AECOM

Appendix A

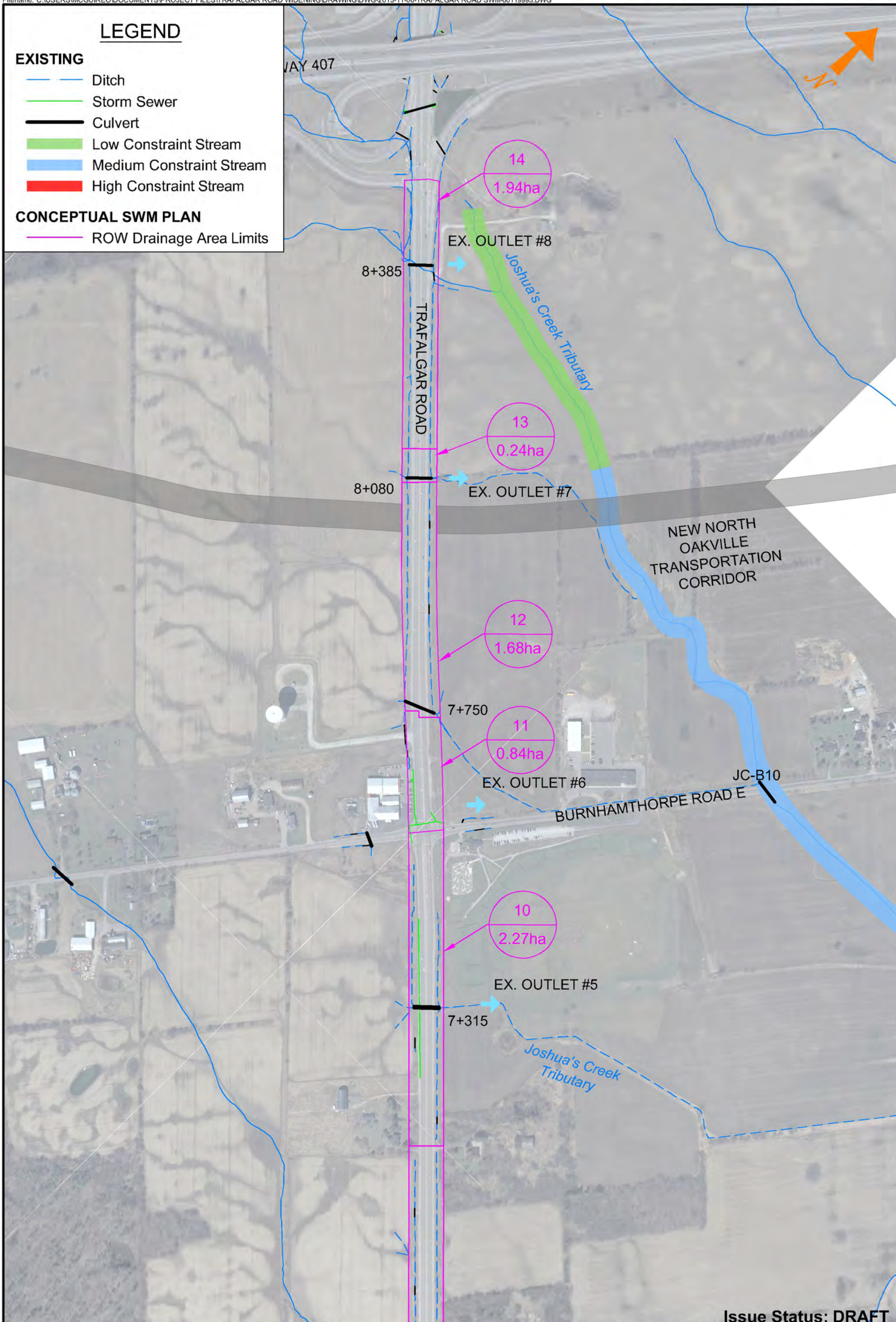
Trafalgar Road Corridor Improvements
EA, Cornwall Road to Highway 407

Stormwater Management
Report

- **Drawings**

Last saved by: MCGUIREO (2013-11-08) Last Plotted: 2013-11-09
Filename: C:\USERS\MCGUIREO\DOCUMENTS\PROJECT FILES\TRAFALGAR ROAD WIDENING\DRAWING\DWG-2013-11-06-TRAFALGAR ROAD SWM-60119993.DWG

Project Management Initials: Designer: ____ Checked: ____ Approved: ____ ANSI B 279.4mm x 431.8mm



TRAFALGAR ROAD CORRIDOR IMPROVEMENTS EA, CORNWALL ROAD TO HIGHWAY 407
EXISTING ROAD DRAINAGE - HIGHWAY 407 TO CULVERT 7+315
REGIONAL MUNICIPALITY OF HALTON, OAKVILLE, ON
Project No.: 60119993 Date: 2013-07-17

AECOM

Drawing: 1

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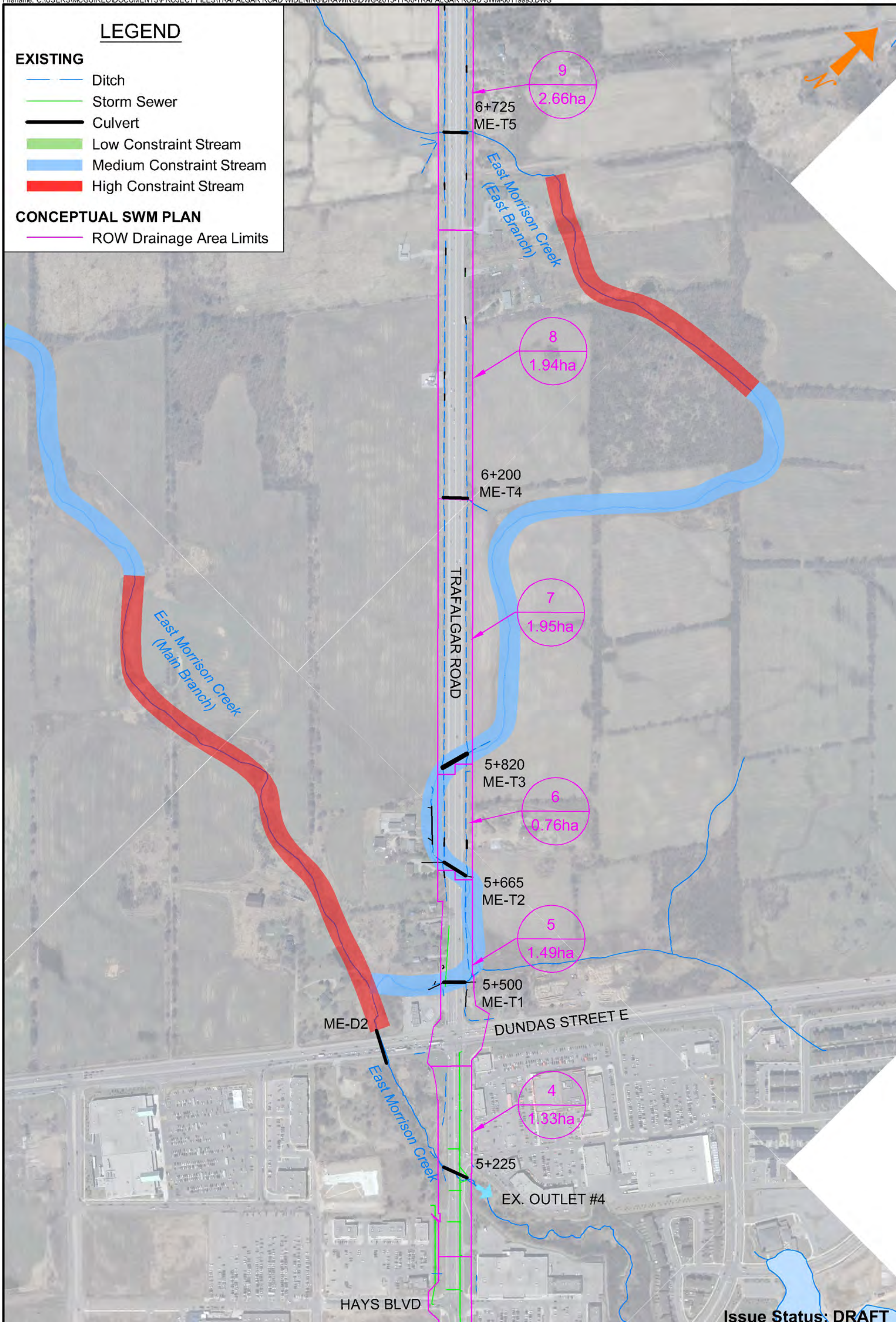

TRAFALGAR ROAD CORRIDOR IMPROVEMENTS EA, CORNWALL ROAD TO HIGHWAY 407
EXISTING ROAD DRAINAGE - CULVERT 6+725 TO HAYS BLVD
REGIONAL MUNICIPALITY OF HALTON, OAKVILLE, ON
Project No.: 60119993 Date: 2013-07-17

AECOM

Drawing: 2

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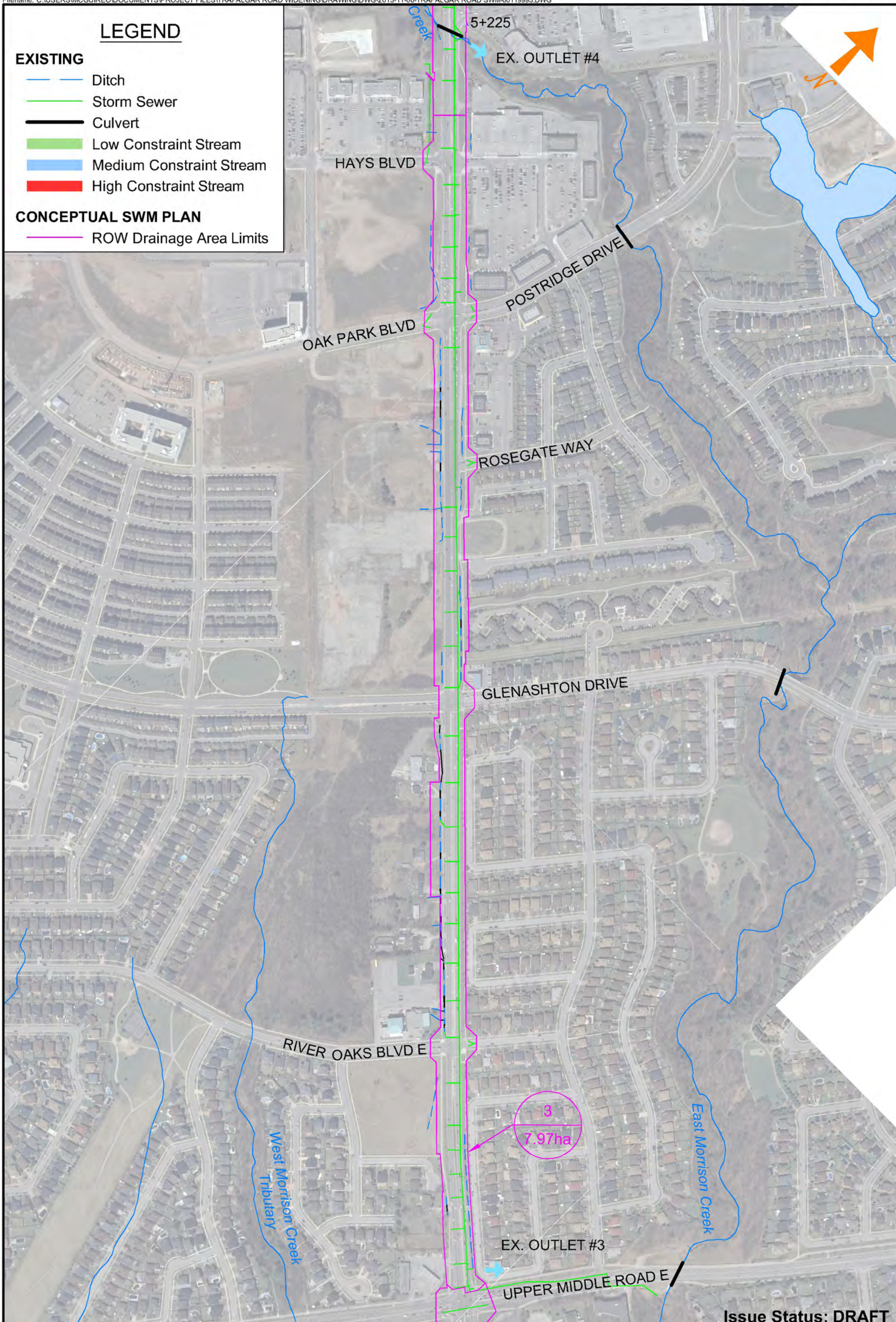

TRAFALGAR ROAD CORRIDOR IMPROVEMENTS EA, CORNWALL ROAD TO HIGHWAY 407
EXISTING ROAD DRAINAGE - HAYS BLVD TO UPPER MIDDLE ROAD E
REGIONAL MUNICIPALITY OF HALTON, OAKVILLE, ON
Project No.: 60119993 Date: 2013-07-17

AECOM

Drawing: 3

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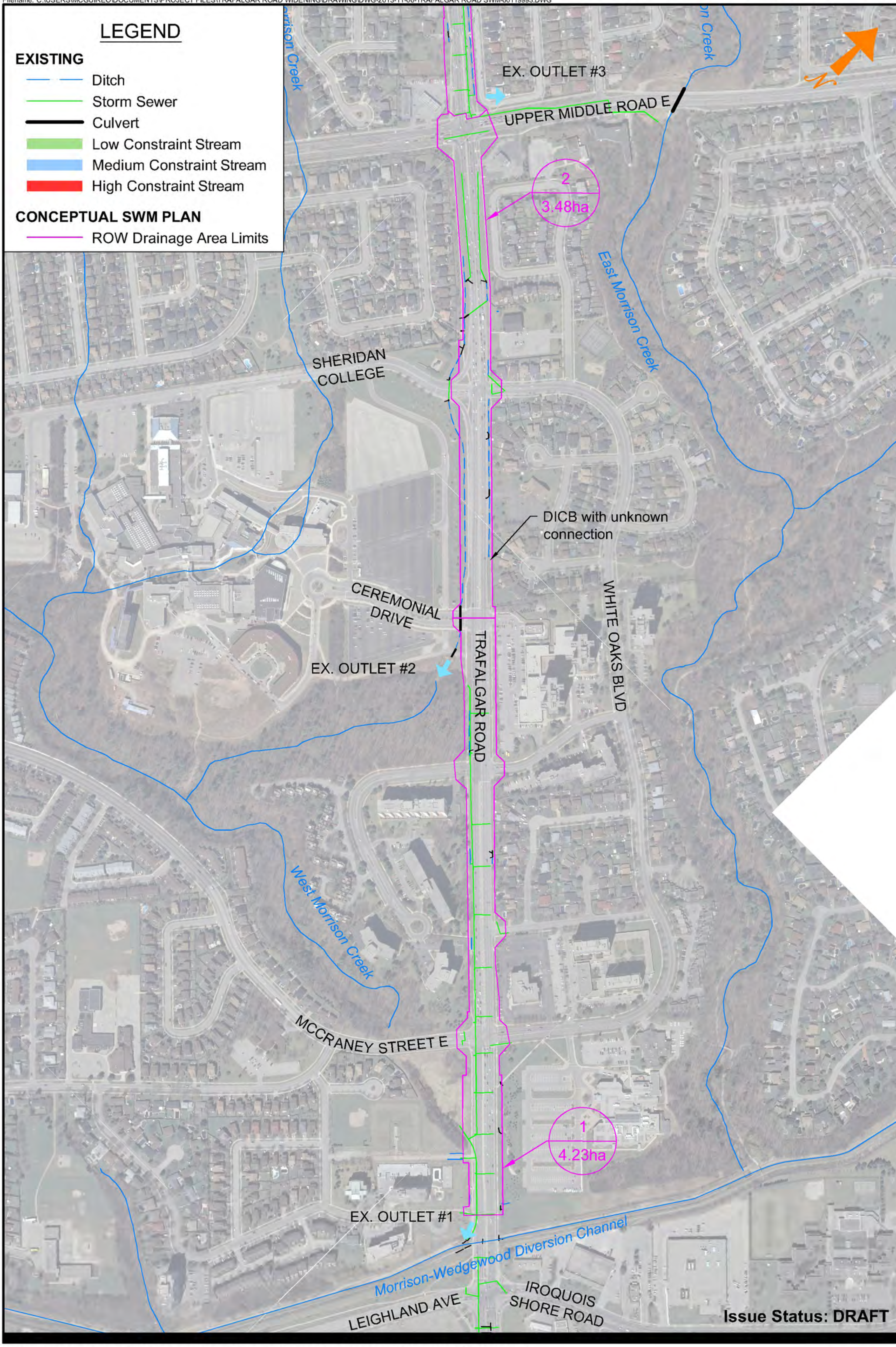

TRAFALGAR ROAD CORRIDOR IMPROVEMENTS EA, CORNWALL ROAD TO HIGHWAY 407
EXISTING ROAD DRAINAGE - UPPER MIDDLE ROAD E TO MORRISON-WEDGEWOOD DIVERSION CHANNEL
REGIONAL MUNICIPALITY OF HALTON, OAKVILLE, ON
Project No.: 60119993 Date: 2013-07-17

AECOM

Drawing: 4

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Project Management Initials: Designer: ____ Checked: ____ Approved: ____ ANSI B 279.4mm x 431.8mm

TRAFALGAR ROAD CORRIDOR IMPROVEMENTS EA, CORNWALL ROAD TO HIGHWAY 407
EXISTING ROAD DRAINAGE - MORRISON-WEDGEWOOD DIVERSION CHANNEL TO CORNWALL ROAD
REGIONAL MUNICIPALITY OF HALTON, OAKVILLE, ON
Project No.: 60119993 Date: 2013-07-17

AECOM

Drawing: 5

ANSI A 215.9mm x 279.4mm
Approved: ____ Checked: ____ Designer: ____ Project Management Initials: ____
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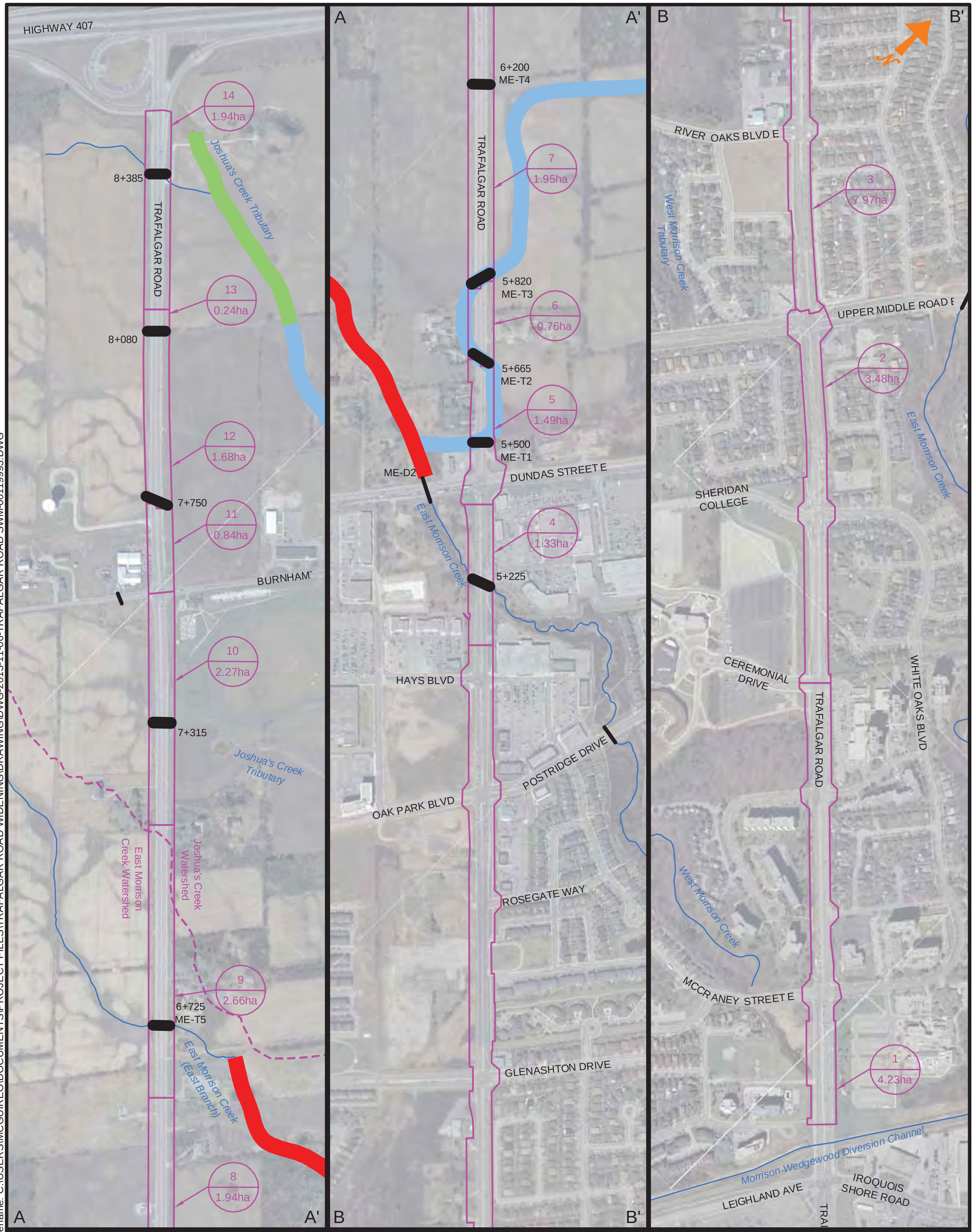

TRAFALGAR ROAD CORRIDOR IMPROVEMENTS EA, CORNWALL ROAD TO HIGHWAY 407
RIGHT-OF-WAY CATCHMENTS
REGIONAL MUNICIPALITY OF HALTON, OAKVILLE, ON
60119993 Date: 2013-07-10 Scale: 1:10000

AECOM

Drawing: 6

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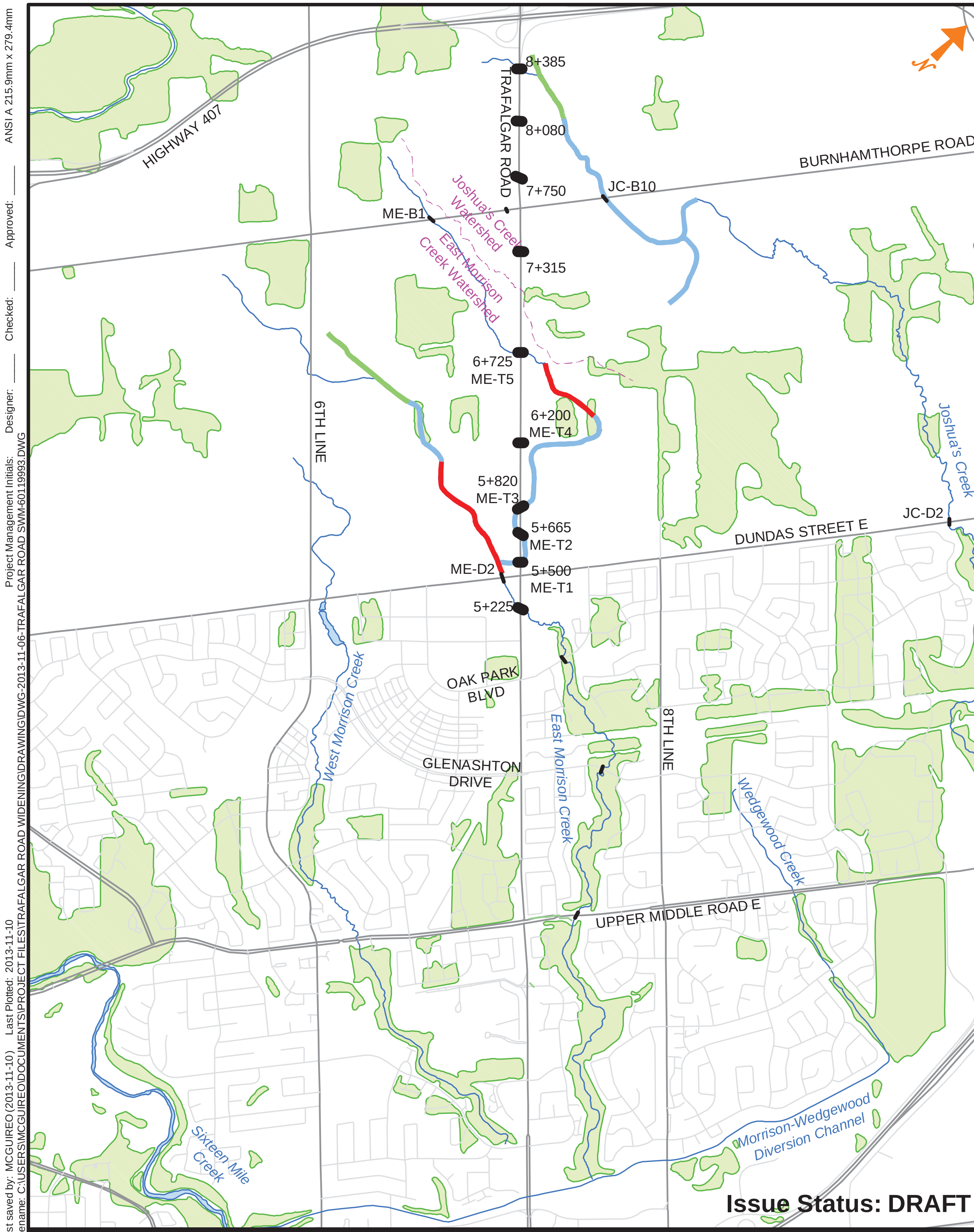

TRAFALGAR ROAD CORRIDOR IMPROVEMENTS EA, CORNWALL ROAD TO HIGHWAY 407
CULVERT LOCATIONS
REGIONAL MUNICIPALITY OF HALTON, OAKVILLE, ON
60119993 Date: 2013-07-10 Scale: 1:30000

AECOM

Drawing: 7

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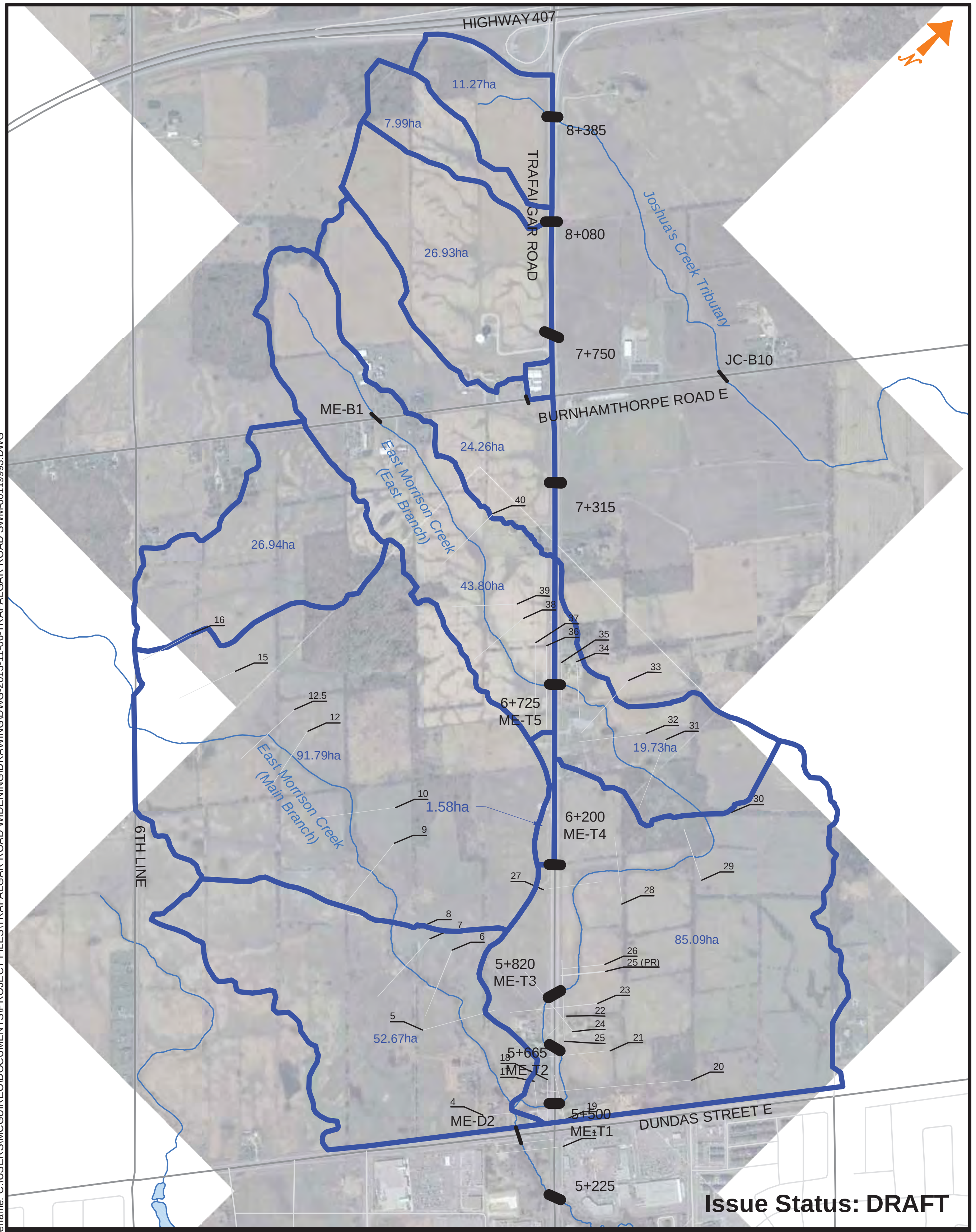

TRAFALGAR ROAD CORRIDOR IMPROVEMENTS EA, CORNWALL ROAD TO HIGHWAY 407
CULVERT DRAINAGE AREAS
REGIONAL MUNICIPALITY OF HALTON, OAKVILLE, ON
60119993 Date: 2013-07-10 Scale: 1:15000

AECOM

Drawing: 8

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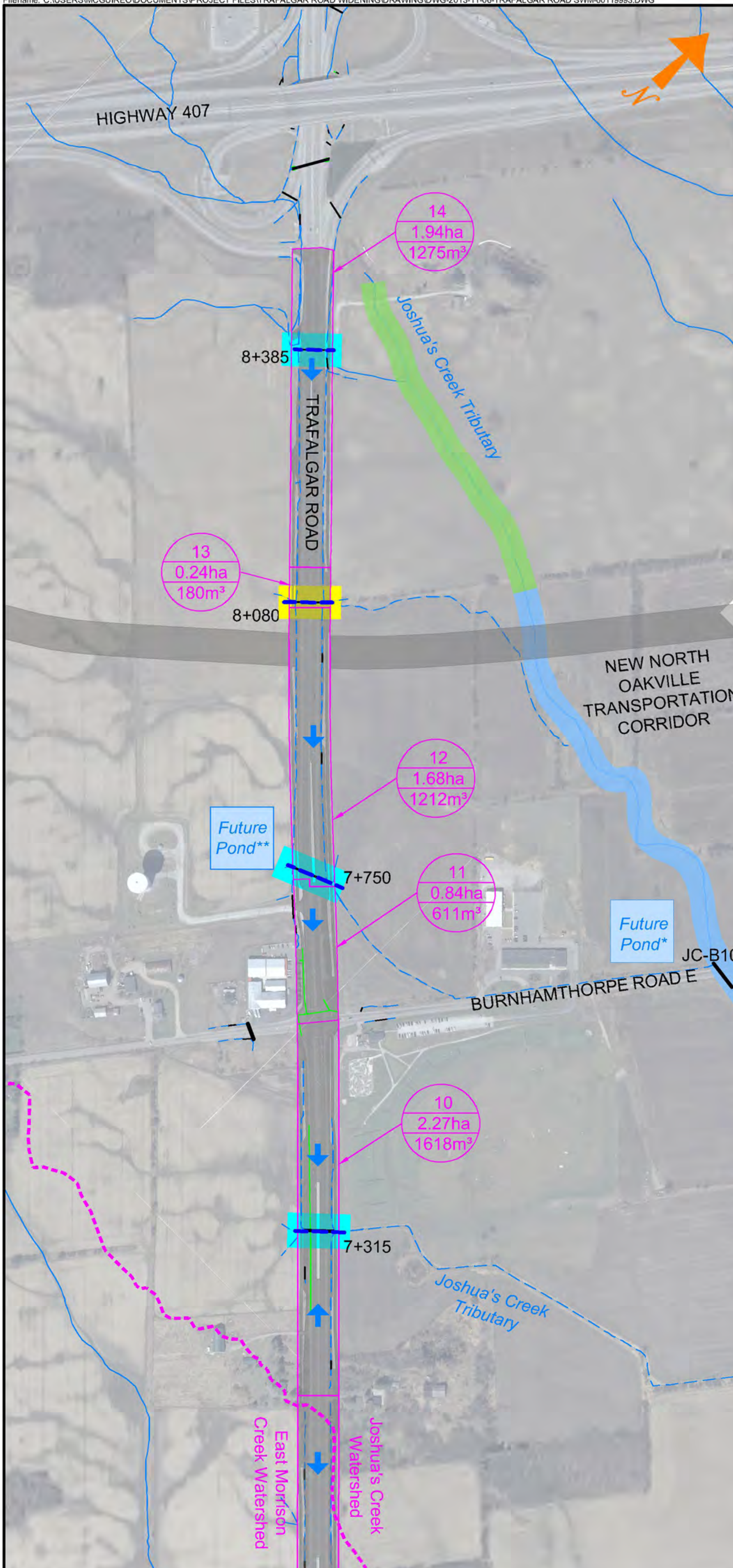


LEGEND

EXISTING

- Ditch
- Storm Sewer
- Culvert
- Low Constraint Stream
- Medium Constraint Stream
- High Constraint Stream

CONCEPTUAL SWM PLAN

- ROW Drainage Area Limits
- Culvert Replacement
- Temporary Culvert

Culvert Recommendations

- Replacement & Extension
- Extension
- Overland Flow Direction

1 / 7.97ha / 200m³ — Area ID; Area (ha); Storage Volume Required to Control Runoff (m³)

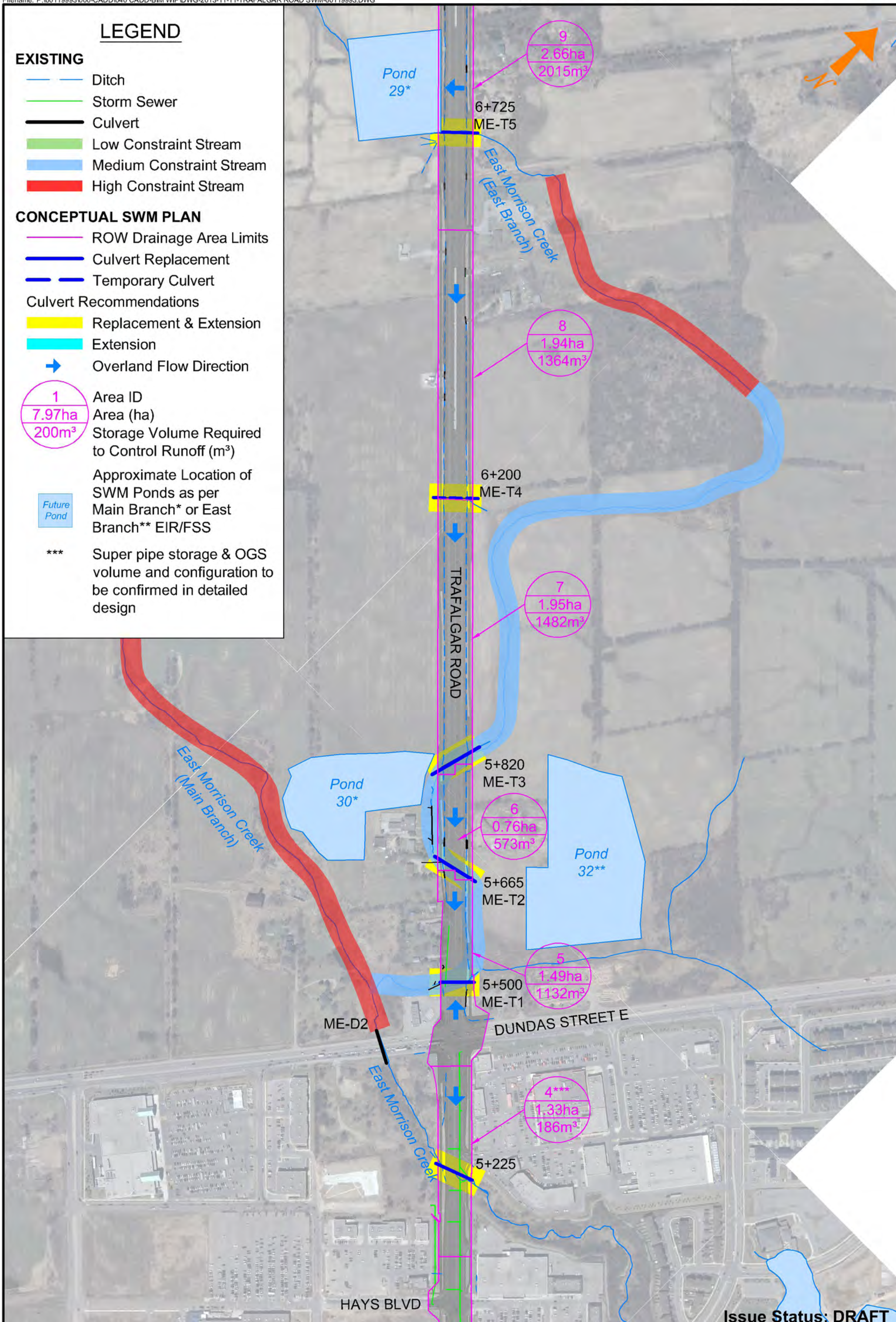
Future Pond — Approximate Location of SWM Ponds as per NOCSS* or North Oakville Secondary Plan**

Issue Status: DRAFT

TRAFALGAR ROAD CORRIDOR IMPROVEMENTS EA, CORNWALL ROAD TO HIGHWAY 407
ULTIMATE CONDITIONS ROAD DRAINAGE DESIGN CONCEPT - HIGHWAY 407 TO CULVERT 7+315
REGIONAL MUNICIPALITY OF HALTON, OAKVILLE, ON
Project No.: 60119993 Date: 2013-07-17

AECOM

Drawing: 9



TRAFALGAR ROAD CORRIDOR IMPROVEMENTS EA, CORNWALL ROAD TO HIGHWAY 407
ROAD DRAINAGE DESIGN CONCEPT - CULVERT 6+725 TO HAYS BLVD
REGIONAL MUNICIPALITY OF HALTON, OAKVILLE, ON
Project No.: 60119993 Date: 2013-07-17

