7 PROJECT DESCRIPTION

7.1 Description of the Recommended Design

The Recommended Design for the New North Oakville Transportation Corridor between Bronte Road and Ninth Line, as illustrated in Plates 1 to 22 in Part II of this ESR, includes:

- 4-lane roadway comprised of 2 through lanes per direction with turning lanes at signalized intersections;
- On-road bike lanes and a 3.0 m multi-use pathway on both sides of the roadway; and
- New bridge crossing of Sixteen Mile Creek.

Property acquisition will be required for the new corridor. A basic right-of-way width of 35 m is proposed with additional property acquisition required at intersection locations for turning lanes and daylight triangles (15m x 15m). Additional property will also be required in areas of cut and fill where the grading requirements extend beyond the basic 35m right-of-way width.

7.1.1 Forecasted Traffic Volumes on the Recommended Corridor

The forecasted 2021 traffic volumes on the proposed New North Oakville Transportation Corridor for the preferred alternative are as shown in **Exhibit 7-1**.

Exhibit 7-1: 2021 Traffic Volumes for the NNOTC

Location	NNOTC 2021 PM Peak Hour Volume		
	Eastbound	Westbound	Total
East of Bronte Rd.	904	1,031	1,935
East of 3rd Line	1,122	1,139	2,261
East of Neyagawa Blvd.	863	1,122	1,986
East of 6th Line	766	870	1,636
East of Trafalgar Rd.	980	1,219	2,199

7.1.2 Roadway

A basic four-lane urban cross section will be provided throughout the study corridor. The median treatment varies according to the roadside environment. From west of Sixteen Mile Creek to south of the North Park access the roadway travels through greenspace and parkland. A 2 m flush median is provided (see **Exhibit 7-2)**. Where the new corridor passes through areas of planned urban growth, a 5 m median is provided to facilitate provision of turning lanes at intersections without median width changes between intersections. In areas of planned redevelopment, a raised median will be provided to provide more positive control of roadside access (see **Exhibit 7-3)**. Where the new corridor is coincident with existing Burnhamthorpe Road (short sections east/west of Neyagawa Boulevard and west of Ninth Line), and existing private entrances are expected to remain, a 5 m flush median will be provided to allow for a centre turn lane to improve accessibility to roadside residences (see

Exhibit 7-4). The Town of Oakville Transportation Master Plan, 2007 identifies Burnhamthorpe Road, as a secondary transit corridor (NNOTC).

7.1.3 Intersections

The proposed plan requires new road intersections, upgrades to existing intersections and new local and collector road intersections to serve planned development. New intersections with existing roads are required at:

- 10+000 - Bronte Road
- 12+175 - Third Line[30]
- 17+825 - Sixth Line
- 19+050 - Trafalgar Road

New intersections to connect to existing Burnhamthorpe Road are required at:

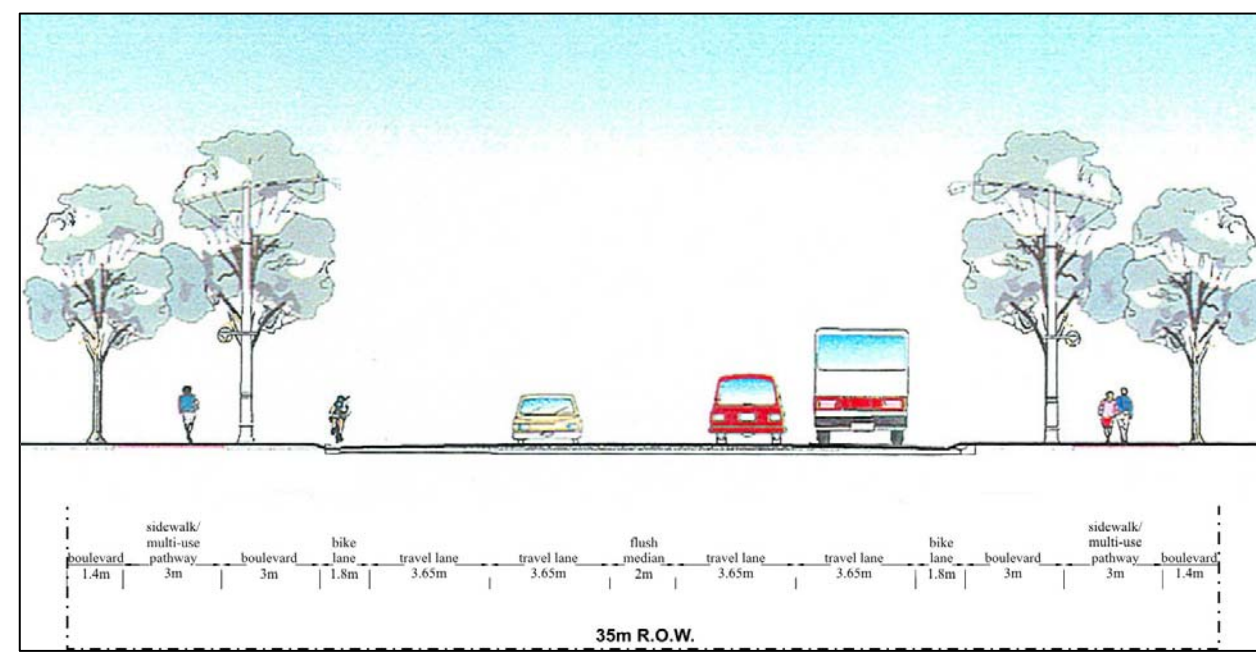
- 14+850 – west of Fourth Line
- 16+600 – east of Neyagawa Boulevard
- 21+350 – west of Ninth Line

Upgraded intersections including signals and turning lanes will be required at:

- 15+450 - Fourth Line
- 15+775 - Neyagawa Boulevard
- 22+000 - Ninth Line

Numerous potential intersections are planned to serve development in the corridor. The locations as shown on the Preferred Design Plans in Part II of this ESR correspond to the approved North Oakville East Secondary Plan and the North Oakville West Secondary Plan. It is recognized that these intersections are conceptual and adjustments with respect to the locations and configurations may be required as development proceeds, subject to Halton Region review and approval. As noted above, additional property for daylight triangles at intersections will be necessary.

Exhibit 7-2: Typical 4-Lane Section (with Flush Median) of the Recommended Design



[30] Third Line is planned to be extended north of Dundas Street.

Exhibit 7-3: Typical 4-Lane Section (with Raised Median) of the Recommended Design

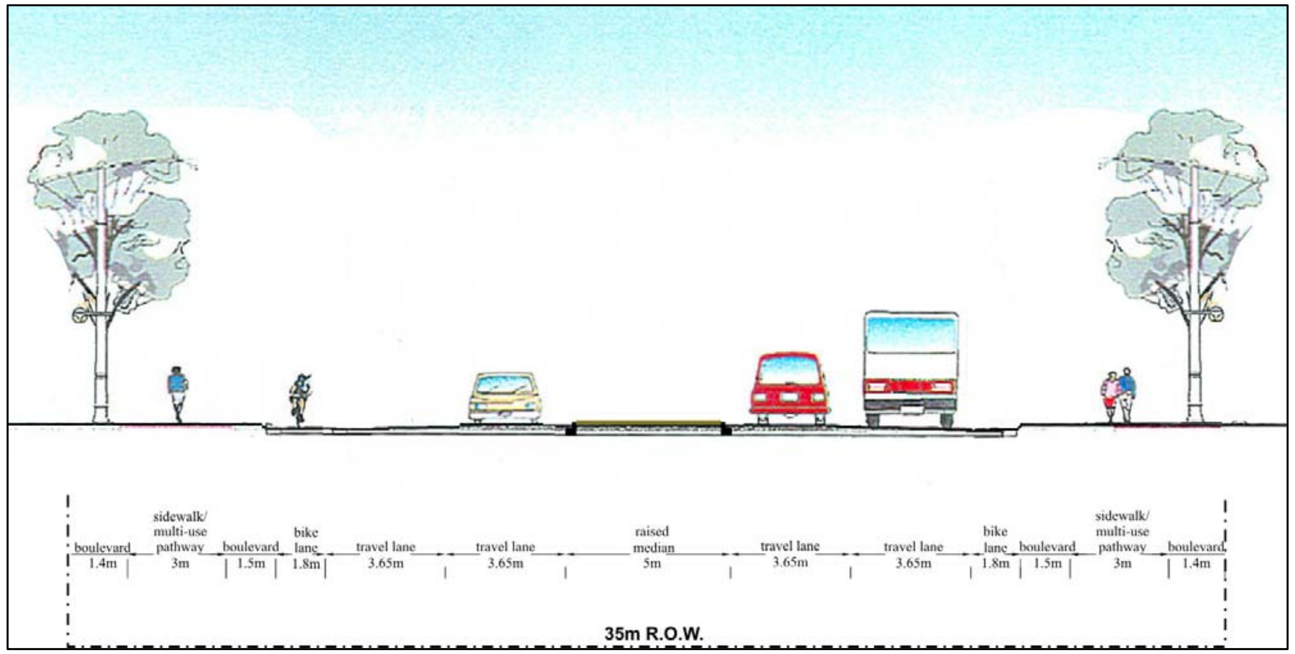
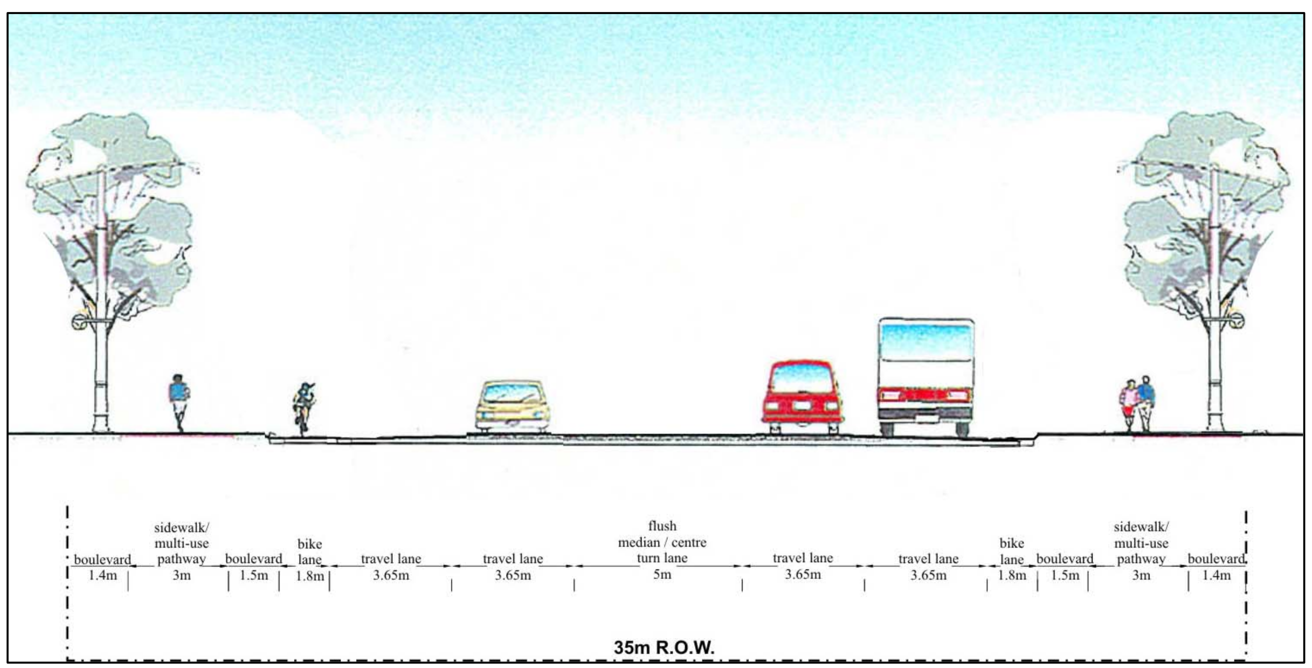


Exhibit 7-4: Typical 5-Lane Section (with Flush Median) of the Recommended Design



The horizontal alignment of the roadway consists of tangent and curvilinear segments. The vertical alignment is relatively flat with grades typically in the range of 1.0%. The horizontal and vertical alignments are detailed on the Recommended Design Plates in **Part II of this ESR**. The design criteria for the new roadway are summarized in **Exhibit 7-5**.

