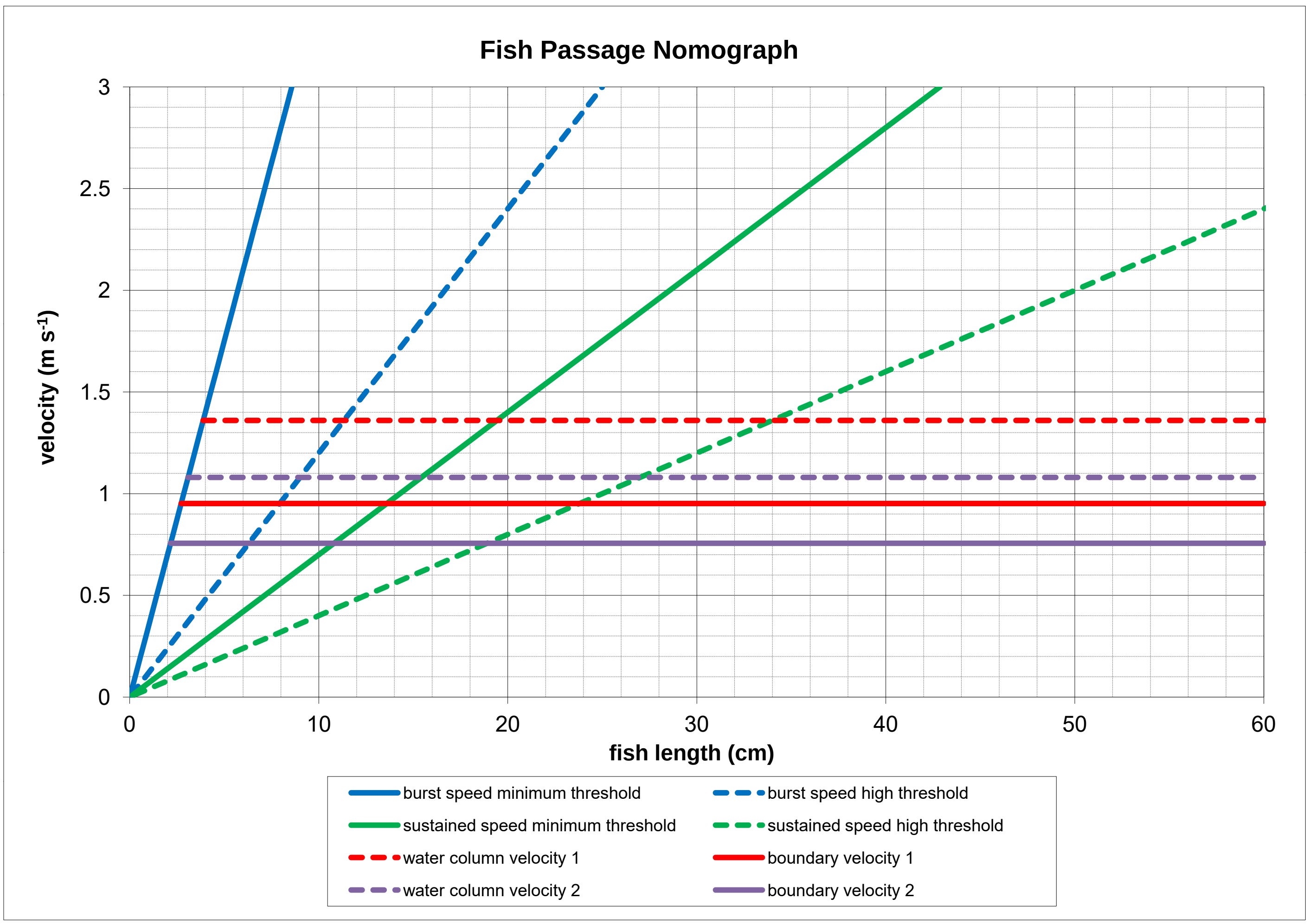
Velocity 1 proposed riffle
Velocity 2 proposed pool

Velocity Data	1	2
water column velocity V ($m\ s^{-1}$)	1.36	1.08
boundary velocity V_b ($m\ s^{-1}$)	0.95	0.76

S_b D_s burst speed swimming distance (m)	1	2
water column	90.2	105.6
boundary	112.6	123.4

Fish Length Data

		sustained speed high threshold	sustained speed minimum threshold	burst speed high threshold	burst speed minimum threshold
1	fish length L_f (cm) at V	34.0	19.4	11.3	3.9
	fish length L_f (cm) at V_b	23.8	13.6	7.9	2.7
2	fish length L_f (cm) at V	27.0	15.4	9.0	3.1
	fish length L_f (cm) at V_b	18.9	10.8	6.3	2.2



McCraney Creek Aquatic and Bat Habitat Surveys

Memo

To: Corporation of the Town of Oakville
1225 Trafalgar Road
Oakville, ON L6H 0H3

From: Daryl Rideout (Amec Foster Wheeler)

CC: Steve Chips (Amec Foster Wheeler)
David Sinke (Amec Foster Wheeler)
Neal Smith (Amec Foster Wheeler)

Ref: Amec Foster Wheeler TPB166047

Date: January 24, 2018

Re: **Aquatic and Bat Habitat Surveys for Proposed Channel Realignment of McCraney Creek North of Lakeshore Road to Rebecca Street.**

1.0 INTRODUCTION

To meet existing and future needs, the Town of Oakville is proposing roadway and intersection improvements for approximately 6.2 kilometers (km) of Lakeshore Road West from Mississaga Street to Dorval Drive (Attachment 1; Figure 1). Amec Foster Wheeler Environment & Infrastructure, a Division of Amec Foster Wheeler Americas Limited (Amec Foster Wheeler) was retained by the Town of Oakville to undertake the required Schedule 'C' Municipal Class Environmental Assessment (EA) for the proposed improvements to Lakeshore Road West. The proposed work includes; intersection improvements, provision of pedestrian and cycle facilities, urban design streetscape improvements, and the provision of other transit-related infrastructure.

Within the study area, Lakeshore Road West crosses four (4) permanent watercourses including McCraney Creek, which is located approximately 1.37 km west of Dorval Drive at the easternmost end of the Lakeshore Road West study area. During the preliminary design process for Lakeshore Road West road improvements, alternatives for replacement of the McCraney Creek structure were assessed and included an alternative to skew the replacement structure and/or realign the stream to accommodate a more direct flow path into the structure and reduce erosion in the immediate vicinity of the structure.

Correspondence with the Ministry of Natural Resources and Forestry (MNRF) was conducted during the EA background review, in which the MNRF indicated several aquatic and terrestrial species at risk (SAR) which have the potential to exist on site. Two bat species, Little Brown Myotis (*Myotis lucifugus*) and Northern Myotis (*Myotis septentrionalis*), both provincially listed as 'Endangered' under the *Endangered Species Act*, 2007 (ESA), were identified as having the potential to utilize treed habitat on site. The woodlot at McCraney Creek and Lakeshore Road has been identified as a Fresh-Moist Lowland Deciduous Forest, with common tree species including

Norway Maple, ashes and willows. Vegetation removals will be required to accommodate a potential structure skew and/or stream realignment upstream of the crossing. As such, an assessment of potential bat habitat (i.e. maternity roost areas) was conducted within the woodland north of the McCraney Creek crossing to determine the extent of impacts which may result from the proposed crossing skew and/or watercourse realignment.

This memorandum provides a summary of the aquatic and potential bat habitat existing conditions reported within the study area associated with the proposed creek realignment footprint, which may be up to 200 m in length upstream of Lakeshore Road towards Rebecca Street. The memo also identifies opportunities for aquatic habitat enhancement and vegetation improvement within the woodlot

2.0 METHODOLOGY

Amec Foster Wheeler biologists revisited the crossing of McCraney Creek at Lakeshore Road West on December 18th, 2017, to conduct surveys within the enlarged study area (Attachment 1, Figure 2 and 3) associated with the proposed creek realignment.

2.1 Aquatic Field Surveys

McCraney Creek was assessed for opportunities for fish habitat enhancement (i.e. fish passage barriers, areas exhibiting bank instability). The watercourse was assessed from approximately 50m upstream of Rebecca Street to Lakeshore Road West. Detailed mapping of areas requiring enhancement/rehabilitation was performed and key areas were geographically referenced using a handheld GPS. The GPS coordinates recorded marked the approximate areas of erosion as well as the approximate location of fish passage barriers found within the reach. The GPS coordinates were also used to map the approximate location of the watercourse within the woodlot. As the GPS coordinates are approximate, they should not be used for construction purposes. Photographic records are provided in a photographic log (Attachment 2).

2.2 Terrestrial Field Surveys

The woodlot was thoroughly surveyed by visual inspection for trees with cavities, cracks, knotholes and loose bark that may be suitable for a bat maternity roost. These trees may provide maternity roost habitat for Little Brown Myotis and Northern Myotis. All trees with a Diameter at Breast Height (DBH) of 10 centimetres (cm) or greater were identified, georeferenced, and any other pertinent information was noted.

Maple and Oak trees provide potential maternity roost sites for Tri-colored Bat (*Perimyotis subflavus*), which typically roost in clusters of dead leaves. Although not identified by MNRF for this site, this species occurs throughout Southern Ontario. As such, the presence of maple and oak trees with or without dead leaf clusters was also noted.

It should be noted that the late seasonality of the study reduced the ability to assess the presence of dead leaf clusters, as the dead leaf clusters are dynamic habitat feature which are temporary, occurring seasonally. The identification of preferred tree species within the woodlot provides an indication of whether potential habitat is present on site.

3.0 RESULTS

3.1 Aquatic Habitat

A depiction of the key features and habitat mapping for the site are provided in (Attachment 1; Figure 2). Upstream of Lakeshore Road West, McCraney Creek maintains a relatively uniform wetted width of approximately 6 m as it meanders through the woodlot. Flows are slow and is mainly comprised of flats with a few small sets of riffles where rocky substrate is present in shallower areas.

Immediately downstream of Rebecca Street, there is a vertical drop where the poured concrete slab foundation of the crossing meets the natural stream substrate. Flows at the outlet of the crossing structure are concentrated on the easternmost side of the crossing where they flow over this structure, as a large accumulation of woody debris and leaves blocks the majority of the channel at the westernmost side of the crossing outlet. The vertical drop from the poured cement slab to the natural stream substrate is approximately 0.5 m high on the west and 0.8 m high on the east. This area of concentrated flow exhibits a higher velocity then the surrounding watercourse and laminar flow is present. As such, this feature is a barrier to the upstream movement of small-bodied fish. The effects of this barrier would be exacerbated during periods of high flow.

Immediately downstream of this area past the southwest headwall of the Rebecca Street crossing, erosion is evident along the east bank of the watercourse, spanning a length of approximately 10.3 m. Unstable soil and exposed roots are evident up to a height of approximately 1 m. The west bank was stable in this area. No further erosion was observed on the easternmost bank approaching the Lakeshore Road ROW.

Downstream of this area, erosion became evident on the west bank of the watercourse, with exposed soils and bare roots evident spanning along approximately 31.5 m of channel. The unstable banks were approximately 1m high. As the watercourse approaches the tight bend at Lakeshore Road, the erosion becomes more severe with the greatest amounts of erosion found at the crest of the turn where McCraney Creek transitions its flow from a southerly direction to an easterly direction as it reaches the Lakeshore Road ROW. The bank height, through this area reaches a maximum height of approximately 2.5 m.

At the inlet of the Lakeshore Road crossing, an area of exposed limestone is evident. At the downstream end of the limestone, a poured concrete pad is evident. This was potentially installed for the protection of a conduit or other underground infrastructure. A step/face of concrete is present at the edge of the concrete pad, where the pad stops and meets with the natural channel bed downstream. Laminar flow was evident flowing over the limestone bedrock and concrete pad during surveys previously conducted in June, 2017. During a revisit of the site in September 2017 as well as the December 18th, 2017 surveys, flows were significantly reduced, exposing much of the limestone and resulting in shallow laminar flow. As such, it is believed that this area may pose a barrier to fish movement. Removal of this feature represents a potential enhancement opportunity.

3.2 Terrestrial Habitat

Four trees with potentially suitable maternity roost sites for Little Brown and Northern Myotis were recorded within the study area, as well as one additional tree in a backyard immediately adjacent to the study area. Cavities noted included: two knotholes in willow species; two woodpecker cavities in a willow and a dead tree of unknown species; and a natural cavity in a rotting dead tree. The rotting dead tree also had loose bark which may provide roosting habitat. The data for potentially suitable roosting trees is summarised in Table 1 and mapped locations provided in Figure 3 (Attachment 1).

Table 1 – Potentially suitable roost trees for Little Brown and Northern Myotis

Tree Number	Tree Species	Diameter at Breast Height (cm)	Height	Habitat Attributes	Decay Status	Easting	Northing	Notes
22	Willow species	55	Canopy height	Knot Hole (5 m high)	Declining live tree	606091	4808924	Small knothole
23	Willow species	41	Just below canopy	Knot Hole (3 m high)	Very recently dead, no canopy, bark intact, branches intact	606081	4808926	Small knothole
24	Unknown dead tree	unknown	Just below canopy	Cavity (6 m high), Loose Bark	Recently dead, bark peeling, only large branches intact	606063	4808943	In backyard on private property, lots of loose bark
25	Willow species	61	Canopy height	Cavity (8 m high)	Healthy Live Tree	606024	4808902	Woodpecker nest hole. Several other large trunks without visible cavities
26	Unknown dead tree	22	Well below canopy	Cavity (3 m high)	Recently dead, bark peeling, only large branches intact	606040	4808894	Likely a woodpecker feeding cavity

Potentially suitable trees for Tri-colored Bat found included fourteen Norway Maple (*Acer platanoides*) and one Manitoba Maple (*Acer negundo*). No dead leaf clusters were observed on any of these trees. This data is summarised in Table 2 and mapped in Figure 3 (Attachment 1).

Table 2 – Potentially suitable roost trees for Tri-colored Bat

Tree Number	Tree Species	Tree Status	Diameter at Breast Height (cm)	Tree Location	Easting	Northing
1	Norway Maple	Live	22	Forest Edge	606063	4808896
2	Norway Maple	Live	24	Forest Edge	606059	4808907
3	Norway Maple	Live	35	Forest Edge	606059	4808907
4	Norway Maple	Live	33	Forest Edge	606054	4808900
5	Norway Maple	Live	26	Forest Edge	606054	4808900
6	Norway Maple	Live	21	Forest Edge	606054	4808900
7	Norway Maple	Live	22	Forest Edge	606054	4808900
8	Manitoba Maple	Live	31	Forest Edge	606075	4808895
9	Norway Maple	Live	20	Forest Edge	606030	4808888
10	Norway Maple	Live	40	Forest Edge	606048	4808912
11	Norway Maple	Live	49	Forest Edge	606049	4808924
12	Norway Maple	Live	35	Forest Edge	606058	4808919
13	Norway Maple	Live	23	Forest Edge	606058	4808919
14	Norway Maple	Live	21	Forest Edge	606066	4808934
15	Norway Maple	Live	15	Forest Edge	606065	4808935
16	Norway Maple	Live	18	Forest Edge	606064	4808925
17	Norway Maple	Live	20	Forest Edge	606068	4808924
18	Norway Maple	Live	36	Forest Edge	606077	4808920
19	Norway Maple	Live	22	Forest Edge	606080	4808926
20	Norway Maple	Live	23	Forest Edge	606081	4808926
21	Norway Maple	Live	39	Forest Edge	606081	4808926

4.0 ENHANCEMENT OPPORTUNITIES

4.1 Aquatic Habitat

Enhancement measures which could be utilized to improve aquatic habitat as a component of the crossing replacement/extension works and stream realignment include:

- Select a new replacement structure that will improve fish passage:
    - Consider flow velocities and select the structure, grading, etc. that will ensure the crossing structure is passable by fish species known to inhabit the watercourse which include smaller-bodied species which may move through the watercourse seasonally based on stream temperatures and are capable of low/moderate swim speeds (i.e. Longnose Dace 0.65 meters per second (m/sec) and White Sucker 0.45-0.60 m/sec). Rainbow Trout, a sensitive cool/coldwater species has also been found within the watercourse and is likely migrating through the study area to reach upstream breeding grounds. This species can move up to 5.70 m/sec (Peake, S.J, 2008).
    - Naturalize the substrate within the ROW. Consider modifying the limestone bedrock and poured concrete slab substrate at the upstream end of the ROW to improve fish passage within the ROW by creating a low flow channel.
- Incorporate natural channel design for the channel realignment to improve bank stability, and create flow morphology diversity;
- Following the completion of the construction activities, vegetate margins under the structure where light penetration is sufficient for growth;
- Enhance riparian vegetation in areas adjacent to and upstream of the crossing through restoration and revegetation following the completion of the construction activities to increase: shading to the watercourse; maintain cooler water temperatures and increase bank stability / provide scour protection;
- Enhance stormwater drains at Lakeshore Road which outlet to McCraney Creek to ensure the flows are thermally regulated and of good quality; and
- Protect natural channel areas and habitats which provide refuge and potential spawning habitat.

4.2 Terrestrial Habitat

Enhancement measures which could be utilized to improve bat habitat as a component of the stream realignment include:

- Selection of native species for vegetation restoration including selection of native trees able to outcompete invasive trees and shrubs present such as Norway Maple. Recommended trees may include Black Maple (*Acer nigrum*) and Red Maple (*Acer rubrum*);

- Provide forest management to monitor the site to encourage the growth of native tree species and maintain existing large trees, as well as potentially controlling invasive species such as Norway Maple and Multiflora Rose;

- Install bat roosting boxes to provide additional roosting habitat for SAR bats.

5.0 CLOSURE

This document is intended for the exclusive use of Amec Foster Wheeler and Town of Oakville representatives only for the purpose of Project compliance with contract specifications and regulatory requirements, and for the definition of any recommended SAR mitigation/management procedures. The findings, interpretations and recommendations as outlined herein are based on the expertise of Amec Foster Wheeler and their representative specialists based on the observations and information available at the time of document preparation and on the assumptions and interpretation of the Project contract and any other regulatory compliance requirements.

Sincerely,

Amec Foster Wheeler Environment & Infrastructure,
a Division of Amec Foster Wheeler Americas Limited

DRAFT

Daryl Rideout, B.Sc.
Environmental Biologist and Species at Risk Specialist

6.0 REFERENCES

Peake, S.J. 2008. Swimming performance and behaviour of fish species endemic to Newfoundland and Labrador: A literature review for the purpose of establishing design and water velocity criteria for fishways and culverts. Can. Manuscr. Rep. Fish. Aquat. Sci. 2843: v + 52p.

ATTACHMENT 1

Figure 1 – Project Location

Figure 2 – Aquatic Study Area and Areas Requiring Restoration

Figure 3 – Potentially Suitable Bat Maternity Roost Trees

LEGEND

- Approximate Study Area
- Watercourse
- Wetland
- Waterbody

NOTES:
- Background imagery from Google Earth.
- Topographic features extracted from LIO, MNRF.
* Scale when printed 8.5 x 11 in. letter size

OAKVILLE

TOWN OF OAKVILLE
LAKESHORE ROAD WEST IMPROVEMENTS

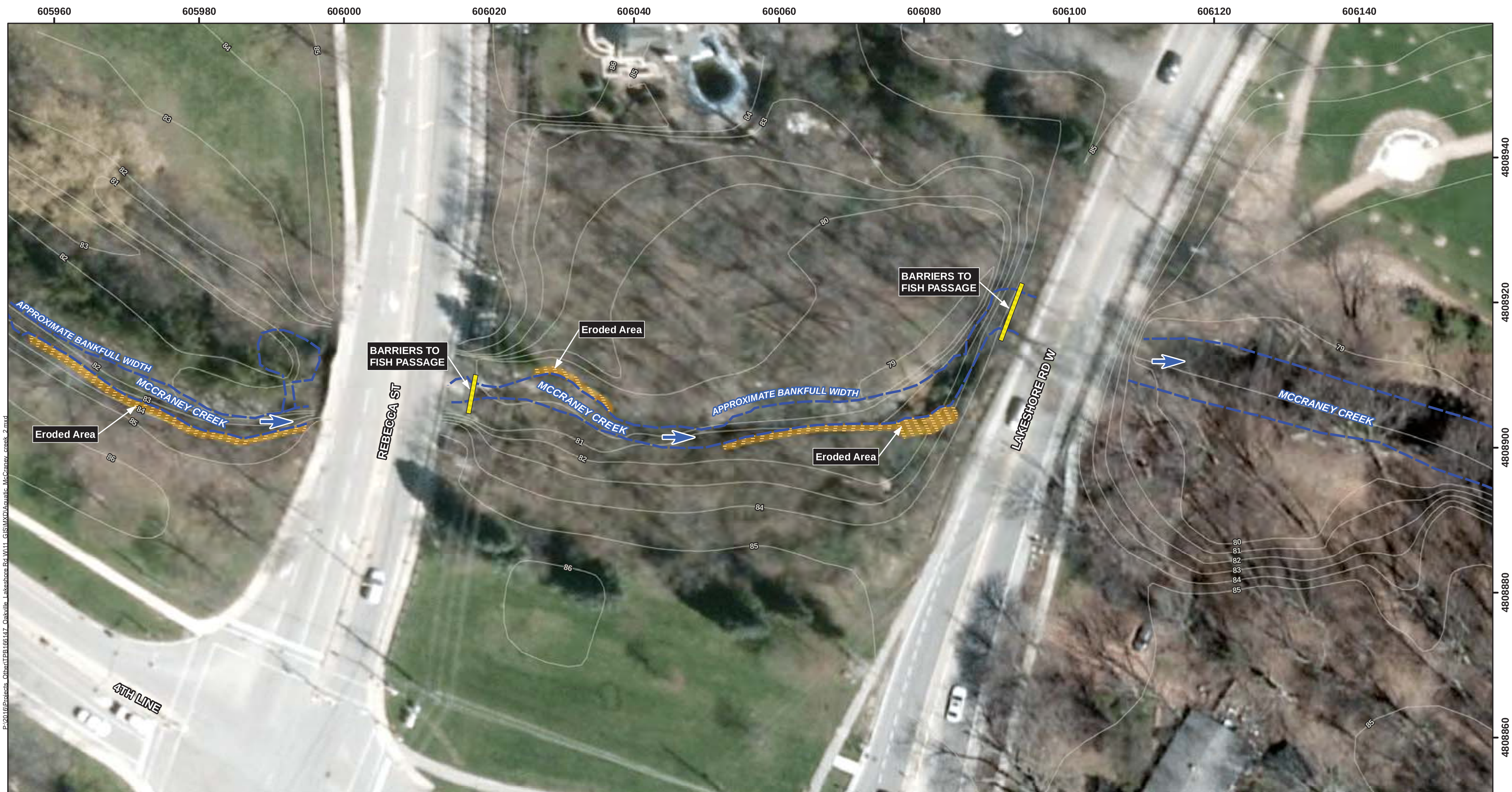
Project Location

Datum & Projection: NAD 1983 UTM Zone 17N

0 0.6 1.2 1.8 2.4 3 Kilometres

N E S W

PROJECT N°: TPB166147	FIGURE 1
SCALE: 1:40,000	DATE: September 2017



LEGEND

- McCraney Creek Bankfull (approximate)
- Fish Barrier
- Erosion Areas [1]
- Flow Direction
- Contours 1 m Interval

0 20 40 60 80 100 Metres

OVERVIEW

500 Meters

NOTES:
[1] Approximate location of Erosion areas (accuracy of ~ 3m)

Datum & Projection: NAD 1983 UTM Zone 17N

OAKVILLE

TOWN OF OAKVILLE
LAKESHORE ROAD WEST IMPROVEMENTS

Aquatic Areas and Erosion Areas

PROJECT Nº: TPB166147	FIGURE 2
SCALE: 1:500	DATE: December 2017

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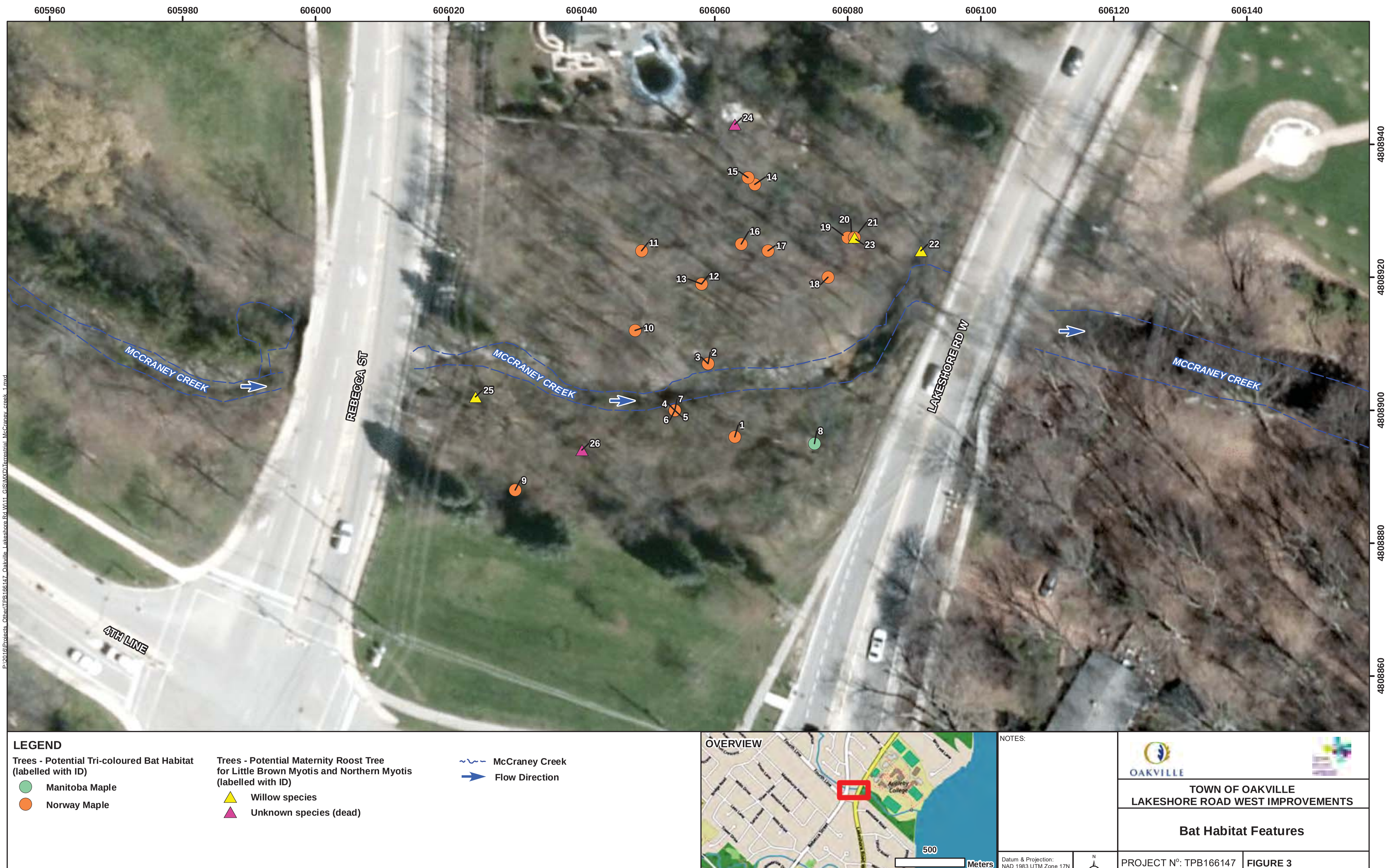

LEGEND

Trees - Potential Tri-coloured Bat Habitat (labelled with ID)
- Manitoba Maple
- Norway Maple

Trees - Potential Maternity Roost Tree for Little Brown Myotis and Northern Myotis (labelled with ID)
- Willow species
- Unknown species (dead)

McCraney Creek
Flow Direction

0 20 40 60 80 100 Metres

NOTES:

Datum & Projection: NAD 1983 UTM Zone 17N

OAKVILLE

TOWN OF OAKVILLE
LAKESHORE ROAD WEST IMPROVEMENTS

Bat Habitat Features

PROJECT Nº: TPB166147 | FIGURE 3
SCALE: 1:500 | DATE: December 2017

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ATTACHMENT 2

AQUATIC HABITAT PHOTOGRAPHIC LOG

Photo 1: *Within Rebecca Street ROW facing downstream. Note large area of debris at west downstream end of crossing forcing flows to move over cement ledge on east.*

Photo 2: *Cement slab present at downstream end of Rebecca Street crossing is a barrier to small-bodied fish.*

Photo 3: *Photo of stable west bank at Rebecca Street.*

Photo 4: *Photo of stable east bank at Rebecca Street.*

Photo 5: *Erosion evident at east bank immediately downstream of Rebecca Street retaining wall. Area spans approximately 10.3 m in length. Height of erosion averages at 1 meter.*

Photo 6: *Erosion evident at east bank immediately downstream of Rebecca Street retaining wall.*

Photo 7: *Downstream banks stabilize before erosion area present on west bank.*

Photo 8: *Erosion evident on west bank for approximately 31.5 meters prior to reaching retaining wall for Lakeshore Road.*

Photo 9: *Erosion evident at west bank on approach to Lakeshore Road ROW.*

Photo 10: *Close up or exposed roots present on west bank.*

Photo 11: *Bank nearest the retaining wall structure experiencing significant erosion. Erosion of bank reaches approximately 2.5 meters in height at its highest point.*

Photo 12: *Emergency works were completed in the summer of 2017 to repair the severely eroded bank present directly west of the Lakeshore Road crossing.*

Photo 13: *Upstream end of Lakeshore Road crossing. Note some erosion is also evident at northeast bank, where exposed sandy soils are present.*

Photo 14: *Standing within Lakeshore Road ROW facing upstream. Note large area of limestone present to right (east) of structure inlet. Cement slab located at left may pose a potential barrier to smaller-bodied fish during periods of high flow.*

ATTACHMENT 3

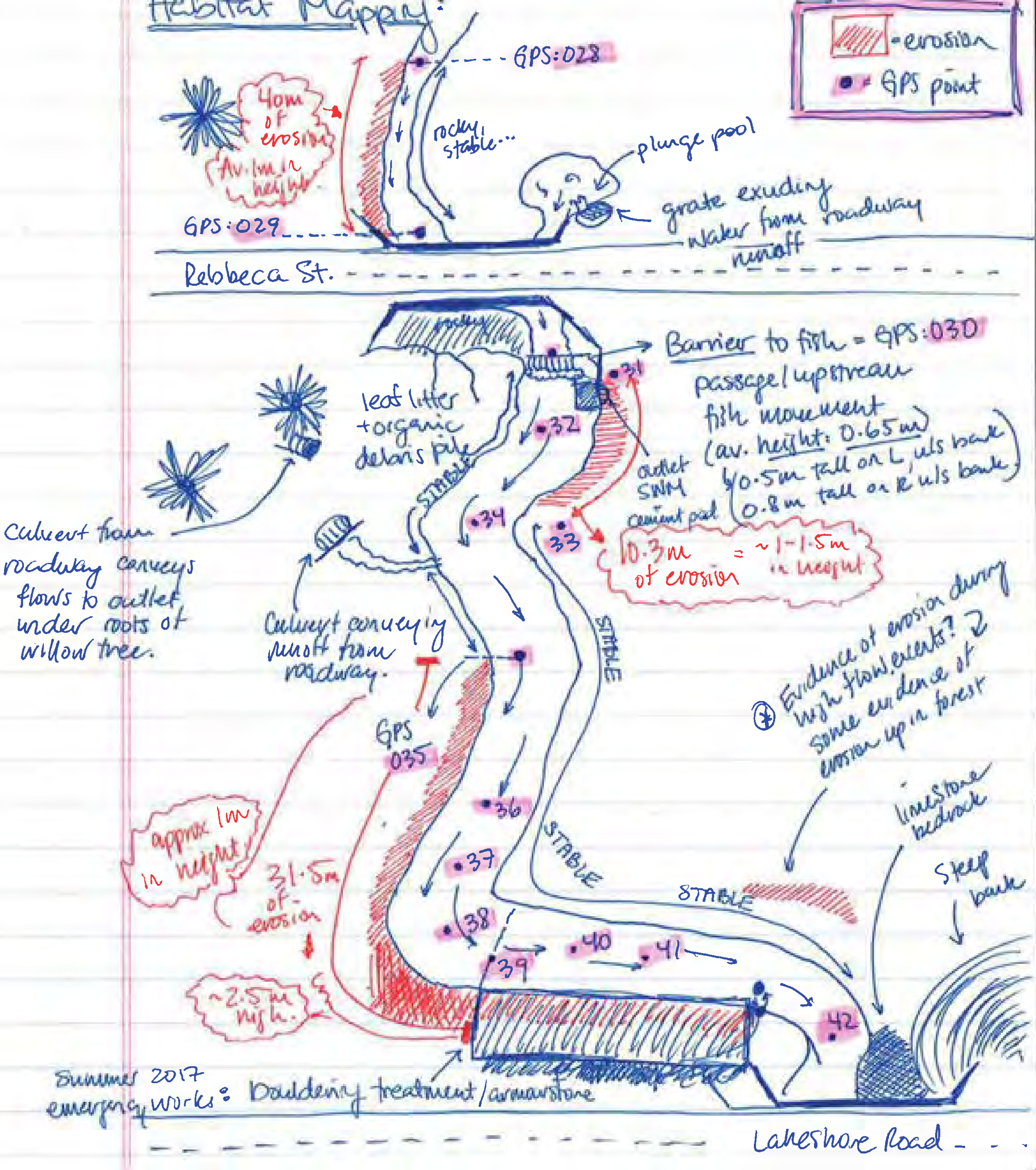
FIELD NOTES

Dec 18, 2017

Lakeshore Road Project:

McCraney Creek - Aquatic Habitat Survey:

Habitat Mapping:



Suitable Maternity Roost Trees for Little Brown Myotis/Northern Myotis

Include all live and dead standing trees ≥10cm dbh with loose or naturally exfoliating bark, cavities, hollows or cracks.

Project Name:

Survey Date(s): Dec 18, 2017

Site Name: Lakeshore Rd

Observers(s): RJM

ELC Ecosite: Norway Maple Lowland Forest

Snag Density (snags/ha):

	Tree #	Tree Species ID	dbh (cm)	Height Class[1]	Snag attributes (check all that apply)	Easting	Northing	Notes Cavity Height
22	288	Salix	55	2	☒ cavity[2] ☐ loose bark ☐ crack ☒ knot hole ☐ other snag within 10m? ☒ Decay Class 1-3?[3] 2	0606091	4808424	5 m, knot hole, small
23	289	Salix	41	3	☒ cavity ☐ loose bark ☐ crack ☒ knot hole ☐ other snag within 10m? ☒ Decay Class 1-3? 2.	0606081	4808926	3 m, knot hole, small
24	290	Dead	?	3	☒ cavity ☒ loose bark ☐ crack ☐ knot hole ☐ other snag within 10m? ☐ Decay Class 1-3?	0606063	4808943	on private property, backyard lots of l. bark
25	291	Salix	61	2	☐ cavity ☐ loose bark ☐ crack ☐ knot hole ☐ other snag within 10m? ☐ Decay Class 1-3?	0606024	4808902	w-p cavity, 8 m high several trunks
26	292	dead	22	4	☐ cavity ☐ loose bark ☐ crack ☐ knot hole ☐ other snag within 10m? ☐ Decay Class 1-3?	0606010	4808814	w-p cavity/feeding hole? 3 m high
					☐ cavity ☐ loose bark ☐ crack ☐ knot hole ☐ other snag within 10m? ☐ Decay Class 1-3?			
					☐ cavity ☐ loose bark ☐ crack ☐ knot hole ☐ other snag within 10m? ☐ Decay Class 1-3?			
					☐ cavity ☐ loose bark ☐ crack ☐ knot hole ☐ other snag within 10m? ☐ Decay Class 1-3?			
					☐ cavity ☐ loose bark ☐ crack ☐ knot hole ☐ other snag within 10m? ☐ Decay Class 1-3?			
					☐ cavity ☐ loose bark ☐ crack ☐ knot hole ☐ other snag within 10m? ☐ Decay Class 1-3?			
					☐ cavity ☐ loose bark ☐ crack ☐ knot hole ☐ other snag within 10m? ☐ Decay Class 1-3?			
					☐ cavity ☐ loose bark ☐ crack ☐ knot hole ☐ other snag within 10m? ☐ Decay Class 1-3?			

[1] **Height Class**: 1 = Dominant (above canopy); 2 = Co-dominant (canopy height); 3 = Intermediate (just below canopy); 4 = suppressed (well below canopy)

[2] The approx. height of the cavity should be noted.

[3] **Decay Class**: 1 = Healthy, live tree; 2 = Declining live tree, part of canopy lost; 3 = Very recently dead, bark intact, branches intact.

Suitable Maternity Roost Trees for Tri-colored Bat

Include all oak trees ≥10cm dbh (if present). If oaks are absent, include maples ≥10cm dbh IF dead/dying leaf clusters are present; and maples >25cm dbh if no dead/dying leaf clusters are present.

Project Name: Lakeshore Rd

Survey Date(s): Dec 18 2017

Site Name

Observer(s): RDM

ELC Ecosite: Norway Maple Lowland Forest

Wintertime survey

	Tree#	Tree Species ID	Tree Status (live/dead)	Dbh (cm)	Tree Structural & Locational Attributes (check all that apply)	Easting	Northing	Notes
1	293	ACERPLA	L	22	☐ dead/dying leaf cluster ☐ cavity ☐ open area/forest gap ☒ forest edge ☐ interior ☐ preferred tree species within 10m?	0606063	4808896	
2 3	294	ACERPLA	L	24 35	☐ dead/dying leaf cluster ☐ cavity ☐ open area/forest gap ☒ forest edge ☐ interior ☐ preferred tree species within 10m?	0606059	4808907	2 trees
4 5 6 7	295	ACERPLA	L	33 26 21 22	☐ dead/dying leaf cluster ☐ cavity ☐ open area/forest gap ☒ forest edge ☐ interior ☐ preferred tree species within 10m?	0606054	4808900	4 trees
8	296	ACERNEG	L	31	☐ dead/dying leaf cluster ☐ cavity ☐ open area/forest gap ☒ forest edge ☐ interior ☐ preferred tree species within 10m?	0606075	4808895	
9	297	ACERPLA	L	20	☐ dead/dying leaf cluster ☐ cavity ☐ open area/forest gap ☒ forest edge ☐ interior ☐ preferred tree species within 10m?	0606030	4808888	
10	298	ACERPLA	L	40	☐ dead/dying leaf cluster ☐ cavity ☐ open area/forest gap ☐ forest edge ☐ interior ☐ preferred tree species within 10m?	0606048	4808912	
11	299	ACERPLA	L	44	☐ dead/dying leaf cluster ☐ cavity ☐ open area/forest gap ☐ forest edge ☐ interior ☐ preferred tree species within 10m?	0606049	4808924	
12 13	300	ACERPLA	L	35 23	☐ dead/dying leaf cluster ☐ cavity ☐ open area/forest gap ☐ forest edge ☐ interior ☐ preferred tree species within 10m?	0606058	4808919	2 trees

Suitable Maternity Roost Trees for Tri-colored Bat

Include all oak trees ≥10cm dbh (if present). If oaks are absent, include maples ≥10cm dbh IF dead/dying leaf clusters are present; and maples >25cm dbh if no dead/dying leaf clusters are present.

Project Name:

Survey Date(s): Dec 18/2017

Site Name: Lakeshore Rd.

Observer(s): RDM

ELC Ecosite: Norway Maple Lowland Forest

Wintertime Survey

	Tree#	Tree Species ID	Tree Status (live/dead)	Dbh (cm)	Tree Structural & Locational Attributes (check all that apply)	Easting	Northing	Notes
14	302	ACERPLA	L	21 ~~15~~	☐ dead/dying leaf cluster ☐ cavity ☐ open area/forest gap ☒ forest edge ☐ interior ☐ preferred tree species within 10m?	0606066	4808934	
15	301	ACERPLA	L	15	☐ dead/dying leaf cluster ☐ cavity ☐ open area/forest gap ☒ forest edge ☐ interior ☒ preferred tree species within 10m?	0606065	4808935	
16	303	ACERPLA	L	18	☐ dead/dying leaf cluster ☐ cavity ☐ open area/forest gap ☒ forest edge ☐ interior ☐ preferred tree species within 10m?	0606064	4808925	
17	304	ACERPLA	L	20	☐ dead/dying leaf cluster ☐ cavity ☐ open area/forest gap ☒ forest edge ☐ interior ☐ preferred tree species within 10m?	0606068	4808924	
18	305	ACERPLA	L	36	☐ dead/dying leaf cluster ☐ cavity ☐ open area/forest gap ☒ forest edge ☐ interior ☐ preferred tree species within 10m?	0606077	4808920	
19 20	306	ACERPLA	L	22 23	☐ dead/dying leaf cluster ☐ cavity ☐ open area/forest gap ☒ forest edge ☐ interior ☐ preferred tree species within 10m?	0606080	4808926	2 trees
21	307	ACERPLA	L	34	☐ dead/dying leaf cluster ☐ cavity ☐ open area/forest gap ☒ forest edge ☐ interior ☐ preferred tree species within 10m?	0606081	4808926	
					☐ dead/dying leaf cluster ☐ cavity ☐ open area/forest gap ☐ forest edge ☐ interior ☐ preferred tree species within 10m?			

McCraney Creek Presentation_23Mar2018

McCraney Creek Structure On Lakeshore Road West

Agenda

1. Introductions
2. Overview of the McCraney Creek Structure
3. Emergency work completed in 2017
4. Existing Aquatic Areas and Erosion Areas
5. Existing Creek Alignment
6. Assessment of Alternatives
7. Preferred Alternative
8. Discussion
9. Next Steps

1. Introductions

2. Overview - McCraney Creek Structure

Existing Structure Cross Section – McCraney Creek

Facts

- Built in 1940
- Structure is actually made up of 2 culverts
- Bridge length (along the roadway centreline) is 21m
- Bridge width is 5.4m
- No Species at Risk (SAR) habitat identified within the creek
- Creek has a warm/cool thermal regime
- Creek also provides a migratory route for sport fish including Rainbow Trout
- Potential SAR bat habitat in the nearby forested areas
- Erosion issues

2. Overview - McCraney Creek Structure

2. Overview - McCraney Creek Structure

3. Emergency Work - 2017

3. Emergency Work - 2017

3. Emergency Work - 2017

3. Emergency Work - 2017

3. Emergency Work - 2017

3. Emergency Work - 2017

3. Emergency Work - 2017

3. Emergency Work - 2017

3. Emergency Work - 2017

4. Existing Aquatic Areas and Erosion Areas

- Areas of erosion evident
- Most extreme erosion is present at west bank on approach to Lakeshore Road crossing
- Fish passage barriers evident

4. Existing Aquatic Areas and Erosion Areas

4. Existing Aquatic Areas and Erosion Areas

5. Existing Creek Alignment

- Vertical drop downstream of Rebecca Street where concrete slab foundation meets natural channel substrate.
- Permanent barrier to passage of small-bodied fish species.

5. Existing Creek Alignment

- Upstream end of the Lakeshore Road crossing
- Area of exposed limestone is evident adjacent to a poured concrete pad
- Likely a partial barrier to fish passage
- Existing conditions create laminar flow at the culvert inlet resulting in few resting locations for fish or flow dissipation for fish passage.

5. Existing Creek Alignment

5. Existing Creek Alignment

5. Existing Creek Alignment

Channel realignment can provide opportunity for planting of native species and removal and management of invasive vegetation species.

5. Existing Creek Alignment

5. Existing Creek Alignment

Stone placement within the channel would provide an improved baseflow, and habitat diversity.