AECOM

Drawing: 10

Last saved by: MCGUIREO (2013-11-13) Last Plotted: 2013-11-13
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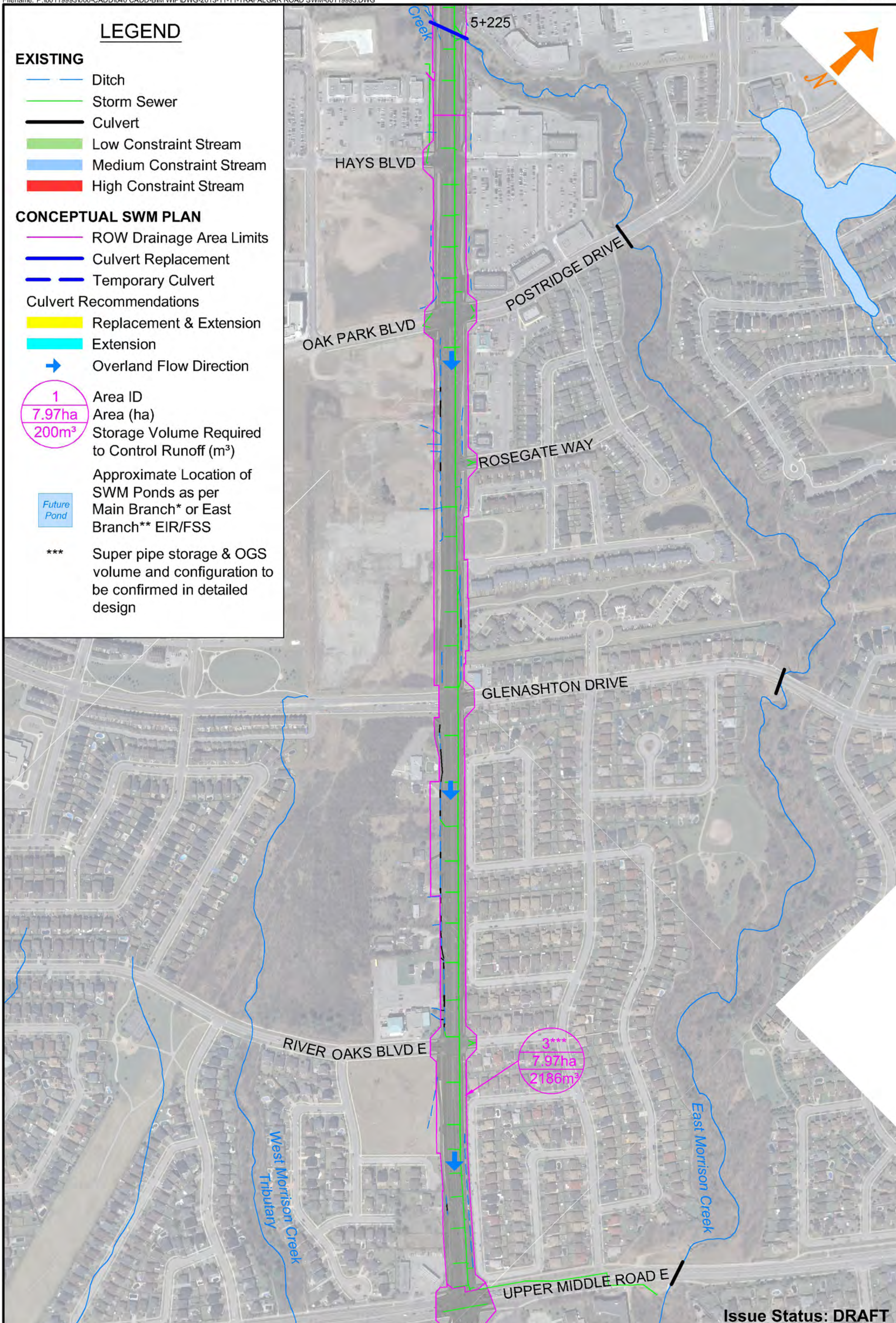
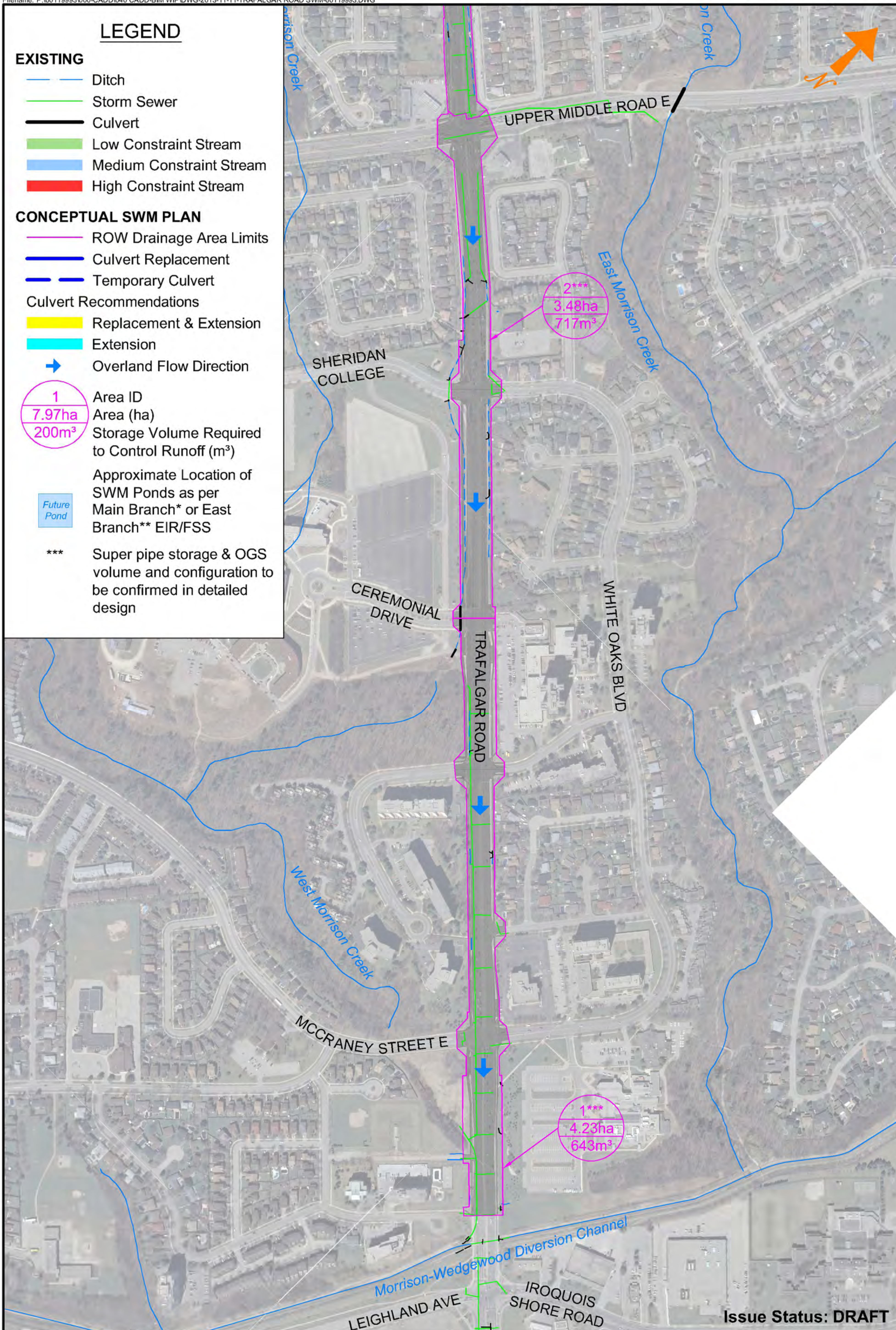


TRAFALGAR ROAD CORRIDOR IMPROVEMENTS EA, CORNWALL ROAD TO HIGHWAY 407
ROAD DRAINAGE DESIGN CONCEPT - HAYS BLVD TO UPPER MIDDLE ROAD E
REGIONAL MUNICIPALITY OF HALTON, OAKVILLE, ON
Project No.: 60119993 Date: 2013-07-17

AECOM

Drawing: 11



TRAFALGAR ROAD CORRIDOR IMPROVEMENTS EA, CORNWALL ROAD TO HIGHWAY 407
ROAD DRAINAGE DESIGN CONCEPT - UPPER MIDDLE ROAD E TO MORRISON-WEDGEWOOD DIVERSION CHANNEL
REGIONAL MUNICIPALITY OF HALTON, OAKVILLE, ON
Project No.: 60119993 Date: 2013-07-17

AECOM

Drawing: 12

Appendix B

Trafalgar Road Corridor Improvements
EA, Cornwall Road to Highway 407

Stormwater Management
Report

- **SWM Design Calculations**

Project Name Trafalgar Road Corridor Improvements EA
Project Number 60119993-10.08

Table B.1 Right-of-Way Catchments

Task: Divide Trafalgar Road corridor into catchments using the proposed right-of-way, high points in the road profile, and storm sewer outlets
Delineate the existing impervious area based on survey data provided by Halton Region and proposed impervious area based on the road desigr

Catchment No.	Culvert Station	Culvert NOCSS ID	Watershed or Tributary	Reach	Constraint Ranking	Length of Roadway (m)	Drainage Area (ROW) [1] (ha)	Existing Conditions Impervious Area (ha)	Existing Conditions Impervious Area (%)	Proposed Conditions Impervious Area (ha)	Proposed Conditions Impervious Area (%)	Proposed Increase in Impervious Area (ha)
1			East Morrison Creek		n/a	860	4.23	2.89	68%	3.31	78%	0.42
2			East Morrison Creek		n/a	720	3.48	2.18	63%	2.76	79%	0.58
3			East Morrison Creek		n/a	1689	7.97	4.82	60%	6.43	81%	1.61
4	5+225		East Morrison Creek		n/a	275	1.33	0.69	51%	1.04	78%	0.35
		ME-D2	East Morrison Creek	MOC-4	High							
5	5+500	ME-T1	East Morrison Creek (EM4)	MOC-2	Medium	268	1.49	0.82	55%	1.25	84%	0.43
6	5+665	ME-T2	East Morrison Creek (EM4)	MOC-2	Medium	152	0.76	0.29	39%	0.61	80%	0.32
7	5+820	ME-T3	East Morrison Creek (EM4)	MOC-2	Medium	397	1.95	0.67	34%	1.65	85%	0.99
8	6+200	ME-T4	East Morrison Creek (EM4)		none	388	1.94	0.78	40%	1.42	73%	0.64
9	6+725	ME-T5	East Morrison Creek (EM3)		none	531	2.66	1.00	38%	2.21	83%	1.21
10	7+315		Joshua's Creek (JC9)		none	453	2.27	1.02	45%	1.78	78%	0.76
11			Joshua's Creek (JC7)		none	164	0.84	0.48	57%	0.70	84%	0.22
12	7+750		Joshua's Creek (JC7)		none	339	1.68	0.60	36%	1.35	80%	0.75
13	8+080		Joshua's Creek (JC7)		none	49	0.24	0.09	35%	0.22	90%	0.13
14	8+385		Joshua's Creek (JC7)		none	388	1.94	0.81	42%	1.38	71%	0.57

Notes:
1 - Drainage area is within boundary of proposed Right-of-Way
Refer to drawing: *P:\60119993\000-CADD\040 CADD-BIM WIP\DWG-2013-08-15-Trafalgar Road SWM-60119993.dwg*
Proposed ROW Drainage Areas layer in drawing (drawn based on *Proposed ROW* from *DE-05.dwg* and *PROPERTY* in *Base.dwg*)

Project Name Trafalgar Road Corridor Improvements EA
Project Number 60119993-10.08

Table B.2 Storage Required for Quality Control

Task: Calculate the maximum active storage required to treat runoff from the ROW.
Calculate the permanent pool volume required under proposed conditions to provide enhanced treatment.

Catchment No.	Culvert		Proposed Conditions		MOE Required Quality Storage Volume [2]		Active Storage			Permanent Pool[6]
	Station	NOCSS ID	Drainage Area (ROW) [1] (ha)	Impervious Area (ha)	Unit Area Volume (m^3/ha)	Total (m^3)	Water Quality[3] (m^3)	Erosion Control (25 mm Event)[4] (m^3)	Maximum[5] (m^3)	(m^3)
5	5+500	ME-T1	1.49	1.25	248	370	60	372	**372**	310
6	5+665	ME-T2	0.76	0.61	242	184	30	190	**190**	154
7	5+820	ME-T3	1.95	1.65	250	486	78	486	**486**	409
8	6+200	ME-T4	1.94	1.42	230	446	78	485	**485**	369
9	6+725	ME-T5	2.66	2.21	247	657	106	664	**664**	550
10	7+315		2.27	1.78	239	542	91	566	**566**	451
11			0.84	0.70	248	208	34	210	**210**	174
12	7+750		1.68	1.35	242	406	67	419	**419**	339
13	8+080		0.24	0.22	258	63	10	61	**61**	53
14	8+385		1.94	1.38	227	439	77	484	**484**	362

Notes:
1 - Drainage area is within boundary of proposed Right-of-Way
2 - Water Quality Storage volume calculated using Table 3.2 in the MOW SWMP manual for enhanced protection (80%). The volume includes 40 m^3/ha of extended detention and the remaining volume is permanent pool.
Require protection level: Enhanced
SWMP Type: Wet Pond
Extended Detention: 40 m^3/ha
3 - The portion of active storage required to treat runoff from the increase in impervious area is calculated using 40 m^3/ha.
4 - Erosion control storage provides detention for runoff produced by a 25 mm storm.
5 - The larger of the erosion control active storage and the water quality active storage should be provided as per page 4-52 of the MOE SWM Planning and Design Manual.
6 - The permanent pool required to treat runoff from the ROW is calculated as the difference between total storage required to provide enhanced protection and the active storage calculated using 40 m^3/ha.
Refer to drawing: *P:\60119993\000-CADD\040 CADD-BIM WIP\DWG-2013-08-15-Trafalgar Road SWM-60119993.dwg*

Project Name Trafalgar Road Corridor Improvements EA
Project Number 60119993-10.08

Table B.3 Runoff Coefficients

Existing Conditions

Catchment No.	Drainage Area (ha)	Sub-Area 1				Sub-Area 2				Total Area (ha)	Total Area (ha) (Check)	Average C	100-year C C x 1.25
		Area (ha)	Soil	Land Use	C	Area (ha)	Soil	Land Use	C				
1	4.23	2.89	Clay loam	asphalt/concrete	0.95	1.33	Clay loam	grassed, average slope	0.22	**4.23**	4.23	**0.72**	**0.90**
2	3.48	2.18	Clay loam	asphalt/concrete	0.95	1.30	Clay loam	grassed, average slope	0.22	**3.48**	3.48	**0.68**	**0.85**
3	7.97	4.82	Clay loam	asphalt/concrete	0.95	3.15	Clay loam	grassed, average slope	0.22	**7.97**	7.97	**0.66**	**0.83**
4	1.33	0.69	Clay loam	asphalt/concrete	0.95	0.65	Clay loam	grassed, average slope	0.22	**1.33**	1.33	**0.60**	**0.74**

Proposed Conditions

Catchment No.	Drainage Area (ha)	Sub-Area 1				Sub-Area 2				Total Area (ha)	Total Area (ha) (Check)	Average C	100-year C C x 1.25
		Area (ha)	Soil	Land Use	C	Area (ha)	Soil	Land Use	C				
1	4.23	3.31	Clay loam	asphalt/concrete	0.95	0.91	Clay loam	grassed, average slope	0.22	**4.23**	4.23	**0.79**	**0.99**
2	3.48	2.76	Clay loam	asphalt/concrete	0.95	0.72	Clay loam	grassed, average slope	0.22	**3.48**	3.48	**0.80**	**1.00**
3	7.97	6.43	Clay loam	asphalt/concrete	0.95	1.54	Clay loam	grassed, average slope	0.22	**7.97**	7.97	**0.81**	**1.00**
4	1.33	1.04	Clay loam	asphalt/concrete	0.95	0.29	Clay loam	grassed, average slope	0.22	**1.33**	1.33	**0.79**	**0.99**
5	1.49	1.25	Clay loam	asphalt/concrete	0.95	0.24	Clay loam	grassed, average slope	0.22	**1.49**	1.49	**0.83**	**1.00**
6	0.76	0.61	Clay loam	asphalt/concrete	0.95	0.15	Clay loam	grassed, average slope	0.22	**0.76**	0.76	**0.80**	**1.00**
7	1.95	1.65	Clay loam	asphalt/concrete	0.95	0.29	Clay loam	grassed, average slope	0.22	**1.95**	1.95	**0.84**	**1.00**
8	1.94	1.42	Clay loam	asphalt/concrete	0.95	0.52	Clay loam	grassed, average slope	0.22	**1.94**	1.94	**0.75**	**0.94**
9	2.66	2.21	Clay loam	asphalt/concrete	0.95	0.44	Clay loam	grassed, average slope	0.22	**2.66**	2.66	**0.83**	**1.00**
10	2.27	1.78	Clay loam	asphalt/concrete	0.95	0.49	Clay loam	grassed, average slope	0.22	**2.27**	2.27	**0.79**	**0.99**
11	0.84	0.70	Clay loam	asphalt/concrete	0.95	0.14	Clay loam	grassed, average slope	0.22	**0.84**	0.84	**0.83**	**1.00**
12	1.68	1.35	Clay loam	asphalt/concrete	0.95	0.33	Clay loam	grassed, average slope	0.22	**1.68**	1.68	**0.81**	**1.00**
13	0.24	0.22	Clay loam	asphalt/concrete	0.95	0.03	Clay loam	grassed, average slope	0.22	**0.24**	0.24	**0.87**	**1.00**
14	1.94	1.38	Clay loam	asphalt/concrete	0.95	0.56	Clay loam	grassed, average slope	0.22	**1.94**	1.94	**0.74**	**0.92**

Notes:
Runoff Coefficients from MTO Design Chart 1.07 (urban)
For return period of more than 10 years, increase runoff coefficients listed in Design Chart 1.07 as 25-year - add 10%, 50-year - add 20%, 100-year - add 25%. For urban areas only.

Project Name Trafalgar Road Corridor Improvements EA
Project Number 60119993-10.08

Table B.4 Runoff Routing (Existing Conditions - South Corridor)

Catchment No.	Drainage Area (ha)	Runoff Coefficient 100-year (+25%)	Catchment Length (m)	High Point (m)	Outlet (m)	Slope	Time to Peak (hr) [2]: (a) Watt & Chow	(b) HYMO - 3 parameter	(c) HYMO - 2 parameter	(d) Bransby-Williams	(e) Airport Method	Method Selected (a/b/c/d/e)	Time to Peak (hr)
1	4.2	0.90	860	143.60	116.80	3.1%	0.267	0.114	0.142	0.395	0.153	a	0.267
2	3.5	0.85	720	149.56	143.60	0.8%	0.392	0.189	0.259	0.439	0.275	a	0.392
3	8.0	0.83	1689	168.16	149.56	1.1%	0.686	0.264	0.290	0.895	0.413	a	0.686
4	1.3	0.74	275	170.44	168.16	0.8%	0.183	0.111	0.192	0.184	0.238	a	0.183

Notes:
1 - Slope calculated using standard method
2 - Selection of the Most Appropriate Time to Peak Formula
Watt and Chow - Generalized expression based on data from Canada and US. Reasonable average of other methods.
HYMO 3 Parameter - Intended for rural basins with slopes < 2%
HYMO 2 Parameter - Intended for rural basins with slopes > 2%
Bransby-Williams - Intended for urban basins, C > 0.4
HYMO 2 Parameter - Intended for rural basins with slopes > 2%

Project Name Trafalgar Road Corridor Improvements EA
Project Number 60119993-10.08

Table B.5 Rational Method (Existing Conditions - South Corridor)

100-YEAR DESIGN STORM

DRAINAGE AREA: Catchment No.	Drainage Area (ha) A	Design Storm	Runoff Coefficient C x 1.25	AC	Time of Conc. to Outlet (min) [1] Tc	RUNOFF: i (mm/hr)	Q (m^3/s)
1	4.23	100	0.90	3.80	22.90	119.83	**1.27**
2	3.48	100	0.85	2.95	33.57	91.19	**0.75**
3	7.97	100	0.83	6.59	58.82	59.47	**1.09**
4	1.33	100	0.74	0.99	15.69	153.89	**0.42**

Notes:
1 - Time of Concentration (Tc) calculated using equation (8.95) from the MTO Drainage Management Manual (Tc = Tp/0.7)
The A, B, and C parameters ($i=A/(t+B)^C$) were taken from the Town of Oakville's Development Engineering Guidelines.

	100 Year
A	2150
B	5.7
C	0.861

Project Name Trafalgar Road Corridor Improvements EA
Project Number 60119993-10.08

Table B.6 Storage Required for Quantity Control (100-Year Design Storm Event)

Task: Calculate the volume of storage required to meet peak flow requirements north and south of Dundas Street East, where runoff must be controlled to existing peak flo
North of Dundas Street, existing peak flow was calculated by prorating the target unit area peak flow in NOCSS Table 7.4.1 for the downstream culvert crossing Dundas Stree
South of Dundas Street, the existing peak flow was calculated using Rational Method.

			Existing Conditions			Proposed Conditions				
			D/S NOCSS Culvert						Superpipe Diameter	
Catchment No.	Drainage Area (ROW) [1]	Length of Roadway	Culvert ID	Unit Area Peak Flow[2]	Peak Flow[3]	Runoff Coefficient	AC	Required Storage	Minimum	Available Pipe Size
	(ha)	(m)		($m^3/s/ha$)	(m^3/s)	C x 1.25		(m^3)	(mm)	(mm)
1	4.23	860	n/a	n/a	1.266	0.99	4.19	643	975	975
2	3.48	720	n/a	n/a	0.747	1.00	3.48	717	1126	1200
3	7.97	1689	n/a	n/a	1.088	1.00	7.97	2186	1284	1350
4	1.33	275	n/a	n/a	0.425	0.99	1.32	186	928	975
5	1.49	268	ME-D2	0.016	0.025	1.00	1.49	821	1975	2100
6	0.76	152	ME-D2	0.016	0.013	1.00	0.76	420	1875	1950
7	1.95	397	ME-D2	0.016	0.032	1.00	1.95	1073	1855	1950
8	1.94	388	ME-D2	0.016	0.032	0.94	1.83	995	1807	1950
9	2.66	531	ME-D2	0.016	0.044	1.00	2.66	1465	1874	1950
10	2.27	453	JC-D1	0.021	0.048	0.99	2.25	1167	1811	1950
11	0.84	164	JC-D1	0.021	0.018	1.00	0.84	437	1841	1950
12	1.68	339	JC-D1	0.021	0.036	1.00	1.68	873	1811	1950
13	0.24	49	JC-D1	0.021	0.005	1.00	0.24	127	1814	1950
14	1.94	388	JC-D1	0.021	0.041	0.92	1.79	913	1731	1800
1	2	3	4	5	6	7	8			

<--column index number count for proposed peak flow calcu

Notes:
1 - Drainage area is within boundary of proposed Right-of-Way
2 - Unit area peak flows ($m^3/s/ha$) were published in Table 7.4.1 of the September, 2007 Addendum to NOCSS for only some of the culverts modelled in the study
3 - Calculated for areas south of Dundas Street using Rational Method and for areas north of Dundas Street by proportioning the peak flow published in NOCSS to the area of the ROW. Multiplied the unit area peak flow rate by the ROW drainage area
4 - Time of Concentration (Tc) calculated using equation (8.95) from the MTO Drainage Management Manual (Tc = Tp/0.7
5 - Time to Peak calculated using Watt and Chow - Generalized expression based on data from Canada and US. Reasonable average of other methods

IDF Parameters

Storm	100 Year
A	2150
B	5.7
C	0.861

The A, B, and C parameters ($i=A/(t+B)^C$) were taken from the Town of Oakville's Development Engineering Guidelines.

Quantity Control Storage Calculations:
Control 100-year post to 100-year existing

Check lookups for Drainage Area 14: If cells below are red, change lookup column/row index until correct. Then, adjust the lookup calculations in the table below to match

AC = 1.7877 <-- used in Proposed Flow calculation
Allowable Q = 0.0414 <-- used in Required Storage calculation
Time Step (min) = 5

Catchment No.:		14	13	12	11	10	9	8	7	6	5	4	3	2	1
Time (min)	Intensity (mm/hr)	Flow Proposed (m^3/s)													
5	279	1.388	0.189	1.302	0.651	1.744	2.063	1.419	1.511	0.591	1.157	1.022	6.188	2.701	3.251
10	201	0.998	0.136	0.936	0.468	1.254	1.483	1.020	1.086	0.425	0.831	0.735	4.448	1.942	2.337
15	158	0.787	0.107	0.738	0.369	0.988	1.169	0.804	0.856	0.335	0.655	0.579	3.506	1.530	1.842
20	131	0.653	0.089	0.612	0.306	0.820	0.970	0.667	0.710	0.278	0.544	0.481	2.910	1.270	1.529
25	113	0.560	0.076	0.525	0.263	0.704	0.832	0.573	0.610	0.239	0.467	0.413	2.497	1.090	1.312
30	99	0.492	0.067	0.461	0.231	0.618	0.731	0.503	0.535	0.209	0.410	0.362	2.193	0.957	1.152
35	88	0.439	0.060	0.412	0.206	0.552	0.653	0.449	0.478	0.187	0.366	0.324	1.959	0.855	1.029
40	80	0.398	0.054	0.373	0.187	0.500	0.591	0.407	0.433	0.169	0.331	0.293	1.773	0.774	0.931
45	73	0.364	0.050	0.341	0.171	0.457	0.540	0.372	0.396	0.155	0.303	0.268	1.621	0.708	0.852
50	67	0.335	0.046	0.315	0.157	0.421	0.498	0.343	0.365	0.143	0.279	0.247	1.495	0.653	0.785
55	63	0.311	0.042	0.292	0.146	0.391	0.463	0.318	0.339	0.133	0.260	0.229	1.388	0.606	0.729
60	59	0.291	0.040	0.273	0.137	0.366	0.432	0.297	0.317	0.124	0.242	0.214	1.297	0.566	0.681
65	55	0.273	0.037	0.256	0.128	0.343	0.406	0.279	0.297	0.116	0.228	0.201	1.218	0.531	0.640
70	52	0.258	0.035	0.242	0.121	0.324	0.383	0.263	0.280	0.110	0.215	0.190	1.148	0.501	0.603
75	49	0.244	0.033	0.229	0.114	0.306	0.362	0.249	0.265	0.104	0.203	0.180	1.086	0.474	0.571
80	47	0.231	0.032	0.217	0.109	0.291	0.344	0.237	0.252	0.099	0.193	0.170	1.032	0.450	0.542
85	44	0.220	0.030	0.207	0.103	0.277	0.328	0.225	0.240	0.094	0.184	0.162	0.983	0.429	0.516
90	42	0.210	0.029	0.197	0.099	0.264	0.313	0.215	0.229	0.090	0.175	0.155	0.938	0.409	0.493
95	41	0.201	0.027	0.189	0.095	0.253	0.299	0.206	0.219	0.086	0.168	0.148	0.898	0.392	0.472
100	39	0.193	0.026	0.181	0.091	0.243	0.287	0.197	0.210	0.082	0.161	0.142	0.861	0.376	0.452
105	37	0.186	0.025	0.174	0.087	0.233	0.276	0.190	0.202	0.079	0.155	0.137	0.828	0.361	0.435
110	36	0.179	0.024	0.168	0.084	0.225	0.266	0.183	0.195	0.076	0.149	0.132	0.797	0.348	0.419
115	35	0.172	0.023	0.162	0.081	0.217	0.256	0.176	0.188	0.073	0.144	0.127	0.768	0.335	0.404
120	33	0.166	0.023	0.156	0.078	0.209	0.247	0.170	0.181	0.071	0.139	0.123	0.742	0.324	0.390
125	32	0.161	0.022	0.151	0.076	0.202	0.239	0.165	0.175	0.069	0.134	0.119	0.717	0.313	0.377
130	31	0.156	0.021	0.146	0.073	0.196	0.232	0.159	0.170	0.066	0.130	0.115	0.695	0.303	0.365
135	30	0.151	0.021	0.142	0.071	0.190	0.224	0.154	0.164	0.064	0.126	0.111	0.673	0.294	0.354
140	29	0.147	0.020	0.137	0.069	0.184	0.218	0.150	0.159	0.062	0.122	0.108	0.653	0.285	0.343
145	29	0.142	0.019	0.134	0.067	0.179	0.212	0.146	0.155	0.061	0.119	0.105	0.635	0.277	0.333
150	28	0.138	0.019	0.130	0.065	0.174	0.206	0.141	0.151	0.059	0.115	0.102	0.617	0.269	0.324
155	27	0.135	0.018	0.126	0.063	0.169	0.200	0.138	0.147	0.057	0.112	0.099	0.600	0.262	0.315
160	26	0.131	0.018	0.123	0.062	0.165	0.195	0.134	0.143	0.056	0.109	0.097	0.585	0.255	0.307
165	26	0.128	0.017	0.120	0.060	0.161	0.190	0.131	0.139	0.054	0.107	0.094	0.570	0.249	0.299
170	25	0.125	0.017	0.117	0.059	0.157	0.185	0.128	0.136	0.053	0.104	0.092	0.556	0.243	0.292
175	25	0.122	0.017	0.114	0.057	0.153	0.181	0.124	0.133	0.052	0.101	0.090	0.543	0.237	0.285
180	24	0.119	0.016	0.112	0.056	0.149	0.177	0.122	0.129	0.051	0.099	0.088	0.530	0.231	0.279
185	23	0.116	0.016	0.109	0.055	0.146	0.173	0.119	0.127	0.049	0.097	0.086	0.518	0.226	0.272
190	23	0.114	0.015	0.107	0.053	0.143	0.169	0.116	0.124	0.048	0.095	0.084	0.507	0.221	0.266
195	22	0.111	0.015	0.104	0.052	0.140	0.165	0.114	0.121	0.047	0.093	0.082	0.496	0.216	0.261
200	22	0.109	0.015	0.102	0.051	0.137	0.162	0.111	0.119	0.046	0.091	0.080	0.485	0.212	0.255
205	21	0.107	0.015	0.100	0.050	0.134	0.159	0.109	0.116	0.045	0.089	0.079	0.476	0.208	0.250
210	21	0.105	0.014	0.098	0.049	0.131	0.155	0.107	0.114	0.045	0.087	0.077	0.466	0.203	0.245
215	21	0.103	0.014	0.096	0.048	0.129	0.152	0.105	0.112	0.044	0.085	0.075	0.457	0.199	0.240
220	20	0.101	0.014	0.094	0.047	0.126	0.149	0.103	0.109	0.043	0.084	0.074	0.448	0.196	0.235
		Required Storage (m^3)													
5	279	404	55	380	190	509	606	416	444	174	340	179	1530	586	595
10	201	574	78	540	270	723	863	593	632	247	484	186	2016	717	643
15	158	671	92	632	316	846	1012	695	741	290	568	139	2176	705	518
20	131	734	100	692	346	926	1112	762	814	318	623	67	2186	628	315
25	113	778	107	734	367	983	1183	811	866	339	663	-18	2113	515	69
30	99	811	111	766	383	1025	1237	848	906	354	694	-113	1988	379	-205
35	88	836	115	790	395	1058	1279	876	937	367	717	-213	1828	228	-498
40	80	855	117	809	405	1083	1313	899	962	376	736	-317	1642	65	-803
45	73	870	120	824	412	1103	1341	917	982	384	752	-424	1438	-105	-1119
50	67	882	121	836	418	1119	1364	933	999	391	765	-534	1220	-282	-1442
55	63	891	123	846	423	1132	1383	945	1013	396	775	-645	990	-464	-1771
60	59	898	124	854	427	1142	1399	955	1024	401	784	-758	751	-650	-2105
65	55	904	125	860	430	1150	1412	964	1034	405	792	-872	504	-839	-2443
70	52	908	125	864	432	1156	1423	971	1042	408	798	-988	250	-1031	-2784
75	49	911	126	868	434	1160	1433	977	1049	411	803	-1104	-9	-1226	-3129
80	47	912	126	870	435	1163	1441	982	1055	413	808	-1221	-272	-1422	-3475
85	44	913	127	872	436	1165	1447	986	1060	415	811	-1339	-540	-1620	-3824
90	42	913	127	873	436	1166	1452	989	1064	416	814	-1457	-811	-1820	-4175
95	41	912	127	873	437	1167	1456	991	1067	417	817	-1576	-1086	-2022	-4528
100	39	911	127	872	436	1166	1460	993	1069	418	818	-1696	-1363	-2224	-4881
105	37	909	126	871	436	1165	1462	994	1071	419	820	-1815	-1643	-2428	-5237
110	36	906	126	870	435	1163	1464	995	1072	419	821	-1935	-1925	-2632	-5593
115	35	904	126	868	434	1160	1465	995	1073	420	821	-2056	-2209	-2838	-5951
120	33	900	126	866	433	1157	1465	994	1073	420	821	-2177	-2495	-3044	-6309
125	32	896	125	863	432	1153	1465	994	1073	420	821	-2298	-2783	-3251	-6669
130	31	892	125	860	430	1149	1464	993	1072	420	821	-2419	-3072	-3459	-7029
135	30	888	124	857	429	1145	1463	991	1071	419	820	-2541	-3363	-3667	-7390
140	29	883	124	854	427	1140	1461	990	1070	419	819	-2662	-3655	-3876	-7752
145	29	878	123	850	425	1135	1459	988	1069	418	818	-2784	-3948	-4086	-8114
150	28	873	123	846	423	1129	1457	985	1067	417	817	-2907	-4243	-4296	-8477
155	27	868	122	842	421	1123	1454	983	1065	417	815	-3029	-4538	-4506	-8841
160	26	862	122	837	419	1117	1451	980	1063	416	813	-3151	-4835	-4717	-9205
165	26	856	121	833	416	1111	1447	977	1060	415	812	-3274	-5132	-4928	-9569
170	25	850	120	828	414	1105	1444	974	1057	414	809	-3397	-5430	-5140	-9934
175	25	844	119	823	412	1098	1440	971	1054	412	807	-3520	-5730	-5352	-10299
180	24	837	119	818	409	1091	1435	967	1051	411	805	-3643	-6029	-5564	-10665
185	23	831	118	813	406	1084	1431	964	1048	410	802	-3766	-6330	-5777	-11031
190	23	824	117	807	404	1076	1426	960	1044	409	800	-3889	-6631	-5990	-11398
195	22	817	116	801	401	1069	1421	956	1041	407	797	-4013	-6933	-6203	-11765
200	22	810	116	796	398	1061	1416	952	1037	406	794	-4136	-7236	-6416	-12132
205	21	803	115	790	395	1053	1411	948	1033	404	791	-4260	-7539	-6630	-12499
210	21	796	114	784	392	1045	1405	943	1029	403	788	-4383	-7842	-6844	-12867
Maximum =		913	127	873	437	1167	1465	995	1073	420	821	186	2186	717	643

Project Name **Trafalgar Road Corridor Improvements EA**
Project Number **60119993-10.08**

Table B.7 Land Area Required for North Corridor Wet Ponds

Catchment No.	Equation 7.3			Equation 7.4		Equation 7.5
	Average Depth of Permanent Pool h_P (m)	Permanent Pool Volume PV (m^3)	Bottom Width of Wet Pond X (ha)	Extended Detention Volume [1] EV (m^3)	Active Storage Depth h_e (m)	Land Area Required for Wet Pond LA (m^2)
5	1.00	310	7.5	821	1	1198
6	1.00	154	4.5	420	1	757
7	1.00	409	9.0	1073	1	1443
8	1.00	369	8.4	995	1	1364
9	1.00	550	10.9	1465	1	1792
10	1.00	451	9.6	1167	1	1534
11	1.00	174	5.0	437	1	782
12	1.00	339	8.0	873	1	1253
13	1.00	53	1.5	127	1	344
14	1.00	362	8.3	913	1	1297

Notes:
Equations taken from MOE SWM Planning and Design Manual (2003) Section 7.6.1 and assume typical design parameters for wet ponds:
Bottom of the wet pond was assumed to be rectangular in shape
Length-to-width ratio of 3:1
Side slopes of 4:1 within the permanent pool
Side slopes of 5:1 in the extended detention portion of the pond/wetland
1 - The extended detention volume required for quality control was estimated to be less than quantity control. As such, the quantity control volume was used to estimate the pond footprint.

Project Name **Trafalgar Road Corridor Improvements EA**
Project Number **60119993-10.08**

Table B.8 Summary of Storage Required for Water Quality and Quantity Control

Catchment No.	Drainage Area (ROW) [1]	Proposed Impervious Area		Length of Roadway	Active Storage Volume			Permanent Pool Volume	Total Pond Volume (Max Active Storage + Permanent Pool)	Pond Footprint	Super Pipe Diameter
		Increase	Total		Quality Control	Quantity Control	Maximum	Quality Control			
	(ha)	(ha)	(ha)	(m)	(m^3)	(m^3)	(m^3)	(m^3)	(m^3)	(m^2)	(mm)
1	4.23	0.42	3.31	860		643	643				975
2	3.48	0.58	2.76	720		717	717				1200
3	7.97	1.61	6.43	1689		2186	2186				1350
4	1.33	0.35	1.04	275		186	186				975
5	1.49	0.43	1.25	268	372	821	821	310	1132	1198	2100
6	0.76	0.32	0.61	152	190	420	420	154	573	757	1950
7	1.95	0.99	1.65	397	486	1073	1073	409	1482	1443	1950
8	1.94	0.64	1.42	388	485	995	995	369	1364	1364	1950
9	2.66	1.21	2.21	531	664	1465	1465	550	2015	1792	1950
10	2.27	0.76	1.78	453	566	1167	1167	451	1618	1534	1950
11	0.84	0.22	0.70	164	210	437	437	174	611	782	1950
12	1.68	0.75	1.35	339	419	873	873	339	1212	1253	1950
13	0.24	0.13	0.22	49	61	127	127	53	180	344	1950
14	1.94	0.57	1.38	388	484	913	913	362	1275	1297	1800

Notes:
1 - Drainage area is within boundary of proposed Right-of-Way
2 - Water Quality Storage volume calculated using Table 3.2 in the MOW SWMP manual for enhanced protection (80%). The volume includes 40 m3/ha of extended detention. The remaining volume is permanent pool.
3 - As defined in Section 3.3.2 of the MOE SWM Planning and Design Manual, 40 m^3/ha is extended detention, while the remainder represents permanent pool
4 - The portion of water quality storage in the extended detention required to treat the increase in impervious area calculated using 40 m^3/ha of extended detention.
5 - Erosion Control Storage provides detention for runoff produced by a 25 mm storm. The required storage volume calculated

6 - The permanent pool required to treat runoff from the ROW is calculated as the difference between total storage required to provide enhanced protection and the active storage calculated using 40 m3/ha.
Refer to drawing: *P:\60119993\000-CADD\040 CADD-BIM WIP\DWG-2013-08-15-Trafalgar Road SWM-60119993.dwg*

Appendix C

Trafalgar Road Corridor Improvements EA, Cornwall Road to Highway 407

Stormwater Management Report

- **Hydraulic Modelling and Design Calculations**

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1. Introduction

A hydraulic analysis was completed to assess the ability of the culverts crossing Trafalgar Road within the Study Area to safely convey the applicable peak flow under existing conditions. The performance of each culvert was evaluated based on the MTO and Town drainage criteria outlined in Section 1.3.2 of the report. Two previously developed hydraulic models of East Morrison Creek including culverts 5+225, 5+500, 5+665, 5+820, and 6+725 were updated in HEC-RAS and used to evaluate the five (5) culverts under existing conditions, as highlighted in yellow on Figures 1.1 and 1.2. The remaining culverts at stations 6+200, 7+315, 7+750, 8+080, and 8+385 were modelled using CulvertMaster, as highlighted in cyan on Figures 1.1 and 1.2. This appendix discusses the updates to the previously developed HEC-RAS hydraulic models. The appropriate methodology for this hydraulic analysis was determined through communications with CH.

A hydraulic model of East Morrison Creek extending from the Morrison-Wedgewood Diversion Channel to Dundas Street was previously prepared using HEC-2 for the East Morrison Creek Subwatershed Study (EMCSS) in 1995 by Cosburn Patterson Wardman Limited. The extents of the EMCSS HEC-2 model are highlighted in red on Figure 1.1 As part of this EA, the EMCSS HEC-2 model was converted to HEC-RAS and updated to evaluate the culvert crossing Trafalgar Road south of Dundas Street at station 5+225. The updated model is hereafter referred to as the south hydraulic model.

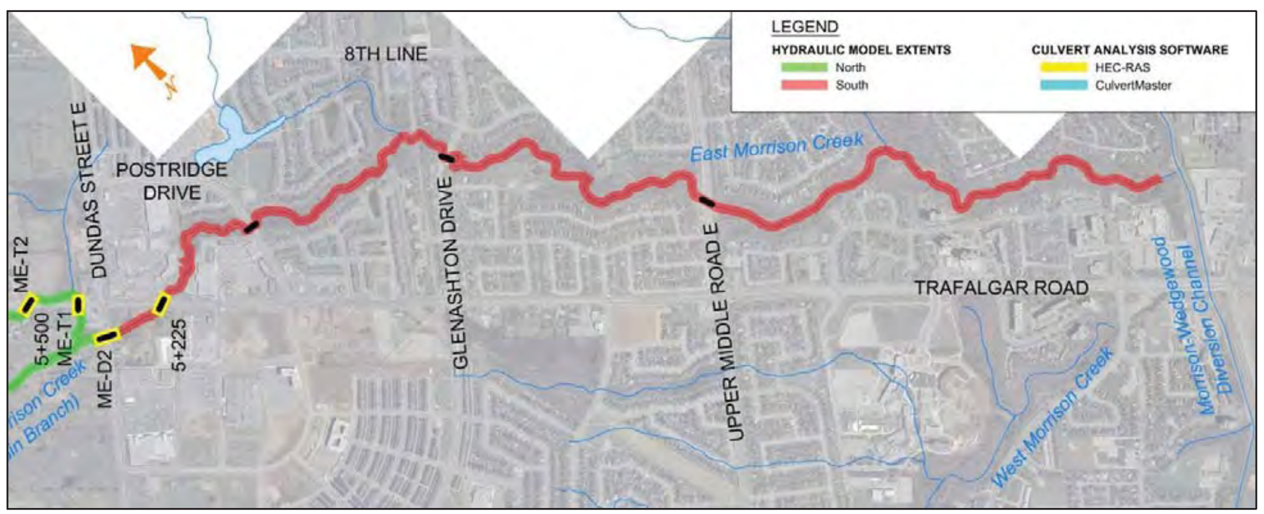

Figure 1.1 Extent of South Hydraulic Model

A separate hydraulic model of East Morrison Creek extending from the headwaters of the creek to Dundas Street was previously prepared using HEC-RAS for the North Oakville Creeks Subwatershed Study (NOCSS) in 2006 by AECOM (formerly TSH). The extents of the NOCSS HEC-RAS model are highlighted in green on Figure 1.2. The NOCSS HEC-RAS model was updated in this study to evaluate four culverts north of Dundas Street within the Study Area. All four culverts convey the east branch of East Morrison Creek. The updated model is hereafter referred to as the north hydraulic model.

AECOM Regional Municipality of Halton Trafalgar Road Corridor Improvements EA, Cornwall Road to Highway 407
Stormwater Management Report

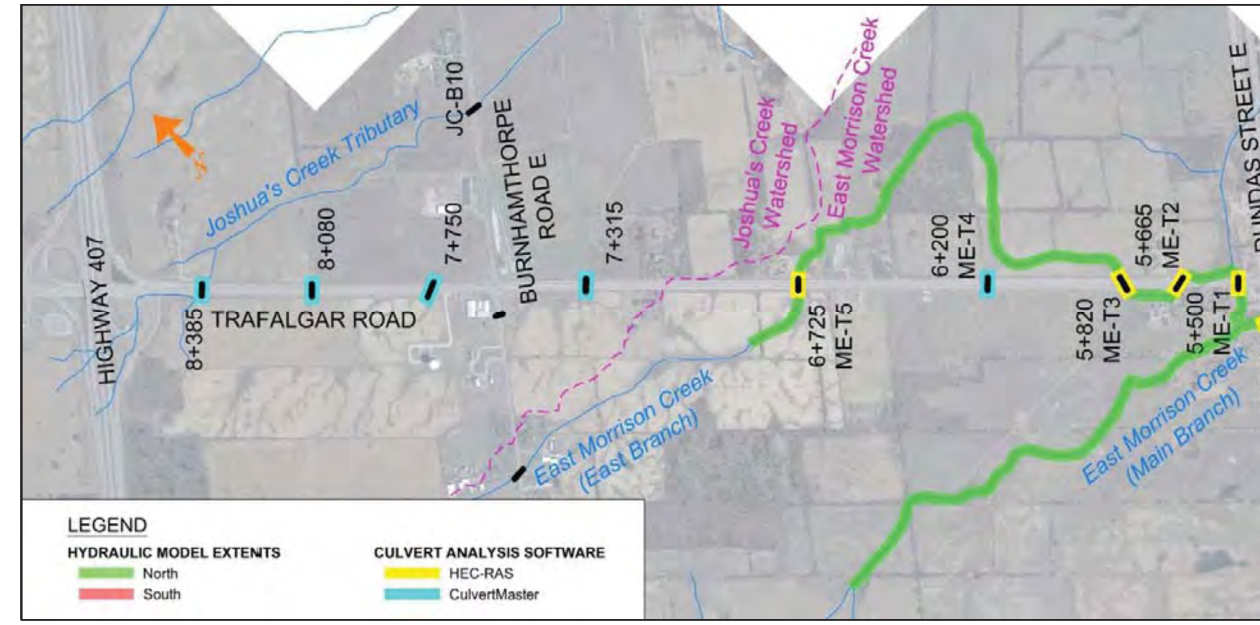

Figure 1.2 North Hydraulic Models

Several other hydraulic models of the East Morrison Creek crossings of Dundas Street and Trafalgar Road are being prepared simultaneous to the Trafalgar Road Corridor Improvements EA. These models are in support of the subdivision developments adjacent to Trafalgar Road and the reconstruction of Dundas Street. All of the above hydraulic models will be coordinated at detailed design and, as such, the analysis and recommendations provided in this report are subject to changes during future coordination of hydraulic models.