Exhibit 7-5: Recommended Design Criteria

Criteria	Proposed Standards[31]
Classification	Major Arterial
Design Speed	80 km/h
Posted Speed	60 km/h
Minimum Radius	300 m
Minimum Stopping Sight Distance	135 m
Minimum K Value	Crest – 35 / Sag – 40
Maximum Grades	5.0%
Lane Width	4 x 3.65 m
Median Width	2.0 m / 5.0 m[32]
Median Type	Raised/Flush[33]
Bike Lanes	1.8 m
Multi-use pathway/Sidewalks	3.0 m

7.1.4 Drainage and Stormwater Management Requirements

General Requirements

Existing Burnhamthorpe Road and the recommended alignment for the NNOTC generally extend in an east-west direction. Watercourses within this area of Oakville drain predominantly from the north to the south, with some smaller tributaries running at various angles to the main branches. As a result, the existing sections of Burnhamthorpe Road and the NNOTC cross a number of watercourses and their respective watersheds. The North Oakville Creek Subwatershed Study (NOCSS) outlines a number of drainage management requirements for future urban development in North Oakville to address the issue of the number of existing and potential watercourse crossings.

The NOCSS categorizes various watercourses within the Study Area and provides a corresponding drainage management requirement, as detailed in **Exhibit 7-6**.

Exhibit 7-6: Watercourse Drainage Management Plan

Watercourse Category	Drainage Management Requirement
Red Streams (High Constraint)	Retain in current form and location Protect significant fish habitat and riparian corridor system Protect the environmental and geomorphic conditions of the watercourse when considering crossing structures
Red-hatched Streams (High Constraint Requiring Rehabilitation)	Enhance environmentally and physically Retain in current location

[31] From TAC Geometric Design Standards manual
[32] A 2m median applies to sections of NNOTC in parkland and on the Sixteen Mile Creek bridge. A 5m median applies to remainder of the project to both raised and flush (centre turn lane) conditions.
[33] Raised median applied in areas of new development. Flush median applied in areas where existing private entrances retained to allow for centre turn lane to facilitate full property access (5m) and through parkland (2m).

Watercourse Category	Drainage Management Requirement
Blue Streams (Medium Constraint)	Protect riparian corridor system May be moved or deepened during urban development
Green Streams (Low Constraint)	Maintain as either open stream, piped system, piped system with open channels or part of Storm Water Management (SWM) pond
Storm Sewers & SWM Ponds	Locate SWM ponds at top of open watercourses SWM ponds may provide storage for major events within a piped storm sewer system

The following is a list of watersheds, related watercourses and corresponding tributaries (listed in an east to west direction):

- Joshua Creek
- East Morrison Creek
- West Morrison Creek
- Munn's Creek
- Shannon's Creek
- Sixteen Mile Creek
- Glenn Oaks Creek
- Taplow Creek
- McCraney Creek
- Fourteen Mile Creek

Exhibit 7-7 illustrates the various watercourses and their NOCSS category. Given the current uncertainty regarding the timing of development adjacent to the proposed transportation corridor, it is anticipated that a drainage and stormwater management strategy will be required for both interim (proposed NNOTC constructed in advance of adjacent development) and ultimate conditions. Such strategies will address transverse drainage across the corridor and stormwater quantity and quality control at each outlet to an existing watercourse or future drainage system. These strategies are discussed in the following sections of this report.

Transverse Drainage

As noted above the proposed NNOTC corridor alignment will cross a number of watercourses within the project limits. A total of 25 individual crossings have been identified, including the major bridge crossing at Sixteen Mile Creek (**Exhibit 7-8** and **Exhibit 7-9**). Detailed mapping of each crossing location is provided in **Part II of this ESR** showing the culvert location, meander belt width, bank full width and constraint classification. It can be seen from the available data that, due to the minor nature of most of the watercourse crossings, only twelve have a defined meander belt width and of those, only two have a defined bank full width.

At each crossing location, appropriate transverse drainage capacity will need to be provided under both interim (existing conditions) and ultimate development conditions (North Oakville Secondary Plans) in order to satisfy MTO and Halton Conservation drainage criteria. Criteria to be satisfied includes:

- MTO Technical Directive B-100 – Defines return period capacity required based on roadway classification and culvert/bridge span. Based on a roadway classification of "Urban Arterial" and culvert spans less than 6.0m, a 50 year design capacity is deemed adequate. The major bridge structure at Sixteen Mile Creek is much larger, and would require 100 year capacity.
- Freeboard – Generally 1.0m of freeboard under design flow conditions is to be provided where topography and road profile design constraints permit. Where this is not feasible, freeboard is to be maximized to the greatest extent that is feasible.
- Clearance – Wherever feasible, 0.3m of clearance between the culvert soffit and design peak water level (e.g. 50 year water level) is to be provided. Where this is not readily achievable, clearance will be maximized to the greatest extent possible without adversely impacting the design of the roadway or adjacent lands.
- Roadway is to be flood free under Regional flow conditions as per Halton Conservation requirements.[34]
- Geomorphic requirements based on spanning three times bank full width, where applicable.

A preliminary hydraulic analysis has been completed to establish potential culvert sizing requirements at each crossing location under both interim and ultimate conditions. While many of the impacted crossings are very minor and have either a low constraint classification or no constraint classification at all, under interim conditions it is expected that at least a temporary crossing will be required pending construction of the final storm sewer system(s) associated with adjacent development when it proceeds in the vicinity of a low or unconstrained reach. This is expected to be necessary to prevent undesirable ponding/flooding immediately upstream of the proposed corridor right of way, despite the minor nature of these crossings.

Using Manning's equation, sizing of temporary CSP culverts with a 50 year flow capacity has been established at all crossings as an interim transverse drainage mechanism, and is presented in

Exhibit 7-10. Flow rates used in the analysis were obtained by proportioning peak flows from the NOCSS GAWSER model on a drainage area basis. CSP culverts are assumed under interim conditions for cost effectiveness and simplicity. Where low constraint or unconstrained reaches are crossed by the proposed roadway, these temporary culvert crossings are expected to be abandoned and replaced by a fully piped drainage system to be constructed as part of adjacent development. If feasible, a temporary culvert pipe design will be considered that can later be incorporated into the piped system. Depending on local topography under interim conditions and future land use requirements, it may be possible to incorporate a CBMH or DICBMH at the upstream side of the proposed crossing to expedite incorporation of the crossing into the ultimate piped drainage system without disturbing the newly constructed roadway in the future. Otherwise the temporary CSP crossing will be replaced under ultimate conditions by a concrete storm sewer where required and appropriate. At medium or high constraint crossings, the temporary culvert crossing should not be necessary. It should be possible to install the ultimate culvert at these locations instead so that future replacement or modification will not be necessary after construction of the new roadway. Installation details will be established at the detailed design stage of the project.

[34] *Policies, Procedures & Guidelines for the Administration of Ont. Reg. 162-06 and Land Use Planning Policy Document*, April 27, 2006

Exhibit 7-7: Watercourses of the North Oakville Subwatershed by Category

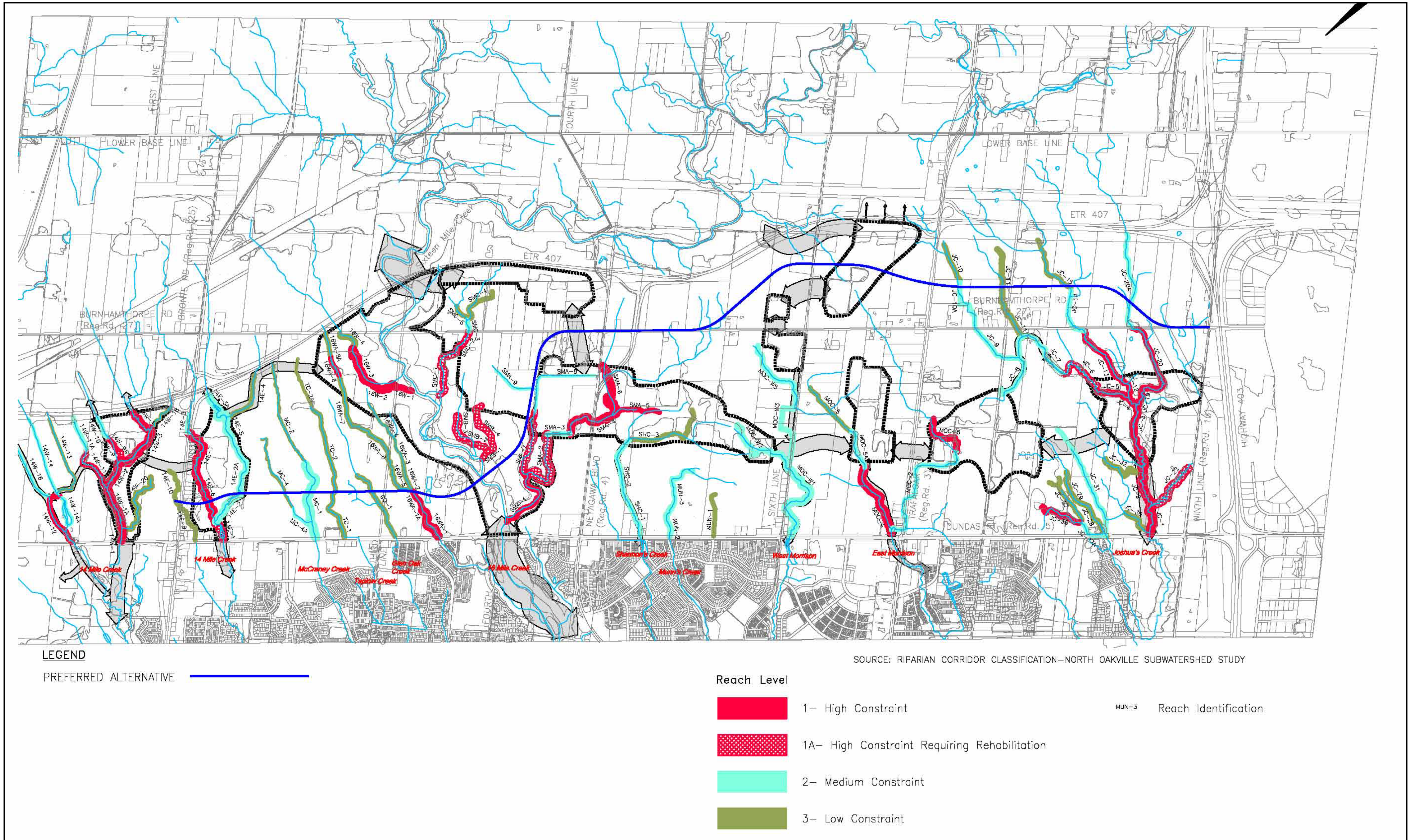


Exhibit 7-8: Culvert Crossing and SWM Pond Locations (West of Neyagawa)