5. Assessment of Alternatives (Creek Alignment)

6. Assessment of Alternatives

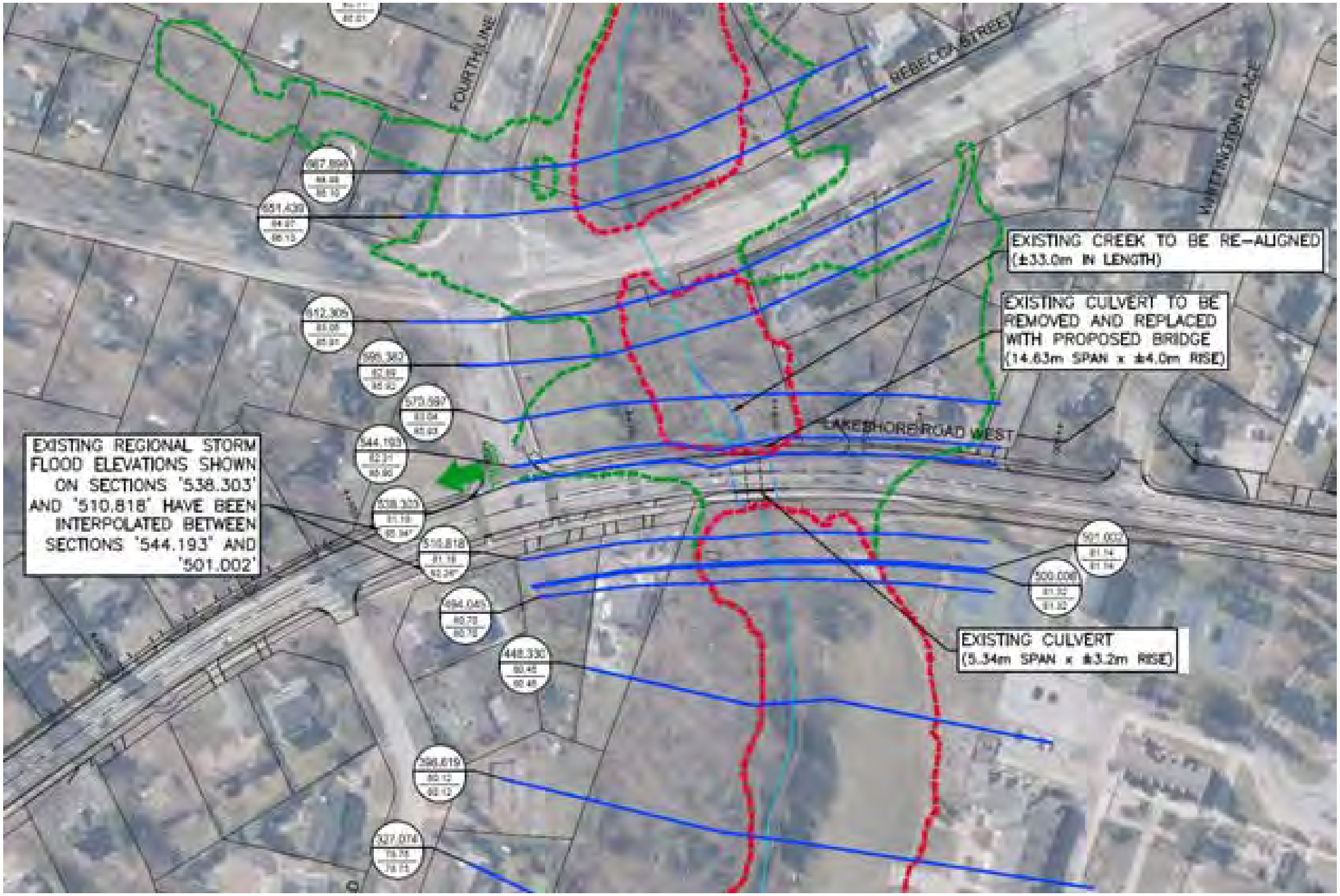
6. Assessment of Alternatives (Creek Alignment)

6. Assessment of Alternatives (Creek Alignment)

6. Assessment of Alternatives (Creek Alignment)

6. Assessment of Alternatives (Storm outfall – northwest bank)

6. Assessment of Alternatives (Hydraulics)



6. Assessment of Alternatives

- **Alternative 1: Do Nothing - Maintain existing structure**
- **Alternative 2: Remove and replace existing structure**
  - Replace with a new con span structure 14.65m X 3.75m
  - Re-alignment of McCraney Creek
- **Alternative 3: Remove and replace existing structure**
  - Replace with a new con span structure 14.65m X 3.75m (slightly skewed)
  - Re-alignment of McCraney Creek

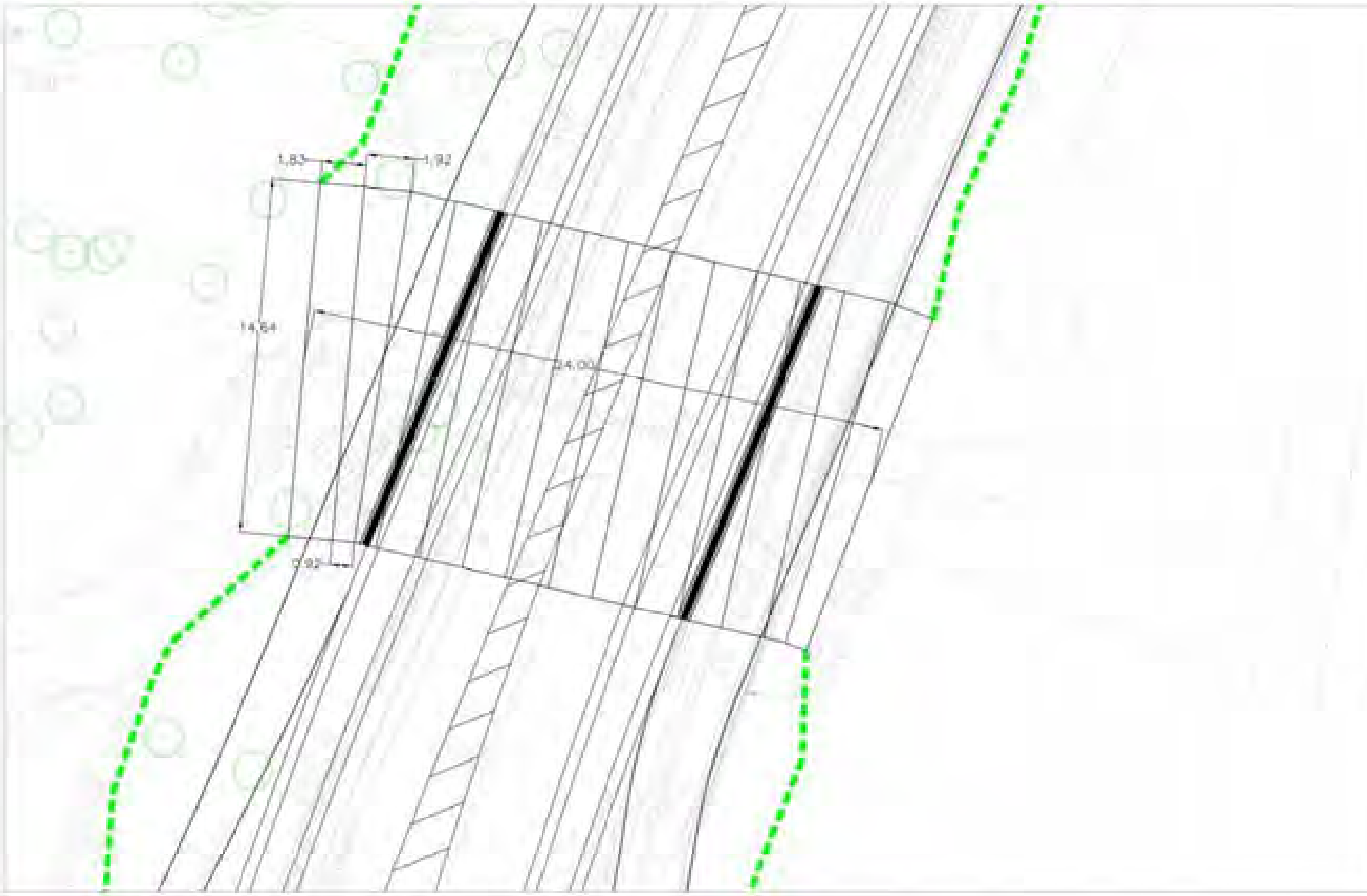
6. Assessment of Alternatives

- Assessment Table – Hardcopy provided

7. Preferred Alternative

- **Alternative 3: Remove existing structure**
  - Replace with a new con span structure 14.65m X 3.75m (slightly skewed)
  - Re-alignment of McCraney Creek upstream for structure

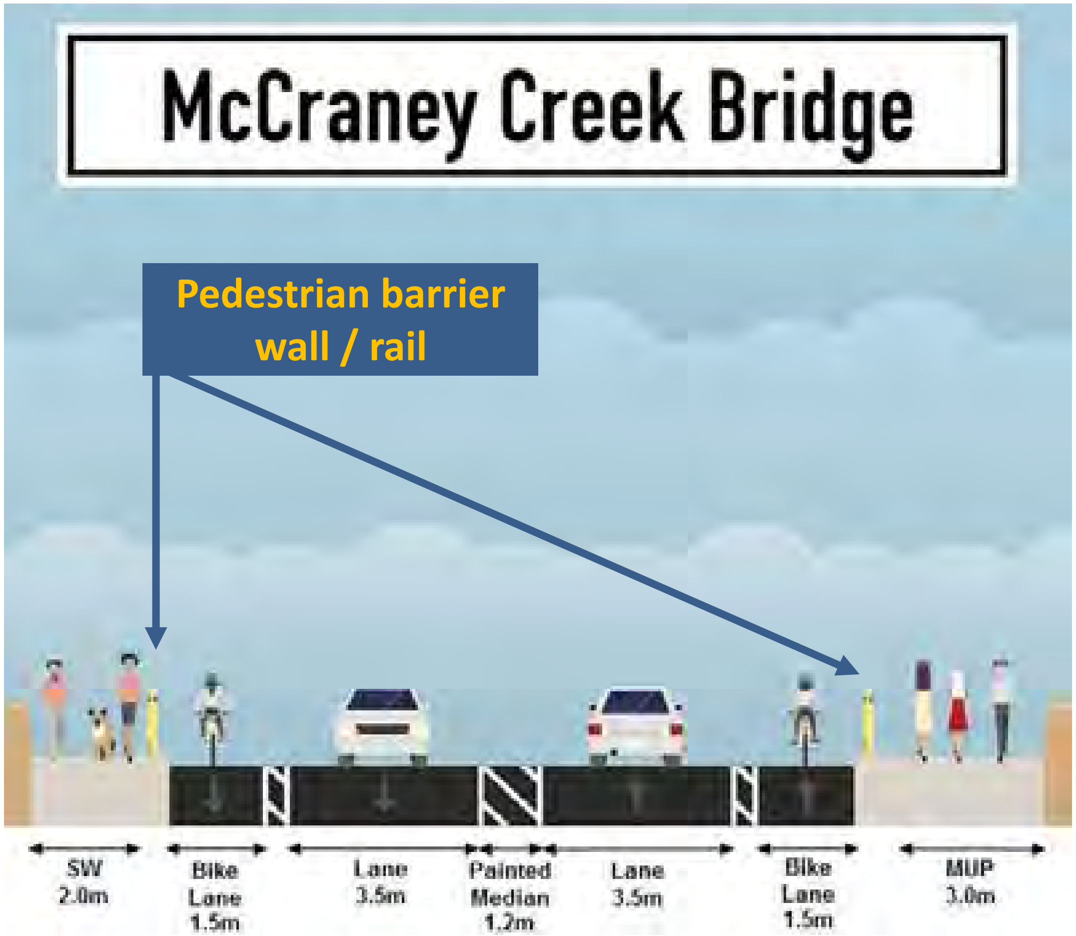
7. Preferred Alternative



7. Preferred Alternative

Proposed Cross Section of Lakeshore Road West over McCraney Creek

- Proposed structure will convey the Regional Storm Event and accommodate 2 lanes of traffic, on-road bike lanes, sidewalk and multi-use trail

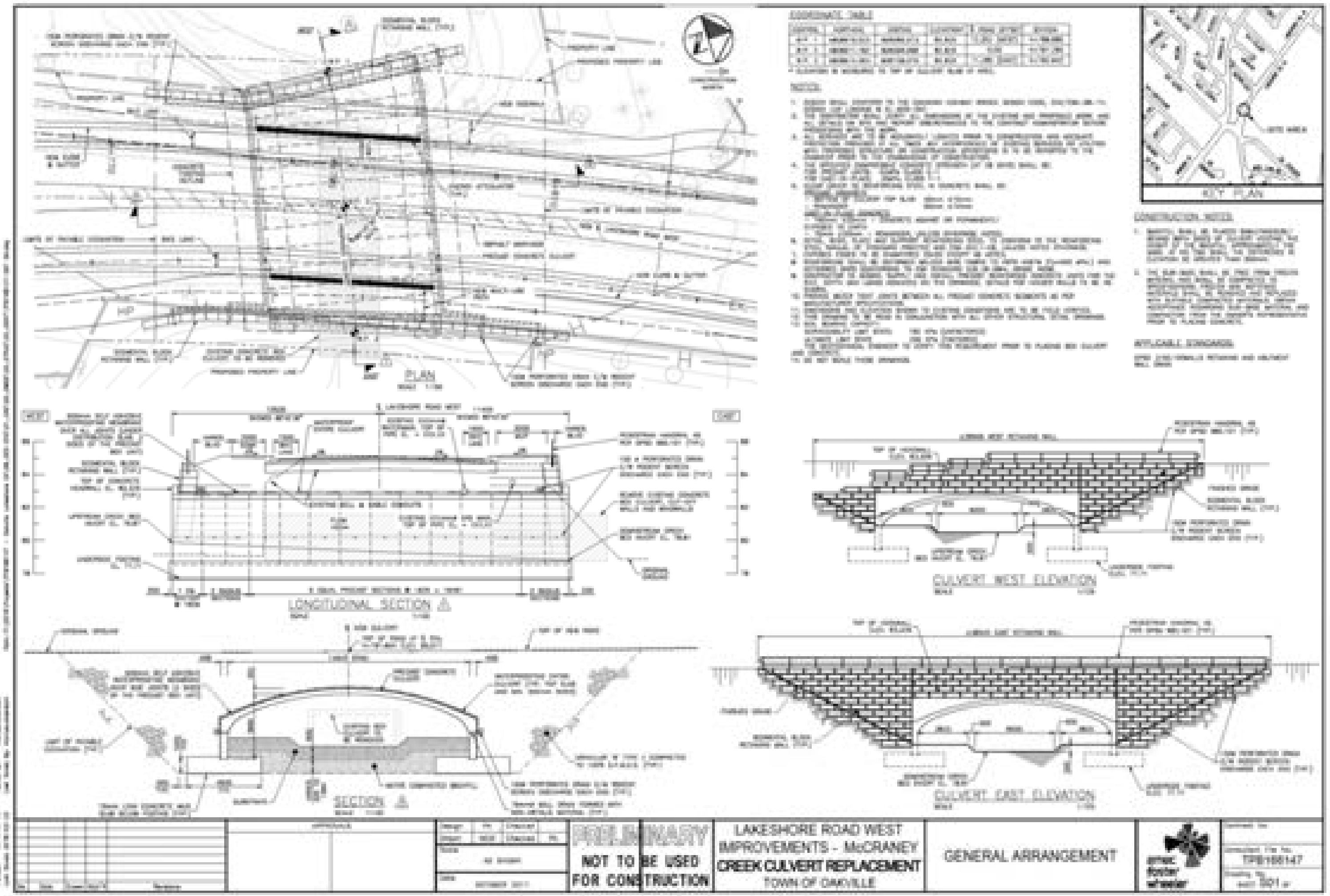


New Structure Details

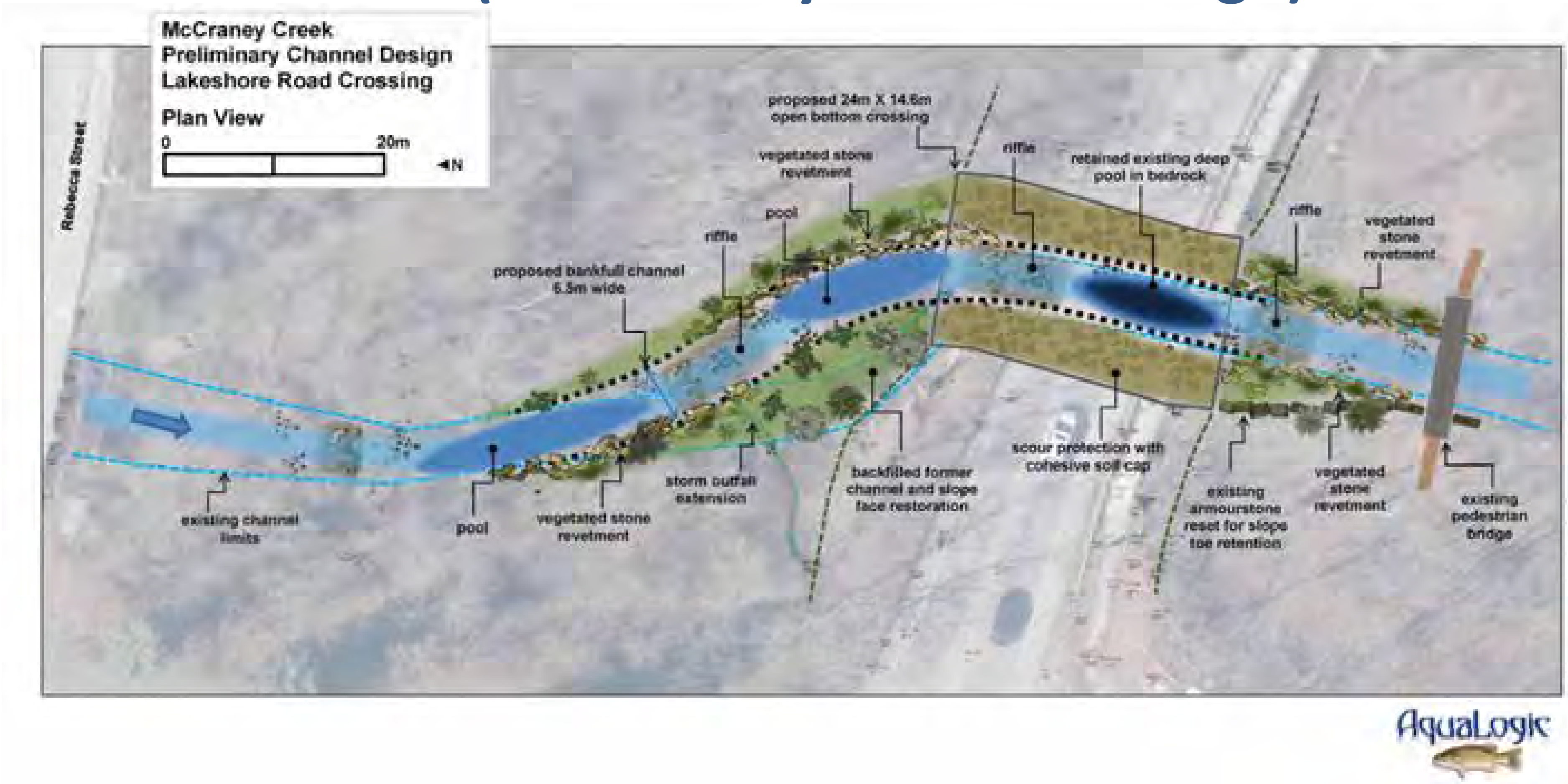
- Structure length will be 24.00m (along watercourse)
- Structure span will be 14.65m
- Structure will provide pedestrian protection separated by a barrier wall / railing
- On-road bike lane in each direction over the structure
- Multi-use trail on the south side and sidewalk on the north side

7. Preferred Alternative

General Arrangement Drawing for the McCraney Creek Structure



7. Preferred Alternative (Preliminary Channel Design)

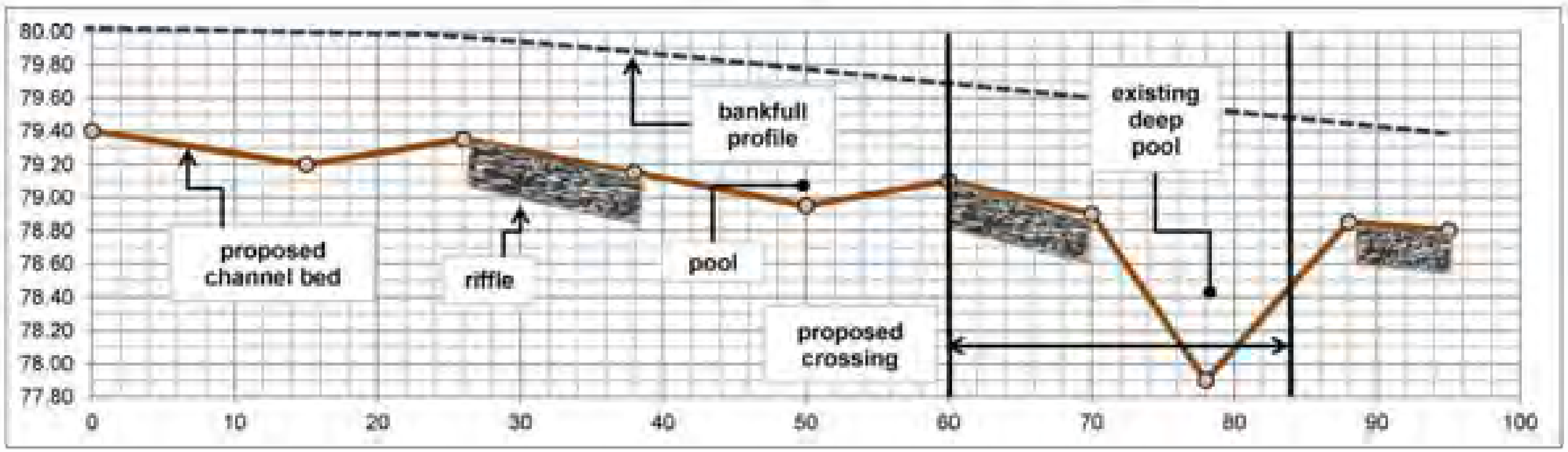


7. Preferred Alternative (Preliminary Channel Design)

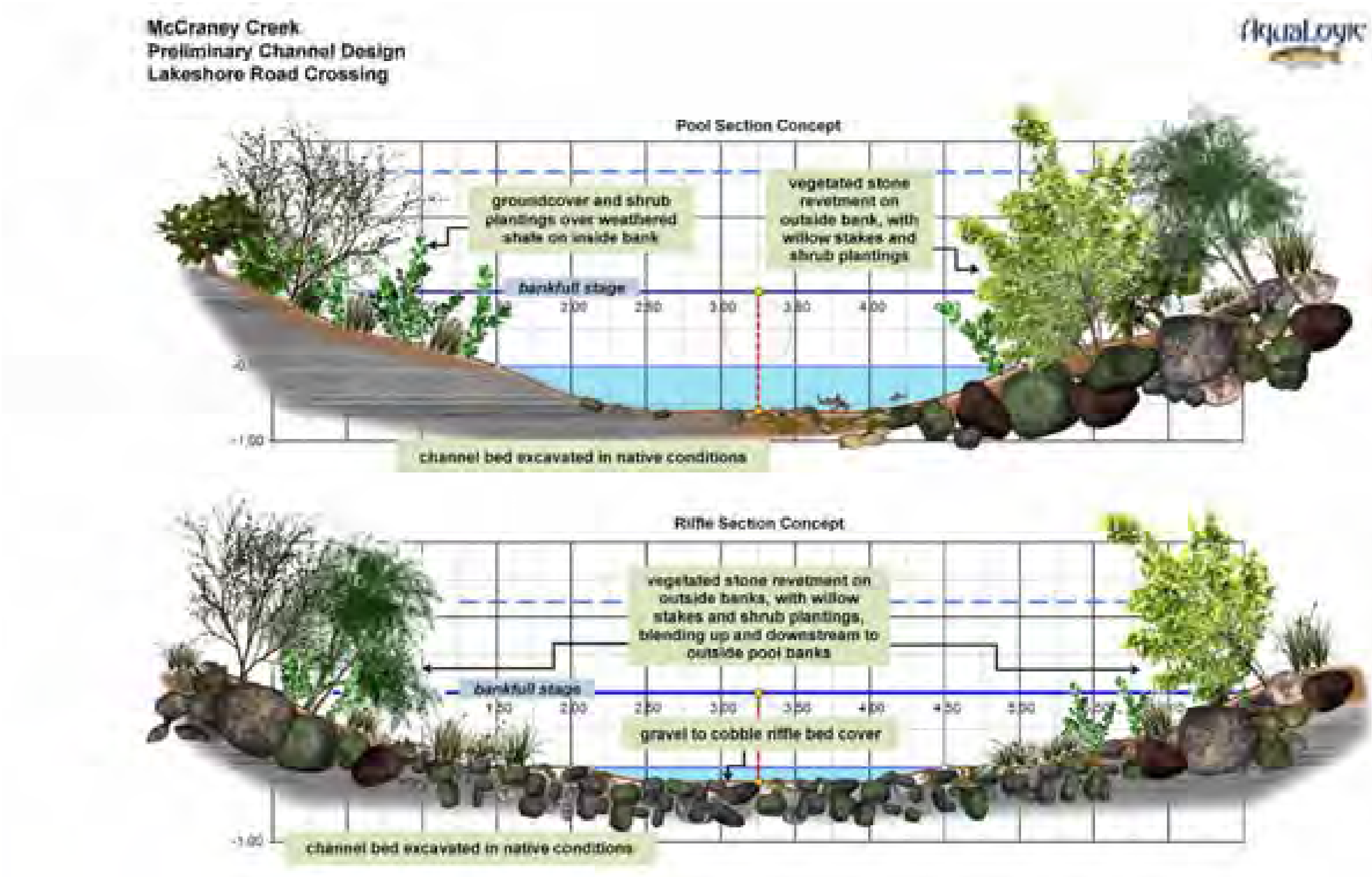
McCraney Creek
Preliminary Channel Design
Lakeshore Road Crossing

Channel Profile

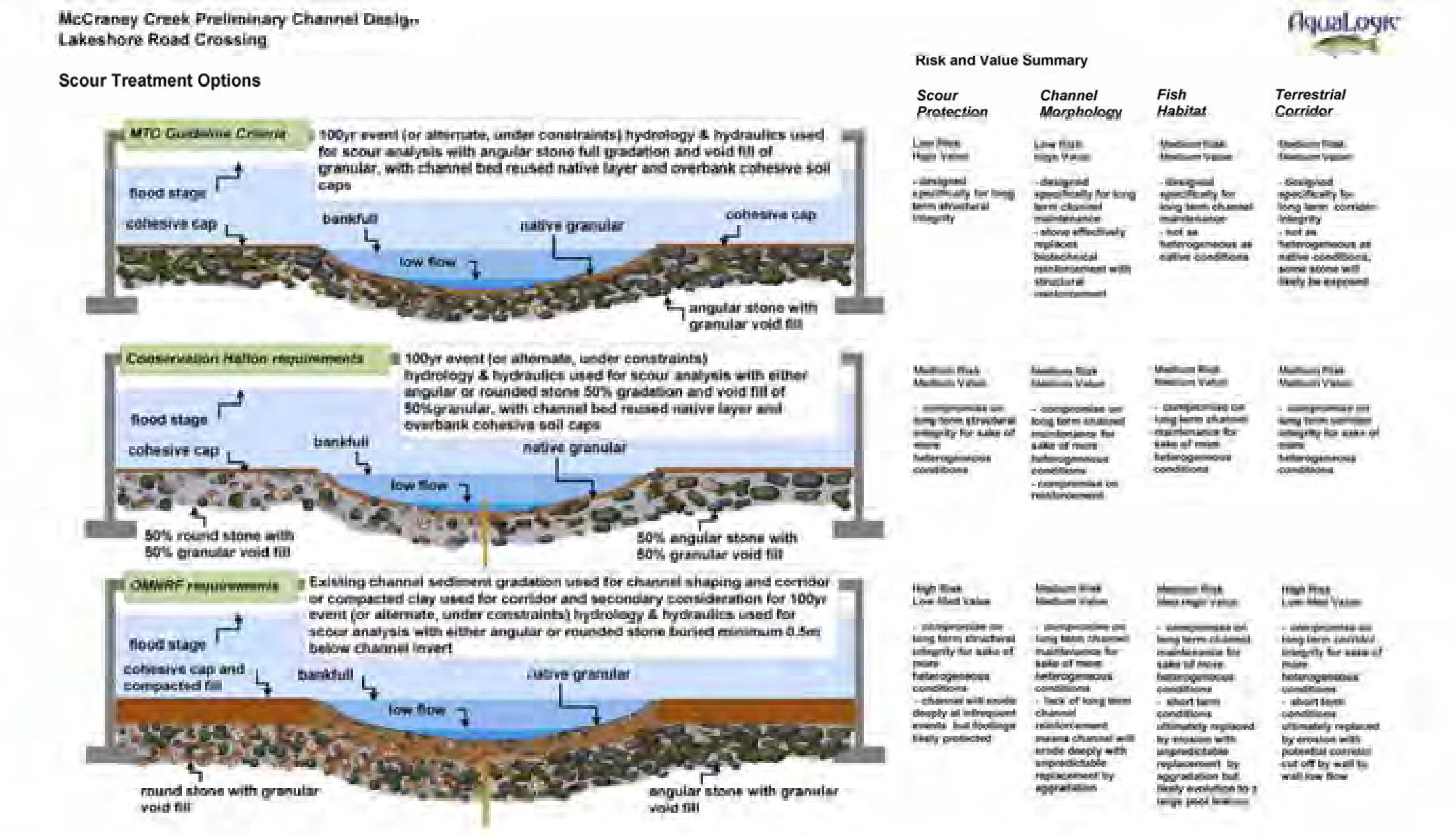
elev. m	distance m	ID
79.40	0	bottom of riffle / upstream tie-in
79.20	15	max depth pool
79.35	26	top of riffle
79.15	38	bottom of riffle
78.95	50	max depth pool
79.10	60	top of riffle
78.90	70	bottom of riffle
77.90	78	max depth existing deep pool
78.85	88	top of riffle
78.80	95	bottom of riffle / downstream tie-in



7. Preferred Alternative (Preliminary Channel Design)



7. Preferred Alternative (Preliminary Channel Design)



8. Discussion

9. Next Steps

1. Input on the Proposed Re-alignment and Structure
2. File the Environmental Study Report
3. Detailed Design and Permitting by Town
4. Construction by Town

Table_Assessment of Structure_03_26 2018 4 Options

Assessment Table - Alternatives for the McCraney Creek Crossing					
Category	**Criteria**	**Alternative 1: Do Nothing Maintain existing structure**	**Alternative 2: Replace with a new con span structure 14.65m X 3.75m No re-alignment of McCraney Creek**	**Alternative 3: Remove existing structure Replace with a new con span structure 14.65m X 3.75m Re-alignment of McCraney Creek**	**Alternative 4: Remove existing structure Replace with a new con span structure 14.65m X 3.75m (with skewed ends) Re-alignment of McCraney Creek**
NATURAL ENVIRONMENT	Wetlands and Vegetation	No additional loss of natural areas, terrestrial areas, or wetland areas. No proposed improvements to natural areas	Limited disturbance would occur to channel banks. Vegetation removal would be required on the west and east sides to accommodate structure replacement. Opportunity to improve riparian vegetation with in the ROW limits.	Disturbance would occur to channel banks. Vegetation removal would be required on the west and east sides to accommodate structure replacement. Opportunity to improve riparian vegetation with in the ROW limits.	Disturbance would occur to channel banks. Vegetation removal would be required on the west and east sides to accommodate structure replacement. Opportunity to improve riparian vegetation with in the ROW limits.
	Wildlife Habitat: Endangered bat species reported in the area but not observed. Includes Eastern Small-footed Myotis, Little Brown Myotis, and Northern Myotis.	No impacts to wildlife or wildlife habitat.	Vegetation removal would be limited to areas immeditley adjacent the structure. Timing restrictions during vegetation removal would provide mitigation measures sufficent to protect both birds and bats.	Vegetation removal would be limited to areas immeditley adjacent the structure. Timing restrictions during vegetation removal would provide mitigation measures sufficent to protect both birds and bats.	Vegetation removal would be limited to areas immeditley adjacent the structure. Timing restrictions during vegetation removal would provide mitigation measures sufficent to protect both birds and bats.
	Hydraulics and SWM	No impacts to the surface water with this alternative. Increased runoff due to road widening. Therefore quality and erosion impacts would require mitigation through SWM The bridge would continue to be overtopped by the Regional Storm.	Water surface elevations would decrease upstream of the crossing for all storm events. Flooding of residential property would be reduced. Increased runoff due to road widening. Therefore quality and erosion impacts would require mitigation through SWM New structure would be able to convey the Regional Storm.	Water surface elevations would decrease upstream of the crossing for all storm events. Flooding of residential property would be reduced. Increased runoff due to road widening. Therefore quality and erosion impacts would require mitigation through SWM New structure would be able to convey the Regional Storm.	Water surface elevations would decrease upstream of the crossing for all storm events. Flooding of residential property would be reduced. Skewed crossing would be hydraulically marginally less effective. Increased runoff due to road widening. Therefore quality and erosion impacts would require mitigation through SWM New structure would be able to convey the Regional Storm.
	Fluvial Geomorphology	The current bridge consists of 2 structures of different age. Current span is 5.3m. Creek is confined by embankment. No opportunity for improvement to the watercourse to address the deficiencies observed.	The wider structure would be able to span the low flow channel and provide adequate erosion setbacks with channel modifications. Limited opportunities for Improvements to watercourse at the replacement structure. Risk of further erosion of Lakeshore Road West embankment will not be addressed. Localized bank errosion protection would be used to address existing northwest bank errsion condition.	The wider structure would be able to span the low flow channel and provide adequate erosion setbacks with channel modifications. Limited opportunities for Improvements to watercourse at the replacement structure. Risk of further erosion of Lakeshore Road West embankment will not be addressed.	The wider structure would be able to span the low flow channel and provide adequate erosion setbacks with channel modifications. Opportunity for improvements to watercourse. Risk of further erosion of Lakeshore Road West embankment could be minimized.
	Fisheries: Habitat is present for several common warm water species and Rainbow Trout.	No impacts on fish or fish habitat.	Channel banks and vegetation will be disturbed to facilitate the structure replacement. Significant disturbance to the riparian vegetation and channel will be required for channel works related to the structure replacement. Fish and fish habitat and vegetation would be temporarily disturbed. In-water timing window would provide protection for both spring and summer spawners and extend from July 1 to March 15.	Channel banks and vegetation will be disturbed to facilitate the structure replacement. Significant disturbance to the riparian vegetation and channel will be required for channel realignment. Channel realignment will provide improved bank stability. Fish and fish habitat and vegetation would be temporarily disturbed. In-water timing window would provide protection for both spring and summer spawners and extend from July 1 to March 15.	Channel banks and vegetation will be disturbed to facilitate the structure replacement. Significant disturbance to the riparian vegetation and channel will be required for channel realignment. Channel realignment will provide improved bank stability. Fish and fish habitat and vegetation would be temporarily disturbed. In-water timing window would provide protection for both spring and summer spawners and extend from July 1 to March 15.
SOCIAL, CULTURAL & ECONOMIC ENVIRONNENT	Land Use	Encroachment into town-owned property No impact to private property.	Encroachment into town-owned property No impact to private property.	Encroachment into town-owned property No impact to private property.	Encroachment into town-owned property No impact to private property.
	Archaeology and Cultural Heritage Resources	No impact to archaeology and cultural heritage resources.	Potential for impact to archaeological resources which can be mitigated through further archaeological investigations	Potential for impact to archaeological resources which can be mitigated through further archaeological investigations	Potential for impact to archaeological resources which can be mitigated through further archaeological investigations
	Access Considerations	No impact to existing entrances.	No impacts to the existing entrances	No impacts to the existing entrances	No impacts to the existing entrances
	Utilities	No impact to existing utilities	Relocation of utilities as required for new structure	Relocation of utilities as required for new structure	Relocation of utilities as required for new structure
	Construction Disruption	No impact to community from construction.	Disruptions to traffic patterns would occur. Traffic control required for staged structure replacement.	Disruptions to traffic patterns would occur. Traffic control required for staged structure replacement.	Disruptions to traffic patterns would occur. Traffic control required for staged structure replacement.
	Safety	No improvement to cyclist safety with new on road cycle lanes	Improvement to cyclist safety with new on road cycle lanes	Improvement to cyclist safety with new on road cycle lanes	Improvement to cyclist safety with new on road cycle lanes
	Travel Delay/ Traffic Capacity	Existing and future capacity issues will be addressed with the proposed road widening along corridor.	Existing and future capacity issues will be addressed with the proposed road widening along corridor.	Existing and future capacity issues will be addressed with the proposed road widening along corridor.	Existing and future capacity issues will be addressed with the proposed road widening along corridor.
TRANSPORTATION	Active Modes of Transportation	No new cycling infrastructure across structure	The need for facilities to allow cycling requirements will be addressed.	The need for facilities to allow cycling requirements will be addressed.	The need for facilities to allow cycling requirements will be addressed.
	Incremental Capital Cost	No incremental cost for this option.	Full Structure Replacement cost TBD	Full Structure Replacement cost TBD	Full Structure Replacement cost TBD
	Compatibility with Town's and Region of Halton Transportation Plans and Policies	Not compatible with Town's Transportation Master Plan, Active Transportation Plan.	Meets the Town's Transportation Master Plan, Active Transportation Plan.	Meets the Town's Transportation Master Plan, Active Transportation Plan.	Meets the Town's Transportation Master Plan, Active Transportation Plan.
STRUCTURAL	Structure Condition: Structure in poor condition and rehab or replacement required. Wing wall failure 2017.	Structure condition not addressed	New structure	New structure	New structure

Appendix F
Oil/Grit Separator Sizing Reports

Oakville Lakeshore - TSS Removal Calculations

Location	Change in Paved Area	TSS Removal Required	Drainage Area			Equivalent TSS Removal Required	Recommended Stormceptor EF Model	TSS Removal Provided
	(ha)	(%)	Total (ha)	Imp (%)	Imp (ha)	(%)		(%)
West of Bronte Creek - Triller Place	0.0601	80	1.55	54.3	0.84	5.71	EF4	51
East of Bronte Creek	0.1140	80	1.06	70.0	0.74	12.29	EF4	54
Nelson Street	0.0126	80	2.60	95.0	2.47	0.41	EF4	41
Coronation Park East - Third Line West	0.1528	80	1.63	75.0	1.22	10.00	EF4	48
Coronation Park East - Westminster Drive East	0.0355	80	1.22	65.0	0.79	3.58	EF4	53
Drainage Easement - West	0.0240	80	0.79	53.0	0.42	4.59	EF4	58
Drainage Easement - East	0.0547	80	2.99	48.0	1.44	3.05	EF4	44
14 Mile Creek - East	0.0590	80	3.62	55.0	1.99	2.37	EF4	41
McCraney Creek - West	0.0295	80	1.49	51.0	0.76	3.11	EF4	52
McCraney Creek - East	0.0861	80	3.82	50.0	1.91	3.61	EF4	41
Birch Hill Lane - Suffolk Avenue	0.0295	80	2.82	50.0	1.41	1.67	EF4	44
Birch Hill Lane - West	0.0250	80	0.88	64.0	0.56	3.55	EF4	56
Birch Hill Lane - East	0.0360	80	3.76	51.0	1.92	1.50	EF4	41

Stormceptor® EF Sizing Report

STORMCEPTOR®
ESTIMATED NET ANNUAL SEDIMENT (TSS) LOAD REDUCTION

11/13/2020

Province:	Ontario
City:	Oakville
Nearest Rainfall Station:	HAMILTON AP
NCDC Rainfall Station Id:	3195
Years of Rainfall Data:	34

Project Name:	Lakeshore Road Class EA
Project Number:	43762
Designer Name:	Gurkanwal Arora
Designer Company:	Wood Environment & Infrastructure
Designer Email:	gurkanwal.arora@woodplc.com
Designer Phone:	905-335-2353
EOR Name:	
EOR Company:	
EOR Email:	
EOR Phone:	

Site Name:	East of Bronte Creek

Drainage Area (ha):	1.06
% Imperviousness:	70.00

Runoff Coefficient 'c': 0.72

Particle Size Distribution:	CA ETV
Target TSS Removal (%):	12.2

Required Water Quality Runoff Volume Capture (%):	90.00
Estimated Water Quality Flow Rate (L/s):	29.05
Oil / Fuel Spill Risk Site?	No
Upstream Flow Control?	No
Peak Conveyance (maximum) Flow Rate (L/s):	
Site Sediment Transport Rate (kg/ha/yr):	

Net Annual Sediment (TSS) Load Reduction Sizing Summary

Stormceptor Model	TSS Removal Provided (%)
EF4	54
EF6	61
EF8	64
EF10	65
EF12	67

Recommended Stormceptor EF Model: EF4

Estimated Net Annual Sediment (TSS) Load Reduction (%): 54

Water Quality Runoff Volume Capture (%): > 90

THIRD-PARTY TESTING AND VERIFICATION

►**Stormceptor® EF and Stormceptor® EFO** are the latest evolutions in the Stormceptor® oil-grit separator (OGS) technology series, and are designed to remove a wide variety of pollutants from stormwater and snowmelt runoff. These technologies have been third-party tested in accordance with the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators** and performance has been third-party verified in accordance with the **ISO 14034 Environmental Technology Verification (ETV)** protocol.

PERFORMANCE

►**Stormceptor® EF and EFO** remove stormwater pollutants through gravity separation and floatation, and feature a patent-pending design that generates positive removal of total suspended solids (TSS) throughout each storm event, including high-intensity storms. Captured pollutants include sediment, free oils, and sediment-bound pollutants such as nutrients, heavy metals, and petroleum hydrocarbons. Stormceptor is sized to remove a high level of TSS from the frequent rainfall events that contribute the vast majority of annual runoff volume and pollutant load. The technology incorporates an internal bypass to convey excessive stormwater flows from high-intensity storms through the device without resuspension and washout (scour) of previously captured pollutants. Proper routine maintenance ensures high pollutant removal performance and protection of downstream waterways.

PARTICLE SIZE DISTRIBUTION (PSD)

►The **Canadian ETV PSD** shown in the table below was used, or in part, for this sizing. This is the identical PSD that is referenced in the Canadian ETV ***Procedure for Laboratory Testing of Oil-Grit Separators*** for both sediment removal testing and scour testing. The Canadian ETV PSD contains a wide range of particle sizes in the sand and silt fractions, and is considered reasonably representative of the particle size fractions found in typical urban stormwater runoff.

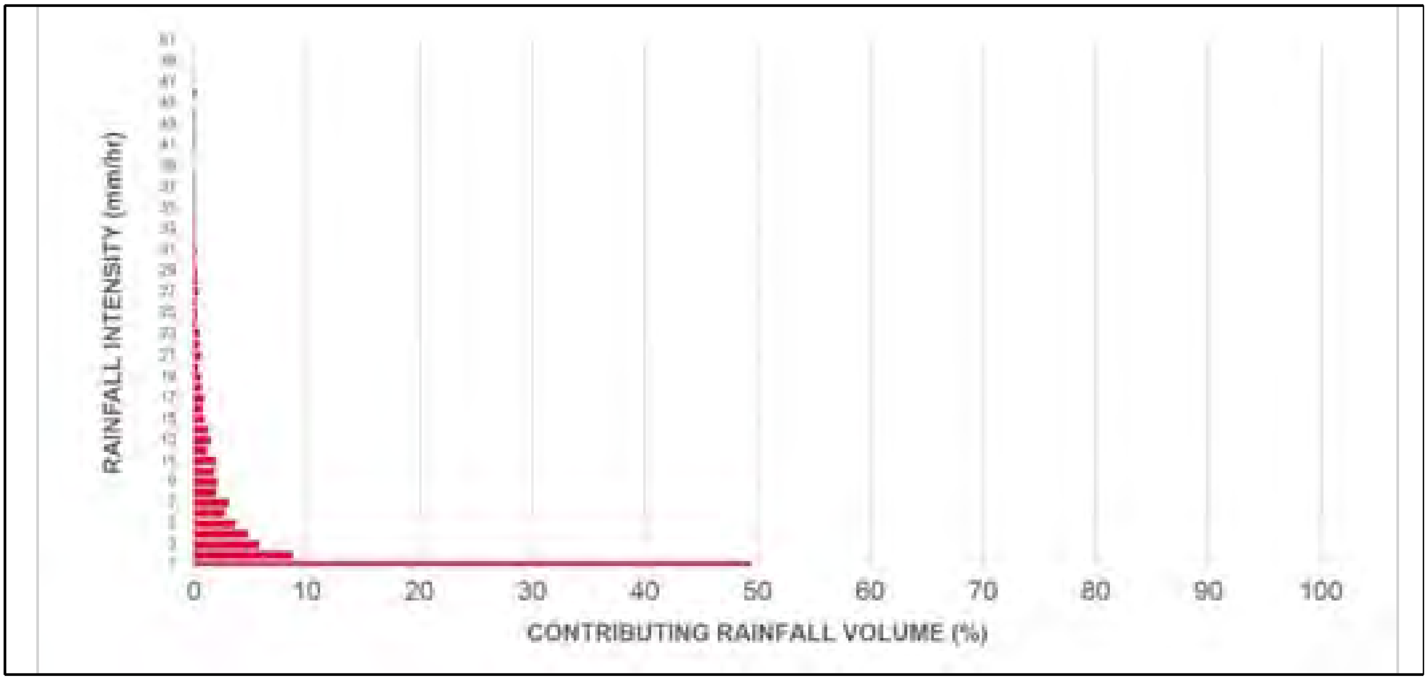
Particle Size (μm)	Percent Less Than	Particle Size Fraction (μm)	Percent
1000	100	500-1000	5
500	95	250-500	5
250	90	150-250	15
150	75	100-150	15
100	60	75-100	10
75	50	50-75	5
50	45	20-50	10
20	35	8-20	15
8	20	5-8	10
5	10	2-5	5
2	5	<2	5

Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
1	49.5	49.5	2.12	127.0	106.0	62	30.9	30.9
2	8.8	58.3	4.24	255.0	212.0	54	4.7	35.6
3	5.8	64.1	6.37	382.0	318.0	51	2.9	38.5
4	4.8	68.9	8.49	509.0	424.0	48	2.3	40.8
5	3.7	72.6	10.61	637.0	530.0	47	1.7	42.5
6	2.8	75.4	12.73	764.0	637.0	46	1.3	43.8
7	3.1	78.5	14.85	891.0	743.0	45	1.4	45.2
8	2.0	80.5	16.97	1018.0	849.0	45	0.9	46.1
9	2.1	82.6	19.10	1146.0	955.0	44	0.9	47.1
10	1.8	84.4	21.22	1273.0	1061.0	45	0.8	47.9
11	2.0	86.4	23.34	1400.0	1167.0	46	0.9	48.8
12	1.2	87.6	25.46	1528.0	1273.0	47	0.6	49.4
13	1.5	89.1	27.58	1655.0	1379.0	49	0.7	50.1
14	1.3	90.4	29.70	1782.0	1485.0	46	0.6	50.7
15	0.9	91.3	31.83	1910.0	1591.0	43	0.4	51.1
16	0.8	92.1	33.95	2037.0	1697.0	41	0.3	51.4
17	0.9	93.0	36.07	2164.0	1803.0	38	0.3	51.7
18	0.7	93.7	38.19	2291.0	1910.0	36	0.3	52.0
19	0.6	94.3	40.31	2419.0	2016.0	34	0.2	52.2
20	0.4	94.7	42.43	2546.0	2122.0	32	0.1	52.3
21	0.6	95.3	44.56	2673.0	2228.0	31	0.2	52.5
22	0.5	95.8	46.68	2801.0	2334.0	29	0.1	52.7
23	0.5	96.3	48.80	2928.0	2440.0	28	0.1	52.8
24	0.2	96.5	50.92	3055.0	2546.0	27	0.1	52.9
25	0.3	96.8	53.04	3183.0	2652.0	26	0.1	52.9

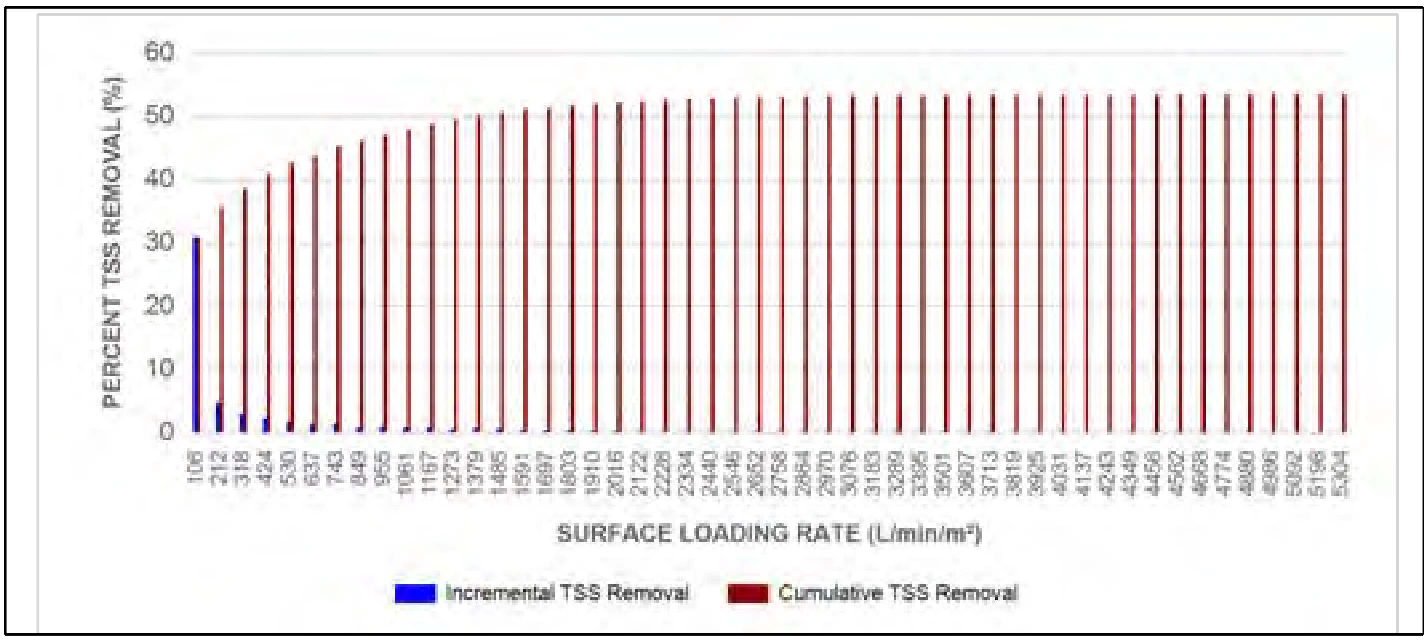
Stormceptor® EF Sizing Report

Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
26	0.2	97.0	55.16	3310.0	2758.0	25	0.1	53.0
27	0.4	97.4	57.29	3437.0	2864.0	25	0.1	53.1
28	0.3	97.7	59.41	3564.0	2970.0	24	0.1	53.2
29	0.3	98.0	61.53	3692.0	3076.0	23	0.1	53.2
30	0.1	98.1	63.65	3819.0	3183.0	22	0.0	53.2
31	0.2	98.3	65.77	3946.0	3289.0	21	0.0	53.3
32	0.1	98.4	67.89	4074.0	3395.0	21	0.0	53.3
33	0.1	98.5	70.02	4201.0	3501.0	20	0.0	53.3
34	0.1	98.6	72.14	4328.0	3607.0	19	0.0	53.3
35	0.1	98.7	74.26	4456.0	3713.0	19	0.0	53.4
36	0.1	98.8	76.38	4583.0	3819.0	18	0.0	53.4
37	0.1	98.9	78.50	4710.0	3925.0	18	0.0	53.4
38	0.1	99.0	80.62	4837.0	4031.0	17	0.0	53.4
39	0.0	99.0	82.75	4965.0	4137.0	17	0.0	53.4
40	0.0	99.0	84.87	5092.0	4243.0	16	0.0	53.4
41	0.1	99.1	86.99	5219.0	4349.0	16	0.0	53.4
42	0.1	99.2	89.11	5347.0	4456.0	16	0.0	53.4
43	0.1	99.3	91.23	5474.0	4562.0	15	0.0	53.5
44	0.1	99.4	93.35	5601.0	4668.0	15	0.0	53.5
45	0.0	99.4	95.48	5729.0	4774.0	15	0.0	53.5
46	0.2	99.6	97.60	5856.0	4880.0	14	0.0	53.5
47	0.0	99.6	99.72	5983.0	4986.0	14	0.0	53.5
48	0.0	99.6	101.84	6110.0	5092.0	14	0.0	53.5
49	0.0	99.6	103.96	6238.0	5198.0	13	0.0	53.5
50	0.0	99.6	106.08	6365.0	5304.0	13	0.0	53.5
Estimated Net Annual Sediment (TSS) Load Reduction =								**54 %**

RAINFALL DATA FROM HAMILTON AP RAINFALL STATION



INCREMENTAL AND CUMULATIVE TSS REMOVAL
FOR THE RECOMMENDED STORMCEPTOR® MODEL



Maximum Pipe Diameter / Peak Conveyance

Stormceptor EF / EFO	Model Diameter		Min Angle Inlet / Outlet Pipes	Max Inlet Pipe Diameter		Max Outlet Pipe Diameter		Peak Conveyance Flow Rate	
	(m)	(ft)		(mm)	(in)	(mm)	(in)	(L/s)	(cfs)
EF4 / EFO4	1.2	4	90	609	24	609	24	425	15
EF6 / EFO6	1.8	6	90	914	36	914	36	990	35
EF8 / EFO8	2.4	8	90	1219	48	1219	48	1700	60
EF10 / EFO10	3.0	10	90	1828	72	1828	72	2830	100
EF12 / EFO12	3.6	12	90	1828	72	1828	72	2830	100

SCOUR PREVENTION AND ONLINE CONFIGURATION

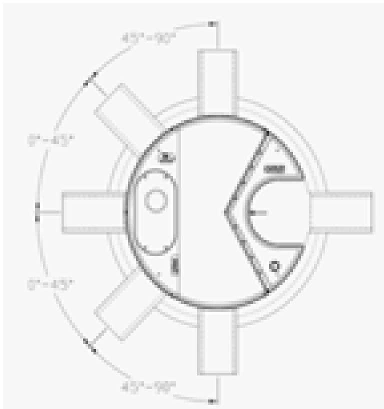
►**Stormceptor® EF and EFO** feature an internal bypass and superior scour prevention technology that have been demonstrated in third-party testing according to the scour testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**, and the exceptional scour test performance has been third-party verified in accordance with the ISO 14034 ETV protocol. As a result, Stormceptor EF and EFO are approved for online installation, eliminating the need for costly additional bypass structures, piping, and installation expense.

DESIGN FLEXIBILITY

►**Stormceptor® EF** and **EFO** offers design flexibility in one simplified platform, accepting stormwater flow from a single inlet pipe or multiple inlet pipes, and/or surface runoff through an inlet grate. The device can also serve as a junction structure, accommodate a 90-degree inlet-to-outlet bend angle, and can be modified to ensure performance in submerged conditions.

OIL CAPTURE AND RETENTION

►While Stormceptor® EF will capture and retain oil from dry weather spills and low intensity runoff, **Stormceptor® EFO** has demonstrated superior oil capture and greater than 99% oil retention in third-party testing according to the light liquid re-entrainment testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**. Stormceptor EFO is recommended for sites where oil capture and retention is a requirement.



INLET-TO-OUTLET DROP

Elevation differential between inlet and outlet pipe inverts is dictated by the angle at which the inlet pipe(s) enters the unit.

0° - 45° : The inlet pipe is 1-inch (25mm) higher than the outlet pipe.

45° - 90° : The inlet pipe is 2-inches (50mm) higher than the outlet pipe.

HEAD LOSS

The head loss through Stormceptor EF is similar to that of a 60-degree bend structure. The applicable K value for calculating minor losses through the unit is 1.1. For submerged conditions the applicable K value is 3.0.