2. South Hydraulic Model

The hydraulic model prepared using HEC-2 in support of the EMCSS with a subcritical flow regime was provided by CH on December 8, 2011. As part of this study, the HEC-2 model was converted to HEC-RAS and updated to evaluate the hydraulic performance of the existing Trafalgar Road culvert at station 5+225. The following sections discuss the background of the EMCSS hydraulic model, the conversion process to HEC-RAS, and the updates made to evaluate Culvert 5+225.

2.1 Background on EMCSS Hydraulic Analysis

The HEC-2 model prepared for the EMCSS extends from the Morrison-Wedgewood Diversion Channel to Highway 5 (Dundas Street) as shown on Figure 1.1. The HEC-2 model was based on an older model created by Proctor and Redfern in 1977. Starting from the south end, the sub-critical model includes road crossings at Upper Middle Road, Glenashton Drive, Postridge Drive, Trafalgar Road, and Dundas Street. Cross sections and bridges are drawn left to right looking upstream. The topography and characteristics of crossings were confirmed with field survey as part of the 1995 study for Upper Middle Road, Trafalgar Road, and Highway 5. An inlet control pipe and overflow weir are located immediately upstream of the Upper Middle Road crossing. As-built drawings were used to confirm the Glenashton Drive crossing properties while the Postridge Drive crossing (referred to as the Grand Boulevard crossing in the report) was proposed at the time of the EMCSS to be a 6 m by 2.5 m Hyspan culvert. The properties for all East Morrison Creek crossings are summarized in Table 2.1.

Table 2.1 Culvert Properties Defined in EMCSS

Location	Size and Material	Invert u/s, d/s (m)	Length (m)	Top of Road (m)
Upper Middle Road – Culvert	3400 x 2900 mm CSP ARCH	137.23, 136.91	72	147.58
Upper Middle Road – Inlet Control	1250 x 1250 mm WEIR	137.32, 137.32	3	n/a
Glenashton Drive	15505 x 9830 mm CLEAR SPAN	149.27, 148.95	20	159.9
Postridge Drive	6000 x 2500 mm ARCH	159.56, 159.35	20	166.00
Trafalgar Road (5+225)	3500 x 2330 mm CSP ARCH	164.43, 164.25	30	168.40
Dundas Street (ME-D2)	5000 x 2320 mm CONC. BOX	165.07, 165.03	40	169.90

Notes: Culvert properties of Postridge Drive crossing taken from Section 9 of the EMCSS and the HEC-2 model. The properties of all other culverts taken from Appendix C of EMCSS (1995)

A hydrologic model was also developed as part of the EMCSS using GAWSER and the existing conditions flows during the Regional storm calculated by the model are summarized in Table 2.2. Relevant information from the EMCSS, such as the hydrologic model schematic, is included in Appendix D of this report.

Table 2.2 EMCSS Hydrologic Model Results – Existing Conditions, Regional Storm

Location	Regional Storm Peak Flow (m^3/s)
Highway 5 (Dundas Street)	37.7
Eighth Line Tributary	8.1
Glenashton Drive	48.9
Upper Middle Road	59.8
Morrison-Wedgewood Diversion Channel	67.7

Source: Table 7 of EMCSS

The EMCSS states that the study's hydrologic model results were used to create the HEC-2 flow profiles summarized in Table 2.3. However, comparison of the existing conditions Regional storm peak flows estimated in the hydrologic model (Table 2.2) and those used in the HEC-2 model (PF 1 in Table 2.3) shows discrepancies between the two models.

Table 2.3 EMCSS HEC-2 Flow Profiles

Flow Change Location				Profile Names[1] and Flow Rates (m^3/s)				
River	Reach	RS[2]	Description	PF 1	PF 2	PF 3	PF 4	PF 5
RIVER-1	Reach-1	5524.71 *(3.315)*	U/S of Dundas Street	54.20	18.50	12.80	35.50	31.30
RIVER-1	Reach-1	3226.5 *(3.19)*	150 m D/S of Glenashton Drive	60.80	61.20	65.80	37.50	33.10
RIVER-1	Reach-1	1909.57 *(3.12)*	200 m D/S of Upper Middle Road	67.70	68.50	72.30	39.90	35.20

Notes:
1 - Profile names from HEC-2 input code:
PF 1 - Regional_ex_landuse
PF 2- Regional_official_plan_landuse
PF 3 – Regional_foreseeable_landuse
PF 4 – 100yr_foreseeable_landuse
PF 5 – 50yr_foreseeable_landuse
2 – Original cross section numbering from HEC-2 provided in brackets. After importing to HEC-RAS, cross sections were renumbered according to cumulative channel length.

The peak flows from the hydrologic and hydraulic models are compared based on location on Figure 2.1. Starting from the downstream end of the model, the flow change at RS 1909.57 is located approximately 200 m downstream of Upper Middle Road in the HEC-2 model. The Regional storm flow at this node is 67.7 m^3/s and is equal to the flow calculated at the Morrison-Wedgewood Diversion Channel using GAWSER, as labelled on Figure 2.1. Moving upstream, the flow change at RS 3226.5 is located approximately 150 m downstream of Glenashton Drive. The Regional storm flow (60.8 m^3/s) at this node is similar to the hydrologic model flow calculated at the Upper Middle Road confluence point which has a Regional storm peak flow of 59.8 m^3/s. It appears that the Upper Middle Road hydrologic flow was applied to the upstream end of the reach between Glenashton Drive and Upper Middle Road. Therefore, the peak flows calculated by the hydrologic model at Upper Middle Road and the Morrison-Wedgewood Diversion were applied upstream in the HEC-2 model.

However, the same does not apply to the third and farthest upstream flow change at RS 5524.71 located immediately upstream of Dundas Street. The peak flow 54.20 m^3/s from the HEC-2 model does not match the hydrologic model results at any of the confluence points.

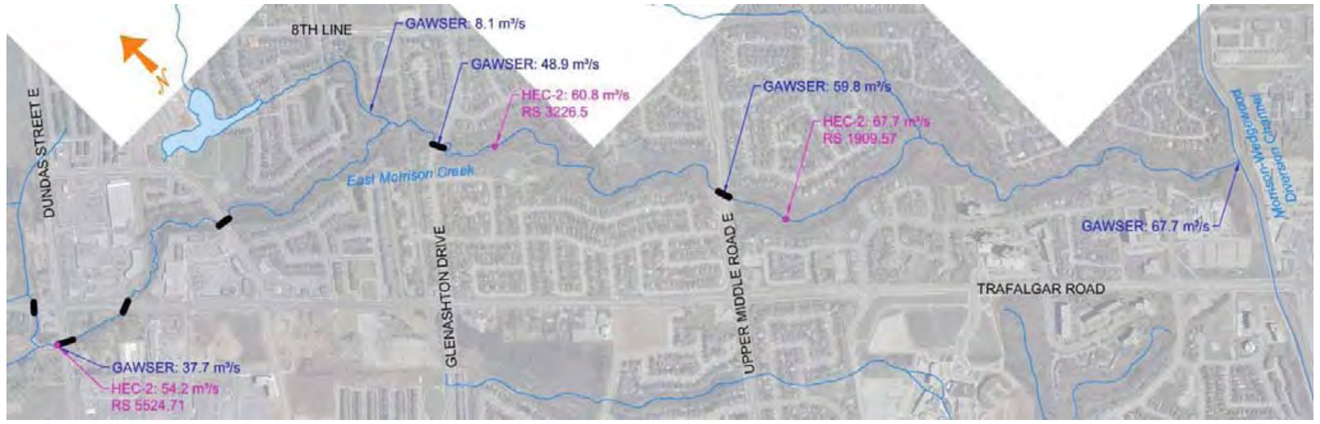

Figure 2.1 Peak Flows in Hydrologic and Hydraulic Models

The EMCSS HEC-2 input code defines the downstream boundary condition as critical depth. The EMCSS found that a sub-critical flow regime resulted in numerous warnings of assuming critical depth, indicating that super-critical flow regimes may exist throughout the model. A second model was prepared using a super-critical flow regime and compared with the first model. The study determined that a super-critical flow regime dominates throughout most of the watercourse.

The performance of all culverts is summarized in Table 2.4, showing that the culvert at Trafalgar Road had insufficient capacity to convey storms larger than the 25-year storm. Grading of overland spill routes through ditches parallel to Trafalgar Road are selected in Section 6.4.1 of the EMCSS to divert flooding from overtopping the road. The ditches would direct part of the flooding to East Morrison Creek and the rest towards West Morrison Creek.

Table 2.4 EMCSS Culvert Performance

Location	Level of Service
Upper Middle Road – Culvert	Regional Storm
Upper Middle Road – Inlet Control	Regional Storm
Glenashton Drive	Regional Storm
Postridge Drive	Regional Storm
Trafalgar Road (5+225)	25-Year Storm
Dundas Street (ME-D2)	Regional Storm

Source: Table 11 of the EMCSS

2.2 Conversion of EMCSS HEC-2 Model to HEC-RAS

The input file for the HEC-2 model was imported into HEC-RAS and reviewed for consistency with the results from the HEC-2 output file. Changes were made to the imported model to address differences in computational routines and parameter requirements between the HEC-2 and HEC-RAS software.

Three initial adjustments were made to the model after importing it into HEC-RAS to enable functionality. First, the river station identification method was changed from the HEC-2 Section IDs to a sequential counter representing the cumulative reach length. The original numbering from HEC-2 was recorded in each cross section description. Several of the HEC-2 cross sections were not numbered in sequence (326.5, 326.6, and 326.7). Second, the profile names were updated to those in the notes of Table 2.3. Third, an initial run of the model returned six identical errors

of incomplete data at each bridge. Each upstream distance of zero as defined by the HEC-2 file was revised to 1 m to enable HEC-RAS to run.

The HEC-2 input and output files were read using the data descriptions provided in the *HEC-2 User Manual*. The computational differences between HEC-2 and HEC-RAS summarized in Appendix C of the *HEC-RAS Reference Manual* (v 4.1, January 2010) and in Chapter 3 of the *HEC-RAS User Manual* (v 4.1, January 2010) were also reviewed.

According to the *HEC-RAS User Manual*, the following options in HEC-2 are not available in HEC-RAS:

- Compute Manning's n from high water marks (J1)
- Archive (AC)
- Free Format (FR): HEC-2 files that are in free format are delimited using commas and single spaces, instead of the fixed format of eight column fields
- Storage Outflow for HEC-1 (J4)

HEC-RAS is able to import HEC-2 data input files including any of the above options, except for free formatted input files, although the options will be ignored. None of the above issues are relevant to the EMCSS HEC-2 conversion to HEC-RAS because they were not used in the EMCSS model.

The following features in HEC-2 have different data requirements in HEC-RAS, such as more detailed bridge routines, and therefore modifications may be required after the import:

- Special Culvert (SC)
- Encroachments and Floodway Determination (X3, ET)
- Special Bridge (SB)
- Normal Bridge (X2, BT)
- Ineffective Flow Areas (X3)

The SC and ET features are not included in the EMCSS HEC-2 input file while all the other features listed above (SB, X2, BT, and X3) are included. The input parameters for the latter features were reviewed and appropriate modifications to the imported model are discussed below.

The special bridge feature (SB) includes several parameters that are not used by HEC-RAS and may explain differences in model results. The SB feature defines a total loss coefficient that is used in the orifice equation in HEC-2 whereas losses upstream of a bridge are defined in HEC-RAS using contraction coefficients. Entrance loss coefficients are considered in HEC-RAS for culverts, however they are not equivalent to the total loss coefficient used in HEC-2 for bridges. The appropriate expansion and contraction coefficients were applied upstream and downstream of the bridges in the imported model. All of the crossings in the original HEC-2 model were modelled as bridges, not culverts.

In addition, the SB feature defines the area of the orifice opening to be used in pressure flow calculations. In contrast, HEC-RAS calculates the area of the bridge opening using the bridge and cross section geometry. As the geometry for the cross sections and bridges imported from HEC-2 to HEC-RAS successfully, no changes were needed to address this difference. However, the automatic calculation of bridge opening area may explain different pressure flows calculated in HEC-RAS.

The SB feature also defines the upstream and downstream inverts of the channel, however this is considered in HEC-RAS based on the geometry of the upstream and downstream cross sections. No changes were required to address this difference.

The bridge feature (X2) provides known high water marks, however this option is not used in the EMCSS HEC-2 model. Elevations of the bridge openings are also provided in the X2 feature to determine if low or pressure flow occur. HEC-RAS automatically determines if low or high flow computations are occurring. However, unlike HEC-2, HEC-RAS allows the user to select from different high flow calculation methods: The energy equation or pressure flow calculation. In the imported model, the energy equation was used for bridges openings under Glenashton Drive and Postridge Drive because they are always free flowing whereas the pressure flow calculation method was selected for the Upper Middle Road crossing.

The bridge feature BT defines the bridge roadway, including the high and low coordinates of each road station. HEC-2 uses one bridge profile whereas HEC-RAS requires an upstream and downstream road profile. Review of the HEC-2 input file BT commands in comparison to the upstream and downstream invert information in Appendix C of the EMCSS indicates that the upstream bridge deck is provided in the BT commands. The downstream profile was created for HEC-RAS appropriately shifting the bridge opening to match the downstream inverts.

The ineffective flow area feature X3 is used at each bridge to contain flow between levees until overtopping occurs. This is automatically considered in HEC-RAS based on the bridge deck geometry. The imported geometry was reviewed to verify that the appropriate minimum weir elevation was applied.

Another difference between HEC-2 and HEC-RAS is found in conveyance calculations. Conveyance is calculated in HEC-2 between every coordinate point in the cross section overbanks. In comparison, HEC-RAS defaults to calculating conveyance at n-value break points. The HEC-2 method is supported by HEC-RAS and was used to compare the HEC-2 EMCSS output file with the imported model. The parabolic method of calculating critical depth was maintained in HEC-RAS.

The adjustments made to the imported EMCSS model discussed above resulted in very similar water surface elevations and energy gradelines calculated along the creek. The comparison of the results from HEC-2 and HEC-RAS during the Regional storm with a subcritical flow regime is provided in Appendix C. Notable differences occur at Upper Middle Road and Postridge Drive, likely due to the differences between bridge calculations in the two programs. The results are assumed to be acceptable because both crossings are beyond the Study Area and the differences do not appear to affect the Trafalgar Road and Dundas Street crossings.

2.3 Updates to South Hydraulic Model

After reviewing the imported south hydraulic model for consistency with HEC-2 results, additional changes were made to the model to reflect existing conditions, including the following:

- The Trafalgar Road bridge opening was changed to a culvert with the latest surveyed and inspected size, updated invert elevations, appropriate Manning's n, and entrance loss coefficient.
- The Trafalgar Road bridge deck was updated with the latest survey.
- The Dundas Street bridge opening was changed to a culvert with the size and invert elevations proposed in the *Drainage and SWM Final Report* for the reconstruction of Dundas Street (McCormick Rankin, 2011).
- The Dundas Street bridge deck, Manning's n, and entrance loss coefficient were updated to match the north hydraulic model.
- The cross section located upstream of ME-D2 in the north hydraulic model (RS 4) was copied and added to the south hydraulic model as RS 5565.71.

- The variables defining RS 5310.71 in the HEC-2 input code were shifted by one field. As a result, the distance between each station was increased by a factor of 3.29 and the distance to the downstream cross section on the left overbank was almost 300 m too long. The cross section was updated to the intended geometry.
- Cross section 5310.74 was copied and inserted 10 m upstream. The elevations in the cross section were increased to maintain the longitudinal slope of the creek.
- The conveyance calculation method was changed to be at breaks in n values.
- Main channel elevations in creek were adjusted to match updated culvert inverts.
- Reach lengths were adjusted to account for full culvert length.
- Ineffective flow areas in cross sections immediately upstream and downstream of Dundas Street and Trafalgar Road were updated to match the revised culvert spans and top of road elevation.
- Ineffective flow areas for the crossings downstream of Trafalgar Road were updated using 1:1 contraction and 2:1 expansion ratios.
- Manning's 'n' for the main channel and overbanks were changed to 0.03 and 0.07, respectively, for all cross sections upstream of and including RS 5265.41 to make the channel properties consistent with the north hydraulic model.
- The bridge modelling approach for high flow to pressure/weir methods for the crossings at Upper Middle Road were also revised. The energy equation is appropriate for the Glenashton Drive and Postridge Drive crossings because they do not exhibit pressure or weir flow.

In addition to the above changes, the flow profiles were updated to match the hydrologic model results under existing conditions summarized in Table 7 of the EMCSS, including the creation of a flow change location within the updated HEC-RAS model just upstream of Trafalgar Road to account for flows defined for Glenashton Drive. The flow calculated at Dundas Street was applied immediately downstream of Dundas Street (RS 5466.84) while flows from NOCSS were applied to the upstream end of the model (RS 5565.71). Further discussion of the NOCSS peak flows is provided in Section 3regarding the north hydraulic model. During detailed design, the peak flows based on NOCSS unit area peak flows should be confirmed based on any refined drainage area delineation. In particular, the area draining to ME-D2 will be revised in the final EIR/FSS for North Oakville Main-East Morrison Creek (Green Ginger). The flow change downstream of Glenashton Drive was changed to the flows calculated at Upper Middle Road. The flow at RS 1909.57 was unchanged from the HEC-2 profiles as they matched flows calculated at the diversion channel. The profiles for the 2- through 100-year storms were also added to the model. A fourth flow change location was added upstream of ME-D2 at the new section RS 5565.71 to match flows in the north hydraulic model. All updated profiles in the south hydraulic model are summarized in Table 2.5.

Table 2.5 South Hydraulic Model Flow Profiles

Flow Change Location				Profile Names and Flow Rates (m^3/s)							
River	Reach	RS	Description	2 YR	5 YR	10 YR	25 YR	50 YR	100 YR	1.3 x 100 YR	Regional
RIVER-1	Reach-1	5565.71	U/S of Dundas (HWY 5)	1.66	2.63	3.22	4.10	4.69	5.31	6.90	14.00
RIVER-1	Reach-1	5466.84	D/S of Dundas (HWY 5)	7.5	11.6	14.3	17.8	20.4	22.9	29.77	37.7
RIVER-1	Reach-1	5320.74	U/S of Trafalgar Road*	9.3	14.4	17.9	22.2	25.6	28.7	37.31	48.9
RIVER-1	Reach-1	3226.50	@ Glenashton Drive	9.2	15.5	19.4	24.3	28.1	31.6	41.08	59.8
RIVER-1	Reach-1	1909.57	@ Upper Middle Road	9.6	16.5	20.8	26.1	30.3	34.0	44.20	67.7

* – Flow change location not included with provided EMCSS HEC-RAS model; flows extracted from Table 7 of EMCSS Report and appended to model

The updated south hydraulic model was run using subcritical, supercritical, and mixed regimes. The comparison of the resulting water surface elevations and energy gradelines computed during the Regional storm under the three regimes is provided in Appendix C and indicates that the subcritical flow regime resulted in the highest energy gradeline at the upstream end of the model. The subcritical flow regime was used for hydraulic analysis in this report to conservatively represent water surface elevation estimates.

The results of the south hydraulic model indicated that Trafalgar Road overtops during the Regional storm under existing conditions.

Observations were made while reviewing the HEC-2 input code and the imported HEC-RAS model regarding the representation of East Morrison Creek downstream of the Study Area. Additional field reconnaissance, clarification by the regulatory authorities, and modifications may be required in the future to address the following observations:

- Manning's n values applied in HEC-2 model not discussed in the EMCSS report
- Revisions were made to the HEC-2 model after publication of the EMCSS (i.e. cross sections added)
- Insufficient expansion and contraction coefficients
- Inconsistencies between reach lengths in model and drawing (i.e. RS 5265.41)
- Inconsistencies between reported and modelled culvert properties

Inconsistencies between the culvert properties reported in the EMCSS and defined in the HEC-2 input file for the Trafalgar Road crossing were noted in that the culvert is represented in the HEC-2 model as a box culvert although it is reported in the EMCSS to be a CSPA. Field investigation completed by AECOM as part of this study confirmed that the Trafalgar Road culvert is a CSPA. Differences in culvert spans were also noted for all other crossings ranging from +/- 0.2 to 2.2 m. These inconsistencies are noted for reference at detailed design for further review and possible revision. The south hydraulic model results are subject to change due to future updates.

3. North Hydraulic Model

The HEC-RAS model prepared for the NOCSS in 2006 and revised for the addendum in 2007 is described in Section 5.6 of the NOCSS Analysis Report. Hydraulic models were prepared for all North Oakville creeks, including East Morrison Creek, to calculate flood elevations for the full range of design flows (1:2 to Regional). The peak flows calculated in the NOCSS GAWSER model were used in the hydraulic models.

The East Morrison Creek HEC-RAS model prepared for the NOCSS was updated for this study with the latest survey of culvert properties, road elevations, and flow profiles to represent existing conditions. The revisions included the following:

- Flow profiles were updated with more detailed drainage area delineation (using LiDAR data) and flow changes were added upstream of ME-T2 and ME-T3.
- Culvert ME-D2 was updated with the size and invert elevations proposed in the *Drainage and SWM Final Report* for the reconstruction of Dundas Street (McCormick Rankin, 2011).
- Culvert inverts and lengths as well as deck elevations and widths of all other crossings were revised to match survey data provided by the Region.
- Dimensions of Culvert ME-T1 were updated to match culvert inspection.
- Dimensions and shape of ME-T5 were updated from a circular to arch culvert.
- Weir coefficients of all decks except for ME-T2 were changed from 2.6 to 1.44 to be within typical metric range for metric calculations.
- Main channel inverts upstream and downstream of crossings were lowered to match the inverts of culverts.
- Repetitive points at the same elevation were removed from cross sections.
- Ineffective flow areas upstream and downstream of each crossing were updated to match culvert span and lowest top of road elevation. Upstream cross sections were updated using a 1:1 contraction ratio from the cross section to the culvert and setting the elevation to the sag in the road. Downstream cross sections were updated using a 2:1 expansion ratio and the elevation of the ineffective area was estimated to be the average of the minimum top of road and the corresponding low point. All ineffective areas were set to be permanent.
- Downstream boundary condition was changed from normal depth to known water surface elevation. The energy gradeline was interpolated between cross sections 5462.43 and 5320.74 in the south hydraulic model and conservatively used for the known water surface elevation of each profile of the north hydraulic model.
- Several cross sections were extended using a combination of survey data provided by the Region, elevation contour data provided by the Town, and OBM elevation contours.
  Stationing of bridge deck elevations were revised to be drawn left to right looking upstream.

The flow profiles were updated based on discussions with CH, including the seven flow change locations in the original NOCSS HEC-RAS model and two additional locations illustrated on Figure 3.1.

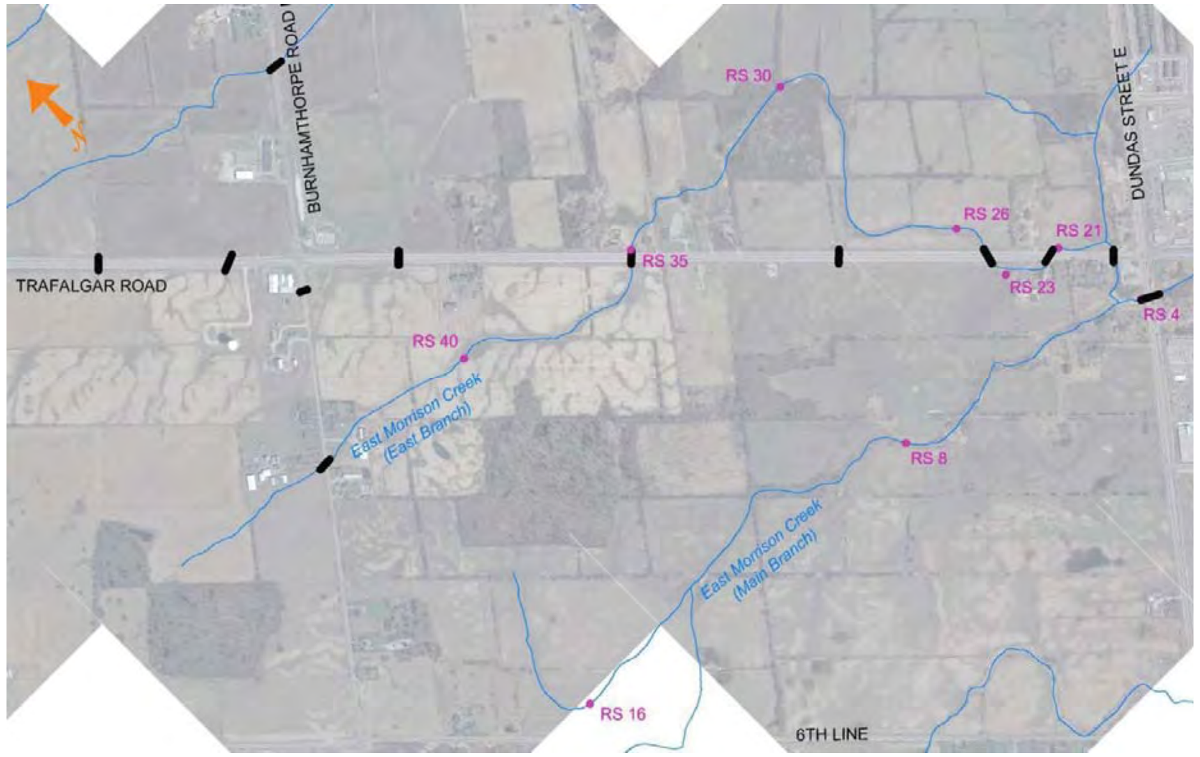

Figure 3.1 North Hydraulic Model Flow Change Locations

The method used to update each flow change location is outlined in Table 3.1. When updated areas were not available in the EIR/FSS reports, areas were delineated using LiDAR from East and Main Branch EIR/FSS Reports. The resulting drainage divides were confirmed with elevation contours available from the Town of Oakville, Ontario Base Mapping, and survey data provided by the Region. Detailed calculations of the updated peak flows at each culvert are provided in Appendix C.

Table 3.1 Updated Flows in North Hydraulic Model

	Flow Change Location	Reasoning and Description of Updated Peak Flows
East Branch	RS 40	The NOCSS HEC-RAS model applies peak flows at ME-T5 (Reported in Table 6.3.6 of the NOCSS Addendum) at RS 40. However, RS 40 is located approximately 600 m upstream of ME-T5. Based on discussion with the CH regarding the flows at RS 40 and RS 35, the use of ME-T5 flows at this location is to be continued as a conservative approach. The peak flows at ME-T5 were updated using the NOCSS unit area peak flows at ME-T5 and the refined drainage area delineated using LiDAR as part of the East Branch EIR/FSS, Table 5.8 (43.8 ha). This revision provides the appropriate flow for hydraulic analysis at culvert ME-T5. ME-T5 flows updated with NOCSS unit area flow and East Branch EIR/FSS drainage area were applied to RS 40.
	RS 35	The source of the NOCSS HEC-RAS model flows at RS 35 is unknown as the location and flows do not correspond to the NOCSS hydrologic model. It is speculated drainage from Trafalgar Road was added and/or flows were prorated. Although the flows could not be confirmed with the CH, RS 35 is located immediately downstream of ME-T5 and therefore the flow change location was updated to match ME-T5 flows also applied at RS 40.
	RS 30	This flow change is located approximately 1100 m upstream of ME-T3. The NOCSS HEC-RAS model applies the target flows for ME-T1 to this flow change location. Discussions with CH indicated that the Transposition Equation (MTO DMM, Equation 8.31) should be applied to calculate more appropriate flows at this location to allow for appropriate hydraulic analysis of culverts ME-T3 and ME-T2. The transposition coefficient was calculated using the known flows and basin areas upstream and downstream of RS 30 at ME-T5 and ME-T1. Refined drainage areas delineated using LiDAR as part of the East Branch EIR/FSS used in the calculation include 43.8 ha for ME-T5 (Table 5.8) and 150.20 ha for ME-T1 (Table 5.9). The area draining to RS 30 was approximated using the LiDAR from the East Branch EIR/FSS. Updated flows calculated using transposition between ME-T5 (43.8 ha) and ME-T1 (150.20 ha) in addition to an approximated area drainage to RS 30 delineated using EIR/FSS LiDAR.
	RS 26	This flow change was added to represent and evaluate the existing capacity of ME-T3. The flows were calculated using the area draining to ME-T3 delineated using LiDAR as part of the Main Branch EIR/FSS (96.10 ha) and the NOCSS unit area flow. ME-T3 flows calculated with refined drainage area from Main Branch EIR/FSS (96.10 ha) and NOCSS unit area flow.
	RS 23	This flow change was added to represent and evaluate the existing capacity of ME-T2. The flows were calculated using the area draining to ME-T3 delineated using LiDAR as part of the Main Branch EIR/FSS (105.20 ha) and the NOCSS unit area flow. ME-T2 flows calculated with refined drainage area from Main Branch EIR/FSS (105.20 ha) and NOCSS unit area flow.
	RS 21	This flow change location is located immediately downstream of ME-T2. The source of the flows in the NOCSS HEC-RAS model used at this location could not be confirmed based on the hydrologic model in NOCSS and discussions with CH. The flows were updated to match the NOCSS peak flows at ME-T1. The area draining to ME-T1 was updated in the East Branch EIR/FSS using LiDAR to 150.20 ha and closely matches the NOCSS hydrologic model (150.17 ha), resulting in the same peak flow targets. Applied ME-T1 flows updated with refined drainage area (150.20 ha).
Main Branch	RS 16	This flow change location is approximately 1900 m upstream of ME-D2. The source of the flows used in HEC-RAS at this location could not be confirmed. To update the flows, the location was approximated and the drainage area was delineated using LiDAR from the Main Branch EIR/FSS. The updated flow was calculated by proportioning the unit area flow for ME-D2 with the area draining to RS 16. Delineated new drainage area to RS 16 and calculated new flows with ME-D2 unit area flow from NOCSS.
	RS 8	This flow change is located approximately 720 m upstream of ME-D2. The approach used to update flows for RS 16 was also applied here. Delineated new drainage area to RS 8 and calculated new flows with ME-D2 unit area flow from NOCSS.
	RS 4	This flow change is located immediately upstream of ME-D2. The NOCSS HEC-RAS model uses the peak flows for ME-D2 from NOCSS at this location. The refined drainage area to ME-D2 delineated using LiDAR as part of the Main Branch EIR/FSS (Table 7.3) was used to update the flows at RS 4. ME-D2 flows were calculated with refined drainage area from Main Branch EIR/FSS (321.60 ha).

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The updated flow profiles in the north hydraulic model are summarized in Table 3.2. Detailed calculations of updated peak flows are provided in Appendix C. The areas draining to each culvert are illustrated in Drawing 8.

Table 3.2 North Hydraulic Model Flow Profiles

Flow Change Location					Profile Names and Flow Rates (m^3/s)							
River	Reach	RS	Drainage Area (ha)	Description	2 YR	5 YR	10 YR	25 YR	50 YR	100 YR	1.3 x 100 YR	Regional
RIVER-1	Reach-1	40	43.80	ME-T5	0.42	0.65	0.78	0.99	1.13	1.27	1.65	2.72
RIVER-1	Reach-1	35	43.80	ME-T5	0.42	0.65	0.78	0.99	1.13	1.27	1.65	2.72
RIVER-1	Reach-1	30	63.53	Transposition	0.53	0.83	1.01	1.28	1.46	1.65	2.14	4.05
RIVER-1	Reach-1	26	96.10	ME-T3	0.63	0.99	1.20	1.52	1.74	1.96	2.55	4.83
RIVER-1	Reach-1	23	105.20	ME-T2	0.69	1.08	1.32	1.67	1.91	2.15	2.80	5.29
RIVER-1	Reach-1	21	150.20	ME-T1	0.98	1.54	1.88	2.38	2.72	3.07	3.99	7.55
RIVER-2	Reach-1	16	26.94	Prorated ME-	0.14	0.22	0.27	0.34	0.39	0.44	0.58	1.17

Flow Change Location					Profile Names and Flow Rates (m^3/s)							
				D2								
RIVER-2	Reach-1	8	118.73	Prorated ME-D2	0.61	0.97	1.19	1.51	1.73	1.96	2.55	5.17
RIVER-2	Reach-2	4	321.60	ME-D2	1.66	2.63	3.22	4.10	4.69	5.31	6.90	14.00

Different unit area peak flows were used for culvert and SWM storage analysis in order to attain conservative estimates from preliminary calculations. The conservative approach for culvert sizing uses high flows whereas controlling discharge to low flows is conservative for sizing SWM facilities. Overall, the NOCSS unit area peak flows are lowest at the Dundas Street crossings and highest at the crossings farther north. Therefore, the low unit area peak flows from the Dundas Street crossings were used for SWM storage estimates whereas the specific unit area peak flows were calculated for each culvert in order to evaluate hydraulic performance. The different approaches were confirmed by Janette Brenner of CH on July 29, 2013 and provide conservative estimates for storage and culvert sizing.

4. References

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Table C.1 Peak Flows at Crossing Culverts

Station	NOCSS Culvert No. Identical Culvert *(Downstream Culvert)* [5]	Watershed / Tributary	Drainage Area (ha) NOCSS Area *Unit Area* **Refined Area**	Peak Flow (m^3/s) NOCSS Peak Flow *Unit Area Peak Flow (/ha)* **Revised Target Peak Flow** 2-Year	5-Year	10-Year	25-Year	50-Year	100-Year	Regional	Notes
n/a	ME-D2	East Morrison Creek	313.94	1.62	2.57	3.14	4.00	4.58	5.18	13.67	1
			1	*0.0052*	*0.0082*	*0.0100*	*0.0127*	*0.0146*	*0.0165*	*0.0435*	
			321.60	**1.66**	**2.63**	**3.22**	**4.10**	**4.69**	**5.31**	**14.00**	2
5+500	ME-T1	East Morrison Creek (EM4)	150.17	0.98	1.54	1.88	2.38	2.72	3.07	7.55	3, 4
			1	*0.0065*	*0.0103*	*0.0125*	*0.0158*	*0.0181*	*0.0204*	*0.0503*	
			150.20	**0.98**	**1.54**	**1.88**	**2.38**	**2.72**	**3.07**	**7.55**	7
	(ME-T1)	East Morrison Creek (EM4)	150.17	0.98	1.54	1.88	2.38	2.72	3.07	7.55	3, 4
			1	*0.0065*	*0.0103*	*0.0125*	*0.0158*	*0.0181*	*0.0204*	*0.0503*	
5+665	ME-T2		**105.20**	**0.69**	**1.08**	**1.32**	**1.67**	**1.91**	**2.15**	**5.29**	7
	(ME-T1)	East Morrison Creek (EM4)	150.17	0.98	1.54	1.88	2.38	2.72	3.07	7.55	3, 4
			1	*0.0065*	*0.0103*	*0.0125*	*0.0158*	*0.0181*	*0.0204*	*0.0503*	
5+820	ME-T3		**96.10**	**0.63**	**0.99**	**1.20**	**1.52**	**1.74**	**1.96**	**4.83**	7
	(ME-T1)	East Morrison Creek (EM4)	150.17	0.98	1.54	1.88	2.38	2.72	3.07	7.55	3, 4
			1	*0.0065*	*0.0103*	*0.0125*	*0.0158*	*0.0181*	*0.0204*	*0.0503*	
6+200	ME-T4		**1.58**	**0.010**	**0.016**	**0.020**	**0.025**	**0.029**	**0.032**	**0.080**	8
6+725	ME-T5	East Morrison Creek (EM3)	43.76	0.42	0.65	0.78	0.99	1.13	1.27	2.72	3, 4
			1	*0.0096*	*0.0149*	*0.0178*	*0.0226*	*0.0258*	*0.0290*	*0.0622*	
			43.80	**0.42**	**0.65**	**0.78**	**0.99**	**1.13**	**1.27**	**2.72**	9
	(JC-D1)	Joshua's Creek (JC9)	962.74	6.53	10.35	12.57	16.02	18.18	20.58	50.06	1, 6
			1	*0.0068*	*0.0108*	*0.0131*	*0.0166*	*0.0189*	*0.0214*	*0.0520*	
7+315	n/a		**24.26**	**0.16**	**0.26**	**0.32**	**0.40**	**0.46**	**0.52**	**1.26**	8
	(JC-B10)	Joshua's Creek (JC7)	98.95	0.73	1.15	1.38	1.75	1.99	2.24	5.33	3, 4
			1	*0.0074*	*0.0116*	*0.0139*	*0.0177*	*0.0201*	*0.0226*	*0.0539*	
7+750	n/a		**26.93**	**0.20**	**0.31**	**0.38**	**0.48**	**0.54**	**0.61**	**1.45**	8
	(JC-B10)	Joshua's Creek (JC7)	98.95	0.73	1.15	1.38	1.75	1.99	2.24	5.33	3, 4
			1	*0.0074*	*0.0116*	*0.0139*	*0.0177*	*0.0201*	*0.0226*	*0.0539*	
8+080	n/a		**7.99**	**0.06**	**0.09**	**0.11**	**0.14**	**0.16**	**0.18**	**0.43**	8
	(JC-B10)	Joshua's Creek (JC7)	98.95	0.73	1.15	1.38	1.75	1.99	2.24	5.33	3, 4
			1	*0.0074*	*0.0116*	*0.0139*	*0.0177*	*0.0201*	*0.0226*	*0.0539*	
8+385	n/a		**11.27**	**0.08**	**0.13**	**0.16**	**0.20**	**0.23**	**0.26**	**0.61**	8

Notes:
1 - NOCSS area and peak flows from Table 7.4.1 of NOCSS Addendum (September, 2007)
2 - Refined area delineated using LiDAR data as part of the Green Ginger Developments Inc, EIR/FSS for North Oakville Main-East Morrison Creek (May, 2012) reported in Table 7.3
3 - NOCSS peak flows from Table 6.3.6 of NOCSS Addendum (September 5, 2007)
4 - NOCSS Area from GAWSER Model input code.
5 - When a unit flow rate is not provided in NOCSS for the culvert, the nearest downstream NOCSS culvert in Figure 7.4.7 of NOCSS Addendum (September, 2007) was used.
6 - Culvert 7+315 is located within Joshua Creek NOCCS Catchment JC9, however there are no crossing culverts with target flow rates until the final culvert at Dundas Street JC-D1.
7 - Refined area delineated using LiDAR data as part of Dundas-Trafalgar Inc. & Shieldbay Inc. EIR/FSS for East Morrison Creek Subcatchment EM4 (December, 2012) reported in Table 5.1 (page 5-4).
8 - Area draining to culvert drawn using available topo data, including OBM contours, Town of Oakville contours, survey for this EA, and LiDAR maps from EIR/FSS Reports. Figure 1.3 in the Main Branch EIR/FSS also used to confirm difference between NOCSS and EIR/FSS drainage area delineation.

9 - Refined area delineated using LiDAR data as part of Dundas-Trafalgar Inc. & Shieldbay Inc., EIR/FSS for East Morrison Creek Subcatchment EM4 (December, 2012) reported in Table 5.8.

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Talbe C.2 Peak Flow Summary for Crossing Culverts

Station	NOCSS Culvert No. Identical Culvert or *(Downstream Culvert)* [1]	Watershed / Tributary	Drainage Area (ha)	Peak Flow (m^3/s) 50-Year	100-Year	Regional
5+225	n/a	East Morrison Creek	n/a	20.40	22.90	37.70
n/a	ME-D2	East Morrison Creek	321.60	4.69	5.31	14.00
5+500	ME-T1	East Morrison Creek (EM4)	150.20	2.72	3.07	7.55
5+665	ME-T2	East Morrison Creek (EM4)	105.20	1.91	2.15	5.29
5+820	ME-T3	East Morrison Creek (EM4)	96.10	1.74	1.96	4.83
6+200	*(ME-T1)*	East Morrison Creek (EM4)	1.58	0.029	0.032	0.080
6+725	ME-T5	East Morrison Creek (EM3)	43.80	1.13	1.27	2.72
7+315	*(JC-D1)*	Joshua's Creek (JC9)	24.26	0.46	0.52	1.26
7+750	*(JC-B10)*	Joshua's Creek (JC7)	26.93	0.54	0.61	1.45
8+080	*(JC-B10)*	Joshua's Creek (JC7)	7.99	0.16	0.18	0.43
8+385	*(JC-B10)*	Joshua's Creek (JC7)	11.27	0.23	0.26	0.61

Notes:
1 - When a unit flow rate is not provided in NOCSS for a culvert analyzed in the Trafalgar Road EA, the nearest downstream NOCSS culvert Figure 7.4.7 of NOCSS Implementation Report (August 2006).