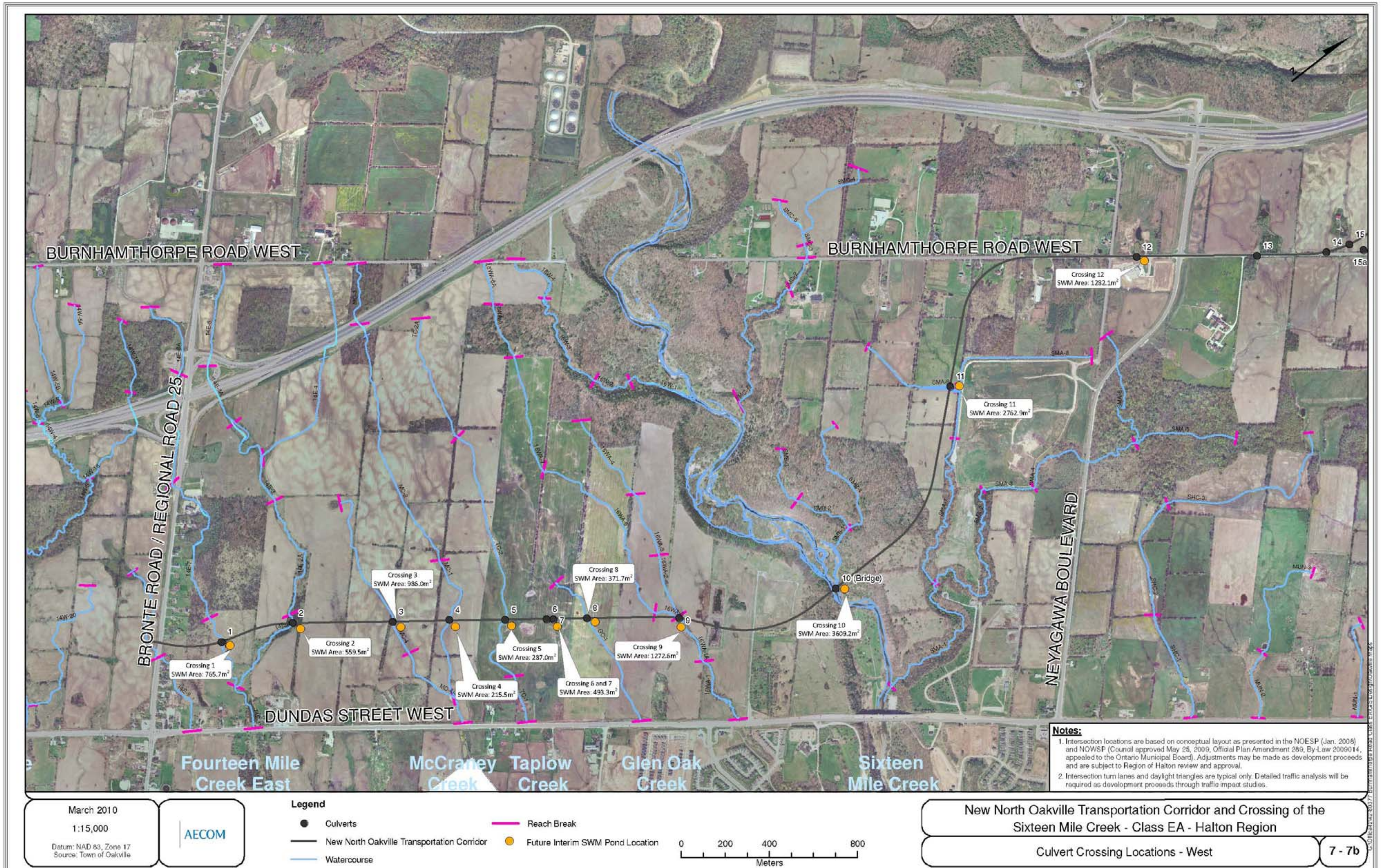


Exhibit 7-9: Culvert Crossing and SWM Pond Locations (East of Neyagawa)

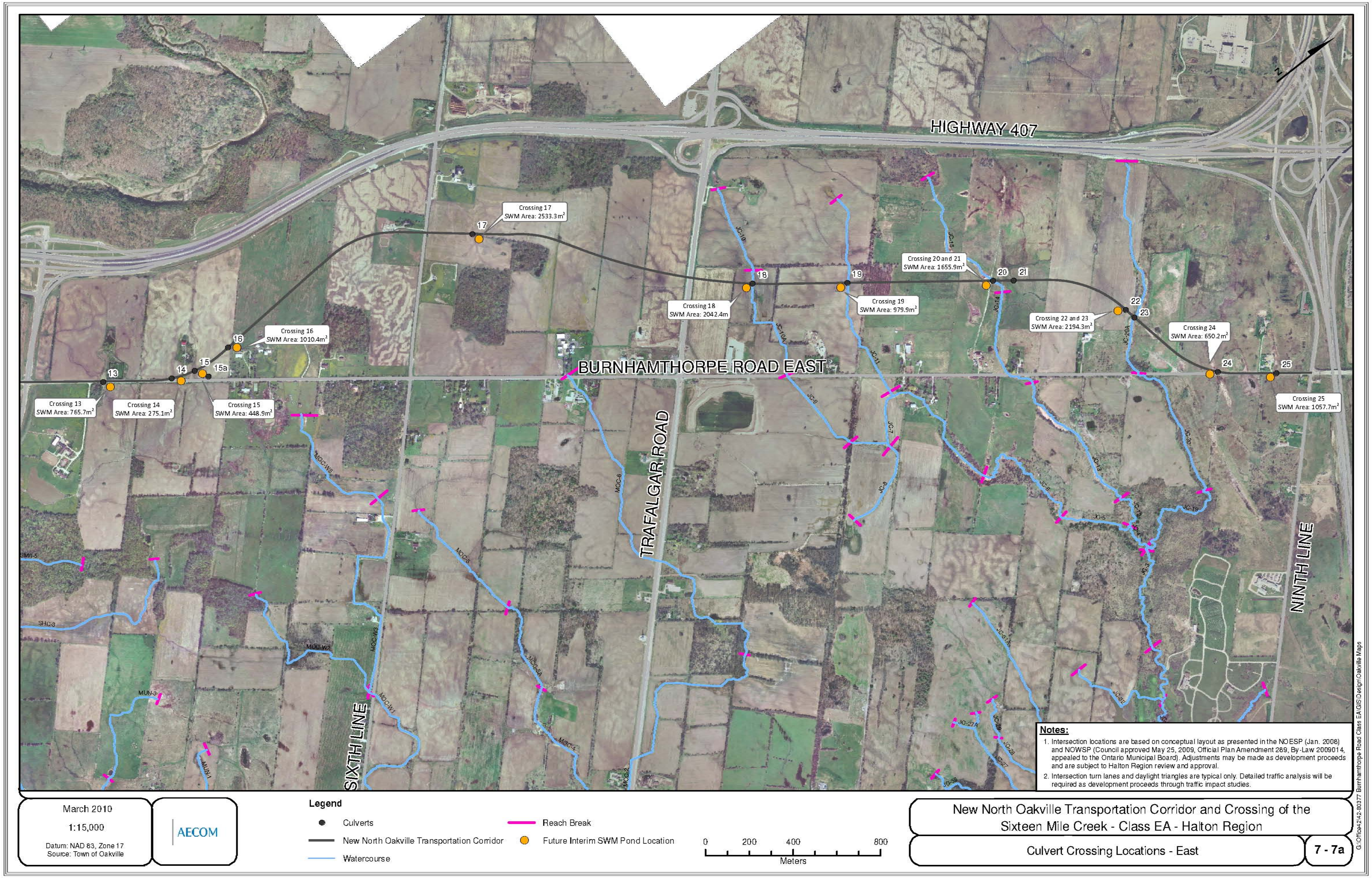


Exhibit 7-10: Sizing of Temporary CSP Culvert Crossings

CROSSING I.D. NO.	STATION	MANAGEMENT REACH	CONSTRAINT RANKING	MEANDER BELT WIDTH (m)	BANKFULL WIDTH (m)	50 YEAR ESTIMATED PEAK FLOW TRIBUTARY TO CULVERT (m^3/s)	TEMPORARY CSP CULVERT SIZE (mm) (@ 0.50% Slope)	TEMPORARY CSP CULVERT SIZE (mm) (@ 0.25% Slope)	ESTIMATED FREEBOARD (m)	NOTES
1	10+360	14E-6	High	40	Undefined	1.63	1,350	1,500	1.0	Temporary CSP culvert not required. Should be possible to install permanent culvert as per ultimate design conditions prior to adjacent development taking place.
2	10+700	14E-2	Medium	40	Undefined	2.28	1,300	1,650	1.4	Temporary CSP culvert not required. Should be possible to install permanent culvert as per ultimate design conditions prior to adjacent development taking place.
3	11+140	MC-4	Low	Not Surveyed (Swale)	Not Surveyed (Swale)	0.42	750	900	1.3	Open drainage swale expected to be eliminated and incorporated into piped drainage system as part of future development. Temporary culvert likely required in short term to prevent upstream ponding/flooding
4	11+400	MC-1	Medium	55	0.5	1.46	1,200	1,500	1.8	Temporary CSP culvert not required. Should be possible to install permanent culvert as per ultimate design conditions prior to adjacent development taking place.
5	11+660	TC-2	Low	Not Surveyed (Swale)	Undefined	0.40	750	900	1.5	Open drainage swale expected to be eliminated and incorporated into piped drainage system as part of future development. Temporary culvert likely required in short term to prevent upstream ponding/flooding
6	11+850	N/A	N/A	N/A	N/A	0.00				Open drainage swale expected to be eliminated and incorporated into piped drainage system as part of future development. Temporary culvert likely required in short term to prevent upstream ponding/flooding
7	11+870	N/A	N/A	N/A	N/A	0.23	600	750	1.0	Open drainage swale expected to be eliminated and incorporated into piped drainage system as part of future development. Temporary culvert likely required in short term to prevent upstream ponding/flooding
8	12+025	GO-1	Low	N/A	Undefined	0.23	600	750	0.7	Open drainage swale expected to be eliminated and incorporated into piped drainage system as part of future development. Temporary culvert likely required in short term to prevent upstream ponding/flooding
9	12+450	16WA-2	High	Not Surveyed (Swale)	Not Surveyed (Swale)	0.94 0.14				Temporary CSP culvert not required. Should be possible to install permanent culvert as per ultimate design conditions prior to adjacent development taking place.
						1.07	1,200	1,350	0.5	
10	13+220	16 Mile Creek Bridge	N/A	N/A	N/A	N/A			N/A	Large scale bridge crossing required.
11	14+325	SMA-9	Medium	15	3.5	1.23	4,000	4,000	1.0	Temporary CSP culvert not required. Should be possible to install permanent culvert as per ultimate design conditions prior to adjacent development taking place.
12	15+580	N/A	N/A	N/A	N/A	0.36	750	825		Open drainage swale expected to be eliminated and incorporated into piped drainage system as part of future development. Temporary culvert likely required in short term to prevent upstream ponding/flooding
13	16+120	N/A	N/A	N/A	N/A	0.41	750	825	0.8	Open drainage swale expected to be eliminated and incorporated into piped drainage system as part of future development. Temporary culvert likely required in short term to prevent upstream ponding/flooding
15	16+550	N/A	N/A	N/A	N/A	0.13	525	600	1.1	Open drainage swale expected to be eliminated and incorporated into piped drainage system as part of future development. Temporary culvert likely required in short term to prevent upstream ponding/flooding
16	16+740	N/A	N/A	N/A	N/A	0.18	600	675	0.8	Open drainage swale expected to be eliminated and incorporated into piped drainage system as part of future development. Temporary culvert likely required in short term to prevent upstream ponding/flooding
17	18+040	N/A	N/A	N/A	N/A	0.00	N/A	N/A	N/A	Open drainage swale expected to be eliminated and incorporated into piped drainage system as part of future development. Temporary culvert likely required in short term to prevent upstream ponding/flooding
18	19+340	JC-10A	Medium	25	Undefined	0.94	1,050	1,200	2.8	Temporary CSP culvert not required. Should be possible to install permanent culvert as per ultimate design conditions prior to adjacent development taking place.
19	19+780	JC-11	Low	Not Surveyed (Swale)	Undefined	0.40	750	900	2.0	Open drainage swale expected to be eliminated and incorporated into piped drainage system as part of future development. Temporary culvert likely required in short term to prevent upstream ponding/flooding
20	20+450	JC-14	Medium	25	Undefined	3.18	1,650	1,950	0.4	Temporary CSP culvert not required. Should be possible to install permanent culvert as per ultimate design conditions prior to adjacent development taking place.
21	20+540	N/A	N/A	N/A	N/A	4.32	1,800	2,100	0.1	Open drainage swale expected to be eliminated and incorporated into piped drainage system as part of future development. Temporary culvert likely required in short term to prevent upstream ponding/flooding
22	21+090	N/A	N/A	N/A	N/A	2.65	N/A	N/A	N/A	Open drainage swale expected to be eliminated and incorporated into piped drainage system as part of future development. Temporary culvert likely required in short term to prevent upstream ponding/flooding
23	21+120	JC-20A	Medium	20	Undefined	2.65	1,500	1,800	1.2	Temporary CSP culvert not required. Should be possible to install permanent culvert as per ultimate design conditions prior to adjacent development taking place.
24	21+600	N/A	N/A	N/A	N/A	0.68	900	1,050	2.4	Open drainage swale expected to be eliminated and incorporated into piped drainage system as part of future development. Temporary culvert likely required in short term to prevent upstream ponding/flooding
25	21+870	N/A	N/A	N/A	N/A	0.68	750	825	0.0	Open drainage swale expected to be eliminated and incorporated into piped drainage system as part of future development. Temporary culvert likely required in short term to prevent upstream ponding/flooding

Similarly, sizing of permanent culvert crossings for ultimate conditions have also been established. Using MTO design chart nomographs (MTO Design Chart 5.39), sizing was initially established based on the provision of 1.0m of freeboard for 50 year flow conditions as shown on **Exhibit 7-11**. Having established a required size on that basis, the size was checked under Regional flow conditions to confirm whether an upgrade would be required to keep the roadway flood free for the Regional storm, as shown on **Exhibit 7-12**. This preliminary analysis indicates that the 50 year sizing is generally adequate to keep the roadway flood free under Regional flow conditions. Sizing of permanent culvert crossings has been provided for the necessary eight crossings (in addition to the Sixteen Mile Creek bridge) located at medium or high constraint watercourses. As noted above, permanent culverts are not expected to be needed at the remaining crossings where a piped drainage system is expected to be implemented when adjacent development takes place.