Pollutant Capacity

Stormceptor EF / EFO	Model Diameter		Depth (Outlet Pipe Invert to Sump Floor)		Oil Volume		Recommended Sediment Maintenance Depth *		Maximum Sediment Volume *		Maximum Sediment Mass **	
	(m)	(ft)	(m)	(ft)	(L)	(Gal)	(mm)	(in)	(L)	(ft³)	(kg)	(lb)
EF4 / EFO4	1.2	4	1.52	5.0	265	70	203	8	1190	42	1904	5250
EF6 / EFO6	1.8	6	1.93	6.3	610	160	305	12	3470	123	5552	15375
EF8 / EFO8	2.4	8	2.59	8.5	1070	280	610	24	8780	310	14048	38750
EF10 / EFO10	3.0	10	3.25	10.7	1670	440	610	24	17790	628	28464	78500
EF12 / EFO12	3.6	12	3.89	12.8	2475	655	610	24	31220	1103	49952	137875

*Increased sump depth may be added to increase sediment storage capacity

** Average density of wet packed sediment in sump = 1.6 kg/L (100 lb/ft³)

Feature	Benefit	Feature Appeals To
Patent-pending enhanced flow treatment and scour prevention technology	Superior, verified third-party performance	Regulator, Specifying & Design Engineer
Third-party verified light liquid capture and retention for EFO version	Proven performance for fuel/oil hotspot locations	Regulator, Specifying & Design Engineer, Site Owner
Functions as bend, junction or inlet structure	Design flexibility	Specifying & Design Engineer
Minimal drop between inlet and outlet	Site installation ease	Contractor
Large diameter outlet riser for inspection and maintenance	Easy maintenance access from grade	Maintenance Contractor & Site Owner

STANDARD STORMCEPTOR EF/EFO DRAWINGS

For standard details, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

STANDARD STORMCEPTOR EF/EFO SPECIFICATION

For specifications, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

Table of TSS Removal vs Surface Loading Rate Based on Third-Party Test Results
Stormceptor® EF

SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL
1	70	660	46	1320	48	1980	35
30	70	690	46	1350	48	2010	34

60	67	720	45	1380	49	2040	34
90	63	750	45	1410	49	2070	33
120	61	780	45	1440	48	2100	33
150	58	810	45	1470	47	2130	32
180	56	840	45	1500	46	2160	32
210	54	870	45	1530	45	2190	31
240	53	900	45	1560	44	2220	31
270	52	930	44	1590	43	2250	30
300	51	960	44	1620	42	2280	30
330	50	990	44	1650	42	2310	30
360	49	1020	44	1680	41	2340	29
390	48	1050	45	1710	40	2370	29
420	48	1080	45	1740	39	2400	29
450	48	1110	45	1770	39	2430	28
480	47	1140	46	1800	38	2460	28
510	47	1170	46	1830	37	2490	28
540	47	1200	47	1860	37	2520	27
570	46	1230	47	1890	36	2550	27
600	46	1260	47	1920	36	2580	27
630	46	1290	48	1950	35		

STANDARD PERFORMANCE SPECIFICATION FOR
"OIL GRIT SEPARATOR" (OGS) STORMWATER QUALITY TREATMENT DEVICE

PART 1 – GENERAL

1.1 WORK INCLUDED

This section specifies requirements for selecting, sizing, and designing an underground Oil Grit Separator (OGS) device for stormwater quality treatment, with third-party testing results and a Statement of Verification in accordance with ISO 14034 Environmental Management – Environmental Technology Verification (ETV).

1.2 REFERENCE STANDARDS & PROCEDURES

ISO 14034:2016 Environmental management – Environmental technology verification (ETV)

Canadian Environmental Technology Verification (ETV) Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**

1.3 SUBMITTALS

1.3.1 All submittals, including sizing reports & shop drawings, shall be submitted upon request with each order to the contractor then forwarded to the Engineer of Record for review and acceptance. Shop drawings shall detail all OGS components, elevations, and sequence of construction.

1.3.2 Alternative devices shall have features identical to or greater than the specified device, including: treatment chamber diameter, treatment chamber wet volume, sediment storage volume, and oil storage volume.

1.3.3 Unless directed otherwise by the Engineer of Record, OGS stormwater quality treatment product substitutions or alternatives submitted within ten days prior to project bid shall not be accepted. All alternatives or substitutions submitted shall be signed and sealed by a local registered Professional Engineer, based on the exact same criteria detailed in Section 3, in entirety, subject to review and approval by the Engineer of Record.

PART 2 – PRODUCTS

2.1 OGS POLLUTANT STORAGE

The OGS device shall include a sump for sediment storage, and a protected volume for the capture and storage of petroleum hydrocarbons and buoyant gross pollutants. The **minimum** sediment & petroleum hydrocarbon storage capacity shall be as follows:

2.1.1	4 ft (1219 mm) Diameter OGS Units:	1.19 m^3 sediment / 265 L oil
	6 ft (1829 mm) Diameter OGS Units:	3.48 m^3 sediment / 609 L oil
	8 ft (2438 mm) Diameter OGS Units:	8.78 m^3 sediment / 1,071 L oil
	10 ft (3048 mm) Diameter OGS Units:	17.78 m^3 sediment / 1,673 L oil
	12 ft (3657 mm) Diameter OGS Units:	31.23 m^3 sediment / 2,476 L oil

PART 3 – PERFORMANCE & DESIGN

3.1 GENERAL

The OGS stormwater quality treatment device shall be verified in accordance with ISO 14034:2016 Environmental management – Environmental technology verification (ETV). The OGS stormwater quality treatment device shall remove oil, sediment and gross pollutants from stormwater runoff during frequent wet weather events, and retain these pollutants during less frequent high flow wet weather events below the insert within the OGS for later removal during maintenance. The Manufacturer shall have at least ten (10) years of local experience, history and success in engineering design, manufacturing and production and supply of OGS stormwater quality treatment device systems, acceptable to the Engineer of Record.

3.2 SIZING METHODOLOGY

The OGS device shall be engineered, designed and sized to provide stormwater quality treatment based on treating a minimum of 90 percent of the average annual runoff volume and a minimum removal of an annual average 60% of the sediment (TSS) load based on the Particle Size Distribution (PSD) specified in the sizing report for the specified device. Sizing shall be determined using historical rainfall data and a sediment removal performance curve derived from the actual third-party verified laboratory testing data. The OGS device shall also have sufficient annual sediment storage capacity as specified and calculated in Section 2.1.

3.3 CANADIAN ETV or ISO 14034 ETV VERIFICATION OF SCOUR TESTING

The OGS device shall have Canadian ETV or ISO 14034 ETV Verification of third-party scour testing conducted in accordance with the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**

3.3.1 To be acceptable for on-line installation, the OGS device must demonstrate an average scour test effluent concentration less than 10 mg/L at each surface loading rate tested, up to and including 2600 L/min/m^2.

Stormceptor®

Stormceptor® EF Sizing Report

STORMCEPTOR®
ESTIMATED NET ANNUAL SEDIMENT (TSS) LOAD REDUCTION

11/13/2020

Province:	Ontario
City:	Oakville
Nearest Rainfall Station:	HAMILTON AP
NCDC Rainfall Station Id:	3195
Years of Rainfall Data:	34
Site Name:	West of Bronte Creek - Triller Place
Drainage Area (ha):	1.55
% Imperviousness:	54.30
Runoff Coefficient 'c':	0.62
Particle Size Distribution:	CA ETV
Target TSS Removal (%):	5.7
Required Water Quality Runoff Volume Capture (%):	90.00
Estimated Water Quality Flow Rate (L/s):	36.92
Oil / Fuel Spill Risk Site?	No
Upstream Flow Control?	No
Peak Conveyance (maximum) Flow Rate (L/s):	
Site Sediment Transport Rate (kg/ha/yr):	

Project Name:	Lakeshore Road Class EA
Project Number:	43762
Designer Name:	Gurkanwal Arora
Designer Company:	Wood Environment & Infrastructure
Designer Email:	gurkanwal.arora@woodplc.com
Designer Phone:	905-335-2353
EOR Name:	
EOR Company:	
EOR Email:	
EOR Phone:	

Net Annual Sediment (TSS) Load Reduction Sizing Summary

Stormceptor Model	TSS Removal Provided (%)
EF4	51
EF6	58
EF8	63
EF10	64
EF12	66

Recommended Stormceptor EF Model: EF4

Estimated Net Annual Sediment (TSS) Load Reduction (%): 51

Water Quality Runoff Volume Capture (%): > 90

imbrium

THIRD-PARTY TESTING AND VERIFICATION

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PERFORMANCE

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PARTICLE SIZE DISTRIBUTION (PSD)

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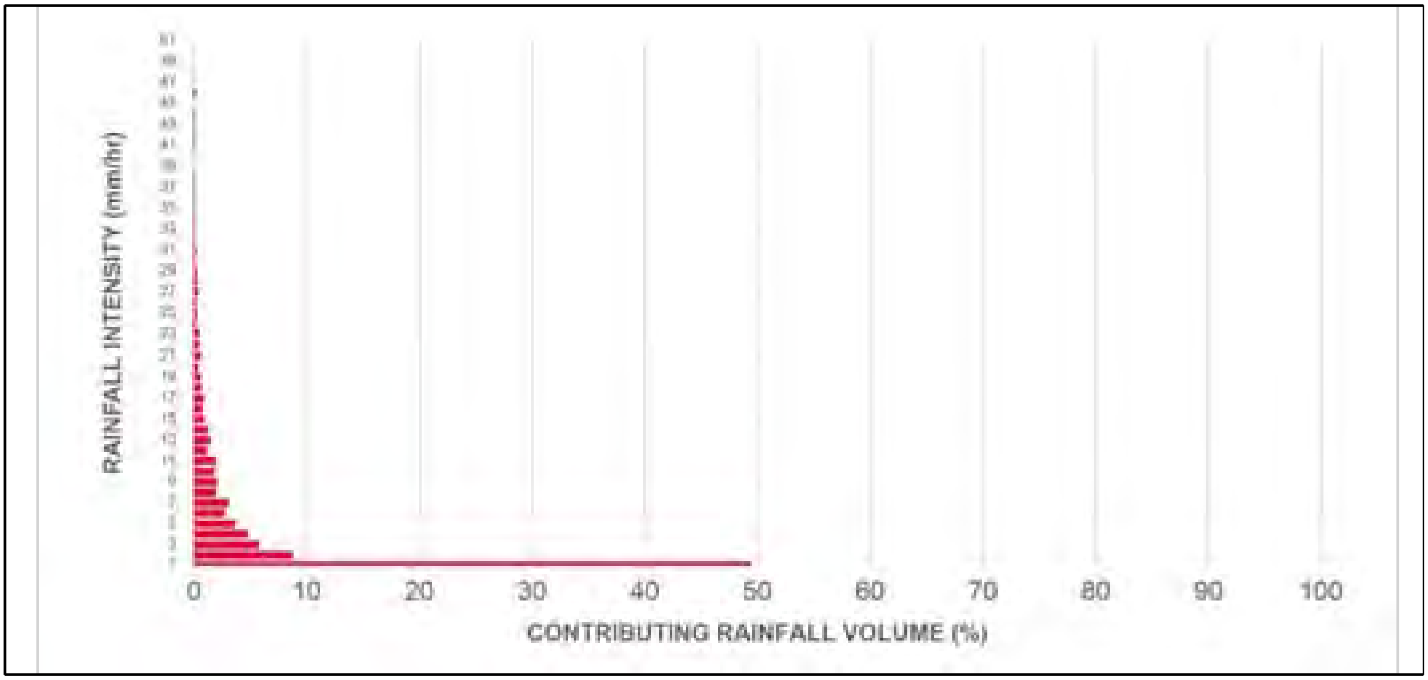
Particle Size (µm)	Percent Less Than	Particle Size Fraction (µm)	Percent
1000	100	500-1000	5
500	95	250-500	5
250	90	150-250	15
150	75	100-150	15
100	60	75-100	10
75	50	50-75	5
50	45	20-50	10
20	35	8-20	15
8	20	5-8	10
5	10	2-5	5
2	5	<2	5

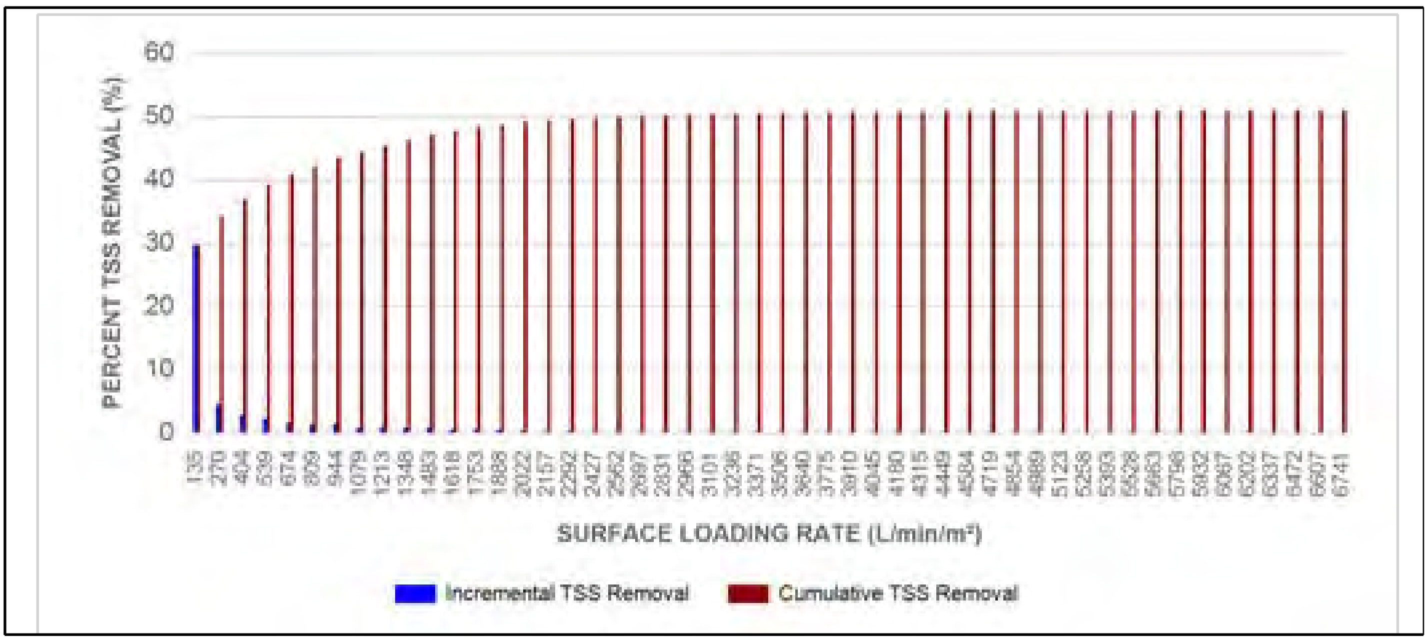
Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
1	49.5	49.5	2.70	162.0	135.0	60	29.6	29.6
2	8.8	58.3	5.39	324.0	270.0	52	4.6	34.2
3	5.8	64.1	8.09	485.0	404.0	48	2.8	37.0
4	4.8	68.9	10.79	647.0	539.0	47	2.2	39.2
5	3.7	72.6	13.48	809.0	674.0	46	1.7	40.9
6	2.8	75.4	16.18	971.0	809.0	45	1.3	42.2
7	3.1	78.5	18.88	1133.0	944.0	44	1.4	43.5
8	2.0	80.5	21.57	1294.0	1079.0	45	0.9	44.4
9	2.1	82.6	24.27	1456.0	1213.0	47	1.0	45.4
10	1.8	84.4	26.97	1618.0	1348.0	48	0.9	46.3
11	2.0	86.4	29.66	1780.0	1483.0	46	0.9	47.2
12	1.2	87.6	32.36	1942.0	1618.0	43	0.5	47.7
13	1.5	89.1	35.06	2103.0	1753.0	39	0.6	48.3
14	1.3	90.4	37.75	2265.0	1888.0	36	0.5	48.8
15	0.9	91.3	40.45	2427.0	2022.0	34	0.3	49.1
16	0.8	92.1	43.15	2589.0	2157.0	32	0.3	49.3
17	0.9	93.0	45.84	2751.0	2292.0	30	0.3	49.6
18	0.7	93.7	48.54	2912.0	2427.0	28	0.2	49.8
19	0.6	94.3	51.23	3074.0	2562.0	27	0.2	50.0
20	0.4	94.7	53.93	3236.0	2697.0	26	0.1	50.1
21	0.6	95.3	56.63	3398.0	2831.0	25	0.1	50.2
22	0.5	95.8	59.32	3559.0	2966.0	24	0.1	50.3
23	0.5	96.3	62.02	3721.0	3101.0	22	0.1	50.4
24	0.2	96.5	64.72	3883.0	3236.0	21	0.0	50.5
25	0.3	96.8	67.41	4045.0	3371.0	21	0.1	50.6

Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
26	0.2	97.0	70.11	4207.0	3506.0	20	0.0	50.6
27	0.4	97.4	72.81	4368.0	3640.0	19	0.1	50.7
28	0.3	97.7	75.50	4530.0	3775.0	19	0.1	50.7
29	0.3	98.0	78.20	4692.0	3910.0	18	0.1	50.8
30	0.1	98.1	80.90	4854.0	4045.0	17	0.0	50.8
31	0.2	98.3	83.59	5016.0	4180.0	17	0.0	50.8
32	0.1	98.4	86.29	5177.0	4315.0	16	0.0	50.8
33	0.1	98.5	88.99	5339.0	4449.0	16	0.0	50.9
34	0.1	98.6	91.68	5501.0	4584.0	15	0.0	50.9
35	0.1	98.7	94.38	5663.0	4719.0	15	0.0	50.9
36	0.1	98.8	97.08	5825.0	4854.0	14	0.0	50.9
37	0.1	98.9	99.77	5986.0	4989.0	14	0.0	50.9
38	0.1	99.0	102.47	6148.0	5123.0	13	0.0	50.9
39	0.0	99.0	105.17	6310.0	5258.0	13	0.0	50.9
40	0.0	99.0	107.86	6472.0	5393.0	13	0.0	50.9
41	0.1	99.1	110.56	6634.0	5528.0	12	0.0	50.9
42	0.1	99.2	113.26	6795.0	5663.0	12	0.0	51.0
43	0.1	99.3	115.95	6957.0	5798.0	12	0.0	51.0
44	0.1	99.4	118.65	7119.0	5932.0	12	0.0	51.0
45	0.0	99.4	121.35	7281.0	6067.0	11	0.0	51.0
46	0.2	99.6	124.04	7443.0	6202.0	11	0.0	51.0
47	0.0	99.6	126.74	7604.0	6337.0	11	0.0	51.0
48	0.0	99.6	129.44	7766.0	6472.0	11	0.0	51.0
49	0.0	99.6	132.13	7928.0	6607.0	10	0.0	51.0
50	0.0	99.6	134.83	8090.0	6741.0	10	0.0	51.0
Estimated Net Annual Sediment (TSS) Load Reduction =								**51 %**

RAINFALL DATA FROM HAMILTON AP RAINFALL STATION



INCREMENTAL AND CUMULATIVE TSS REMOVAL
FOR THE RECOMMENDED STORMCEPTOR® MODEL



Maximum Pipe Diameter / Peak Conveyance

Stormceptor EF / EFO	Model Diameter		Min Angle Inlet / Outlet Pipes	Max Inlet Pipe Diameter		Max Outlet Pipe Diameter		Peak Conveyance Flow Rate	
	(m)	(ft)		(mm)	(in)	(mm)	(in)	(L/s)	(cfs)
EF4 / EFO4	1.2	4	90	609	24	609	24	425	15
EF6 / EFO6	1.8	6	90	914	36	914	36	990	35
EF8 / EFO8	2.4	8	90	1219	48	1219	48	1700	60
EF10 / EFO10	3.0	10	90	1828	72	1828	72	2830	100
EF12 / EFO12	3.6	12	90	1828	72	1828	72	2830	100

SCOUR PREVENTION AND ONLINE CONFIGURATION

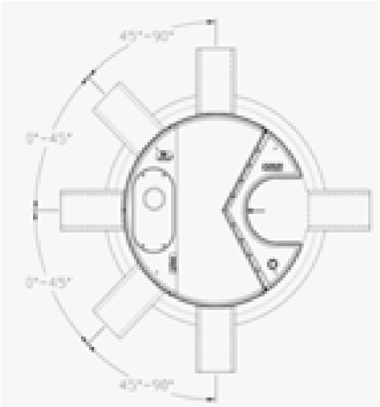
►**Stormceptor® EF and EFO** feature an internal bypass and superior scour prevention technology that have been demonstrated in third-party testing according to the scour testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**, and the exceptional scour test performance has been third-party verified in accordance with the ISO 14034 ETV protocol. As a result, Stormceptor EF and EFO are approved for online installation, eliminating the need for costly additional bypass structures, piping, and installation expense.

DESIGN FLEXIBILITY

►**Stormceptor® EF** and **EFO** offers design flexibility in one simplified platform, accepting stormwater flow from a single inlet pipe or multiple inlet pipes, and/or surface runoff through an inlet grate. The device can also serve as a junction structure, accommodate a 90-degree inlet-to-outlet bend angle, and can be modified to ensure performance in submerged conditions.

OIL CAPTURE AND RETENTION

►While Stormceptor® EF will capture and retain oil from dry weather spills and low intensity runoff, **Stormceptor® EFO** has demonstrated superior oil capture and greater than 99% oil retention in third-party testing according to the light liquid re-entrainment testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**. Stormceptor EFO is recommended for sites where oil capture and retention is a requirement.



INLET-TO-OUTLET DROP

Elevation differential between inlet and outlet pipe inverts is dictated by the angle at which the inlet pipe(s) enters the unit.

0° - 45° : The inlet pipe is 1-inch (25mm) higher than the outlet pipe.

45° - 90° : The inlet pipe is 2-inches (50mm) higher than the outlet pipe.

HEAD LOSS

The head loss through Stormceptor EF is similar to that of a 60-degree bend structure. The applicable K value for calculating minor losses through the unit is 1.1. For submerged conditions the applicable K value is 3.0.

Pollutant Capacity

Stormceptor EF / EFO	Model Diameter		Depth (Outlet Pipe Invert to Sump Floor)		Oil Volume		Recommended Sediment Maintenance Depth *		Maximum Sediment Volume *		Maximum Sediment Mass **	
	(m)	(ft)	(m)	(ft)	(L)	(Gal)	(mm)	(in)	(L)	(ft³)	(kg)	(lb)
EF4 / EFO4	1.2	4	1.52	5.0	265	70	203	8	1190	42	1904	5250
EF6 / EFO6	1.8	6	1.93	6.3	610	160	305	12	3470	123	5552	15375
EF8 / EFO8	2.4	8	2.59	8.5	1070	280	610	24	8780	310	14048	38750
EF10 / EFO10	3.0	10	3.25	10.7	1670	440	610	24	17790	628	28464	78500
EF12 / EFO12	3.6	12	3.89	12.8	2475	655	610	24	31220	1103	49952	137875

*Increased sump depth may be added to increase sediment storage capacity

** Average density of wet packed sediment in sump = 1.6 kg/L (100 lb/ft^3)

Feature	Benefit	Feature Appeals To
Patent-pending enhanced flow treatment and scour prevention technology	Superior, verified third-party performance	Regulator, Specifying & Design Engineer
Third-party verified light liquid capture and retention for EFO version	Proven performance for fuel/oil hotspot locations	Regulator, Specifying & Design Engineer, Site Owner
Functions as bend, junction or inlet structure	Design flexibility	Specifying & Design Engineer
Minimal drop between inlet and outlet	Site installation ease	Contractor
Large diameter outlet riser for inspection and maintenance	Easy maintenance access from grade	Maintenance Contractor & Site Owner

STANDARD STORMCEPTOR EF/EFO DRAWINGS

For standard details, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

STANDARD STORMCEPTOR EF/EFO SPECIFICATION

For specifications, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

Table of TSS Removal vs Surface Loading Rate Based on Third-Party Test Results

Stormceptor® EF

SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL
1	70	660	46	1320	48	1980	35
30	70	690	46	1350	48	2010	34

60	67	720	45	1380	49	2040	34
90	63	750	45	1410	49	2070	33
120	61	780	45	1440	48	2100	33
150	58	810	45	1470	47	2130	32
180	56	840	45	1500	46	2160	32
210	54	870	45	1530	45	2190	31
240	53	900	45	1560	44	2220	31
270	52	930	44	1590	43	2250	30
300	51	960	44	1620	42	2280	30
330	50	990	44	1650	42	2310	30
360	49	1020	44	1680	41	2340	29
390	48	1050	45	1710	40	2370	29
420	48	1080	45	1740	39	2400	29
450	48	1110	45	1770	39	2430	28
480	47	1140	46	1800	38	2460	28
510	47	1170	46	1830	37	2490	28
540	47	1200	47	1860	37	2520	27
570	46	1230	47	1890	36	2550	27
600	46	1260	47	1920	36	2580	27
630	46	1290	48	1950	35		

STANDARD PERFORMANCE SPECIFICATION FOR "OIL GRIT SEPARATOR" (OGS) STORMWATER QUALITY TREATMENT DEVICE

PART 1 – GENERAL

1.1 WORK INCLUDED

This section specifies requirements for selecting, sizing, and designing an underground Oil Grit Separator (OGS) device for stormwater quality treatment, with third-party testing results and a Statement of Verification in accordance with ISO 14034 Environmental Management – Environmental Technology Verification (ETV).

1.2 REFERENCE STANDARDS & PROCEDURES

ISO 14034:2016 Environmental management – Environmental technology verification (ETV)

Canadian Environmental Technology Verification (ETV) Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**

1.3 SUBMITTALS

1.3.1 All submittals, including sizing reports & shop drawings, shall be submitted upon request with each order to the contractor then forwarded to the Engineer of Record for review and acceptance. Shop drawings shall detail all OGS components, elevations, and sequence of construction.

1.3.2 Alternative devices shall have features identical to or greater than the specified device, including: treatment chamber diameter, treatment chamber wet volume, sediment storage volume, and oil storage volume.

1.3.3 Unless directed otherwise by the Engineer of Record, OGS stormwater quality treatment product substitutions or alternatives submitted within ten days prior to project bid shall not be accepted. All alternatives or substitutions submitted shall be signed and sealed by a local registered Professional Engineer, based on the exact same criteria detailed in Section 3, in entirety, subject to review and approval by the Engineer of Record.

PART 2 – PRODUCTS

2.1 OGS POLLUTANT STORAGE

The OGS device shall include a sump for sediment storage, and a protected volume for the capture and storage of petroleum hydrocarbons and buoyant gross pollutants. The **minimum** sediment & petroleum hydrocarbon storage capacity shall be as follows:

2.1.1	4 ft (1219 mm) Diameter OGS Units:	1.19 m^3 sediment / 265 L oil
	6 ft (1829 mm) Diameter OGS Units:	3.48 m^3 sediment / 609 L oil
	8 ft (2438 mm) Diameter OGS Units:	8.78 m^3 sediment / 1,071 L oil
	10 ft (3048 mm) Diameter OGS Units:	17.78 m^3 sediment / 1,673 L oil
	12 ft (3657 mm) Diameter OGS Units:	31.23 m^3 sediment / 2,476 L oil

PART 3 – PERFORMANCE & DESIGN

3.1 GENERAL

The OGS stormwater quality treatment device shall be verified in accordance with ISO 14034:2016 Environmental management – Environmental technology verification (ETV). The OGS stormwater quality treatment device shall remove oil, sediment and gross pollutants from stormwater runoff during frequent wet weather events, and retain these pollutants during less frequent high flow wet weather events below the insert within the OGS for later removal during maintenance. The Manufacturer shall have at least ten (10) years of local experience, history and success in engineering design, manufacturing and production and supply of OGS stormwater quality treatment device systems, acceptable to the Engineer of Record.

3.2 SIZING METHODOLOGY

The OGS device shall be engineered, designed and sized to provide stormwater quality treatment based on treating a minimum of 90 percent of the average annual runoff volume and a minimum removal of an annual average 60% of the sediment (TSS) load based on the Particle Size Distribution (PSD) specified in the sizing report for the specified device. Sizing shall be determined using historical rainfall data and a sediment removal performance curve derived from the actual third-party verified laboratory testing data. The OGS device shall also have sufficient annual sediment storage capacity as specified and calculated in Section 2.1.

3.3 CANADIAN ETV or ISO 14034 ETV VERIFICATION OF SCOUR TESTING

The OGS device shall have Canadian ETV or ISO 14034 ETV Verification of third-party scour testing conducted in accordance with the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**

3.3.1 To be acceptable for on-line installation, the OGS device must demonstrate an average scour test effluent concentration less than 10 mg/L at each surface loading rate tested, up to and including 2600 L/min/m^2.

Stormceptor EF Sizing Report

STORMCEPTOR®
ESTIMATED NET ANNUAL SEDIMENT (TSS) LOAD REDUCTION

11/13/2020

Province:	Ontario
City:	Oakville
Nearest Rainfall Station:	HAMILTON AP
NCDC Rainfall Station Id:	3195
Years of Rainfall Data:	34

Site Name:	Coronation Park East - Third Line West

Drainage Area (ha):	1.63
% Imperviousness:	75.00

Runoff Coefficient 'c': 0.75

Particle Size Distribution:	CA ETV
Target TSS Removal (%):	10.0

Required Water Quality Runoff Volume Capture (%):	90.00
Estimated Water Quality Flow Rate (L/s):	46.53
Oil / Fuel Spill Risk Site?	No
Upstream Flow Control?	No
Peak Conveyance (maximum) Flow Rate (L/s):	
Site Sediment Transport Rate (kg/ha/yr):	

Project Name:	Lakeshore Road Class EA
Project Number:	43762
Designer Name:	Gurkanwal Arora
Designer Company:	Wood Environment & Infrastructure
Designer Email:	gurkanwal.arora@woodplc.com
Designer Phone:	905-335-2353
EOR Name:	
EOR Company:	
EOR Email:	
EOR Phone:	

Net Annual Sediment (TSS) Load Reduction Sizing Summary

Stormceptor Model	TSS Removal Provided (%)
EF4	48
EF6	57
EF8	61
EF10	63
EF12	65

Recommended Stormceptor EF Model:	**EF4**
Estimated Net Annual Sediment (TSS) Load Reduction (%):	**48**
Water Quality Runoff Volume Capture (%):	**> 90**

THIRD-PARTY TESTING AND VERIFICATION

►**Stormceptor® EF and Stormceptor® EFO** are the latest evolutions in the Stormceptor® oil-grit separator (OGS) technology series, and are designed to remove a wide variety of pollutants from stormwater and snowmelt runoff. These technologies have been third-party tested in accordance with the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators** and performance has been third-party verified in accordance with the **ISO 14034 Environmental Technology Verification (ETV)** protocol.

PERFORMANCE

►**Stormceptor® EF and EFO** remove stormwater pollutants through gravity separation and floatation, and feature a patent-pending design that generates positive removal of total suspended solids (TSS) throughout each storm event, including high-intensity storms. Captured pollutants include sediment, free oils, and sediment-bound pollutants such as nutrients, heavy metals, and petroleum hydrocarbons. Stormceptor is sized to remove a high level of TSS from the frequent rainfall events that contribute the vast majority of annual runoff volume and pollutant load. The technology incorporates an internal bypass to convey excessive stormwater flows from high-intensity storms through the device without resuspension and washout (scour) of previously captured pollutants. Proper routine maintenance ensures high pollutant removal performance and protection of downstream waterways.

PARTICLE SIZE DISTRIBUTION (PSD)

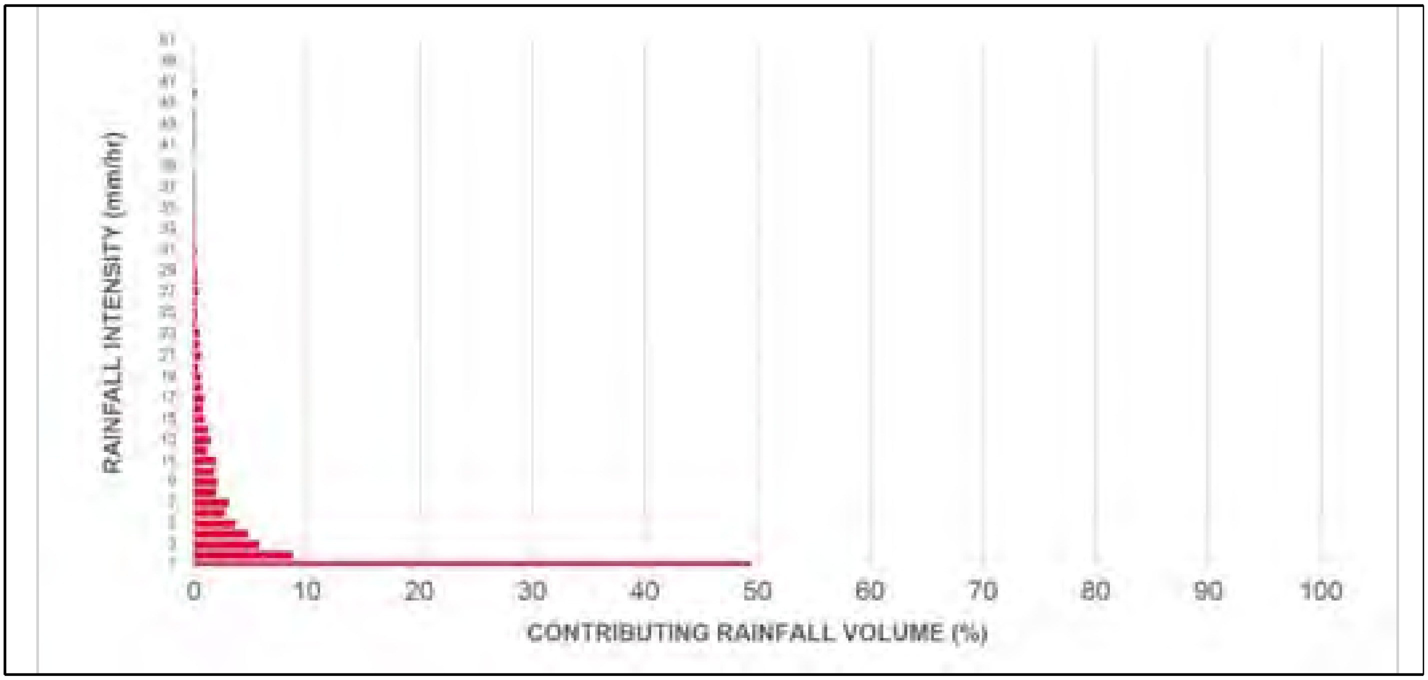
►The **Canadian ETV PSD** shown in the table below was used, or in part, for this sizing. This is the identical PSD that is referenced in the Canadian ETV ***Procedure for Laboratory Testing of Oil-Grit Separators*** for both sediment removal testing and scour testing. The Canadian ETV PSD contains a wide range of particle sizes in the sand and silt fractions, and is considered reasonably representative of the particle size fractions found in typical urban stormwater runoff.

Particle Size (µm)	Percent Less Than	Particle Size Fraction (µm)	Percent
1000	100	500-1000	5
500	95	250-500	5
250	90	150-250	15
150	75	100-150	15
100	60	75-100	10
75	50	50-75	5
50	45	20-50	10
20	35	8-20	15
8	20	5-8	10
5	10	2-5	5
2	5	<2	5

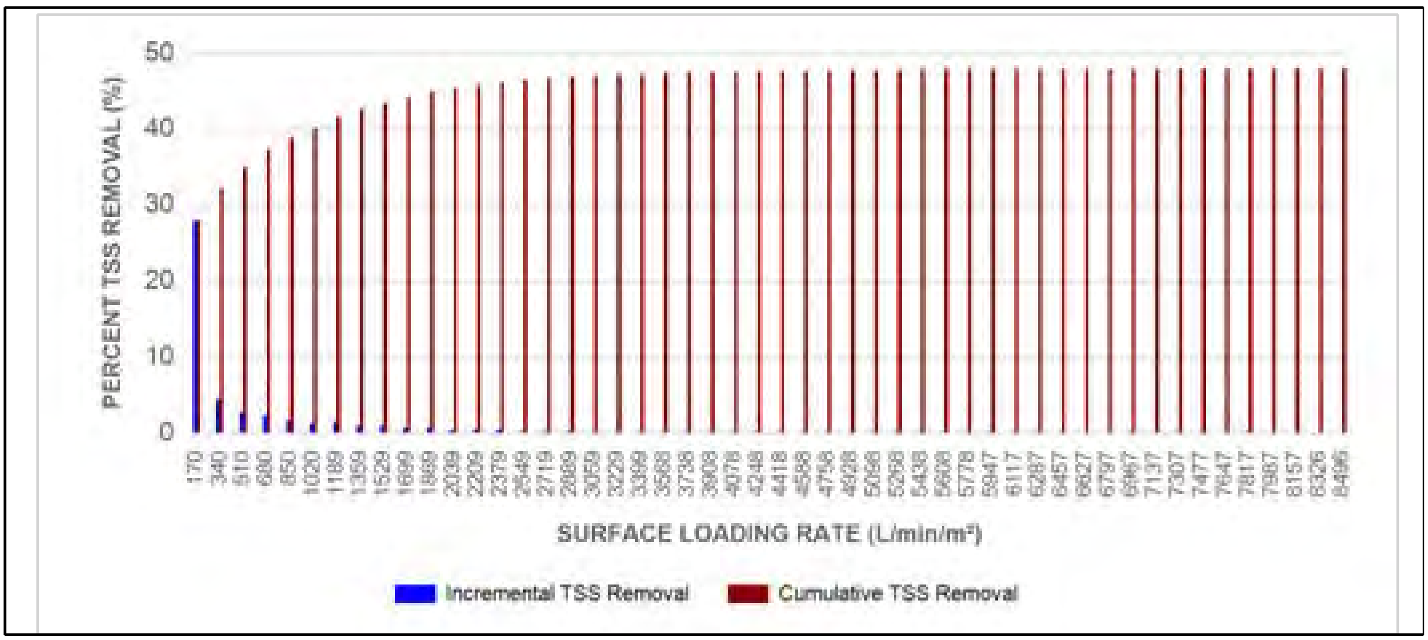
Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
1	49.5	49.5	3.40	204.0	170.0	57	28.0	28.0
2	8.8	58.3	6.80	408.0	340.0	50	4.4	32.3
3	5.8	64.1	10.20	612.0	510.0	47	2.7	35.1
4	4.8	68.9	13.59	816.0	680.0	46	2.2	37.3
5	3.7	72.6	16.99	1020.0	850.0	45	1.7	38.9
6	2.8	75.4	20.39	1223.0	1020.0	44	1.2	40.2
7	3.1	78.5	23.79	1427.0	1189.0	46	1.4	41.6
8	2.0	80.5	27.19	1631.0	1359.0	49	1.0	42.6
9	2.1	82.6	30.59	1835.0	1529.0	45	0.9	43.5
10	1.8	84.4	33.99	2039.0	1699.0	40	0.7	44.2
11	2.0	86.4	37.38	2243.0	1869.0	37	0.7	45.0
12	1.2	87.6	40.78	2447.0	2039.0	34	0.4	45.4
13	1.5	89.1	44.18	2651.0	2209.0	31	0.5	45.8
14	1.3	90.4	47.58	2855.0	2379.0	29	0.4	46.2
15	0.9	91.3	50.98	3059.0	2549.0	27	0.2	46.5
16	0.8	92.1	54.38	3263.0	2719.0	25	0.2	46.7
17	0.9	93.0	57.78	3467.0	2889.0	25	0.2	46.9
18	0.7	93.7	61.17	3670.0	3059.0	23	0.2	47.0
19	0.6	94.3	64.57	3874.0	3229.0	21	0.1	47.2
20	0.4	94.7	67.97	4078.0	3399.0	21	0.1	47.2
21	0.6	95.3	71.37	4282.0	3568.0	20	0.1	47.4
22	0.5	95.8	74.77	4486.0	3738.0	19	0.1	47.5
23	0.5	96.3	78.17	4690.0	3908.0	18	0.1	47.5
24	0.2	96.5	81.57	4894.0	4078.0	17	0.0	47.6
25	0.3	96.8	84.96	5098.0	4248.0	16	0.0	47.6

Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
26	0.2	97.0	88.36	5302.0	4418.0	16	0.0	47.7
27	0.4	97.4	91.76	5506.0	4588.0	15	0.1	47.7
28	0.3	97.7	95.16	5710.0	4758.0	15	0.0	47.8
29	0.3	98.0	98.56	5913.0	4928.0	14	0.0	47.8
30	0.1	98.1	101.96	6117.0	5098.0	14	0.0	47.8
31	0.2	98.3	105.36	6321.0	5268.0	13	0.0	47.8
32	0.1	98.4	108.75	6525.0	5438.0	13	0.0	47.9
33	0.1	98.5	112.15	6729.0	5608.0	12	0.0	47.9
34	0.1	98.6	115.55	6933.0	5778.0	12	0.0	47.9
35	0.1	98.7	118.95	7137.0	5947.0	12	0.0	47.9
36	0.1	98.8	122.35	7341.0	6117.0	11	0.0	47.9
37	0.1	98.9	125.75	7545.0	6287.0	11	0.0	47.9
38	0.1	99.0	129.14	7749.0	6457.0	11	0.0	47.9
39	0.0	99.0	132.54	7953.0	6627.0	10	0.0	47.9
40	0.0	99.0	135.94	8157.0	6797.0	10	0.0	47.9
41	0.1	99.1	139.34	8360.0	6967.0	10	0.0	47.9
42	0.1	99.2	142.74	8564.0	7137.0	10	0.0	47.9
43	0.1	99.3	146.14	8768.0	7307.0	9	0.0	48.0
44	0.1	99.4	149.54	8972.0	7477.0	9	0.0	48.0
45	0.0	99.4	152.93	9176.0	7647.0	9	0.0	48.0
46	0.2	99.6	156.33	9380.0	7817.0	9	0.0	48.0
47	0.0	99.6	159.73	9584.0	7987.0	9	0.0	48.0
48	0.0	99.6	163.13	9788.0	8157.0	8	0.0	48.0
49	0.0	99.6	166.53	9992.0	8326.0	8	0.0	48.0
50	0.0	99.6	169.93	10196.0	8496.0	8	0.0	48.0
Estimated Net Annual Sediment (TSS) Load Reduction =								**48 %**

RAINFALL DATA FROM HAMILTON AP RAINFALL STATION



INCREMENTAL AND CUMULATIVE TSS REMOVAL FOR THE RECOMMENDED STORMCEPTOR® MODEL



Maximum Pipe Diameter / Peak Conveyance

Stormceptor EF / EFO	Model Diameter (m)	Model Diameter (ft)	Min Angle Inlet / Outlet Pipes	Max Inlet Pipe Diameter (mm)	Max Inlet Pipe Diameter (in)	Max Outlet Pipe Diameter (mm)	Max Outlet Pipe Diameter (in)	Peak Conveyance Flow Rate (L/s)	Peak Conveyance Flow Rate (cfs)
EF4 / EFO4	1.2	4	90	609	24	609	24	425	15
EF6 / EFO6	1.8	6	90	914	36	914	36	990	35
EF8 / EFO8	2.4	8	90	1219	48	1219	48	1700	60
EF10 / EFO10	3.0	10	90	1828	72	1828	72	2830	100
EF12 / EFO12	3.6	12	90	1828	72	1828	72	2830	100

SCOUR PREVENTION AND ONLINE CONFIGURATION

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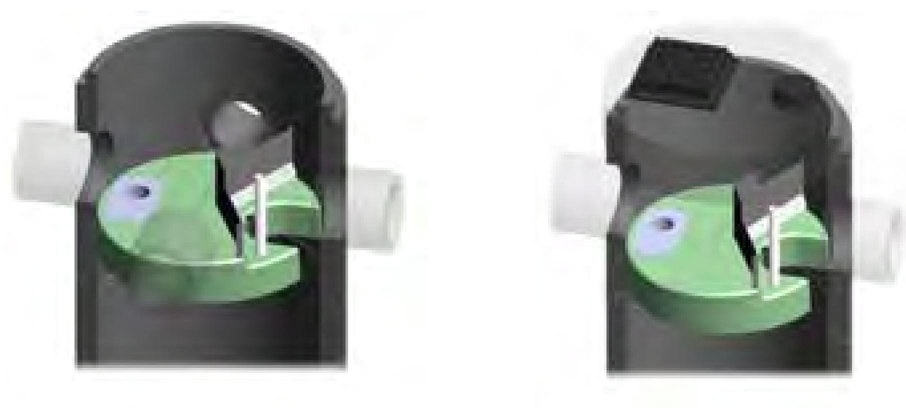
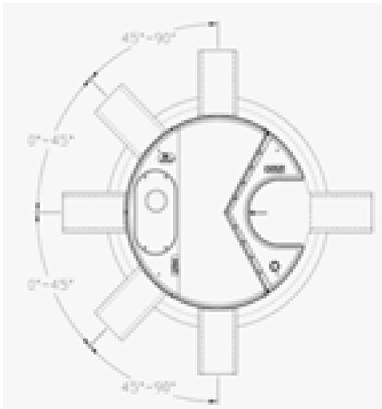
DESIGN FLEXIBILITY

►**Stormceptor® EF** and **EFO** offers design flexibility in one simplified platform, accepting stormwater flow from a single inlet pipe or multiple inlet pipes, and/or surface runoff through an inlet grate. The device can also serve as a junction structure, accommodate a 90-degree inlet-to-outlet bend angle, and can be modified to ensure performance in submerged conditions.

OIL CAPTURE AND RETENTION

►While Stormceptor® EF will capture and retain oil from dry weather spills and low intensity runoff, **Stormceptor® EFO** has demonstrated superior oil capture and greater than 99% oil retention in third-party testing according to the light liquid re-entrainment testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**. Stormceptor EFO is recommended for sites where oil capture and retention is a requirement.





INLET-TO-OUTLET DROP

Elevation differential between inlet and outlet pipe inverts is dictated by the angle at which the inlet pipe(s) enters the unit.

0° - 45° : The inlet pipe is 1-inch (25mm) higher than the outlet pipe.

45° - 90° : The inlet pipe is 2-inches (50mm) higher than the outlet pipe.

HEAD LOSS

The head loss through Stormceptor EF is similar to that of a 60-degree bend structure. The applicable K value for calculating minor losses through the unit is 1.1. For submerged conditions the applicable K value is 3.0.

Pollutant Capacity

Stormceptor EF / EFO	Model Diameter		Depth (Outlet Pipe Invert to Sump Floor)		Oil Volume		Recommended Sediment Maintenance Depth *		Maximum Sediment Volume *		Maximum Sediment Mass **	
	(m)	(ft)	(m)	(ft)	(L)	(Gal)	(mm)	(in)	(L)	(ft³)	(kg)	(lb)
EF4 / EFO4	1.2	4	1.52	5.0	265	70	203	8	1190	42	1904	5250
EF6 / EFO6	1.8	6	1.93	6.3	610	160	305	12	3470	123	5552	15375
EF8 / EFO8	2.4	8	2.59	8.5	1070	280	610	24	8780	310	14048	38750
EF10 / EFO10	3.0	10	3.25	10.7	1670	440	610	24	17790	628	28464	78500
EF12 / EFO12	3.6	12	3.89	12.8	2475	655	610	24	31220	1103	49952	137875

*Increased sump depth may be added to increase sediment storage capacity

** Average density of wet packed sediment in sump = 1.6 kg/L (100 lb/ft³)

Feature	Benefit	Feature Appeals To
Patent-pending enhanced flow treatment and scour prevention technology	Superior, verified third-party performance	Regulator, Specifying & Design Engineer
Third-party verified light liquid capture and retention for EFO version	Proven performance for fuel/oil hotspot locations	Regulator, Specifying & Design Engineer, Site Owner
Functions as bend, junction or inlet structure	Design flexibility	Specifying & Design Engineer
Minimal drop between inlet and outlet	Site installation ease	Contractor
Large diameter outlet riser for inspection and maintenance	Easy maintenance access from grade	Maintenance Contractor & Site Owner

STANDARD STORMCEPTOR EF/EFO DRAWINGS

For standard details, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

STANDARD STORMCEPTOR EF/EFO SPECIFICATION

For specifications, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

Table of TSS Removal vs Surface Loading Rate Based on Third-Party Test Results

Stormceptor® EF

SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL
1	70	660	46	1320	48	1980	35
30	70	690	46	1350	48	2010	34

60	67	720	45	1380	49	2040	34
90	63	750	45	1410	49	2070	33
120	61	780	45	1440	48	2100	33
150	58	810	45	1470	47	2130	32
180	56	840	45	1500	46	2160	32
210	54	870	45	1530	45	2190	31
240	53	900	45	1560	44	2220	31
270	52	930	44	1590	43	2250	30
300	51	960	44	1620	42	2280	30
330	50	990	44	1650	42	2310	30
360	49	1020	44	1680	41	2340	29
390	48	1050	45	1710	40	2370	29
420	48	1080	45	1740	39	2400	29
450	48	1110	45	1770	39	2430	28
480	47	1140	46	1800	38	2460	28
510	47	1170	46	1830	37	2490	28
540	47	1200	47	1860	37	2520	27
570	46	1230	47	1890	36	2550	27
600	46	1260	47	1920	36	2580	27
630	46	1290	48	1950	35		

STANDARD PERFORMANCE SPECIFICATION FOR “OIL GRIT SEPARATOR” (OGS) STORMWATER QUALITY TREATMENT DEVICE

PART 1 – GENERAL

1.1 WORK INCLUDED

This section specifies requirements for selecting, sizing, and designing an underground Oil Grit Separator (OGS) device for stormwater quality treatment, with third-party testing results and a Statement of Verification in accordance with ISO 14034 Environmental Management – Environmental Technology Verification (ETV).