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Table C.3 Original Steady Flow Data from NOCSS and EMCSS Hydraulic Models

NOCSS HEC-RAS Model

Location of Original HEC-RAS File: P:\60119993\400-Technical Information & Discipline Work In Progress\403-Water Resources WIP\403.4-Modeling\HEC-RAS EMC North\2013 06 07 Import of East_MorrisonUpdatedFlows to HEC-RAS

Flow Change Location			Profile Names and Flow Rates (m^3/s)		
River	Reach	RS	Regional	25YR	2YR
RIVER-1	Reach-1	40	2.72	0.99	0.42
RIVER-1	Reach-1	35	4.09	1.40	0.59
RIVER-1	Reach-1	30	7.55	2.38	0.98
RIVER-1	Reach-1	21	8.87	2.74	1.12
RIVER-2	Reach-1	16	5.74	1.68	0.68
RIVER-2	Reach-1	8	6.93	2.02	0.82
RIVER-2	Reach-2	4	13.67	4.00	1.62

EMCSS HEC-2 Model

Location of Original HEC-2 File: P:\60119993\400-Technical Information & Discipline Work In Progress\403-Water Resources WIP\403.4-Modeling\HEC-RAS EMC South\HEC-2 model from Brian Evans at CH

Flow Change Location			Profile Names and Flow Rates (m^3/s)				
River	Reach	RS	PF 1 *Regional_ex_landuse*	PF 2 *Regional_official_plan_landuse*	PF 3 *Regional_foreseeable_landuse*	PF 4 *100yr_foreseeable_landuse*	PF 5 *50yr_foreseeable_landuse*
RIVER-1	Reach-1	5524.71	54.20	18.50	12.80	35.50	31.30
RIVER-1	Reach-1	3226.50	60.80	61.20	65.80	37.50	33.10
RIVER-1	Reach-1	1909.57	67.70	68.50	72.30	39.90	35.20

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Table C.4 Comparison of South Hydraulic Model in HEC-2 and HEC-RAS - Regional Storm, Subcritical

HEC-2	HEC-RAS	Water Surface Elevation (m)				Energy Gradeline (m)			
SECNO	River Sta	HEC-2 Output Code	HEC-2 imported to HEC-RAS	HEC-RAS AECOM EX		HEC-2 Output Code	EMCSS Floodplain Map	HEC-2 imported to HEC-RAS	HEC-RAS AECOM EX
		WSE	WSE	Station	WSE	EGL	EGL	EGL	EGL
				5565.71	170.22				170.22
3.32	5524.71	170.11	170.08	5532.59	170.22	170.11		170.08	170.22
3.31	5520.30	170.11	170.08	5530.59	170.22	170.11		170.08	170.22
3.31	5479.20	168.81	168.85	5466.84	168.49	168.81		168.85	168.81
3.31	5474.79	168.79	168.84	5462.43	168.57	168.81		168.85	168.73
3.31	5306.91	168.80	168.84	5310.74	168.56	168.80	168.87	168.84	168.62
3.30	5303.62	168.63	168.81	5307.45	168.44	168.75		168.83	168.59
3.30	5272.52	165.87	165.87	5268.70	166.48	166.44		166.44	167.62
3.30	5269.23	165.62	165.63	5265.41	165.98	165.96	165.83	165.96	166.71
3.29	5125.52	164.58	164.50	5125.52	164.41	164.67	164.48	164.61	164.48
3.28	4954.84	163.46	163.70	4954.84	163.32	163.81	163.81	163.88	163.60
3.27	4747.57	162.76	163.69	4747.57	161.91	162.79	161.82	163.70	161.99
326.70	4567.74	162.74	163.68	4567.74	161.91	162.76		163.68	161.92
326.60	4542.74	162.07	163.37	4542.74	161.58	162.60		163.61	161.84
326.50	4521.64	161.26	161.26	4521.64	160.98	162.14		162.13	161.54
3.26	4341.64	160.04	160.04	4341.64	159.73	160.56	160.45	160.56	160.24
3.25	4183.14	158.16	158.15	4183.14	157.90	158.49	158.47	158.49	158.20
3.24	4023.12	156.51	156.52	4023.12	156.25	157.06	156.95	157.06	156.73
3.23	3864.63	154.79	154.79	3864.63	154.58	154.99	154.91	154.99	154.76
3.22	3721.37	153.54	153.55	3721.37	153.38	153.89	153.82	153.89	153.69
3.21	3562.88	152.00	152.00	3562.88	151.70	152.29	152.22	152.29	151.99
3.21	3384.76	151.39	151.40	3384.76	151.14	151.62	151.38	151.63	151.30
3.20	3363.66	150.93	150.95	3363.66	150.74	151.44	151.34	151.44	151.12
3.19	3226.50	149.12	149.13	3226.50	149.14	149.76	149.90	149.76	149.78
3.18	3130.48	147.51	147.51	3130.48	147.55	147.95	148.30	147.95	147.95
3.17	2961.32	146.35	146.35	2961.32	146.31	147.08	147.05	147.08	147.08
3.16	2767.77	144.06	144.06	2767.77	144.07	144.73	145.21	144.73	144.75
3.15	2542.22	143.87	143.93	2542.22	143.91	143.95	143.84	144.01	143.99
3.14	2386.77	143.89	143.95	2386.77	143.93	143.91	143.86	143.98	143.95
3.13	2211.77	143.88	143.95	2211.77	143.93	143.90	143.86	143.97	143.95
3.13	2201.77	143.83	143.90	2201.77	143.86	143.89		143.96	143.93
3.13	2196.67	141.54	143.02	2196.67	142.93	142.06		143.31	143.15
3.13	2123.57	138.98	138.98	2123.57	139.38	140.08	142.85	140.08	140.71
3.12	1909.57	136.85	136.85	1909.57	136.86	137.27	137.27	137.27	137.29
3.11	1711.45	134.92	134.92	1711.45	134.93	135.39	135.39	135.39	135.41
3.10	1545.34	132.81	132.82	1545.34	132.85	133.15	133.10	133.16	133.18
3.09	1380.74	130.92	130.91	1380.74	130.93	131.54	131.55	131.55	131.59
3.08	1232.92	129.16	129.18	1232.92	129.20	129.59	129.74	129.59	129.63
3.07	1147.57	128.19	128.20	1147.57	128.27	128.66	128.66	128.66	128.72
3.06	1019.56	126.97	126.97	1019.56	127.03	127.51	127.51	127.51	127.60
3.05	803.15	124.49	124.51	803.15	124.55	124.96	125.07	124.95	124.99
3.04	635.51	122.25	122.25	635.51	122.24	122.84	122.92	122.84	122.87
3.03	470.92	119.41	119.41	470.92	119.49	120.21	120.41	120.21	120.30
3.02	262.13	117.66	117.66	262.13	117.71	117.91	117.88	117.91	117.96
3.01	0.00	115.02	115.02	0.00	115.08	115.59	115.59	115.59	115.69

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Table C.5 Comparison of Subcritical, Supercritical, and Mixed Regimes in the South Hydraulic Model, Regional Storm

HEC-2	HEC-RAS	Reach Length		Subcritical			Supercritical	Mixed
SECNO	River Sta	Incremental	Cumulative	W.S. Elev (m)	Velocity Head (m)	EGL (m)	W.S. Elev (m)	W.S. Elev (m)
n/a	5565.71	33.13	5449.33	169.21	0.00	169.21	166.47	169.21
3.315	5532.59	2.00	5416.20	169.20	0.01	169.21	166.02	169.20
3.314	5530.59	63.75	5414.20	169.20	0.00	169.20	165.62	169.20
3.312	5466.84	4.41	5350.45	168.97	0.01	168.97	165.62	168.97
3.31	5462.43	141.69	5346.04	168.80	0.14	168.93	167.11	168.80
n/a	5320.74	10.00	5204.35	168.82	0.03	168.85	166.34	168.82
3.305	5310.74	3.29	5194.35	168.82	0.03	168.85	166.61	168.82
3.304	5307.45	38.75	5191.06	168.78	0.06	168.84	165.58	168.78
3.302	5268.7	3.29	5152.31	167.28	0.09	167.36	165.61	167.28
3.3	5265.41	139.88	5149.02	166.25	0.87	167.12	166.25	166.25
3.29	5125.52	170.69	5009.14	164.58	0.08	164.66	163.62	164.58
3.28	4954.84	207.26	4838.45	163.43	0.33	163.76	163.43	163.43
3.27	4747.57	179.83	4631.19	162.46	0.04	162.51	161.62	162.46
326.7	4567.74	25.00	4451.36	162.45	0.01	162.46	160.30	162.45
326.6	4542.74	1.00	4426.36	162.09	0.28	162.38	161.02	162.09
326.5	4521.64	180.00	4425.36	161.21	0.75	161.95	160.96	161.21
3.26	4341.64	158.50	4245.36	159.96	0.54	160.51	159.96	159.96
3.25	4183.14	160.02	4086.86	158.09	0.32	158.41	157.78	158.09
3.24	4023.12	158.50	3926.84	156.46	0.54	156.99	156.46	156.46
3.23	3864.63	143.26	3768.34	154.74	0.19	154.93	154.46	154.74
3.22	3721.37	158.50	3625.08	153.51	0.34	153.85	153.51	153.51
3.21	3562.88	178.12	3466.58	151.90	0.31	152.21	151.49	151.90
3.205	3384.76	1.00	3288.46	151.31	0.20	151.51	150.88	151.31
3.2	3363.66	137.16	3287.46	150.88	0.46	151.34	150.88	150.88
3.19	3226.5	96.01	3150.30	149.14	0.64	149.78	148.74	148.74
3.18	3130.48	169.16	3054.29	147.55	0.40	147.95	147.16	147.55
3.17	2961.32	193.55	2885.13	146.31	0.77	147.08	146.31	146.31
3.16	2767.77	225.55	2691.58	144.07	0.68	144.75	143.41	143.41
3.15	2542.22	155.45	2466.03	143.94	0.08	144.03	142.09	143.94
3.14	2386.77	175.00	2310.58	143.96	0.03	143.99	139.71	143.96
3.133	2211.77	10.00	2135.58	143.96	0.02	143.98	139.83	143.96
3.132	2201.77	1.00	2125.58	143.76	0.17	143.93	142.70	143.76
3.131	2196.67	1.00	2124.58	142.94	0.22	143.16	138.45	142.94
3.13	2123.57	214.00	2123.58	139.38	1.34	140.71	139.37	139.38
3.12	1909.57	198.12	1909.58	136.86	0.43	137.29	136.33	136.33
3.11	1711.45	166.12	1711.46	134.93	0.48	135.41	134.93	134.93
3.1	1545.34	164.59	1545.34	132.85	0.33	133.18	132.59	132.85
3.09	1380.74	147.83	1380.75	130.93	0.65	131.59	130.93	130.93
3.08	1232.92	85.34	1232.92	129.20	0.43	129.63	128.92	128.92
3.07	1147.57	128.02	1147.58	128.27	0.44	128.72	128.18	128.18
3.06	1019.56	216.41	1019.56	127.03	0.57	127.60	127.03	127.03
3.05	803.15	167.64	803.15	124.55	0.44	124.99	124.28	124.28
3.04	635.51	164.59	635.51	122.24	0.62	122.87	122.02	122.02
3.03	470.92	208.79	470.92	119.49	0.81	120.30	118.82	118.82
3.02	262.13	262.13	262.13	117.71	0.26	117.96	117.50	117.71
3.01	0.00		0.00	115.08	0.61	115.69	115.08	115.08

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Table C.6 Original and Updated Boundary Conditions for North and South Hydraulic Models

North Hydraulic Models

Location of updated north hydraulic model: P:\60119993\400-Technical Information & Discipline Work In Progress\403-Water Resources WIP\403.4-Modeling\HEC-RAS EMC North

File Name: EMC_North.prj

Original Plan: East Morrison - Post QA/QC Aug23 07

Updated Plan: EX_AECOM2013

River	Reach	Profile	Original HEC-RAS Model	
			Upstream	Downstream
RIVER-1	Reach-1	all		Junction=A
RIVER-2	Reach-1	all		Junction=A
RIVER-2	Reach-2	all	Junction = A	Normal Depth S = 0.001

River	Reach	Profile	Updated HEC-RAS Model		
RIVER-1	Reach-1	2 YR		Junction=A	
RIVER-1	Reach-1	5 YR		Junction=A	
RIVER-1	Reach-1	10 YR		Junction=A	
RIVER-1	Reach-1	25 YR		Junction=A	
RIVER-1	Reach-1	50 YR		Junction=A	
RIVER-1	Reach-1	100 YR		Junction=A	
RIVER-1	Reach-1	130% of 100 YR		Junction=A	
RIVER-1	Reach-1	Regional		Junction=A	
RIVER-2	Reach-1	2 YR		Junction=A	
RIVER-2	Reach-1	5 YR		Junction=A	
RIVER-2	Reach-1	10 YR		Junction=A	
RIVER-2	Reach-1	25 YR		Junction=A	
RIVER-2	Reach-1	50 YR		Junction=A	
RIVER-2	Reach-1	100 YR		Junction=A	
RIVER-1	Reach-1	130% of 100 YR		Junction=A	
RIVER-2	Reach-1	Regional		Junction=A	
RIVER-2	Reach-2	2 YR	Junction = A	Known W.S.	166.361
RIVER-2	Reach-2	5 YR	Junction = A	Known W.S.	166.920
RIVER-2	Reach-2	10 YR	Junction = A	Known W.S.	167.354
RIVER-2	Reach-2	25 YR	Junction = A	Known W.S.	168.066
RIVER-2	Reach-2	50 YR	Junction = A	Known W.S.	168.648
RIVER-2	Reach-2	100 YR	Junction = A	Known W.S.	168.706
RIVER-1	Reach-1	130% of 100 YR	Junction = A	Known W.S.	168.805
RIVER-2	Reach-2	Regional	Junction = A	Known W.S.	168.923

South Hydraulic Models

Location of updated north hydraulic model: P:\60119993\400-Technical Information & Discipline Work In Progress\403-Water Resources WIP\403.4-Modeling\HEC-RAS EMC South

File Name: EMC_South.prj

Original Plan: BROP2DWS

Updated Plan: EX_AECOM2013

River	Reach	Profile	Original HEC-2 Model		Updated HEC-RAS Model	
			Upstream	Downstream	Upstream	Downstream
RIVER-1	Reach-1	all		Critical Depth		Critical Depth

Project Name Trafalgar Road Corridor Improvements EA
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Table C.7 Existing Culvert Properties

Station	Upstream Invert El. (m)	Downstream Invert El. (m)	Length (m)	Slope	Material	Shape	Footing Type	Span (mm)	Height (mm)	Manning's 'n'	Inlet: Entrance	Inlet: Ke
5+225	164.40	164.19	36.8	0.6%	CSP	ARCH	Closed	3480	2210	0.024		
n/a (ME-D2)	165.17	164.92	61.8	0.4%	CONC.	BOX	Closed	4270	2000	0.011		
5+500	166.11	166.01	31.4	0.3%	CONC.	BOX	Closed	2440	1520	0.011		
5+665	167.24	167.24	37.1	0.0%	CONC.	BOX	Open	1800	1050	0.011		
5+820 South	169.11	169.00	41.3	0.3%	CSP	CIRCULAR	Closed	1000	1000	0.024		
5+820 North	168.94	169.02	41.5	-0.2%	CSP	CIRCULAR	Closed	1000	1000	0.024		
6+200	174.61	174.32	35.2	0.8%	CSP	CIRCULAR	Closed	600	600	0.016	Projecting	0.90
6+725	179.27	179.29	33.0	-0.1%	CSP	ARCH	Closed	1880	1260	0.024		
7+315 South	180.60	180.55	35.8	0.1%	CSP	ARCH	Closed	1390	970	0.012	Headwall	0.50
7+315 North	180.58	180.55	35.9	0.1%	CSP	ARCH	Closed	1390	970	0.012	Headwall	0.50
7+750	182.16	181.80	45.2	0.8%	CSP	CIRCULAR	Closed	1400	1400	0.022	Projecting	0.90
8+080	184.32	184.14	35.5	0.5%	CSP	CIRCULAR	Closed	1000	1000	0.019	Projecting	0.90
8+385	184.38	184.32	32.6	0.2%	CSP	CIRCULAR	Closed	800	800	0.017	Projecting	0.90

Notes:
Items in **GREEN** could not be confirmed from survey data. The minimum acceptable velocity of 0.9 m/s for corrugated trunk sewer was used with Mannings equation to calculate the slope and inverts. The span and height are from the 2009 inventory.
Sources: Town of Oakville Drawings, survey in base drawing, existing HEC-RAS file

Project Name Trafalgar Road Corridor Improvements EA
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Table C.8 Culvert Hydraulics - Existing Conditions

			Edge of Pavement (m) [1]			50-Year[2]					100-Year			130% of 100-Year			Regional		
Station	Rise (m)	U/S Invert (m)	at sag point	at culvert	Cover (m) [7]	Flow (m^3/s)	Headwater Elevation (m)	HW/D[3]	Clearance[4]	Freeboard (m)[5]	Flow (m^3/s)	Headwater Elevation (m)	HW/D[6]	Flow (m^3/s)	Headwater Elevation (m)	Freeboard (m)[5]	Flow (m^3/s)	Headwater Elevation (m)	Freeboard (m)[5]
5+225	2.21	164.40	168.57	168.59	1.98	25.60	168.63	1.91	n/a	(0.06)	28.70	168.67	1.93	37.31	168.76	(0.19)	48.90	168.85	(0.28)
5+500	1.52	166.11	168.40	169.01	1.38	2.72	168.72	1.72	n/a	(0.32)	3.07	168.80	1.77	3.99	168.96	(0.56)	7.55	169.17	(0.77)
5+665	1.05	167.24	168.80	169.14	0.85	1.91	168.85	n/a	(0.56)	(0.05)	2.15	168.97	1.65	2.80	169.24	(0.44)	5.29	169.50	(0.70)
5+820	1.00	169.11	169.68	171.05	0.94	1.74	170.03	0.92	n/a	(0.35)	1.96	170.12	1.01	2.55	170.41	(0.73)	4.83	170.86	(1.18)
	1.00	168.94	169.68	171.07	1.13		170.03	1.09	n/a	(0.35)		170.12	1.18		170.41	(0.73)		170.86	(1.18)
6+200	0.60	174.61	174.83	176.69	1.48	0.029	174.79	0.30	n/a	1.90	0.032	174.80	0.32	0.042	174.82	1.87	0.08	174.91	1.78
6+725	1.26	179.27	180.90	180.91	0.38	1.13	180.05	0.62	n/a	0.85	1.27	180.05	0.62	1.65	180.14	0.76	2.72	180.50	0.40
7+315	0.97	180.60	182.30	182.30	0.73	0.46	180.88	0.29	n/a	1.42	0.52	180.90	0.31	0.67	180.95	1.35	1.26	181.11	1.19
	0.97	180.58	182.30	182.30	0.75		180.88	0.31	n/a	1.42		180.90	0.33		180.95	1.35		181.11	1.19
7+750	1.40	182.16	184.76	185.00	1.44	0.54	182.78	0.44	n/a	1.98	0.61	182.82	0.47	0.79	182.92	1.84	1.45	183.21	1.55
8+080	1.00	184.32	185.06	186.40	1.08	0.16	184.68	0.36	n/a	1.72	0.18	184.70	0.38	0.24	184.76	1.64	0.43	184.92	1.48
8+385	0.80	184.38	186.41	186.41	1.23	0.23	184.85	0.59	n/a	1.56	0.26	184.89	0.64	0.33	184.96	1.45	0.61	185.23	1.18
				Requirements:	Varies			< 1.5	> 0.3	> 1 m			< 1			> 0 m			> 0 m
				Applicable to:				Closed Footing	Open Footing	All			All			All			All

Notes:

[1] Edge of pavement elevations in **BLUE** used to calculate freeboard.

[2] Refer to MTO Highway Drainage Design Standard (HDDS) WC-1 for the appropriate return periods for design flow, check flow, and additional analysis

Road Classification	Major Arterial	As per Schedule C Transportation Plan of Livable Oakville (September 7, 2012)
Return period Design Flow (total span <6 m)	50-year	As per WC-1, Section 1.1.1
Check flow for scour	130% of 100 year	As per WC-1, Section 1.1.1
Additional analysis	Regional	As per WC-1, Section 1.1.2

[3] MTO HDDS (WC-7, Section 3.5, arterials): Closed-footing culverts with non-erodible bottom

Diameter or rise	HW/D Ratio
< 3 m	HW/D <= 1.5
3 to 4.5 m	HW <= 4.5
> 4.5 m	HW/D <= 1

[4] MTO HDDS (WC-7, Section 3.4.2): Clearance >= 0.3 m to the obvert of open bottom culverts with erodible bottom

[5] Freeboard Requirements

MTO HDDS, arterial crossing	Design Storm	50-year	> 1 m	As per WC-7, Section 3.2
	Check Storm	130% of 100 year	> 0 m	As per WC-7, Section 3.7
Conservation Halton	Regional Storm		> 0 m Road must be flood free	O.Reg. 162/06
Town of Oakville	Regional Storm		no increase in WSE at road crossings	Development Engineering Manual (2009)

[6] The Town of Oakville's Development Engineering Manual (2009) requires culverts to provide capacity for the 100-year to regional storms.

[7] Minimum required cover specifications from OPSD

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Table C.9 Proposed Boundary Conditions for North and South Hydraulic Models

North Hydraulic Models

Location of north hydraulic model: P:\60119993\400-Technical Information & Discipline Work In Progress\403-Water Resources WIP\403.4-Modeling\HEC-RAS EMC North

File Name: EMC_North.prj

Proposed Conditions Plans: PR_AECOM2013

			Updated HEC-RAS Model		
RIVER-1	Reach-1	2 YR		Junction=A	
RIVER-1	Reach-1	5 YR		Junction=A	
RIVER-1	Reach-1	10 YR		Junction=A	
RIVER-1	Reach-1	25 YR		Junction=A	
RIVER-1	Reach-1	50 YR		Junction=A	
RIVER-1	Reach-1	100 YR		Junction=A	
RIVER-1	Reach-1	130% of 100 YR		Junction=A	
RIVER-1	Reach-1	Regional		Junction=A	
RIVER-2	Reach-1	2 YR		Junction=A	
RIVER-2	Reach-1	5 YR		Junction=A	
RIVER-2	Reach-1	10 YR		Junction=A	
RIVER-2	Reach-1	25 YR		Junction=A	
RIVER-2	Reach-1	50 YR		Junction=A	
RIVER-2	Reach-1	100 YR		Junction=A	
RIVER-2	Reach-1	130% of 100 YR		Junction=A	
RIVER-2	Reach-1	Regional		Junction=A	
RIVER-2	Reach-2	2 YR	Junction = A	Known W.S.	166.236
RIVER-2	Reach-2	5 YR	Junction = A	Known W.S.	166.534
RIVER-2	Reach-2	10 YR	Junction = A	Known W.S.	166.700
RIVER-2	Reach-2	25 YR	Junction = A	Known W.S.	166.916
RIVER-2	Reach-2	50 YR	Junction = A	Known W.S.	167.070
RIVER-2	Reach-2	100 YR	Junction = A	Known W.S.	167.214
RIVER-2	Reach-2	130% of 100 YR	Junction = A	Known W.S.	167.601
RIVER-2	Reach-2	Regional	Junction = A	Known W.S.	168.097

South Hydraulic Models

Location of south hydraulic model: P:\60119993\400-Technical Information & Discipline Work In Progress\403-Water Resources WIP\403.4-Modeling\HEC-RAS EMC South

File Name: EMC_South.prj

Proposed Conditions Plan: PR_AECOM2013

			Updated HEC-RAS Model	
River	Reach	Profile	Upstream	Downstream
RIVER-1	Reach-1	all		Critical Depth

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Project Number 60119993-10.08

Table C.10 Updated Steady Flow Data for North and South Hydraulic Models

North HEC-RAS Model

Location of north hydraulic model: P:\60119993\400-Technical Information & Discipline Work In Progress\403-Water Resources WIP\403.4-Modeling\HEC-RAS EMC North

File Name: EMC_North.prj **Proposed Conditions Plans:** PR_AECOM2013_Alternative2, PR_AECOM2013_Alternative5

Flow Change Location			Profile Names and Flow Rates (m^3/s)									
River	Reach	RS	2 YR	5 YR	10 YR	25 YR	50 YR	100 YR	1.3 x 100 YR	Regional	Drainage Area (ha)	Notes
RIVER-1	Reach-1	40	0.42	0.65	0.78	0.99	1.13	1.27	1.65	2.72	43.80	ME-T5 (revised with updated LiDAR area)
RIVER-1	Reach-1	35	0.42	0.65	0.78	0.99	1.13	1.27	1.65	2.72	43.80	ME-T5 (revised with updated LiDAR area)
RIVER-1	Reach-1	30	0.53	0.83	1.01	1.28	1.46	1.65	2.14	4.05	63.53	Transposition, area estimated using LiDAR drawings [1]
RIVER-1	Reach-1	26	0.63	0.99	1.20	1.52	1.74	1.96	2.55	4.83	96.10	ME-T3 (revised with updated LiDAR area)
RIVER-1	Reach-1	23	0.69	1.08	1.32	1.67	1.91	2.15	2.80	5.29	105.20	ME-T2 (revised with updated LiDAR area)
RIVER-1	Reach-1	21	0.98	1.54	1.88	2.38	2.72	3.07	3.99	7.55	150.20	ME-T1 (revised with updated LiDAR area)
RIVER-2	Reach-1	16	0.14	0.22	0.27	0.34	0.39	0.44	0.58	1.17	26.94	Prorated from ME-D2 flows, area estimated using LiDAR drawings [1]
RIVER-2	Reach-1	8	0.61	0.97	1.19	1.51	1.73	1.96	2.55	5.17	118.73	Prorated from ME-D2 flows, area estimated using LiDAR drawings [1]
RIVER-2	Reach-2	4	1.66	2.63	3.22	4.10	4.69	5.31	6.90	14.00	321.60	ME-D2 (revised with updated LiDAR area)

South HEC-RAS Model

Location of south hydraulic model: P:\60119993\400-Technical Information & Discipline Work In Progress\403-Water Resources WIP\403.4-Modeling\HEC-RAS EMC South

File Name: EMC_South.prj **Proposed Conditions Plan:** PR_AECOM2013

Flow Change Location			Profile Names and Flow Rates (m^3/s) [3]								
River	Reach	RS	2 YR	5 YR	10 YR	25 YR	50 YR	100 YR	1.3 x 100 YR	Regional	Notes
RIVER-1	Reach-1	5565.71	1.66	2.63	3.22	4.10	4.69	5.31	6.90	14.00	NOCSS flows at ME-D2
RIVER-1	Reach-1	5466.84	7.5	11.6	14.3	17.8	20.4	22.9	29.77	37.7	Station located downstream of Dundas (HWY 5) and Culvert ME-D2
RIVER-1	Reach-1	5320.74	9.3	14.4	17.9	22.2	25.6	28.7	37.31	48.9	Station located upstream (west) of Trafalgar Road; added 2014-12-01 as per comments from CH
RIVER-1	Reach-1	3226.50	9.2	15.5	19.4	24.3	28.1	31.6	41.08	59.8	Station located downstream of Glenashton Drive (EMCSS Cross Section 3.19), flows @ Upper Middle Road applied here [2]
RIVER-1	Reach-1	1909.57	9.6	16.5	20.8	26.1	30.3	34.0	44.20	67.7	Station located downstream of Upper Middle Road (EMCSS Cross Section 3.12), flows @ Diversion Channel applied here [2]

Notes:

[1] Transposition Equation 8.31 from MTO Drainage Management Manual used to calculate transposition exponent for the East Morrison Creek Basin and to calculate unknown nodes at new nodes of interest.

		Flow Rates (m^3/s)								
	A (ha)	2 YR	5 YR	10 YR	25 YR	50 YR	100 YR		Regional	
1 (ME-T1)	150.20	0.98	1.54	1.88	2.38	2.72	3.07		7.55	
2 (ME-T5)	43.80	0.42	0.65	0.78	0.99	1.13	1.27		2.72	Average
Transposition exponent, n =		0.687	0.699	0.713	0.711	0.712	0.716		0.828	0.724

[2] Cross section numbering from EMCSS included in description of each HEC-RAS cross section and labelled in Drawings 4, 5, and 6 of EMCSS (except for cross sections upstream of 3.304)

[3] All flows taken from Table 7 of EMCSS.

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Table C.11 Proposed Culvert Properties

Station	Existing Deck Width (m)	Proposed Deck Width (m): U/S Widening	Proposed Deck Width (m): D/S Widening	Proposed Deck Width (m): Total Change in Width	Proposed Deck Width (m): Total Deck Width	Existing Culvert Length (m)	Proposed Culvert Length (m): U/S Extension	Proposed Culvert Length (m): D/S Extension	Proposed Culvert Length (m): Total Extension	Proposed Culvert Length (m): Total Length	Upstream Invert (m)	Downstream Invert (m)	Slope	Material	Shape	Span (mm)	Height (mm)	Manning 'n' Value: Top	Manning 'n' Value: Bottom
5+225	23.257	12.711	8.559	21.27	44.527	36.750	12.712	8.560	21.272	58.0	164.47	164.14	0.57%	CONC.	BOX	6400	2700	0.011	0.03
n/a (ME-D2)						61.750	0.000	0.000	0.000	61.8	165.17	164.92	0.40%	CONC.	BOX	4270	2000	0.011	
5+500	25.246	12.959	5.044	18.00	43.249	31.386	12.959	5.044	18.003	49.4	166.12	166.13	-0.01%	CONC.	BOX	5000	1500	0.011	0.03
5+665	19.996	16.131	16.128	32.26	52.256	37.111	16.131	16.128	32.259	69.4	167.35	167.20	0.21%	CONC.	BOX	3500	1100	0.011	0.03
5+820 South	19.679	20.333	17.812	38.15	57.833	41.331	20.333	17.812	38.145	79.5	168.94	168.14	1.01%	CONC.	BOX	2100	1100	0.011	0.03
5+820 North	19.679	17.863	17.728	35.59	55.260	41.464	17.863	17.728	35.591	77.1	168.94	168.14	1.04%	n/a	n/a	n/a	n/a	n/a	n/a
6+200 South	17.249	13.759	15.153	28.91	46.161	35.235	13.759	15.153	28.912	64.1	174.72	174.20	0.82%	CSP	CIRCULAR	675	675	0.012	n/a
6+200 North	17.249	13.759	15.153	28.91	46.161	35.235	13.759	15.153	28.912	64.1	174.72	174.20	0.82%	CSP	CIRCULAR	675	675	0.012	n/a
6+725	17.207	13.654	15.598	29.25	46.459	33.040	13.654	15.598	29.252	62.3	179.28	179.19	0.14%	CONC.	BOX	2200	1000	0.011	0.03
7+315 South	20.500	10.514	13.400	23.91	44.414	35.803	10.514	13.400	23.914	59.7	180.61	180.53	0.14%	CSP	ARCH	1390	970	0.012	
7+315 North	20.571	10.484	13.366	23.85	44.421	35.938	10.484	13.366	23.850	59.8	180.59	180.54	0.08%	CSP	ARCH	1390	970	0.012	
7+750	21.986	7.149	19.823	26.97	48.958	45.218	7.149	19.823	26.972	72.2	182.22	181.64	0.80%	CSP	CIRCULAR	1400	1400	0.022	
8+080	17.380	13.499	9.625	23.12	40.503	35.474	13.499	9.625	23.124	58.6	184.39	184.09	0.51%	CSP	CIRCULAR	1400	1400	0.022	
8+385	20.827	4.779	10.672	15.45	36.277	32.597	4.779	10.672	15.451	48.0	184.39	184.31	0.17%	CSP	CIRCULAR	800	800	0.017	

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Table C.12 Culvert Hydraulics - Proposed Conditions

Station	Rise (m)	U/S Invert (m)	Edge of Pavement (m)[1]: at sag point	Edge of Pavement (m)[1]: at culvert	Cover (m)[7]	50-Year[2]: Flow (m^3/s)	50-Year[2]: Headwater Elevation (m)	50-Year[2]: HW/D[3]	50-Year[2]: Clearance (m)[4]	50-Year[2]: Freeboard (m)[5]	100-Year: Flow (m^3/s)	100-Year: Headwater Elevation (m)	100-Year: HW/D[6]	130% of 100-Year: Flow (m^3/s)	130% of 100-Year: Headwater Elevation (m)	130% of 100-Year: Freeboard (m)[5]	Regional: Flow (m^3/s)	Regional: Headwater Elevation (m): Existing	Regional: Headwater Elevation (m): Proposed	Regional: Headwater Elevation (m): Change	Regional: Freeboard (m)[5]
5+225	2.700	164.473	168.57	168.59	1.42	25.60	166.67	n/a	0.50	1.90	28.70	166.85	0.88	37.31	167.31	1.26	48.90	168.85	167.87	-0.98	0.70
5+500	1.500	166.122	168.40	169.01	1.39	2.72	167.27	n/a	0.35	1.13	3.07	167.35	0.82	3.99	167.70	0.70	7.55	169.17	168.40	-0.77	0.00
5+665	1.100	167.349	168.80	169.14	0.69	1.91	168.14	n/a	0.31	0.66	2.15	168.10	0.68	2.80	168.24	0.56	5.29	169.50	168.62	-0.88	0.18
5+820	1.100	168.940	169.68	171.06	1.02	1.74	169.67	n/a	0.37	1.39	1.96	169.73	0.72	2.55	169.89	1.17	4.83	170.86	170.42	-0.44	0.64
6+200	0.675	174.723	174.83	176.69	1.29	0.029	174.84	0.17	n/a	1.85	0.032	174.85	0.19	0.042	174.87	1.82	0.080	174.91	174.92	0.01	1.77
	0.675	174.723	174.83	176.69	1.29	0.029	174.84	0.17	n/a	1.85	0.032	174.85	0.19	0.042	174.87	1.82	0.080	174.91	174.92	0.01	1.77
6+725	1.000	179.277	180.90	180.91	0.63	1.13	179.89	n/a	0.39	1.01	1.27	179.93	0.65	1.65	180.04	0.86	2.72	180.50	180.31	-0.19	0.59
7+315	0.970	180.615	182.30	182.30	0.72	0.46	180.89	0.28	n/a	1.41	0.52	180.92	0.31	0.67	180.96	1.34	1.26	181.11	181.12	0.01	1.18
	0.970	180.589	182.30	182.30	0.74		180.89	0.31	n/a	1.41		180.92	0.34		180.96	1.34		181.11	181.12	0.01	1.18
7+750	1.400	182.217	184.76	185.00	1.38	0.54	182.83	0.44	n/a	1.93	0.61	182.88	0.47	0.79	182.97	1.79	1.45	183.21	183.27	0.06	1.49
8+080	1.400	184.388	185.06	186.40	0.61	0.16	184.71	0.23	n/a	1.69	0.18	184.73	0.24	0.24	184.78	1.62	0.43	184.92	184.92	0.00	1.48
8+385	0.800	184.388	186.41	186.41	1.22	0.23	184.87	0.60	n/a	1.54	0.26	184.91	0.65	0.33	184.98	1.43	0.61	185.23	185.26	0.03	1.15
				Requirements:	Varies			< 1.5	> 0.3	> 1 m			< 1			> 0 m				< 0	> 0 m
				Applicable to:				Closed Footing	Open Footing	All			All			All				All	All

Notes:

[1] Edge of pavement elevations in **BLUE** used to calculate freeboard.