In addition, the minimum recommended span at Crossing 11, with a bank full width of 3.5 metres, is estimated to be 4.0 metres. This is a reduction over the general recommendation of three times bank full width as the crossing is very close to perpendicular to the proposed roadway alignment and is deemed to be within a low risk area. This sizing is consistent with the hydraulic capacity requirements as well.

It is recommended that either open footing culverts or closed culverts embedded into the existing streambed be used to maintain a suitable natural stream bottom for fish habitat, as appropriate for the particular reach and existing habitat in the area.

It should be noted that more detailed hydraulic analysis, including appropriate modeling (e.g. HEC-RAS. Culvert Master, etc.) will be undertaken at the detailed design stage in order to confirm or refine the results of this preliminary analysis. More detailed flow transposition calculations or updated hydrologic modeling will also be carried out to confirm the required flow capacity.

<u>*Stormwater Management Requirements*</u>

In addition to providing adequate runoff conveyance, the proposed drainage system associated with the new NNOTC corridor alignment must also incorporate adequate stormwater management measures or strategy to address and mitigate the potential runoff quantity and quality impacts of the new roadway under both interim and ultimate long term conditions. It is expected that the interim SWM ponds would need to be located on the downstream side of the roadway and optimum locations would be established at the detail design stage of the project. The stormwater management strategies for both scenarios are described below.

Interim Conditions

Under interim conditions the ultimate roadway configuration will be built, including a fully urbanized cross section with storm sewers and curb and gutter. Given that there will be no interim road cross section based on a rural cross section, the number of available SWM options is somewhat limited, as is usually the case under urban conditions. Therefore, it is recommended that provision be made for an appropriately sized temporary dry SWM pond at each watercourse outlet affected by the proposed roadway corridor. Dry ponds are recommended for simplicity due to the temporary nature of the installations and safety given their close proximity to the road allowance.

Due to space constraints within the right of way, it will likely be necessary to construct such facilities on privately owned property immediately adjacent to the NNOTC corridor. This will require negotiation with the property owners/developers to acquire a temporary easement for construction and maintenance purposes, but is expected to be feasible. The 3.05 ha (7.53 ac) of land area required for the SWM ponds was estimated based on MOE conceptual formula and tabulated in **Exhibit 7-13**. The exact location/area limits for each facility will be established at detail design.

Quantity control within the proposed right of way is difficult due to lack of space associated with the urban cross section. However, under interim conditions, sizing of the temporary dry ponds can be designed to provide both quality and quantity control. Preliminary calculations/analysis (including MIDUSS modeling of quantity control requirements for the 100 year and Regional storms) has shown that the most significant quantity control requirement is for the 100 year storm. An enhanced level of quality control storage requirements for dry ponds was established based on typical MOE guidelines/criteria (Table 4.1, Stormwater Management Practices Planning and Design Manual, June 1994). Based on the imperviousness and drainage area of each right-of-way catchment, an estimated storage volume requirement for enhanced level quality control and quantity control has been established, as shown on **Exhibit 7-13**. Since these facilities are proposed to be dry ponds, they are entirely made up of active storage (i.e. no permanent pool). Hence, the total required storage volume should be the larger of the quality control volumes and the maximum quantity control volume for the same outlet. Approximate bottom widths and total land area requirements for each facility have also been estimated on a preliminary basis. Each will require a dual outlet design to accommodate the dual function (quality and quantity control) since each function requires different discharge timing. Locations of the interim facilities will need to be such that they do no interfere with the temporary or permanent culvert crossings discussed in the transverse drainage section of this report.

Ultimate Long Term Conditions

Under ultimate development conditions it is intended that future SWM facilities proposed for servicing of development(s) adjacent to the new North Oakville Transportation Corridor would also be designed to accommodate SWM requirements of the Transportation Corridor as well. The quality and quantity control storage requirements for the NNOTC right of way established under interim conditions will need to be incorporated into the long term SWM pond designs within each affected adjacent development.

The final location of future SWM ponds may change slightly during the preparation of development plans within North Oakville but the approximate locations have been established as part of the NOCSS, as shown on **Exhibit 7-14**. SWM ponds to accommodate the NNOTC under ultimate long term conditions will be implemented in conjunction with planned development. Specific details of the ultimate drainage system required to convey NNOTC runoff to the ponds and design characteristics of the SWM facilities themselves will be established at the detailed design stage of the proposed roadway and adjacent development servicing.[35] Should diversion of major system flow from the NNOTC to an adjacent SWM facility be found to be infeasible for any given outlet location, then the most appropriate nearby SWM facility should be designed to over-control the local development runoff to compensate for the inability to fully control the runoff from the affected portion of the NNOTC right-of-way. Minor system flow would be routed via the storm sewer system to the most appropriate adjacent development's pond.

<u>*Water Temperature Regimes*</u>

Based on findings of the NOCSS, only East Morrison Creek and Fourteen Mile Creek have temperature concerns associated with them. With regard to the NNOTC, East Morrison Creek is far enough away from the proposed corridor alignment to be of no concern in terms of water temperature. Monitoring of temperatures within Fourteen Mile Creek for approximately one year is recommended prior to construction to better establish existing temperature regimes in this creek and its tributaries. Temperatures are collected by deploying data loggers into the creek upstream and downstream (approx 5 - 20 meters upstream and 5 - 20 meters downstream) of the transportation crossing in the month of May or June and collect them again at the end of September. The data loggers need to be firmly and discretely secured in an appropriate location in the creek to prevent theft and to reduce the risk of being swept away by the current. Once the temperature data is downloaded from the loggers, it needs to be referenced with accurate,

[35] The following documents will be referred to at detailed design: *MOE Stormwater Management Planning & Design Manual*, March 2003 and *Policies, Procedures and Guidelines for the Administration of Ontario Regulation 162-06 & Land Use Planning Policy Document*, April 27, 2006, in addition to consultation with Conservation Halton

local maximum daily air temperature data. Water temperatures obtained on a day where the max. daily air temperature has been above 24 degrees Celsius, where the max daily air on the three preceding days have also been above 24 degree Celsius will provide an indication of the thermal stability of that stretch of the creek. Under post construction conditions, discharge to subsurface rock filtration systems/trenches should be implemented to provide maximum temperature benefits. Tree planting to provide shading of surface runoff is also recommended.

Exhibit 7-11: Proposed Culvert Crossings Size Check to Provide Adequate Freeboard for the 50 Year Storm

CROSSING I.D. NO.	STATION	MANAGEMENT REACH	CONSTRAINT RANKING	MEANDER BELT WIDTH (m)	BANKFULL WIDTH (m)	50 YEAR [1] ESTIMATED PEAK FLOW TRIBUTARY TO CULVERT (m^3/s)	PRELIMINARY PROPOSED CULVERT SIZE (m)		APPROXIMATE ROAD ELEVATION (m)	APPROXIMATE CULVERT INVERT ELEVATION (m)	ESTIMATED [2] HEADWATER ELEVATION (m)	ESTIMATED FREEBOARD (m)
							SPAN	HEIGHT				
1	10+360	14E-6	High	40	Undefined	1.63	1.8	0.9	159.00	156.40	157.15	1.85
2	10+700	14E-2	Medium	40	Undefined	2.28	1.8	0.9	161.10	158.00	158.93	2.17
4	11+400	MC-1	Medium	55	0.5	1.46	1.8	0.9	163.30	159.90	160.60	2.70
9	12+450	16WA-2	High	25	Not Surveyed (Swale)	1.07	1.8	0.9	158.80	157.00	157.58	1.22
11	14+325	SMA-9	Medium	15	3.5	1.23	4.0	0.9	166.70	164.30	164.68	2.02
18	19+340	JC-10A	Medium	25	Undefined	0.94	1.8	0.9	185.00	180.70	181.23	3.77
20	20+450	JC-14	Medium	25	Undefined	3.18	2.4	1.2	179.50	177.10	177.83	1.67
23	21+120	JC-20A	Medium	20	Undefined	2.65	4.8	0.9	178.40	176.00	176.54	1.86

Exhibit 7-12: Proposed Culvert Crossings Size Check to Maintain Road as Flood Free for Regional Storm

CROSSING I.D. NO.	STATION	MANAGEMENT REACH	CONSTRAINT RANKING	MEANDER BELT WIDTH (m)	BANKFULL WIDTH (m)	REGIONAL [1] ESTIMATED PEAK FLOW TRIBUTARY TO CULVERT (m^3/s)	PRELIMINARY PROPOSED CULVERT SIZE (m)		APPROXIMATE ROAD ELEVATION (m)	APPROXIMATE CULVERT INVERT ELEVATION (m)	ESTIMATED [2] HEADWATER ELEVATION (m)	ESTIMATED FREEBOARD (m)
							SPAN	HEIGHT				
1	10+360	14E-6	High	40	Undefined	4.78	1.8	0.9	159.00	156.40	158.26	0.74
2	10+700	14E-2	Medium	40	Undefined	6.70	1.8	0.9	161.10	158.00	160.97	0.13
4	11+400	MC-1	Medium	55	0.5	4.05	1.8	0.9	163.30	159.90	161.43	1.87
9	12+450	16WA-2	High	25	Not Surveyed (Swale)	3.40	1.8	0.9	158.80	157.00	158.26	0.54
11	14+325	SMA-9	Medium	15	3.5	4.12	4.0	0.9	166.70	164.30	165.11	1.59
18	19+340	JC-10A	Medium	25	Undefined	2.51	1.8	0.9	185.00	180.70	181.71	3.29
20	20+450	JC-14	Medium	25	Undefined	6.69	2.4	1.2	179.50	177.10	178.66	0.84
23	21+120	JC-20A	Medium	20	Undefined	7.31	4.8	0.9	178.40	176.00	177.12	1.28

Notes:

1. Flows estimated by proportioning drainage areas defined in GAWSER model from NOCSS.
2. Estimated using nomograph for box culvert operating under inlet control (MTO Design Chart 5.39)