1.2 REFERENCE STANDARDS & PROCEDURES

ISO 14034:2016 Environmental management – Environmental technology verification (ETV)

Canadian Environmental Technology Verification (ETV) Program’s **Procedure for Laboratory Testing of Oil-Grit Separators.**

1.3 SUBMITTALS

1.3.1 All submittals, including sizing reports & shop drawings, shall be submitted upon request with each order to the contractor then forwarded to the Engineer of Record for review and acceptance. Shop drawings shall detail all OGS components, elevations, and sequence of construction.

1.3.2 Alternative devices shall have features identical to or greater than the specified device, including: treatment chamber diameter, treatment chamber wet volume, sediment storage volume, and oil storage volume.

1.3.3 Unless directed otherwise by the Engineer of Record, OGS stormwater quality treatment product substitutions or alternatives submitted within ten days prior to project bid shall not be accepted. All alternatives or substitutions submitted shall be signed and sealed by a local registered Professional Engineer, based on the exact same criteria detailed in Section 3, in entirety, subject to review and approval by the Engineer of Record.

PART 2 – PRODUCTS

2.1 OGS POLLUTANT STORAGE

The OGS device shall include a sump for sediment storage, and a protected volume for the capture and storage of petroleum hydrocarbons and buoyant gross pollutants. The **minimum** sediment & petroleum hydrocarbon storage capacity shall be as follows:

2.1.1	4 ft (1219 mm) Diameter OGS Units:	1.19 m^3 sediment / 265 L oil
	6 ft (1829 mm) Diameter OGS Units:	3.48 m^3 sediment / 609 L oil
	8 ft (2438 mm) Diameter OGS Units:	8.78 m^3 sediment / 1,071 L oil
	10 ft (3048 mm) Diameter OGS Units:	17.78 m^3 sediment / 1,673 L oil
	12 ft (3657 mm) Diameter OGS Units:	31.23 m^3 sediment / 2,476 L oil

PART 3 – PERFORMANCE & DESIGN

3.1 GENERAL

The OGS stormwater quality treatment device shall be verified in accordance with ISO 14034:2016 Environmental management – Environmental technology verification (ETV). The OGS stormwater quality treatment device shall remove oil, sediment and gross pollutants from stormwater runoff during frequent wet weather events, and retain these pollutants during less frequent high flow wet weather events below the insert within the OGS for later removal during maintenance. The Manufacturer shall have at least ten (10) years of local experience, history and success in engineering design, manufacturing and production and supply of OGS stormwater quality treatment device systems, acceptable to the Engineer of Record.

3.2 SIZING METHODOLOGY

The OGS device shall be engineered, designed and sized to provide stormwater quality treatment based on treating a minimum of 90 percent of the average annual runoff volume and a minimum removal of an annual average 60% of the sediment (TSS) load based on the Particle Size Distribution (PSD) specified in the sizing report for the specified device. Sizing shall be determined using historical rainfall data and a sediment removal performance curve derived from the actual third-party verified laboratory testing data. The OGS device shall also have sufficient annual sediment storage capacity as specified and calculated in Section 2.1.

3.3 CANADIAN ETV or ISO 14034 ETV VERIFICATION OF SCOUR TESTING

The OGS device shall have Canadian ETV or ISO 14034 ETV Verification of third-party scour testing conducted in accordance with the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**

3.3.1 To be acceptable for on-line installation, the OGS device must demonstrate an average scour test effluent concentration less than 10 mg/L at each surface loading rate tested, up to and including 2600 L/min/m^2.

Stormceptor® EF Sizing Report

STORMCEPTOR®
ESTIMATED NET ANNUAL SEDIMENT (TSS) LOAD REDUCTION

11/13/2020

Province:	Ontario
City:	Oakville
Nearest Rainfall Station:	HAMILTON AP
NCDC Rainfall Station Id:	3195
Years of Rainfall Data:	34
Site Name:	Nelson Street
Drainage Area (ha):	2.60
% Imperviousness:	95.00

Runoff Coefficient 'c': 0.87

Project Name:	Lakeshore Road Class EA
Project Number:	43762
Designer Name:	Gurkanwal Arora
Designer Company:	Wood Environment & Infrastructure
Designer Email:	gurkanwal.arora@woodplc.com
Designer Phone:	905-335-2353
EOR Name:	
EOR Company:	
EOR Email:	
EOR Phone:	

Particle Size Distribution:	CA ETV
Target TSS Removal (%):	1.0
Required Water Quality Runoff Volume Capture (%):	90.00
Estimated Water Quality Flow Rate (L/s):	86.10
Oil / Fuel Spill Risk Site?	No
Upstream Flow Control?	No
Peak Conveyance (maximum) Flow Rate (L/s):	
Site Sediment Transport Rate (kg/ha/yr):	

Net Annual Sediment (TSS) Load Reduction Sizing Summary

Stormceptor Model	TSS Removal Provided (%)
EF4	41
EF6	50
EF8	56
EF10	60
EF12	62

Recommended Stormceptor EF Model: EF4

Estimated Net Annual Sediment (TSS) Load Reduction (%): 41

Water Quality Runoff Volume Capture (%): > 90

THIRD-PARTY TESTING AND VERIFICATION

►**Stormceptor® EF and Stormceptor® EFO** are the latest evolutions in the Stormceptor® oil-grit separator (OGS) technology series, and are designed to remove a wide variety of pollutants from stormwater and snowmelt runoff. These technologies have been third-party tested in accordance with the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators** and performance has been third-party verified in accordance with the **ISO 14034 Environmental Technology Verification (ETV)** protocol.

PERFORMANCE

►**Stormceptor® EF and EFO** remove stormwater pollutants through gravity separation and floatation, and feature a patent-pending design that generates positive removal of total suspended solids (TSS) throughout each storm event, including high-intensity storms. Captured pollutants include sediment, free oils, and sediment-bound pollutants such as nutrients, heavy metals, and petroleum hydrocarbons. Stormceptor is sized to remove a high level of TSS from the frequent rainfall events that contribute the vast majority of annual runoff volume and pollutant load. The technology incorporates an internal bypass to convey excessive stormwater flows from high-intensity storms through the device without resuspension and washout (scour) of previously captured pollutants. Proper routine maintenance ensures high pollutant removal performance and protection of downstream waterways.

PARTICLE SIZE DISTRIBUTION (PSD)

►The **Canadian ETV PSD** shown in the table below was used, or in part, for this sizing. This is the identical PSD that is referenced in the Canadian ETV ***Procedure for Laboratory Testing of Oil-Grit Separators*** for both sediment removal testing and scour testing. The Canadian ETV PSD contains a wide range of particle sizes in the sand and silt fractions, and is considered reasonably representative of the particle size fractions found in typical urban stormwater runoff.

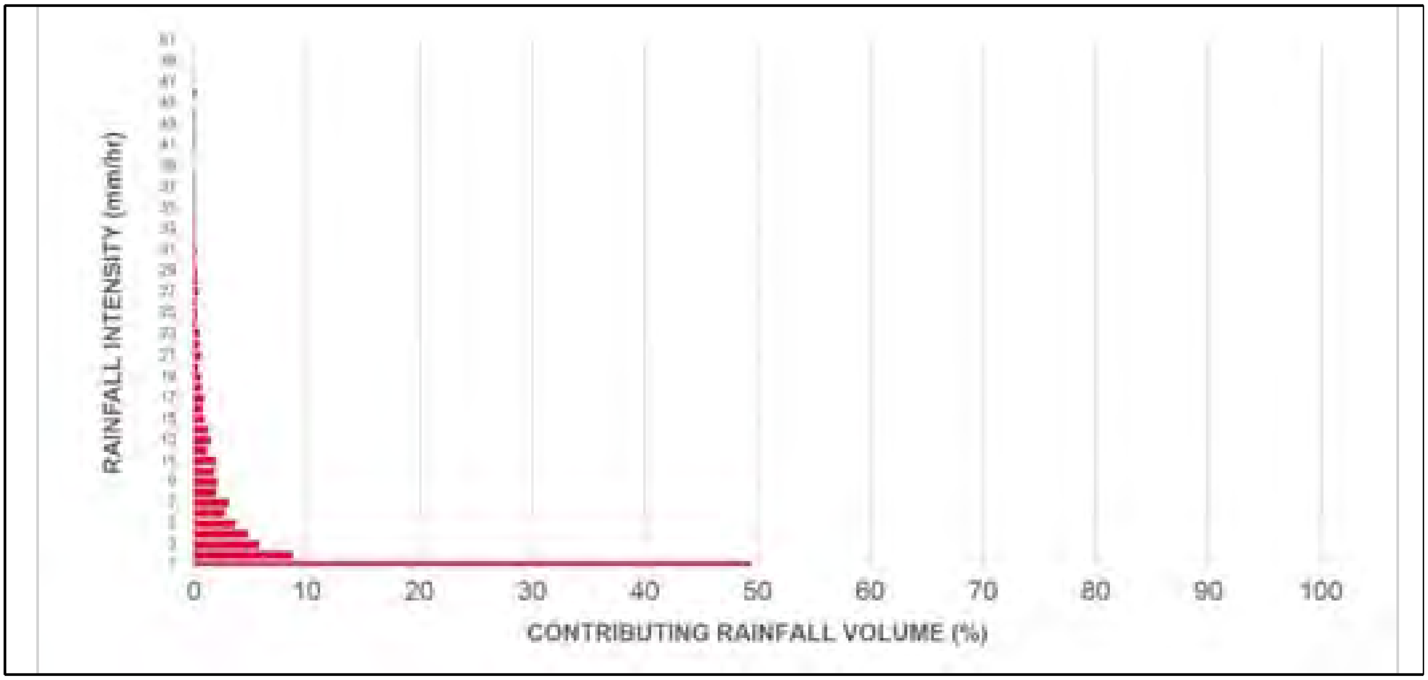
Particle Size (μm)	Percent Less Than	Particle Size Fraction (μm)	Percent
1000	100	500-1000	5
500	95	250-500	5
250	90	150-250	15
150	75	100-150	15
100	60	75-100	10
75	50	50-75	5
50	45	20-50	10
20	35	8-20	15
8	20	5-8	10
5	10	2-5	5
2	5	<2	5

Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
1	49.5	49.5	6.29	377.0	314.0	51	25.1	25.1
2	8.8	58.3	12.58	755.0	629.0	46	4.0	29.1
3	5.8	64.1	18.87	1132.0	943.0	44	2.6	31.7
4	4.8	68.9	25.15	1509.0	1258.0	47	2.3	34.0
5	3.7	72.6	31.44	1887.0	1572.0	44	1.6	35.6
6	2.8	75.4	37.73	2264.0	1887.0	36	1.0	36.6
7	3.1	78.5	44.02	2641.0	2201.0	31	1.0	37.6
8	2.0	80.5	50.31	3018.0	2515.0	27	0.5	38.1
9	2.1	82.6	56.60	3396.0	2830.0	25	0.5	38.6
10	1.8	84.4	62.88	3773.0	3144.0	22	0.4	39.0
11	2.0	86.4	69.17	4150.0	3459.0	20	0.4	39.4
12	1.2	87.6	75.46	4528.0	3773.0	19	0.2	39.7
13	1.5	89.1	81.75	4905.0	4087.0	17	0.3	39.9
14	1.3	90.4	88.04	5282.0	4402.0	16	0.2	40.1
15	0.9	91.3	94.33	5660.0	4716.0	15	0.1	40.2
16	0.8	92.1	100.61	6037.0	5031.0	14	0.1	40.4
17	0.9	93.0	106.90	6414.0	5345.0	13	0.1	40.5
18	0.7	93.7	113.19	6791.0	5660.0	12	0.1	40.6
19	0.6	94.3	119.48	7169.0	5974.0	12	0.1	40.6
20	0.4	94.7	125.77	7546.0	6288.0	11	0.0	40.7
21	0.6	95.3	132.06	7923.0	6603.0	10	0.1	40.7
22	0.5	95.8	138.34	8301.0	6917.0	10	0.1	40.8
23	0.5	96.3	144.63	8678.0	7232.0	10	0.0	40.8
24	0.2	96.5	150.92	9055.0	7546.0	9	0.0	40.9
25	0.3	96.8	157.21	9433.0	7860.0	9	0.0	40.9

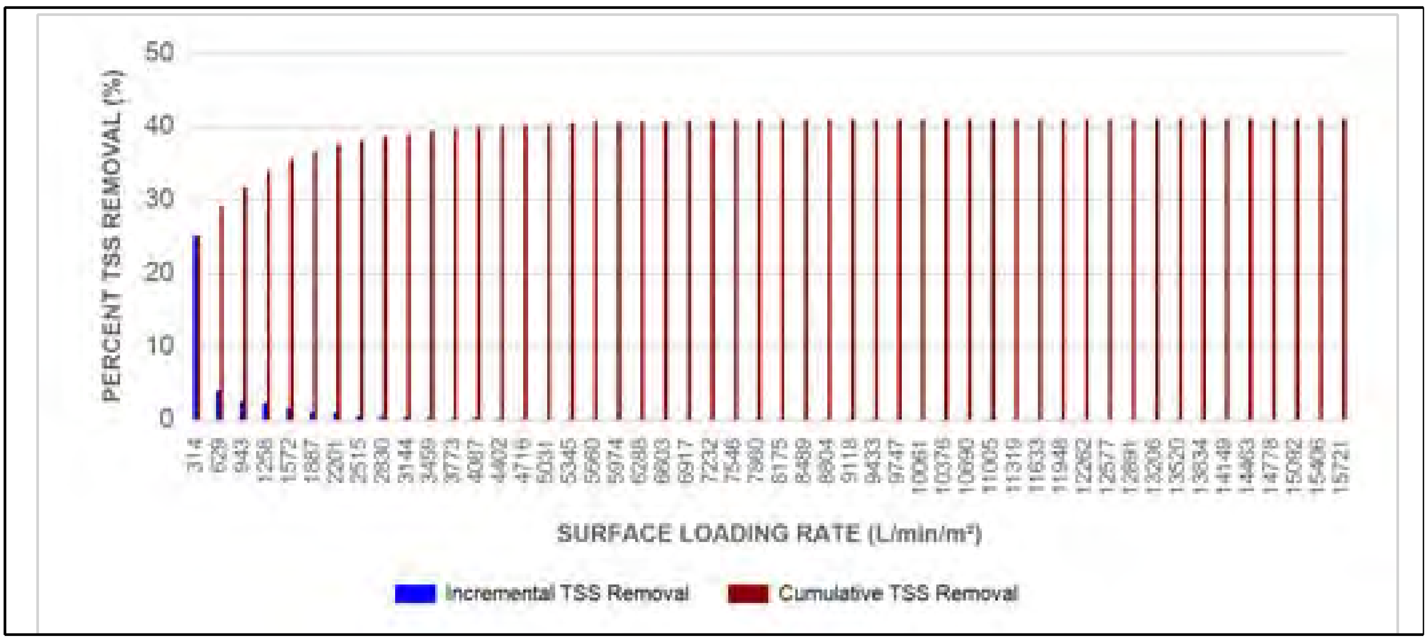
Stormceptor® EF Sizing Report

Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
26	0.2	97.0	163.50	9810.0	8175.0	8	0.0	40.9
27	0.4	97.4	169.79	10187.0	8489.0	8	0.0	40.9
28	0.3	97.7	176.07	10564.0	8804.0	8	0.0	41.0
29	0.3	98.0	182.36	10942.0	9118.0	8	0.0	41.0
30	0.1	98.1	188.65	11319.0	9433.0	7	0.0	41.0
31	0.2	98.3	194.94	11696.0	9747.0	7	0.0	41.0
32	0.1	98.4	201.23	12074.0	10061.0	7	0.0	41.0
33	0.1	98.5	207.52	12451.0	10376.0	7	0.0	41.0
34	0.1	98.6	213.80	12828.0	10690.0	7	0.0	41.0
35	0.1	98.7	220.09	13206.0	11005.0	7	0.0	41.0
36	0.1	98.8	226.38	13583.0	11319.0	7	0.0	41.0
37	0.1	98.9	232.67	13960.0	11633.0	7	0.0	41.0
38	0.1	99.0	238.96	14337.0	11948.0	7	0.0	41.0
39	0.0	99.0	245.25	14715.0	12262.0	7	0.0	41.0
40	0.0	99.0	251.53	15092.0	12577.0	7	0.0	41.0
41	0.1	99.1	257.82	15469.0	12891.0	7	0.0	41.1
42	0.1	99.2	264.11	15847.0	13206.0	7	0.0	41.1
43	0.1	99.3	270.40	16224.0	13520.0	7	0.0	41.1
44	0.1	99.4	276.69	16601.0	13834.0	7	0.0	41.1
45	0.0	99.4	282.98	16979.0	14149.0	7	0.0	41.1
46	0.2	99.6	289.26	17356.0	14463.0	7	0.0	41.1
47	0.0	99.6	295.55	17733.0	14778.0	7	0.0	41.1
48	0.0	99.6	301.84	18110.0	15092.0	7	0.0	41.1
49	0.0	99.6	308.13	18488.0	15406.0	7	0.0	41.1
50	0.0	99.6	314.42	18865.0	15721.0	7	0.0	41.1
Estimated Net Annual Sediment (TSS) Load Reduction =								**41 %**

RAINFALL DATA FROM HAMILTON AP RAINFALL STATION



INCREMENTAL AND CUMULATIVE TSS REMOVAL FOR THE RECOMMENDED STORMCEPTOR® MODEL



Maximum Pipe Diameter / Peak Conveyance

Stormceptor EF / EFO	Model Diameter		Min Angle Inlet / Outlet Pipes	Max Inlet Pipe Diameter		Max Outlet Pipe Diameter		Peak Conveyance Flow Rate	
	(m)	(ft)		(mm)	(in)	(mm)	(in)	(L/s)	(cfs)
EF4 / EFO4	1.2	4	90	609	24	609	24	425	15
EF6 / EFO6	1.8	6	90	914	36	914	36	990	35
EF8 / EFO8	2.4	8	90	1219	48	1219	48	1700	60
EF10 / EFO10	3.0	10	90	1828	72	1828	72	2830	100
EF12 / EFO12	3.6	12	90	1828	72	1828	72	2830	100

SCOUR PREVENTION AND ONLINE CONFIGURATION

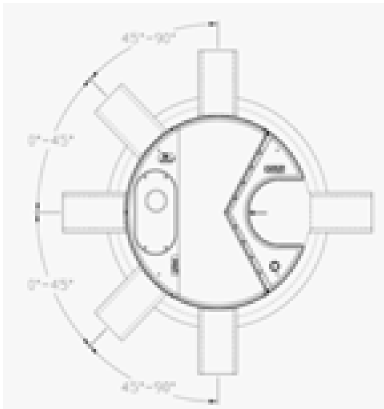
►**Stormceptor® EF and EFO** feature an internal bypass and superior scour prevention technology that have been demonstrated in third-party testing according to the scour testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**, and the exceptional scour test performance has been third-party verified in accordance with the ISO 14034 ETV protocol. As a result, Stormceptor EF and EFO are approved for online installation, eliminating the need for costly additional bypass structures, piping, and installation expense.

DESIGN FLEXIBILITY

►**Stormceptor® EF** and **EFO** offers design flexibility in one simplified platform, accepting stormwater flow from a single inlet pipe or multiple inlet pipes, and/or surface runoff through an inlet grate. The device can also serve as a junction structure, accommodate a 90-degree inlet-to-outlet bend angle, and can be modified to ensure performance in submerged conditions.

OIL CAPTURE AND RETENTION

►While Stormceptor® EF will capture and retain oil from dry weather spills and low intensity runoff, **Stormceptor® EFO** has demonstrated superior oil capture and greater than 99% oil retention in third-party testing according to the light liquid re-entrainment testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**. Stormceptor EFO is recommended for sites where oil capture and retention is a requirement.



INLET-TO-OUTLET DROP

Elevation differential between inlet and outlet pipe inverts is dictated by the angle at which the inlet pipe(s) enters the unit.

0° - 45° : The inlet pipe is 1-inch (25mm) higher than the outlet pipe.

45° - 90° : The inlet pipe is 2-inches (50mm) higher than the outlet pipe.

HEAD LOSS

The head loss through Stormceptor EF is similar to that of a 60-degree bend structure. The applicable K value for calculating minor losses through the unit is 1.1. For submerged conditions the applicable K value is 3.0.

Pollutant Capacity

Stormceptor EF / EFO	Model Diameter		Depth (Outlet Pipe Invert to Sump Floor)		Oil Volume		Recommended Sediment Maintenance Depth *		Maximum Sediment Volume *		Maximum Sediment Mass **	
	(m)	(ft)	(m)	(ft)	(L)	(Gal)	(mm)	(in)	(L)	(ft³)	(kg)	(lb)
EF4 / EFO4	1.2	4	1.52	5.0	265	70	203	8	1190	42	1904	5250
EF6 / EFO6	1.8	6	1.93	6.3	610	160	305	12	3470	123	5552	15375
EF8 / EFO8	2.4	8	2.59	8.5	1070	280	610	24	8780	310	14048	38750
EF10 / EFO10	3.0	10	3.25	10.7	1670	440	610	24	17790	628	28464	78500
EF12 / EFO12	3.6	12	3.89	12.8	2475	655	610	24	31220	1103	49952	137875

*Increased sump depth may be added to increase sediment storage capacity

** Average density of wet packed sediment in sump = 1.6 kg/L (100 lb/ft³)

Feature	Benefit	Feature Appeals To
Patent-pending enhanced flow treatment and scour prevention technology	Superior, verified third-party performance	Regulator, Specifying & Design Engineer
Third-party verified light liquid capture and retention for EFO version	Proven performance for fuel/oil hotspot locations	Regulator, Specifying & Design Engineer, Site Owner
Functions as bend, junction or inlet structure	Design flexibility	Specifying & Design Engineer
Minimal drop between inlet and outlet	Site installation ease	Contractor
Large diameter outlet riser for inspection and maintenance	Easy maintenance access from grade	Maintenance Contractor & Site Owner

STANDARD STORMCEPTOR EF/EFO DRAWINGS

For standard details, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

STANDARD STORMCEPTOR EF/EFO SPECIFICATION

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Table of TSS Removal vs Surface Loading Rate Based on Third-Party Test Results

Stormceptor® EF

SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL
1	70	660	46	1320	48	1980	35
30	70	690	46	1350	48	2010	34

60	67	720	45	1380	49	2040	34
90	63	750	45	1410	49	2070	33
120	61	780	45	1440	48	2100	33
150	58	810	45	1470	47	2130	32
180	56	840	45	1500	46	2160	32
210	54	870	45	1530	45	2190	31
240	53	900	45	1560	44	2220	31
270	52	930	44	1590	43	2250	30
300	51	960	44	1620	42	2280	30
330	50	990	44	1650	42	2310	30
360	49	1020	44	1680	41	2340	29
390	48	1050	45	1710	40	2370	29
420	48	1080	45	1740	39	2400	29
450	48	1110	45	1770	39	2430	28
480	47	1140	46	1800	38	2460	28
510	47	1170	46	1830	37	2490	28
540	47	1200	47	1860	37	2520	27
570	46	1230	47	1890	36	2550	27
600	46	1260	47	1920	36	2580	27
630	46	1290	48	1950	35		

STANDARD PERFORMANCE SPECIFICATION FOR
"OIL GRIT SEPARATOR" (OGS) STORMWATER QUALITY TREATMENT DEVICE

PART 1 – GENERAL

1.1 WORK INCLUDED

This section specifies requirements for selecting, sizing, and designing an underground Oil Grit Separator (OGS) device for stormwater quality treatment, with third-party testing results and a Statement of Verification in accordance with ISO 14034 Environmental Management – Environmental Technology Verification (ETV).

1.2 REFERENCE STANDARDS & PROCEDURES

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Canadian Environmental Technology Verification (ETV) Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**

1.3 SUBMITTALS

1.3.1 All submittals, including sizing reports & shop drawings, shall be submitted upon request with each order to the contractor then forwarded to the Engineer of Record for review and acceptance. Shop drawings shall detail all OGS components, elevations, and sequence of construction.

1.3.2 Alternative devices shall have features identical to or greater than the specified device, including: treatment chamber diameter, treatment chamber wet volume, sediment storage volume, and oil storage volume.

1.3.3 Unless directed otherwise by the Engineer of Record, OGS stormwater quality treatment product substitutions or alternatives submitted within ten days prior to project bid shall not be accepted. All alternatives or substitutions submitted shall be signed and sealed by a local registered Professional Engineer, based on the exact same criteria detailed in Section 3, in entirety, subject to review and approval by the Engineer of Record.

PART 2 – PRODUCTS

2.1 OGS POLLUTANT STORAGE

The OGS device shall include a sump for sediment storage, and a protected volume for the capture and storage of petroleum hydrocarbons and buoyant gross pollutants. The **minimum** sediment & petroleum hydrocarbon storage capacity shall be as follows:

2.1.1	4 ft (1219 mm) Diameter OGS Units:	1.19 m^3 sediment / 265 L oil
	6 ft (1829 mm) Diameter OGS Units:	3.48 m^3 sediment / 609 L oil
	8 ft (2438 mm) Diameter OGS Units:	8.78 m^3 sediment / 1,071 L oil
	10 ft (3048 mm) Diameter OGS Units:	17.78 m^3 sediment / 1,673 L oil
	12 ft (3657 mm) Diameter OGS Units:	31.23 m^3 sediment / 2,476 L oil

PART 3 – PERFORMANCE & DESIGN

3.1 GENERAL

The OGS stormwater quality treatment device shall be verified in accordance with ISO 14034:2016 Environmental management – Environmental technology verification (ETV). The OGS stormwater quality treatment device shall remove oil, sediment and gross pollutants from stormwater runoff during frequent wet weather events, and retain these pollutants during less frequent high flow wet weather events below the insert within the OGS for later removal during maintenance. The Manufacturer shall have at least ten (10) years of local experience, history and success in engineering design, manufacturing and production and supply of OGS stormwater quality treatment device systems, acceptable to the Engineer of Record.

3.2 SIZING METHODOLOGY

The OGS device shall be engineered, designed and sized to provide stormwater quality treatment based on treating a minimum of 90 percent of the average annual runoff volume and a minimum removal of an annual average 60% of the sediment (TSS) load based on the Particle Size Distribution (PSD) specified in the sizing report for the specified device. Sizing shall be determined using historical rainfall data and a sediment removal performance curve derived from the actual third-party verified laboratory testing data. The OGS device shall also have sufficient annual sediment storage capacity as specified and calculated in Section 2.1.

3.3 CANADIAN ETV or ISO 14034 ETV VERIFICATION OF SCOUR TESTING

The OGS device shall have Canadian ETV or ISO 14034 ETV Verification of third-party scour testing conducted in accordance with the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**

3.3.1 To be acceptable for on-line installation, the OGS device must demonstrate an average scour test effluent concentration less than 10 mg/L at each surface loading rate tested, up to and including 2600 L/min/m^2.

Stormceptor® EF Sizing Report

STORMCEPTOR®
ESTIMATED NET ANNUAL SEDIMENT (TSS) LOAD REDUCTION

11/13/2020

Province:	Ontario
City:	Oakville
Nearest Rainfall Station:	HAMILTON AP
NCDC Rainfall Station Id:	3195
Years of Rainfall Data:	34
Site Name:	Coronation Park East - Westminster Drive East
Drainage Area (ha):	1.22
% Imperviousness:	65.00

Runoff Coefficient 'c': 0.69

Project Name:	Lakeshore Road Class EA
Project Number:	43762
Designer Name:	Gurkanwal Arora
Designer Company:	Wood Environment & Infrastructure
Designer Email:	gurkanwal.arora@woodplc.com
Designer Phone:	905-335-2353
EOR Name:	
EOR Company:	
EOR Email:	
EOR Phone:	

Particle Size Distribution:	CA ETV
Target TSS Removal (%):	3.5
Required Water Quality Runoff Volume Capture (%):	90.00
Estimated Water Quality Flow Rate (L/s):	32.04
Oil / Fuel Spill Risk Site?	No
Upstream Flow Control?	No
Peak Conveyance (maximum) Flow Rate (L/s):	
Site Sediment Transport Rate (kg/ha/yr):	

Net Annual Sediment (TSS) Load Reduction Sizing Summary

Stormceptor Model	TSS Removal Provided (%)
EF4	53
EF6	60
EF8	63
EF10	65
EF12	66

Recommended Stormceptor EF Model: EF4

Estimated Net Annual Sediment (TSS) Load Reduction (%): 53

Water Quality Runoff Volume Capture (%): > 90

THIRD-PARTY TESTING AND VERIFICATION

►**Stormceptor® EF and Stormceptor® EFO** are the latest evolutions in the Stormceptor® oil-grit separator (OGS) technology series, and are designed to remove a wide variety of pollutants from stormwater and snowmelt runoff. These technologies have been third-party tested in accordance with the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators** and performance has been third-party verified in accordance with the **ISO 14034 Environmental Technology Verification (ETV)** protocol.

PERFORMANCE

►**Stormceptor® EF and EFO** remove stormwater pollutants through gravity separation and floatation, and feature a patent-pending design that generates positive removal of total suspended solids (TSS) throughout each storm event, including high-intensity storms. Captured pollutants include sediment, free oils, and sediment-bound pollutants such as nutrients, heavy metals, and petroleum hydrocarbons. Stormceptor is sized to remove a high level of TSS from the frequent rainfall events that contribute the vast majority of annual runoff volume and pollutant load. The technology incorporates an internal bypass to convey excessive stormwater flows from high-intensity storms through the device without resuspension and washout (scour) of previously captured pollutants. Proper routine maintenance ensures high pollutant removal performance and protection of downstream waterways.

PARTICLE SIZE DISTRIBUTION (PSD)

►The **Canadian ETV PSD** shown in the table below was used, or in part, for this sizing. This is the identical PSD that is referenced in the Canadian ETV ***Procedure for Laboratory Testing of Oil-Grit Separators*** for both sediment removal testing and scour testing. The Canadian ETV PSD contains a wide range of particle sizes in the sand and silt fractions, and is considered reasonably representative of the particle size fractions found in typical urban stormwater runoff.

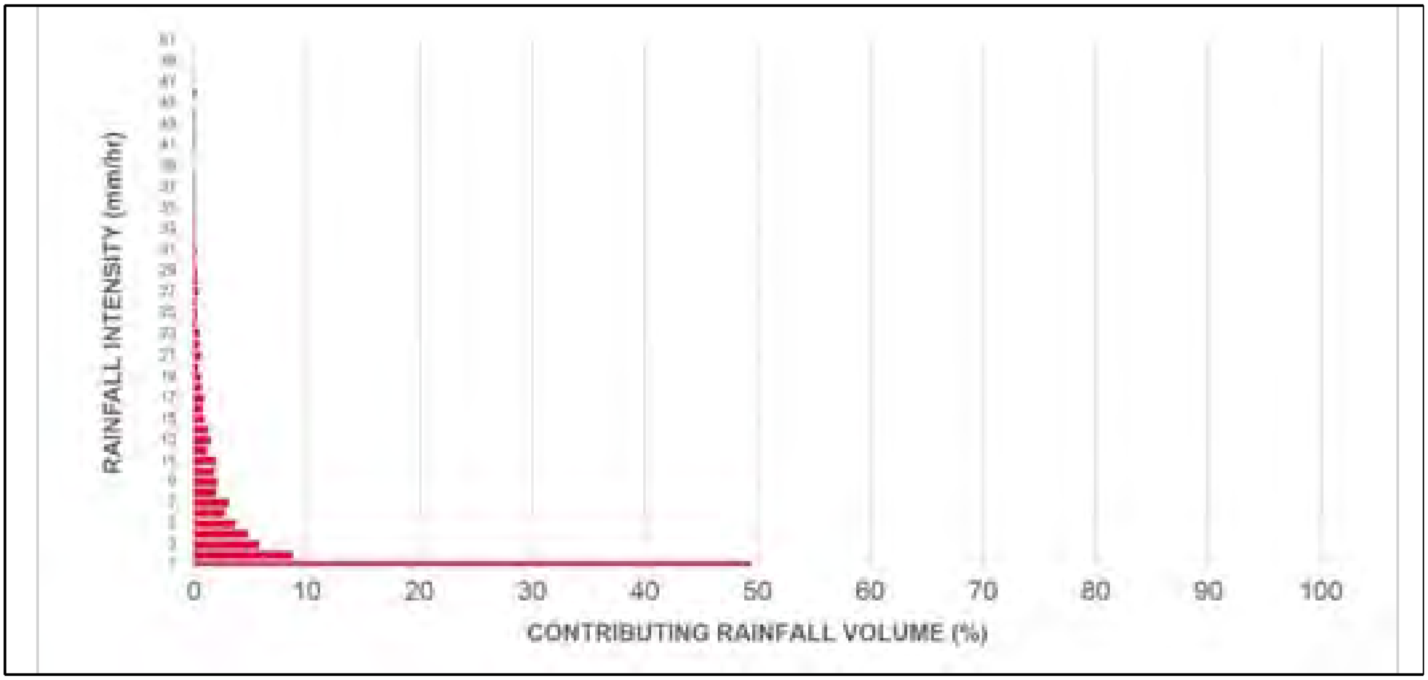
Particle Size (µm)	Percent Less Than	Particle Size Fraction (µm)	Percent
1000	100	500-1000	5
500	95	250-500	5
250	90	150-250	15
150	75	100-150	15
100	60	75-100	10
75	50	50-75	5
50	45	20-50	10
20	35	8-20	15
8	20	5-8	10
5	10	2-5	5
2	5	<2	5

Stormceptor® EF Sizing Report

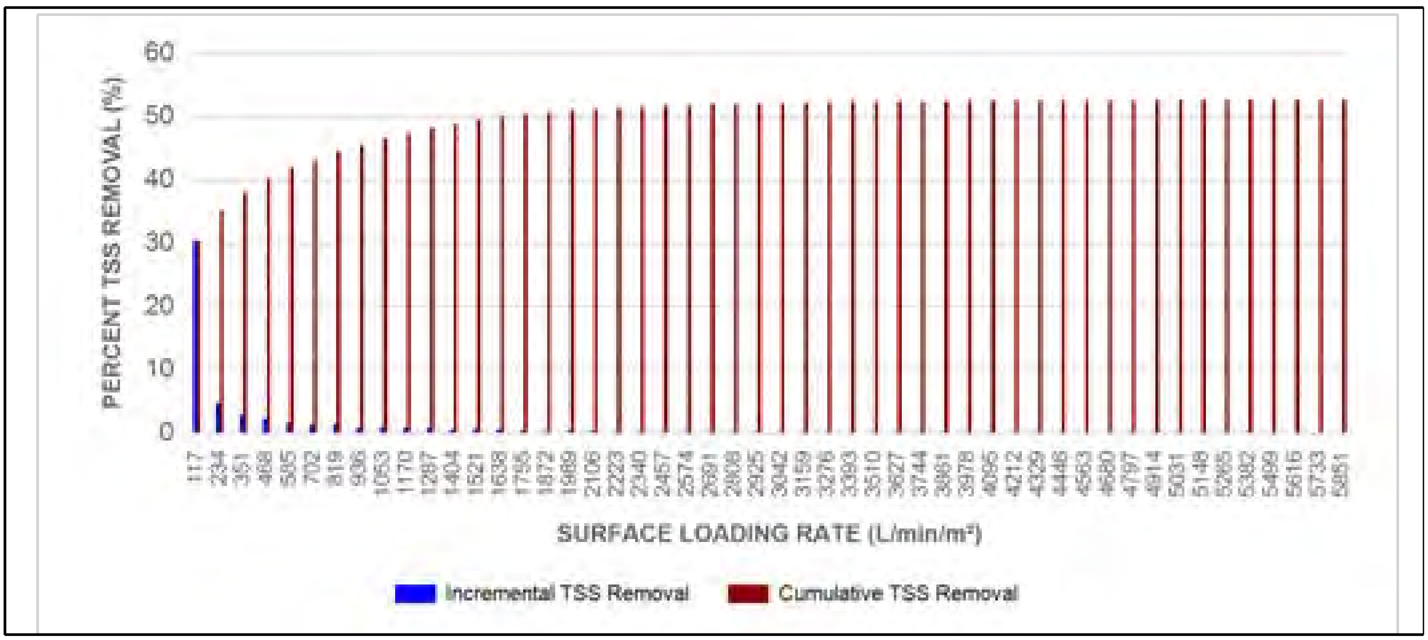
Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
1	49.5	49.5	2.34	140.0	117.0	62	30.4	30.4
2	8.8	58.3	4.68	281.0	234.0	53	4.7	35.1
3	5.8	64.1	7.02	421.0	351.0	50	2.9	38.0
4	4.8	68.9	9.36	562.0	468.0	47	2.3	40.3
5	3.7	72.6	11.70	702.0	585.0	46	1.7	42.0
6	2.8	75.4	14.04	842.0	702.0	46	1.3	43.2
7	3.1	78.5	16.38	983.0	819.0	45	1.4	44.6
8	2.0	80.5	18.72	1123.0	936.0	44	0.9	45.5
9	2.1	82.6	21.06	1264.0	1053.0	45	0.9	46.5
10	1.8	84.4	23.40	1404.0	1170.0	46	0.8	47.3
11	2.0	86.4	25.74	1545.0	1287.0	48	1.0	48.2
12	1.2	87.6	28.08	1685.0	1404.0	49	0.6	48.8
13	1.5	89.1	30.42	1825.0	1521.0	45	0.7	49.5
14	1.3	90.4	32.76	1966.0	1638.0	42	0.5	50.1
15	0.9	91.3	35.10	2106.0	1755.0	39	0.4	50.4
16	0.8	92.1	37.44	2247.0	1872.0	37	0.3	50.7
17	0.9	93.0	39.78	2387.0	1989.0	34	0.3	51.0
18	0.7	93.7	42.12	2527.0	2106.0	33	0.2	51.2
19	0.6	94.3	44.46	2668.0	2223.0	31	0.2	51.4
20	0.4	94.7	46.80	2808.0	2340.0	29	0.1	51.5
21	0.6	95.3	49.14	2949.0	2457.0	28	0.2	51.7
22	0.5	95.8	51.48	3089.0	2574.0	27	0.1	51.8
23	0.5	96.3	53.82	3229.0	2691.0	26	0.1	52.0
24	0.2	96.5	56.16	3370.0	2808.0	25	0.0	52.0
25	0.3	96.8	58.51	3510.0	2925.0	24	0.1	52.1

Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
26	0.2	97.0	60.85	3651.0	3042.0	23	0.0	52.1
27	0.4	97.4	63.19	3791.0	3159.0	22	0.1	52.2
28	0.3	97.7	65.53	3932.0	3276.0	21	0.1	52.3
29	0.3	98.0	67.87	4072.0	3393.0	21	0.1	52.4
30	0.1	98.1	70.21	4212.0	3510.0	20	0.0	52.4
31	0.2	98.3	72.55	4353.0	3627.0	19	0.0	52.4
32	0.1	98.4	74.89	4493.0	3744.0	19	0.0	52.4
33	0.1	98.5	77.23	4634.0	3861.0	18	0.0	52.4
34	0.1	98.6	79.57	4774.0	3978.0	18	0.0	52.5
35	0.1	98.7	81.91	4914.0	4095.0	17	0.0	52.5
36	0.1	98.8	84.25	5055.0	4212.0	16	0.0	52.5
37	0.1	98.9	86.59	5195.0	4329.0	16	0.0	52.5
38	0.1	99.0	88.93	5336.0	4446.0	16	0.0	52.5
39	0.0	99.0	91.27	5476.0	4563.0	15	0.0	52.5
40	0.0	99.0	93.61	5616.0	4680.0	15	0.0	52.5
41	0.1	99.1	95.95	5757.0	4797.0	15	0.0	52.5
42	0.1	99.2	98.29	5897.0	4914.0	14	0.0	52.6
43	0.1	99.3	100.63	6038.0	5031.0	14	0.0	52.6
44	0.1	99.4	102.97	6178.0	5148.0	13	0.0	52.6
45	0.0	99.4	105.31	6319.0	5265.0	13	0.0	52.6
46	0.2	99.6	107.65	6459.0	5382.0	13	0.0	52.6
47	0.0	99.6	109.99	6599.0	5499.0	12	0.0	52.6
48	0.0	99.6	112.33	6740.0	5616.0	12	0.0	52.6
49	0.0	99.6	114.67	6880.0	5733.0	12	0.0	52.6
50	0.0	99.6	117.01	7021.0	5851.0	12	0.0	52.6
Estimated Net Annual Sediment (TSS) Load Reduction =								53 %

RAINFALL DATA FROM HAMILTON AP RAINFALL STATION



INCREMENTAL AND CUMULATIVE TSS REMOVAL FOR THE RECOMMENDED STORMCEPTOR® MODEL



Maximum Pipe Diameter / Peak Conveyance

Stormceptor EF / EFO	Model Diameter (m)	Model Diameter (ft)	Min Angle Inlet / Outlet Pipes	Max Inlet Pipe Diameter (mm)	Max Inlet Pipe Diameter (in)	Max Outlet Pipe Diameter (mm)	Max Outlet Pipe Diameter (in)	Peak Conveyance Flow Rate (L/s)	Peak Conveyance Flow Rate (cfs)
EF4 / EFO4	1.2	4	90	609	24	609	24	425	15
EF6 / EFO6	1.8	6	90	914	36	914	36	990	35
EF8 / EFO8	2.4	8	90	1219	48	1219	48	1700	60
EF10 / EFO10	3.0	10	90	1828	72	1828	72	2830	100
EF12 / EFO12	3.6	12	90	1828	72	1828	72	2830	100

SCOUR PREVENTION AND ONLINE CONFIGURATION

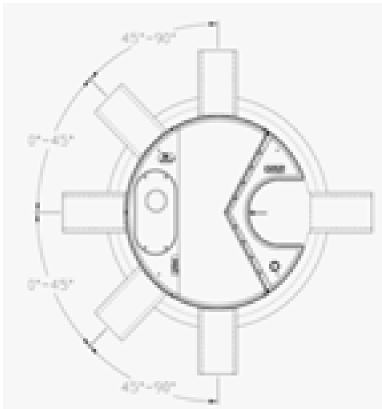
►**Stormceptor® EF and EFO** feature an internal bypass and superior scour prevention technology that have been demonstrated in third-party testing according to the scour testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**, and the exceptional scour test performance has been third-party verified in accordance with the ISO 14034 ETV protocol. As a result, Stormceptor EF and EFO are approved for online installation, eliminating the need for costly additional bypass structures, piping, and installation expense.

DESIGN FLEXIBILITY

►**Stormceptor® EF** and **EFO** offers design flexibility in one simplified platform, accepting stormwater flow from a single inlet pipe or multiple inlet pipes, and/or surface runoff through an inlet grate. The device can also serve as a junction structure, accommodate a 90-degree inlet-to-outlet bend angle, and can be modified to ensure performance in submerged conditions.

OIL CAPTURE AND RETENTION

►While Stormceptor® EF will capture and retain oil from dry weather spills and low intensity runoff, **Stormceptor® EFO** has demonstrated superior oil capture and greater than 99% oil retention in third-party testing according to the light liquid re-entrainment testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**. Stormceptor EFO is recommended for sites where oil capture and retention is a requirement.



INLET-TO-OUTLET DROP

Elevation differential between inlet and outlet pipe inverts is dictated by the angle at which the inlet pipe(s) enters the unit.

0° - 45° : The inlet pipe is 1-inch (25mm) higher than the outlet pipe.

45° - 90° : The inlet pipe is 2-inches (50mm) higher than the outlet pipe.

HEAD LOSS

The head loss through Stormceptor EF is similar to that of a 60-degree bend structure. The applicable K value for calculating minor losses through the unit is 1.1. For submerged conditions the applicable K value is 3.0.

Pollutant Capacity

Stormceptor EF / EFO	Model Diameter		Depth (Outlet Pipe Invert to Sump Floor)		Oil Volume		Recommended Sediment Maintenance Depth *		Maximum Sediment Volume *		Maximum Sediment Mass **	
	(m)	(ft)	(m)	(ft)	(L)	(Gal)	(mm)	(in)	(L)	(ft³)	(kg)	(lb)
EF4 / EFO4	1.2	4	1.52	5.0	265	70	203	8	1190	42	1904	5250
EF6 / EFO6	1.8	6	1.93	6.3	610	160	305	12	3470	123	5552	15375
EF8 / EFO8	2.4	8	2.59	8.5	1070	280	610	24	8780	310	14048	38750
EF10 / EFO10	3.0	10	3.25	10.7	1670	440	610	24	17790	628	28464	78500
EF12 / EFO12	3.6	12	3.89	12.8	2475	655	610	24	31220	1103	49952	137875

*Increased sump depth may be added to increase sediment storage capacity

** Average density of wet packed sediment in sump = 1.6 kg/L (100 lb/ft³)

Feature	Benefit	Feature Appeals To
Patent-pending enhanced flow treatment and scour prevention technology	Superior, verified third-party performance	Regulator, Specifying & Design Engineer
Third-party verified light liquid capture and retention for EFO version	Proven performance for fuel/oil hotspot locations	Regulator, Specifying & Design Engineer, Site Owner
Functions as bend, junction or inlet structure	Design flexibility	Specifying & Design Engineer
Minimal drop between inlet and outlet	Site installation ease	Contractor
Large diameter outlet riser for inspection and maintenance	Easy maintenance access from grade	Maintenance Contractor & Site Owner

STANDARD STORMCEPTOR EF/EFO DRAWINGS

For standard details, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

STANDARD STORMCEPTOR EF/EFO SPECIFICATION

For specifications, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

Table of TSS Removal vs Surface Loading Rate Based on Third-Party Test Results

Stormceptor® EF

SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL
1	70	660	46	1320	48	1980	35
30	70	690	46	1350	48	2010	34

60	67	720	45	1380	49	2040	34
90	63	750	45	1410	49	2070	33
120	61	780	45	1440	48	2100	33
150	58	810	45	1470	47	2130	32
180	56	840	45	1500	46	2160	32
210	54	870	45	1530	45	2190	31
240	53	900	45	1560	44	2220	31
270	52	930	44	1590	43	2250	30
300	51	960	44	1620	42	2280	30
330	50	990	44	1650	42	2310	30
360	49	1020	44	1680	41	2340	29
390	48	1050	45	1710	40	2370	29
420	48	1080	45	1740	39	2400	29
450	48	1110	45	1770	39	2430	28
480	47	1140	46	1800	38	2460	28
510	47	1170	46	1830	37	2490	28
540	47	1200	47	1860	37	2520	27
570	46	1230	47	1890	36	2550	27
600	46	1260	47	1920	36	2580	27
630	46	1290	48	1950	35		

STANDARD PERFORMANCE SPECIFICATION FOR "OIL GRIT SEPARATOR" (OGS) STORMWATER QUALITY TREATMENT DEVICE

PART 1 – GENERAL

1.1 WORK INCLUDED

This section specifies requirements for selecting, sizing, and designing an underground Oil Grit Separator (OGS) device for stormwater quality treatment, with third-party testing results and a Statement of Verification in accordance with ISO 14034 Environmental Management – Environmental Technology Verification (ETV).

1.2 REFERENCE STANDARDS & PROCEDURES

ISO 14034:2016 Environmental management – Environmental technology verification (ETV)

Canadian Environmental Technology Verification (ETV) Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**

1.3 SUBMITTALS

1.3.1 All submittals, including sizing reports & shop drawings, shall be submitted upon request with each order to the contractor then forwarded to the Engineer of Record for review and acceptance. Shop drawings shall detail all OGS components, elevations, and sequence of construction.

1.3.2 Alternative devices shall have features identical to or greater than the specified device, including: treatment chamber diameter, treatment chamber wet volume, sediment storage volume, and oil storage volume.

1.3.3 Unless directed otherwise by the Engineer of Record, OGS stormwater quality treatment product substitutions or alternatives submitted within ten days prior to project bid shall not be accepted. All alternatives or substitutions submitted shall be signed and sealed by a local registered Professional Engineer, based on the exact same criteria detailed in Section 3, in entirety, subject to review and approval by the Engineer of Record.

PART 2 – PRODUCTS

2.1 OGS POLLUTANT STORAGE

The OGS device shall include a sump for sediment storage, and a protected volume for the capture and storage of petroleum hydrocarbons and buoyant gross pollutants. The **minimum** sediment & petroleum hydrocarbon storage capacity shall be as follows:

2.1.1	4 ft (1219 mm) Diameter OGS Units:	1.19 m^3 sediment / 265 L oil
	6 ft (1829 mm) Diameter OGS Units:	3.48 m^3 sediment / 609 L oil
	8 ft (2438 mm) Diameter OGS Units:	8.78 m^3 sediment / 1,071 L oil
	10 ft (3048 mm) Diameter OGS Units:	17.78 m^3 sediment / 1,673 L oil
	12 ft (3657 mm) Diameter OGS Units:	31.23 m^3 sediment / 2,476 L oil

PART 3 – PERFORMANCE & DESIGN

3.1 GENERAL

The OGS stormwater quality treatment device shall be verified in accordance with ISO 14034:2016 Environmental management – Environmental technology verification (ETV). The OGS stormwater quality treatment device shall remove oil, sediment and gross pollutants from stormwater runoff during frequent wet weather events, and retain these pollutants during less frequent high flow wet weather events below the insert within the OGS for later removal during maintenance. The Manufacturer shall have at least ten (10) years of local experience, history and success in engineering design, manufacturing and production and supply of OGS stormwater quality treatment device systems, acceptable to the Engineer of Record.

3.2 SIZING METHODOLOGY

The OGS device shall be engineered, designed and sized to provide stormwater quality treatment based on treating a minimum of 90 percent of the average annual runoff volume and a minimum removal of an annual average 60% of the sediment (TSS) load based on the Particle Size Distribution (PSD) specified in the sizing report for the specified device. Sizing shall be determined using historical rainfall data and a sediment removal performance curve derived from the actual third-party verified laboratory testing data. The OGS device shall also have sufficient annual sediment storage capacity as specified and calculated in Section 2.1.

3.3 CANADIAN ETV or ISO 14034 ETV VERIFICATION OF SCOUR TESTING

The OGS device shall have Canadian ETV or ISO 14034 ETV Verification of third-party scour testing conducted in accordance with the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**

3.3.1 To be acceptable for on-line installation, the OGS device must demonstrate an average scour test effluent concentration less than 10 mg/L at each surface loading rate tested, up to and including 2600 L/min/m^2.