[2] Refer to MTO Highway Drainage Design Standard (HDDS) WC-1 for the appropriate return periods for design flow, check flow, and additional analysis

Road Classification	Major Arterial	As per Schedule C Transportation Plan of Livable Oakville (September 7, 2012)
Return period Design Flow (total span <6 m)	50-year	As per WC-1, Section 1.1.1
Check flow for scour	130% of 100 year	As per WC-1, Section 1.1.1
Additional analysis	Regional	As per WC-1, Section 1.1.2

[3] MTO HDDS (WC-7, Section 3.5, arterials): Closed-footing culverts with non-erodible bottom

Diameter or rise	HW/D Ratio
< 3 m	HW/D <= 1.5
3 to 4.5 m	HW <= 4.5
> 4.5 m	HW/D <= 1

[4] MTO HDDS (WC-7, Section 3.4.2): Clearance >= 0.3 m to the obvert of open bottom culverts with erodible bottom

[5] Freeboard Requirements

MTO HDDS, arterial crossing	Design Storm	50-year	> 1 m	As per WC-7, Section 3.2
	Check Storm	130% of 100 year	> 0 m	As per WC-7, Section 3.7
Conservation Halton	Regional Storm		> 0 m Road must be flood free	O.Reg. 162/06
Town of Oakville	Regional Storm		no increase in WSE at road crossings	Development Engineering Manual (2009)

[6] The Town of Oakville's Development Engineering Manual (2009) requires culverts to provide capacity for the 100-year to regional storms

[7] Minimum required cover specifications from OPSD

Figure C.1: Comparison of Water Surface Elevations Computed in HEC-2 and HEC-RAS, Regional Storm, Subcritical

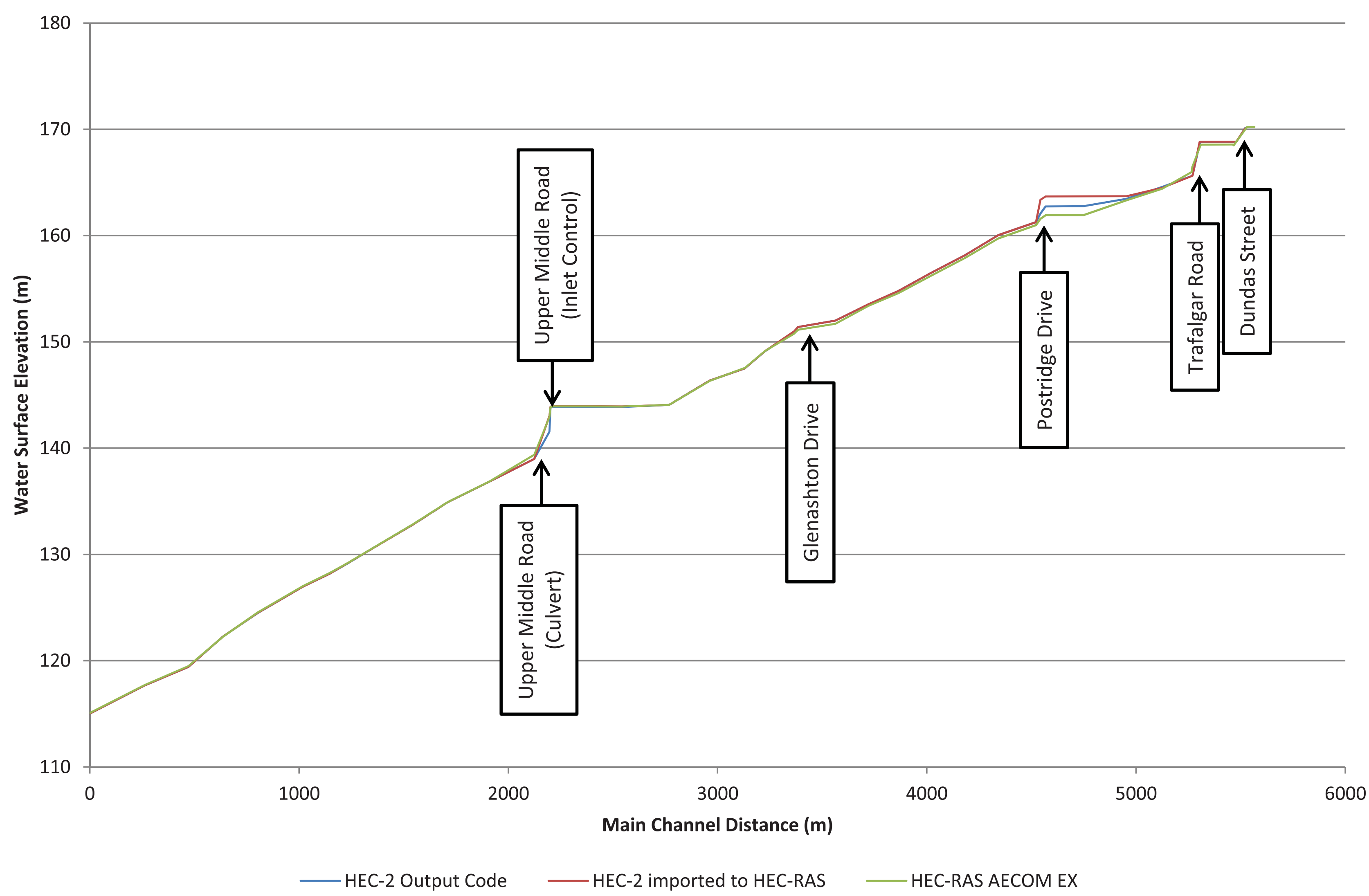
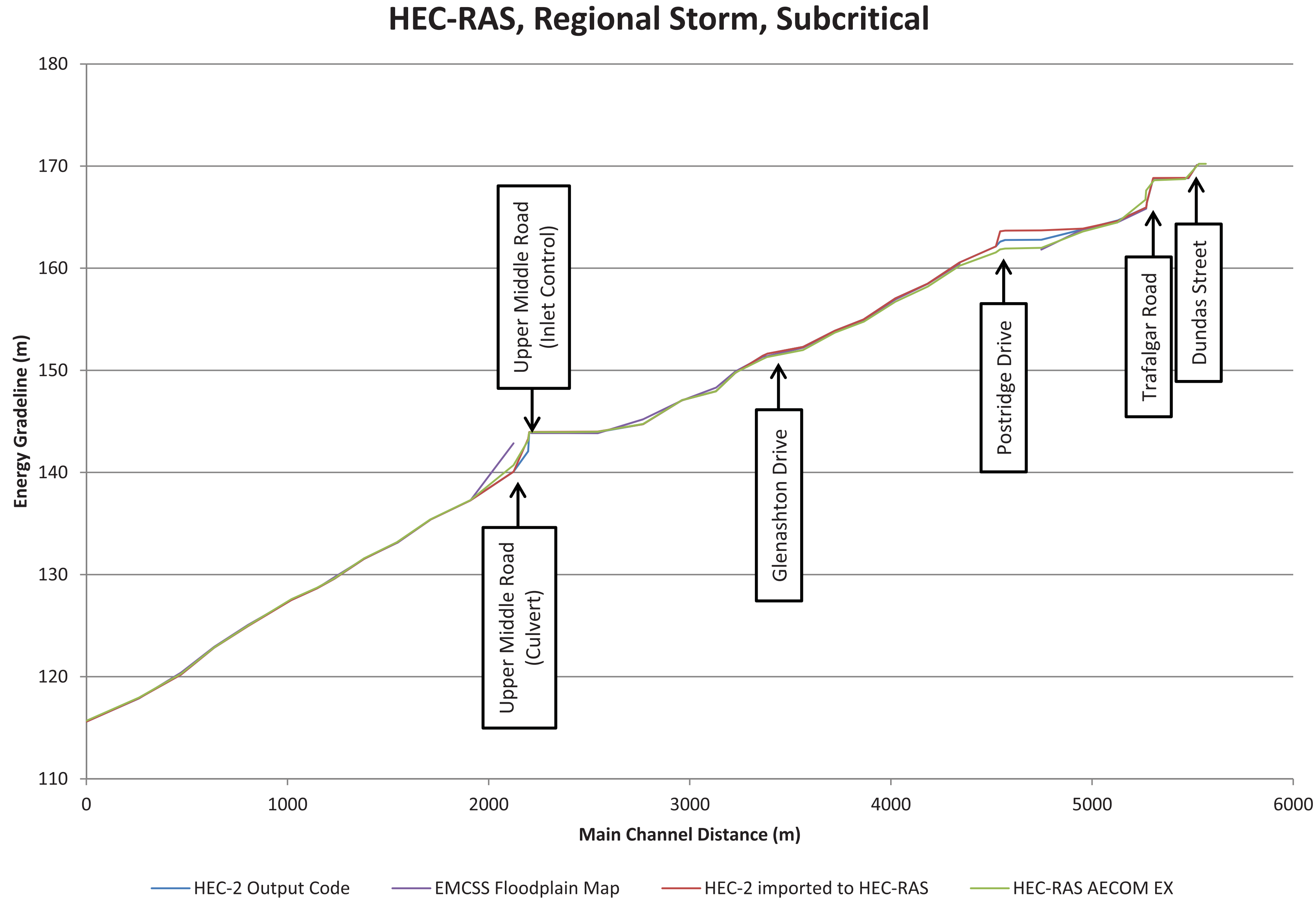


Figure C.2: Comparison of Energy Gradelines Computed in HEC-2 and HEC-RAS, Regional Storm, Subcritical



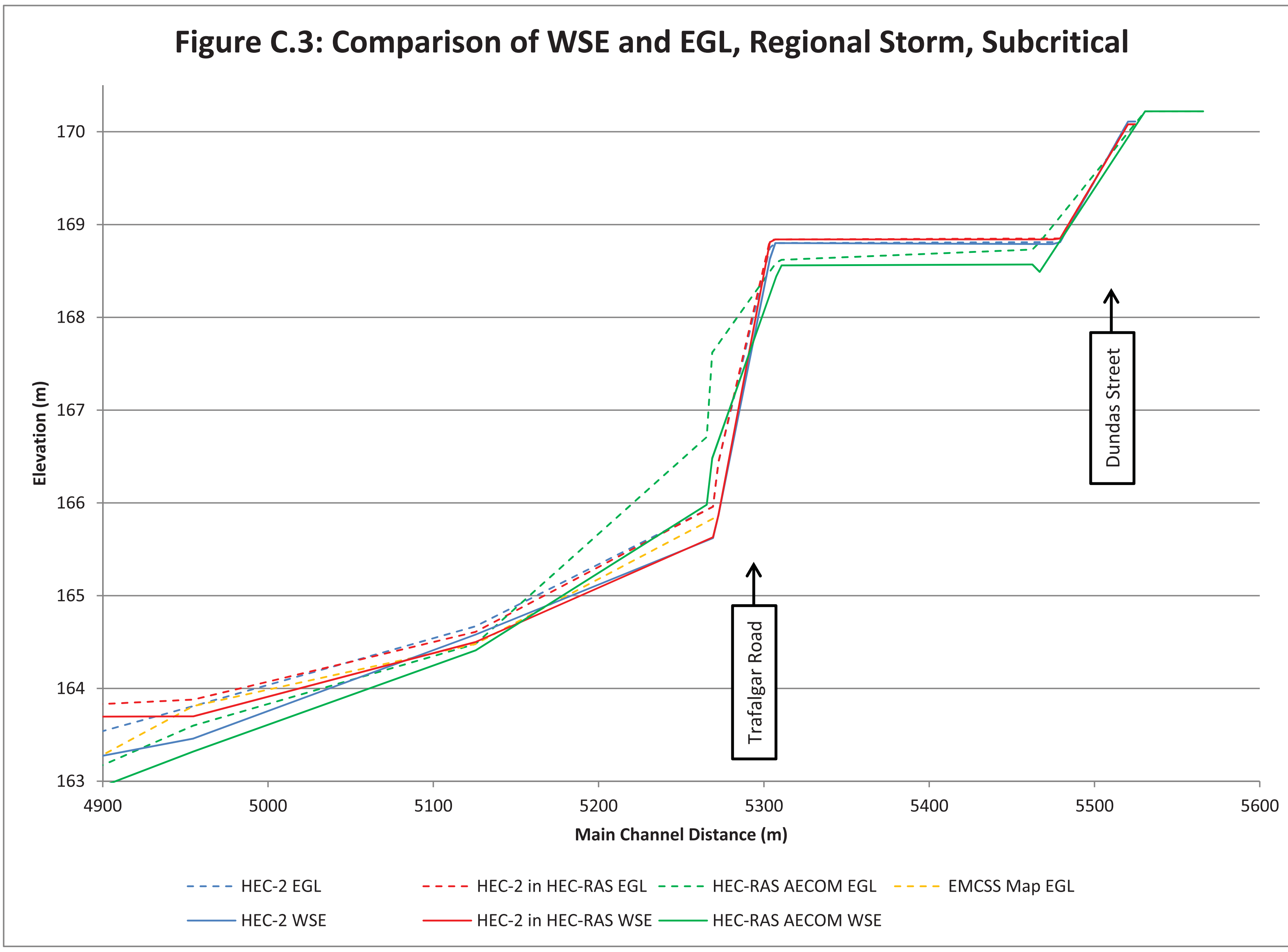


Figure C.3: Comparison of WSE and EGL, Regional Storm, Subcritical
Elevation (m)
170
169
168
167
166
165
164
163
4900
5000
5100
5200
5300
5400
5500
5600
Main Channel Distance (m)
Trafalgar Road
Dundas Street
HEC-2 EGL
HEC-2 WSE
HEC-2 in HEC-RAS EGL
HEC-2 in HEC-RAS WSE
HEC-RAS AECOM EGL
HEC-RAS AECOM WSE
EMCSS Map EGL

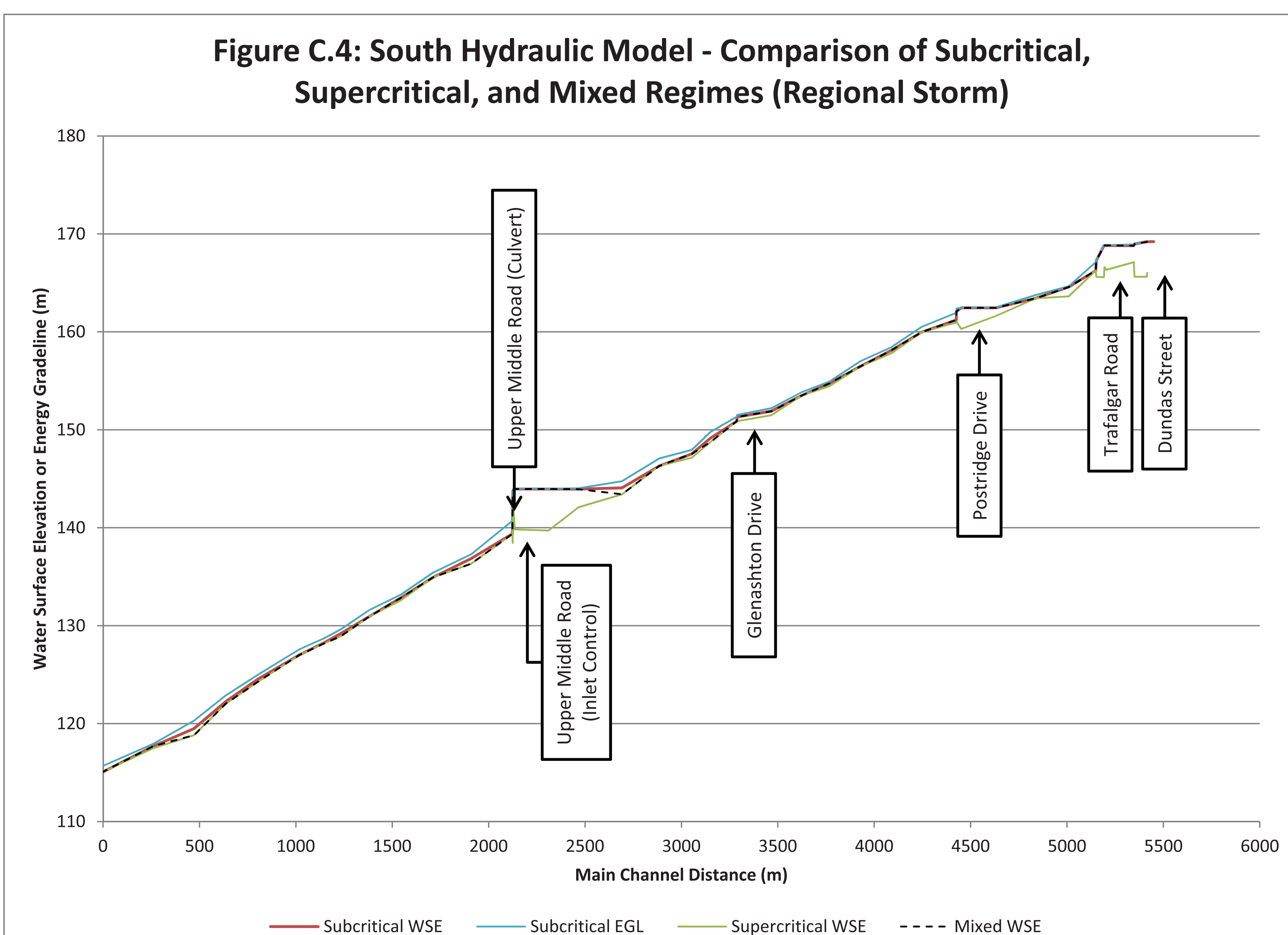
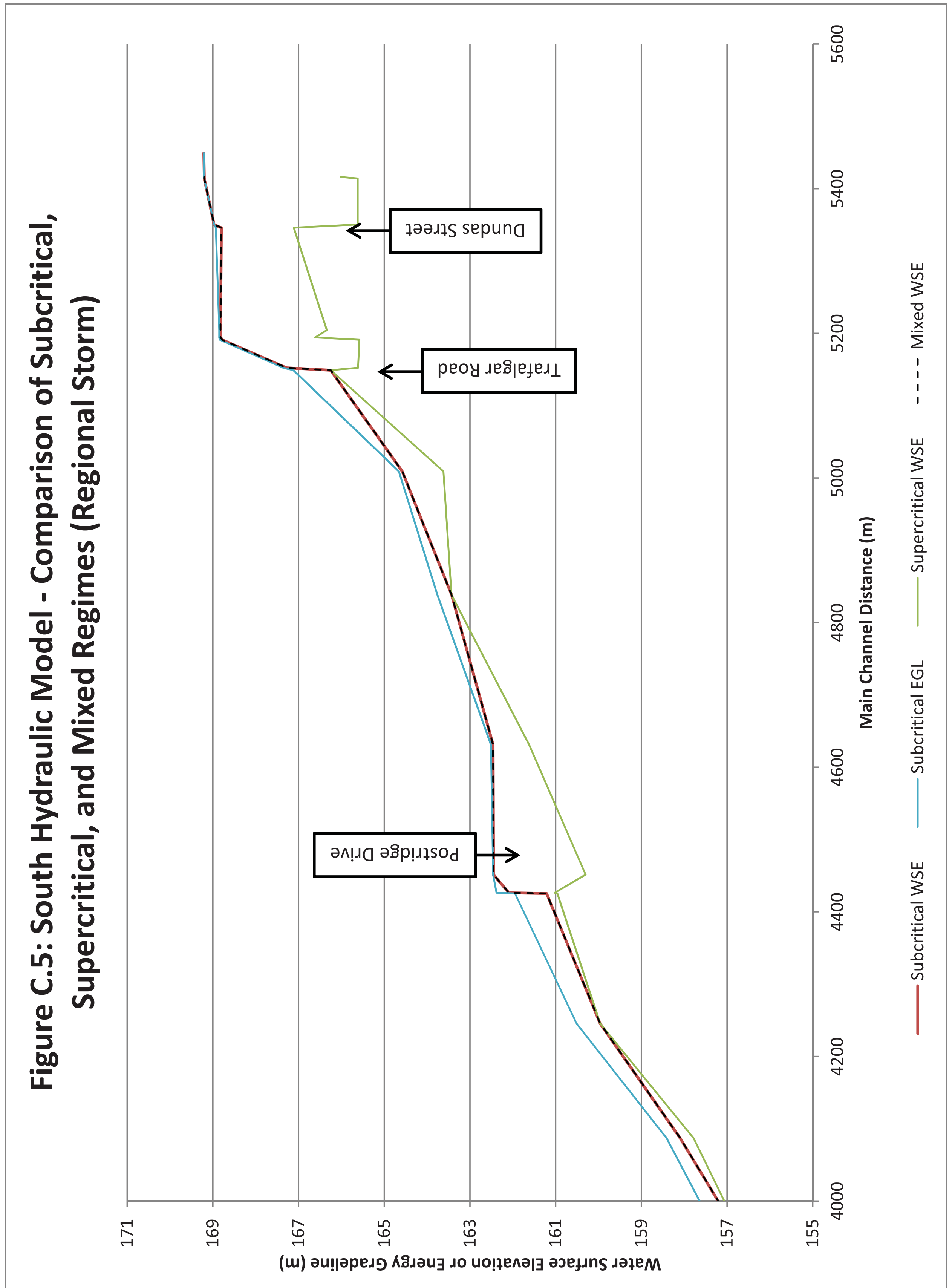


Figure C.4: South Hydraulic Model - Comparison of Subcritical, Supercritical, and Mixed Regimes (Regional Storm)
Water Surface Elevation or Energy Gradeline (m)
180
170
160
150
140
130
120
110
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
Main Channel Distance (m)
Upper Middle Road (Culvert)
Upper Middle Road (Inlet Control)
Glenashton Drive
Postridge Drive
Trafalgar Road
Dundas Street
Subcritical WSE
Subcritical EGL
Supercritical WSE
Mixed WSE

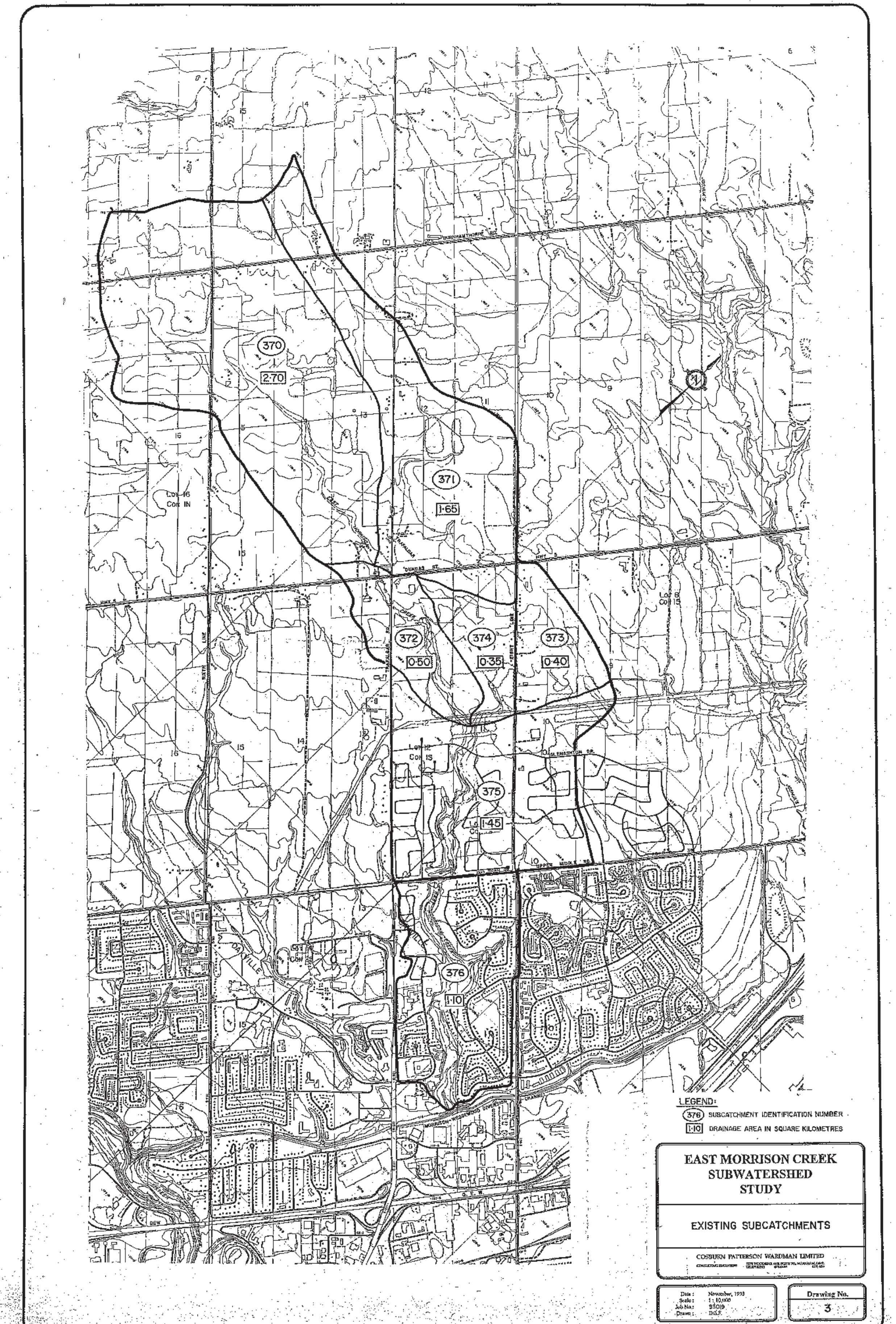


Appendix D

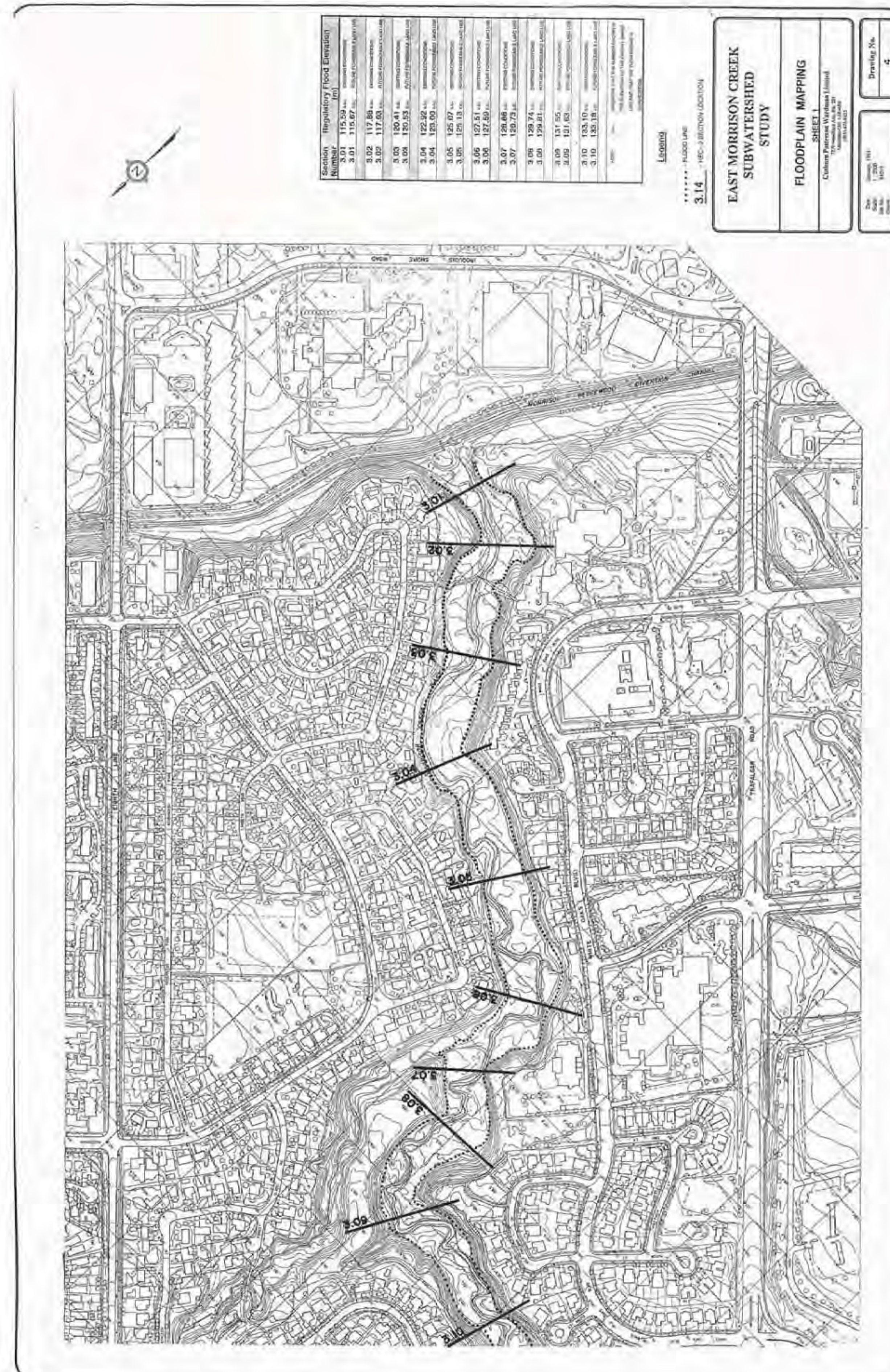
Trafalgar Road Corridor Improvements EA, Cornwall Road to Highway 407

Stormwater Management Report

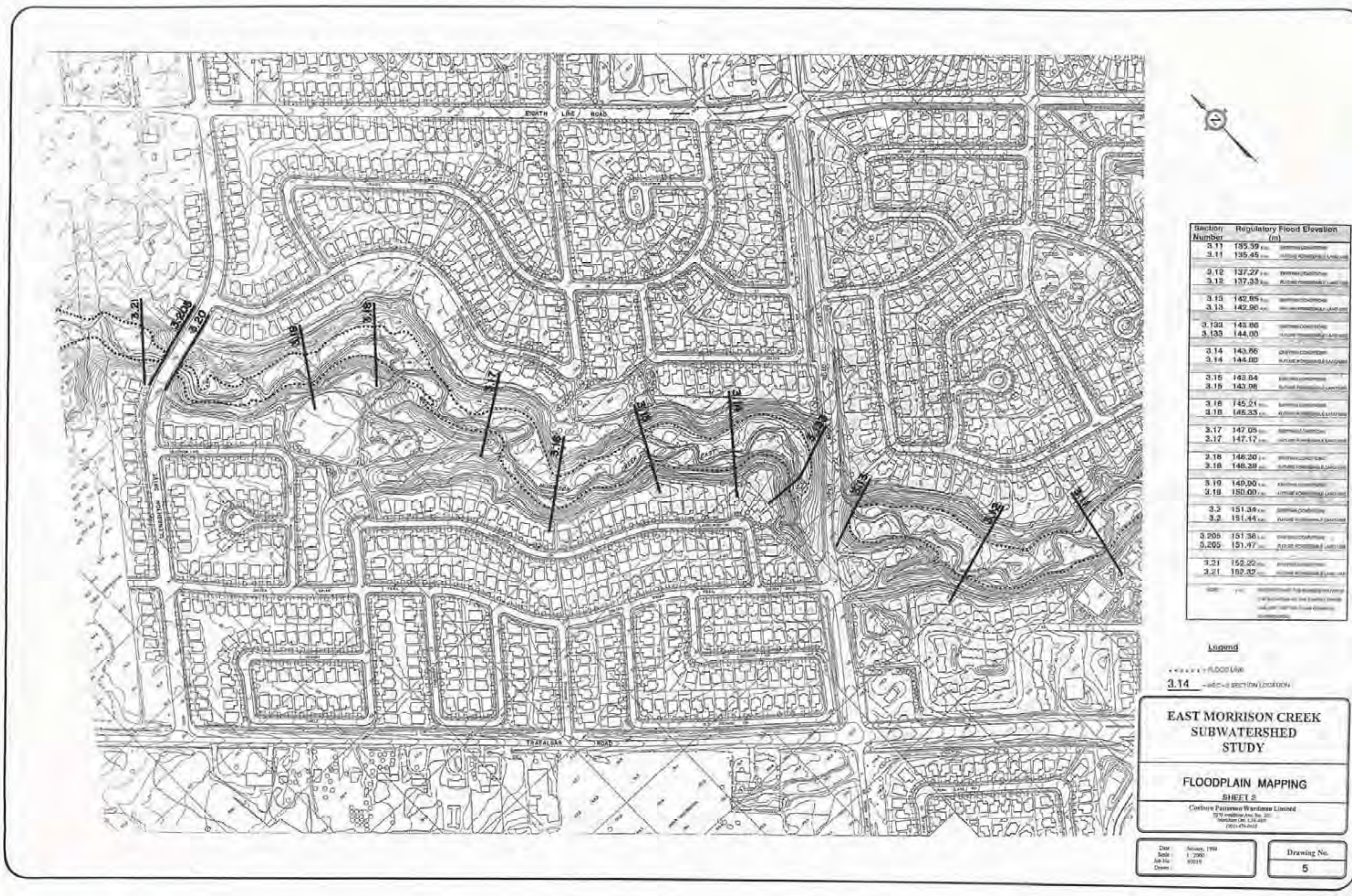
- **East Morrison Creek Subwatershed Study**



370
2.70
371
1.65
372
0.50
374
0.35
373
0.40
375
1.45
376
1.10
LEGEND:
376 SUBCATCHMENT IDENTIFICATION NUMBER
1.10 DRAINAGE AREA IN SQUARE KILOMETRES
EAST MORRISON CREEK SUBWATERSHED STUDY
EXISTING SUBCATCHMENTS
COSBURN PATTERSON WARDMAN LIMITED
Scale: 1 : 10,000
Job No.: 93019
Drawn: D.G.F.
Drawing No.
3



Section Number
Regulatory Flood Elevation (m)
3.01 115.59
3.01 115.67
3.02 117.88
3.02 117.93
3.03 120.41
3.03 120.53
3.04 122.92
3.04 123.00
3.05 125.07
3.05 125.13
3.06 127.51
3.06 127.59
3.07 128.66
3.07 128.73
3.08 129.74
3.08 129.81
3.09 131.55
3.09 131.63
3.10 133.10
3.10 133.18
Legend
FLOOD LINE
3.14 HEC-2 SECTION LOCATION
EAST MORRISON CREEK SUBWATERSHED STUDY
FLOODPLAIN MAPPING
SHEET 1
Drawing No.
4
3.01
3.02
3.03
3.04
3.05
3.06
3.07
3.08
3.09
3.10


Section Number / Regulatory Flood Elevation (m)
3.11 135.39
3.11 135.45
3.12 137.27
3.12 137.33
3.13 142.85
3.13 142.90
3.133 143.86
3.133 144.00
3.14 143.86
3.14 144.00
3.15 143.84
3.15 143.98
3.16 145.21
3.16 145.33
3.17 147.05
3.17 147.17
3.18 148.20
3.18 148.28
3.19 149.90
3.19 150.00
3.2 151.34
3.2 151.44
3.205 151.36
3.205 151.47
3.21 152.22
3.21 152.32
Legend
FLOOD LINE
3.14 HEC-2 SECTION LOCATION
EAST MORRISON CREEK SUBWATERSHED STUDY
FLOODPLAIN MAPPING
SHEET 2
Cosburn Patterson Wardman Limited
Drawing No.
5

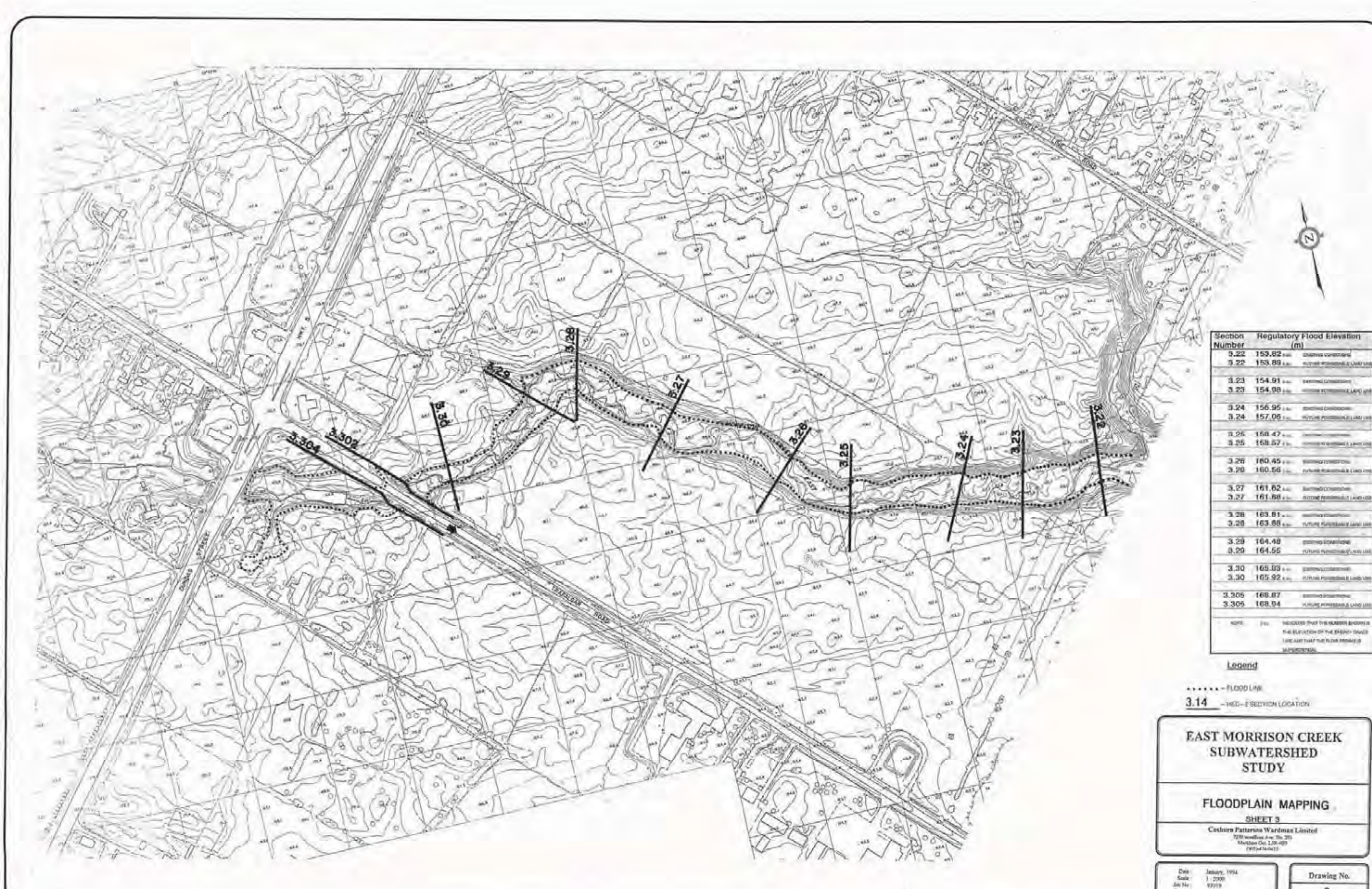

Section Number / Regulatory Flood Elevation (m)
3.22 153.82
3.22 153.89
3.23 154.91
3.23 154.98
3.24 156.95
3.24 157.06
3.25 158.47
3.25 158.57
3.26 160.45
3.26 160.56
3.27 161.62
3.27 161.88
3.28 163.81
3.28 163.88
3.29 164.48
3.29 164.55
3.30 165.83
3.30 165.92
3.305 168.87
3.305 168.94
Legend
FLOOD LINE
3.14 HEC-2 SECTION LOCATION
EAST MORRISON CREEK SUBWATERSHED STUDY
FLOODPLAIN MAPPING
SHEET 3
Cosburn Patterson Wardman Limited
Date: January, 1994
Scale: 1:2000
Drawing No.
6

Table 7
Summary of Existing Flows
East Morrison Creek Subwatershed

Storm	Peak Flows (cms) @ Hwy. 5	In 8th Line Tributary	@ Glenashton Drive	@ Upper Middle Road	@ Diversion Channel
2 Year	7.5	2.5	9.3	9.2	9.6
5 Year	11.6	3.8	14.4	15.5	16.5
10 Year	14.3	4.6	17.9	19.4	20.8
25 Year	17.8	5.7	22.2	24.3	26.1
50 Year	20.4	6.5	25.6	28.1	30.3
100 Year	22.9	7.2	28.7	31.6	34.0
Regional	37.7	8.1	48.9	59.8	67.7