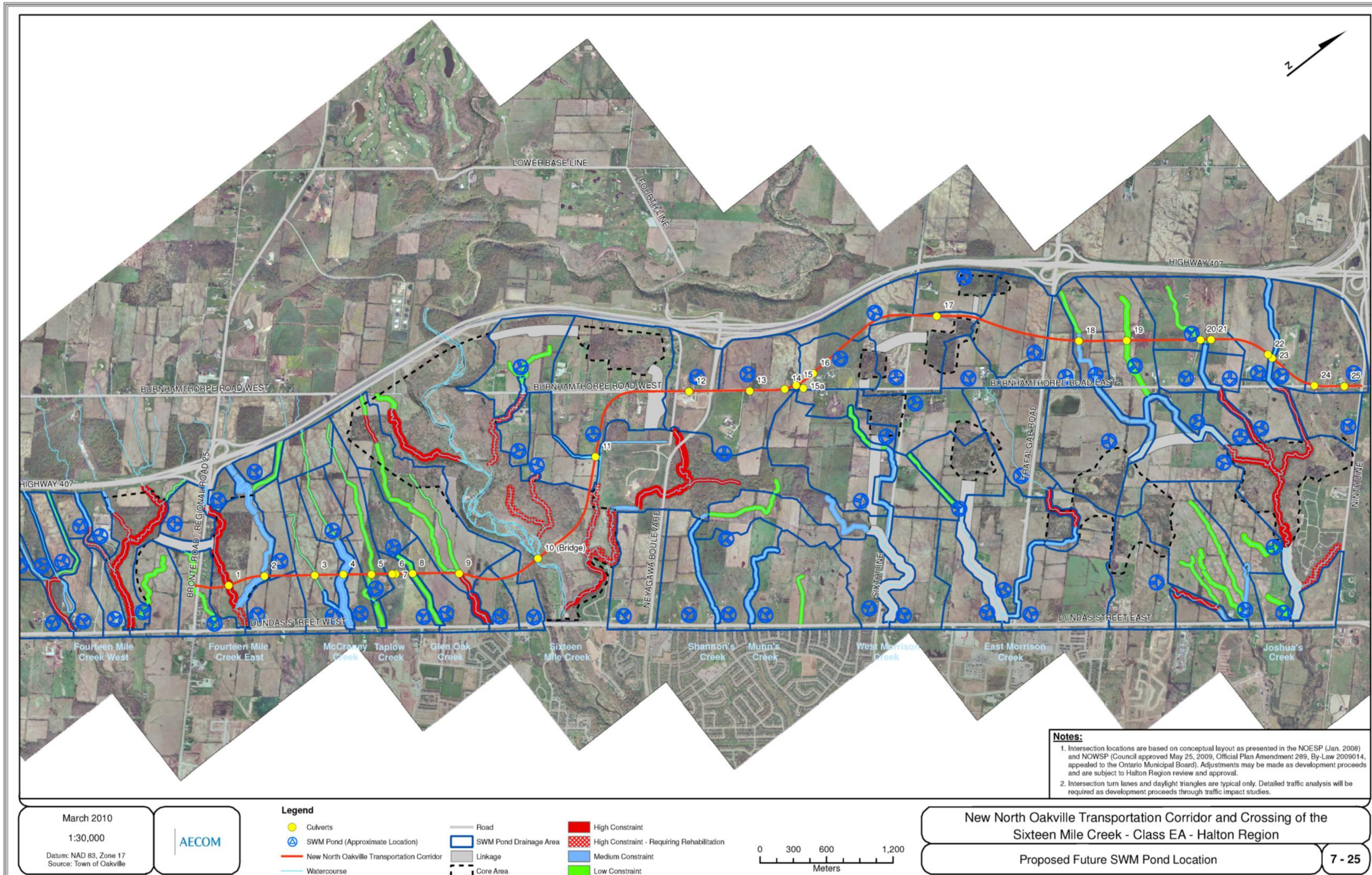
G:\Office42\42-80377 Burnhamthorpe Road Class EA\ESR\SWM_Drainage\ESR Exhibits\Exhibit 7-22 and 7-23 Permanent Culvert Crossings (Revised March 12, 2010).xlsx

Exhibit 7-13: Right-of-Way Drainage Areas & Estimated SWM Storage Requirements

CROSSING I.D. NO.	STATION	WATERSHED OR TRIBUTARY	MANAGEMENT REACH	CONSTRAINT RANKING	ESTIMATED LENGTH OF ROADWAY TRIBUTARY TO SUBJECT OUTLET (m)	ESTIMATED R.O.W. DRAINAGE AREA (ha)	IMPERVIOUSNESS (%)	MOE UNIT STORAGE REQUIREMENT FOR ENHANCED LEVEL OF PROTECTION (m^3/ha)	REQUIRED QUALITY CONTROL STORAGE VOLUME (m^3)	ESTIMATED QUANTITY CONTROL REQUIREMENTS (m^3) — 100 Year Storm		ESTIMATED QUANTITY CONTROL REQUIREMENTS (m^3) — Regional Storm		100 YEAR ASSUMED DEPTH PONDING (m)	100 YEAR REQUIRED POND BOTTOM WIDTH (3:1 L:W Ratio) (m)	100 YEAR REQUIRED LAND AREA (m^2)
										Allowable Peak Flow (m^3/s)	Required Storage (m^3)	Allowable Peak Flow (m^3/s)	Required Storage (m^3)			
1	10+360	14 Mile Creek East	14E-6	High	340	1.19	67	218	259	0.044	506	0.135	306	1	9.7	765.7
2	10+700	14 Mile Creek East	14E-2	Medium	243	0.85	67	218	185	0.037	345	0.102	181	1	7.4	559.5
3	11+140	McRaney Creek	MC-4	Low	457	1.60	67	218	349	0.058	684	0.181	415	1	11.8	986.0
4	11+400	McRaney Creek	MC-1	Medium	83	0.29	67	218	63	0.020	100	0.041	0	1	2.4	215.5
5	11+660	Taplow Creek	TC-2	Low	118	0.41	67	218	90	0.026	147	0.056	26	1	3.7	287.0
6 [4]	11+850	Glen Oak Creek	N/A	N/A	211	0.74	67	218	161	0.034	295	0.092	134	1	6.6	493.3
7 [4]	11+870	Glen Oak Creek	N/A	N/A												
8	12+025	Glen Oak Creek	GO-1	Low	154	0.54	67	218	118	0.029	206	0.071	74	1	5.0	371.7
9	12+450	16 Mile Creek West	16WA-2	Low	600	2.10	67	218	458	0.068	922	0.229	599	1	14.2	1,272.6
10	13+220	16 Mile Creek	16 Mile Creek Bridge	N/A	1,700	5.95	71	227	1,351	0.114	2,979	0.502	3,618	1	28.2	3,609.2
11	14+325	16 Mile Creek East	SMA-9	Medium	1,254	4.39	71	227	997	0.080	2,219	0.358	2,857	1	23.9	2,762.9
12	15+580	16 Mile Creek East	N/A	N/A	551	1.93	82	245	473	0.055	930	0.202	612	1	14.3	1,282.1
13	16+120	16 Mile Creek East	N/A	N/A	320	1.12	82	245	274	0.042	506	0.128	281	1	9.7	765.7
14	16+440	16 Mile Creek East	N/A	N/A	111	0.39	67	218	85	0.025	139	0.054	6	1	3.5	275.1
15	16+550	16 Mile Creek East	N/A	N/A	191	0.67	67	218	146	0.033	262	0.085	112	1	6.0	448.9
16	16+740	West Morrison	N/A	N/A	454	1.59	67	218	346	0.050	704	0.172	463	1	12.0	1,010.4
17	18+040	N/A	N/A	N/A	1,209	4.23	67	218	922	0.096	2,015	0.397	1,950	1	22.6	2,533.3
18	19+340	Joshua's Creek Tributary	JC-10A	Medium	936	3.28	67	218	714	0.070	1,583	0.298	1,676	1	19.6	2,042.4
19	19+780	Joshua's Creek Tributary	JC-11	Low	440	1.54	67	218	336	0.049	679	0.168	439	1	11.7	979.9
20 [4]	20+450	Joshua's Creek Tributary	JC-14	Medium	760	2.66	67	218	580	0.065	1,248	0.258	1,089	1	17.1	1,655.9
21 [4]	20+540	Joshua's Creek Tributary	N/A	N/A												
22 [4]	21+090	Joshua's Creek Tributary	N/A	N/A	1,080	3.78	67	218	824	0.105	1,716	0.389	1,190	1	20.6	2,194.3
23 [4]	21+120	Joshua's Creek Tributary	JC-20A	Medium												
24	21+600	Joshua's Creek Tributary	N/A	N/A	271	0.95	82	245	233	0.040	415	0.112	214	1	8.4	650.2
25	21+870	Joshua's Creek Tributary	N/A	N/A	450	1.575	82	245	386	0.050	743	0.171	461	1	12.4	1,057.7

Notes:
1. Imperviousness based on typical proposed cross sections (Exhibits 7-1, 7-2, 7-3)
2. Total extended detention storage volume is estimated by the greater of quantity and quality storage requirements.
3. Required storage is for control of right of way runoff only. Separate interim facilities should be implemented for this purpose under interim conditions should the road be constructed prior to development of adjacent lands. Under ultimate, long term conditions, right of way storage requirements should be co-ordinated/combined with SWM facilities implemented to service adjacent developments.
4. Due to the close proximity of the culverts to each other at Crossings 6/7, 20/21, and 22/23, a single SWM pond is expected to be implemented for each of these culvert pairings. The SWM volume and area requirements indicated are combined totals for each pairing.

Exhibit 7-14: Proposed Future SWM Pond Locations



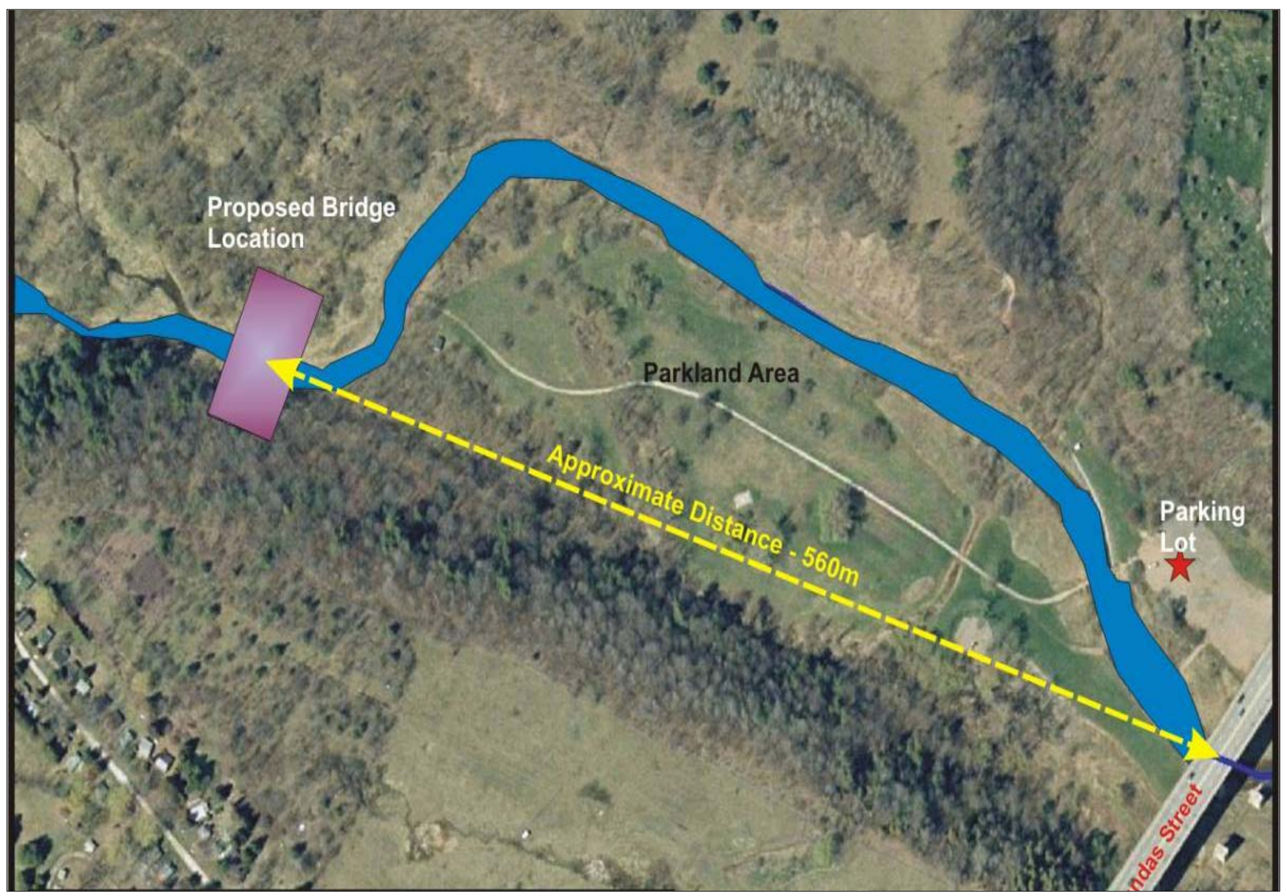
7.1.5 Sixteen Mile Creek Bridge

The Recommended Alternative Route includes a new bridge crossing of Sixteen Mile Creek situated approximately 560 m north of Dundas Street. The structural design drawing for the preferred bridge is presented on Plate PA-1 in Part II of this ESR.