Stormceptor®

Stormceptor® EF Sizing Report

STORMCEPTOR®
ESTIMATED NET ANNUAL SEDIMENT (TSS) LOAD REDUCTION

11/13/2020

Province:	Ontario
City:	Oakville
Nearest Rainfall Station:	HAMILTON AP
NCDC Rainfall Station Id:	3195
Years of Rainfall Data:	34
Site Name:	Drainage Easement - West
Drainage Area (ha):	0.79
% Imperviousness:	53.00
Runoff Coefficient 'c':	0.61
Particle Size Distribution:	CA ETV
Target TSS Removal (%):	4.5
Required Water Quality Runoff Volume Capture (%):	90.00
Estimated Water Quality Flow Rate (L/s):	18.58
Oil / Fuel Spill Risk Site?	No
Upstream Flow Control?	No
Peak Conveyance (maximum) Flow Rate (L/s):	
Site Sediment Transport Rate (kg/ha/yr):	

Project Name:	Lakeshore Road Class EA
Project Number:	43762
Designer Name:	Gurkanwal Arora
Designer Company:	Wood Environment & Infrastructure
Designer Email:	gurkanwal.arora@woodplc.com
Designer Phone:	905-335-2353
EOR Name:	
EOR Company:	
EOR Email:	
EOR Phone:	

Net Annual Sediment (TSS) Load Reduction Sizing Summary

Stormceptor Model	TSS Removal Provided (%)
EF4	58
EF6	63
EF8	65
EF10	67
EF12	68

Recommended Stormceptor EF Model:	**EF4**
Estimated Net Annual Sediment (TSS) Load Reduction (%):	**58**
Water Quality Runoff Volume Capture (%):	**> 90**

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THIRD-PARTY TESTING AND VERIFICATION

►**Stormceptor® EF and Stormceptor® EFO** are the latest evolutions in the Stormceptor® oil-grit separator (OGS) technology series, and are designed to remove a wide variety of pollutants from stormwater and snowmelt runoff. These technologies have been third-party tested in accordance with the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators** and performance has been third-party verified in accordance with the **ISO 14034 Environmental Technology Verification (ETV)** protocol.

PERFORMANCE

►**Stormceptor® EF and EFO** remove stormwater pollutants through gravity separation and floatation, and feature a patent-pending design that generates positive removal of total suspended solids (TSS) throughout each storm event, including high-intensity storms. Captured pollutants include sediment, free oils, and sediment-bound pollutants such as nutrients, heavy metals, and petroleum hydrocarbons. Stormceptor is sized to remove a high level of TSS from the frequent rainfall events that contribute the vast majority of annual runoff volume and pollutant load. The technology incorporates an internal bypass to convey excessive stormwater flows from high-intensity storms through the device without resuspension and washout (scour) of previously captured pollutants. Proper routine maintenance ensures high pollutant removal performance and protection of downstream waterways.

PARTICLE SIZE DISTRIBUTION (PSD)

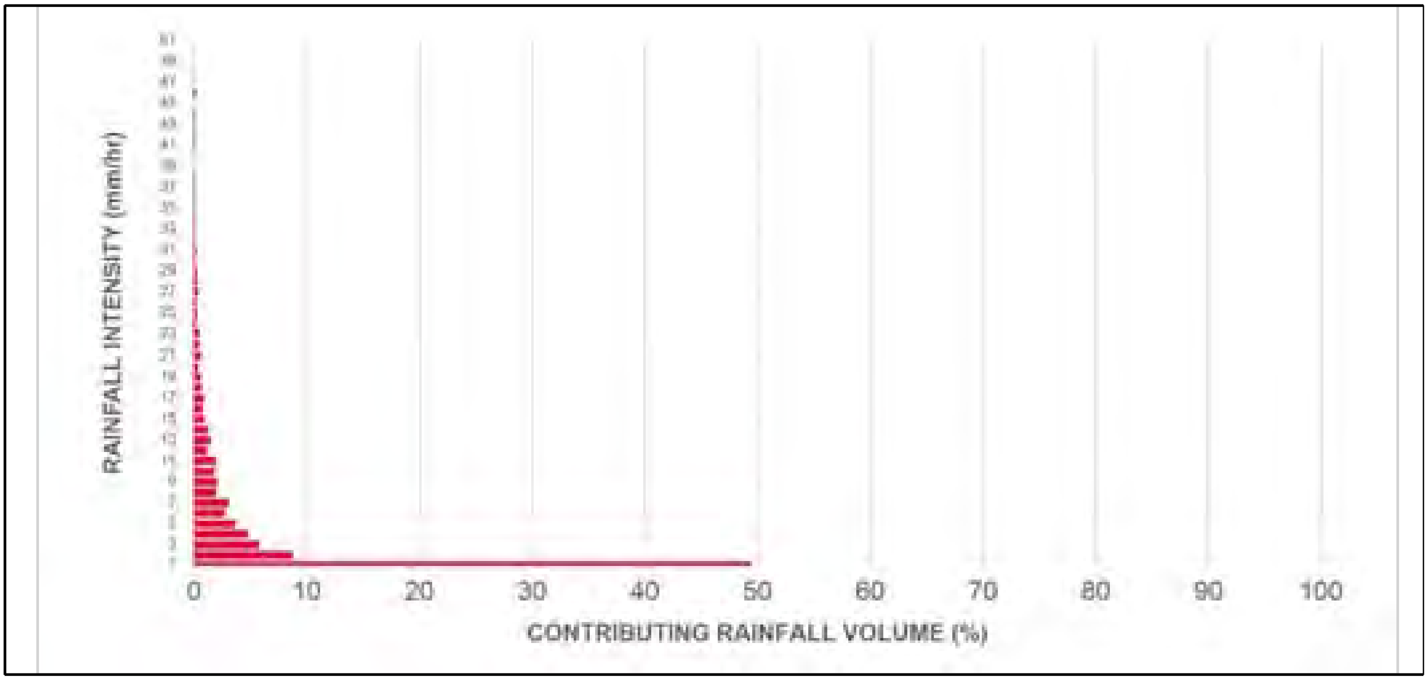
►The **Canadian ETV PSD** shown in the table below was used, or in part, for this sizing. This is the identical PSD that is referenced in the Canadian ETV ***Procedure for Laboratory Testing of Oil-Grit Separators*** for both sediment removal testing and scour testing. The Canadian ETV PSD contains a wide range of particle sizes in the sand and silt fractions, and is considered reasonably representative of the particle size fractions found in typical urban stormwater runoff.

Particle Size (µm)	Percent Less Than	Particle Size Fraction (µm)	Percent
1000	100	500-1000	5
500	95	250-500	5
250	90	150-250	15
150	75	100-150	15
100	60	75-100	10
75	50	50-75	5
50	45	20-50	10
20	35	8-20	15
8	20	5-8	10
5	10	2-5	5
2	5	<2	5

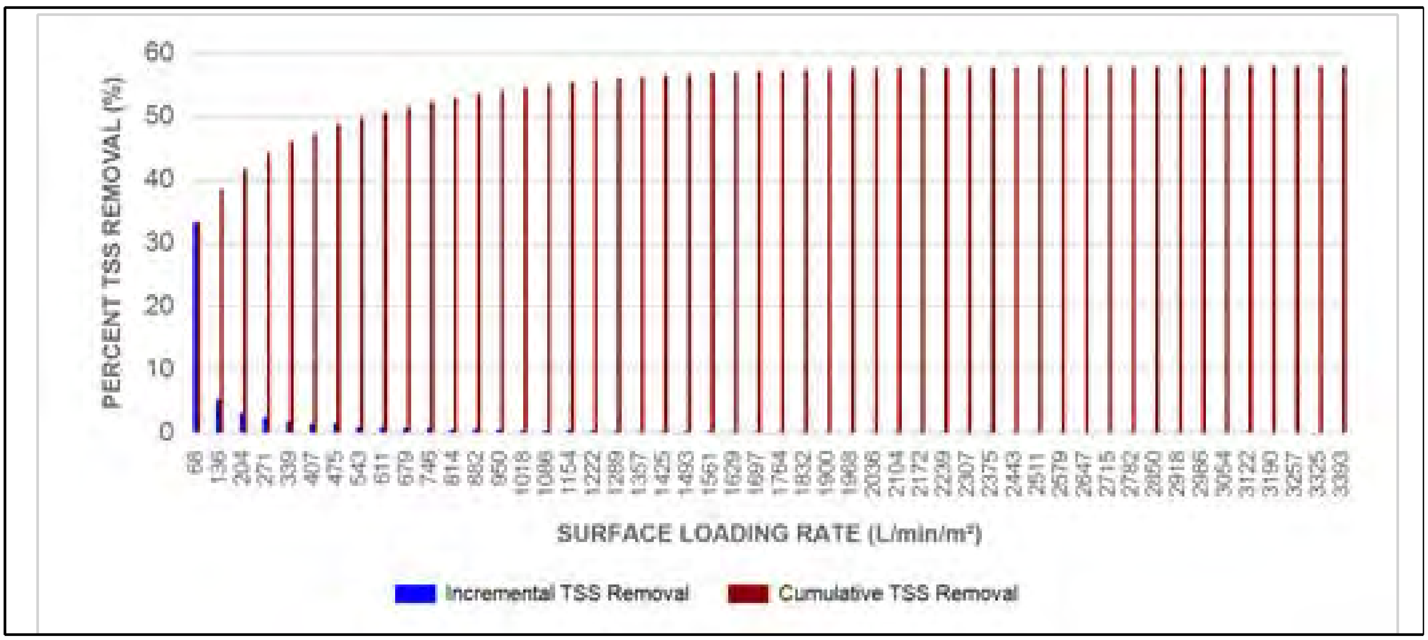
Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
1	49.5	49.5	1.36	81.0	68.0	67	33.3	33.3
2	8.8	58.3	2.71	163.0	136.0	60	5.3	38.5
3	5.8	64.1	4.07	244.0	204.0	54	3.1	41.7
4	4.8	68.9	5.43	326.0	271.0	52	2.5	44.2
5	3.7	72.6	6.79	407.0	339.0	50	1.8	46.0
6	2.8	75.4	8.14	489.0	407.0	48	1.3	47.3
7	3.1	78.5	9.50	570.0	475.0	47	1.5	48.8
8	2.0	80.5	10.86	651.0	543.0	47	0.9	49.7
9	2.1	82.6	12.22	733.0	611.0	46	1.0	50.7
10	1.8	84.4	13.57	814.0	679.0	46	0.8	51.5
11	2.0	86.4	14.93	896.0	746.0	45	0.9	52.4
12	1.2	87.6	16.29	977.0	814.0	45	0.5	53.0
13	1.5	89.1	17.64	1059.0	882.0	45	0.7	53.6
14	1.3	90.4	19.00	1140.0	950.0	44	0.6	54.2
15	0.9	91.3	20.36	1222.0	1018.0	44	0.4	54.6
16	0.8	92.1	21.72	1303.0	1086.0	45	0.4	55.0
17	0.9	93.0	23.07	1384.0	1154.0	46	0.4	55.4
18	0.7	93.7	24.43	1466.0	1222.0	47	0.3	55.7
19	0.6	94.3	25.79	1547.0	1289.0	48	0.3	56.0
20	0.4	94.7	27.15	1629.0	1357.0	48	0.2	56.2
21	0.6	95.3	28.50	1710.0	1425.0	48	0.3	56.5
22	0.5	95.8	29.86	1792.0	1493.0	46	0.2	56.7
23	0.5	96.3	31.22	1873.0	1561.0	44	0.2	56.9
24	0.2	96.5	32.57	1954.0	1629.0	42	0.1	57.0
25	0.3	96.8	33.93	2036.0	1697.0	41	0.1	57.1

Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
26	0.2	97.0	35.29	2117.0	1764.0	39	0.1	57.2
27	0.4	97.4	36.65	2199.0	1832.0	37	0.2	57.4
28	0.3	97.7	38.00	2280.0	1900.0	36	0.1	57.5
29	0.3	98.0	39.36	2362.0	1968.0	35	0.1	57.6
30	0.1	98.1	40.72	2443.0	2036.0	34	0.0	57.6
31	0.2	98.3	42.07	2524.0	2104.0	33	0.1	57.7
32	0.1	98.4	43.43	2606.0	2172.0	32	0.0	57.7
33	0.1	98.5	44.79	2687.0	2239.0	31	0.0	57.7
34	0.1	98.6	46.15	2769.0	2307.0	30	0.0	57.8
35	0.1	98.7	47.50	2850.0	2375.0	29	0.0	57.8
36	0.1	98.8	48.86	2932.0	2443.0	28	0.0	57.8
37	0.1	98.9	50.22	3013.0	2511.0	27	0.0	57.9
38	0.1	99.0	51.58	3095.0	2579.0	27	0.0	57.9
39	0.0	99.0	52.93	3176.0	2647.0	26	0.0	57.9
40	0.0	99.0	54.29	3257.0	2715.0	25	0.0	57.9
41	0.1	99.1	55.65	3339.0	2782.0	25	0.0	57.9
42	0.1	99.2	57.00	3420.0	2850.0	25	0.0	57.9
43	0.1	99.3	58.36	3502.0	2918.0	24	0.0	58.0
44	0.1	99.4	59.72	3583.0	2986.0	24	0.0	58.0
45	0.0	99.4	61.08	3665.0	3054.0	23	0.0	58.0
46	0.2	99.6	62.43	3746.0	3122.0	22	0.0	58.0
47	0.0	99.6	63.79	3827.0	3190.0	22	0.0	58.0
48	0.0	99.6	65.15	3909.0	3257.0	21	0.0	58.0
49	0.0	99.6	66.51	3990.0	3325.0	21	0.0	58.0
50	0.0	99.6	67.86	4072.0	3393.0	21	0.0	58.0
Estimated Net Annual Sediment (TSS) Load Reduction =								58 %

RAINFALL DATA FROM HAMILTON AP RAINFALL STATION



INCREMENTAL AND CUMULATIVE TSS REMOVAL FOR THE RECOMMENDED STORMCEPTOR® MODEL



Maximum Pipe Diameter / Peak Conveyance									
Stormceptor EF / EFO	Model Diameter		Min Angle Inlet / Outlet Pipes	Max Inlet Pipe Diameter		Max Outlet Pipe Diameter		Peak Conveyance Flow Rate	
	(m)	(ft)		(mm)	(in)	(mm)	(in)	(L/s)	(cfs)
EF4 / EFO4	1.2	4	90	609	24	609	24	425	15
EF6 / EFO6	1.8	6	90	914	36	914	36	990	35
EF8 / EFO8	2.4	8	90	1219	48	1219	48	1700	60
EF10 / EFO10	3.0	10	90	1828	72	1828	72	2830	100
EF12 / EFO12	3.6	12	90	1828	72	1828	72	2830	100

SCOUR PREVENTION AND ONLINE CONFIGURATION

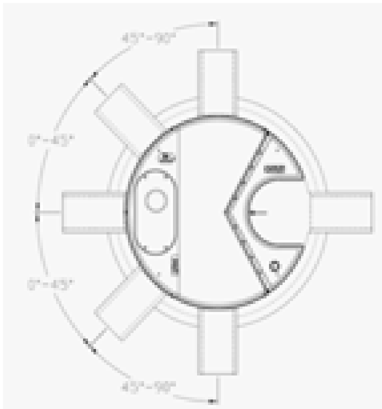
►**Stormceptor® EF and EFO** feature an internal bypass and superior scour prevention technology that have been demonstrated in third-party testing according to the scour testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**, and the exceptional scour test performance has been third-party verified in accordance with the ISO 14034 ETV protocol. As a result, Stormceptor EF and EFO are approved for online installation, eliminating the need for costly additional bypass structures, piping, and installation expense.

DESIGN FLEXIBILITY

►**Stormceptor® EF** and **EFO** offers design flexibility in one simplified platform, accepting stormwater flow from a single inlet pipe or multiple inlet pipes, and/or surface runoff through an inlet grate. The device can also serve as a junction structure, accommodate a 90-degree inlet-to-outlet bend angle, and can be modified to ensure performance in submerged conditions.

OIL CAPTURE AND RETENTION

►While Stormceptor® EF will capture and retain oil from dry weather spills and low intensity runoff, **Stormceptor® EFO** has demonstrated superior oil capture and greater than 99% oil retention in third-party testing according to the light liquid re-entrainment testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**. Stormceptor EFO is recommended for sites where oil capture and retention is a requirement.



INLET-TO-OUTLET DROP

Elevation differential between inlet and outlet pipe inverts is dictated by the angle at which the inlet pipe(s) enters the unit.

0° - 45° : The inlet pipe is 1-inch (25mm) higher than the outlet pipe.

45° - 90° : The inlet pipe is 2-inches (50mm) higher than the outlet pipe.

HEAD LOSS

The head loss through Stormceptor EF is similar to that of a 60-degree bend structure. The applicable K value for calculating minor losses through the unit is 1.1. For submerged conditions the applicable K value is 3.0.

Pollutant Capacity

Stormceptor EF / EFO	Model Diameter		Depth (Outlet Pipe Invert to Sump Floor)		Oil Volume		Recommended Sediment Maintenance Depth *		Maximum Sediment Volume *		Maximum Sediment Mass **	
	(m)	(ft)	(m)	(ft)	(L)	(Gal)	(mm)	(in)	(L)	(ft³)	(kg)	(lb)
EF4 / EFO4	1.2	4	1.52	5.0	265	70	203	8	1190	42	1904	5250
EF6 / EFO6	1.8	6	1.93	6.3	610	160	305	12	3470	123	5552	15375
EF8 / EFO8	2.4	8	2.59	8.5	1070	280	610	24	8780	310	14048	38750
EF10 / EFO10	3.0	10	3.25	10.7	1670	440	610	24	17790	628	28464	78500
EF12 / EFO12	3.6	12	3.89	12.8	2475	655	610	24	31220	1103	49952	137875

*Increased sump depth may be added to increase sediment storage capacity

** Average density of wet packed sediment in sump = 1.6 kg/L (100 lb/ft³)

Feature	Benefit	Feature Appeals To
Patent-pending enhanced flow treatment and scour prevention technology	Superior, verified third-party performance	Regulator, Specifying & Design Engineer
Third-party verified light liquid capture and retention for EFO version	Proven performance for fuel/oil hotspot locations	Regulator, Specifying & Design Engineer, Site Owner
Functions as bend, junction or inlet structure	Design flexibility	Specifying & Design Engineer
Minimal drop between inlet and outlet	Site installation ease	Contractor
Large diameter outlet riser for inspection and maintenance	Easy maintenance access from grade	Maintenance Contractor & Site Owner

STANDARD STORMCEPTOR EF/EFO DRAWINGS

For standard details, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

STANDARD STORMCEPTOR EF/EFO SPECIFICATION

For specifications, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

Table of TSS Removal vs Surface Loading Rate Based on Third-Party Test Results
Stormceptor® EF

SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL
1	70	660	46	1320	48	1980	35
30	70	690	46	1350	48	2010	34

60	67	720	45	1380	49	2040	34
90	63	750	45	1410	49	2070	33
120	61	780	45	1440	48	2100	33
150	58	810	45	1470	47	2130	32
180	56	840	45	1500	46	2160	32
210	54	870	45	1530	45	2190	31
240	53	900	45	1560	44	2220	31
270	52	930	44	1590	43	2250	30
300	51	960	44	1620	42	2280	30
330	50	990	44	1650	42	2310	30
360	49	1020	44	1680	41	2340	29
390	48	1050	45	1710	40	2370	29
420	48	1080	45	1740	39	2400	29
450	48	1110	45	1770	39	2430	28
480	47	1140	46	1800	38	2460	28
510	47	1170	46	1830	37	2490	28
540	47	1200	47	1860	37	2520	27
570	46	1230	47	1890	36	2550	27
600	46	1260	47	1920	36	2580	27
630	46	1290	48	1950	35		

STANDARD PERFORMANCE SPECIFICATION FOR
"OIL GRIT SEPARATOR" (OGS) STORMWATER QUALITY TREATMENT DEVICE

PART 1 – GENERAL

1.1 WORK INCLUDED

This section specifies requirements for selecting, sizing, and designing an underground Oil Grit Separator (OGS) device for stormwater quality treatment, with third-party testing results and a Statement of Verification in accordance with ISO 14034 Environmental Management – Environmental Technology Verification (ETV).

1.2 REFERENCE STANDARDS & PROCEDURES

ISO 14034:2016 Environmental management – Environmental technology verification (ETV)

Canadian Environmental Technology Verification (ETV) Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**

1.3 SUBMITTALS

1.3.1 All submittals, including sizing reports & shop drawings, shall be submitted upon request with each order to the contractor then forwarded to the Engineer of Record for review and acceptance. Shop drawings shall detail all OGS components, elevations, and sequence of construction.

1.3.2 Alternative devices shall have features identical to or greater than the specified device, including: treatment chamber diameter, treatment chamber wet volume, sediment storage volume, and oil storage volume.

1.3.3 Unless directed otherwise by the Engineer of Record, OGS stormwater quality treatment product substitutions or alternatives submitted within ten days prior to project bid shall not be accepted. All alternatives or substitutions submitted shall be signed and sealed by a local registered Professional Engineer, based on the exact same criteria detailed in Section 3, in entirety, subject to review and approval by the Engineer of Record.

PART 2 – PRODUCTS

2.1 OGS POLLUTANT STORAGE

The OGS device shall include a sump for sediment storage, and a protected volume for the capture and storage of petroleum hydrocarbons and buoyant gross pollutants. The **minimum** sediment & petroleum hydrocarbon storage capacity shall be as follows:

2.1.1	4 ft (1219 mm) Diameter OGS Units:	1.19 m^3 sediment / 265 L oil
	6 ft (1829 mm) Diameter OGS Units:	3.48 m^3 sediment / 609 L oil
	8 ft (2438 mm) Diameter OGS Units:	8.78 m^3 sediment / 1,071 L oil
	10 ft (3048 mm) Diameter OGS Units:	17.78 m^3 sediment / 1,673 L oil
	12 ft (3657 mm) Diameter OGS Units:	31.23 m^3 sediment / 2,476 L oil

PART 3 – PERFORMANCE & DESIGN

3.1 GENERAL

The OGS stormwater quality treatment device shall be verified in accordance with ISO 14034:2016 Environmental management – Environmental technology verification (ETV). The OGS stormwater quality treatment device shall remove oil, sediment and gross pollutants from stormwater runoff during frequent wet weather events, and retain these pollutants during less frequent high flow wet weather events below the insert within the OGS for later removal during maintenance. The Manufacturer shall have at least ten (10) years of local experience, history and success in engineering design, manufacturing and production and supply of OGS stormwater quality treatment device systems, acceptable to the Engineer of Record.

3.2 SIZING METHODOLOGY

The OGS device shall be engineered, designed and sized to provide stormwater quality treatment based on treating a minimum of 90 percent of the average annual runoff volume and a minimum removal of an annual average 60% of the sediment (TSS) load based on the Particle Size Distribution (PSD) specified in the sizing report for the specified device. Sizing shall be determined using historical rainfall data and a sediment removal performance curve derived from the actual third-party verified laboratory testing data. The OGS device shall also have sufficient annual sediment storage capacity as specified and calculated in Section 2.1.

3.3 CANADIAN ETV or ISO 14034 ETV VERIFICATION OF SCOUR TESTING

The OGS device shall have Canadian ETV or ISO 14034 ETV Verification of third-party scour testing conducted in accordance with the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**

3.3.1 To be acceptable for on-line installation, the OGS device must demonstrate an average scour test effluent concentration less than 10 mg/L at each surface loading rate tested, up to and including 2600 L/min/m^2.

Stormceptor®

Stormceptor® EF Sizing Report

STORMCEPTOR®
ESTIMATED NET ANNUAL SEDIMENT (TSS) LOAD REDUCTION

11/13/2020

Province:	Ontario
City:	Oakville
Nearest Rainfall Station:	HAMILTON AP
NCDC Rainfall Station Id:	3195
Years of Rainfall Data:	34
Site Name:	Drainage Easement - East
Drainage Area (ha):	2.99
% Imperviousness:	48.00
Runoff Coefficient 'c':	0.58
Particle Size Distribution:	CA ETV
Target TSS Removal (%):	3.1
Required Water Quality Runoff Volume Capture (%):	90.00
Estimated Water Quality Flow Rate (L/s):	66.92
Oil / Fuel Spill Risk Site?	No
Upstream Flow Control?	No
Peak Conveyance (maximum) Flow Rate (L/s):	
Site Sediment Transport Rate (kg/ha/yr):	

Project Name:	Lakeshore Road Class EA
Project Number:	43762
Designer Name:	Gurkanwal Arora
Designer Company:	Wood Environment & Infrastructure
Designer Email:	gurkanwal.arora@woodplc.com
Designer Phone:	905-335-2353
EOR Name:	
EOR Company:	
EOR Email:	
EOR Phone:	

Net Annual Sediment (TSS) Load Reduction Sizing Summary

Stormceptor Model	TSS Removal Provided (%)
EF4	44
EF6	53
EF8	58
EF10	62
EF12	63

Recommended Stormceptor EF Model:	**EF4**
Estimated Net Annual Sediment (TSS) Load Reduction (%):	**44**
Water Quality Runoff Volume Capture (%):	**> 90**

imbrium

THIRD-PARTY TESTING AND VERIFICATION

►**Stormceptor® EF and Stormceptor® EFO** are the latest evolutions in the Stormceptor® oil-grit separator (OGS) technology series, and are designed to remove a wide variety of pollutants from stormwater and snowmelt runoff. These technologies have been third-party tested in accordance with the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators** and performance has been third-party verified in accordance with the **ISO 14034 Environmental Technology Verification (ETV)** protocol.

PERFORMANCE

►**Stormceptor® EF and EFO** remove stormwater pollutants through gravity separation and floatation, and feature a patent-pending design that generates positive removal of total suspended solids (TSS) throughout each storm event, including high-intensity storms. Captured pollutants include sediment, free oils, and sediment-bound pollutants such as nutrients, heavy metals, and petroleum hydrocarbons. Stormceptor is sized to remove a high level of TSS from the frequent rainfall events that contribute the vast majority of annual runoff volume and pollutant load. The technology incorporates an internal bypass to convey excessive stormwater flows from high-intensity storms through the device without resuspension and washout (scour) of previously captured pollutants. Proper routine maintenance ensures high pollutant removal performance and protection of downstream waterways.

PARTICLE SIZE DISTRIBUTION (PSD)

►The **Canadian ETV PSD** shown in the table below was used, or in part, for this sizing. This is the identical PSD that is referenced in the Canadian ETV ***Procedure for Laboratory Testing of Oil-Grit Separators*** for both sediment removal testing and scour testing. The Canadian ETV PSD contains a wide range of particle sizes in the sand and silt fractions, and is considered reasonably representative of the particle size fractions found in typical urban stormwater runoff.

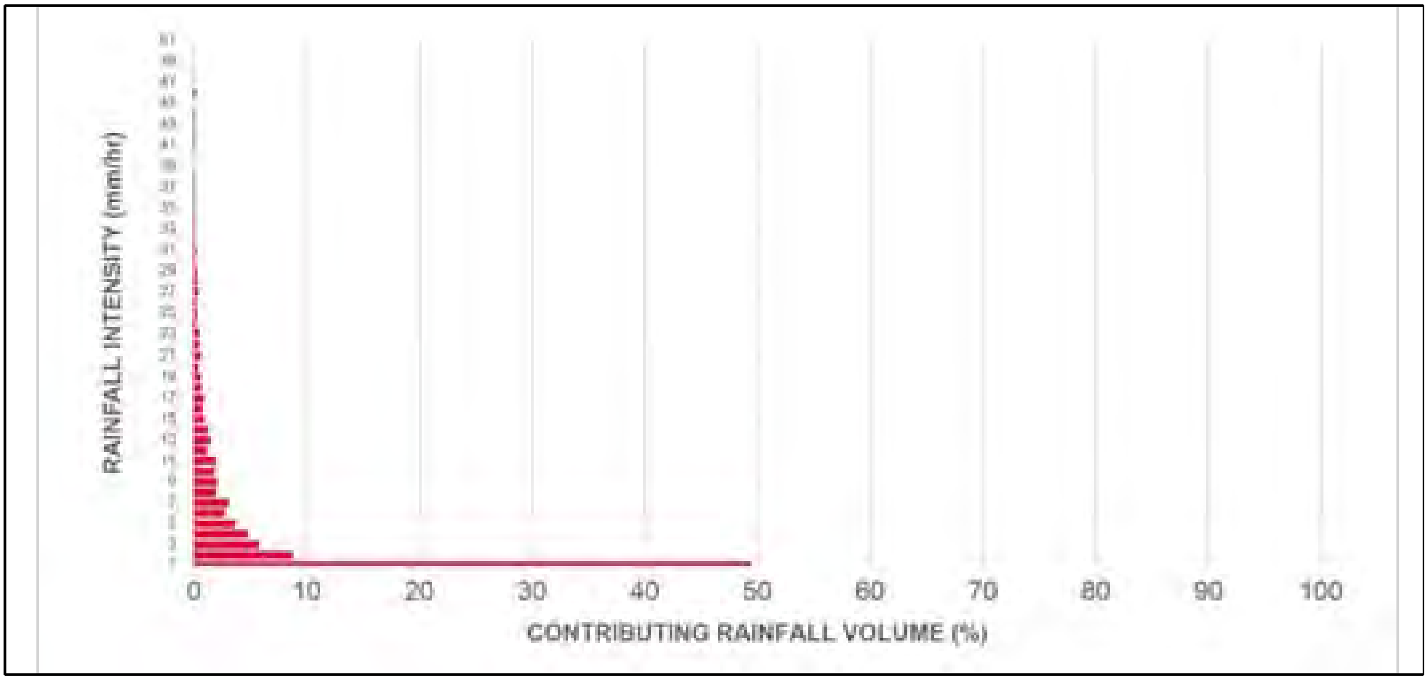
Particle Size (µm)	Percent Less Than	Particle Size Fraction (µm)	Percent
1000	100	500-1000	5
500	95	250-500	5
250	90	150-250	15
150	75	100-150	15
100	60	75-100	10
75	50	50-75	5
50	45	20-50	10
20	35	8-20	15
8	20	5-8	10
5	10	2-5	5
2	5	<2	5

Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
1	49.5	49.5	4.89	293.0	244.0	53	26.1	26.1
2	8.8	58.3	9.78	587.0	489.0	47	4.2	30.3
3	5.8	64.1	14.66	880.0	733.0	45	2.6	32.9
4	4.8	68.9	19.55	1173.0	978.0	44	2.1	35.0
5	3.7	72.6	24.44	1466.0	1222.0	47	1.7	36.8
6	2.8	75.4	29.33	1760.0	1466.0	47	1.3	38.1
7	3.1	78.5	34.21	2053.0	1711.0	40	1.2	39.3
8	2.0	80.5	39.10	2346.0	1955.0	35	0.7	40.0
9	2.1	82.6	43.99	2639.0	2199.0	31	0.7	40.7
10	1.8	84.4	48.88	2933.0	2444.0	28	0.5	41.2
11	2.0	86.4	53.76	3226.0	2688.0	26	0.5	41.7
12	1.2	87.6	58.65	3519.0	2933.0	24	0.3	42.0
13	1.5	89.1	63.54	3812.0	3177.0	22	0.3	42.3
14	1.3	90.4	68.43	4106.0	3421.0	20	0.3	42.6
15	0.9	91.3	73.31	4399.0	3666.0	19	0.2	42.8
16	0.8	92.1	78.20	4692.0	3910.0	18	0.1	42.9
17	0.9	93.0	83.09	4985.0	4154.0	17	0.2	43.1
18	0.7	93.7	87.98	5279.0	4399.0	16	0.1	43.2
19	0.6	94.3	92.86	5572.0	4643.0	15	0.1	43.3
20	0.4	94.7	97.75	5865.0	4888.0	14	0.1	43.3
21	0.6	95.3	102.64	6158.0	5132.0	13	0.1	43.4
22	0.5	95.8	107.53	6452.0	5376.0	13	0.1	43.5
23	0.5	96.3	112.41	6745.0	5621.0	12	0.1	43.5
24	0.2	96.5	117.30	7038.0	5865.0	12	0.0	43.5
25	0.3	96.8	122.19	7331.0	6109.0	11	0.0	43.6

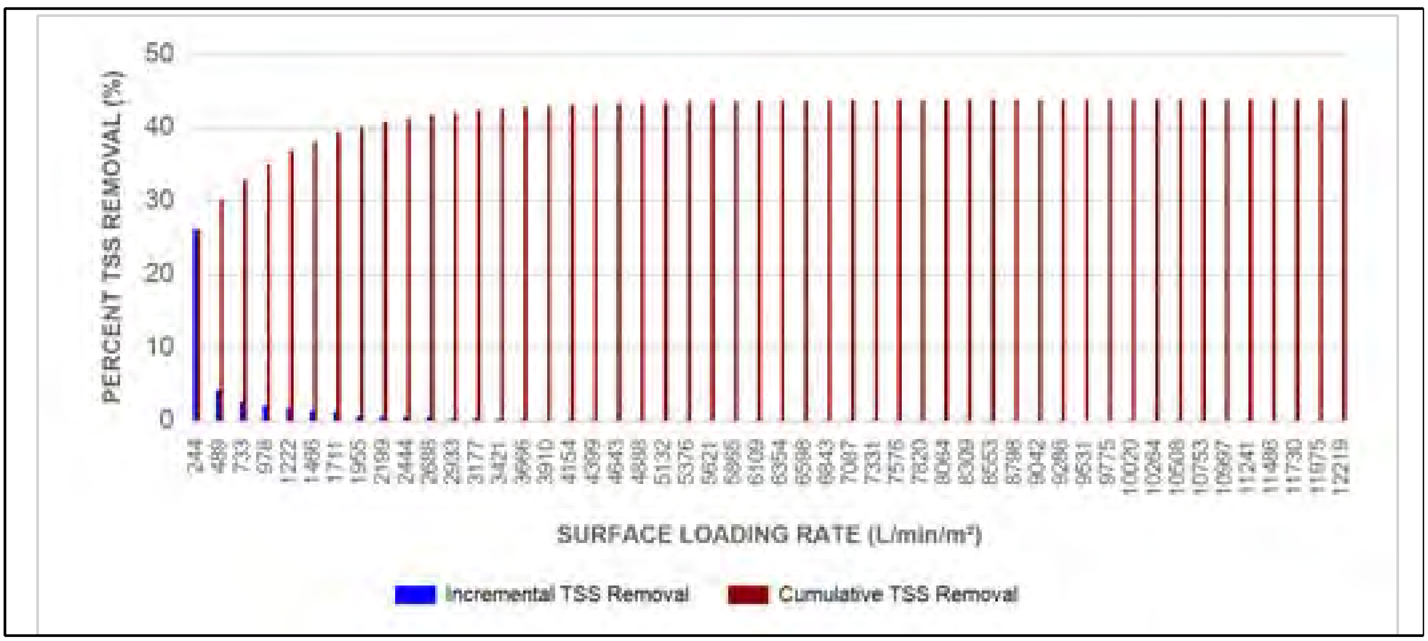
Stormceptor® EF Sizing Report

Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
26	0.2	97.0	127.08	7625.0	6354.0	11	0.0	43.6
27	0.4	97.4	131.96	7918.0	6598.0	11	0.0	43.6
28	0.3	97.7	136.85	8211.0	6843.0	10	0.0	43.7
29	0.3	98.0	141.74	8504.0	7087.0	10	0.0	43.7
30	0.1	98.1	146.63	8798.0	7331.0	9	0.0	43.7
31	0.2	98.3	151.51	9091.0	7576.0	9	0.0	43.7
32	0.1	98.4	156.40	9384.0	7820.0	9	0.0	43.7
33	0.1	98.5	161.29	9677.0	8064.0	9	0.0	43.8
34	0.1	98.6	166.18	9971.0	8309.0	8	0.0	43.8
35	0.1	98.7	171.07	10264.0	8553.0	8	0.0	43.8
36	0.1	98.8	175.95	10557.0	8798.0	8	0.0	43.8
37	0.1	98.9	180.84	10850.0	9042.0	8	0.0	43.8
38	0.1	99.0	185.73	11144.0	9286.0	7	0.0	43.8
39	0.0	99.0	190.62	11437.0	9531.0	7	0.0	43.8
40	0.0	99.0	195.50	11730.0	9775.0	7	0.0	43.8
41	0.1	99.1	200.39	12023.0	10020.0	7	0.0	43.8
42	0.1	99.2	205.28	12317.0	10264.0	7	0.0	43.8
43	0.1	99.3	210.17	12610.0	10508.0	7	0.0	43.8
44	0.1	99.4	215.05	12903.0	10753.0	7	0.0	43.8
45	0.0	99.4	219.94	13196.0	10997.0	7	0.0	43.8
46	0.2	99.6	224.83	13490.0	11241.0	7	0.0	43.8
47	0.0	99.6	229.72	13783.0	11486.0	7	0.0	43.8
48	0.0	99.6	234.60	14076.0	11730.0	7	0.0	43.8
49	0.0	99.6	239.49	14369.0	11975.0	7	0.0	43.8
50	0.0	99.6	244.38	14663.0	12219.0	7	0.0	43.8
Estimated Net Annual Sediment (TSS) Load Reduction =								**44 %**

RAINFALL DATA FROM HAMILTON AP RAINFALL STATION



INCREMENTAL AND CUMULATIVE TSS REMOVAL
FOR THE RECOMMENDED STORMCEPTOR® MODEL



Maximum Pipe Diameter / Peak Conveyance

Stormceptor EF / EFO	Model Diameter		Min Angle Inlet / Outlet Pipes	Max Inlet Pipe Diameter		Max Outlet Pipe Diameter		Peak Conveyance Flow Rate	
	(m)	(ft)		(mm)	(in)	(mm)	(in)	(L/s)	(cfs)
EF4 / EFO4	1.2	4	90	609	24	609	24	425	15
EF6 / EFO6	1.8	6	90	914	36	914	36	990	35
EF8 / EFO8	2.4	8	90	1219	48	1219	48	1700	60
EF10 / EFO10	3.0	10	90	1828	72	1828	72	2830	100
EF12 / EFO12	3.6	12	90	1828	72	1828	72	2830	100

SCOUR PREVENTION AND ONLINE CONFIGURATION

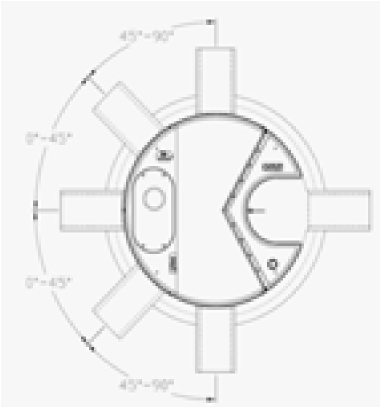
►**Stormceptor® EF and EFO** feature an internal bypass and superior scour prevention technology that have been demonstrated in third-party testing according to the scour testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**, and the exceptional scour test performance has been third-party verified in accordance with the ISO 14034 ETV protocol. As a result, Stormceptor EF and EFO are approved for online installation, eliminating the need for costly additional bypass structures, piping, and installation expense.

DESIGN FLEXIBILITY

►**Stormceptor® EF** and **EFO** offers design flexibility in one simplified platform, accepting stormwater flow from a single inlet pipe or multiple inlet pipes, and/or surface runoff through an inlet grate. The device can also serve as a junction structure, accommodate a 90-degree inlet-to-outlet bend angle, and can be modified to ensure performance in submerged conditions.

OIL CAPTURE AND RETENTION

►While Stormceptor® EF will capture and retain oil from dry weather spills and low intensity runoff, **Stormceptor® EFO** has demonstrated superior oil capture and greater than 99% oil retention in third-party testing according to the light liquid re-entrainment testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**. Stormceptor EFO is recommended for sites where oil capture and retention is a requirement.



INLET-TO-OUTLET DROP

Elevation differential between inlet and outlet pipe inverts is dictated by the angle at which the inlet pipe(s) enters the unit.

0° - 45° : The inlet pipe is 1-inch (25mm) higher than the outlet pipe.

45° - 90° : The inlet pipe is 2-inches (50mm) higher than the outlet pipe.

HEAD LOSS

The head loss through Stormceptor EF is similar to that of a 60-degree bend structure. The applicable K value for calculating minor losses through the unit is 1.1. For submerged conditions the applicable K value is 3.0.

Pollutant Capacity

Stormceptor EF / EFO	Model Diameter		Depth (Outlet Pipe Invert to Sump Floor)		Oil Volume		Recommended Sediment Maintenance Depth *		Maximum Sediment Volume *		Maximum Sediment Mass **	
	(m)	(ft)	(m)	(ft)	(L)	(Gal)	(mm)	(in)	(L)	(ft^3)	(kg)	(lb)
EF4 / EFO4	1.2	4	1.52	5.0	265	70	203	8	1190	42	1904	5250
EF6 / EFO6	1.8	6	1.93	6.3	610	160	305	12	3470	123	5552	15375
EF8 / EFO8	2.4	8	2.59	8.5	1070	280	610	24	8780	310	14048	38750
EF10 / EFO10	3.0	10	3.25	10.7	1670	440	610	24	17790	628	28464	78500
EF12 / EFO12	3.6	12	3.89	12.8	2475	655	610	24	31220	1103	49952	137875

*Increased sump depth may be added to increase sediment storage capacity

** Average density of wet packed sediment in sump = 1.6 kg/L (100 lb/ft^3)

Feature	Benefit	Feature Appeals To
Patent-pending enhanced flow treatment and scour prevention technology	Superior, verified third-party performance	Regulator, Specifying & Design Engineer
Third-party verified light liquid capture and retention for EFO version	Proven performance for fuel/oil hotspot locations	Regulator, Specifying & Design Engineer, Site Owner
Functions as bend, junction or inlet structure	Design flexibility	Specifying & Design Engineer
Minimal drop between inlet and outlet	Site installation ease	Contractor
Large diameter outlet riser for inspection and maintenance	Easy maintenance access from grade	Maintenance Contractor & Site Owner

STANDARD STORMCEPTOR EF/EFO DRAWINGS

For standard details, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

STANDARD STORMCEPTOR EF/EFO SPECIFICATION

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Table of TSS Removal vs Surface Loading Rate Based on Third-Party Test Results

Stormceptor® EF

SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL
1	70	660	46	1320	48	1980	35
30	70	690	46	1350	48	2010	34

60	67	720	45	1380	49	2040	34
90	63	750	45	1410	49	2070	33
120	61	780	45	1440	48	2100	33
150	58	810	45	1470	47	2130	32
180	56	840	45	1500	46	2160	32
210	54	870	45	1530	45	2190	31
240	53	900	45	1560	44	2220	31
270	52	930	44	1590	43	2250	30
300	51	960	44	1620	42	2280	30
330	50	990	44	1650	42	2310	30
360	49	1020	44	1680	41	2340	29
390	48	1050	45	1710	40	2370	29
420	48	1080	45	1740	39	2400	29
450	48	1110	45	1770	39	2430	28
480	47	1140	46	1800	38	2460	28
510	47	1170	46	1830	37	2490	28
540	47	1200	47	1860	37	2520	27
570	46	1230	47	1890	36	2550	27
600	46	1260	47	1920	36	2580	27
630	46	1290	48	1950	35		

STANDARD PERFORMANCE SPECIFICATION FOR
"OIL GRIT SEPARATOR" (OGS) STORMWATER QUALITY TREATMENT DEVICE

PART 1 – GENERAL

1.1 WORK INCLUDED

This section specifies requirements for selecting, sizing, and designing an underground Oil Grit Separator (OGS) device for stormwater quality treatment, with third-party testing results and a Statement of Verification in accordance with ISO 14034 Environmental Management – Environmental Technology Verification (ETV).

1.2 REFERENCE STANDARDS & PROCEDURES

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1.3 SUBMITTALS

1.3.1 All submittals, including sizing reports & shop drawings, shall be submitted upon request with each order to the contractor then forwarded to the Engineer of Record for review and acceptance. Shop drawings shall detail all OGS components, elevations, and sequence of construction.

1.3.2 Alternative devices shall have features identical to or greater than the specified device, including: treatment chamber diameter, treatment chamber wet volume, sediment storage volume, and oil storage volume.

1.3.3 Unless directed otherwise by the Engineer of Record, OGS stormwater quality treatment product substitutions or alternatives submitted within ten days prior to project bid shall not be accepted. All alternatives or substitutions submitted shall be signed and sealed by a local registered Professional Engineer, based on the exact same criteria detailed in Section 3, in entirety, subject to review and approval by the Engineer of Record.

PART 2 – PRODUCTS

2.1 OGS POLLUTANT STORAGE

The OGS device shall include a sump for sediment storage, and a protected volume for the capture and storage of petroleum hydrocarbons and buoyant gross pollutants. The **minimum** sediment & petroleum hydrocarbon storage capacity shall be as follows:

2.1.1	4 ft (1219 mm) Diameter OGS Units:	1.19 m^3 sediment / 265 L oil
	6 ft (1829 mm) Diameter OGS Units:	3.48 m^3 sediment / 609 L oil
	8 ft (2438 mm) Diameter OGS Units:	8.78 m^3 sediment / 1,071 L oil
	10 ft (3048 mm) Diameter OGS Units:	17.78 m^3 sediment / 1,673 L oil
	12 ft (3657 mm) Diameter OGS Units:	31.23 m^3 sediment / 2,476 L oil

PART 3 – PERFORMANCE & DESIGN

3.1 GENERAL

The OGS stormwater quality treatment device shall be verified in accordance with ISO 14034:2016 Environmental management – Environmental technology verification (ETV). The OGS stormwater quality treatment device shall remove oil, sediment and gross pollutants from stormwater runoff during frequent wet weather events, and retain these pollutants during less frequent high flow wet weather events below the insert within the OGS for later removal during maintenance. The Manufacturer shall have at least ten (10) years of local experience, history and success in engineering design, manufacturing and production and supply of OGS stormwater quality treatment device systems, acceptable to the Engineer of Record.

3.2 SIZING METHODOLOGY

The OGS device shall be engineered, designed and sized to provide stormwater quality treatment based on treating a minimum of 90 percent of the average annual runoff volume and a minimum removal of an annual average 60% of the sediment (TSS) load based on the Particle Size Distribution (PSD) specified in the sizing report for the specified device. Sizing shall be determined using historical rainfall data and a sediment removal performance curve derived from the actual third-party verified laboratory testing data. The OGS device shall also have sufficient annual sediment storage capacity as specified and calculated in Section 2.1.

3.3 CANADIAN ETV or ISO 14034 ETV VERIFICATION OF SCOUR TESTING

The OGS device shall have Canadian ETV or ISO 14034 ETV Verification of third-party scour testing conducted in accordance with the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**

3.3.1 To be acceptable for on-line installation, the OGS device must demonstrate an average scour test effluent concentration less than 10 mg/L at each surface loading rate tested, up to and including 2600 L/min/m^2.

Stormceptor®

Stormceptor® EF Sizing Report

STORMCEPTOR®
ESTIMATED NET ANNUAL SEDIMENT (TSS) LOAD REDUCTION

11/13/2020

Province:	Ontario
City:	Oakville
Nearest Rainfall Station:	HAMILTON AP
NCDC Rainfall Station Id:	3195
Years of Rainfall Data:	34

Project Name:	Lakeshore Road Class EA
Project Number:	43762
Designer Name:	Gurkanwal Arora
Designer Company:	Wood Environment & Infrastructure
Designer Email:	gurkanwal.arora@woodplc.com
Designer Phone:	905-335-2353
EOR Name:	
EOR Company:	
EOR Email:	
EOR Phone:	

Site Name:	14 Mile Creek - East

Drainage Area (ha):	3.62
% Imperviousness:	55.00

Runoff Coefficient 'c': 0.63

Particle Size Distribution:	CA ETV
Target TSS Removal (%):	2.4

Required Water Quality Runoff Volume Capture (%):	90.00
Estimated Water Quality Flow Rate (L/s):	86.81
Oil / Fuel Spill Risk Site?	No
Upstream Flow Control?	No
Peak Conveyance (maximum) Flow Rate (L/s):	
Site Sediment Transport Rate (kg/ha/yr):	

Net Annual Sediment (TSS) Load Reduction Sizing Summary

Stormceptor Model	TSS Removal Provided (%)
EF4	41
EF6	50
EF8	56
EF10	60
EF12	62

Recommended Stormceptor EF Model: EF4

Estimated Net Annual Sediment (TSS) Load Reduction (%): 41

Water Quality Runoff Volume Capture (%): > 90

THIRD-PARTY TESTING AND VERIFICATION

►**Stormceptor® EF and Stormceptor® EFO** are the latest evolutions in the Stormceptor® oil-grit separator (OGS) technology series, and are designed to remove a wide variety of pollutants from stormwater and snowmelt runoff. These technologies have been third-party tested in accordance with the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators** and performance has been third-party verified in accordance with the **ISO 14034 Environmental Technology Verification (ETV)** protocol.

PERFORMANCE

►**Stormceptor® EF and EFO** remove stormwater pollutants through gravity separation and floatation, and feature a patent-pending design that generates positive removal of total suspended solids (TSS) throughout each storm event, including high-intensity storms. Captured pollutants include sediment, free oils, and sediment-bound pollutants such as nutrients, heavy metals, and petroleum hydrocarbons. Stormceptor is sized to remove a high level of TSS from the frequent rainfall events that contribute the vast majority of annual runoff volume and pollutant load. The technology incorporates an internal bypass to convey excessive stormwater flows from high-intensity storms through the device without resuspension and washout (scour) of previously captured pollutants. Proper routine maintenance ensures high pollutant removal performance and protection of downstream waterways.

PARTICLE SIZE DISTRIBUTION (PSD)

►The **Canadian ETV PSD** shown in the table below was used, or in part, for this sizing. This is the identical PSD that is referenced in the Canadian ETV ***Procedure for Laboratory Testing of Oil-Grit Separators*** for both sediment removal testing and scour testing. The Canadian ETV PSD contains a wide range of particle sizes in the sand and silt fractions, and is considered reasonably representative of the particle size fractions found in typical urban stormwater runoff.