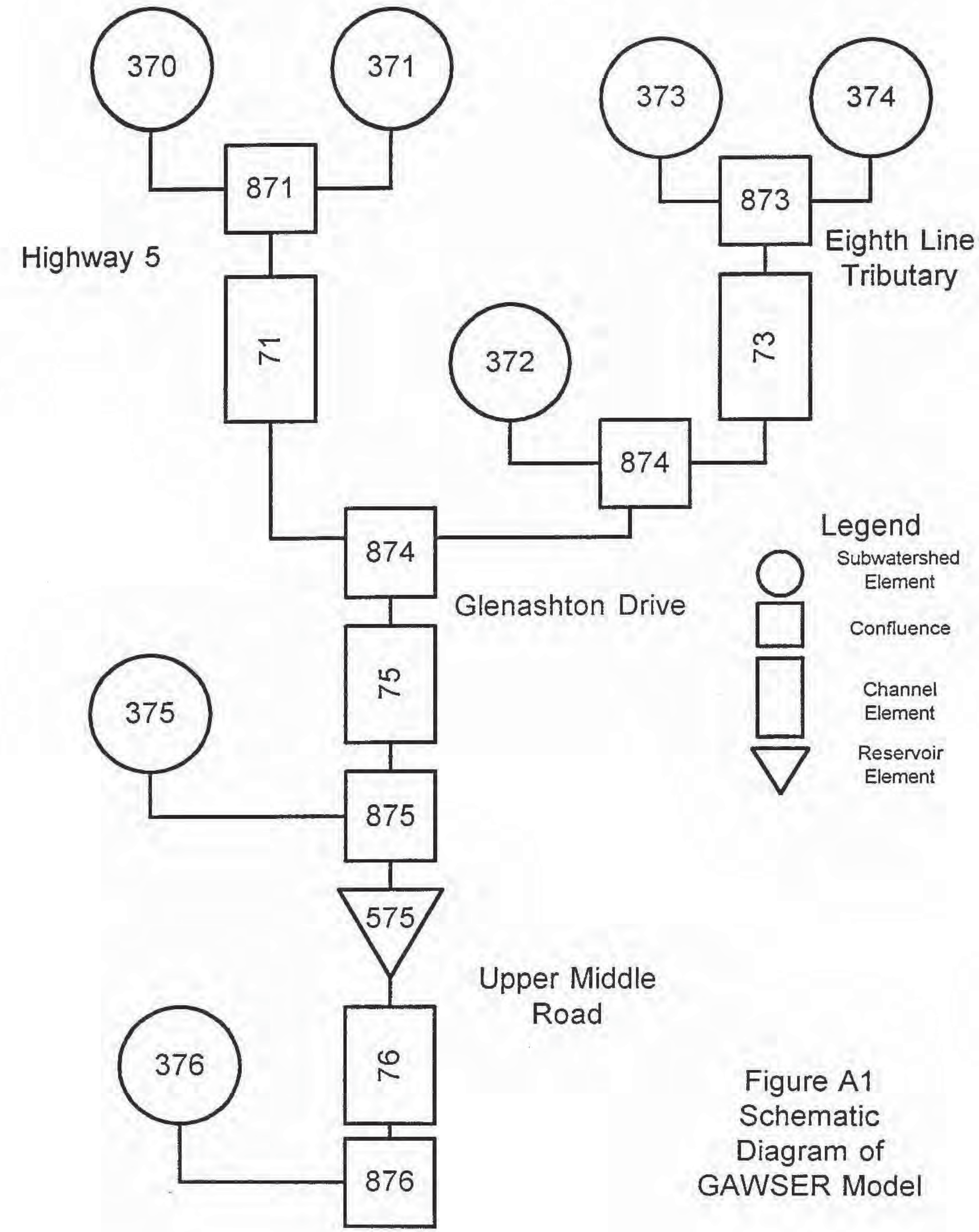


Figure A1
Schematic
Diagram of
GAWSER Model

EMCSS HEC-2 Input File

```
C
C     4
C  3.130     - UPPER MIDDLE ROAD (9-5 X 14-4 CSP)
C  3.200     - GLENASHTON DRIVE BRIDGE (CLEAR SPAN)
C  3.300     - TRAFALGAR ROAD (137' X 87' CSP)
C  3.310     - HWY # 5 (4.267 X 2.134 CONCRETE BOX)
T1      EAST MORRISON CREEK SUBWATERSHED STUDY  # 93019
T2      FLOOD LINE ANALYSIS FOR MORRISON CREEK EAST - OCTOBER 21, 1993
T3      REGIONAL FLOW  - EXISTING CONDITIONS - SUBCRITICAL
J1      0       2       0       0      -1       1       0       0     115       0
J2      1       0      -1       0       0       0      -1       0       0       0
J3    150
NC     .1      .1    .035      .1      .3
QT      5    67.7    68.5    72.3    39.9    35.2
X1  3.01      11  71.628  75.900
GR117.35   30.48 115.824    38.1   114.3   60.96 113.538  67.056 113.390  71.628
GR112.78  71.933 112.776   75.59  113.39  75.900 113.538  77.724   114.3  82.296
GR121.92   97.54
X1  3.02      12  48.768  53.035 204.216   152.4 262.128
GR126.49   30.48 117.348   45.72 116.738  48.768 116.129  48.768 116.129  53.035
GR116.74  53.035 116.586  56.388 116.586  86.868 117.348  89.916 118.872 118.872
GR124.97  129.54 126.492 153.924
X1  3.03      14  79.248  83.515 164.592 164.592 208.788
GR129.54   30.48 128.016  42.672  121.92  51.816 120.396  54.864 118.872  73.152
GR117.04  79.248 116.434  79.553 116.434  83.210 117.043  83.515 118.872  85.344
GR120.40 112.776  121.92 120.396 128.016 131.064  129.54 161.544
X1  3.04       9  89.916  94.183 128.016 153.924 164.592
GR131.06   30.48  129.54  39.624  121.92  73.152 120.396  89.916 119.786  90.221
GR119.79  93.878 120.396  94.183  121.92 100.584 131.064 115.824
X1  3.05      11  92.964  97.231   152.4 161.544  167.64
GR132.59   30.48  129.54  36.576 124.206  48.768 123.444  85.344 122.682  92.964
GR122.07  93.269 122.072  96.926 122.682  97.231 123.444  97.536 131.064  106.68
GR132.59 123.444
X1  3.06      12  59.436  63.703 210.312  160.02 216.408
GR135.64   30.48 126.492  48.768  125.73  54.864 125.425  59.436 124.816  59.741
GR124.82  63.398 125.425  63.703  125.73  70.104 126.492    76.2 128.016 100.584
GR134.11  106.68 135.636 112.776
X1  3.07      10   53.34  57.607  121.92 128.016 128.016
GR135.64   30.48 128.016  41.148 127.559  42.672 126.492   53.34 125.882  53.645
GR125.88  57.302 126.492  57.607 127.559   68.58 128.016  88.392 135.636 103.632
X1  3.08      11 111.252 115.519  97.536  54.864  85.344
GR137.16   30.48 135.636  36.576  129.54  51.816 128.778  67.056 128.016  106.68
GR127.41 111.252 126.797 111.557 126.797 115.214 127.406 115.519 128.016 115.824
GR137.16 131.064
X1  3.09      10   60.96  65.227 134.112  175.26 147.828
GR138.68   30.48  137.16  36.576  129.54  54.864 129.235   60.96 128.626  61.265
GR128.63  64.922 129.235  65.227  129.54  67.056 131.064   83.82 138.684  97.536
X1   3.1      11  54.864  59.131 155.448 173.736 164.592
GR141.73   30.48  137.16  36.576 131.826  50.292 131.521  54.864 130.912  55.169
GR130.91  58.826 131.521  59.131 131.826  67.056 131.064  79.248 135.636  89.916
GR141.73 102.108
X1  3.11      10  57.912  62.179 146.304 158.496 166.116
GR143.26   30.48  137.16  42.672 134.112  51.816 133.655  57.912 133.045  58.217
GR133.05  61.874 133.655  62.179 134.112  85.344  137.16  89.916 143.256 103.632
X1  3.12      13  54.864  59.131 192.024 131.064  198.12
GR146.30   30.48  144.78    38.1  137.16  47.244 135.636  50.292 135.331  54.864
GR134.72  55.169 134.722  58.826 135.331  59.131 135.636  59.436 136.398  94.488
GR141.72  106.68  144.78 112.776 146.304  121.92
NC      0       0    .024      .3      .5
QT      5    60.8    61.2    65.8    37.5    33.1
X1 3.130       8     150     156     189     196     214
X3     10       0       0       0       0       0       0   143.8   143.8
GR147.16     100   143.3     113  138.68     140  137.08     150  136.53     153
GR137.04     156  138.97     164   150.6     181
SB      0    1.56     1.5       0     3.4       0    9.76       0  137.23  136.91
X1 3.131      10   337.8  342.21      72      72      72
X2      0       0       1  140.13  147.58
X3     10       0       0       0       0       0       0  147.58  147.58
BT    -10     100   148.8   148.8     245  147.81  147.81     285  147.58     146
BT      0     332  147.95   140.5   337.8  147.95  137.23  337.81  147.95  140.13
BT      0   342.2     148  140.13  342.21     148  137.23     348  148.05     140
BT      0     400   149.3   149.3
GR 148.8     100  147.81     245     146     285   140.5     332  137.23   337.8
GR137.23  337.81  137.23   342.2  137.23  342.21     140     348   149.3     400
SB      0    1.56     1.5       0    1.25       0    1.56       0  137.32  137.32
X1 3.132      16 339.374 340.626       3       3       3
X2      0       0       1  138.57  141.32
X3     10                                                 141.32  141.32
BT    -16     100   148.8   148.8     245  147.81  147.81     285  147.58     146
BT      0  331.99  147.95   140.5     332   142.7   140.5  337.49   142.7   138.7
BT      0   337.5  141.32   138.7 339.374  141.32  137.32 339.375  141.32  138.57
BT      0 340.625  141.32  138.57 340.626  141.32  137.32   342.5  141.32   138.7
BT      0  342.51   142.7   138.7     348   142.7     140  348.01  148.05     140
BT      0     400   149.3   149.3
GR 148.8     100  147.81     245     146     285   140.5  331.99   140.5     332
GR 138.7  337.49   138.7   337.5  137.32 339.374  137.32 339.375  137.32 340.625
GR137.32 340.626   138.7   342.5   138.7  342.51     140     348     140  348.01
GR 149.3     400
X1 3.133       7     132     145      10      10      10
GR150.98     100  144.55     115  139.63     132  137.86     142  138.39     145
GR140.84     160  149.37     193
NC                            .1      .3
X1 3.140      13  94.488  98.755     146     108     175
GR 152.4   30.48 149.352  39.624  144.78  65.532 140.208    76.2 138.684  88.392
GR138.68  94.488 138.074  94.793 138.074   98.45 138.684  98.755 138.684 100.584
GR141.73   114.3  144.78  121.92   152.4  137.16
X1 3.150      13   53.34  57.607 126.492 150.876 155.448
GR153.92   30.48   152.4  35.052  144.78  42.672  140.97  51.816 140.513   53.34
GR139.90   53.34 139.903  57.607 140.513  57.607  140.97   60.96 141.732  79.248
GR143.26   91.44   152.4   114.3 153.924  121.92
X1 3.160      13  50.292  54.559  160.02 134.112 225.552
GR155.45   30.48   152.4  36.576  144.78  42.672 142.494  48.768 142.342  50.292
GR141.73  50.597 141.732  54.254 142.342  54.559 142.494  57.912  144.78  88.392
GR 152.4 109.728 153.924  121.92 155.448 124.968
X1 3.170      12  50.292  54.559 135.636 141.732 193.548
GR155.45   30.48   152.4  39.624  144.78   45.72 144.475  50.292 143.866  50.597
GR143.87  54.559 144.475  54.559  144.78  54.864 146.304  70.104 147.828  82.296
GR 152.4  89.916 155.448 131.064
X1 3.180      10  51.816  56.083  144.78 109.728 169.164
GR156.97   30.48 147.066  48.768 146.609  51.816 145.999  52.121 145.999  55.778
GR146.61  56.083 146.304  85.344 147.066   91.44   152.4   99.06 156.972   114.3
X1 3.190      11  65.532  69.799  51.816  129.54  96.012
GR157.73   30.48   152.4   45.72 147.828   60.96 147.523  65.532 146.914  65.837
GR146.91  69.494 147.523  69.799 147.828  74.676  148.59  86.868   152.4  96.012
GR158.50 108.204
QT      5    54.2    18.5    12.8    35.5    31.3
X1 3.200      24   112.7   130.4 123.444 126.492  137.16
X3     10       0       0       0       0       0       0  159.52  159.52
GR 160.5       0  159.97    78.9  159.99   82.65   159.0   90.65     157   94.65
GR 154.8    98.9   152.0   102.1   151.2   105.3   150.4   112.7   150.4  112.71
GR   150   115.5     149  115.51     149  119.49     150   119.5   150.5  130.39
GR 150.5   130.4     151   140.8   152.2   146.4     156   149.9   158.2   152.7
GR 159.1   156.4   160.2  161.65   160.9  178.90   161.1   218.9
SB      0   1.618     1.6       0  15.505       0 152.418       0  149.27  148.95
NC                 0.035      .3      .5
X1 3.205       0       0       0      20      20      20       0       0
X2      0       0       1   159.1  159.99
X3     10       0       0       0       0       0       0  160.14  160.14
BT      9   82.65  159.99  159.99   90.65  160.03  160.03   112.7  160.14  160.14
BT112.71  160.14   158.9  130.39  160.23   159.1  130.40  160.23  160.23   146.4
BT 160.3   160.3   149.9  160.35  160.35   178.9   160.9   160.9
X1 3.210      14   99.06 103.327 136.972  89.728  178.12
GR161.54   30.48  160.02    76.2   152.4   91.44 150.114  97.536 149.962   99.06
GR149.35  99.365 149.352 103.022 149.962 103.327 150.114 103.632 150.876  106.68
GR151.64 135.636   152.4 140.208  160.02 149.352 161.544 179.832
NC    .07     .07
X1 3.220      12  106.68 110.947 126.492 161.544 158.496
GR162.31   30.48  160.02  42.672 153.924   68.58 153.071  80.772   152.4  106.68
GR151.79 106.985 151.790 110.642   152.4 110.947 153.162 112.776 153.924 126.492
GR160.02  137.16 162.306 158.496
NC     .1      .1             0.1     0.3
X1 3.230      10  88.392  92.659   114.3 131.064 143.256
```

```
GR163.07   30.48  160.02  50.292 153.924   60.96 153.772  88.392 153.162  88.697
GR153.16  92.354 153.772  92.659 153.924  106.68  160.02  121.92 163.068 131.064
X1 3.240      10 102.108 106.375 128.016 128.016 158.496
GR163.07   30.48 161.544  57.912 156.972    76.2 155.448   91.44 155.143 102.108
GR154.53 102.413 154.534 106.070 155.143 106.375 155.298  106.68 163.068  121.92
X1 3.250      13  56.388  60.655 131.064 123.444  160.02
GR163.83   30.48  160.02  39.624 158.496  42.672 156.972  56.388 156.362  56.693
GR156.36  60.350 156.972  60.655 156.972    76.2 157.734  82.296  160.02  85.344
GR163.07   91.44  163.83 108.204 164.592 120.396
X1 3.260      13  88.392  92.659  137.16 118.872 158.496
GR166.12   30.48 161.544   45.72  160.02  67.056 159.258    76.2 158.496  88.392
GR157.89  88.697 157.886  92.354 158.496  92.659 159.258  94.488  160.02  97.536
GR164.59 105.156 165.354 108.204 166.116  160.02
NC   .05     .05             0.3     0.5
X1 326.5      21   14.26   20.36     110     120     180
X3   10                                                   164.0   164.0
GR 166.0     7.5  159.36    14.0  159.36  14.255  159.35   14.26  159.32    14.3
GR 159.3   14.39  159.27   14.59  159.25   14.88  159.22   15.38  159.15   16.23
GR158.65   17.31  159.15   18.39  159.22   19.24  159.25   19.74  159.27   20.03
GR 159.3   20.23  159.32   20.32  159.35   20.36  159.36  20.365  159.36   20.37
GR 166.0    72.0
SB    0      1.6     1.6       0     6.1            13.4          158.85  158.65
X1 326.6    21.0   14.26   20.36    20.0    20.0    20.0
X2                   1.0   162.0   166.0
X3   10                                                   166.0   166.0
BT   -21     7.5   166.0   166.0    14.0   166.0  159.56  14.255   166.0  159.56
BT         14.26   166.0  160.47   14.30   166.0  160.71   14.39   166.0  160.96
BT         14.59   166.0  161.18   14.88   166.0  161.45   15.38   166.0  161.68
BT         16.23   166.0  161.90   17.31   166.0  162.00   18.39   166.0  161.90
BT         19.24   166.0  161.68   19.74   166.0  161.45   20.03   166.0  161.18
BT         20.23   166.0  160.96   20.32   166.0  160.71   20.36   166.0  160.47
BT        20.365   166.0  159.56   20.37   166.0  159.56    72.0   166.0   166.0
GR 166.0     7.5  159.56    14.0  159.56  14.255  159.55   14.26  159.52    14.3
GR 159.5   14.39  159.47   14.59  159.45   14.88  159.42   15.38  159.35   16.23
GR158.85   17.31  159.35   18.39  159.42   19.24  159.45   19.74  159.47   20.03
GR 159.5   20.23  159.52   20.32  159.55   20.36  159.56  20.365  159.56   20.37
GR 166.0    72.0
X1 326.7       7     8.0    42.0    25.0    25.0    25.0
GR 166.0     0.0   160.0     8.0   159.5     9.0   159.3    11.0   159.5    13.0
GR 160.0    42.0   166.0    60.0
NC    .1      .1     .05     0.1     0.3
X1 3.270      12  71.628  75.895 126.492 134.112 179.832
GR166.12   30.48 164.592  39.624 161.544  51.816 160.782  62.484 160.630  71.628
GR160.02  71.933  160.02  75.590  160.63  75.895 160.782  82.296 161.544  96.012
GR162.31 102.108 166.116 118.872
NC   .04     .04
X1 3.280      11 135.636 139.903  129.54 140.208 207.264
GR167.64   30.48 166.878  35.052 166.116  80.772 164.592  96.012 163.068  129.54
GR162.46 135.636 161.849 135.941 161.849 139.598 162.458 139.903 163.068   152.4
GR167.64 163.068
X1 3.290      14    76.2  80.467  129.54 179.832 170.688
GR168.40   30.48  167.64    38.1 164.592  48.768  163.83   68.58 163.068  73.152
GR163.07    76.2 162.458  76.505 162.458  80.162 163.068  80.467 163.068  85.344
GR164.59  96.012 166.116 112.776  167.64  137.16 168.402   152.4
NC     0       0    .024      .3      .5
X1 3.300       8     261     291 136.090  139.14  143.71
GR168.34   245.5  166.81     253  165.32     261  164.86     282  164.27     286
GR164.92     291  167.27     296  167.65     301
NC                 0.015
X1 3.302      20   282.5     297    3.29    3.29    3.29
X3   10        0       0       0       0       0       0   167.6   167.6
GR168.04     100  168.19   131.5  168.27     166  168.32     197  168.40     229
GR168.59     265  167.43     274  166.02   282.5  164.43   284.6  164.43   284.7
GR164.43   287.2  164.43   287.3  164.61     294  165.86     297   167.5     302
GR167.54     305  168.05   306.5  169.41     335  170.16     402   170.2     469
SB     0    1.56     1.5       0     2.6       0     6.0       0  164.43  164.25
X1 3.304      20   282.5     297      30      30      30
X2     0       0       1  166.76   168.4
X3    10       0       0       0       0       0       0   168.4   168.4
BT   -14     229   168.4   168.4     265  168.59  168.59     274  168.66  167.43
BT         282.5  168.73  166.02   284.6  168.75  164.43   284.7  168.76  166.76
BT         287.2  168.80  166.76   287.3  168.81  164.43     294  168.88  164.61
BT           297  168.92  165.86     302  168.97   167.5     305  169.01  167.54
BT         306.5  169.03  168.05     335  169.41  169.41
GR168.04     100  168.19   131.5  168.27     166  168.32     197  168.40     229
GR168.59     265  167.43     274  166.02   282.5  164.43   284.6  164.43   284.7
GR164.43   287.2  164.43   287.3  164.61     294  165.86     297   167.5     302
GR167.54     305  168.05   306.5  169.41     335  170.16     402   170.2     469
NC                  .035
X1 3.305       9     286   286.5     297    3.29    3.29    3.29
GR 168.5     240  167.87     274  166.46   282.5  164.87     286  164.87   286.5
GR165.05     294   166.3     297  168.98     305     170     340
X1 3.310       9     319     350 170.928   137.4  167.88
GR169.94     303  169.67     311  167.26     319  165.26     322  165.54     327
GR165.82     338  166.69     350  170.06     359  169.92     367
X1 3.312      20     306     338    4.41    4.41    4.41       0
X3    10       0       0       0       0       0       0  168.53  168.53
GR171.83     100  171.52     130  171.24     157  170.93     187  170.59     219
GR170.34     251   170.1     285  169.42     289  165.96     306   165.4   314.5
GR165.07   319.4  165.07   319.5  165.07   324.5  165.07   324.6   165.7   332.5
GR166.16     338  168.96     355   169.9     361  169.93     375   170.2     418
SB     0    1.56     1.5       0       5       0  11.125       0  165.07  165.03
X1 3.314      20     306     338      40      40      40       0
X2     0       0       1  167.39  169.90
X3    10       0       0       0       0       0       0  169.90  169.90
BT     9     251  170.34  170.34     285  170.10  170.10   314.5  169.90  169.90
BT 319.4  169.90  165.07   319.5  169.90  167.39   324.5  169.90  167.39   324.6
BT169.90  165.07   332.5  169.92  169.92     375  169.93  169.93
GR171.83     100  171.52     130  171.24     157  170.93     187  170.59     219
GR170.34     251   170.1     285  169.42     289  165.96     306   165.4   314.5
GR165.07   319.4  165.07   319.5  165.07   324.5  165.07   324.6   165.7   332.5
GR166.16     338  168.96     355   169.9     361  169.93     375   170.2     418
X1 3.315       6     306     338    4.41    4.41    4.41
GR170.49     281  169.64     289  166.18     306  165.29     322  166.38     338
GR169.18     355
EJ
T1      EAST MORRISON CREEK SUBWATERSHED STUDY
T2      FLOOD LINE ANALYSIS FOR MORRISON CREEK EAST - OCTOBER 21, 1993
T3      REGIONAL STORM  - O.P LAND USE
J1   -10       3       0       0      -1       1       0       0     115
J2     2       0      -1
T1      EAST MORRISON CREEK SUBWATERSHED STUDY
T2      FLOOD LINE ANALYSIS FOR MORRISON CREEK EAST - OCTOBER 21, 1993
T3      REGIONAL STORM - FUTURE FORSEEABLE LAND USE
J1   -10       4       0       0      -1       1       0       0     115
J2     3       0      -1
T1      EAST MORRISON CREEK SUBWATERSHED STUDY
T2      FLOOD LINE ANALYSIS FOR MORRISON CREEK EAST - OCTOBER 21, 1993
T3      100 YEAR STORM - FUTURE FORSEEABLE LAND USE
J1   -10       5       0       0      -1       1       0       0     115
J2     4       0      -1
T1      EAST MORRISON CREEK SUBWATERSHED STUDY
T2      FLOOD LINE ANALYSIS FOR MORRISON CREEK EAST - OCTOBER 21, 1993
T3      50 YEAR STORM - FUTURE FORSEEABLE LAND USE
J1   -10       6       0       0      -1       1       0       0     115
J2     5       0      -1
ER
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AECOM

Appendix E

Trafalgar Road Corridor Improvements
EA, Cornwall Road to Highway 407

Stormwater Management
Report

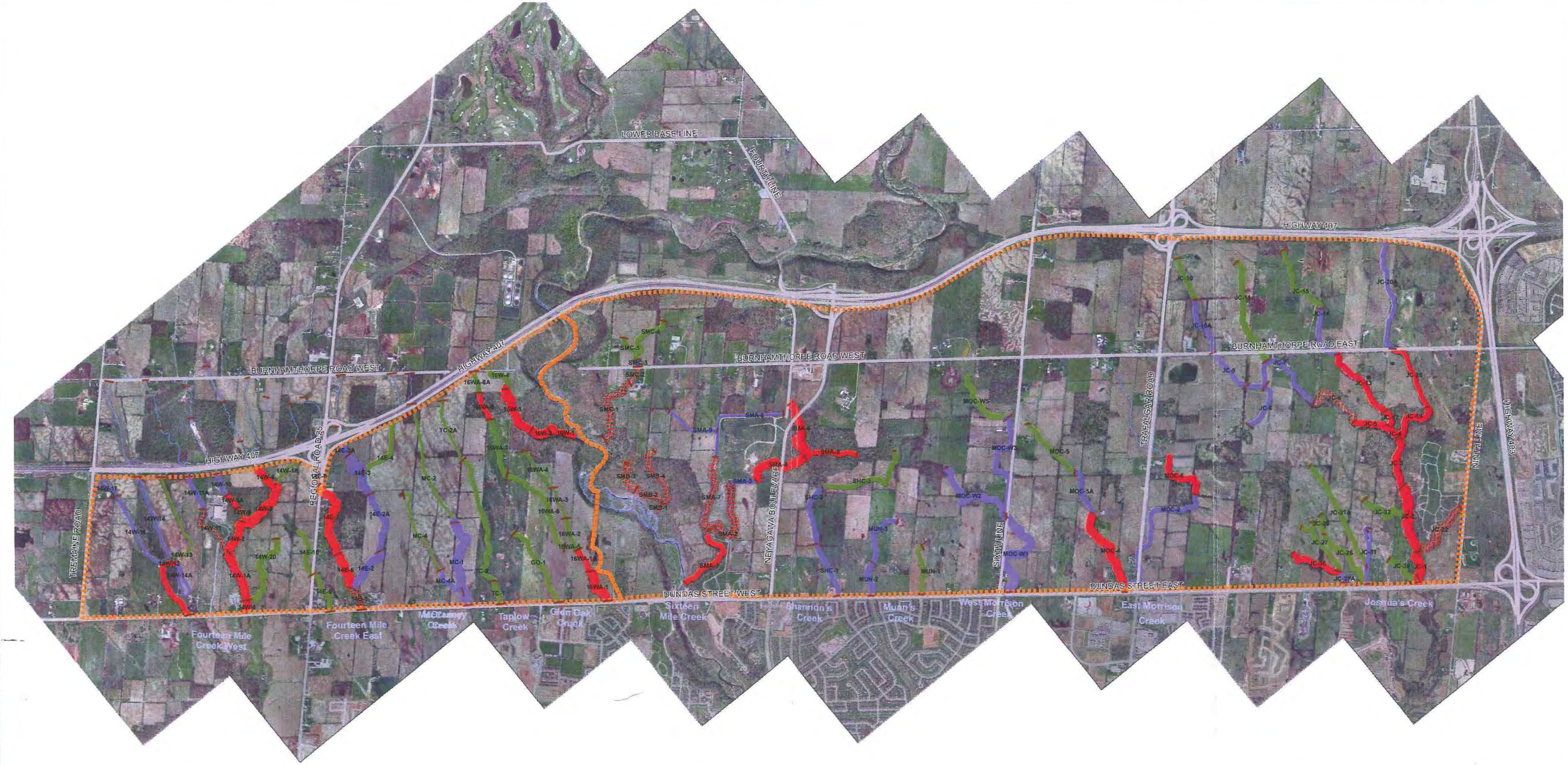
- **North Oakville Creeks Subwatershed Study**

	A	B	C	D	E	F	G	H	I	J	K
1	**TABLE 6.3.6 TARGET UNIT AREA PEAK FLOW RATES**										
2	**EXISTING LAND USE**										
3					**Reg.**	**100 year**	**50 year**	**25 year**	**10 year**	**5 year**	**2 year**
4	**Location**	**Culvert No.**	**GAWSER Hyd. No.**	**Land Use**							
5					**m^3/s**	**m^3/s**	**m^3/s**	**m^3/s**	**m^3/s**	**m^3/s**	**m^3/s**
6											
7	***14 Mile Creek***										
8	Dundas St. W.	FM-D1	1101	Existing	1.20	0.56	0.50	0.44	0.35	0.29	0.19
9											
10	Dundas St. W.	FM-D2	1102	Existing	2.50	1.04	0.92	0.80	0.62	0.51	0.31
11											
12	Dundas St. W.	FM-D3	1103	Existing	0.76	0.36	0.32	0.28	0.23	0.19	0.12
13											
14	Highway 407	FM-1	1001	Existing	7.32	2.93	2.59	2.27	1.79	1.48	0.94
15											
16	Highway 407	FM-2	1002	Existing	1.65	0.71	0.63	0.55	0.43	0.36	0.23
17											
18	Burnhamthorpe Rd. W.	FM-B1	0031	Existing	4.44	1.67	1.47	1.28	1.00	0.81	0.50
19											
20	Highway 407	FM-3	2019	Existing	5.95	2.31	2.05	1.79	1.40	1.14	0.71
21											
22	Highway 407	FM-4	1004	Existing	0.30	0.09	0.08	0.06	0.04	0.03	0.01
23											
24	Dundas St. W.	FM-D4	2034	Existing	20.96	8.39	7.42	6.49	5.09	4.17	2.62
25											
26	Highway 407	FM-5	1005	Existing	1.57	0.59	0.51	0.44	0.33	0.25	0.13
27											
28	Highway 407	FM-6	1006	Existing	1.83	0.69	0.60	0.51	0.38	0.29	0.15
29											
30	Burnhamthorpe Rd. W.	FM-B2	0071	Existing	2.58	1.02	0.91	0.79	0.62	0.52	0.33
31											
32	Burnhamthorpe Rd. W.	FM-B3	0073	Existing	3.42	1.34	1.17	1.01	0.77	0.61	0.36
33											
34	Highway 407	FM-7	2048	Existing	8.68	3.48	3.05	2.65	2.05	1.64	0.99
35											
36	Highway 407	FM-8	1008	Existing	0.39	0.15	0.13	0.10	0.07	0.04	0.01
37											
38	Dundas St. W.	FM-D5	2061	Existing	18.73	7.56	6.60	5.68	4.35	3.43	2.01
39											
40	Highway 407	FM-9	1009	Existing	2.74	1.01	0.89	0.78	0.60	0.49	0.30
41											
42	Dundas St. W.	FM-D6	1110	Existing	0.88	0.36	0.32	0.28	0.23	0.19	0.12
43											
44	Dundas St. W.	FM-D6a	2367	Existing	1.38	0.57	0.50	0.44	0.34	0.28	0.18
45											
46	Highway 407	FM-10	1010	Existing	4.04	1.62	1.43	1.26	0.99	0.82	0.52
47											
48	Highway 407	FM-11	1011	Existing	0.51	0.24	0.21	0.18	0.14	0.11	0.06

	A	B	C	D	E	F	G	H	I	J	K
1	TABLE 6.3.6 TARGET UNIT AREA PEAK FLOW RATES										
2	EXISTING LAND USE										
3					Reg.	100	50	25	10	5	2
4	Location	Culvert	GAWSER	Land Use		year	year	year	year	year	year
5		No.	Hyd. No.		m^3/s	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s
6											
49											
50	Dundas St. W.	FM-D7	2475	Existing	11.96	4.63	4.07	3.54	2.75	2.23	1.36
51											
52	Dundas St. W.	FM-D8	1112	Existing	0.66	0.37	0.33	0.29	0.23	0.19	0.12
53											
54	Dundas St. W.	FM-D9	1113	Existing	1.47	0.86	0.76	0.67	0.54	0.44	0.28
55											
56	*McCraney Creek*										
57	Highway 407	FM-12	1012	Existing	1.75	0.74	0.65	0.57	0.45	0.37	0.23
58											
59	Dundas St. W.	MC-D1	2085	Existing	6.43	2.60	2.31	2.02	1.59	1.31	0.83
60											
61	*Taplow Creek*										
62	Dundas St. W.	TC-D1	1115	Existing	1.64	0.64	0.57	0.50	0.39	0.32	0.21
63											
64	*Glen Oak Creek*										
65	Dundas St. W.	GO-D1	1116	Existing	2.34	0.93	0.83	0.73	0.58	0.48	0.31
66											
67	*West 16 Mile Creek Tribs.*										
68	Dundas St. W.	SM-D1	2392	Existing	3.58	1.24	1.09	0.95	0.73	0.59	0.36
69											
70	Dundas St. W.	SM-D1a	1117	Existing	0.81	0.38	0.34	0.30	0.24	0.20	0.13
71											
72	Dundas St. W.	SM-D2	1118	Existing	0.52	0.24	0.22	0.19	0.15	0.13	0.08
73											
74	Highway 407	SM-1	1020	Existing	5.01	1.81	1.59	1.38	1.07	0.86	0.52
75											
76	Highway 407	SM-2	1021	Existing	1.67	0.70	0.62	0.54	0.42	0.34	0.20
77											
78	Highway 407	SM-3	1022	Existing	0.58	0.28	0.24	0.21	0.16	0.12	0.07
79											
80	*East 16 Mile Creek Tribs.*										
81	Neyagawa Blvd.	ESM-NG3	2124	Existing	6.96	2.90	2.57	2.25	1.77	1.47	0.94
82											
83	Neyagawa Blvd.	ESM-NG2	2128	Existing	8.80	6.49	3.07	2.66	2.06	1.66	1.01
84											
85	Sixteen Mile Creek	----	2137	Existing	16.86	6.28	5.48	4.70	3.58	2.82	1.64
86											
87	Burnhamthorpe Rd. W.	ESM-B14	2914	Existing	2.47	1.11	0.97	0.84	0.65	0.52	0.31
88											
89	**Osenego Creek**										
90	Dundas St. W.	OC-D1	2143	Existing	2.63	1.20	1.06	0.94	0.74	0.62	0.40

	A	B	C	D	E	F	G	H	I	J	K
1	TABLE 6.3.6 TARGET UNIT AREA PEAK FLOW RATES										
2	EXISTING LAND USE										
3					Reg.	100	50	25	10	5	2
4	Location	Culvert	GAWSER	Land Use		year	year	year	year	year	year
5		No.	Hyd. No.		m^3/s	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s
6											
91											
92	**Shannon's Creek**										
93	Dundas St. W.	SC-D1	2146	Existing	3.81	1.39	1.23	1.06	0.82	0.66	0.40
94											
95	**Munn's Creek**										
96	Dundas St. W.	MC-D1	2177	Existing	2.01	0.99	0.88	0.77	0.62	0.51	0.33
97											
98	Dundas St. W.	MC-D4	2174	Existing	3.19	1.31	1.16	1.02	0.80	0.67	0.43
99											
100	**West Morrison Creek**										
101	Sixth Line	MW-S2	2149	Existing	7.88	2.97	2.62	2.29	1.79	1.47	0.92
102											
103	Dundas St. E.	MW-D3	2154	Existing	10.93	4.26	3.77	3.30	2.59	2.13	1.35
104											
105	**East Morrison Creek**										
106	Bunhamthorpe Rd. E.	ME-B1	2160	Existing	0.99	0.49	0.43	0.38	0.30	0.25	0.16
107											
108	Trafalgar Road	ME-T5	2165	Existing	2.72	1.27	1.13	0.99	0.78	0.65	0.42
109											
110	Trafalgar Road	ME-T1	2170	Existing	7.55	3.07	2.72	2.38	1.88	1.54	0.98
111											
112	Dundas St. E.	ME-D2	2171	Existing	13.67	5.18	4.58	4.00	3.14	2.57	1.62
113											
114	**Joshua's Creek**										
115	Highway 407	J - 5	1041	Existing	1.36	0.66	0.59	0.52	0.41	0.34	0.22
116											
117	Highway 407	J - 6	1042	Existing	0.20	0.14	0.13	0.11	0.09	0.07	0.05
118											
119	Highway 407	J - 7	1043	Existing	0.14	0.10	0.09	0.08	0.06	0.05	0.03
120											
121	Highway 407	J - 8	1044	Existing	1.40	0.73	0.65	0.57	0.45	0.38	0.24
122											
123	Highway 407	J - 9	1045	Existing	2.03	0.92	0.81	0.72	0.57	0.47	0.30
124											
125	Highway 407	J - 11	1046	Existing	3.38	1.27	1.13	0.99	0.78	0.65	0.42
126											
127	Bunhamthorpe Rd. E.	JC-B1	2255	Existing	0.83	0.40	0.35	0.31	0.25	0.21	0.13
128											
129	Bunhamthorpe Rd. E.	JC-B2	2252	Existing	1.69	0.76	0.68	0.60	0.47	0.39	0.25
130											
131	Bunhamthorpe Rd. E.	JC-B4	2238	Existing	7.31	2.98	2.65	2.33	1.85	1.54	1.00
132											

	A	B	C	D	E	F	G	H	I	J	K
1	**TABLE 6.3.6 TARGET UNIT AREA PEAK FLOW RATES**										
2	**EXISTING LAND USE**										
3					**Reg.**	**100**	**50**	**25**	**10**	**5**	**2**
4	**Location**	**Culvert**	**GAWSER**	**Land Use**		**year**	**year**	**year**	**year**	**year**	**year**
5		**No.**	**Hyd. No.**		**m^3/s**	**m^3/s**	**m^3/s**	**m^3/s**	**m^3/s**	**m^3/s**	**m^3/s**
6											
133	Bunhamthorpe Rd. E.	JC-B7	2215	Existing	11.33	5.50	4.90	4.30	3.40	2.83	1.81
134											
135	Bunhamthorpe Rd. E.	JC-B9	2225	Existing	1.96	0.82	0.72	0.63	0.50	0.42	0.26
136											
137	Bunhamthorpe Rd. E.	JC-B10	2222	Existing	5.33	2.24	1.99	1.75	1.38	1.15	0.73
138											
139	Dundas St. E.	JC-D1	2275	Existing	50.06	20.58	18.18	16.02	12.57	10.35	6.53
140											