Key bridge crossing features for the Recommended Design (refer to **Exhibit 7-15**), include:

- Crossing location accessible from disturbed valley area – Lions Valley Park;
- Bridge piers located in flat areas – no disturbance to valley slopes;
- Location ideal with respect to creek meander trends;
- No "in-water" works required;
- No rare or endangered species identified in crossing area; and
- Bridge superstructure can be launched from top of valley – reduces intrusion effects.

Exhibit 7-15: Bridge Crossing Features



Bridge Type

A number of different bridge types were examined for the crossing, including conventional steel and concrete girder bridges as well as several special structures. The special structures included suspension, cable-stayed and arch bridges.

The following bridge type concepts were reviewed:

Option 1 Four to five span girder bridge (base scheme)
Option 2 Three span cable stayed bridge with two towers
Option 3 Two span cable stayed bridge with single inclined tower
Option 4 Three span suspension bridge with two inclined or vertical towers
Option 5 Arch bridge

The relative cost comparison between the base scheme (Option 1) and the other options is presented below:

	Option				
	1 (Base Scheme)	2	3	4	5
Cost (% of Base Scheme)	100%	180%	155%	250%	275%

Based purely on an assessment of cost, Option 1 is preferred because the cost of all other options increases significantly, without offering a commensurate level of benefits.

Bridge main spans for all bridge types considered vary from 75 m minimum to over 400 m. The minimum length of bridge main spans was determined to be in the order of 70 to 75 m. Shorter spans were not considered suitable due to the following:

- Impact on the natural environment of the Sixteen Mile Creek valley;
- Consideration of hydraulics and fluvial geomorphology; and
- Height of the bridge above the valley and overall aesthetic considerations.

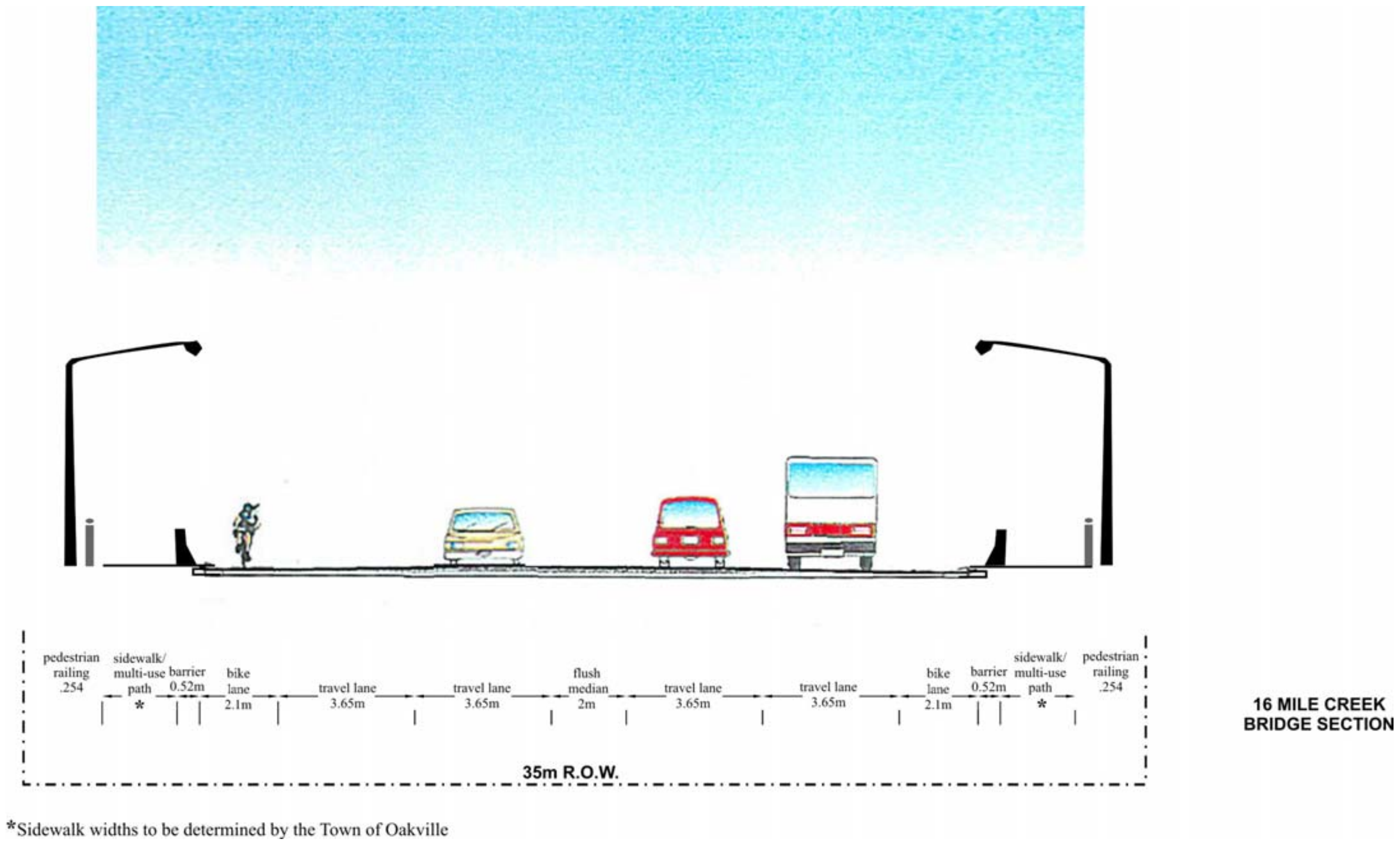
During further detailed investigation involving the fluvial geomorphology study, examination of creek meandering and detailed field investigation of the topography of the site, the bridge span configuration was further refined. This resulted in a four span 280 m long structural steel girder bridge (60 m + 2 @ 80 m + 60 m). By increasing the length of all spans and reducing the number of spans the following was achieved:

- No bridge piers located in Sixteen Mile Creek;
- Creek meandering is addressed;
- Hydraulic improvements are realized;
- End piers are located in the valley rather than on the steep slopes; and
- Abutment locations selected such that the stem is relatively low and wingwalls relatively short.

Structure Geometric Design Criteria

The proposed cross section for the Sixteen Mile Creek Bridge is illustrated in **Exhibit 7-16**. The final structural design will be confirmed during detail design in consultation with the appropriate approval agencies.

Exhibit 7-16: Typical Sixteen Mile Creek Bridge Crossing Cross-Section



* Sidewalk widths to be determined by the Town of Oakville (2.0 m – 4.2 m)

1. Number and Width of Traffic Lanes

To accommodate the anticipated traffic volume on this structure, four traffic lanes with a width of 3.65 m each are required. In addition, a 2.1 m exclusive bicycle lane would be provided for each direction of traffic. The traffic and bicycle lanes require a 2% crossfall toward the outside of the structure.

2. Side Clearances

Bicycle lanes are accommodated within the 2.1 m side clearances for the outer traffic lanes.

3. Requirements for Sidewalks

Sidewalk widths to be determined by the Town of Oakville (2.0 m – 4.2 m).

4. Barrier types

Each sidewalk would be separated from the traffic lanes by a 0.52m wide concrete barrier wall with parapet located between the sidewalk and the bicycle lane. The outside of each sidewalk would be protected by a 1.4 m high open pedestrian railing. The opposing traffic lanes would be separated by a 2 m wide flush (painted) median located along the centerline of the structure. The design of the barriers must comply with Section 12 of the Canadian Highway Bridge Design Code (CHBDC).

Structural Design Elements

As part of the development and assessment of structural design alternatives, the following elements and factors were considered:

- Horizontal and vertical alignment of the New North Oakville Transportation Corridor at the bridge crossing;
- Sub-structure type, location and geometry;
- Superstructure cross-section and type, based on lane requirements, vertical clearance requirements, structure skew and span arrangement;
- Hydraulic requirements and navigability requirements;
- Construction staging and access requirements;
- Constructability;
- Approach embankment requirements considering height, slope stability, fill material requirements, and warrants for retaining walls; and
- Preliminary cost estimate.

Structural components, including the deck, girders, piers, foundations, and abutments, will be designed in accordance with the CHBDC. Preliminary designs based on the CHBDC have arrived at a span length of 80 m for both the steel girders and the steel box girder options.

- Sub-Structure

Piers

Three cast-in-place reinforced concrete piers would be required to support the superstructure, with two piers located north of the creek and one pier located south of the creek. Each pier would consist of two sections: one section for each direction of traffic. Each section would be comprised of two cast-in-place concrete pier shafts and would be topped with a pier cap upon which two steel box girders would be supported. Each pier would be supported by a spread footing.

Abutments

Abutments would be of the conventional type with expansion joints. The abutments are expected to be founded on bedrock high on the valley walls and recessed into original valley banks, thereby limiting the need for embankment fill on bridge approaches.

- Superstructure

Vertical clearance requirements with respect to traffic are not an issue as there are no structures above the bridge. Vertical clearance beneath the structure is greater than 35 m.

The superstructure would be of uniform cross section with a tangent alignment and no skew. These requirements are well suited for slab-on-girder or slab-on-box girder construction.

- Construction Method and Access

Because the bridge is on a new alignment, traffic impacts are not anticipated for the bridge construction.

Pier construction would be required on the valley floor. Access to the valley floor is most direct from Dundas Street to the south (via Lions Valley Park Road South). Temporary access roads along the valley floor would be required and would need to be restored upon completion of the structure. One or more temporary bridges would be required for access across the creek, for example to access the west pier footing which is located between the creek and the valley wall.

The abutments can be constructed from atop the valley walls and accessed via the new right-of-way.

Two options for erection of the superstructure were considered. The first option involves erection from the valley floor. Challenges associated with this option include access to the valley due to the steep ramp from Dundas Street and the anticipated difficulty in delivering the girders to the bridge location. Another consideration is the environmental impact from the increased construction performed on the valley floor. The second alternative would require launching of prefabricated structural steel girder sections from the new roadway level. Further investigation would be required in detail design to confirm the preferred approach.

- Retaining walls

The abutments have been proposed to be located high on the valley walls and recessed into original valley banks in such a way as to minimize the amount of retaining walls and fill needed.

5. Navigable Waters Protection

The designed span and vertical clearance above the channel, which is greater than 35 m, exceeds Navigable Waters Protection Act requirements.

6. Hydraulic Requirements

Given the large vertical clearance and span, and the configuration of the piers, hydraulic effects of the structure on Sixteen Mile Creek are expected to be insignificant. The piers have been located clear of the main channel and beyond the meander belt (50 year projection). The abutments would be constructed high on the valley walls.

Preliminary Cost Estimate

The preliminary cost estimate for the proposed conventional girder bridge is $41.5 M, excluding the cost of bridge approaches, and including $2M for environmental mitigation and access roads. The assumed roadway grade is approximately 40 m above the valley floor.

7.1.6 Right-of-way Requirements

A basic right-of-way width of 35 m is proposed, with additional property required at intersection locations, for utilities and for grading (cuts and fills). The property requirements are identified on the Recommended Design Plates in Part II of this ESR.

To identify approximate property requirements based on grading needs a digital terrain model was developed based on existing mapping. Cross sections were generated at 50m intervals and a right-of-way plotted. The resulting right-of-way indicates that property beyond the 35m basic width will be necessary at numerous locations throughout the length of the project. Opportunities for refinement will be reviewed during detail design and/or through development of adjacent lands in the NOESP and NOWSP areas.