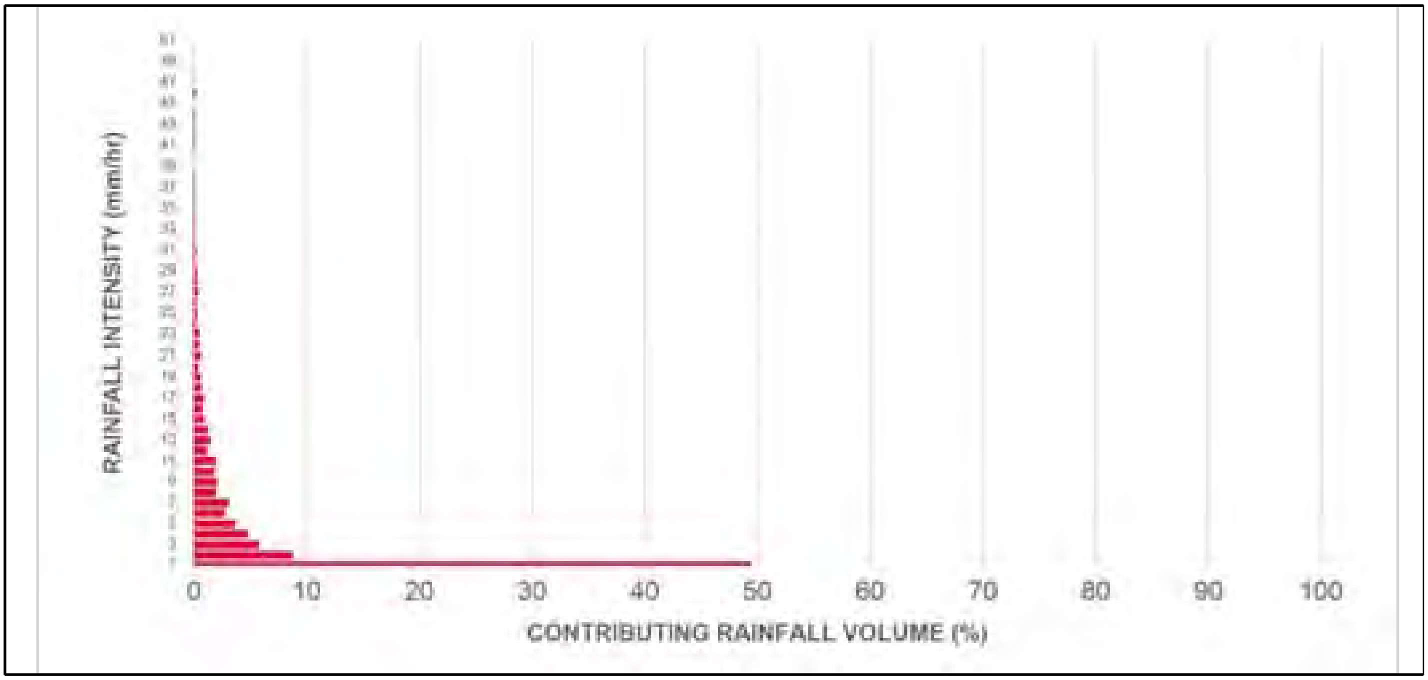
Particle Size (µm)	Percent Less Than	Particle Size Fraction (µm)	Percent
1000	100	500-1000	5
500	95	250-500	5
250	90	150-250	15
150	75	100-150	15
100	60	75-100	10
75	50	50-75	5
50	45	20-50	10
20	35	8-20	15
8	20	5-8	10
5	10	2-5	5
2	5	<2	5

Stormceptor® EF Sizing Report

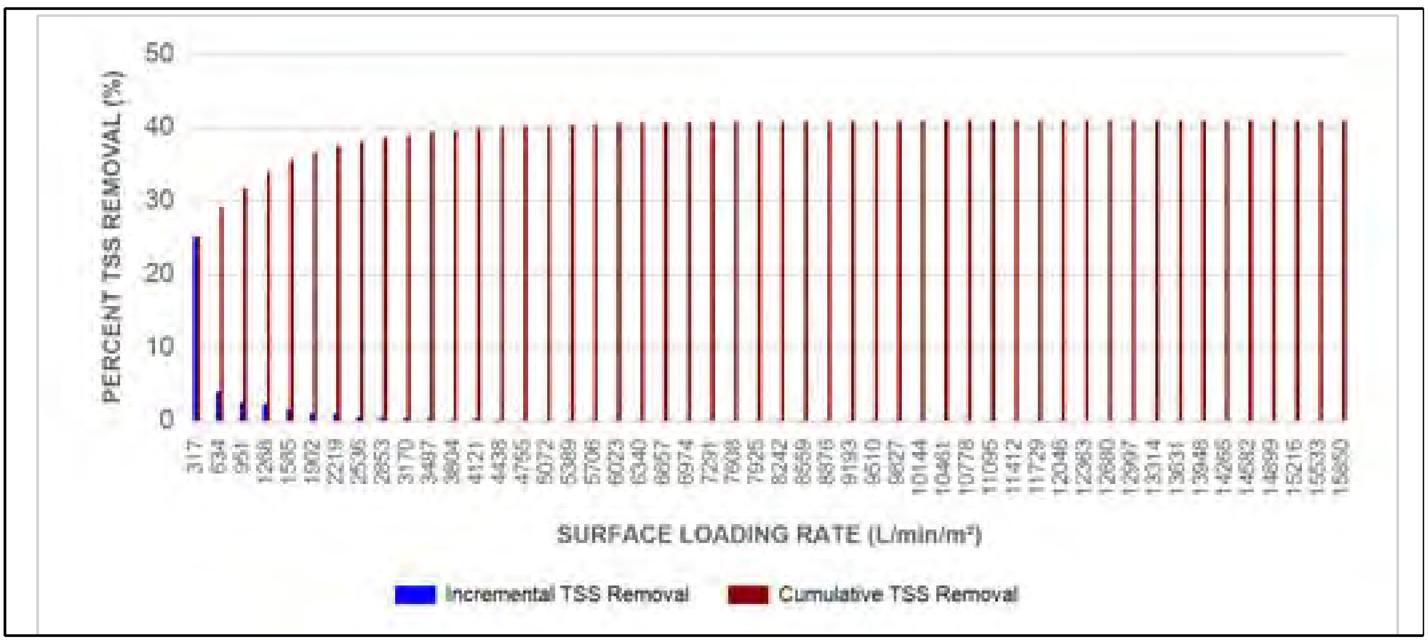
Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
1	49.5	49.5	6.34	380.0	317.0	51	25.1	25.1
2	8.8	58.3	12.68	761.0	634.0	46	4.0	29.1
3	5.8	64.1	19.02	1141.0	951.0	44	2.6	31.7
4	4.8	68.9	25.36	1522.0	1268.0	47	2.3	34.0
5	3.7	72.6	31.70	1902.0	1585.0	43	1.6	35.6
6	2.8	75.4	38.04	2282.0	1902.0	36	1.0	36.6
7	3.1	78.5	44.38	2663.0	2219.0	31	1.0	37.5
8	2.0	80.5	50.72	3043.0	2536.0	27	0.5	38.1
9	2.1	82.6	57.06	3424.0	2853.0	25	0.5	38.6
10	1.8	84.4	63.40	3804.0	3170.0	22	0.4	39.0
11	2.0	86.4	69.74	4184.0	3487.0	20	0.4	39.4
12	1.2	87.6	76.08	4565.0	3804.0	18	0.2	39.6
13	1.5	89.1	82.42	4945.0	4121.0	17	0.3	39.9
14	1.3	90.4	88.76	5326.0	4438.0	16	0.2	40.1
15	0.9	91.3	95.10	5706.0	4755.0	15	0.1	40.2
16	0.8	92.1	101.44	6086.0	5072.0	14	0.1	40.3
17	0.9	93.0	107.78	6467.0	5389.0	13	0.1	40.4
18	0.7	93.7	114.12	6847.0	5706.0	12	0.1	40.5
19	0.6	94.3	120.46	7228.0	6023.0	11	0.1	40.6
20	0.4	94.7	126.80	7608.0	6340.0	11	0.0	40.6
21	0.6	95.3	133.14	7988.0	6657.0	10	0.1	40.7
22	0.5	95.8	139.48	8369.0	6974.0	10	0.1	40.7
23	0.5	96.3	145.82	8749.0	7291.0	10	0.0	40.8
24	0.2	96.5	152.16	9130.0	7608.0	9	0.0	40.8
25	0.3	96.8	158.50	9510.0	7925.0	9	0.0	40.8

Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
26	0.2	97.0	164.84	9891.0	8242.0	8	0.0	40.8
27	0.4	97.4	171.18	10271.0	8559.0	8	0.0	40.9
28	0.3	97.7	177.52	10651.0	8876.0	8	0.0	40.9
29	0.3	98.0	183.86	11032.0	9193.0	8	0.0	40.9
30	0.1	98.1	190.20	11412.0	9510.0	7	0.0	40.9
31	0.2	98.3	196.54	11793.0	9827.0	7	0.0	40.9
32	0.1	98.4	202.88	12173.0	10144.0	7	0.0	41.0
33	0.1	98.5	209.22	12553.0	10461.0	7	0.0	41.0
34	0.1	98.6	215.56	12934.0	10778.0	7	0.0	41.0
35	0.1	98.7	221.90	13314.0	11095.0	7	0.0	41.0
36	0.1	98.8	228.24	13695.0	11412.0	7	0.0	41.0
37	0.1	98.9	234.58	14075.0	11729.0	7	0.0	41.0
38	0.1	99.0	240.92	14455.0	12046.0	7	0.0	41.0
39	0.0	99.0	247.26	14836.0	12363.0	7	0.0	41.0
40	0.0	99.0	253.60	15216.0	12680.0	7	0.0	41.0
41	0.1	99.1	259.94	15597.0	12997.0	7	0.0	41.0
42	0.1	99.2	266.28	15977.0	13314.0	7	0.0	41.0
43	0.1	99.3	272.62	16357.0	13631.0	7	0.0	41.0
44	0.1	99.4	278.96	16738.0	13948.0	7	0.0	41.0
45	0.0	99.4	285.30	17118.0	14265.0	7	0.0	41.0
46	0.2	99.6	291.64	17499.0	14582.0	7	0.0	41.0
47	0.0	99.6	297.98	17879.0	14899.0	7	0.0	41.0
48	0.0	99.6	304.32	18259.0	15216.0	7	0.0	41.0
49	0.0	99.6	310.66	18640.0	15533.0	7	0.0	41.0
50	0.0	99.6	317.00	19020.0	15850.0	7	0.0	41.0
Estimated Net Annual Sediment (TSS) Load Reduction =								**41 %**

RAINFALL DATA FROM HAMILTON AP RAINFALL STATION



INCREMENTAL AND CUMULATIVE TSS REMOVAL
FOR THE RECOMMENDED STORMCEPTOR® MODEL



Maximum Pipe Diameter / Peak Conveyance

Stormceptor EF / EFO	Model Diameter		Min Angle Inlet / Outlet Pipes	Max Inlet Pipe Diameter		Max Outlet Pipe Diameter		Peak Conveyance Flow Rate	
	(m)	(ft)		(mm)	(in)	(mm)	(in)	(L/s)	(cfs)
EF4 / EFO4	1.2	4	90	609	24	609	24	425	15
EF6 / EFO6	1.8	6	90	914	36	914	36	990	35
EF8 / EFO8	2.4	8	90	1219	48	1219	48	1700	60
EF10 / EFO10	3.0	10	90	1828	72	1828	72	2830	100
EF12 / EFO12	3.6	12	90	1828	72	1828	72	2830	100

SCOUR PREVENTION AND ONLINE CONFIGURATION

►**Stormceptor® EF and EFO** feature an internal bypass and superior scour prevention technology that have been demonstrated in third-party testing according to the scour testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**, and the exceptional scour test performance has been third-party verified in accordance with the ISO 14034 ETV protocol. As a result, Stormceptor EF and EFO are approved for online installation, eliminating the need for costly additional bypass structures, piping, and installation expense.

DESIGN FLEXIBILITY

►**Stormceptor® EF** and **EFO** offers design flexibility in one simplified platform, accepting stormwater flow from a single inlet pipe or multiple inlet pipes, and/or surface runoff through an inlet grate. The device can also serve as a junction structure, accommodate a 90-degree inlet-to-outlet bend angle, and can be modified to ensure performance in submerged conditions.

OIL CAPTURE AND RETENTION

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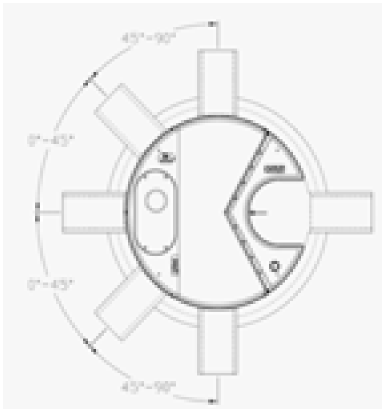

INLET-TO-OUTLET DROP

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HEAD LOSS

The head loss through Stormceptor EF is similar to that of a 60-degree bend structure. The applicable K value for calculating minor losses through the unit is 1.1. For submerged conditions the applicable K value is 3.0.

Pollutant Capacity

Stormceptor EF / EFO	Model Diameter		Depth (Outlet Pipe Invert to Sump Floor)		Oil Volume		Recommended Sediment Maintenance Depth *		Maximum Sediment Volume *		Maximum Sediment Mass **	
	(m)	(ft)	(m)	(ft)	(L)	(Gal)	(mm)	(in)	(L)	(ft³)	(kg)	(lb)
EF4 / EFO4	1.2	4	1.52	5.0	265	70	203	8	1190	42	1904	5250
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EF12 / EFO12	3.6	12	3.89	12.8	2475	655	610	24	31220	1103	49952	137875

*Increased sump depth may be added to increase sediment storage capacity

** Average density of wet packed sediment in sump = 1.6 kg/L (100 lb/ft³)

Feature	Benefit	Feature Appeals To
Patent-pending enhanced flow treatment and scour prevention technology	Superior, verified third-party performance	Regulator, Specifying & Design Engineer
Third-party verified light liquid capture and retention for EFO version	Proven performance for fuel/oil hotspot locations	Regulator, Specifying & Design Engineer, Site Owner
Functions as bend, junction or inlet structure	Design flexibility	Specifying & Design Engineer
Minimal drop between inlet and outlet	Site installation ease	Contractor
Large diameter outlet riser for inspection and maintenance	Easy maintenance access from grade	Maintenance Contractor & Site Owner

STANDARD STORMCEPTOR EF/EFO DRAWINGS

For standard details, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

STANDARD STORMCEPTOR EF/EFO SPECIFICATION

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150	58	810	45	1470	47	2130	32
180	56	840	45	1500	46	2160	32
210	54	870	45	1530	45	2190	31
240	53	900	45	1560	44	2220	31
270	52	930	44	1590	43	2250	30
300	51	960	44	1620	42	2280	30
330	50	990	44	1650	42	2310	30
360	49	1020	44	1680	41	2340	29
390	48	1050	45	1710	40	2370	29
420	48	1080	45	1740	39	2400	29
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STANDARD PERFORMANCE SPECIFICATION FOR "OIL GRIT SEPARATOR" (OGS) STORMWATER QUALITY TREATMENT DEVICE

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2.1 OGS POLLUTANT STORAGE

The OGS device shall include a sump for sediment storage, and a protected volume for the capture and storage of petroleum hydrocarbons and buoyant gross pollutants. The **minimum** sediment & petroleum hydrocarbon storage capacity shall be as follows:

2.1.1	4 ft (1219 mm) Diameter OGS Units:	1.19 m^3 sediment / 265 L oil
	6 ft (1829 mm) Diameter OGS Units:	3.48 m^3 sediment / 609 L oil
	8 ft (2438 mm) Diameter OGS Units:	8.78 m^3 sediment / 1,071 L oil
	10 ft (3048 mm) Diameter OGS Units:	17.78 m^3 sediment / 1,673 L oil
	12 ft (3657 mm) Diameter OGS Units:	31.23 m^3 sediment / 2,476 L oil

PART 3 – PERFORMANCE & DESIGN

3.1 GENERAL

The OGS stormwater quality treatment device shall be verified in accordance with ISO 14034:2016 Environmental management – Environmental technology verification (ETV). The OGS stormwater quality treatment device shall remove oil, sediment and gross pollutants from stormwater runoff during frequent wet weather events, and retain these pollutants during less frequent high flow wet weather events below the insert within the OGS for later removal during maintenance. The Manufacturer shall have at least ten (10) years of local experience, history and success in engineering design, manufacturing and production and supply of OGS stormwater quality treatment device systems, acceptable to the Engineer of Record.

3.2 SIZING METHODOLOGY

The OGS device shall be engineered, designed and sized to provide stormwater quality treatment based on treating a minimum of 90 percent of the average annual runoff volume and a minimum removal of an annual average 60% of the sediment (TSS) load based on the Particle Size Distribution (PSD) specified in the sizing report for the specified device. Sizing shall be determined using historical rainfall data and a sediment removal performance curve derived from the actual third-party verified laboratory testing data. The OGS device shall also have sufficient annual sediment storage capacity as specified and calculated in Section 2.1.

3.3 CANADIAN ETV or ISO 14034 ETV VERIFICATION OF SCOUR TESTING

The OGS device shall have Canadian ETV or ISO 14034 ETV Verification of third-party scour testing conducted in accordance with the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**

3.3.1 To be acceptable for on-line installation, the OGS device must demonstrate an average scour test effluent concentration less than 10 mg/L at each surface loading rate tested, up to and including 2600 L/min/m^2.

Stormceptor®

Stormceptor® EF Sizing Report

STORMCEPTOR®
ESTIMATED NET ANNUAL SEDIMENT (TSS) LOAD REDUCTION

11/13/2020

Province:	Ontario
City:	Oakville
Nearest Rainfall Station:	HAMILTON AP
NCDC Rainfall Station Id:	3195
Years of Rainfall Data:	34

Project Name:	Lakeshore Road Class EA
Project Number:	43762
Designer Name:	Gurkanwal Arora
Designer Company:	Wood Environment & Infrastructure
Designer Email:	gurkanwal.arora@woodplc.com
Designer Phone:	905-335-2353
EOR Name:	
EOR Company:	
EOR Email:	
EOR Phone:	

Site Name:	McCraney Creek - West

Drainage Area (ha):	1.49
% Imperviousness:	51.00

Runoff Coefficient 'c': 0.60

Particle Size Distribution:	CA ETV
Target TSS Removal (%):	3.1

Required Water Quality Runoff Volume Capture (%):	90.00
Estimated Water Quality Flow Rate (L/s):	34.37
Oil / Fuel Spill Risk Site?	No
Upstream Flow Control?	No
Peak Conveyance (maximum) Flow Rate (L/s):	
Site Sediment Transport Rate (kg/ha/yr):	

Net Annual Sediment (TSS) Load Reduction Sizing Summary

Stormceptor Model	TSS Removal Provided (%)
EF4	52
EF6	60
EF8	63
EF10	65
EF12	66

Recommended Stormceptor EF Model: EF4

Estimated Net Annual Sediment (TSS) Load Reduction (%): 52

Water Quality Runoff Volume Capture (%): > 90

THIRD-PARTY TESTING AND VERIFICATION

► **Stormceptor® EF and Stormceptor® EFO** are the latest evolutions in the Stormceptor® oil-grit separator (OGS) technology series, and are designed to remove a wide variety of pollutants from stormwater and snowmelt runoff. These technologies have been third-party tested in accordance with the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators** and performance has been third-party verified in accordance with the **ISO 14034 Environmental Technology Verification (ETV)** protocol.

PERFORMANCE

► **Stormceptor® EF and EFO** remove stormwater pollutants through gravity separation and floatation, and feature a patent-pending design that generates positive removal of total suspended solids (TSS) throughout each storm event, including high-intensity storms. Captured pollutants include sediment, free oils, and sediment-bound pollutants such as nutrients, heavy metals, and petroleum hydrocarbons. Stormceptor is sized to remove a high level of TSS from the frequent rainfall events that contribute the vast majority of annual runoff volume and pollutant load. The technology incorporates an internal bypass to convey excessive stormwater flows from high-intensity storms through the device without resuspension and washout (scour) of previously captured pollutants. Proper routine maintenance ensures high pollutant removal performance and protection of downstream waterways.

PARTICLE SIZE DISTRIBUTION (PSD)

► The **Canadian ETV PSD** shown in the table below was used, or in part, for this sizing. This is the identical PSD that is referenced in the Canadian ETV ***Procedure for Laboratory Testing of Oil-Grit Separators*** for both sediment removal testing and scour testing. The Canadian ETV PSD contains a wide range of particle sizes in the sand and silt fractions, and is considered reasonably representative of the particle size fractions found in typical urban stormwater runoff.

Particle Size (µm)	Percent Less Than	Particle Size Fraction (µm)	Percent
1000	100	500-1000	5
500	95	250-500	5
250	90	150-250	15
150	75	100-150	15
100	60	75-100	10
75	50	50-75	5
50	45	20-50	10
20	35	8-20	15
8	20	5-8	10
5	10	2-5	5
2	5	<2	5

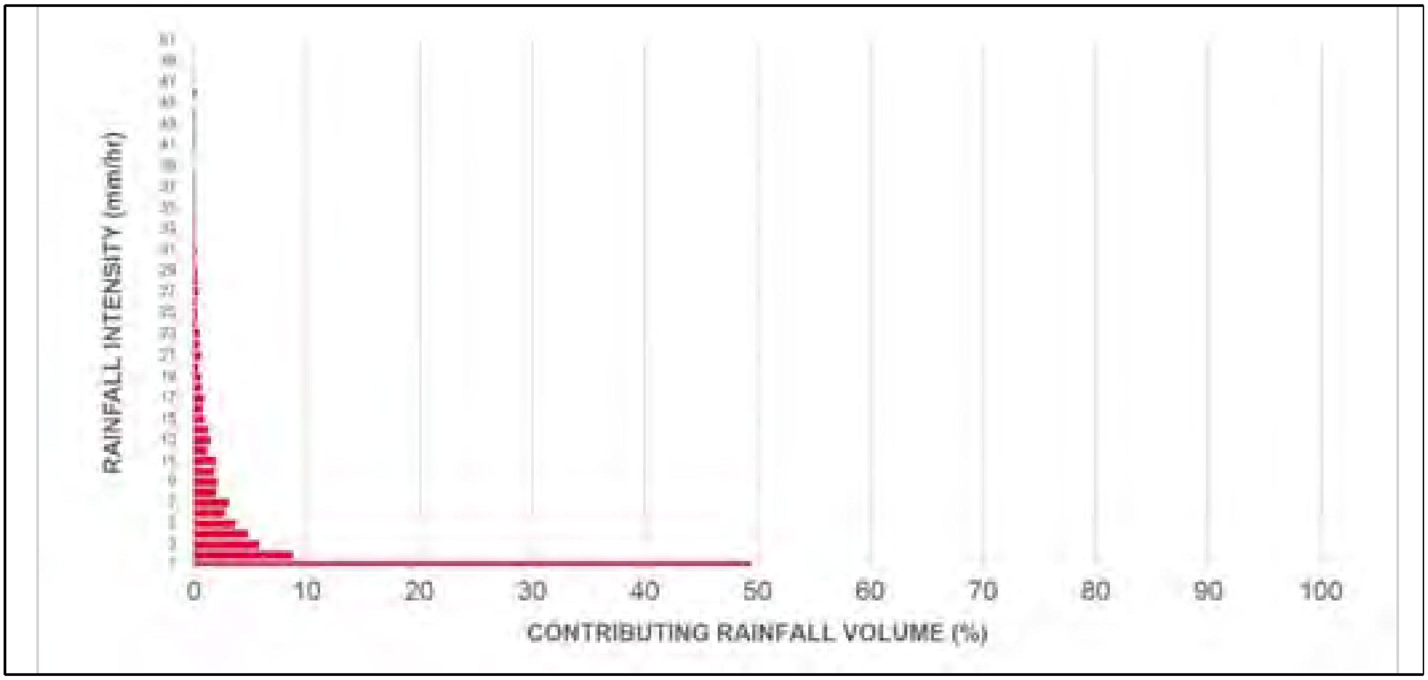
Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
1	49.5	49.5	2.51	151.0	126.0	61	30.0	30.0
2	8.8	58.3	5.02	301.0	251.0	53	4.6	34.7
3	5.8	64.1	7.53	452.0	377.0	49	2.8	37.5
4	4.8	68.9	10.04	602.0	502.0	47	2.3	39.7
5	3.7	72.6	12.55	753.0	628.0	46	1.7	41.4
6	2.8	75.4	15.06	904.0	753.0	45	1.3	42.7
7	3.1	78.5	17.57	1054.0	879.0	45	1.4	44.1
8	2.0	80.5	20.08	1205.0	1004.0	44	0.9	45.0
9	2.1	82.6	22.59	1355.0	1130.0	46	1.0	45.9
10	1.8	84.4	25.10	1506.0	1255.0	47	0.8	46.8
11	2.0	86.4	27.61	1657.0	1381.0	49	1.0	47.8
12	1.2	87.6	30.12	1807.0	1506.0	46	0.5	48.3
13	1.5	89.1	32.63	1958.0	1632.0	42	0.6	48.9
14	1.3	90.4	35.14	2109.0	1757.0	39	0.5	49.4
15	0.9	91.3	37.65	2259.0	1883.0	36	0.3	49.8
16	0.8	92.1	40.16	2410.0	2008.0	34	0.3	50.0
17	0.9	93.0	42.67	2560.0	2134.0	32	0.3	50.3
18	0.7	93.7	45.18	2711.0	2259.0	30	0.2	50.5
19	0.6	94.3	47.69	2862.0	2385.0	29	0.2	50.7
20	0.4	94.7	50.20	3012.0	2510.0	27	0.1	50.8
21	0.6	95.3	52.71	3163.0	2636.0	26	0.2	51.0
22	0.5	95.8	55.22	3313.0	2761.0	25	0.1	51.1
23	0.5	96.3	57.73	3464.0	2887.0	25	0.1	51.2
24	0.2	96.5	60.24	3615.0	3012.0	23	0.0	51.3
25	0.3	96.8	62.75	3765.0	3138.0	22	0.1	51.4

Stormceptor® EF Sizing Report

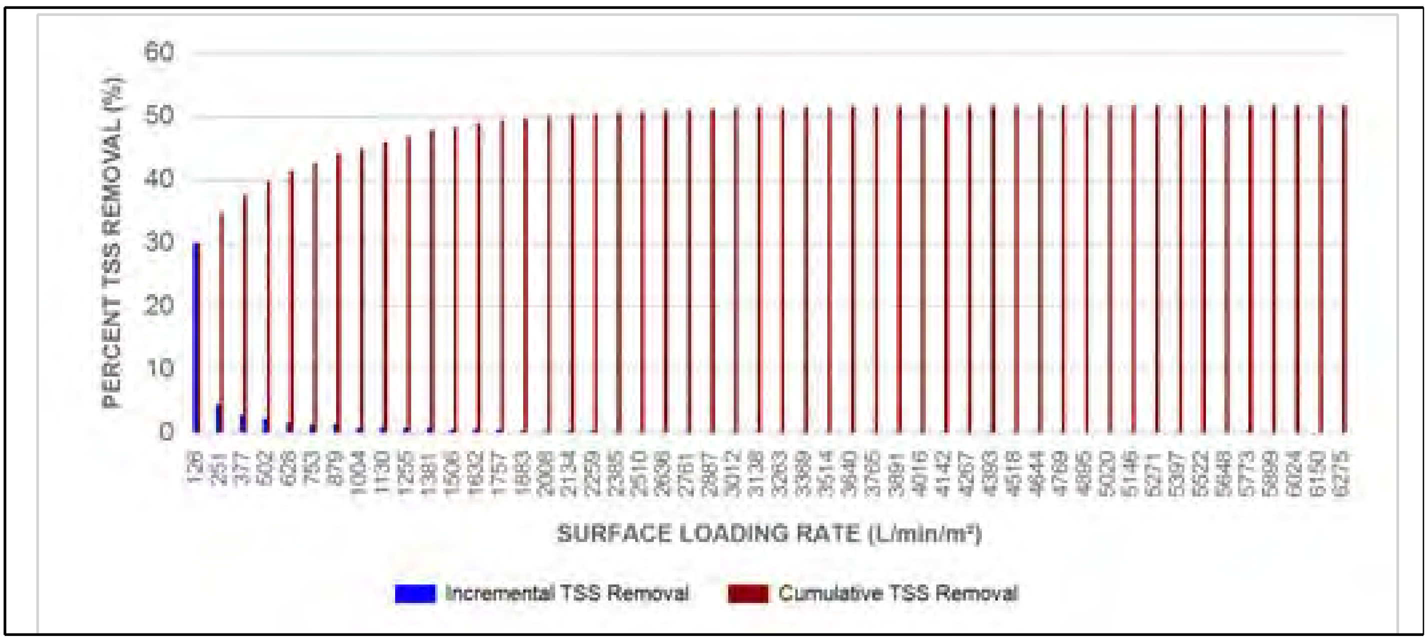
Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
26	0.2	97.0	65.26	3916.0	3263.0	21	0.0	51.4
27	0.4	97.4	67.77	4066.0	3389.0	21	0.1	51.5
28	0.3	97.7	70.28	4217.0	3514.0	20	0.1	51.5
29	0.3	98.0	72.80	4368.0	3640.0	19	0.1	51.6
30	0.1	98.1	75.31	4518.0	3765.0	19	0.0	51.6
31	0.2	98.3	77.82	4669.0	3891.0	18	0.0	51.6
32	0.1	98.4	80.33	4820.0	4016.0	17	0.0	51.7
33	0.1	98.5	82.84	4970.0	4142.0	17	0.0	51.7
34	0.1	98.6	85.35	5121.0	4267.0	16	0.0	51.7
35	0.1	98.7	87.86	5271.0	4393.0	16	0.0	51.7
36	0.1	98.8	90.37	5422.0	4518.0	15	0.0	51.7
37	0.1	98.9	92.88	5573.0	4644.0	15	0.0	51.7
38	0.1	99.0	95.39	5723.0	4769.0	15	0.0	51.8
39	0.0	99.0	97.90	5874.0	4895.0	14	0.0	51.8
40	0.0	99.0	100.41	6024.0	5020.0	14	0.0	51.8
41	0.1	99.1	102.92	6175.0	5146.0	13	0.0	51.8
42	0.1	99.2	105.43	6326.0	5271.0	13	0.0	51.8
43	0.1	99.3	107.94	6476.0	5397.0	13	0.0	51.8
44	0.1	99.4	110.45	6627.0	5522.0	12	0.0	51.8
45	0.0	99.4	112.96	6777.0	5648.0	12	0.0	51.8
46	0.2	99.6	115.47	6928.0	5773.0	12	0.0	51.8
47	0.0	99.6	117.98	7079.0	5899.0	12	0.0	51.8
48	0.0	99.6	120.49	7229.0	6024.0	11	0.0	51.8
49	0.0	99.6	123.00	7380.0	6150.0	11	0.0	51.8
50	0.0	99.6	125.51	7531.0	6275.0	11	0.0	51.8
Estimated Net Annual Sediment (TSS) Load Reduction =								**52 %**

Stormceptor® EF Sizing Report

RAINFALL DATA FROM HAMILTON AP RAINFALL STATION



INCREMENTAL AND CUMULATIVE TSS REMOVAL FOR THE RECOMMENDED STORMCEPTOR® MODEL



Maximum Pipe Diameter / Peak Conveyance

Stormceptor EF / EFO	Model Diameter (m)	Model Diameter (ft)	Min Angle Inlet / Outlet Pipes	Max Inlet Pipe Diameter (mm)	Max Inlet Pipe Diameter (in)	Max Outlet Pipe Diameter (mm)	Max Outlet Pipe Diameter (in)	Peak Conveyance Flow Rate (L/s)	Peak Conveyance Flow Rate (cfs)
EF4 / EFO4	1.2	4	90	609	24	609	24	425	15
EF6 / EFO6	1.8	6	90	914	36	914	36	990	35
EF8 / EFO8	2.4	8	90	1219	48	1219	48	1700	60
EF10 / EFO10	3.0	10	90	1828	72	1828	72	2830	100
EF12 / EFO12	3.6	12	90	1828	72	1828	72	2830	100

SCOUR PREVENTION AND ONLINE CONFIGURATION

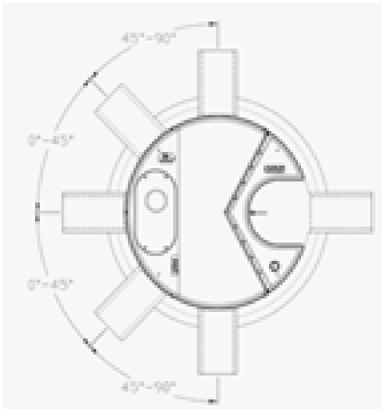
►**Stormceptor® EF and EFO** feature an internal bypass and superior scour prevention technology that have been demonstrated in third-party testing according to the scour testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**, and the exceptional scour test performance has been third-party verified in accordance with the ISO 14034 ETV protocol. As a result, Stormceptor EF and EFO are approved for online installation, eliminating the need for costly additional bypass structures, piping, and installation expense.

DESIGN FLEXIBILITY

►**Stormceptor® EF** and **EFO** offers design flexibility in one simplified platform, accepting stormwater flow from a single inlet pipe or multiple inlet pipes, and/or surface runoff through an inlet grate. The device can also serve as a junction structure, accommodate a 90-degree inlet-to-outlet bend angle, and can be modified to ensure performance in submerged conditions.

OIL CAPTURE AND RETENTION

►While Stormceptor® EF will capture and retain oil from dry weather spills and low intensity runoff, **Stormceptor® EFO** has demonstrated superior oil capture and greater than 99% oil retention in third-party testing according to the light liquid re-entrainment testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**. Stormceptor EFO is recommended for sites where oil capture and retention is a requirement.



INLET-TO-OUTLET DROP

Elevation differential between inlet and outlet pipe inverts is dictated by the angle at which the inlet pipe(s) enters the unit.

0° - 45° : The inlet pipe is 1-inch (25mm) higher than the outlet pipe.

45° - 90° : The inlet pipe is 2-inches (50mm) higher than the outlet pipe.

HEAD LOSS

The head loss through Stormceptor EF is similar to that of a 60-degree bend structure. The applicable K value for calculating minor losses through the unit is 1.1. For submerged conditions the applicable K value is 3.0.

Pollutant Capacity

Stormceptor EF / EFO	Model Diameter		Depth (Outlet Pipe Invert to Sump Floor)		Oil Volume		Recommended Sediment Maintenance Depth *		Maximum Sediment Volume *		Maximum Sediment Mass **	
	(m)	(ft)	(m)	(ft)	(L)	(Gal)	(mm)	(in)	(L)	(ft³)	(kg)	(lb)
EF4 / EFO4	1.2	4	1.52	5.0	265	70	203	8	1190	42	1904	5250
EF6 / EFO6	1.8	6	1.93	6.3	610	160	305	12	3470	123	5552	15375
EF8 / EFO8	2.4	8	2.59	8.5	1070	280	610	24	8780	310	14048	38750
EF10 / EFO10	3.0	10	3.25	10.7	1670	440	610	24	17790	628	28464	78500
EF12 / EFO12	3.6	12	3.89	12.8	2475	655	610	24	31220	1103	49952	137875

*Increased sump depth may be added to increase sediment storage capacity

** Average density of wet packed sediment in sump = 1.6 kg/L (100 lb/ft³)

Feature	Benefit	Feature Appeals To
Patent-pending enhanced flow treatment and scour prevention technology	Superior, verified third-party performance	Regulator, Specifying & Design Engineer
Third-party verified light liquid capture and retention for EFO version	Proven performance for fuel/oil hotspot locations	Regulator, Specifying & Design Engineer, Site Owner
Functions as bend, junction or inlet structure	Design flexibility	Specifying & Design Engineer
Minimal drop between inlet and outlet	Site installation ease	Contractor
Large diameter outlet riser for inspection and maintenance	Easy maintenance access from grade	Maintenance Contractor & Site Owner

STANDARD STORMCEPTOR EF/EFO DRAWINGS

For standard details, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

STANDARD STORMCEPTOR EF/EFO SPECIFICATION

For specifications, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

Table of TSS Removal vs Surface Loading Rate Based on Third-Party Test Results

Stormceptor® EF

SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL
1	70	660	46	1320	48	1980	35
30	70	690	46	1350	48	2010	34

60	67	720	45	1380	49	2040	34
90	63	750	45	1410	49	2070	33
120	61	780	45	1440	48	2100	33
150	58	810	45	1470	47	2130	32
180	56	840	45	1500	46	2160	32
210	54	870	45	1530	45	2190	31
240	53	900	45	1560	44	2220	31
270	52	930	44	1590	43	2250	30
300	51	960	44	1620	42	2280	30
330	50	990	44	1650	42	2310	30
360	49	1020	44	1680	41	2340	29
390	48	1050	45	1710	40	2370	29
420	48	1080	45	1740	39	2400	29
450	48	1110	45	1770	39	2430	28
480	47	1140	46	1800	38	2460	28
510	47	1170	46	1830	37	2490	28
540	47	1200	47	1860	37	2520	27
570	46	1230	47	1890	36	2550	27
600	46	1260	47	1920	36	2580	27
630	46	1290	48	1950	35		

STANDARD PERFORMANCE SPECIFICATION FOR “OIL GRIT SEPARATOR” (OGS) STORMWATER QUALITY TREATMENT DEVICE

PART 1 – GENERAL

1.1 WORK INCLUDED

This section specifies requirements for selecting, sizing, and designing an underground Oil Grit Separator (OGS) device for stormwater quality treatment, with third-party testing results and a Statement of Verification in accordance with ISO 14034 Environmental Management – Environmental Technology Verification (ETV).

1.2 REFERENCE STANDARDS & PROCEDURES

ISO 14034:2016 Environmental management – Environmental technology verification (ETV)

Canadian Environmental Technology Verification (ETV) Program’s **Procedure for Laboratory Testing of Oil-Grit Separators.**

1.3 SUBMITTALS

1.3.1 All submittals, including sizing reports & shop drawings, shall be submitted upon request with each order to the contractor then forwarded to the Engineer of Record for review and acceptance. Shop drawings shall detail all OGS components, elevations, and sequence of construction.

1.3.2 Alternative devices shall have features identical to or greater than the specified device, including: treatment chamber diameter, treatment chamber wet volume, sediment storage volume, and oil storage volume.

1.3.3 Unless directed otherwise by the Engineer of Record, OGS stormwater quality treatment product substitutions or alternatives submitted within ten days prior to project bid shall not be accepted. All alternatives or substitutions submitted shall be signed and sealed by a local registered Professional Engineer, based on the exact same criteria detailed in Section 3, in entirety, subject to review and approval by the Engineer of Record.

PART 2 – PRODUCTS

2.1 OGS POLLUTANT STORAGE

The OGS device shall include a sump for sediment storage, and a protected volume for the capture and storage of petroleum hydrocarbons and buoyant gross pollutants. The **minimum** sediment & petroleum hydrocarbon storage capacity shall be as follows:

2.1.1	4 ft (1219 mm) Diameter OGS Units:	1.19 m^3 sediment / 265 L oil
	6 ft (1829 mm) Diameter OGS Units:	3.48 m^3 sediment / 609 L oil
	8 ft (2438 mm) Diameter OGS Units:	8.78 m^3 sediment / 1,071 L oil
	10 ft (3048 mm) Diameter OGS Units:	17.78 m^3 sediment / 1,673 L oil
	12 ft (3657 mm) Diameter OGS Units:	31.23 m^3 sediment / 2,476 L oil

PART 3 – PERFORMANCE & DESIGN

3.1 GENERAL

The OGS stormwater quality treatment device shall be verified in accordance with ISO 14034:2016 Environmental management – Environmental technology verification (ETV). The OGS stormwater quality treatment device shall remove oil, sediment and gross pollutants from stormwater runoff during frequent wet weather events, and retain these pollutants during less frequent high flow wet weather events below the insert within the OGS for later removal during maintenance. The Manufacturer shall have at least ten (10) years of local experience, history and success in engineering design, manufacturing and production and supply of OGS stormwater quality treatment device systems, acceptable to the Engineer of Record.

3.2 SIZING METHODOLOGY

The OGS device shall be engineered, designed and sized to provide stormwater quality treatment based on treating a minimum of 90 percent of the average annual runoff volume and a minimum removal of an annual average 60% of the sediment (TSS) load based on the Particle Size Distribution (PSD) specified in the sizing report for the specified device. Sizing shall be determined using historical rainfall data and a sediment removal performance curve derived from the actual third-party verified laboratory testing data. The OGS device shall also have sufficient annual sediment storage capacity as specified and calculated in Section 2.1.

3.3 CANADIAN ETV or ISO 14034 ETV VERIFICATION OF SCOUR TESTING

The OGS device shall have Canadian ETV or ISO 14034 ETV Verification of third-party scour testing conducted in accordance with the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**

3.3.1 To be acceptable for on-line installation, the OGS device must demonstrate an average scour test effluent concentration less than 10 mg/L at each surface loading rate tested, up to and including 2600 L/min/m^2.

STORMCEPTOR®
ESTIMATED NET ANNUAL SEDIMENT (TSS) LOAD REDUCTION

11/13/2020

Province:	Ontario
City:	Oakville
Nearest Rainfall Station:	HAMILTON AP
NCDC Rainfall Station Id:	3195
Years of Rainfall Data:	34
Site Name:	McCraney Creek - East
Drainage Area (ha):	3.82
% Imperviousness:	50.00

Runoff Coefficient 'c': 0.60

Particle Size Distribution:	CA ETV
Target TSS Removal (%):	3.6
Required Water Quality Runoff Volume Capture (%):	90.00
Estimated Water Quality Flow Rate (L/s):	87.24
Oil / Fuel Spill Risk Site?	No
Upstream Flow Control?	No
Peak Conveyance (maximum) Flow Rate (L/s):	
Site Sediment Transport Rate (kg/ha/yr):	

Project Name:	Lakeshore Road Class EA
Project Number:	43762
Designer Name:	Gurkanwal Arora
Designer Company:	Wood Environment & Infrastructure
Designer Email:	gurkanwal.arora@woodplc.com
Designer Phone:	905-335-2353
EOR Name:	
EOR Company:	
EOR Email:	
EOR Phone:	

Net Annual Sediment (TSS) Load Reduction Sizing Summary

Stormceptor Model	TSS Removal Provided (%)
EF4	41
EF6	50
EF8	56
EF10	60
EF12	62

Recommended Stormceptor EF Model:	**EF4**
Estimated Net Annual Sediment (TSS) Load Reduction (%):	**41**
Water Quality Runoff Volume Capture (%):	**> 90**

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THIRD-PARTY TESTING AND VERIFICATION

►**Stormceptor® EF and Stormceptor® EFO** are the latest evolutions in the Stormceptor® oil-grit separator (OGS) technology series, and are designed to remove a wide variety of pollutants from stormwater and snowmelt runoff. These technologies have been third-party tested in accordance with the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators** and performance has been third-party verified in accordance with the **ISO 14034 Environmental Technology Verification (ETV)** protocol.

PERFORMANCE

►**Stormceptor® EF and EFO** remove stormwater pollutants through gravity separation and floatation, and feature a patent-pending design that generates positive removal of total suspended solids (TSS) throughout each storm event, including high-intensity storms. Captured pollutants include sediment, free oils, and sediment-bound pollutants such as nutrients, heavy metals, and petroleum hydrocarbons. Stormceptor is sized to remove a high level of TSS from the frequent rainfall events that contribute the vast majority of annual runoff volume and pollutant load. The technology incorporates an internal bypass to convey excessive stormwater flows from high-intensity storms through the device without resuspension and washout (scour) of previously captured pollutants. Proper routine maintenance ensures high pollutant removal performance and protection of downstream waterways.

PARTICLE SIZE DISTRIBUTION (PSD)

►The **Canadian ETV PSD** shown in the table below was used, or in part, for this sizing. This is the identical PSD that is referenced in the Canadian ETV ***Procedure for Laboratory Testing of Oil-Grit Separators*** for both sediment removal testing and scour testing. The Canadian ETV PSD contains a wide range of particle sizes in the sand and silt fractions, and is considered reasonably representative of the particle size fractions found in typical urban stormwater runoff.