141	Dundas St. E.	JC-D2	2278	Existing	5.68	2.21	1.95	1.69	1.31	1.07	0.65



NORTH OAKVILLE CREEKS SUBWATERSHED STUDY

TSH engineers architects planners

PARISH geomorphic

Natural Resource Solutions Inc.

Donald G. Weatherbe Associates

Morrison Environmental Limited

Environmental Water Resources Group Ltd.

OAKVILLE

0 500 1,000

Meters

Legend

Road

Secondary Plan Boundary

Watercourse

Reach Break

Stream Corridor

High Constraint

High Constraint - Requiring Rehabilitation

Medium Constraint

Low Constraint

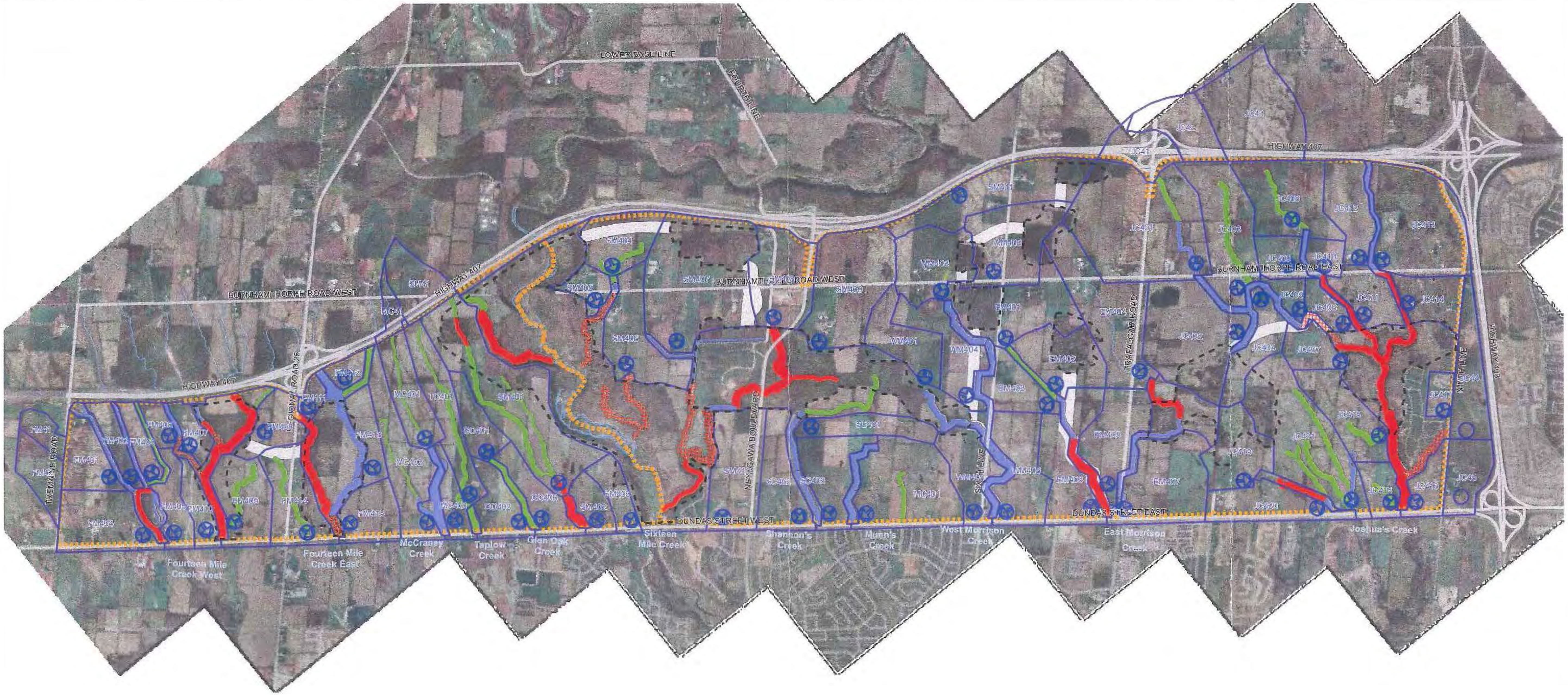
Riparian Corridor Classification

Scale: 1:34,500

August 2007

Figure 6.3.13

Revised September 5, 2007



NORTH OAKVILLE CREEKS SUBWATERSHED STUDY

TSH engineers architects planners · PARISH geomorphic · Natural Resource Solutions Inc. · Donald G. Weatherbe Associates · Morrison Environmental Limited · Environmental Water Resources Group Ltd. · Oakville

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August 2006

Legend

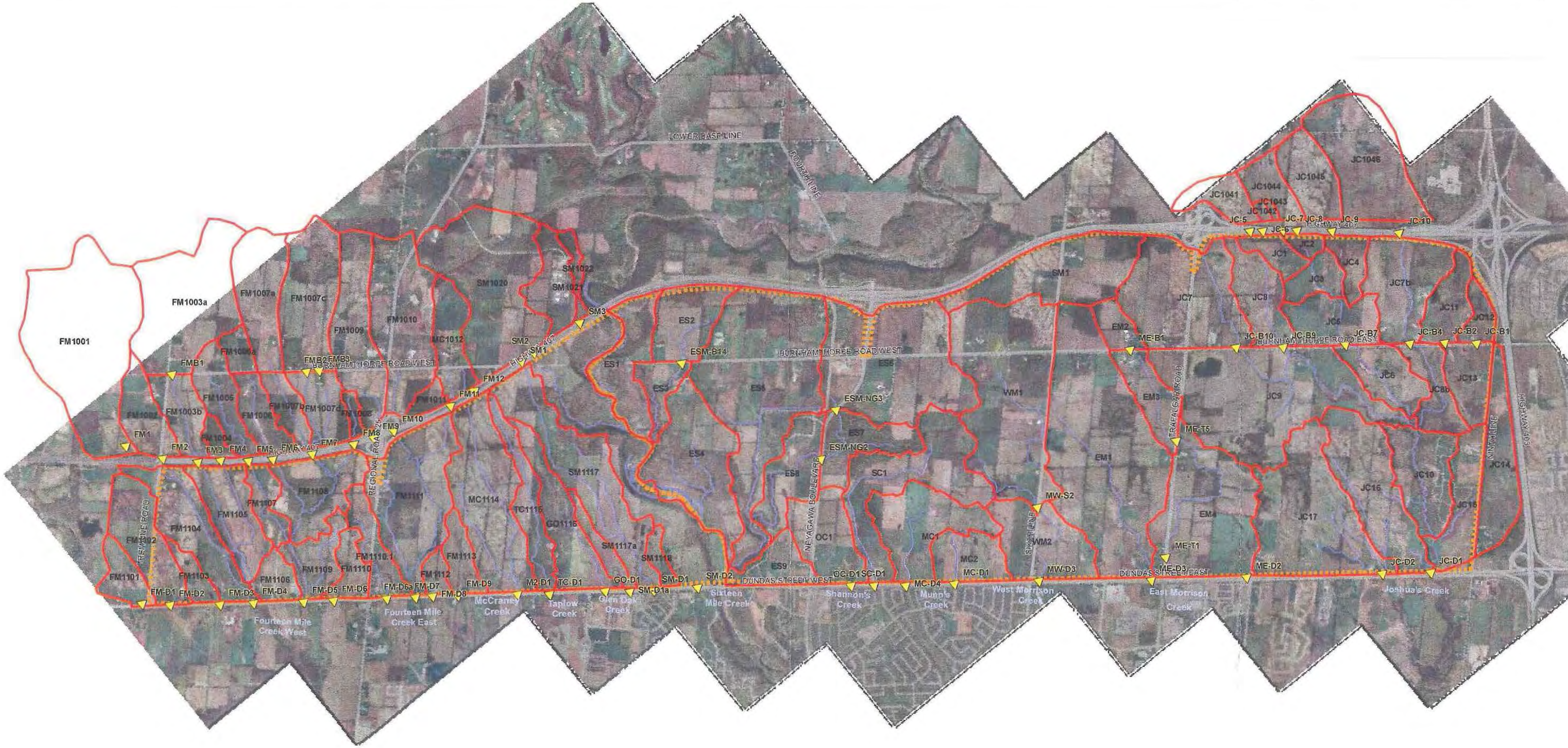
- Secondary Plan Boundary
- Road
- Watercourse
- SWM Pond (Approximate Location)
- SWM Pond Drainage Area
- Core
- Linkage

Stream Corridor

- High Constraint
- High Constraint - Requiring Rehabilitation
- Medium Constraint
- Low Constraint

Approximate Stormwater Facility Locations

Figure 7.4.6



NORTH OAKVILLE CREEKS SUBWATERSHED STUDY

TSH engineers architects planners
PARISH geomorphic
NATURAL RESOURCE SOLUTIONS INC.
Donald G. Weatherbe Associates
Morrison Environmental Limited
Environmental Water Resources Group Ltd.
OAKVILLE

August 2006

N

0 500 1,000

Meters

Legend

- Study Area
- Road
- Watercourse
- Subcatchments
- Culvert

Unit Flow Rate Target Locations

Figure 7.4.7

TABLE 7.4.1 TARGET UNIT AREA PEAK FLOW RATES
EXISTING LAND USE

Location	Culvert No.	Drainage Area	Regional Storm	100 year storm	50 year storm	25 year storm	10 year storm	5 year storm	2 year storm
		ha.	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s
14 Mile Creek									
Dundas St. W.	FM-D2	46.56	2.50	1.04	0.92	0.80	0.62	0.51	0.31
	Flow rate / Area ($m^3/s/ha$)		0.054	0.022	0.020	0.017	0.013	0.011	0.007
	FM-D3	11.71	0.76	0.36	0.32	0.28	0.23	0.19	0.12
	Flow rate / Area ($m^3/s/ha$)		0.065	0.031	0.027	0.024	0.020	0.016	0.010
	FM-D4	423.70	20.96	8.39	7.42	6.49	5.09	4.17	2.62
	Flow rate / Area ($m^3/s/ha$)		0.049	0.020	0.018	0.015	0.012	0.010	0.006
	FM-D5	339.99	18.73	7.56	6.60	5.68	4.35	3.43	2.01
	Flow rate / Area ($m^3/s/ha$)		0.055	0.022	0.019	0.017	0.013	0.010	0.006
	FM-D6	16.91	0.88	0.36	0.32	0.28	0.23	0.19	0.12
	Flow rate / Area ($m^3/s/ha$)		0.052	0.021	0.019	0.017	0.014	0.011	0.007
	FM-D6a	26.23	1.38	0.57	0.50	0.44	0.34	0.28	0.18
	Flow rate / Area ($m^3/s/ha$)		0.053	0.022	0.019	0.017	0.013	0.011	0.007
	FM-D7	247.92	11.96	4.63	4.07	3.54	2.75	2.23	1.36
	Flow rate / Area ($m^3/s/ha$)		0.048	0.019	0.016	0.014	0.011	0.009	0.005
	FM-D8	8.45	0.66	0.37	0.33	0.29	0.23	0.19	0.12
	Flow rate / Area ($m^3/s/ha$)		0.078	0.044	0.039	0.034	0.027	0.022	0.014
	FM-D9	18.58	1.47	0.86	0.76	0.67	0.54	0.44	0.28
	Flow rate / Area ($m^3/s/ha$)		0.079	0.046	0.041	0.036	0.029	0.024	0.015
McCraney Creek									
Dundas St. W.	MC-D1	126.46	6.43	2.60	2.31	2.02	1.59	1.31	0.83
	Flow rate / Area ($m^3/s/ha$)		0.051	0.021	0.018	0.016	0.013	0.010	0.007
Taplow Creek									
Dundas St. W.	TC-D1	33.61	1.64	0.64	0.57	0.50	0.39	0.32	0.21
	Flow rate / Area ($m^3/s/ha$)		0.049	0.019	0.017	0.015	0.012	0.010	0.006
Glen Oak Creek									
Dundas St. W.	GO-D1	47.16	2.34	0.93	0.83	0.73	0.58	0.48	0.31
	Flow rate / Area ($m^3/s/ha$)		0.050	0.020	0.018	0.015	0.012	0.010	0.007
West 16 Mile Creek Tribs.									
Dundas St. W.	SM-D1	87.97	3.58	1.24	1.09	0.95	0.73	0.59	0.36
	Flow rate / Area ($m^3/s/ha$)		0.041	0.014	0.012	0.011	0.008	0.007	0.004
	SM-D1a	12.53	0.81	0.38	0.34	0.30	0.24	0.20	0.13
	Flow rate / Area ($m^3/s/ha$)		0.065	0.030	0.027	0.024	0.019	0.016	0.010
	SM-D2	8.01	0.52	0.24	0.22	0.19	0.15	0.13	0.08
	Flow rate / Area ($m^3/s/ha$)		0.065	0.030	0.027	0.024	0.019	0.016	0.010
East 16 Mile Creek Tribs.									
Sixteen Mile Creek	----	383.10	16.86	6.28	5.48	4.70	3.58	2.82	1.64
	Flow rate / Area ($m^3/s/ha$)		0.044	0.016	0.014	0.012	0.009	0.007	0.004
Osenego Creek									
Dundas St. W.	OC-D1	43.93	2.63	1.20	1.06	0.94	0.74	0.62	0.40
	Flow rate / Area ($m^3/s/ha$)		0.060	0.027	0.024	0.021	0.017	0.014	0.009
Shannon's Creek									
Dundas St. W.	SC-D1	84.37	3.81	1.39	1.23	1.06	0.82	0.66	0.40
	Flow rate / Area ($m^3/s/ha$)		0.045	0.016	0.015	0.013	0.010	0.008	0.005

TABLE 7.4.1 TARGET UNIT AREA PEAK FLOW RATES
EXISTING LAND USE

Location	Culvert No.	Drainage Area	Regional Storm	100 year storm	50 year storm	25 year storm	10 year storm	5 year storm	2 year storm
		ha.	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s
Munn's Creek									
Dundas St. W.	MC-D1	29.99	2.01	0.99	0.88	0.77	0.62	0.51	0.33
	Flow rate / Area ($m^3/s/ha$)		0.067	0.033	0.029	0.026	0.021	0.017	0.011
	MC-D4	59.61	3.19	1.31	1.16	1.02	0.80	0.67	0.43
	Flow rate / Area ($m^3/s/ha$)		0.054	0.022	0.019	0.017	0.013	0.011	0.007
West Morrison Creek									
Dundas St. E.	MW-D3	226.38	10.93	4.26	3.77	3.30	2.59	2.13	1.35
	Flow rate / Area ($m^3/s/ha$)		0.048	0.019	0.017	0.015	0.011	0.009	0.006
East Morrison Creek									
Dundas St. E.	ME-D2	313.94	13.67	5.18	4.58	4.00	3.14	2.57	1.62
	Flow rate / Area ($m^3/s/ha$)		0.044	0.016	0.015	0.013	0.010	0.008	0.005
Joshua's Creek									
Dundas St. E.	JC-D1	962.74	50.06	20.58	18.18	16.02	12.57	10.35	6.53
	Flow rate / Area ($m^3/s/ha$)		0.052	0.021	0.019	0.017	0.013	0.011	0.007
	JC-D2	111.80	5.68	2.21	1.95	1.69	1.31	1.07	0.65
	Flow rate / Area ($m^3/s/ha$)		0.051	0.020	0.017	0.015	0.012	0.010	0.006

Legend

2001 I	COMPUTE FLOWRATE COMMAND, IMPERVIOUS AREA
2002 P	COMPUTE FLOWRATE COMMAND, PERVIOUS AREA
+	ADD HYDROGRAPH COMMAND
1101	GAWSER HYDROGRAPH IDENTIFICATION NUMBER
	COMPUTE RATING CURVE AND ROUTE CHANNEL COMMAND

FM	Fourteen Mile Creek
MC	McCraney Creek
GO	Glen Oak Creek
TC	Taplow Creek
SM	Sixteen Mile Creek - West
ES	East Sixteen Mile Creek Tributaries
SC	Shannon Creek
OC	Osenego Creek
MW	Morrison Creek West Branch
EM	Morrison Creek East Branch
MC	Munn's Creek
JC	Joshua's Creek

Figure 1 **GAWSER Schematic, North Oakville Creeks Subwatershed Study**

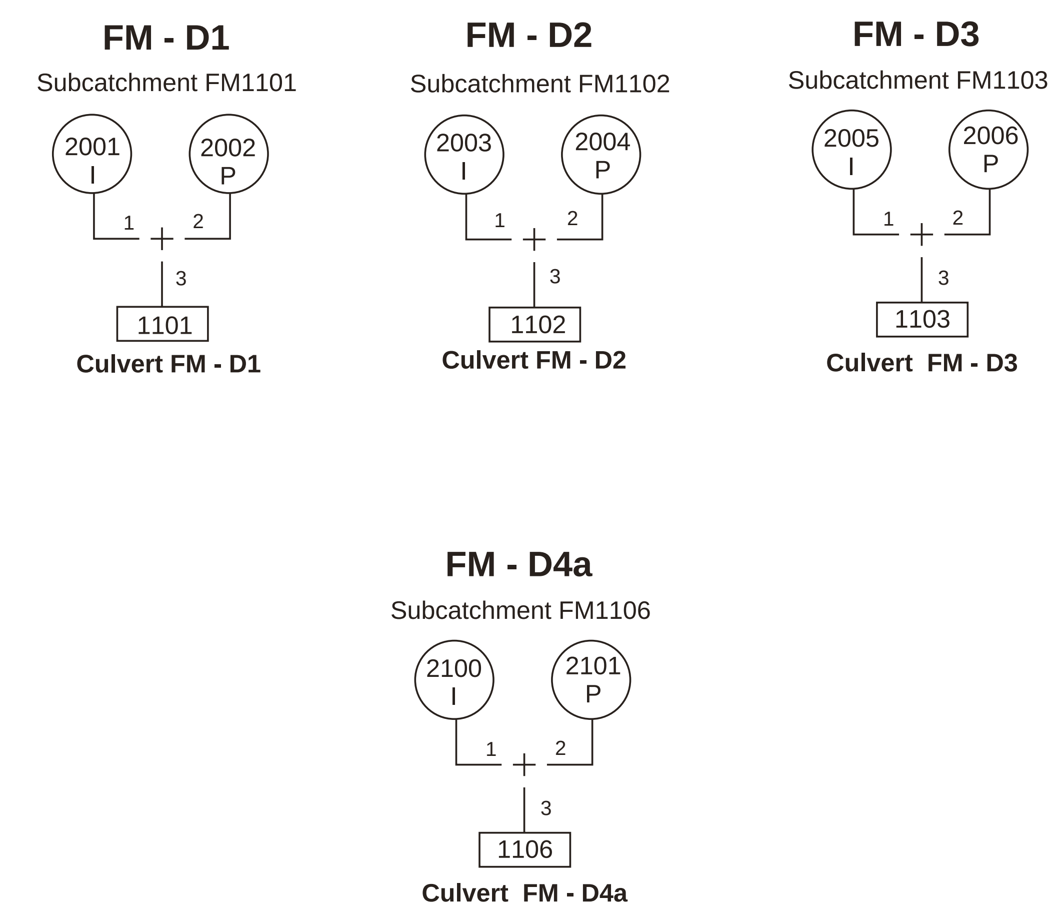


Figure 2 **GAWSER Schematic, North Oakville Creeks Subwatershed Study**

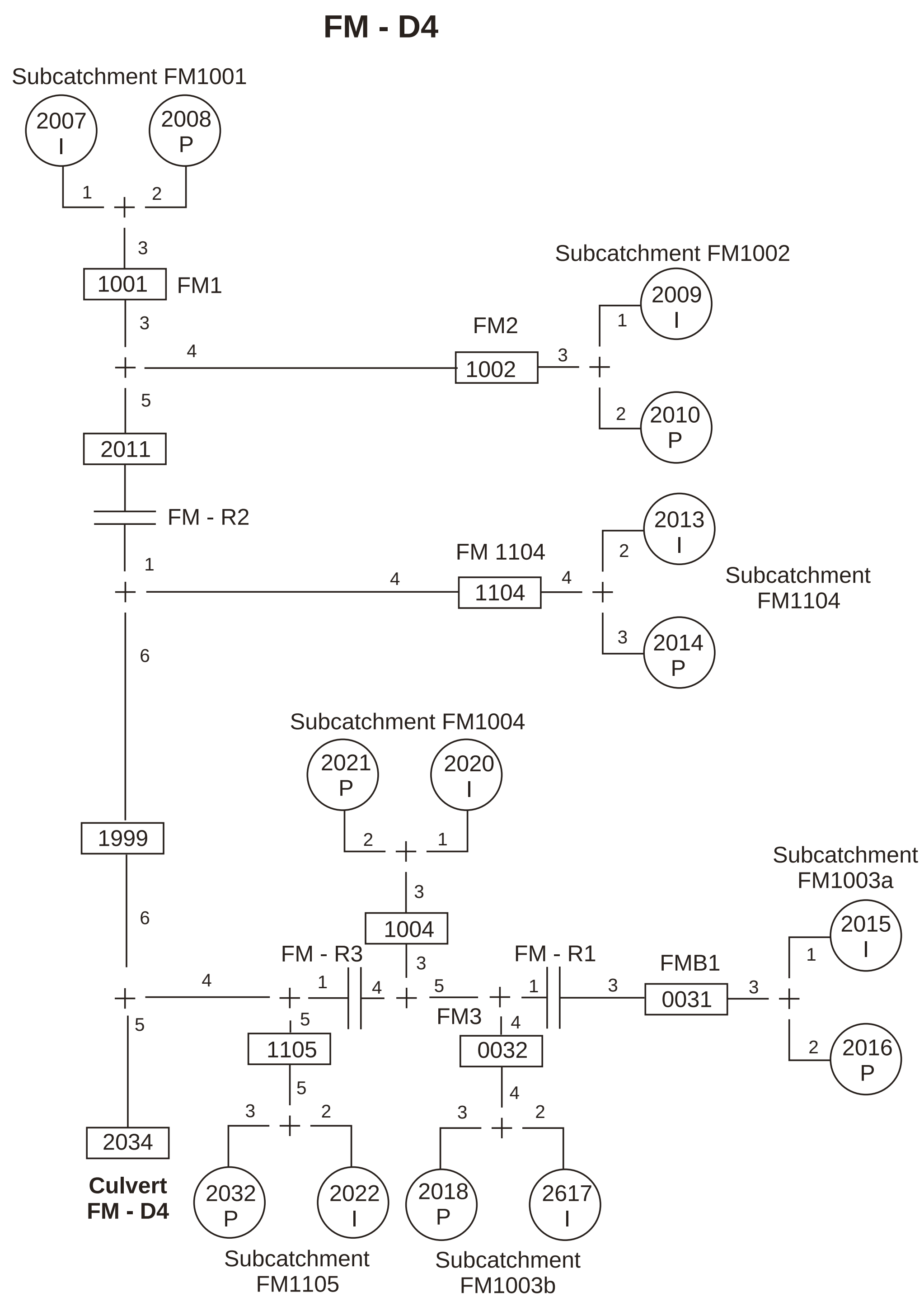


Figure 3 **GAWSER Schematic, North Oakville Creeks Subwatershed Study**

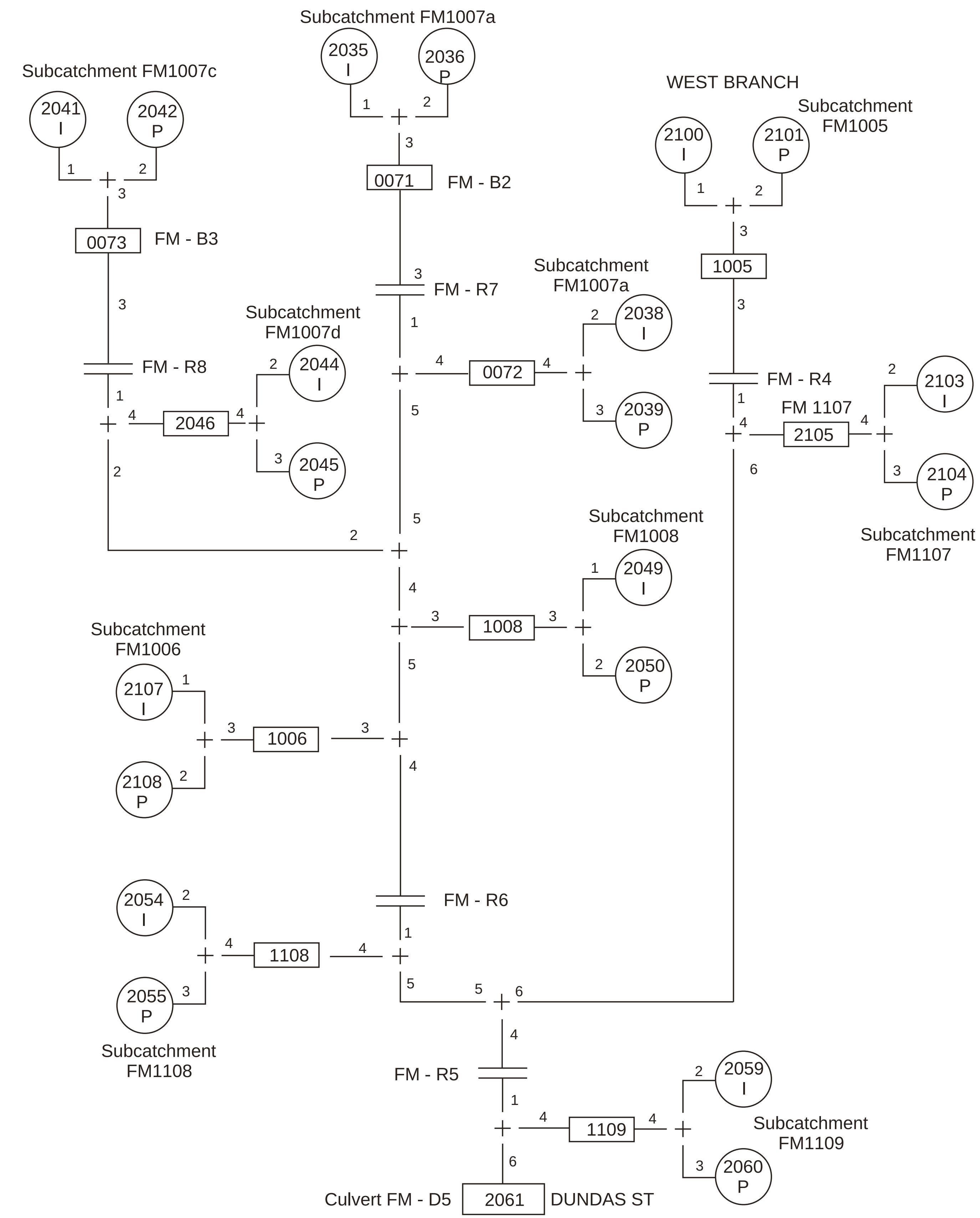


Figure 4 **GAWSER Schematic, North Oakville Creeks Subwatershed Study**

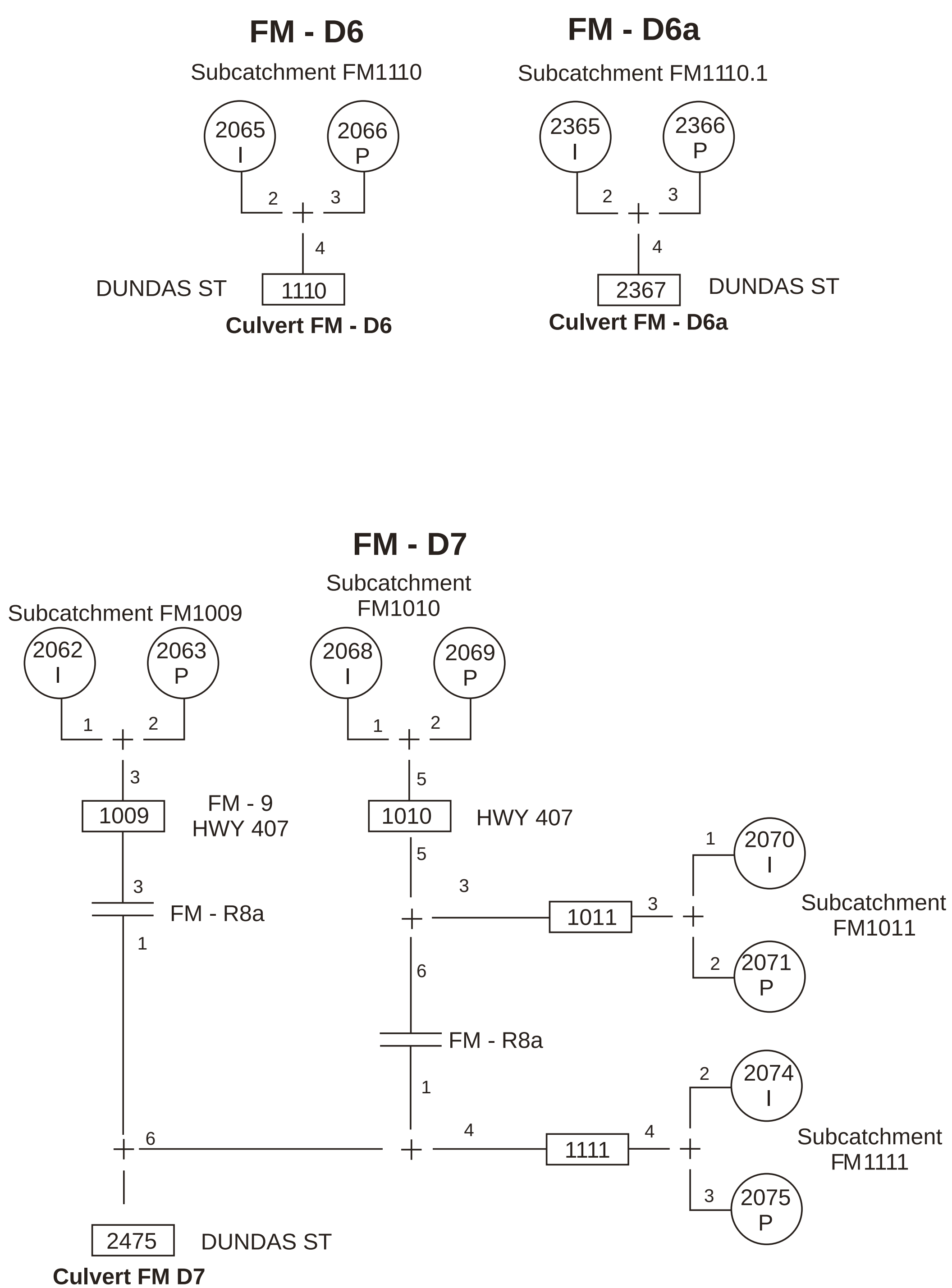


Figure 5 **GAWSER Schematic, North Oakville Creeks Subwatershed Study**

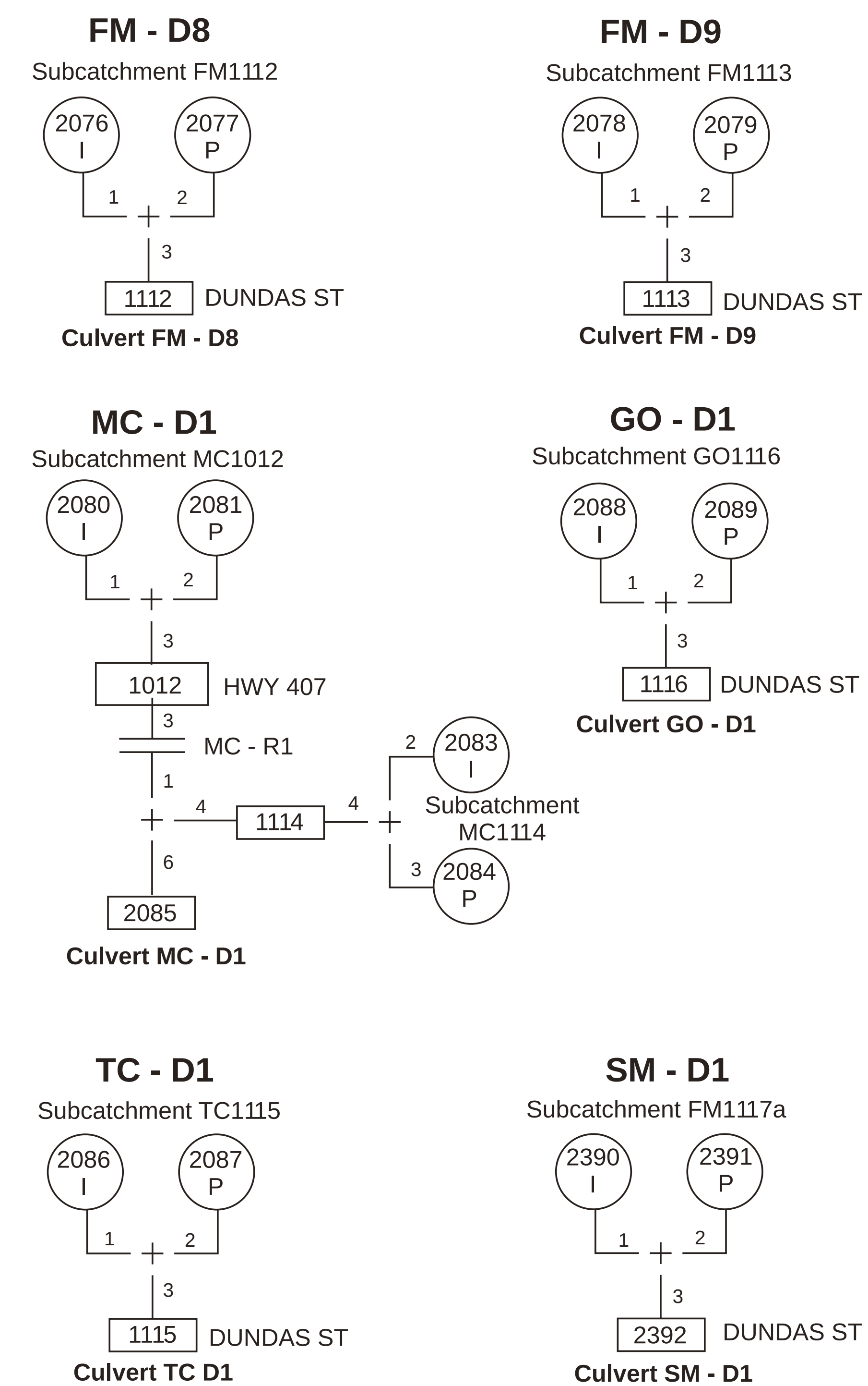


Figure 6 **GAWSER Schematic,**
North Oakville Creeks Subwatershed Study

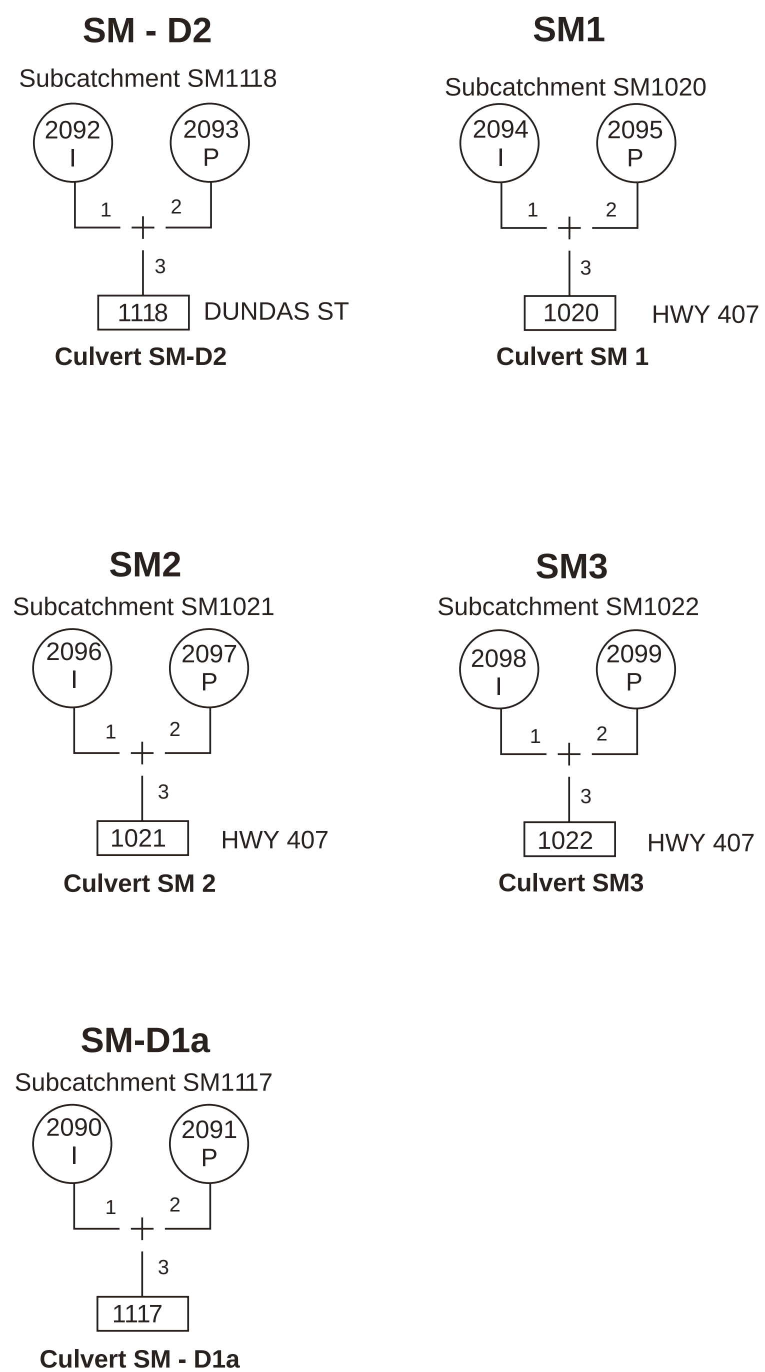


Figure 7 **GAWSER Schematic,**
North Oakville Creeks Subwatershed Study

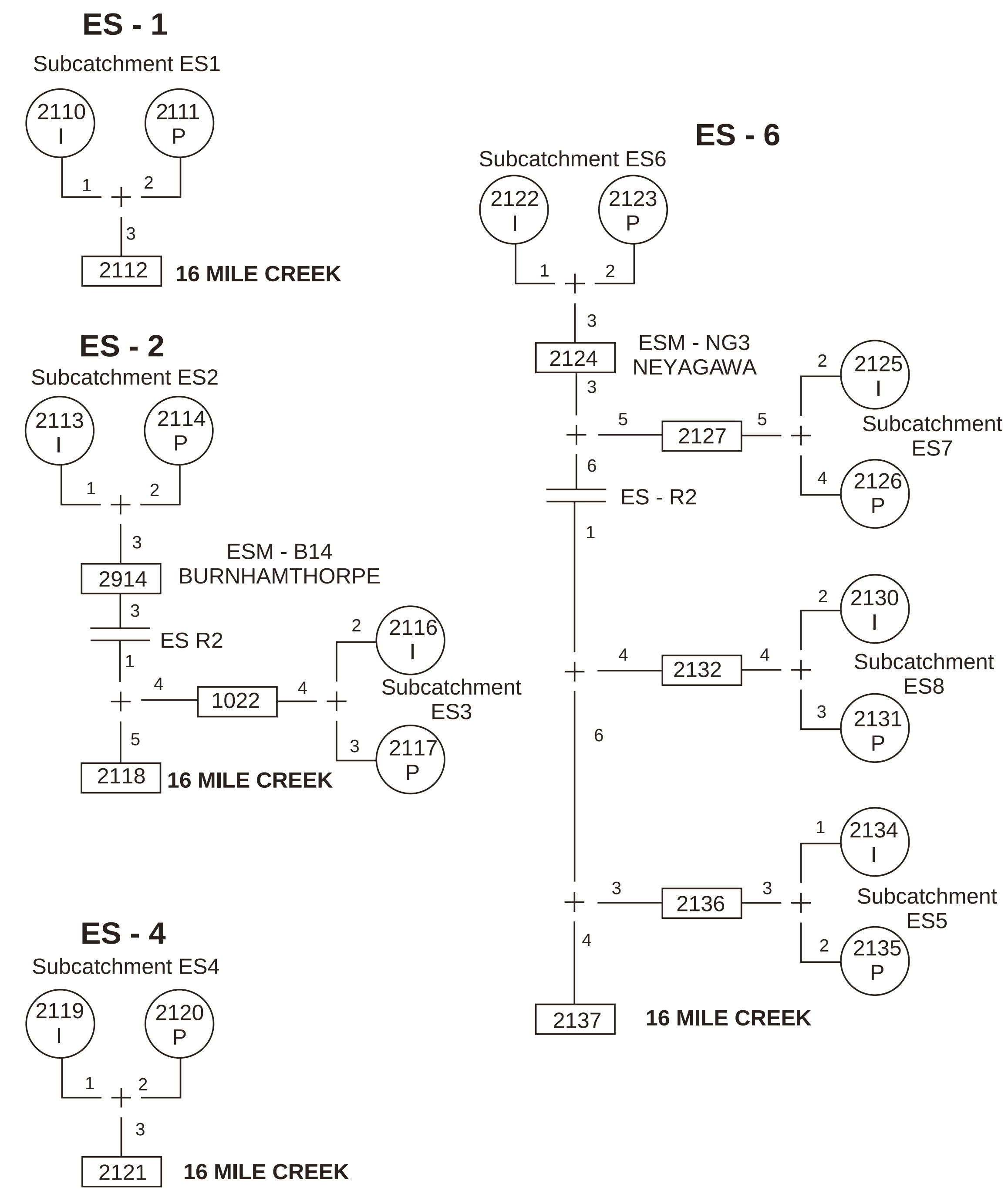


Figure 8 **GAWSER Schematic, North Oakville Creeks Subwatershed Study**

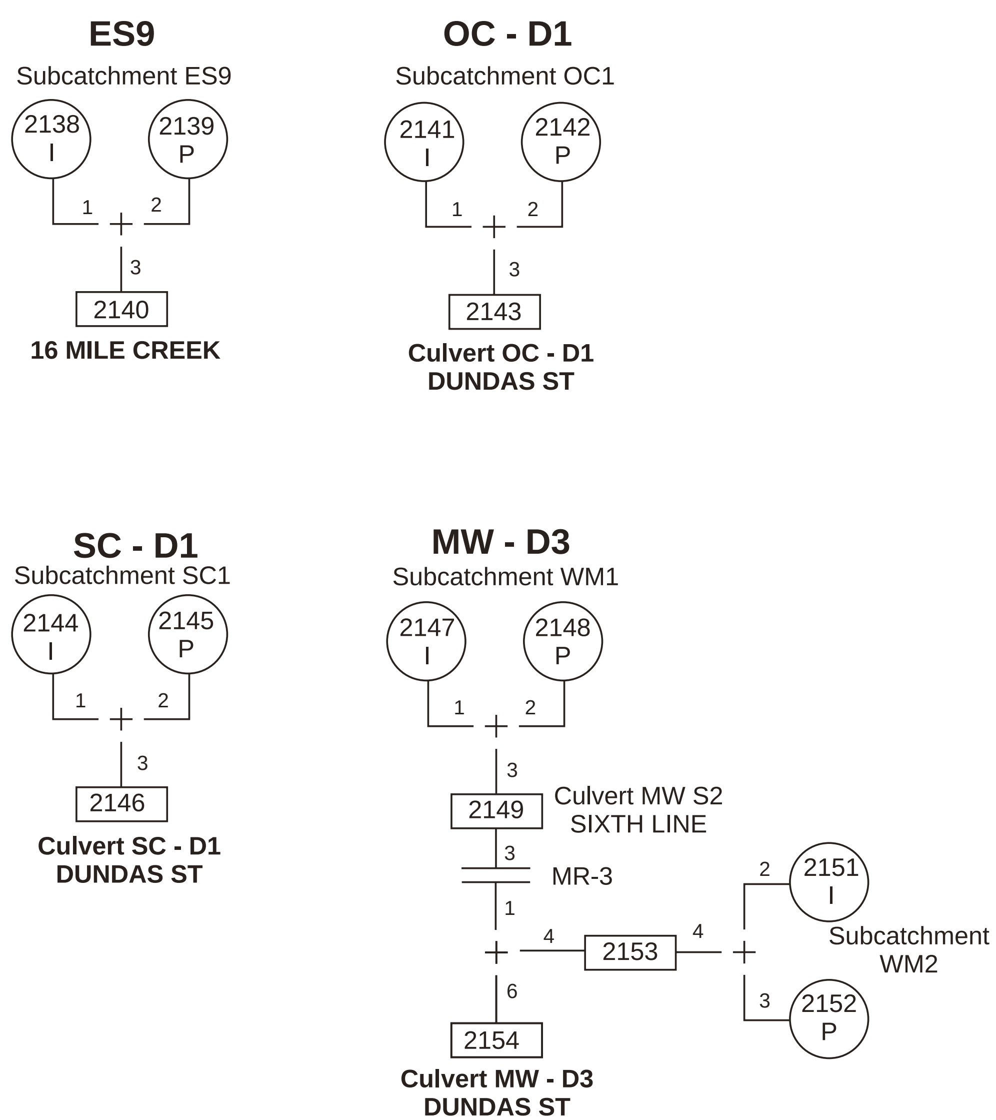


Figure 9 **GAWSER Schematic, North Oakville Creeks Subwatershed Study**

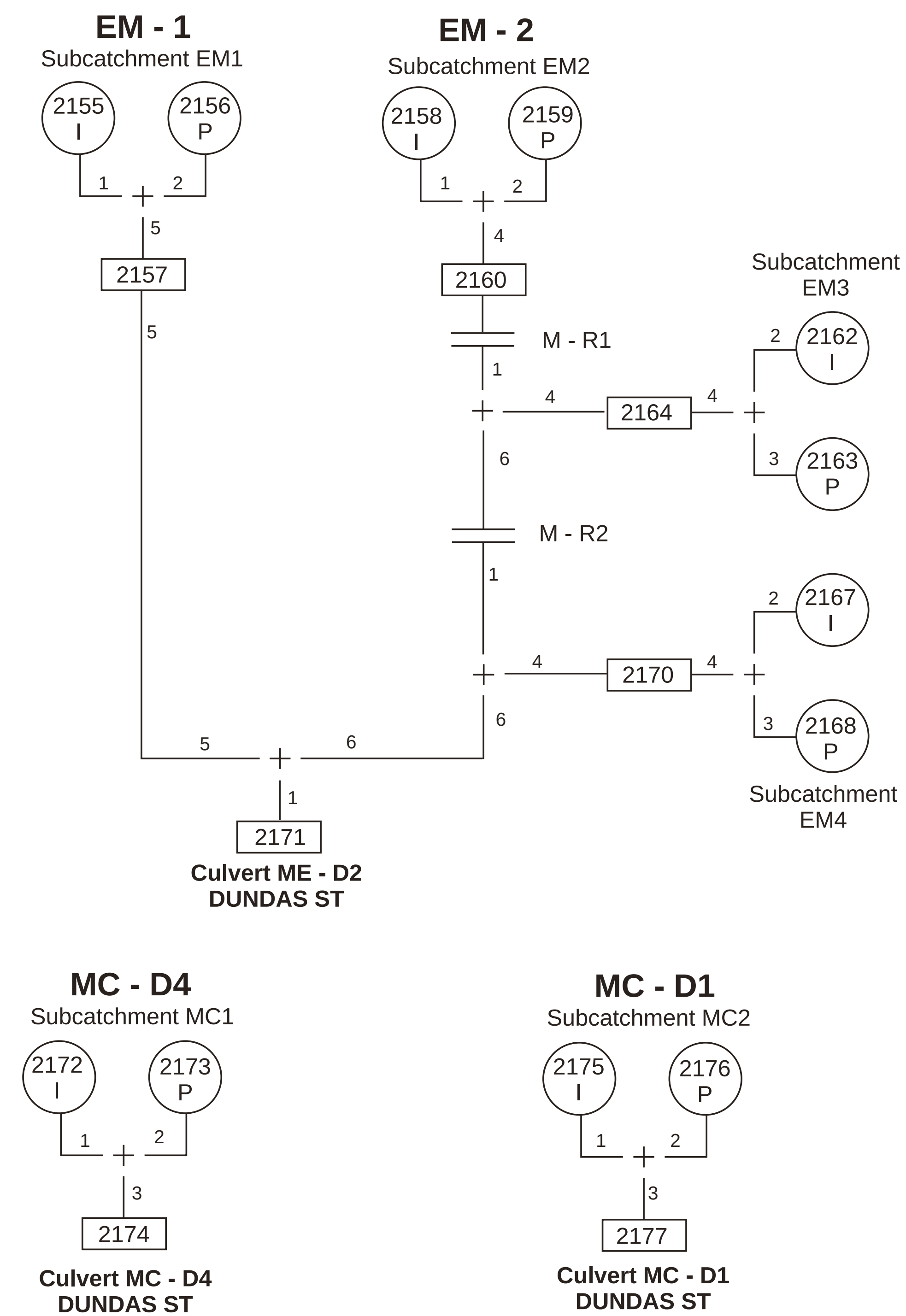


Figure 10 **GAWSER Schematic, North Oakville Creeks Subwatershed Study**

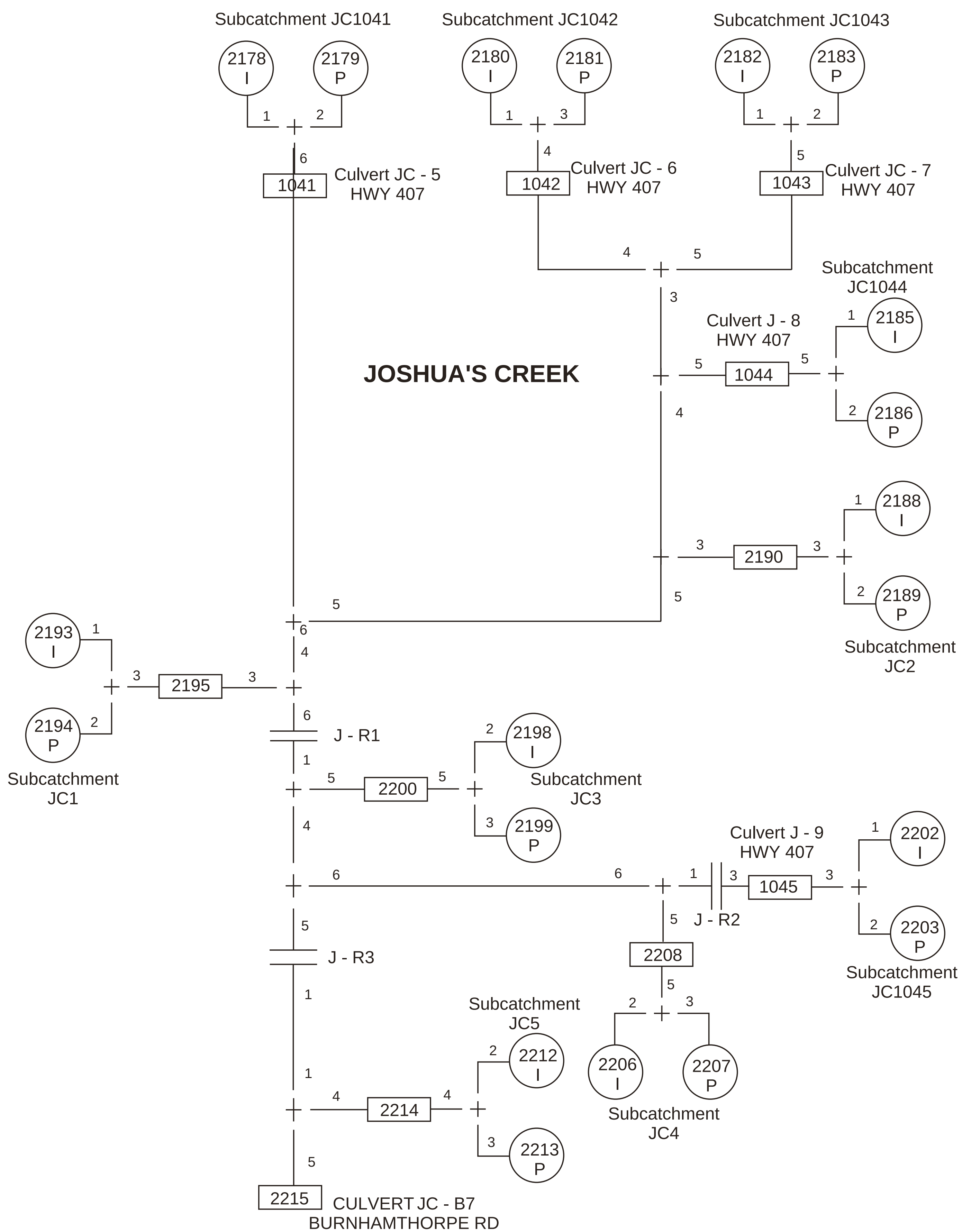
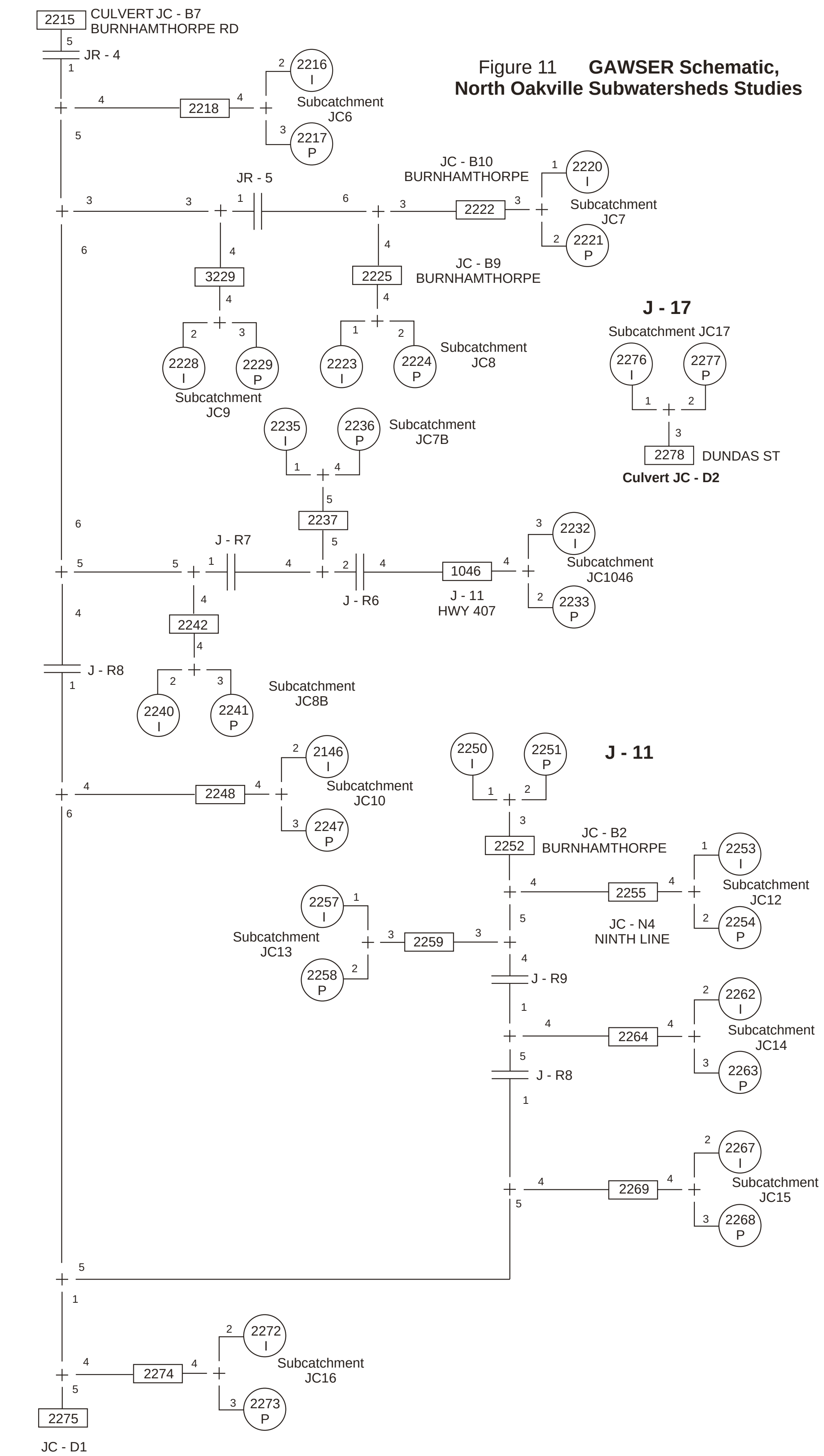


Figure 11 **GAWSER Schematic, North Oakville Subwatersheds Studies**



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Appendix F

Trafalgar Road Corridor Improvements
EA, Cornwall Road to Highway 407

Stormwater Management
Report

- **McCormick Rankin Detailed Design of Dundas Street**

Table 1 - Hydraulic Assessment of Transverse Culverts - Existing Conditions

			Culvert Characteristics									Peak Design Flows (m^3/s)		Headwater Elevation (m)		Depth of Headwater/ Height of Culvert Ratio		Freeboard from E/P at Low Point (m)	
Culvert I.D.[1]	**Station**	**Watercourse Conveyed**	**Span (m)**	**Rise (m)**	**Type**	**Length (m)**	**U/S Invert (m)**	**D/S Invert (m)**	**Slope (%)**	**TW Elevation (m)**	**E/P at Low Point Elevation (m)**	**25 yr**	**Regional**	**25 yr**	**Regional**	**25 yr**	**Regional**	**25 yr**	**Regional**
EM (1+4)	19+890.700	East Morrison Creek	4.27	2	concrete	46	165.41	165.14	0.59	166.34	169.90	4.00	13.67	166.73	167.57	0.7	1.1	3.2	2.3
JC-D2	22+084.300	Joshua's Creek west branch	3.0	1.22	concrete	40.1	159.19	159.09	0.25	159.84	160.50	1.69	5.68	159.55	160.12	0.3	0.7	0.9	0.4
JC-D1	22+532.300	Joshua's Creek Main Tributary	6.1	2.1	concrete	58.3	151.90	151.89	0.02	153.15	160.50	16.02	50.06	154.04	158.36	1.0	3.1	6.5	2.1

Notes:

1. Culvert I.D. as appears in NOCSS GAWSER model.

Table 2 - Hydraulic Assessment of Transverse Culverts - Proposed Conditions

			Culvert Characteristics with Proposed Extensions											Peak Design Flows (m^3/s)		Headwater Elevation (m)		Depth of Headwater/ Height of Culvert Ratio		Freeboard from E/P at Low Point (m)	
Culvert I.D.[1]	Station	Watercourse Conveyed	Span (m)	Rise (m)	Type	Extension Length (m)	Total Length (m)	U/S Invert (m)	D/S Invert (m)	U/S Extension Slope (%)	D/S Extension Slope (%)	TW Elevation (m)	E/P at Low Point Elevation (m)	25 yr	Regional	25 yr	Regional	25 yr	Regional	25 yr	Regional
EM (1+4)[2]	19+890.7	East Morrison Creek	4.27	2	concrete	11 u/s 4.75 d/s	61.75	165.17	164.92	-3.9	4.6	166.12	169.90	4.00	13.67	166.73	167.57	0.7	1.1	3.2	2.3
JC-D2[3]	22+084.3	Joshua's Creek west branch	3.0	1.22	concrete	18.5 u/s 4.7 d/s	63.3	159.57	158.84	4.2	5.3	159.59	160.50	1.69	5.68	159.55	160.12	0.3	0.7	0.9	0.4
JC-D1[4]	22+532.3	Joshua's Creek Main Tributary	6.1	2.1	concrete	8 u/s -	66.3	152.17	151.93	3.4	-	153.19	160.50	16.02	50.06	154.04	158.36	1.0	3.1	6.5	2.1

Notes:

1. Culvert I.D. as appears in NOCSS GAWSER model.
2. Main barrel of Culvert EM (1+4) modelled, as main barrel governs hydraulic characteristics (invert/slope difference of upstream extension is insignificant compared to main barrel hydraulics).
3. Main barrel of JC-D2 modelled, as main barrel governs hydraulic characteristics.
4. Main barrel of JC-D1 modelled, as main barrel governs hydraulic characteristics.

AECOM

Appendix G

Trafalgar Road Corridor Improvements
EA, Cornwall Road to Highway 407

Stormwater Management
Report

- **Correspondence**

CONSERVATION HALTON

PROTECTING THE NATURAL ENVIRONMENT FROM LAKE TO ESCARPMENT

2596 Britannia Road West
R.R. #2 Milton Ontario L9T 2X6
(905) 336-1158 Fax (905) 336-7014
Internet Address: www.conservationhalton.on.ca E-mail: admin@hrca.on.ca

July 7, 2010

Sonya Kapusin
Consultant Environmental Planner
AECOM
220-2000 Argentia Road, Plaza 2
Mississauga ON L5N 1V8

Dear Ms Kapusin:

Re: Trafalgar Road Improvements, Cornwall Road to Highway 407
Class Environmental Assessment
Town of Oakville/Region of Halton
CH File: MPR 531

Staff has reviewed Progress Report 1, prepared by AECOM, dated March 2010 for the above noted EA and would like to offer the following comments.

Section 1, Introduction and Study Background

- Section 1.4- Staff are of the opinion that the AECOM project team should include both terrestrial and aquatic ecologists.

Section 4, Description of the Existing Environment, Pages 32 to 57

- The report does not provide any discussion with respect to erosion hazards associated with confined and unconfined valley systems. This is relevant wherever there is a regulated watercourse but is also particularly relevant where the watercourse runs parallel and in close proximity to the existing roadway. As noted at the TAC Meeting, staff strongly recommends that 'potential impacts to natural hazards' (flooding and/or erosion hazards) should be one of the evaluation criteria.

Section 4.1, Data Collection and Review

- Please consider the following data sources when drainage studies are completed:
  - East Morrison Creek Subwatershed Study (Cosburn Patterson Wardman, 1995)
  - Uptown Core Master Drainage Study and Addendum (Marshall Macklin Monaghan, 1990 & 1994) – subject however to revisions to accommodate revised Midtown Plan
  - Lower Morrison/Wedgewood Creeks – Flood, Erosion and Master Drainage Plan Study (R.V.Anderson, 1993).

Section 4.1, Description of the Existing Environment, Figure 5, Pages 33 to 36

- Additional preliminary flood plain mapping can be obtained from the Town of Oakville from the North Oakville Creeks Subwatershed Study. Extensive flooding overtop of Trafalgar Road north of Dundas Street has been predicted by the preliminary flood plain mapping for this area as well as by more recent detailed mapping completed in conjunction with recent development. Please note that Conservation Halton regulates the lands within 7.5 metres of the flooding hazard.
- The figures make no reference to erosion hazards associated with confined and unconfined valley systems. Please note that Conservation Halton regulates the lands within 7.5 metres of all erosion hazards.
- Staff would recommend that the label "Sixteen Mile Creek Tributary" on Sheet 4 of Figure 5 be renamed as the "Morrison-Wedgewood Diversion Channel".
- Sheet 4 of Figure 5 does not identify the potential spill from the Morrison-Wedgewood Diversion channel to Trafalgar Road as outlined in our previous correspondence (though we note that it was discussed within the text of the report).
- Sheet 4 of Figure 5 does not identify the enclosure of West Morrison Creek between McCraney Street and the Morrison-Wedgewood Diversion Channel.
- There are a number of natural heritage features missing from Figure 5, including:
  - ELC mapping for all natural/semi-natural communities within 120m of the anticipated extent of works;
  - wetlands, including units of the North Oakville-Milton East Provincially Significant Wetland Complex within 120m of the anticipated extent of works. Please note that Conservation Halton regulates the lands within 120 metres of a Provincially Significant Wetland;
  - species at risk and other species of conservation concern as per the PPS within 120m of the anticipated extent of works;
  - candidate significant woodlands as per Halton Region within 120m of the anticipated extent of works;
  - any significant wildlife habitat within 120m of the anticipated extent of works.
- The Natural Sciences Memo indicates that assessments were completed within 30m of the existing right of way, but Section 4.1 (and Figure 5) in the main body of the report references a 250m study area corridor. Please clarify, and note that the province typically considers 120m as the adjacent lands within which to examine potential impacts of development on natural heritage features.
- The level of detail required for natural heritage studies within the study area will need to extend beyond "roadside reconnaissance" in order to fully document environmental conditions. No wildlife surveys have been undertaken to date, and the vegetation work is incomplete. Is this work ongoing as part of the ESR?

Section 4.2.4, Drainage, Page 42

- While the majority of the study area is located within the Joshua's Creek and Morrison Creek watersheds as listed in the report, a small portion of the study area at its southern limits is within the Sixteen Mile Creek watershed.

Section 4.2.4.1, Drainage – Highway 407 to Dundas Street West, Page 42

- While the discussion outlines watercourse crossings of Trafalgar Road it does not discuss reaches where the watercourse runs parallel with the existing roadway, frequently within the road right-of-way. These reaches are crucial since any road widening alternatives would likely require realignment of these watercourse reaches.

Section 4.2.4.2, Dundas Street West to Cornwall Road, Pages 42-43

- There is no discussion provided with respect to the West Morrison Creek enclosure that is believed to run parallel to Trafalgar Road, potentially within the existing road right-of-way, between McCraney Street and the Morrison-Wedgewood Diversion Channel.

Section 4.3, Natural Environment

- It would be helpful if the nine sections could be labelled graphically on Figure 5 and other similar figures in the future.

Section 4.3.1, Designated Natural Areas

- This section is incomplete (refer to preceding comments on Figure 5). Contrary to the statement that no federally or provincially recognized species are known from the study area, examination of the NHIC database suggests otherwise. Please refer to the Halton Natural Areas Inventory for local species status and note that field work will be necessary to confirm the presence/absence of these species.

Section 4.3.2, Terrestrial Habitat

- Several of the woodlands within the study area have been identified by Halton Region as candidate significant woodlands. As such, they should be evaluated in detail to determine whether they meet the criteria for designation and, if so, appropriate protection/mitigation measures identified.
- Page 45- It is stated that Appendix C contains representative photographs of terrestrial features and a floral species list, however staff were unable to locate either. Please provide this information, in addition to a wildlife species list.

Section 4.4.3, Existing Land Uses

- Designated natural areas (e.g. candidate significant woodlands) should be referenced as appropriate throughout this section.

Section 4.4.4, Proposed Development

- In addition to the developments listed, staff notes that there is a proposed gas station on the northeast corner of Trafalgar Road and Dundas Street.

Section 4.4.9, Utilities

- Please assess the impacts of utility relocation (i.e. telephone poles, union gas, etc.) on natural heritage features, natural hazard areas and fish habitat. This should not be left to detailed design as the relocation can have a significant impact on natural heritage features.

References

- Page 59- Please provide additional details regarding the 2009 Conservation Halton personal communication cited- who was contacted, when did the communication occur, what was requested and what was provided.

Appendix C Natural Sciences Memo

- Pg. 2: With respect to the section labeled "Aquatic Findings" and the locations referred to (e.g. South of Dundas East, East Morrison Creek flows under Trafalgar Rd) each of the descriptions of a particular location need to be assigned a location code and these codes or labels need to be clearly marked on a map that includes street names, contour lines and any pertinent natural features. Photographs of the upstream and downstream images of each of the crossing structures are also requested. All pertinent measurements and descriptors of all the affected crossing structures are requested as well (e.g. corrugated steel pipe or concrete culvert? Diameter, width, length, height, open or closed bottom structure?)

Additional Information Required

- It is stated that ELC was completed, however no ELC community codes are referenced in either the Natural Sciences Memo or the main body of the report, and no mapping is presented. Please provide additional information.
- Staff appreciates the inclusion of water and air temperature data collected at each crossing location. Metadata for each of these measurements is requested including the time of day each temperature measurement was taken at and the daily maximum air temperatures on the day the data was collected and for the 3 days prior to that day. The type of equipment used to collect the temperature data is also requested.
- Habitat mapping of each of the crossings as per the MTO protocol is requested for 40 m upstream and downstream of each potentially affected crossing.
- The upstream drainage area for each of the crossing locations and a description of their flow permanency is requested. Please undertake a data search for all existing fish community, aquatic invertebrate, surface water quality, water temperature and channel morphology data in the vicinity of each of the affected crossing locations.
- It is requested that a preliminary list of all appropriate mitigation measures to prevent impacts to fish habitat, groundwater and surface water resources be clearly specified in the next submission.
- Field work is required to identify the presence of any groundwater in the vicinity of all of the affected crossings. It is suggested that piezometers be used to collect this data.

General Comments

- Culvert replacements are requested over culvert extensions.
- It is requested measures such as reducing the widths of medians, the use of retaining walls etc. be used to minimize the lengths of creeks that have to be enclosed under transportation corridors.

- It is requested that all transportation corridors cross creeks at a perpendicular angle to avoid erosion and aggradation associated with improper placements of crossings.
- It is requested that all new crossings be designed with an open bottom to allow interactions between the creek and the hyporheic zone to occur, to help ensure long term viable fish passage and to improve the quality of the low flow channel within the culvert. These parameters are all very important from an ecological standpoint given the excessive length (e.g. 50 meters) length over which the new culverts will enclose the watercourse.
- New crossings should span the meander belt width of the watercourse if possible. It is also preferable that the crossing accommodate a minimum 25 year return flow for fish passage, however from an engineering perspective the culverts must be designed to meet MTO standards, which may be more stringent.
- Any shrub or tree removals near watercourses should be rehabilitated with native riparian trees and shrubs to a ratio of 3:1.
- It is requested that any watercourses flowing parallel to the road (ie. the portion of Morrison Creek that has been designated as Medium Constraint in the North Oakville Creeks Subwatershed Study) be realigned away from the road wherever possible in an effort to reduce inputs of salt, petroleum products and other road based pollutants into creeks.
- This project will require a warmwater timing window that will need to be adhered to during construction.
- It is requested that flow volumes and velocities be calculated for all affected watercourses. It is requested that the minimum amount of reinforcement of structures and creek bank hardening be undertaken at the crossings based on these numbers.

The following points are suggested as commitments to be carried forward to detailed design:

- Long linear stormwater management facilities are requested to be constructed within the road right of way wherever possible as a measure to control stormwater quantity and quality exiting road surfaces.
- A qualified environmental inspector is requested to be on site to ensure that all appropriate mitigation measures are adhered to on all construction sites.
- Sediment and erosion control reporting should be undertaken daily and reported to the Conservation Authority on a weekly basis. Reporting forms should be submitted using the last page in the *Erosion and Sediment Control Guidelines for Urban Construction* manual, which can be found on the Sustainable Technologies website.

Summary

Staff is not in a position to provide comments on the proposed alternatives until we receive the supporting hazard, natural heritage, fisheries and stormwater management assessments for the various alternatives.

We trust the above is of assistance. If you require additional information please contact the undersigned at extension 283.

Yours truly,

Leah Smith
Environmental Planner
LS/

cc: Nick Zervos, Project Manager, Halton Region (by email)
Mike Delsey, Consultant Project Manager, AECOM (by email)

P:\Planning\DEV'T PLG FILES\ENVIRONMENTAL ASSESSMENTS\Halton\Trafalgar Road - Cornwall to 407 (MPR 531)\Progress Report 1.doc

AECOM
5600 Cancross Court, Suite A
Mississauga, ON, Canada L5R 3E9
www.aecom.com
905.501.0641 tel
905.501.0181 fax

Memorandum

To	Sheri Harmsworth, P.Eng.	Page	1
Subject	Trafalgar Road EA SWM – Dunpar Development		
Prepared by:	Janelle Weppler, P.Eng., Water Resources Engineer		
Reviewed by:	Glenn Farmer, Senior Environmental Technologist		
Date	February 15, 2013	Project Number	60119993

AECOM Canada Limited has prepared this technical memo for the Regional Municipality of Halton to review the proposed residential development by Dunpar Developments Inc. located on the west side of Trafalgar Road, between Glenashton Drive and River Oaks Boulevard as shown in Figure 1.

Figure 1: Dunpar Development Site

Background Information

AECOM Comments Provided to Halton Region on November 14th, 2012