7.1.7 Pedestrian and Cyclist Facilities

A 3.0 m multi-use pathway/sidewalk is proposed on both sides of the roadway. On the Sixteen Mile Creek Bridge, a barrier is required between the sidewalk and the roadway.

On-road bike lanes are provided throughout the corridor. The bike lane width is typically 1.8 m, except on the Sixteen Mile Creek Bridge where a width of 2.1 m would apply.

7.1.8 Preliminary Cost Estimate

The preliminary cost for the New North Oakville Transportation Corridor is estimated at $205 M, as summarized in **Exhibit 7-17**. The cost will be dependent on the amount of property acquired through dedications in the development approval process.

Exhibit 7-17: Preliminary Cost Estimate

Description	Ninth Line to Trafalgar Road	Trafalgar Road to Neyagawa Blvd.	Neyagawa Blvd. to 16 Mile Creek	16 Mile Creek Bridge	16 Mile Creek to Bronte Road	Estimated Cost in Millions (2008 Dollars)
Roadworks	$13,155,297	$13,217,251	$9,215,214	$0	$12,799,188	$48,386,950
Structures	$0	$0	$467,334	$29,367,021	$0	$29,834,355
Landscaping/Mitigation	$294,216	$261,170	$233,454	$2,000,000	$333,658	$3,122,498
Electrical	$2,281,240	$1,897,480	$1,143,818	$0	$2,142,660	$7,465,198
Utilities & Services	$64,583	$68,750	$49,271	$0	$63,542	$246,146
SUBTOTAL	$15,795,337	$15,444,651	$11,109,091	$31,367,021	$15,339,048	$89,055,147
Contingency Allowance (15%)	$2,369,300	$2,316,698	$1,666,364	$4,705,053	$2,300,857	$13,358,272
Engineering (15%)	$2,724,696	$2,664,202	$1,916,318	$5,410,811	$2,645,986	$15,362,013
Property	$16,997,373	$23,195,095	$29,063,426	$0	$17,748,901	$87,004,796
TOTAL COST (2008 $)	**$37,886,706**	**$43,620,647**	**$43,755,199**	**$41,482,885**	**$38,034,792**	**$204,780,228**

7.2 GEOTECHNICAL / FOUNDATION REQUIREMENTS

Geotechnical investigations were undertaken on those sections of Burnhamthorpe Road that will form parts of the proposed New North Oakville Transportation Corridor. These sections include existing Burnhamthorpe Road immediately east and west of Ninth Line and from west of Sixth Line to west of Neyagawa Boulevard. A pavement design report was prepared for these sections and is appended to this ESR as **Appendix L**. Further geotechnical investigations will be required on the new alignment sections to support detail design.

A secondary source geotechnical foundation investigation was undertaken by Golder Associates for the proposed new crossing of the Sixteen Mile Creek in order to identify whether there were any concerns with respect to a new crossing at the recommended location. The following literature and reports prepared within the Study Area were used in the review:

- The Physiography of Southern Ontario, Chapman, L.J. and Putnam, D.F. Ontario Geological Survey, Special Volume 2, Third Edition, 1984
- Structural Design Report for Highway 403 (now Highway 407), 16 Mile Creek Bridges, Site No. 10-490, District 4, Burlington, GWP 406-85-00, Highway 403 (now Highway 407) Trafalgar Road to 16 Mile Creek, WP 406-85-01, 16 Mile Creek Bridge (WBL), WP 406-85-02, 16 Mile Creek Bridge (EBL), Ministry of Transportation, Ontario, 1993
- Report of Hydrogeological Assessment of Proposed New North Oakville Transportation Corridor, prepared for TSH by Gartner Lee Limited, May in 2008

Additional work was undertaken by Golder Associates in December, 2008 in response to comments received from Halton Region requesting a site reconnaissance to verify the soil conditions inferred from the literature review and from Conservation Halton comments indicating that the geotechnical assessment should account for potential slope stability impacts resulting from loss of vegetation arising from the crossing's construction. A letter report dated April 23, 2009 provides revised results of the additional work requested by Halton Region and Conservation Halton (**Appendix H**) and is discussed below.

7.2.1 Regional Geology

Physiographically, the Study Area is located within the geological domain known as the "South Slope". The South Slope is the southern slope of the Oak Ridges Moraine including a strip south of the Peel Plain and is predominantly a moraine till plain which, in the Study Area, is known as the Halton Ground Moraine till plain (Halton Till Plain) generally represented by the topographic low area in the Study Area. The moraine till plain was formed following the retreat of the Wisconsinan ice sheet which covered the area during the Pleistocene Epoch. After deglaciation and during the draining of the glacial lakes north of the Trafalgar Moraine, several deep river valleys were formed by erosion of the overburden and bedrock.

The Halton Till Plain is characterized by a surficial clayey silt till. This plain is transected by the Trafalgar End Moraine till ridge on which is generally represented by the topographic high area in the north part of the Study Area. Based on the hydrogeological assessment report as noted above, the southern limit of the Trafalgar Moraine appears to be located on the north side of the present Burnhamthorpe Road between Bronte Road and Neyagawa Boulevard. The Trafalgar Moraine mainly consists of clayey silt till overlying shale bedrock of the Queenston Formation which consists of red-brown shale containing limestone/siltstone interbeds.

7.2.2 Subsurface Conditions

The overburden in the overall Study Area consists generally of unsorted, unstratified heterogeneous mixtures of clayey silts, sands and gravels of glacial till origin. The till is generally classified as a clayey silt of low to medium plasticity and forms the matrix for the sands and gravels which are variable in proportion. The overburden varies in thickness at different areas but is typically less than a few metres except at some locations within/adjacent to the Sixteen Mile Creek valley.

The following summarizes the subsurface conditions encountered during investigations at the existing bridge crossing locations of the Sixteen Mile Creek valley; specifically Highway 407 and Dundas Street West.

Highway 407 Bridges Crossing Sixteen Mile Creek

Based on the available boreholes information contained in the 1993 Ministry of Transportation report mentioned above, the overburden encountered in boreholes put down on the tableland near the crest of the Sixteen Mile Creek valley at Highway 407 consisted of about 7 m of hard clayey silt till in the area of the west abutments, and about 9 m to 13 m of very stiff to hard clayey silt till at the east abutments. The overburden was underlain by red-brown shale bedrock with interbedded siltstone. The shale bedrock was encountered at about Elevation 164 m in the vicinity of the west abutments and at approximate Elevations between 156 m and 160 m in the vicinity of the east abutments of the bridges. The bedrock was generally highly weathered within the top 1 m to 3 m of the formation at most locations; occasionally as much as 5 m was noted as being weathered and fractured.

Shale bedrock is generally exposed on the floodplain and at the toe of the west valley slope. About 2 m to 5 m of stiff to hard clayey silt till was encountered below ground surface in boreholes put down on the floodplain between the east river bank and the toe of east valley slope. The shale bedrock was encountered at approximate Elevations 134 m to 136 m in the flood plain area. The bedrock was generally highly to completely weathered within the upper 2 m to 3 m at most locations.

The measured natural water contents of the clayey silt till ranged from about 7 percent to 18 percent. Atterberg limit tests carried out on selected samples of the deposit measured liquid limits ranging from about 13 percent to 20 percent and plasticity indices ranging from about 8 percent to 15 percent indicating medium to high plasticity.

Groundwater levels in the boreholes on the tableland behind the valley slopes were measured in 1992 between Elevations 162 m and 164 m; groundwater levels in the boreholes in the floodplain area were encountered between Elevations 133 m and 137 m in 1992.

Dundas Street Bridge Crossing Sixteen Mile Creek

Based on the cross section B-B' along Dundas Street as shown in the hydrogeological assessment report mentioned above, relatively shallow (less than 3 m) overburden overlies the shale bedrock at both crests of the Sixteen Mile Creek valley slopes. Shale bedrock is typically exposed on the creek valley slopes and it is understood that there is up to about 3 m of soft clayey soils present overlying the shale bedrock in the floodplain area/under the valley floor. It is further understood that there is poor quality highly weathered shale bedrock to depths of at least 6 m below ground surface.

Subsurface Conditions along Creek Valley

Based on the site reconnaissance on December 5, 2008, both side slopes of the Sixteen Mile Creek valley are generally densely vegetated in the Lions Valley Park. Based on the available overburden in the valley generally consists of unsorted, unstratified heterogeneous mixtures of clayey silts, sands and gravels of glacial till origin. The overburden varies in thickness at different areas but is typically less than a few metres. There is an approximately 260 m long stretch of the east/north creek valley slope within the Lions Valley Park, to the east of the proposed alignment, where the red-brown shale containing limestone/siltstone interbeds of the Queenston Formation is exposed. In the upper portions of the slope, surficial topsoil and shallow overburden overlies the shale bedrock. The lower 3 m to 5 m of the exposed bedrock slope is standing almost vertical; there are significant erosion channels formed on the slope surface.

Subsurface Conditions at the Proposed Creek Crossing

The proposed bridge crossing Sixteen Mile Creek is located between approximately Station 13+120 and 13+420 near the point where a tributary flows into the main creek channel. The total length of the proposed four-span bridge is 280 m. The slope on the north and south sides of the creek at the proposed crossing location is densely vegetated. The slope are at inclinations generally ranging from 27 degrees to 32 degrees; however there is a near vertical bedrock outcrop at the slope toe where red-brown shale containing limestone/siltstone interbeds is exposed. The adjacent slopes are at inclinations of 50 degrees or steeper. Above the exposed bedrock, at heights ranging from 1.5 m to 2.0 m above the creek level, the overburden consists of clayey silt till underlying surficial topsoil; however, the thickness of the overburden is not known. Soils mixed with gravel, cobble, boulder and rock fragments are present at some locations in the creek bed; bedrock was not visible in the creek bed.

7.2.3 Foundation Considerations for the Proposed New North Oakville Transportation Corridor Structure

It is understood that the preferred road alignment crosses the Sixteen Mile Creek in the southern portion of the Study Area and is about 0.5 km north of Dundas Street West. Based on the available subsurface information at the Dundas Street West bridge crossing of the Sixteen Mile Creek as discussed above, spread footings seated on the shale bedrock and/or pile foundations extended into the bedrock would be suitable options for support of the New North Oakville Transportation Corridor structure over the Sixteen Mile Creek. Depending on the thickness of the overburden at the crest of the valley slopes at the abutment locations, spread footings could be feasible for the abutment support. It is noted that the configuration of the valley slope at the abutment locations should be reviewed and an assessment made with respect to where the abutment footings need to be located to maintain them beyond the geotechnical long term stable slope line during detail design.

For the pier footings in the creek valley, depending on the condition of the upper portions of the bedrock and on the thickness of the overburden, it may be preferable to use caissons socketted into the bedrock. If the upper portions of the bedrock are classified as poor quality (which infers that the rock is closely fractured) and highly weathered, then the caissons would have to be extended to sufficient depth to ensure that they are within the underlying less weathered good quality rock. The general concern with this type of construction is that there is potential for significant inflow of groundwater to the caisson excavation. This then precludes inspection of the caisson and requires the use of tremie concrete. The alternative would be to use spread footings founded on or within the shale bedrock. The design will be governed by the quality of the upper portions of the bedrock. Depending on the thickness of overburden in the valley floor, groundwater control measures may be required to maintain a dry excavation.

Based on the site observations from the additional work completed by Golder Associates in December 2008, with respect to subsurface conditions for the Sixteen Mile Creek valley slopes at the proposed bridge crossing, spread footings placed on the shale bedrock and/or pile foundations extended into the bedrock would be suitable for the support of the proposed bridge structure over Sixteen Mile Creek.

7.3 Utilities and Services

Existing utilities located within the project corridor include storm sewers, telephone, hydro, gas and cable. The majority of the developed properties within the study corridor are serviced by private wells and septic systems. Existing utilities and municipal services will be impacted by the recommended design and will require relocation.

During detail design, plans will be forwarded to the utility companies to confirm the impact and relocation requirements of the underground and overhead services within the construction limits.