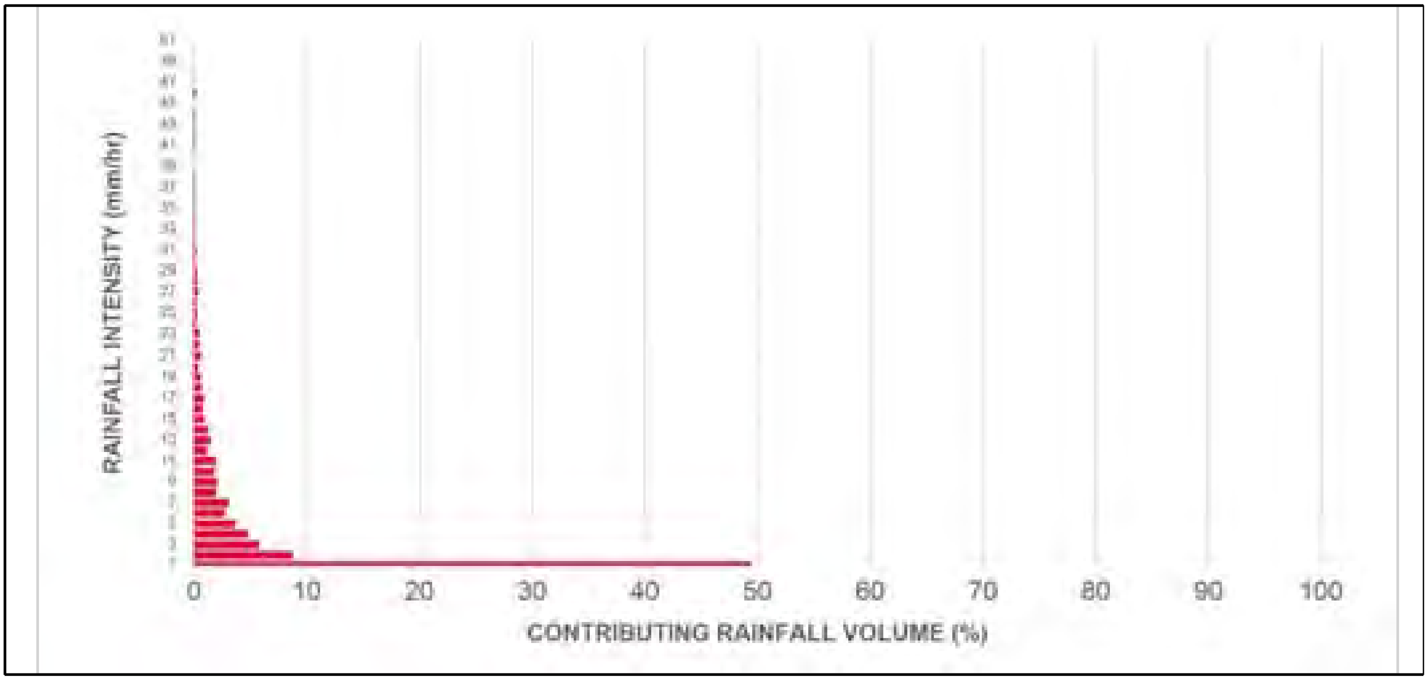
Particle Size (µm)	Percent Less Than	Particle Size Fraction (µm)	Percent
1000	100	500-1000	5
500	95	250-500	5
250	90	150-250	15
150	75	100-150	15
100	60	75-100	10
75	50	50-75	5
50	45	20-50	10
20	35	8-20	15
8	20	5-8	10
5	10	2-5	5
2	5	<2	5

Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
1	49.5	49.5	6.37	382.0	319.0	51	25.1	25.1
2	8.8	58.3	12.74	765.0	637.0	46	4.0	29.1
3	5.8	64.1	19.12	1147.0	956.0	44	2.6	31.7
4	4.8	68.9	25.49	1529.0	1274.0	47	2.3	34.0
5	3.7	72.6	31.86	1912.0	1593.0	43	1.6	35.6
6	2.8	75.4	38.23	2294.0	1912.0	36	1.0	36.6
7	3.1	78.5	44.60	2676.0	2230.0	31	1.0	37.5
8	2.0	80.5	50.97	3058.0	2549.0	27	0.5	38.1
9	2.1	82.6	57.35	3441.0	2867.0	25	0.5	38.6
10	1.8	84.4	63.72	3823.0	3186.0	22	0.4	39.0
11	2.0	86.4	70.09	4205.0	3504.0	20	0.4	39.4
12	1.2	87.6	76.46	4588.0	3823.0	18	0.2	39.6
13	1.5	89.1	82.83	4970.0	4142.0	17	0.3	39.8
14	1.3	90.4	89.20	5352.0	4460.0	16	0.2	40.0
15	0.9	91.3	95.58	5735.0	4779.0	15	0.1	40.2
16	0.8	92.1	101.95	6117.0	5097.0	14	0.1	40.3
17	0.9	93.0	108.32	6499.0	5416.0	13	0.1	40.4
18	0.7	93.7	114.69	6882.0	5735.0	12	0.1	40.5
19	0.6	94.3	121.06	7264.0	6053.0	11	0.1	40.6
20	0.4	94.7	127.44	7646.0	6372.0	11	0.0	40.6
21	0.6	95.3	133.81	8028.0	6690.0	10	0.1	40.7
22	0.5	95.8	140.18	8411.0	7009.0	10	0.0	40.7
23	0.5	96.3	146.55	8793.0	7328.0	9	0.0	40.8
24	0.2	96.5	152.92	9175.0	7646.0	9	0.0	40.8
25	0.3	96.8	159.29	9558.0	7965.0	9	0.0	40.8

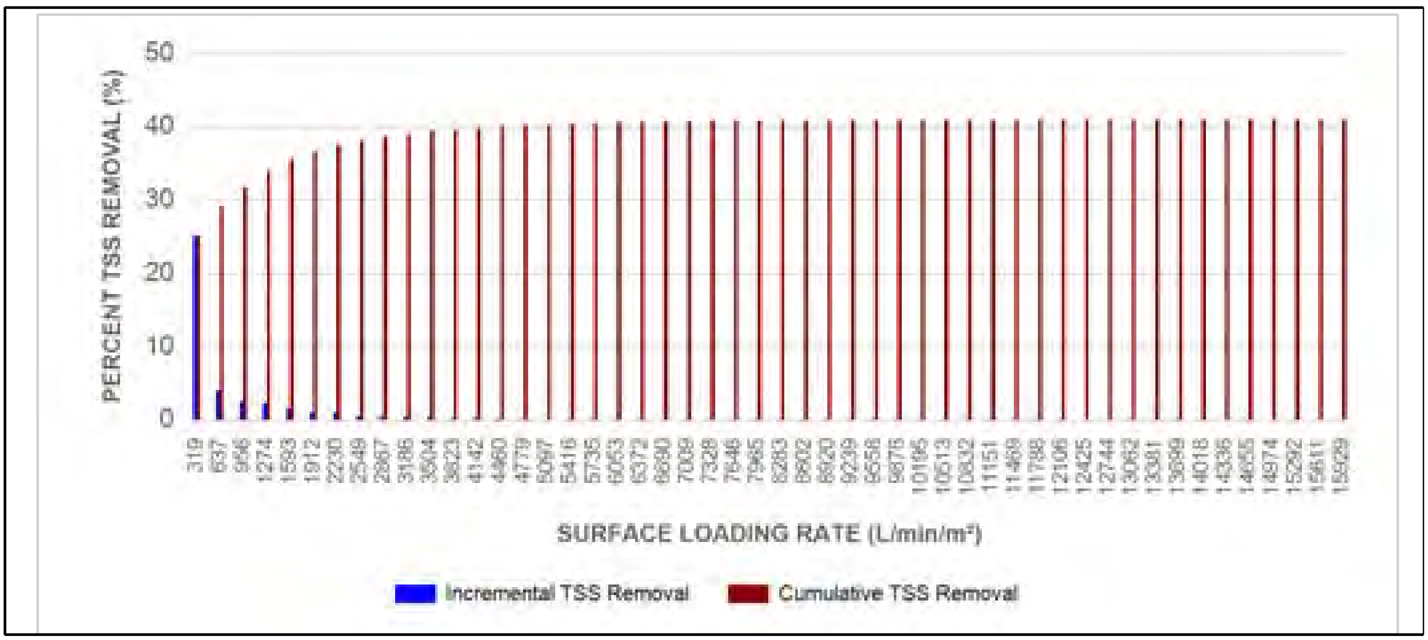
Stormceptor® EF Sizing Report

Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
26	0.2	97.0	165.67	9940.0	8283.0	8	0.0	40.8
27	0.4	97.4	172.04	10322.0	8602.0	8	0.0	40.8
28	0.3	97.7	178.41	10705.0	8920.0	8	0.0	40.9
29	0.3	98.0	184.78	11087.0	9239.0	7	0.0	40.9
30	0.1	98.1	191.15	11469.0	9558.0	7	0.0	40.9
31	0.2	98.3	197.52	11851.0	9876.0	7	0.0	40.9
32	0.1	98.4	203.90	12234.0	10195.0	7	0.0	40.9
33	0.1	98.5	210.27	12616.0	10513.0	7	0.0	40.9
34	0.1	98.6	216.64	12998.0	10832.0	7	0.0	40.9
35	0.1	98.7	223.01	13381.0	11151.0	7	0.0	40.9
36	0.1	98.8	229.38	13763.0	11469.0	7	0.0	40.9
37	0.1	98.9	235.76	14145.0	11788.0	7	0.0	41.0
38	0.1	99.0	242.13	14528.0	12106.0	7	0.0	41.0
39	0.0	99.0	248.50	14910.0	12425.0	7	0.0	41.0
40	0.0	99.0	254.87	15292.0	12744.0	7	0.0	41.0
41	0.1	99.1	261.24	15675.0	13062.0	7	0.0	41.0
42	0.1	99.2	267.61	16057.0	13381.0	7	0.0	41.0
43	0.1	99.3	273.99	16439.0	13699.0	7	0.0	41.0
44	0.1	99.4	280.36	16821.0	14018.0	7	0.0	41.0
45	0.0	99.4	286.73	17204.0	14336.0	7	0.0	41.0
46	0.2	99.6	293.10	17586.0	14655.0	7	0.0	41.0
47	0.0	99.6	299.47	17968.0	14974.0	7	0.0	41.0
48	0.0	99.6	305.84	18351.0	15292.0	7	0.0	41.0
49	0.0	99.6	312.22	18733.0	15611.0	7	0.0	41.0
50	0.0	99.6	318.59	19115.0	15929.0	7	0.0	41.0
Estimated Net Annual Sediment (TSS) Load Reduction =								**41 %**

RAINFALL DATA FROM HAMILTON AP RAINFALL STATION



INCREMENTAL AND CUMULATIVE TSS REMOVAL FOR THE RECOMMENDED STORMCEPTOR® MODEL



Maximum Pipe Diameter / Peak Conveyance

Stormceptor EF / EFO	Model Diameter (m)	Model Diameter (ft)	Min Angle Inlet / Outlet Pipes	Max Inlet Pipe Diameter (mm)	Max Inlet Pipe Diameter (in)	Max Outlet Pipe Diameter (mm)	Max Outlet Pipe Diameter (in)	Peak Conveyance Flow Rate (L/s)	Peak Conveyance Flow Rate (cfs)
EF4 / EFO4	1.2	4	90	609	24	609	24	425	15
EF6 / EFO6	1.8	6	90	914	36	914	36	990	35
EF8 / EFO8	2.4	8	90	1219	48	1219	48	1700	60
EF10 / EFO10	3.0	10	90	1828	72	1828	72	2830	100
EF12 / EFO12	3.6	12	90	1828	72	1828	72	2830	100

SCOUR PREVENTION AND ONLINE CONFIGURATION

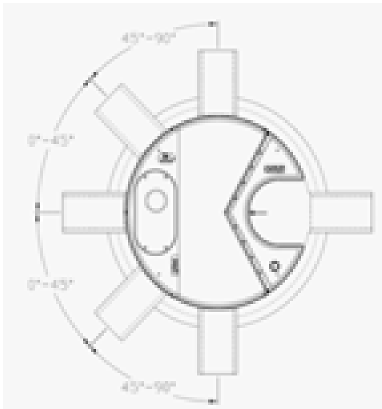
►**Stormceptor® EF and EFO** feature an internal bypass and superior scour prevention technology that have been demonstrated in third-party testing according to the scour testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**, and the exceptional scour test performance has been third-party verified in accordance with the ISO 14034 ETV protocol. As a result, Stormceptor EF and EFO are approved for online installation, eliminating the need for costly additional bypass structures, piping, and installation expense.

DESIGN FLEXIBILITY

►**Stormceptor® EF** and **EFO** offers design flexibility in one simplified platform, accepting stormwater flow from a single inlet pipe or multiple inlet pipes, and/or surface runoff through an inlet grate. The device can also serve as a junction structure, accommodate a 90-degree inlet-to-outlet bend angle, and can be modified to ensure performance in submerged conditions.

OIL CAPTURE AND RETENTION

►While Stormceptor® EF will capture and retain oil from dry weather spills and low intensity runoff, **Stormceptor® EFO** has demonstrated superior oil capture and greater than 99% oil retention in third-party testing according to the light liquid re-entrainment testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**. Stormceptor EFO is recommended for sites where oil capture and retention is a requirement.



INLET-TO-OUTLET DROP

Elevation differential between inlet and outlet pipe inverts is dictated by the angle at which the inlet pipe(s) enters the unit.
0° - 45° : The inlet pipe is 1-inch (25mm) higher than the outlet pipe.
45° - 90° : The inlet pipe is 2-inches (50mm) higher than the outlet pipe.

HEAD LOSS

The head loss through Stormceptor EF is similar to that of a 60-degree bend structure. The applicable K value for calculating minor losses through the unit is 1.1. For submerged conditions the applicable K value is 3.0.

Pollutant Capacity

Stormceptor EF / EFO	Model Diameter		Depth (Outlet Pipe Invert to Sump Floor)		Oil Volume		Recommended Sediment Maintenance Depth *		Maximum Sediment Volume *		Maximum Sediment Mass **	
	(m)	(ft)	(m)	(ft)	(L)	(Gal)	(mm)	(in)	(L)	(ft³)	(kg)	(lb)
EF4 / EFO4	1.2	4	1.52	5.0	265	70	203	8	1190	42	1904	5250
EF6 / EFO6	1.8	6	1.93	6.3	610	160	305	12	3470	123	5552	15375
EF8 / EFO8	2.4	8	2.59	8.5	1070	280	610	24	8780	310	14048	38750
EF10 / EFO10	3.0	10	3.25	10.7	1670	440	610	24	17790	628	28464	78500
EF12 / EFO12	3.6	12	3.89	12.8	2475	655	610	24	31220	1103	49952	137875

*Increased sump depth may be added to increase sediment storage capacity
** Average density of wet packed sediment in sump = 1.6 kg/L (100 lb/ft³)

Feature	Benefit	Feature Appeals To
Patent-pending enhanced flow treatment and scour prevention technology	Superior, verified third-party performance	Regulator, Specifying & Design Engineer
Third-party verified light liquid capture and retention for EFO version	Proven performance for fuel/oil hotspot locations	Regulator, Specifying & Design Engineer, Site Owner
Functions as bend, junction or inlet structure	Design flexibility	Specifying & Design Engineer
Minimal drop between inlet and outlet	Site installation ease	Contractor
Large diameter outlet riser for inspection and maintenance	Easy maintenance access from grade	Maintenance Contractor & Site Owner

STANDARD STORMCEPTOR EF/EFO DRAWINGS

For standard details, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

STANDARD STORMCEPTOR EF/EFO SPECIFICATION

For specifications, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

Table of TSS Removal vs Surface Loading Rate Based on Third-Party Test Results
Stormceptor® EF

SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL
1	70	660	46	1320	48	1980	35
30	70	690	46	1350	48	2010	34

60	67	720	45	1380	49	2040	34
90	63	750	45	1410	49	2070	33
120	61	780	45	1440	48	2100	33
150	58	810	45	1470	47	2130	32
180	56	840	45	1500	46	2160	32
210	54	870	45	1530	45	2190	31
240	53	900	45	1560	44	2220	31
270	52	930	44	1590	43	2250	30
300	51	960	44	1620	42	2280	30
330	50	990	44	1650	42	2310	30
360	49	1020	44	1680	41	2340	29
390	48	1050	45	1710	40	2370	29
420	48	1080	45	1740	39	2400	29
450	48	1110	45	1770	39	2430	28
480	47	1140	46	1800	38	2460	28
510	47	1170	46	1830	37	2490	28
540	47	1200	47	1860	37	2520	27
570	46	1230	47	1890	36	2550	27
600	46	1260	47	1920	36	2580	27
630	46	1290	48	1950	35		

STANDARD PERFORMANCE SPECIFICATION FOR "OIL GRIT SEPARATOR" (OGS) STORMWATER QUALITY TREATMENT DEVICE

PART 1 – GENERAL

1.1 WORK INCLUDED

This section specifies requirements for selecting, sizing, and designing an underground Oil Grit Separator (OGS) device for stormwater quality treatment, with third-party testing results and a Statement of Verification in accordance with ISO 14034 Environmental Management – Environmental Technology Verification (ETV).

1.2 REFERENCE STANDARDS & PROCEDURES

ISO 14034:2016 Environmental management – Environmental technology verification (ETV)

Canadian Environmental Technology Verification (ETV) Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**

1.3 SUBMITTALS

1.3.1 All submittals, including sizing reports & shop drawings, shall be submitted upon request with each order to the contractor then forwarded to the Engineer of Record for review and acceptance. Shop drawings shall detail all OGS components, elevations, and sequence of construction.

1.3.2 Alternative devices shall have features identical to or greater than the specified device, including: treatment chamber diameter, treatment chamber wet volume, sediment storage volume, and oil storage volume.

1.3.3 Unless directed otherwise by the Engineer of Record, OGS stormwater quality treatment product substitutions or alternatives submitted within ten days prior to project bid shall not be accepted. All alternatives or substitutions submitted shall be signed and sealed by a local registered Professional Engineer, based on the exact same criteria detailed in Section 3, in entirety, subject to review and approval by the Engineer of Record.

PART 2 – PRODUCTS

2.1 OGS POLLUTANT STORAGE

The OGS device shall include a sump for sediment storage, and a protected volume for the capture and storage of petroleum hydrocarbons and buoyant gross pollutants. The **minimum** sediment & petroleum hydrocarbon storage capacity shall be as follows:

2.1.1	4 ft (1219 mm) Diameter OGS Units:	1.19 m^3 sediment / 265 L oil
	6 ft (1829 mm) Diameter OGS Units:	3.48 m^3 sediment / 609 L oil
	8 ft (2438 mm) Diameter OGS Units:	8.78 m^3 sediment / 1,071 L oil
	10 ft (3048 mm) Diameter OGS Units:	17.78 m^3 sediment / 1,673 L oil
	12 ft (3657 mm) Diameter OGS Units:	31.23 m^3 sediment / 2,476 L oil

PART 3 – PERFORMANCE & DESIGN

3.1 GENERAL

The OGS stormwater quality treatment device shall be verified in accordance with ISO 14034:2016 Environmental management – Environmental technology verification (ETV). The OGS stormwater quality treatment device shall remove oil, sediment and gross pollutants from stormwater runoff during frequent wet weather events, and retain these pollutants during less frequent high flow wet weather events below the insert within the OGS for later removal during maintenance. The Manufacturer shall have at least ten (10) years of local experience, history and success in engineering design, manufacturing and production and supply of OGS stormwater quality treatment device systems, acceptable to the Engineer of Record.

3.2 SIZING METHODOLOGY

The OGS device shall be engineered, designed and sized to provide stormwater quality treatment based on treating a minimum of 90 percent of the average annual runoff volume and a minimum removal of an annual average 60% of the sediment (TSS) load based on the Particle Size Distribution (PSD) specified in the sizing report for the specified device. Sizing shall be determined using historical rainfall data and a sediment removal performance curve derived from the actual third-party verified laboratory testing data. The OGS device shall also have sufficient annual sediment storage capacity as specified and calculated in Section 2.1.

3.3 CANADIAN ETV or ISO 14034 ETV VERIFICATION OF SCOUR TESTING

The OGS device shall have Canadian ETV or ISO 14034 ETV Verification of third-party scour testing conducted in accordance with the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**

3.3.1 To be acceptable for on-line installation, the OGS device must demonstrate an average scour test effluent concentration less than 10 mg/L at each surface loading rate tested, up to and including 2600 L/min/m^2.

Stormceptor®

Stormceptor® EF Sizing Report

STORMCEPTOR®
ESTIMATED NET ANNUAL SEDIMENT (TSS) LOAD REDUCTION

11/13/2020

Province:	Ontario
City:	Oakville
Nearest Rainfall Station:	HAMILTON AP
NCDC Rainfall Station Id:	3195
Years of Rainfall Data:	34
Site Name:	Birch Hill Lane - Suffolk Avenue
Drainage Area (ha):	2.82
% Imperviousness:	50.00
Runoff Coefficient 'c':	0.60
Particle Size Distribution:	CA ETV
Target TSS Removal (%):	1.7
Required Water Quality Runoff Volume Capture (%):	90.00
Estimated Water Quality Flow Rate (L/s):	64.41
Oil / Fuel Spill Risk Site?	No
Upstream Flow Control?	No
Peak Conveyance (maximum) Flow Rate (L/s):	
Site Sediment Transport Rate (kg/ha/yr):	

Project Name:	Lakeshore Road Class EA
Project Number:	43762
Designer Name:	Gurkanwal Arora
Designer Company:	Wood Environment & Infrastructure
Designer Email:	gurkanwal.arora@woodplc.com
Designer Phone:	905-335-2353
EOR Name:	
EOR Company:	
EOR Email:	
EOR Phone:	

Net Annual Sediment (TSS) Load Reduction Sizing Summary

Stormceptor Model	TSS Removal Provided (%)
EF4	44
EF6	53
EF8	59
EF10	62
EF12	64

Recommended Stormceptor EF Model:	**EF4**
Estimated Net Annual Sediment (TSS) Load Reduction (%):	**44**
Water Quality Runoff Volume Capture (%):	**> 90**

imbrium

THIRD-PARTY TESTING AND VERIFICATION

►**Stormceptor® EF and Stormceptor® EFO** are the latest evolutions in the Stormceptor® oil-grit separator (OGS) technology series, and are designed to remove a wide variety of pollutants from stormwater and snowmelt runoff. These technologies have been third-party tested in accordance with the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators** and performance has been third-party verified in accordance with the **ISO 14034 Environmental Technology Verification (ETV)** protocol.

PERFORMANCE

►**Stormceptor® EF and EFO** remove stormwater pollutants through gravity separation and floatation, and feature a patent-pending design that generates positive removal of total suspended solids (TSS) throughout each storm event, including high-intensity storms. Captured pollutants include sediment, free oils, and sediment-bound pollutants such as nutrients, heavy metals, and petroleum hydrocarbons. Stormceptor is sized to remove a high level of TSS from the frequent rainfall events that contribute the vast majority of annual runoff volume and pollutant load. The technology incorporates an internal bypass to convey excessive stormwater flows from high-intensity storms through the device without resuspension and washout (scour) of previously captured pollutants. Proper routine maintenance ensures high pollutant removal performance and protection of downstream waterways.

PARTICLE SIZE DISTRIBUTION (PSD)

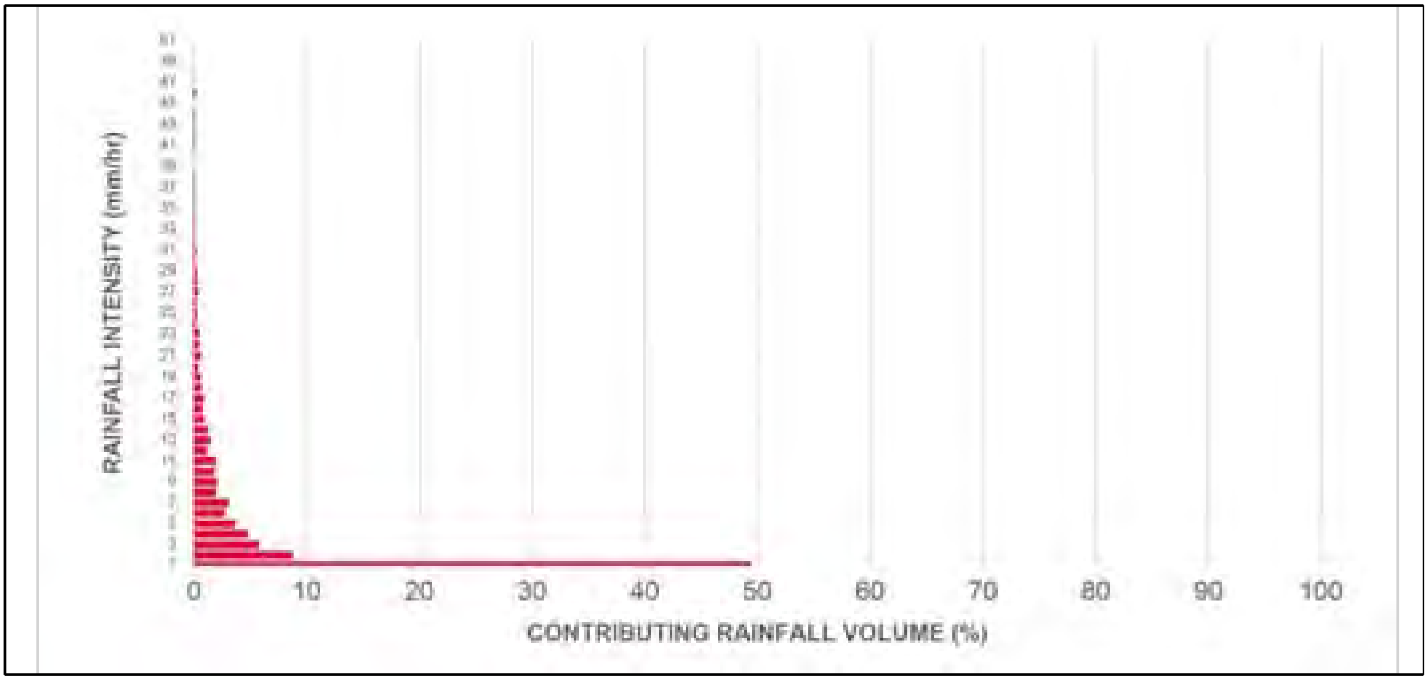
►The **Canadian ETV PSD** shown in the table below was used, or in part, for this sizing. This is the identical PSD that is referenced in the Canadian ETV ***Procedure for Laboratory Testing of Oil-Grit Separators*** for both sediment removal testing and scour testing. The Canadian ETV PSD contains a wide range of particle sizes in the sand and silt fractions, and is considered reasonably representative of the particle size fractions found in typical urban stormwater runoff.

Particle Size (µm)	Percent Less Than	Particle Size Fraction (µm)	Percent
1000	100	500-1000	5
500	95	250-500	5
250	90	150-250	15
150	75	100-150	15
100	60	75-100	10
75	50	50-75	5
50	45	20-50	10
20	35	8-20	15
8	20	5-8	10
5	10	2-5	5
2	5	<2	5

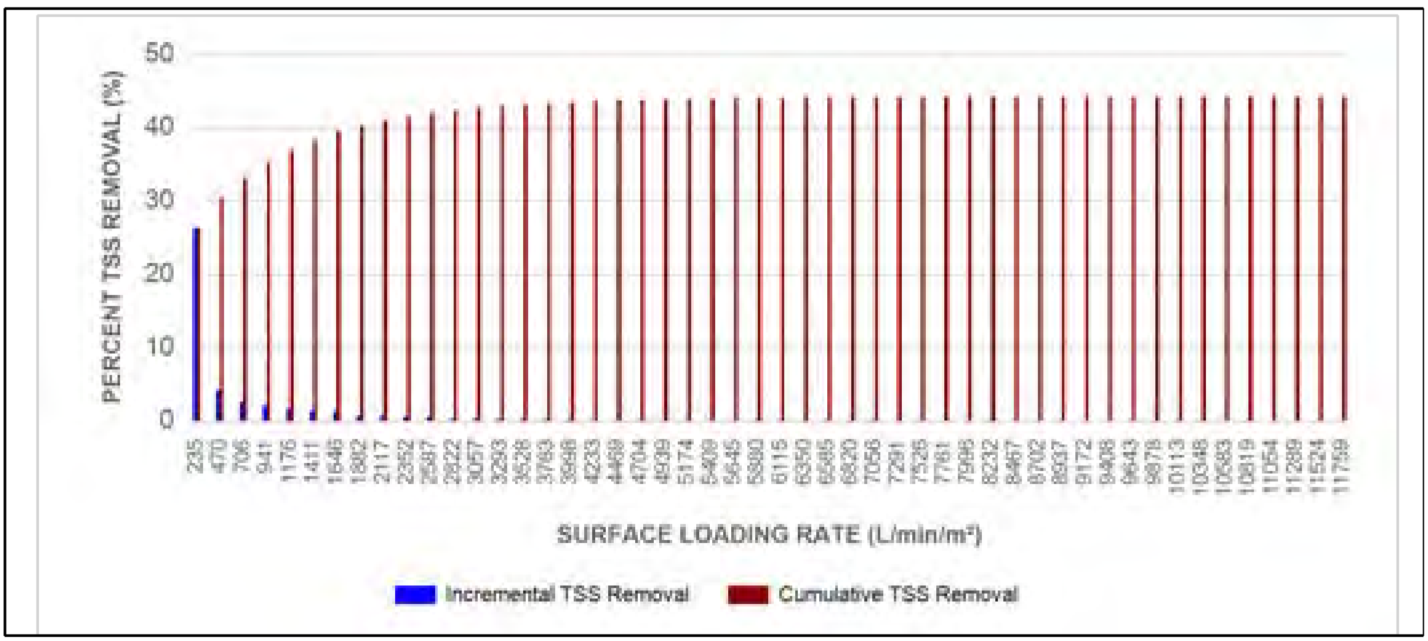
Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
1	49.5	49.5	4.70	282.0	235.0	53	26.3	26.3
2	8.8	58.3	9.41	564.0	470.0	47	4.2	30.4
3	5.8	64.1	14.11	847.0	706.0	46	2.6	33.1
4	4.8	68.9	18.82	1129.0	941.0	44	2.1	35.2
5	3.7	72.6	23.52	1411.0	1176.0	46	1.7	36.9
6	2.8	75.4	28.22	1693.0	1411.0	49	1.4	38.3
7	3.1	78.5	32.93	1976.0	1646.0	42	1.3	39.6
8	2.0	80.5	37.63	2258.0	1882.0	36	0.7	40.3
9	2.1	82.6	42.33	2540.0	2117.0	33	0.7	41.0
10	1.8	84.4	47.04	2822.0	2352.0	29	0.5	41.5
11	2.0	86.4	51.74	3104.0	2587.0	27	0.5	42.0
12	1.2	87.6	56.45	3387.0	2822.0	25	0.3	42.3
13	1.5	89.1	61.15	3669.0	3057.0	23	0.3	42.7
14	1.3	90.4	65.85	3951.0	3293.0	21	0.3	43.0
15	0.9	91.3	70.56	4233.0	3528.0	20	0.2	43.1
16	0.8	92.1	75.26	4516.0	3763.0	19	0.1	43.3
17	0.9	93.0	79.96	4798.0	3998.0	18	0.2	43.4
18	0.7	93.7	84.67	5080.0	4233.0	16	0.1	43.6
19	0.6	94.3	89.37	5362.0	4469.0	16	0.1	43.7
20	0.4	94.7	94.08	5645.0	4704.0	15	0.1	43.7
21	0.6	95.3	98.78	5927.0	4939.0	14	0.1	43.8
22	0.5	95.8	103.48	6209.0	5174.0	13	0.1	43.9
23	0.5	96.3	108.19	6491.0	5409.0	13	0.1	43.9
24	0.2	96.5	112.89	6773.0	5645.0	12	0.0	44.0
25	0.3	96.8	117.59	7056.0	5880.0	12	0.0	44.0

Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
26	0.2	97.0	122.30	7338.0	6115.0	11	0.0	44.0
27	0.4	97.4	127.00	7620.0	6350.0	11	0.0	44.1
28	0.3	97.7	131.71	7902.0	6585.0	11	0.0	44.1
29	0.3	98.0	136.41	8185.0	6820.0	10	0.0	44.1
30	0.1	98.1	141.11	8467.0	7056.0	10	0.0	44.1
31	0.2	98.3	145.82	8749.0	7291.0	10	0.0	44.1
32	0.1	98.4	150.52	9031.0	7526.0	9	0.0	44.2
33	0.1	98.5	155.22	9313.0	7761.0	9	0.0	44.2
34	0.1	98.6	159.93	9596.0	7996.0	9	0.0	44.2
35	0.1	98.7	164.63	9878.0	8232.0	8	0.0	44.2
36	0.1	98.8	169.34	10160.0	8467.0	8	0.0	44.2
37	0.1	98.9	174.04	10442.0	8702.0	8	0.0	44.2
38	0.1	99.0	178.74	10725.0	8937.0	8	0.0	44.2
39	0.0	99.0	183.45	11007.0	9172.0	8	0.0	44.2
40	0.0	99.0	188.15	11289.0	9408.0	7	0.0	44.2
41	0.1	99.1	192.85	11571.0	9643.0	7	0.0	44.2
42	0.1	99.2	197.56	11853.0	9878.0	7	0.0	44.2
43	0.1	99.3	202.26	12136.0	10113.0	7	0.0	44.2
44	0.1	99.4	206.97	12418.0	10348.0	7	0.0	44.2
45	0.0	99.4	211.67	12700.0	10583.0	7	0.0	44.2
46	0.2	99.6	216.37	12982.0	10819.0	7	0.0	44.2
47	0.0	99.6	221.08	13265.0	11054.0	7	0.0	44.2
48	0.0	99.6	225.78	13547.0	11289.0	7	0.0	44.2
49	0.0	99.6	230.48	13829.0	11524.0	7	0.0	44.2
50	0.0	99.6	235.19	14111.0	11759.0	7	0.0	44.2
Estimated Net Annual Sediment (TSS) Load Reduction =								44 %

RAINFALL DATA FROM HAMILTON AP RAINFALL STATION



INCREMENTAL AND CUMULATIVE TSS REMOVAL FOR THE RECOMMENDED STORMCEPTOR® MODEL



Maximum Pipe Diameter / Peak Conveyance

Stormceptor EF / EFO	Model Diameter (m)	Model Diameter (ft)	Min Angle Inlet / Outlet Pipes	Max Inlet Pipe Diameter (mm)	Max Inlet Pipe Diameter (in)	Max Outlet Pipe Diameter (mm)	Max Outlet Pipe Diameter (in)	Peak Conveyance Flow Rate (L/s)	Peak Conveyance Flow Rate (cfs)
EF4 / EFO4	1.2	4	90	609	24	609	24	425	15
EF6 / EFO6	1.8	6	90	914	36	914	36	990	35
EF8 / EFO8	2.4	8	90	1219	48	1219	48	1700	60
EF10 / EFO10	3.0	10	90	1828	72	1828	72	2830	100
EF12 / EFO12	3.6	12	90	1828	72	1828	72	2830	100

SCOUR PREVENTION AND ONLINE CONFIGURATION

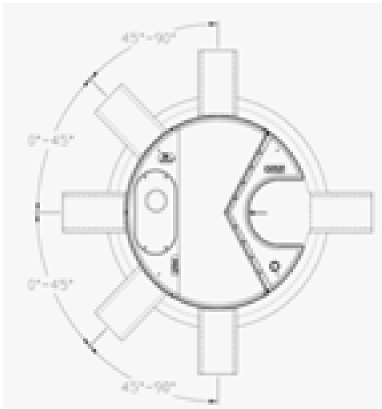
►**Stormceptor® EF and EFO** feature an internal bypass and superior scour prevention technology that have been demonstrated in third-party testing according to the scour testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**, and the exceptional scour test performance has been third-party verified in accordance with the ISO 14034 ETV protocol. As a result, Stormceptor EF and EFO are approved for online installation, eliminating the need for costly additional bypass structures, piping, and installation expense.

DESIGN FLEXIBILITY

►**Stormceptor® EF** and **EFO** offers design flexibility in one simplified platform, accepting stormwater flow from a single inlet pipe or multiple inlet pipes, and/or surface runoff through an inlet grate. The device can also serve as a junction structure, accommodate a 90-degree inlet-to-outlet bend angle, and can be modified to ensure performance in submerged conditions.

OIL CAPTURE AND RETENTION

►While Stormceptor® EF will capture and retain oil from dry weather spills and low intensity runoff, **Stormceptor® EFO** has demonstrated superior oil capture and greater than 99% oil retention in third-party testing according to the light liquid re-entrainment testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**. Stormceptor EFO is recommended for sites where oil capture and retention is a requirement.



INLET-TO-OUTLET DROP

Elevation differential between inlet and outlet pipe inverts is dictated by the angle at which the inlet pipe(s) enters the unit.

0° - 45° : The inlet pipe is 1-inch (25mm) higher than the outlet pipe.

45° - 90° : The inlet pipe is 2-inches (50mm) higher than the outlet pipe.

HEAD LOSS

The head loss through Stormceptor EF is similar to that of a 60-degree bend structure. The applicable K value for calculating minor losses through the unit is 1.1. For submerged conditions the applicable K value is 3.0.

Pollutant Capacity

Stormceptor EF / EFO	Model Diameter		Depth (Outlet Pipe Invert to Sump Floor)		Oil Volume		Recommended Sediment Maintenance Depth *		Maximum Sediment Volume *		Maximum Sediment Mass **	
	(m)	(ft)	(m)	(ft)	(L)	(Gal)	(mm)	(in)	(L)	(ft³)	(kg)	(lb)
EF4 / EFO4	1.2	4	1.52	5.0	265	70	203	8	1190	42	1904	5250
EF6 / EFO6	1.8	6	1.93	6.3	610	160	305	12	3470	123	5552	15375
EF8 / EFO8	2.4	8	2.59	8.5	1070	280	610	24	8780	310	14048	38750
EF10 / EFO10	3.0	10	3.25	10.7	1670	440	610	24	17790	628	28464	78500
EF12 / EFO12	3.6	12	3.89	12.8	2475	655	610	24	31220	1103	49952	137875

*Increased sump depth may be added to increase sediment storage capacity

** Average density of wet packed sediment in sump = 1.6 kg/L (100 lb/ft³)

Feature	Benefit	Feature Appeals To
Patent-pending enhanced flow treatment and scour prevention technology	Superior, verified third-party performance	Regulator, Specifying & Design Engineer
Third-party verified light liquid capture and retention for EFO version	Proven performance for fuel/oil hotspot locations	Regulator, Specifying & Design Engineer, Site Owner
Functions as bend, junction or inlet structure	Design flexibility	Specifying & Design Engineer
Minimal drop between inlet and outlet	Site installation ease	Contractor
Large diameter outlet riser for inspection and maintenance	Easy maintenance access from grade	Maintenance Contractor & Site Owner

STANDARD STORMCEPTOR EF/EFO DRAWINGS

For standard details, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

STANDARD STORMCEPTOR EF/EFO SPECIFICATION

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Table of TSS Removal vs Surface Loading Rate Based on Third-Party Test Results

Stormceptor® EF

SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL
1	70	660	46	1320	48	1980	35
30	70	690	46	1350	48	2010	34

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60	67	720	45	1380	49	2040	34
90	63	750	45	1410	49	2070	33
120	61	780	45	1440	48	2100	33
150	58	810	45	1470	47	2130	32
180	56	840	45	1500	46	2160	32
210	54	870	45	1530	45	2190	31
240	53	900	45	1560	44	2220	31
270	52	930	44	1590	43	2250	30
300	51	960	44	1620	42	2280	30
330	50	990	44	1650	42	2310	30
360	49	1020	44	1680	41	2340	29
390	48	1050	45	1710	40	2370	29
420	48	1080	45	1740	39	2400	29
450	48	1110	45	1770	39	2430	28
480	47	1140	46	1800	38	2460	28
510	47	1170	46	1830	37	2490	28
540	47	1200	47	1860	37	2520	27
570	46	1230	47	1890	36	2550	27
600	46	1260	47	1920	36	2580	27
630	46	1290	48	1950	35		

STANDARD PERFORMANCE SPECIFICATION FOR "OIL GRIT SEPARATOR" (OGS) STORMWATER QUALITY TREATMENT DEVICE

PART 1 – GENERAL

1.1 WORK INCLUDED

This section specifies requirements for selecting, sizing, and designing an underground Oil Grit Separator (OGS) device for stormwater quality treatment, with third-party testing results and a Statement of Verification in accordance with ISO 14034 Environmental Management – Environmental Technology Verification (ETV).

1.2 REFERENCE STANDARDS & PROCEDURES

ISO 14034:2016 Environmental management – Environmental technology verification (ETV)

Canadian Environmental Technology Verification (ETV) Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**

1.3 SUBMITTALS

1.3.1 All submittals, including sizing reports & shop drawings, shall be submitted upon request with each order to the contractor then forwarded to the Engineer of Record for review and acceptance. Shop drawings shall detail all OGS components, elevations, and sequence of construction.

1.3.2 Alternative devices shall have features identical to or greater than the specified device, including: treatment chamber diameter, treatment chamber wet volume, sediment storage volume, and oil storage volume.

1.3.3 Unless directed otherwise by the Engineer of Record, OGS stormwater quality treatment product substitutions or alternatives submitted within ten days prior to project bid shall not be accepted. All alternatives or substitutions submitted shall be signed and sealed by a local registered Professional Engineer, based on the exact same criteria detailed in Section 3, in entirety, subject to review and approval by the Engineer of Record.

PART 2 – PRODUCTS

2.1 OGS POLLUTANT STORAGE

The OGS device shall include a sump for sediment storage, and a protected volume for the capture and storage of petroleum hydrocarbons and buoyant gross pollutants. The **minimum** sediment & petroleum hydrocarbon storage capacity shall be as follows:

2.1.1	4 ft (1219 mm) Diameter OGS Units:	1.19 m^3 sediment / 265 L oil
	6 ft (1829 mm) Diameter OGS Units:	3.48 m^3 sediment / 609 L oil
	8 ft (2438 mm) Diameter OGS Units:	8.78 m^3 sediment / 1,071 L oil
	10 ft (3048 mm) Diameter OGS Units:	17.78 m^3 sediment / 1,673 L oil
	12 ft (3657 mm) Diameter OGS Units:	31.23 m^3 sediment / 2,476 L oil

PART 3 – PERFORMANCE & DESIGN

3.1 GENERAL

The OGS stormwater quality treatment device shall be verified in accordance with ISO 14034:2016 Environmental management – Environmental technology verification (ETV). The OGS stormwater quality treatment device shall remove oil, sediment and gross pollutants from stormwater runoff during frequent wet weather events, and retain these pollutants during less frequent high flow wet weather events below the insert within the OGS for later removal during maintenance. The Manufacturer shall have at least ten (10) years of local experience, history and success in engineering design, manufacturing and production and supply of OGS stormwater quality treatment device systems, acceptable to the Engineer of Record.

3.2 SIZING METHODOLOGY

The OGS device shall be engineered, designed and sized to provide stormwater quality treatment based on treating a minimum of 90 percent of the average annual runoff volume and a minimum removal of an annual average 60% of the sediment (TSS) load based on the Particle Size Distribution (PSD) specified in the sizing report for the specified device. Sizing shall be determined using historical rainfall data and a sediment removal performance curve derived from the actual third-party verified laboratory testing data. The OGS device shall also have sufficient annual sediment storage capacity as specified and calculated in Section 2.1.

3.3 CANADIAN ETV or ISO 14034 ETV VERIFICATION OF SCOUR TESTING

The OGS device shall have Canadian ETV or ISO 14034 ETV Verification of third-party scour testing conducted in accordance with the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**

3.3.1 To be acceptable for on-line installation, the OGS device must demonstrate an average scour test effluent concentration less than 10 mg/L at each surface loading rate tested, up to and including 2600 L/min/m^2.

Stormceptor®

Stormceptor® EF Sizing Report

STORMCEPTOR®
ESTIMATED NET ANNUAL SEDIMENT (TSS) LOAD REDUCTION

11/13/2020

Province:	Ontario
City:	Oakville
Nearest Rainfall Station:	HAMILTON AP
NCDC Rainfall Station Id:	3195
Years of Rainfall Data:	34
Site Name:	Birch Hill Lane - West
Drainage Area (ha):	0.88
% Imperviousness:	64.00
Runoff Coefficient 'c':	0.68
Particle Size Distribution:	CA ETV
Target TSS Removal (%):	3.6
Required Water Quality Runoff Volume Capture (%):	90.00
Estimated Water Quality Flow Rate (L/s):	22.91
Oil / Fuel Spill Risk Site?	No
Upstream Flow Control?	No
Peak Conveyance (maximum) Flow Rate (L/s):	
Site Sediment Transport Rate (kg/ha/yr):	

Project Name:	Lakeshore Road Class EA
Project Number:	43762
Designer Name:	Gurkanwal Arora
Designer Company:	Wood Environment & Infrastructure
Designer Email:	gurkanwal.arora@woodplc.com
Designer Phone:	905-335-2353
EOR Name:	
EOR Company:	
EOR Email:	
EOR Phone:	

Net Annual Sediment (TSS) Load Reduction Sizing Summary

Stormceptor Model	TSS Removal Provided (%)
EF4	56
EF6	62
EF8	65
EF10	66
EF12	68

Recommended Stormceptor EF Model:	**EF4**
Estimated Net Annual Sediment (TSS) Load Reduction (%):	**56**
Water Quality Runoff Volume Capture (%):	**> 90**

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THIRD-PARTY TESTING AND VERIFICATION

►**Stormceptor® EF and Stormceptor® EFO** are the latest evolutions in the Stormceptor® oil-grit separator (OGS) technology series, and are designed to remove a wide variety of pollutants from stormwater and snowmelt runoff. These technologies have been third-party tested in accordance with the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators** and performance has been third-party verified in accordance with the **ISO 14034 Environmental Technology Verification (ETV)** protocol.

PERFORMANCE

►**Stormceptor® EF and EFO** remove stormwater pollutants through gravity separation and floatation, and feature a patent-pending design that generates positive removal of total suspended solids (TSS) throughout each storm event, including high-intensity storms. Captured pollutants include sediment, free oils, and sediment-bound pollutants such as nutrients, heavy metals, and petroleum hydrocarbons. Stormceptor is sized to remove a high level of TSS from the frequent rainfall events that contribute the vast majority of annual runoff volume and pollutant load. The technology incorporates an internal bypass to convey excessive stormwater flows from high-intensity storms through the device without resuspension and washout (scour) of previously captured pollutants. Proper routine maintenance ensures high pollutant removal performance and protection of downstream waterways.

PARTICLE SIZE DISTRIBUTION (PSD)

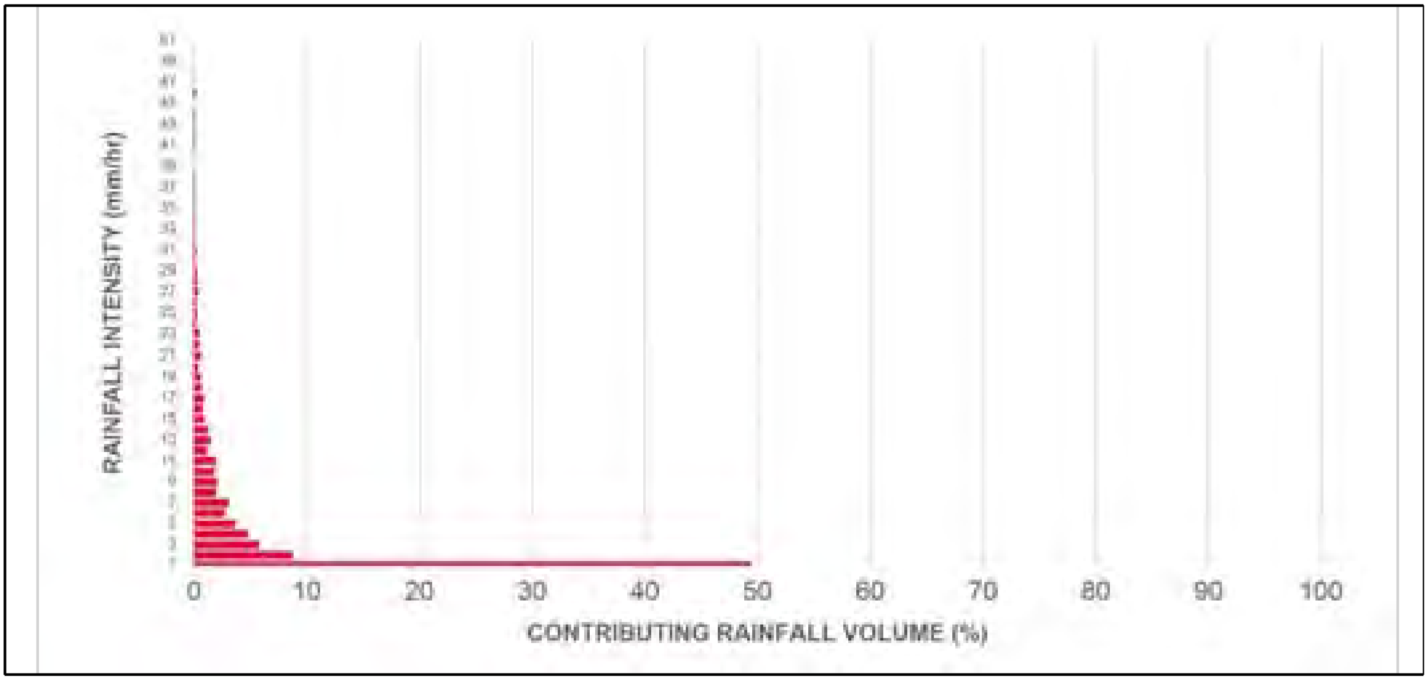
►The **Canadian ETV PSD** shown in the table below was used, or in part, for this sizing. This is the identical PSD that is referenced in the Canadian ETV ***Procedure for Laboratory Testing of Oil-Grit Separators*** for both sediment removal testing and scour testing. The Canadian ETV PSD contains a wide range of particle sizes in the sand and silt fractions, and is considered reasonably representative of the particle size fractions found in typical urban stormwater runoff.

Particle Size (µm)	Percent Less Than	Particle Size Fraction (µm)	Percent
1000	100	500-1000	5
500	95	250-500	5
250	90	150-250	15
150	75	100-150	15
100	60	75-100	10
75	50	50-75	5
50	45	20-50	10
20	35	8-20	15
8	20	5-8	10
5	10	2-5	5
2	5	<2	5

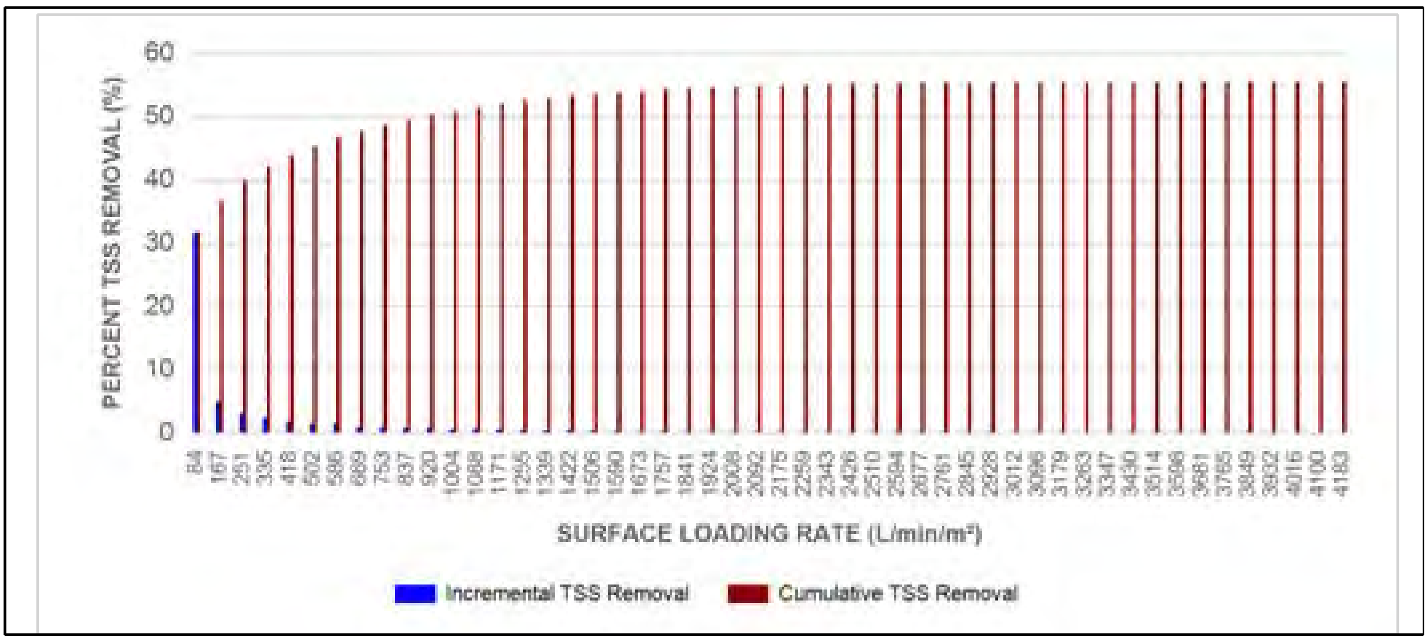
Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
1	49.5	49.5	1.67	100.0	84.0	64	31.7	31.7
2	8.8	58.3	3.35	201.0	167.0	57	5.0	36.7
3	5.8	64.1	5.02	301.0	251.0	53	3.0	39.8
4	4.8	68.9	6.69	402.0	335.0	50	2.4	42.2
5	3.7	72.6	8.37	502.0	418.0	48	1.8	43.9
6	2.8	75.4	10.04	602.0	502.0	47	1.3	45.3
7	3.1	78.5	11.71	703.0	586.0	46	1.4	46.7
8	2.0	80.5	13.39	803.0	669.0	46	0.9	47.6
9	2.1	82.6	15.06	904.0	753.0	45	1.0	48.6
10	1.8	84.4	16.73	1004.0	837.0	45	0.8	49.4
11	2.0	86.4	18.41	1104.0	920.0	44	0.9	50.3
12	1.2	87.6	20.08	1205.0	1004.0	44	0.5	50.8
13	1.5	89.1	21.75	1305.0	1088.0	45	0.7	51.5
14	1.3	90.4	23.43	1406.0	1171.0	46	0.6	52.1
15	0.9	91.3	25.10	1506.0	1255.0	47	0.4	52.5
16	0.8	92.1	26.77	1606.0	1339.0	48	0.4	52.9
17	0.9	93.0	28.45	1707.0	1422.0	48	0.4	53.3
18	0.7	93.7	30.12	1807.0	1506.0	46	0.3	53.6
19	0.6	94.3	31.79	1908.0	1590.0	43	0.3	53.9
20	0.4	94.7	33.47	2008.0	1673.0	41	0.2	54.0
21	0.6	95.3	35.14	2108.0	1757.0	39	0.2	54.3
22	0.5	95.8	36.81	2209.0	1841.0	37	0.2	54.5
23	0.5	96.3	38.49	2309.0	1924.0	36	0.2	54.6
24	0.2	96.5	40.16	2410.0	2008.0	34	0.1	54.7
25	0.3	96.8	41.83	2510.0	2092.0	33	0.1	54.8

Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
26	0.2	97.0	43.51	2610.0	2175.0	32	0.1	54.9
27	0.4	97.4	45.18	2711.0	2259.0	30	0.1	55.0
28	0.3	97.7	46.85	2811.0	2343.0	29	0.1	55.1
29	0.3	98.0	48.53	2912.0	2426.0	28	0.1	55.2
30	0.1	98.1	50.20	3012.0	2510.0	27	0.0	55.2
31	0.2	98.3	51.87	3112.0	2594.0	26	0.1	55.2
32	0.1	98.4	53.55	3213.0	2677.0	26	0.0	55.3
33	0.1	98.5	55.22	3313.0	2761.0	25	0.0	55.3
34	0.1	98.6	56.89	3414.0	2845.0	25	0.0	55.3
35	0.1	98.7	58.57	3514.0	2928.0	24	0.0	55.3
36	0.1	98.8	60.24	3614.0	3012.0	23	0.0	55.4
37	0.1	98.9	61.91	3715.0	3096.0	23	0.0	55.4
38	0.1	99.0	63.59	3815.0	3179.0	22	0.0	55.4
39	0.0	99.0	65.26	3916.0	3263.0	21	0.0	55.4
40	0.0	99.0	66.93	4016.0	3347.0	21	0.0	55.4
41	0.1	99.1	68.61	4116.0	3430.0	20	0.0	55.4
42	0.1	99.2	70.28	4217.0	3514.0	20	0.0	55.5
43	0.1	99.3	71.95	4317.0	3598.0	20	0.0	55.5
44	0.1	99.4	73.63	4418.0	3681.0	19	0.0	55.5
45	0.0	99.4	75.30	4518.0	3765.0	19	0.0	55.5
46	0.2	99.6	76.97	4618.0	3849.0	18	0.0	55.5
47	0.0	99.6	78.65	4719.0	3932.0	18	0.0	55.5
48	0.0	99.6	80.32	4819.0	4016.0	17	0.0	55.5
49	0.0	99.6	81.99	4920.0	4100.0	17	0.0	55.5
50	0.0	99.6	83.67	5020.0	4183.0	17	0.0	55.5
							Estimated Net Annual Sediment (TSS) Load Reduction =	**56 %**

RAINFALL DATA FROM HAMILTON AP RAINFALL STATION



INCREMENTAL AND CUMULATIVE TSS REMOVAL FOR THE RECOMMENDED STORMCEPTOR® MODEL



Maximum Pipe Diameter / Peak Conveyance

Stormceptor EF / EFO	Model Diameter		Min Angle Inlet / Outlet Pipes	Max Inlet Pipe Diameter		Max Outlet Pipe Diameter		Peak Conveyance Flow Rate	
	(m)	(ft)		(mm)	(in)	(mm)	(in)	(L/s)	(cfs)
EF4 / EFO4	1.2	4	90	609	24	609	24	425	15
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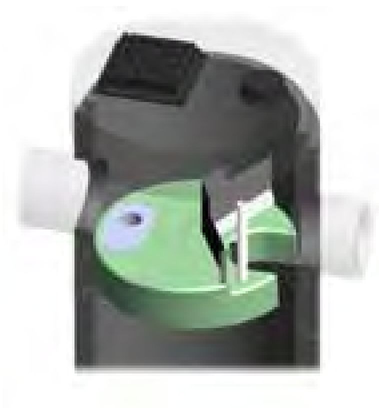
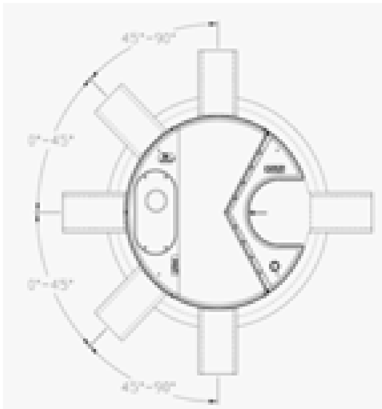
DESIGN FLEXIBILITY

►**Stormceptor® EF** and **EFO** offers design flexibility in one simplified platform, accepting stormwater flow from a single inlet pipe or multiple inlet pipes, and/or surface runoff through an inlet grate. The device can also serve as a junction structure, accommodate a 90-degree inlet-to-outlet bend angle, and can be modified to ensure performance in submerged conditions.

OIL CAPTURE AND RETENTION

►While Stormceptor® EF will capture and retain oil from dry weather spills and low intensity runoff, **Stormceptor® EFO** has demonstrated superior oil capture and greater than 99% oil retention in third-party testing according to the light liquid re-entrainment testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**. Stormceptor EFO is recommended for sites where oil capture and retention is a requirement.





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HEAD LOSS

The head loss through Stormceptor EF is similar to that of a 60-degree bend structure. The applicable K value for calculating minor losses through the unit is 1.1. For submerged conditions the applicable K value is 3.0.

Pollutant Capacity

Stormceptor EF / EFO	Model Diameter		Depth (Outlet Pipe Invert to Sump Floor)		Oil Volume		Recommended Sediment Maintenance Depth *		Maximum Sediment Volume *		Maximum Sediment Mass **	
	(m)	(ft)	(m)	(ft)	(L)	(Gal)	(mm)	(in)	(L)	(ft^3)	(kg)	(lb)
EF4 / EFO4	1.2	4	1.52	5.0	265	70	203	8	1190	42	1904	5250
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EF12 / EFO12	3.6	12	3.89	12.8	2475	655	610	24	31220	1103	49952	137875

*Increased sump depth may be added to increase sediment storage capacity
** Average density of wet packed sediment in sump = 1.6 kg/L (100 lb/ft^3)

Feature	Benefit	Feature Appeals To
Patent-pending enhanced flow treatment and scour prevention technology	Superior, verified third-party performance	Regulator, Specifying & Design Engineer
Third-party verified light liquid capture and retention for EFO version	Proven performance for fuel/oil hotspot locations	Regulator, Specifying & Design Engineer, Site Owner
Functions as bend, junction or inlet structure	Design flexibility	Specifying & Design Engineer
Minimal drop between inlet and outlet	Site installation ease	Contractor
Large diameter outlet riser for inspection and maintenance	Easy maintenance access from grade	Maintenance Contractor & Site Owner

STANDARD STORMCEPTOR EF/EFO DRAWINGS

For standard details, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

STANDARD STORMCEPTOR EF/EFO SPECIFICATION

For specifications, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

Table of TSS Removal vs Surface Loading Rate Based on Third-Party Test Results
Stormceptor® EF

SLR (L/min/m^2)	TSS % REMOVAL	SLR (L/min/m^2)	TSS % REMOVAL	SLR (L/min/m^2)	TSS % REMOVAL	SLR (L/min/m^2)	TSS % REMOVAL
1	70	660	46	1320	48	1980	35
30	70	690	46	1350	48	2010	34

60	67	720	45	1380	49	2040	34
90	63	750	45	1410	49	2070	33
120	61	780	45	1440	48	2100	33
150	58	810	45	1470	47	2130	32
180	56	840	45	1500	46	2160	32
210	54	870	45	1530	45	2190	31
240	53	900	45	1560	44	2220	31
270	52	930	44	1590	43	2250	30
300	51	960	44	1620	42	2280	30
330	50	990	44	1650	42	2310	30
360	49	1020	44	1680	41	2340	29
390	48	1050	45	1710	40	2370	29
420	48	1080	45	1740	39	2400	29
450	48	1110	45	1770	39	2430	28
480	47	1140	46	1800	38	2460	28
510	47	1170	46	1830	37	2490	28
540	47	1200	47	1860	37	2520	27
570	46	1230	47	1890	36	2550	27
600	46	1260	47	1920	36	2580	27
630	46	1290	48	1950	35		

STANDARD PERFORMANCE SPECIFICATION FOR "OIL GRIT SEPARATOR" (OGS) STORMWATER QUALITY TREATMENT DEVICE

PART 1 – GENERAL

1.1 WORK INCLUDED

This section specifies requirements for selecting, sizing, and designing an underground Oil Grit Separator (OGS) device for stormwater quality treatment, with third-party testing results and a Statement of Verification in accordance with ISO 14034 Environmental Management – Environmental Technology Verification (ETV).

1.2 REFERENCE STANDARDS & PROCEDURES

ISO 14034:2016 Environmental management – Environmental technology verification (ETV)

Canadian Environmental Technology Verification (ETV) Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**

1.3 SUBMITTALS

1.3.1 All submittals, including sizing reports & shop drawings, shall be submitted upon request with each order to the contractor then forwarded to the Engineer of Record for review and acceptance. Shop drawings shall detail all OGS components, elevations, and sequence of construction.

1.3.2 Alternative devices shall have features identical to or greater than the specified device, including: treatment chamber diameter, treatment chamber wet volume, sediment storage volume, and oil storage volume.

1.3.3 Unless directed otherwise by the Engineer of Record, OGS stormwater quality treatment product substitutions or alternatives submitted within ten days prior to project bid shall not be accepted. All alternatives or substitutions submitted shall be signed and sealed by a local registered Professional Engineer, based on the exact same criteria detailed in Section 3, in entirety, subject to review and approval by the Engineer of Record.

PART 2 – PRODUCTS

2.1 OGS POLLUTANT STORAGE

The OGS device shall include a sump for sediment storage, and a protected volume for the capture and storage of petroleum hydrocarbons and buoyant gross pollutants. The **minimum** sediment & petroleum hydrocarbon storage capacity shall be as follows:

2.1.1	4 ft (1219 mm) Diameter OGS Units:	1.19 m^3 sediment / 265 L oil
	6 ft (1829 mm) Diameter OGS Units:	3.48 m^3 sediment / 609 L oil
	8 ft (2438 mm) Diameter OGS Units:	8.78 m^3 sediment / 1,071 L oil
	10 ft (3048 mm) Diameter OGS Units:	17.78 m^3 sediment / 1,673 L oil
	12 ft (3657 mm) Diameter OGS Units:	31.23 m^3 sediment / 2,476 L oil

PART 3 – PERFORMANCE & DESIGN

3.1 GENERAL

The OGS stormwater quality treatment device shall be verified in accordance with ISO 14034:2016 Environmental management – Environmental technology verification (ETV). The OGS stormwater quality treatment device shall remove oil, sediment and gross pollutants from stormwater runoff during frequent wet weather events, and retain these pollutants during less frequent high flow wet weather events below the insert within the OGS for later removal during maintenance. The Manufacturer shall have at least ten (10) years of local experience, history and success in engineering design, manufacturing and production and supply of OGS stormwater quality treatment device systems, acceptable to the Engineer of Record.

3.2 SIZING METHODOLOGY

The OGS device shall be engineered, designed and sized to provide stormwater quality treatment based on treating a minimum of 90 percent of the average annual runoff volume and a minimum removal of an annual average 60% of the sediment (TSS) load based on the Particle Size Distribution (PSD) specified in the sizing report for the specified device. Sizing shall be determined using historical rainfall data and a sediment removal performance curve derived from the actual third-party verified laboratory testing data. The OGS device shall also have sufficient annual sediment storage capacity as specified and calculated in Section 2.1.

3.3 CANADIAN ETV or ISO 14034 ETV VERIFICATION OF SCOUR TESTING

The OGS device shall have Canadian ETV or ISO 14034 ETV Verification of third-party scour testing conducted in accordance with the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**

3.3.1 To be acceptable for on-line installation, the OGS device must demonstrate an average scour test effluent concentration less than 10 mg/L at each surface loading rate tested, up to and including 2600 L/min/m^2.

Stormceptor® EF Sizing Report

STORMCEPTOR®
ESTIMATED NET ANNUAL SEDIMENT (TSS) LOAD REDUCTION

11/13/2020

Province:	Ontario
City:	Oakville
Nearest Rainfall Station:	HAMILTON AP
NCDC Rainfall Station Id:	3195
Years of Rainfall Data:	34

Project Name:	Lakeshore Road Class EA
Project Number:	43762
Designer Name:	Gurkanwal Arora
Designer Company:	Wood Environment & Infrastructure
Designer Email:	gurkanwal.arora@woodplc.com
Designer Phone:	905-335-2353
EOR Name:	
EOR Company:	
EOR Email:	
EOR Phone:	

Site Name:	Birch Hill Lane - East

Drainage Area (ha):	3.76
% Imperviousness:	51.00

Runoff Coefficient 'c': 0.60

Particle Size Distribution:	CA ETV
Target TSS Removal (%):	1.5

Required Water Quality Runoff Volume Capture (%):	90.00
Estimated Water Quality Flow Rate (L/s):	86.73
Oil / Fuel Spill Risk Site?	No
Upstream Flow Control?	No
Peak Conveyance (maximum) Flow Rate (L/s):	
Site Sediment Transport Rate (kg/ha/yr):	

Net Annual Sediment (TSS) Load Reduction Sizing Summary

Stormceptor Model	TSS Removal Provided (%)
EF4	41
EF6	50
EF8	56
EF10	60
EF12	62

Recommended Stormceptor EF Model: **EF4**

Estimated Net Annual Sediment (TSS) Load Reduction (%): **41**

Water Quality Runoff Volume Capture (%): **> 90**

imbrium

THIRD-PARTY TESTING AND VERIFICATION

►**Stormceptor® EF and Stormceptor® EFO** are the latest evolutions in the Stormceptor® oil-grit separator (OGS) technology series, and are designed to remove a wide variety of pollutants from stormwater and snowmelt runoff. These technologies have been third-party tested in accordance with the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators** and performance has been third-party verified in accordance with the **ISO 14034 Environmental Technology Verification (ETV)** protocol.

PERFORMANCE

►**Stormceptor® EF and EFO** remove stormwater pollutants through gravity separation and floatation, and feature a patent-pending design that generates positive removal of total suspended solids (TSS) throughout each storm event, including high-intensity storms. Captured pollutants include sediment, free oils, and sediment-bound pollutants such as nutrients, heavy metals, and petroleum hydrocarbons. Stormceptor is sized to remove a high level of TSS from the frequent rainfall events that contribute the vast majority of annual runoff volume and pollutant load. The technology incorporates an internal bypass to convey excessive stormwater flows from high-intensity storms through the device without resuspension and washout (scour) of previously captured pollutants. Proper routine maintenance ensures high pollutant removal performance and protection of downstream waterways.

PARTICLE SIZE DISTRIBUTION (PSD)

►The **Canadian ETV PSD** shown in the table below was used, or in part, for this sizing. This is the identical PSD that is referenced in the Canadian ETV ***Procedure for Laboratory Testing of Oil-Grit Separators*** for both sediment removal testing and scour testing. The Canadian ETV PSD contains a wide range of particle sizes in the sand and silt fractions, and is considered reasonably representative of the particle size fractions found in typical urban stormwater runoff.

Particle Size (µm)	Percent Less Than	Particle Size Fraction (µm)	Percent
1000	100	500-1000	5
500	95	250-500	5
250	90	150-250	15
150	75	100-150	15
100	60	75-100	10
75	50	50-75	5
50	45	20-50	10
20	35	8-20	15
8	20	5-8	10
5	10	2-5	5
2	5	<2	5

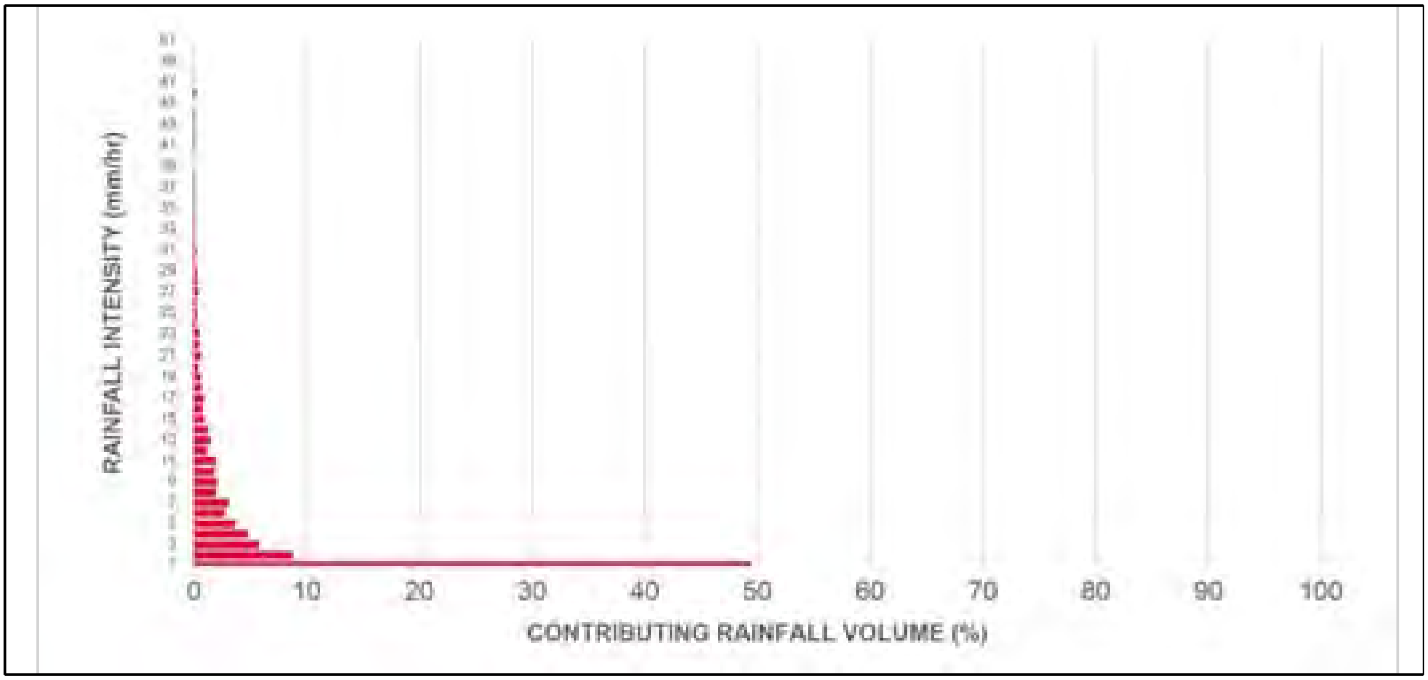
Stormceptor® EF Sizing Report

Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
1	49.5	49.5	6.33	380.0	317.0	51	25.1	25.1
2	8.8	58.3	12.67	760.0	633.0	46	4.0	29.1
3	5.8	64.1	19.00	1140.0	950.0	44	2.6	31.7
4	4.8	68.9	25.34	1520.0	1267.0	47	2.3	34.0
5	3.7	72.6	31.67	1900.0	1584.0	43	1.6	35.6
6	2.8	75.4	38.01	2280.0	1900.0	36	1.0	36.6
7	3.1	78.5	44.34	2660.0	2217.0	31	1.0	37.5
8	2.0	80.5	50.68	3041.0	2534.0	27	0.5	38.1
9	2.1	82.6	57.01	3421.0	2850.0	25	0.5	38.6
10	1.8	84.4	63.34	3801.0	3167.0	22	0.4	39.0
11	2.0	86.4	69.68	4181.0	3484.0	20	0.4	39.4
12	1.2	87.6	76.01	4561.0	3801.0	18	0.2	39.6
13	1.5	89.1	82.35	4941.0	4117.0	17	0.3	39.9
14	1.3	90.4	88.68	5321.0	4434.0	16	0.2	40.1
15	0.9	91.3	95.02	5701.0	4751.0	15	0.1	40.2
16	0.8	92.1	101.35	6081.0	5068.0	14	0.1	40.3
17	0.9	93.0	107.68	6461.0	5384.0	13	0.1	40.4
18	0.7	93.7	114.02	6841.0	5701.0	12	0.1	40.5
19	0.6	94.3	120.35	7221.0	6018.0	11	0.1	40.6
20	0.4	94.7	126.69	7601.0	6334.0	11	0.0	40.6
21	0.6	95.3	133.02	7981.0	6651.0	10	0.1	40.7
22	0.5	95.8	139.36	8361.0	6968.0	10	0.1	40.7
23	0.5	96.3	145.69	8741.0	7285.0	10	0.0	40.8
24	0.2	96.5	152.03	9122.0	7601.0	9	0.0	40.8
25	0.3	96.8	158.36	9502.0	7918.0	9	0.0	40.8

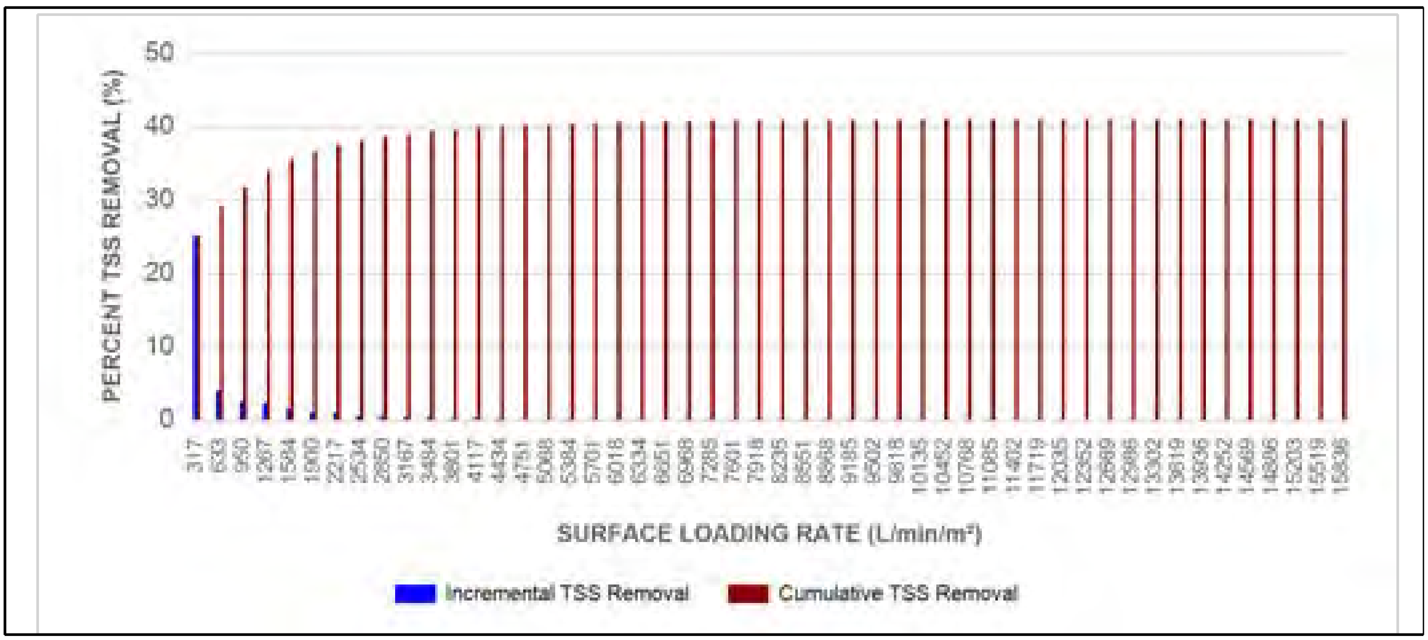
Stormceptor® EF Sizing Report

Rainfall Intensity (mm / hr)	Percent Rainfall Volume (%)	Cumulative Rainfall Volume (%)	Flow Rate (L/s)	Flow Rate (L/min)	Surface Loading Rate (L/min/m²)	Removal Efficiency (%)	Incremental Removal (%)	Cumulative Removal (%)
26	0.2	97.0	164.69	9882.0	8235.0	8	0.0	40.8
27	0.4	97.4	171.03	10262.0	8551.0	8	0.0	40.9
28	0.3	97.7	177.36	10642.0	8868.0	8	0.0	40.9
29	0.3	98.0	183.70	11022.0	9185.0	8	0.0	40.9
30	0.1	98.1	190.03	11402.0	9502.0	7	0.0	40.9
31	0.2	98.3	196.37	11782.0	9818.0	7	0.0	40.9
32	0.1	98.4	202.70	12162.0	10135.0	7	0.0	41.0
33	0.1	98.5	209.04	12542.0	10452.0	7	0.0	41.0
34	0.1	98.6	215.37	12922.0	10768.0	7	0.0	41.0
35	0.1	98.7	221.70	13302.0	11085.0	7	0.0	41.0
36	0.1	98.8	228.04	13682.0	11402.0	7	0.0	41.0
37	0.1	98.9	234.37	14062.0	11719.0	7	0.0	41.0
38	0.1	99.0	240.71	14442.0	12035.0	7	0.0	41.0
39	0.0	99.0	247.04	14822.0	12352.0	7	0.0	41.0
40	0.0	99.0	253.38	15203.0	12669.0	7	0.0	41.0
41	0.1	99.1	259.71	15583.0	12986.0	7	0.0	41.0
42	0.1	99.2	266.04	15963.0	13302.0	7	0.0	41.0
43	0.1	99.3	272.38	16343.0	13619.0	7	0.0	41.0
44	0.1	99.4	278.71	16723.0	13936.0	7	0.0	41.0
45	0.0	99.4	285.05	17103.0	14252.0	7	0.0	41.0
46	0.2	99.6	291.38	17483.0	14569.0	7	0.0	41.0
47	0.0	99.6	297.72	17863.0	14886.0	7	0.0	41.0
48	0.0	99.6	304.05	18243.0	15203.0	7	0.0	41.0
49	0.0	99.6	310.39	18623.0	15519.0	7	0.0	41.0
50	0.0	99.6	316.72	19003.0	15836.0	7	0.0	41.0
Estimated Net Annual Sediment (TSS) Load Reduction =								41 %

RAINFALL DATA FROM HAMILTON AP RAINFALL STATION



INCREMENTAL AND CUMULATIVE TSS REMOVAL
FOR THE RECOMMENDED STORMCEPTOR® MODEL



Maximum Pipe Diameter / Peak Conveyance

Stormceptor EF / EFO	Model Diameter (m)	Model Diameter (ft)	Min Angle Inlet / Outlet Pipes	Max Inlet Pipe Diameter (mm)	Max Inlet Pipe Diameter (in)	Max Outlet Pipe Diameter (mm)	Max Outlet Pipe Diameter (in)	Peak Conveyance Flow Rate (L/s)	Peak Conveyance Flow Rate (cfs)
EF4 / EFO4	1.2	4	90	609	24	609	24	425	15
EF6 / EFO6	1.8	6	90	914	36	914	36	990	35
EF8 / EFO8	2.4	8	90	1219	48	1219	48	1700	60
EF10 / EFO10	3.0	10	90	1828	72	1828	72	2830	100
EF12 / EFO12	3.6	12	90	1828	72	1828	72	2830	100

SCOUR PREVENTION AND ONLINE CONFIGURATION

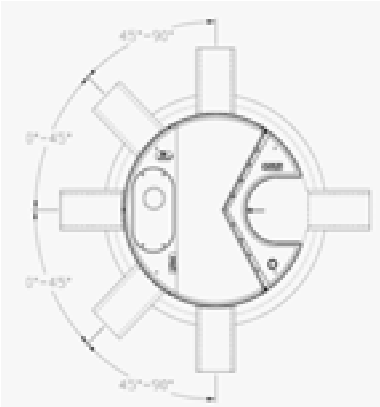
►**Stormceptor® EF and EFO** feature an internal bypass and superior scour prevention technology that have been demonstrated in third-party testing according to the scour testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**, and the exceptional scour test performance has been third-party verified in accordance with the ISO 14034 ETV protocol. As a result, Stormceptor EF and EFO are approved for online installation, eliminating the need for costly additional bypass structures, piping, and installation expense.

DESIGN FLEXIBILITY

►**Stormceptor® EF** and **EFO** offers design flexibility in one simplified platform, accepting stormwater flow from a single inlet pipe or multiple inlet pipes, and/or surface runoff through an inlet grate. The device can also serve as a junction structure, accommodate a 90-degree inlet-to-outlet bend angle, and can be modified to ensure performance in submerged conditions.

OIL CAPTURE AND RETENTION

►While Stormceptor® EF will capture and retain oil from dry weather spills and low intensity runoff, **Stormceptor® EFO** has demonstrated superior oil capture and greater than 99% oil retention in third-party testing according to the light liquid re-entrainment testing provisions of the Canadian ETV **Procedure for Laboratory Testing of Oil-Grit Separators**. Stormceptor EFO is recommended for sites where oil capture and retention is a requirement.



INLET-TO-OUTLET DROP

Elevation differential between inlet and outlet pipe inverts is dictated by the angle at which the inlet pipe(s) enters the unit.

0° - 45° : The inlet pipe is 1-inch (25mm) higher than the outlet pipe.

45° - 90° : The inlet pipe is 2-inches (50mm) higher than the outlet pipe.

HEAD LOSS

The head loss through Stormceptor EF is similar to that of a 60-degree bend structure. The applicable K value for calculating minor losses through the unit is 1.1. For submerged conditions the applicable K value is 3.0.

Pollutant Capacity

Stormceptor EF / EFO	Model Diameter		Depth (Outlet Pipe Invert to Sump Floor)		Oil Volume		Recommended Sediment Maintenance Depth *		Maximum Sediment Volume *		Maximum Sediment Mass **	
	(m)	(ft)	(m)	(ft)	(L)	(Gal)	(mm)	(in)	(L)	(ft³)	(kg)	(lb)
EF4 / EFO4	1.2	4	1.52	5.0	265	70	203	8	1190	42	1904	5250
EF6 / EFO6	1.8	6	1.93	6.3	610	160	305	12	3470	123	5552	15375
EF8 / EFO8	2.4	8	2.59	8.5	1070	280	610	24	8780	310	14048	38750
EF10 / EFO10	3.0	10	3.25	10.7	1670	440	610	24	17790	628	28464	78500
EF12 / EFO12	3.6	12	3.89	12.8	2475	655	610	24	31220	1103	49952	137875

*Increased sump depth may be added to increase sediment storage capacity

** Average density of wet packed sediment in sump = 1.6 kg/L (100 lb/ft³)

Feature	Benefit	Feature Appeals To
Patent-pending enhanced flow treatment and scour prevention technology	Superior, verified third-party performance	Regulator, Specifying & Design Engineer
Third-party verified light liquid capture and retention for EFO version	Proven performance for fuel/oil hotspot locations	Regulator, Specifying & Design Engineer, Site Owner
Functions as bend, junction or inlet structure	Design flexibility	Specifying & Design Engineer
Minimal drop between inlet and outlet	Site installation ease	Contractor
Large diameter outlet riser for inspection and maintenance	Easy maintenance access from grade	Maintenance Contractor & Site Owner

STANDARD STORMCEPTOR EF/EFO DRAWINGS

For standard details, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

STANDARD STORMCEPTOR EF/EFO SPECIFICATION

For specifications, please visit http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-ef

Table of TSS Removal vs Surface Loading Rate Based on Third-Party Test Results
Stormceptor® EF

SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL	SLR (L/min/m²)	TSS % REMOVAL
1	70	660	46	1320	48	1980	35
30	70	690	46	1350	48	2010	34

60	67	720	45	1380	49	2040	34
90	63	750	45	1410	49	2070	33
120	61	780	45	1440	48	2100	33
150	58	810	45	1470	47	2130	32
180	56	840	45	1500	46	2160	32
210	54	870	45	1530	45	2190	31
240	53	900	45	1560	44	2220	31
270	52	930	44	1590	43	2250	30
300	51	960	44	1620	42	2280	30
330	50	990	44	1650	42	2310	30
360	49	1020	44	1680	41	2340	29
390	48	1050	45	1710	40	2370	29
420	48	1080	45	1740	39	2400	29
450	48	1110	45	1770	39	2430	28
480	47	1140	46	1800	38	2460	28
510	47	1170	46	1830	37	2490	28
540	47	1200	47	1860	37	2520	27
570	46	1230	47	1890	36	2550	27
600	46	1260	47	1920	36	2580	27
630	46	1290	48	1950	35		

STANDARD PERFORMANCE SPECIFICATION FOR "OIL GRIT SEPARATOR" (OGS) STORMWATER QUALITY TREATMENT DEVICE

PART 1 – GENERAL

1.1 WORK INCLUDED

This section specifies requirements for selecting, sizing, and designing an underground Oil Grit Separator (OGS) device for stormwater quality treatment, with third-party testing results and a Statement of Verification in accordance with ISO 14034 Environmental Management – Environmental Technology Verification (ETV).

1.2 REFERENCE STANDARDS & PROCEDURES

ISO 14034:2016 Environmental management – Environmental technology verification (ETV)

Canadian Environmental Technology Verification (ETV) Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**

1.3 SUBMITTALS

1.3.1 All submittals, including sizing reports & shop drawings, shall be submitted upon request with each order to the contractor then forwarded to the Engineer of Record for review and acceptance. Shop drawings shall detail all OGS components, elevations, and sequence of construction.

1.3.2 Alternative devices shall have features identical to or greater than the specified device, including: treatment chamber diameter, treatment chamber wet volume, sediment storage volume, and oil storage volume.

1.3.3 Unless directed otherwise by the Engineer of Record, OGS stormwater quality treatment product substitutions or alternatives submitted within ten days prior to project bid shall not be accepted. All alternatives or substitutions submitted shall be signed and sealed by a local registered Professional Engineer, based on the exact same criteria detailed in Section 3, in entirety, subject to review and approval by the Engineer of Record.

PART 2 – PRODUCTS

2.1 OGS POLLUTANT STORAGE

The OGS device shall include a sump for sediment storage, and a protected volume for the capture and storage of petroleum hydrocarbons and buoyant gross pollutants. The **minimum** sediment & petroleum hydrocarbon storage capacity shall be as follows:

2.1.1	4 ft (1219 mm) Diameter OGS Units:	1.19 m^3 sediment / 265 L oil
	6 ft (1829 mm) Diameter OGS Units:	3.48 m^3 sediment / 609 L oil
	8 ft (2438 mm) Diameter OGS Units:	8.78 m^3 sediment / 1,071 L oil
	10 ft (3048 mm) Diameter OGS Units:	17.78 m^3 sediment / 1,673 L oil
	12 ft (3657 mm) Diameter OGS Units:	31.23 m^3 sediment / 2,476 L oil

PART 3 – PERFORMANCE & DESIGN

3.1 GENERAL

The OGS stormwater quality treatment device shall be verified in accordance with ISO 14034:2016 Environmental management – Environmental technology verification (ETV). The OGS stormwater quality treatment device shall remove oil, sediment and gross pollutants from stormwater runoff during frequent wet weather events, and retain these pollutants during less frequent high flow wet weather events below the insert within the OGS for later removal during maintenance. The Manufacturer shall have at least ten (10) years of local experience, history and success in engineering design, manufacturing and production and supply of OGS stormwater quality treatment device systems, acceptable to the Engineer of Record.

3.2 SIZING METHODOLOGY

The OGS device shall be engineered, designed and sized to provide stormwater quality treatment based on treating a minimum of 90 percent of the average annual runoff volume and a minimum removal of an annual average 60% of the sediment (TSS) load based on the Particle Size Distribution (PSD) specified in the sizing report for the specified device. Sizing shall be determined using historical rainfall data and a sediment removal performance curve derived from the actual third-party verified laboratory testing data. The OGS device shall also have sufficient annual sediment storage capacity as specified and calculated in Section 2.1.

3.3 CANADIAN ETV or ISO 14034 ETV VERIFICATION OF SCOUR TESTING

The OGS device shall have Canadian ETV or ISO 14034 ETV Verification of third-party scour testing conducted in accordance with the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators.**

3.3.1 To be acceptable for on-line installation, the OGS device must demonstrate an average scour test effluent concentration less than 10 mg/L at each surface loading rate tested, up to and including 2600 L/min/m^2.

Appendix G
Preliminary Storm Sewer Upgrade Estimates

Preliminary Catch Basin Cost Estimate - 2020 Con Cast Price List

Type	Quantity	Description	Height (m)	Unit Price ($/unit)	Supply Cost ($)	Supply and Construction Cost ($)
DCB	12	600 x 1450 Twin Inlet 115 wall thickness	2.134	$ 2,147.20	$ 25,766.40	$ 77,299.20
CB	49	600 x 600 Single Inlet 150 wall thickness	2.134	$ 1,495.70	$ 73,289.30	$ 219,867.90
Total						**$ 297,167.10**

Preliminary Manhole Cost Estimate - 2020 Con Cast Price List

Type	Quantity	Description	Height (m)	Unit Price ($/unit)	Supply Cost ($)	Supply and Construction Cost ($)
MH	29	2400 mm Diameter	2.94 - 3.25	$ 14,874.00	$ 431,346.00	$ 1,294,038.00
Total						**$ 1,294,038.00**

Drainage Outlet	Road Stations	Chainage		Conduit ID		Sewer		Sewer Length (m)	Supply Cost ($)	Supply and Construction Cost ($)
		From Station	To Station	Conduit ID in Existing Model	Conduit ID in Proposed Model	Existing Sewer Diameter(mm)	Proposed Sewer Diameter(mm)			
West to Bronte Creek	0+000 - 0+300	0+000	0+300	-	-	As Is	As Is**	0	$ -	$ -
East to Bronte Creek	0+310 - 0+700	0+340	0+360	O_0200_6614	Same as Existing	600	1050	29.76	$ 22,421.18	$ 67,263.55
		0+360	0+425	O_0200_400708	Same as Existing	600	1050	62.017	$ 46,723.61	$ 140,170.82
		0+425	0+470	O_0200_400707	Same as Existing	600	1050	43.578	$ 32,831.67	$ 98,495.00
		0+470	0+490	O_0200_400706	Same as Existing	600	825	18.062	$ 9,547.57	$ 28,642.72
		0+490	0+490	O_0200_400705	Same as Existing	525	825	13.716	$ 7,250.28	$ 21,750.83
		0+490	0+580	O_0200_10	O_0200_400765_2	375	600	94.311	$ 19,211.15	$ 57,633.45
		0+580	0+600	O_0200_9	O_0200_400765_1	375	600	22.369	$ 4,556.57	$ 13,669.70
		0+600	0+650	O_0200_7357	Same as Existing	375	450	48.032	$ 5,802.27	$ 17,406.80
		0+700	0+780	Does not Exist	C-Prop_1	-	375	83.12	$ 9,741.66	$ 29,224.99
East to Nelson Creek	0+780 - 1+090	0+840	0+890	Does not Exist	C-Prop_3	-	375	51.43	$ 6,027.60	$ 18,082.79
		0+890	0+960	O_0200	O_0200_6477	375	450	68.816	$ 8,312.97	$ 24,938.92
		0+960	1+020	O_0200_6478	Same as Existing	375	900	59.194	$ 33,764.26	$ 101,292.77
		1+020	1+020	C6_13	Same as Existing	300	900	13	$ 7,415.20	$ 22,245.60
		1+020	1+035	C7_13	Same as Existing	1000	900	16.61	$ 9,474.34	$ 28,423.03
		1+035	1+060	O_0200_6481	Same as Existing	750	900	25.09	$ 14,311.34	$ 42,934.01
West to Nelson Creek	1+090 - 1+400	1+060	1+075	O_0200_15	O_0200_6993_2	675	1050	17.217	$ 12,971.29	$ 38,913.86
		1+075	1+135	O_0200_14	O_0200_6993_1	675	1050	60.33	$ 45,452.62	$ 136,357.87
		1+135	1+145	O_0200_17	O_0200_7023_5	600	900	11.703	$ 6,675.39	$ 20,026.17
		1+145	1+155	O_0200_19	O_0200_7023_4	600	900	4.956	$ 2,826.90	$ 8,480.71
		1+155	1+170	O_0200_20	O_0200_7023_3	600	900	17.471	$ 9,965.46	$ 29,896.38
		1+170	1+180	O_0200_21	O_0200_7023_2	600	900	9.832	$ 5,608.17	$ 16,824.52
		1+180	1+205	O_0200_18	O_0200_7023_1	600	900	26.11	$ 14,893.14	$ 44,679.43
		1+205	1+215	O_0200_22	O_0200_7022_3	600	750	6.731	$ 2,756.34	$ 8,269.03
		1+215	1+220	O_0200_24	O_0200_7022_2	600	750	2.997	$ 1,227.27	$ 3,681.81
		1+220	1+280	O_0200_23	O_0200_7022_1	600	750	62.294	$ 25,509.39	$ 76,528.18
		1+280	1+290	O_0200_7021	O_0200_7021	525	600	12.524	$ 2,551.14	$ 7,653.42
		1+290	1+300	O_0200_25	O_0200_6482_2	300	450	6.465	$ 780.97	$ 2,342.92
		1+300	1+340	O_0200_16	O_0200_6482_1	300	450	42.873	$ 5,179.06	$ 15,537.18
Sarah Lane	1+400 - 1+850	1+415	1+435	O_0200_26	O_0200_6524_1	750	1800	17.2	$ 36,900.88	$ 110,702.64
		1+435	1+475	O_0200_28	O_0200_6524_2	750	1800	45.207	$ 96,987.10	$ 290,961.29
		1+475	1+490	O_0200_29	O_0200_6524_3	750	1800	17.602	$ 37,763.33	$ 113,289.99
		1+490	1+520	C1_6	O_0200_7226_1	825	1800	26.656	$ 57,187.78	$ 171,563.35
		1+520	1+530	C1_18	O_0200_7226_2	825	1800	8.667	$ 18,594.18	$ 55,782.55
		1+530	1+535	O_0200_31	O_0200_7226_4	825	1800	30.082	$ 64,537.92	$ 193,613.77
		1+535	1+560	O_0200_30	O_0200_7226_5	825	1800	24.98	$ 53,592.09	$ 160,776.28
		1+560	1+585	O_0200_33	O_0200_7226_6	825	1800	57.863	$ 124,139.28	$ 372,417.84
		1+585	1+640	O_0200_32	O_0200_6525_1	825	1800	19.206	$ 41,204.55	$ 123,613.66
		1+640	1+660	O_0200_35	O_0200_6525_2	825	1800	27.75	$ 59,534.85	$ 178,604.55
		1+660	1+690	O_0200_34	O_0200_6525_3	825	1800	14.507	$ 31,123.32	$ 93,369.95
		1+705	1+775	O_0200_36	O_0200_6525_4	825	1800	71.701	$ 153,827.33	$ 461,481.98
		1+775	1+795	O_0200_38	O_0200_6525_5	825	1800	18.819	$ 40,374.28	$ 121,122.85
Coronation Park West Channel	1+850 - 2+660	1+925	2+000	Does not Exist	C-Prop_4	-	375	77.95	$ 9,135.74	$ 27,407.22
		2+000	2+080	Does not Exist	C-Prop_5	-	375	79.18	$ 9,279.90	$ 27,839.69
		2+080	2+155	Does not Exist	C-Prop_6	-	525	70.85	$ 10,896.73	$ 32,690.19
		2+155	2+240	Does not Exist	C-Prop_7	-	525	79.42	$ 12,214.80	$ 36,644.39
		2+240	2+265	C36_CP	C36	900	1050	33.93	$ 25,562.86	$ 76,688.59
		2+265	2+265	O_0200_400175	Removed	900	-***			$ -
		2+265	2+400	Does not Exist	PROP-01	-	1050	137.14	$ 103,321.28	$ 309,963.83
		2+400	2+400	O_0200_6144	Removed	1200 x 1000 Rec	-***			$ -
		2+400	2+530	PROP-02	Same as Existing	1050	1350	123.25	$ 149,489.93	$ 448,469.78
		2+530	2+655	PROP-03	Same as Existing	1050	1350	125.5	$ 152,218.95	$ 456,656.85
		2+655	2+655	O_0200_1CP	PROP04	900	1200	17.47	$ 16,486.44	$ 49,459.32

Drainage Outlet	Road Stations	Chainage		Conduit ID		Sewer		Sewer Length (m)	Supply Cost ($)	Supply and Construction Cost ($)
		From Station	To Station	Conduit ID in Existing Model	Conduit ID in Proposed Model	Existing Sewer Diameter(mm)	Proposed Sewer Diameter(mm)			
		2+655	2+655	O_0200_1CP	C614_CP	900	1200	94.63	$ 89,302.33	$ 267,906.99
		2+655	2+655	O_0200_2CP	C15_CP	900	1200	11.7	$ 11,041.29	$ 33,123.87
Coronation Park East Channel	2+660 - 2+950	2+655	2+665	C76	Same as Existing	975	1350	7.54	$ 9,145.27	$ 27,435.80
		2+665	2+775	PROP-05	Same as Existing	975	1350	113.26	$ 137,373.05	$ 412,119.16
		2+775	2+775	O_0200_6228	Same as Existing	400	2400 x 1500 Rec	21.35	$ 82,472.92	$ 247,418.75
		2+775	2+840	Does not Exist	C-Prop_8	-	525	62.5	$ 9,612.50	$ 28,837.50
		2+840	2+900	Does not Exist	C-Prop_9	-	450	62.8	$ 7,586.24	$ 22,758.72
Coronation Park East Parking Lot	2+950 - 3+280	3+100	3+180	Does not Exist	C-Prop_11	-	450	89.73	$ 10,839.38	$ 32,518.15
		3+180	3+260	Does not Exist	C-Prop_10	-	375	76.14	$ 8,923.61	$ 26,770.82
Drainage Easement	3+280 - 3+760	3+360	3+430	Does not Exist	C-Prop_12	-	450	74.87	$ 9,044.30	$ 27,132.89
		3+430	3+540	Does not Exist	C-Prop_13	-	600	108.95	$ 22,193.12	$ 66,579.35
		3+540	3+570	Does not Exist	C-Prop_14	-	525	54.83	$ 8,432.85	$ 25,298.56
		3+570	3+650	Does not Exist	C-Prop_15	-	525	79.91	$ 12,290.16	$ 36,870.47
		3+650	3+730	Does not Exist	C-Prop_16	-	450	81.09	$ 9,795.67	$ 29,387.02
East to Fourteen Mile Creek	3+760 - 3+980	3+860	3+930	Does not Exist	C-Prop_17	-	375	76.87	$ 9,009.16	$ 27,027.49
		3+930	3+950	Does not Exist	C-Prop_18	-	375	27.46	$ 3,218.31	$ 9,654.94
		3+950	3+965	O_0200_400459_1	Same as Existing	450	600	16.004	$ 3,260.01	$ 9,780.04
		3+965	3+980	O_0200_400459_2	Same as Existing	450	600	13.636	$ 2,777.65	$ 8,332.96
West to Fourteen Mile Creek	3+980 - 4+560	4+020	4+125	Does not Exist	C-Prop_19	-	600	112.08	$ 22,830.70	$ 68,492.09
		4+125	4+220	Does not Exist	C-Prop_20	-	600	87.85	$ 17,895.05	$ 53,685.14
		4+220	4+290	Does not Exist	C-Prop_21	-	525	69.2	$ 10,642.96	$ 31,928.88
		4+290	4+350	Does not Exist	C-Prop_22	-	450	56.82	$ 6,863.86	$ 20,591.57
		4+350	4+425	Does not Exist	C-Prop_23	-	450	70.98	$ 8,574.38	$ 25,723.15
		4+425	4+550	Does not Exist	C-Prop_24	-	375	133	$ 15,587.60	$ 46,762.80
East to McCraney Creek	4+560 - 4+780	4+560	4+780	-	-	As Is	As Is**	0	$ -	$ -
West to McCraney Creek	4+780 - 5+090	4+925	5+000	Does not Exist	C-Prop_25	-	375	70.15	$ 8,221.58	$ 24,664.74
Birch Hill Lane	5+090 - 5+700	5+475	5+550	Does not Exist	C-Prop_30	-	450	75.9	$ 9,168.72	$ 27,506.16
		5+550	5+630	Does not Exist	C-Prop_31	-	375	81.87	$ 9,595.16	$ 28,785.49
		5+630	5+675	Does not Exist	C-Prop_32	-	375	44.74	$ 5,243.53	$ 15,730.58
Remnant Channel West of Dorval Drive	5+700 - 6+100	5+725	5+800	Does not Exist	C-Prop_33	-	375	70.79	$ 8,296.59	$ 24,889.76
		5+800	5+850	Does not Exist	C-Prop_34	-	450	50.95	$ 6,154.76	$ 18,464.28
		5+810	5+850	O_0200_5877	Same as Existing	525	675	41.696	$ 12,904.91	$ 38,714.74
		5+850	5+925	O_0200_6188_1	Same as Existing	525	750	70.211	$ 28,751.40	$ 86,254.21
		5+925	5+935	O_0200_6188_2	Same as Existing	525	750	14.592	$ 5,975.42	$ 17,926.27
		5+935	6+015	O_0200_5879	Same as Existing	525	825	80.533	$ 42,569.74	$ 127,709.23
		6+015	6+025	O_0200_5880	Same as Existing	525	825	12.829	$ 6,781.41	$ 20,344.23
		6+075	6+125	O_0200_400596	Same as Existing	750	900	51.01	$ 29,096.10	$ 87,288.31
		6+125	6+150	O_0200_9858	Removed	750	-***		$ -	$ -
		6+125	6+150	Does not Exist	CProp_1007	-	900	18.87	$ 10,763.45	$ 32,290.34
South of Lakewood Dr. and St. Jude's Cemetery		~6+300	~6+300	C15_29	Same as Existing	900	1524 x 965 (Horizontal Ellipse)	13.16	$ 16,805.32	$ 50,415.96
Minor system modifications along the Lakeshore road for Catchbasins									Total	$ 7,221,608.40
2 sets of double catchbasins added on each side of Lakeshore Road at Station 0+175.										
2 sets of double catchbasins added on each side of Lakeshore Road at Station 1+020.										
1 set of double catchbasins added on north side of Lakeshore Road at Station 1+075.										
1 set of double catchbasins added on north side of Lakeshore Road at Station 3+430.										
1 set of double catchbasins added on north side of Lakeshore Road at Station 5+375.										
1 set of double catchbasins added on north side of Lakeshore Road at Station 6+125.										

Drainage Outlet	Road Stations	Chainage		Conduit ID		Sewer		Sewer Length (m)	Supply Cost ($)	Supply and Construction Cost ($)
		From Station	To Station	Conduit ID in Existing Model	Conduit ID in Proposed Model	Existing Sewer Diameter(mm)	Proposed Sewer Diameter(mm)			

*** :** This Conduit is placed perpendicular to the eastbound and westbound lanes

******: There are no changes in sewer pipes as the minor system is non-surcharged for the future conditions.

***: The removed culverts/sewers are to facilitate the reduction in overland drainage for 100-year storm event to the existing drainage outlet.