7.4 Construction Implementation

Subject to the receipt of necessary approvals, the start of construction for the New North Oakville Transportation Corridor is anticipated as follows (as per the 2010 Budget and Forecast):

- Ninth Line to Trafalgar Road – Start of construction in 2012
- Trafalgar Road to Neyagawa Boulevard – Start of construction in 2015
- Neyagawa Boulevard to Sixteen Mile Creek – Start of construction in 2018
- Sixteen Mile Creek to Bronte Road – Start of construction in 2014

8 MITIGATION MEASURES AND DETAILED DESIGN COMMITMENTS

Many of the environmental concerns related to this project have been mitigated through the process by which the recommended design was selected, as described in this ESR. The anticipated impacts and proposed mitigation measures have been described in **Section 6.6**. This section provides a detailed list of specific commitments to be carried forward to Phase 5 of the Municipal Class EA process, Implementation. These commitments have been developed with Conservation Halton and other authorities.

Specific mitigation measures have been selected and committed to by Halton Region to address potential impacts as discussed in **Section 6.6**. It is recommended that these commitments presented in the ESR and **Exhibit 8-1** become part of the contract package so that contractors are aware of the requirements prior to tendering. Monitoring of construction activities must ensure that all environmental standards and commitments for construction are met. Halton Region will work with Conservation Halton and other authorities, during detail design and prior to the start of construction to ensure that the proposed works are acceptable and to obtain required permits.

Environmental monitoring will be combined with construction supervision to include periodic site visits and inspections throughout the course of the work (e.g. confirm the proper placement and maintenance of all erosion and sediment control measures).

Exhibit 8-1: Detailed Design Commitments

ID#	Detailed Design Commitments Extracted from the NNOTC Environmental Study Report
FISHERIES	
1.	Construction controls between construction zone and watercourses to minimize fisheries disruption. Details to be developed at detail design stage.
2.	Fisheries Compensation package to be developed during detail design for the affected creek crossings that have been considered a Harmful, Alteration Disruption Destruction (HADD) of fish habitat.
3.	Obtain Fisheries and Oceans Canada (DFO) authorization prior to any construction as well as any other approvals (Conservation Halton, MNR, etc.).
4.	Restrict in-stream work to approved coldwater fisheries timing windows (timing window to be confirmed with Conservation Halton during detail design).
5.	Maintain flows during construction.
6.	Since drought conditions may influence fish community data collections for McCraney Creek, fish community surveys will be collected between May 30 and July 15 during detail design. Any evidence of fish spawning will be included in inventory results.
7.	Monitoring programs will be undertaken by the Region at least one year prior to site alteration to assess needs for dewatering, potential impacts to fish communities and fish habitat, and to plan mitigation measures where necessary.
8.	Temperatures in Fourteen Mile Creek will be monitored by the Region for approximately one year prior to construction. Deploy data loggers into the creek upstream and downstream (approx 5 - 20 meters upstream and 5 - 20 meters downstream) of the transportation crossing in the month of May or June and collect them again at the end of September. The data loggers need to be firmly and discretely secured in an appropriate location in the creek to prevent theft and to reduce the risk of being swept away by the current. Once the temperature data is downloaded from the loggers, it needs to be referenced with accurate, local maximum daily air temperature data. Water temperatures obtained on a day where the max. daily air temperature has been above 24 degrees Celsius, where the max daily air on the three preceding days have also been above 24 degree Celsius will provide an indication of the thermal stability of that stretch of the creek. Under post construction conditions, discharge to subsurface rock filtration systems/trenches should be implemented to provide maximum temperature benefits. Tree planting to provide shading of surface runoff is also recommended.
STORMWATER MANAGEMENT	
9.	Conservation Halton will be conducting a site inspection of the watercourse located within the woodlot in the vicinity of 13+600 and 13+750 to confirm the crossing status. This information will be obtained by the Region of Halton for consideration during detail design.
10.	Employ stormwater best management practices to reduce discharge of contaminants to receiving watercourse and wetlands.
11.	Develop monitoring and maintenance program for interim stormwater management facilities as per MOE and Conservation Halton guidelines.
12.	Implement infiltration systems, where necessary, to encourage infiltration of precipitation into the ground.
13.	Detailed hydraulic analysis of proposed culvert crossings and detailed assessment/analysis of SWM facilities at each watercourse outlet will be done at the detailed design stage under both interim and ultimate conditions.
HYDROGEOLOGY	
14.	The geology and groundwater conditions in the area on the north side of Burnhamthorpe Road between Trafalgar Road and Ninth Line will be investigated to determine the need for dewatering during construction of service trenches if proposed, and to assess potential impacts on local wells and streams as well as mitigation measures if required.
15.	A local well survey and water quality assessment will be carried out to assess potential road salt impacts on bedrock wells along Dundas Street West between Bronte Road and Neyagawa Boulevard. The survey will address the impacts that the additional road salt will have (if any) on nearby fish communities.
16.	Prior to the permit process for the Sixteen Mile Creek bridge, the following will be completed: • Determine the type of soil in vicinity of abutments on both sides of Sixteen Mile Creek • Determine the groundwater levels in the spring (April) • Compare the elevation of creek water levels to determine if groundwater seepage is entering the creek, specifically where abutments will be constructed • Determine the stability of the creek valley walls on both sides of the creek if seepage is occurring • Determine the extent of dewatering required for construction if a Permit to Take Water is required (volume required) and determine what the impact is to base flow • Determine the connection between the hydrogeological conditions (impacts from pre/post construction) and base flow to creek specifically documenting impacts to fish and thermal regime
WETLANDS, WET FEATURES & DEPRESSIONS	
17.	Standard construction mitigation will be used for roadwork within 120 m of wetlands and will include: • the erection of silt fencing to create 30 m buffers for wetlands • demarcation of fill areas • removal of excess fill or stockpiled materials, and • protect against refuelling within 50 m of wetland areas
18.	The pitted depressions in the area on the north side of Burnhamthorpe Road between Trafalgar Road and Ninth Line should be inspected and monitored by the Region. Potential impacts from the construction and future road maintenance on cold depressions (if identified) will be assessed.
19.	The exact loss of wet features and depressions resulting from infill will be quantified at detail design.
EROSION AND SEDIMENTATION	
20.	To protect downstream fisheries resources, standard erosion and sediment control devices should be used in areas requiring excavation or in-channel works in order to slow runoff velocities and reduce erosive forces, including but not limited to the following: 1. upgraded silt fencing (heavy duty silt fence) will be used at crossing locations where rare species are present (e.g. Sixteen Mile Creek) 2. rock checks or silt fence flow checks will be placed in all ditches immediately upstream of their discharge into a watercourse

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	3. daily inspections are to be carried out particularly after rain events and repairs 4. straw bale dams will be placed in advance of sewer inlets 5. finished slopes will be graded to an acceptable slope and planted according to Conservation Halton's Landscaping and Tree Preservation Guidelines; large cuts should be terraced to minimize surface erosion 6. all excavated materials requiring stockpiling should be in accordance with OPSS 180.07.06 and placed in pre-determined locations; the perimeters of stockpiles will be encircled with silt fencing, according to OPSD 219.110 7. any in-water work that is necessary must be conducted in dry conditions within the appropriate fisheries timing window as per Conservation Halton 8. cleaning and refuelling of machinery will be prohibited within 50 m of a watercourse to prevent the discharge of petroleum products; an emergency spill kit will be kept on-site in case of any fuel or chemical leaks 9. additional supply of silt fence, straw bales and rip-rap will be maintained on-site prior to the commencement of grading operations and throughout the duration of the construction in case of an emergency 10. the integrity of all sediment trapping devices will be monitored regularly (at least weekly, and immediately following rain events) and properly maintained; such structures will be removed only after the soils of the construction areas have been stabilized and then only after the trapped sediments have been removed
21.	The contractor will identify a contingency plan for accidental sediment release
22.	Monitoring of Sixteen Mile Creek (Reach R1) will continue leading up to the construction of the Sixteen Mile Creek bridge crossing to obtain a better understanding of channel processes including local migration rates, possible erosion thresholds, and placement of the footings for the crossing. Five erosion pins were installed throughout this site to determine the rate of bank erosion and migration for future monitoring of the channel. The locations of erosion pins are provided in Table 5 of the Fluvial Geomorphological report found in Appendix G to the ESR.
VEGETATION	
23.	Limits of work to be delineated in field prior to construction commencement to minimize environmental impacts in sensitive areas.
24.	A restoration/landscaping plan will be prepared during detail design and will include but not be limited to the following: • Inventory of all trees to be removed; at time of construction they will be marked and felled into the work area to avoid damage to adjacent vegetation • pre-stress trees in advance of grading operations • vegetation that is subject to significant environmental damage should be fertilized and pruned to accelerate recovery; fertilization should not be undertaken for any plantings within 50 metres of a watercourse to eliminate the risk of introduction of additional nutrients to the watercourse • landscape planting plan to include locally native, non-invasive species and species that blend into the surrounding environment • restoration of the vegetation removed will be completed within an appropriate location within the study area • trees or large shrubs identified for preservation within and immediately adjacent to construction zones will be protected with appropriate hoarding (fence or similar structure using OPSD 220.01) at an appropriate distance from the tree stem, as determined by a qualified professional. • in sensitive areas, higher quality tree protection fencing will be used; in the event that roots or branches of trees to be protected are inadvertently damaged during construction, they will be pruned clean as soon as possible. Exposed roots will be covered with topsoil. • all restoration plantings will consider Conservation Halton's Landscaping Guidelines and will be an appropriate species for the growing conditions at the site • all plantings shall be undertaken in areas of visible topsoil, otherwise top soil should be introduced to the site to increase the success of all rehabilitative plantings

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	• all exposed surfaces susceptible to erosion should be revegetated through the placement of seeding, mulching or sodding immediately upon completion of construction activities or within 45 days of exposure and with sufficient time to allow for successful establishment prior to winter.
25.	Abandoned paved surfaces should be removed and restored to native and landscaped vegetation through a planting plan.
26.	Use lighting that minimizes light trespass and its impacts on natural features.
WILDLIFE	
27.	An amphibian crossing/passageway will be provided east of Sixth Line between 18+200 and 18+400 as per Section 6.6.1 of the ESR.
28.	Warning signs with an advisory speed tab will be implemented through core area crossings.
29.	Implement wildlife crossing at North Park in consultation with Ministry of Natural Resources, Conservation Halton and the Town of Oakville.
ARCHAEOLOGY	
30.	A Stage 2 Archaeological Assessment will be completed in all undisturbed areas during the detail design. In the event that any aboriginal remains or significant aboriginal artifacts are uncovered during further assessment work, all First Nations will be contacted immediately.
31.	A copy of the Stage 2 Archaeological Assessment will be sent to First Nations.
BUILT HERITAGE	
32.	Commemoration of the former historical community of Snider's Corners with a description of the schoolhouse, the former church site and the Snider House by means of an historical plaque will be arranged by the Region of Halton in consultation with the Town of Oakville.
33.	Landscaping will be included as part of the detail design phase to maintain the character of existing Burnhamthorpe Road where required. Existing tree lines, fence lines, hedge rows and field patterns will be retained where possible to minimize the impacts.
NOISE	
34.	Construction noise constraints will be incorporated into contract documents.
35.	Construction activities throughout the project will conform to current local municipal noise by-laws giving due consideration to such factors as the time of day, proximity and size of equipment and type of operation.
36.	Contractors are required to keep idling of construction equipment to a minimum and maintain equipment in good working order to reduce noise from the construction activities.
AIR QUALITY	
37.	Apply water and dust suppressants during construction to protect air quality due to dust.
MATERIALS MANAGEMENT	
38.	A construction work plan will be developed which designates locations for stockpiling of soils and other materials including fuel. Prior to commencement of construction, the limits of protection areas will be delineated and fenced to avoid inadvertent intrusion of machinery or other activities such as stockpiling of excess material. This fencing should be maintained and remain in place until final grading and landscaping has been completed.
39.	All excavated materials requiring stockpiling will be in accordance with OPSS 180.07.06 and placed in pre-determined locations. The perimeters of stockpiles will be encircled with silt fencing, according to OPSD 219.110.