A preliminary review of the document *Dunpar Developments Inc. Proposed Townhouse Development 2158, 2168, 2180 and 2192 Trafalgar Road Oakville, Ontario* (hereinafter referred to as the "Dunpar Developments report") prepared by Johnson Sustronk Weinstein and Associates (August, 2012) was completed by AECOM. Consideration was given for the potential to integrate Trafalgar Road drainage into the Dunpar Developments stormwater management (SWM) system and comments were provided to Halton Region via email on November 14th, 2012. A summary of the report's findings are as follows:

- A SWM tank was sized to accommodate a detention storage volume of 231 m^3 (Section 5.3 of the report)
- Review of the existing Trafalgar Road profile indicates that Trafalgar Road continuously falls from Dundas Street East / Highway 5 southward to just north of the QEW and provides the opportunity for gravity flow towards storage tank
- The available volume of the storage tank is estimated to be approximately 250 m^3 based on the overall dimensions of the tank length, width and height taken from Drawing SD-1 (included with the report)
- The potential surplus volume available in the tank is minimal at approximately 19 m^3
- The proposed tank is located centrally within the proposed development, making access from Trafalgar Road potentially difficult or costly
- The location of the proposed underground tank in a courtyard with a finished top elevation at grade may allow for an increased tank size with a footprint that advances into adjacent laneways of the townhouse development

Meeting with Town of Oakville and Halton Region Staff on January 9th, 2013

Further communication with the Town of Oakville and Halton Region Staff during the meeting on January 9th, 2013 provided the following details:

- Functional Servicing and Stormwater Management Report prepared by JSW (August 2012) shows majority of site draining to east via storm system, including a detention storage tank
- Biddington/Killberry development located west of proposed Dunpar site drains to SWM pond located south of River Oaks Boulevard
- Recommend potential onsite treatment at the Dunpar site in addition to controlled peak flows and water quality treatment prior to entering Trafalgar Road Right-of-Way (ROW) storm sewer system
- Recommend potential superpipe storage on Trafalgar Road ROW to control peak flows and stormceptors for water quality treatment

Storm Drainage Plans Provided by Town of Oakville Staff (January, 1989)

The following storm drainage drawings were provided by Town of Oakville Staff on January 10th, 2013:

- *External Storm Drainage Plan Stan Vine Construction Inc.,* approved on January 30th, 1989
- *Storm Tributary Areas Stan Vine Construction Inc.,* approved on January 30th, 1989

Review of the above drawings indicate that the majority of the proposed Dunpar site currently flows south towards River Oaks Boulevard East where flows are intercepted by an inlet into a 900 mm

diameter concrete pipe storm sewer. This storm sewer eventually discharges to the storage detention facility located between River Oaks Boulevard East and Upper Middle Road, within a tributary of West Morrison Creek.

The drawings also indicate that a small area located on the western boundary of the Dunpar site currently drains west towards Ontario Hydro Lands. This runoff is intercepted by the same tributary of West Morrison Creek described above, drains south across River Oaks Boulevard East through a 600 mm diameter concrete culvert, and ultimately discharges to the storage detention facility previously described.

The defined drainage areas within the drawings suggest that drainage for the Trafalgar Road ROW within the vicinity of the proposed Dunpar site are separate and remain within the ROW.

Stormwater Management Report for the Stan Vine Subdivision in October, 1988

A preliminary review was also completed for the document *Storm Water Management Report for the Stan Vine Subdivision* prepared by Dillon (October, 1988) provided by Town of Oakville Staff on January 14th, 2013. Review of this report confirmed drainage flow paths defined in the previously described drawings. This report also details the design of the storage detention facility based on contributing areas under proposed developed conditions using runoff coefficient values of 0.55 for the majority of the Dunpar site and 0.40 for the small area on the western limits of the Dunpar site.

GIS Data Provided by Town of Oakville Staff on February 4th, 2013

Review of GIS contour data provided by Town of Oakville Staff on February 4th, 2013 confirms drainage paths defined in the previously described drawings and reports for the Stan Vine Subdivision. The GIS data also confirms that the single ditch inlet catchbasin located within the Trafalgar Road ROW near the Dunpar site collects flows from only the ROW and directs them into the storm sewer system along Trafalgar Road through a 250 mm diameter pipe (Dunpar Development report specifies an existing 300 mm diameter pipe connection).

Review of Dunpar Developments Report

Review of the Dunpar Developments report highlights several issues regarding the SWM plan for the proposed development. Overall, the developer should be advised that storm drainage systems on the Dunpar site should provide the appropriate level of treatment and control of site runoff in order to prevent adverse impacts to existing downstream infrastructure. The following sections discuss the findings based on of review of the Dunpar Developments report and additional background information as noted above.

Regrading Dunpar Site Fronting onto Trafalgar Road Towards Trafalgar Road Right-of-Way

The Dunpar Developments report and drawings propose that a portion of the existing site fronting onto Trafalgar Road will be graded to redirect drainage to the east and towards the Trafalgar Road ROW instead of flowing west as defined in the Stan Vine Subdivision design drawings and report. The Dunpar Developments report shows that the redirected drainage will sheetflow towards the Trafalgar Road ROW where it is collected by the Trafalgar Road storm sewer system.

It is recommended that the developer confirm if the Trafalgar Road storm sewer design considered the subject area under the proposed regraded conditions. If the storm sewer design did not include the regraded area, peak flow control may be required.

The developer should also include water quality measures for the regraded area of the Dunpar Development site towards Trafalgar Road including consideration of low impact development (LID) measures.

Comparison of Runoff Coefficients Between Dunpar Developments Report and Design of Stan Vine Subdivision Detention Facility

The runoff coefficients used to represent the Dunpar site in the SWM analysis for the Dunpar site and Stan Vine Subdivision are significantly different. The runoff coefficients used to design the storage detention facility downstream of both sites in the *Storm Water Management Report for the Stan Vine Subdivision* (October, 1988) were 0.40 for the small area on the western limits of the proposed Dunpar site and 0.55 for the majority of the of proposed Dunpar site. A significantly higher runoff coefficient of 0.80 is used in the Storm Drainage Area Plan provided with the Dunpar Developments report.

The higher runoff coefficient is appropriate for high density residential areas as specified within the Town of Oakville's *Development Engineering Procedures & Guidelines Manual* (accessed online February 14, 2013). However, the use of a higher runoff coefficient results in increased peak flows and runoff volumes compared to the design calculations used to size the Stan Vine Subdivision detention storage facility. It is noted that the assumptions made in the Stan Vine Subdivision report predate the Ministry of the Environment's *Stormwater Management Planning and Design Manual* (1993 & 2003). As such, the facility was designed to provide peak flow control and not water quality treatment.

The developer should consider the design capacity constraints associated with the downstream detention facility located within the Stan Vine Subdivision. Previous hydrologic and hydraulic modeling should be updated with the higher runoff coefficient (0.80) to further evaluate the existing level of service of the Stan Vine Subdivision detention facility and potential available capacity. If necessary, the developer should provide additional on-site detention to ensure that downstream target peak flows and storage volumes are not exceeded.

Storm Drainage and Stormwater Management Section of Dunpar Developments Report

The Dunpar Developments report also states that the "100-year post-development flow is controlled to the 5-year post-development flow" and that a "detention stormwater management tank was sized to accommodate the required detention storage volume of 231.0 m^3" (Section 5.3). No details were provided within the Dunpar Developments report for proposed water quality treatment. The developer should provide peak flow control and water quality treatment in accordance with Ministry of the Environment's *Stormwater Management Planning and Design Manual*.

Summary of Recommendations

The following considerations are recommended for Dunpar Developments after reviewing the stormwater management report:

1. The developer should confirm if the Trafalgar Road storm sewer design considered the subject area under the proposed regraded conditions. If the storm sewer design did not include the regraded area, peak flow control may be required.
2. The developer should also include water quality treatment for the regraded area of the Dunpar Development site towards Trafalgar Road including consideration of low impact development (LID) measures.
3. The developer should consider additional on-site peak flow control and water quality treatment in light of the downstream constraints associated with the existing dry pond located within the Stan Vine Subdivision.
4. The developer should provide further details to confirm the SWM measure(s) proposed to provide water quality treatment for the Dunpar site runoff.

AECOM
5600 Cancross Court, Suite A 905.501.0641 tel
Mississauga, ON, Canada L5R 3E9 905.501.0181 fax
www.aecom.com

Memorandum

To	Sheri Harmsworth, P.Eng.	Page	1
Subject	Trafalgar Road EA SWM – Dunpar Development		
Prepared by:	Janelle Weppler, P.Eng., Water Resources Engineer		
Reviewed by:	Paul Frigon, P.Eng., Senior Water Resources Engineer		
Date	July 4, 2014	Project Number	60119993

AECOM Canada Limited has prepared this technical memo for the Regional Municipality of Halton to review the proposed stormwater management for a residential development by Dunpar Developments Incorporated. The site is located on the west side of Trafalgar Road, between Glenashton Drive and River Oaks Boulevard as shown in Figure 1.

Figure 1: Dunpar Development Site

A review and summary of previous background information was provided by AECOM on May 24, 2013. Subsequent to the previous review, AECOM completed a preliminary review of the document *Dunpar Developments Inc. Proposed Townhouse Development 2158, 2168, 2180 and 2192 Trafalgar Road Oakville, Ontario Stormwater Management Report* (JSW, January 2014), (herein after referred to as the “Dunpar SWM Report”) prepared by Johnson Sustronk Weinstein and Associates (JSW). Consideration was only given to SWM impacts of the development on the Trafalgar Road ROW. A summary of findings from AECOM’s review of the Dunpar SWM Report follows.

The drawing *Pre-Development Storm Drainage Area to Trafalgar Road* included with the Dunpar SWM Report shows an area fronting onto Trafalgar Road within the proposed development site that is flowing towards the Trafalgar Road ROW under existing conditions. This area draining towards the Trafalgar Road ROW has an area of 0.407ha with a runoff coefficient of 0.37 and a peak flow of 47 l/s during the 5-year design storm event, under existing conditions. Section 2.1 within the Dunpar SWM Report indicates that drainage from this portion fronting onto Trafalgar Road flows uncontrolled, into a ditch that outlets to an existing storm sewer on Trafalgar Road.

Section 2.3 of the Dunpar SWM Report indicates proposed regrading will result in approximately 0.293ha (total) of the proposed area draining eastwards to Trafalgar Road. The calculated post-development uncontrolled flows directed to Trafalgar Road are estimated at 51 l/s during the 5-year design storm event. The Dunpar SWM Report indicates that the increase from existing conditions (from 47 l/s) is considered inconsequential.

Section 4.0 of the Dunpar SWM Report states that runoff from the uncontrolled area will mostly be generated from landscaped areas, and a small portion of roof surface, and that runoff from the roofs will be conveyed across planters allowing treatment prior to discharge to the Trafalgar Road storm sewer system, requiring no treatment. The proponent is to clarify overland flow paths and provide further details in regards proposed land use changes with justification of no additional water quality treatment measures of flows prior to entering the Trafalgar Road ROW.

Review of drawing *Storm Drainage Area Plan* included with the Dunpar SWM Report shows an area of 0.315ha fronting onto Trafalgar Road. The proponent is asked to clarify the variation in reported area stated in the drawing *Post Development Storm Drainage Area to Trafalgar Road* of 0.293ha, included within the Dunpar SWM Report. The proponent is to confirm the area draining to Trafalgar Road in proposed conditions and advise on the impacts of calculated peak flow rates provided for proposed conditions, as necessary.

The runoff coefficient used for the proposed area that drains towards Trafalgar Road is 0.55, as shown in the drawing *Storm Drainage Area Plan* included with the Dunpar SWM Report. Proponent is to clarify runoff coefficient development with consideration for Town of Oakville’s *Development Engineering Procedures & Guidelines Manual* which indicates a runoff coefficient of 0.70 for townhouses. Proponent is to provide further detail and calculations for determined flows draining towards Trafalgar Road. Additional information is required to prepare a complete review on the calculation of flows draining towards Trafalgar Road.

Table 1 within the Dunpar SWM Report provides a formula for the calculated 5-year rainfall intensity using Town of Oakville design standards. The formula provided includes a coefficient for “A” that corresponds to the Town of Oakville’s formulation for the 100-year event (although, noted that the correctly calculated 5-year rainfall intensity is reported). Proponent is to clarify applicable formulae and verify any impacts on calculated rainfall intensities and resulting flows towards Trafalgar Road.

The attached *Storm Drainage Plan (Regional Drawing No. O-9578)* for Trafalgar Road shows drainage areas contributing to the Trafalgar Road storm sewer system. These areas are limited to the Trafalgar Road ROW and do not include external drainage areas such as those from the Dunpar site. The proponent should confirm if drainage from the subject site can be accommodated in the existing Trafalgar Road major/minor storm system without any adverse effects on the HGL and subject to the Region's approval. If the Trafalgar Road storm system cannot account for drainage from the subject site, peak flow control may be required and will need to be in accordance with Ministry of the Environment's *Stormwater Management Planning and Design Manual*.

AECOM
5600 Cancross Court, Suite A 905.501.0641 tel
Mississauga, ON, Canada L5R 3E9 905.501.0181 fax
www.aecom.com

Memorandum

To	Sheri Harmsworth, P.Eng.	Page	1
Subject	Preliminary Evaluation of Integrating Trafalgar Road SWM with Pond 32 (East Morrison Creek Subcatchment EM4) dated December, 2012		
Prepared By	Janelle Weppler, B.Sc. (Env.), P.Eng., Water Resources Engineer		
Reviewed By	Glenn Farmer, Senior Environmental Technologist		
Date	July 4, 2013	Project Number	60119993

AECOM Canada Limited has prepared this technical memo for the Regional Municipality of Halton to evaluate the potential opportunity to integrate storm drainage from the future Trafalgar Road Right-of Way (ROW) into the proposed stormwater management (SWM) system as described in the Environmental Implementation Report and Functional Servicing Study for the East Morrison Creek Subcatchment EM4 (EIR/FSS).

The area proposed for development by Dundas Trafalgar Inc. (Minto) & Shieldbay Inc. is located north of Dundas Street East/Highway 5 between Trafalgar Road and Eighth Line. The SWM features proposed for the EIR/FSS Study Area include Pond 32 (Figure 1) and various at-source controls or low impact development (LID) features.

The following discussion includes an overview of SWM strategy included in the EIR/FSS and preliminary evaluation of the feasibility to incorporate storm runoff from Trafalgar Road into the adjacent SWM system for treatment and control.

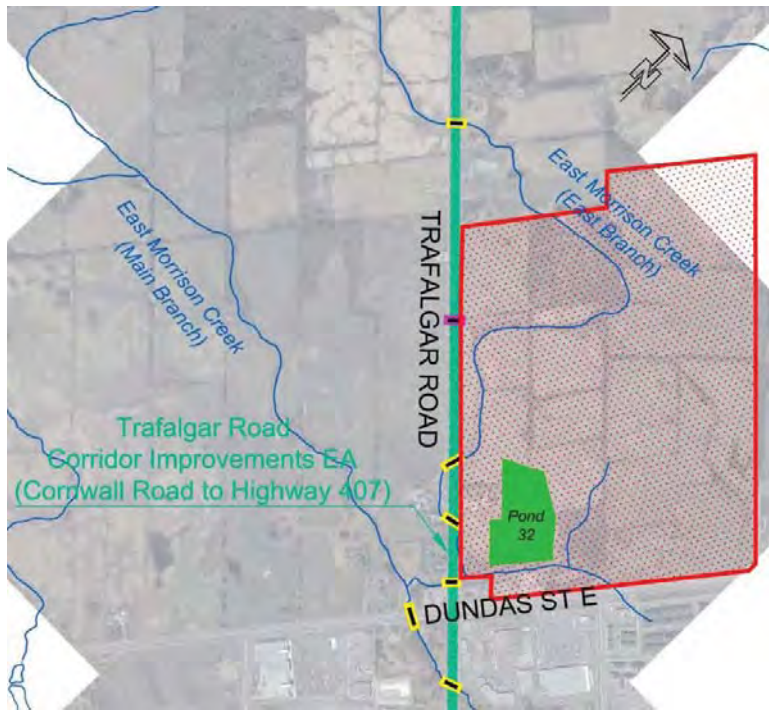

Figure 1: Proposed SWM Ponds Adjacent to Trafalgar Road

The following provides a list of additional clarifications and information required following an initial review of the EIR/FSS document:

- Table 7.4 in the EIR/FSS summarizes the existing culvert types, sizes and capacities:
  - Existing upstream water surface elevations are not clear
  - What design criteria was used to determine the level of service of the existing culverts (i.e. freeboard, clearance and headwater-to-depth ratio, etc.)?
  - Where is the spill elevation located for each culvert? Note that the sag or spill elevation in the road profile may not coincide with the location of the culvert crossing.

- Table 10.1 in the EIR/FSS summarizes design recommendations for road creek crossings and includes the extension of the culvert crossing Trafalgar Road identified as ME-T3.
  - What are the changes in upstream water surface elevations from existing to proposed conditions?
  - What design criteria was considered (i.e. freeboard, clearance and headwater-to-depth ratio, etc.)?

- The total provided, used, and surplus storage volumes associated with Pond 32 are summarised in the following Table 1. The summary reflects differences in the reported volumes and indicates the surplus volume differing between 77 m^3 and 8348 m^3. The proponent should clarify the correct values as well as surplus volume available in Pond 32. As part of the Trafalgar Road EA, a preliminary estimate of additional volume required to service the adjacent Trafalgar Road ROW is approximately 1200m^3. This volume was estimated using the length of the Trafalgar Road ROW able to reach Pond 32 based on positive drainage and accessibility.

Table 1: Total and Regional Storage in Pond 32

Storage Type	Storage Volume (m^3)	Reference[1]
Total Volume of Pond		
	89,811	Table 7.10
	81,100	Appendix H-1, Visual OTTHYMO output code
Regional Storm Storage		
	81,463	Table 7.10
	81,023	Appendix H-1, Visual OTTHYMO output code
Surplus Volume		
Min.	77	n/a
Max.	8348	n/a

1– All references taken from East Morrison Creek Subcatchment EM4, Dundas-Trafalgar Inc. & Shieldbay Inc. North Oakville, EIR/FSS, December, 2012

- Section 10.2.5 in the EIR/FSS indicates that "*The recommended culvert sizes, based on fluvial geomorphologic and wildlife passage requirements, were found to be more than adequate to accommodate future flows, particularly since the future flow in the channel will be less than existing flow as a portion of the Subject Lands is proposed to drain into the SWM pond rather than the channel.".* What are the changes in flows to ME-T3, ME-T2 and ME-T1?

- Figure 7.2b in the EIR/FSS:
  - Shows the drainage area to Pond 32 and does not include the Trafalgar Road ROW
  - Shows proposed storm sewer infrastructure within the Trafalgar Road ROW that appears to service Pond 29 (located on west side of Trafalgar Road). This proposed storm sewer infrastructure includes three outlets to the east side of Trafalgar Road, into the east branch of East Morrison Creek and are located north of the EIR/FSS study area, at Street C (into Block 12) and at the upstream end of Trafalgar Road Culvert ME-T3. Has the proponent designed the downstream storm infrastructure to accommodate runoff flows from the Trafalgar Road ROW? The proponent should clarify the connection between the proposed outlet at Street C (Block 12) and the east branch of East Morrison Creek.

In addition to Pond 32, LID features and source controls are also considered within the EIR/FSS. The proponent should consider the potential for integrating stormwater from the Trafalgar Road ROW with proposed LID and source control strategies where possible, as part of detailed design.

AECOM
AECOM
300 Water Street
Whitby, ON, Canada L1N 9J2
www.aecom.com
905 668 9363 tel
905 668 0221 fax

Memorandum

To	Matt Krusto	Page	1
CC	Halton Region: Melissa Green-Battiston, Nick Zervos AECOM: Brenda Jamieson, Corinne Latimer, Brian Richert		
Subject	Minto Communities – Dundas-Trafalgar Inc., North Oakville Environmental Implementation Report (EIR) / Functional Servicing Study (FSS) Update and Response Documents (dated January 31, 2014 & April 30, 2014) Review of Town and Conservation Halton comments		
From	Joanna Eyquem, Nicola Lower, Janelle Weppler, Sheri Harmsworth		
Date	May 16, 2014	Project Number	60119993

1. Introduction

AECOM Canada Limited prepared a memo dated April 28, 2014 for the Regional Municipality of Halton (Region) to provide a preliminary review of the *EIR/FSS Update and Response Document, Dundas-Trafalgar Inc., North Oakville* prepared by Stonybrook Consulting Inc., dated January 31, 2014. This memo provided a preliminary assessment of the proposed adjacent development located immediately north of Dundas Street, and its impacts on the Trafalgar Road Right-of-Way (ROW) and included a coordinated review of the Stormwater Management, Fluvial Geomorphology / Natural Environment, and Trafalgar Road right-of-way (ROW) (Jan. 2014).

A subsequent update to the *EIR/FSS Update and Response Document, Dundas-Trafalgar Inc., North Oakville* was prepared by Stonybrook Consulting Inc., dated April 30, 2014 and provided by the Region to AECOM for additional review and comment. Additional comments resulting from review of the updated EIR/FSS dated April 30, 2014 are highlighted in the text below.

2. Trafalgar Road ROW

In general, the document is not focused on the Trafalgar Road ROW. Drawing 2 – Proposed Floodplain Mapping was reviewed as it indicated the existing property lines on the west side of Trafalgar Road, as well as a section labelled "Block Road Widening", which is taken to mean the additional ROW to be set aside for widening Trafalgar Road. Several measurements were made particularly at the proposed bus bay and platform locations, to confirm whether sufficient ROW has been allowed by the developer to accommodate Trafalgar Road. As the existing west property line is indicated on the plan, all measurements to the proposed east property line are measured from the existing west property line, which varies along the corridor.

1. At 15+550, the Trafalgar Road plan indicates that the east property line is located 48.396m east of the existing west property line. The developer has allowed 40m in this location; this accommodates the bus bay and multi-use path with little area provided between the edge of the multi-use path and the new property line. On the Trafalgar Road plan, the east edge of the multi-use path (east side of Trafalgar Road) is located 37.946m east of the existing west property line.
2. At 15+860, the Trafalgar Road plan indicates that the east property line should be located 52.199m east of the existing west property line. The developer has allowed 50m in this location; this accommodates the bus bay and multi-use path with little area provided between the edge of the multi-use path and the new property line. On the Trafalgar Road plan, the east edge of the multi-use path (east side of Trafalgar Road) is located 46.749m east of the existing west property line.
3. At 16+175, the Trafalgar Road plan indicates that the east property line should be located 52.285m east of the existing west property line. The developer has allowed 50m in this location; this accommodate the bus bay and multi-use path with little area provided between the edge of the multi-use path and the new property line. On the Trafalgar Road plan, the east edge of the multi-use path (east side of Trafalgar Road) is located 46.828m east of the existing west property line.

Although the bus bay, platform and multi-use path appears to fit within the ROW allotted by the developer, the Region may require additional ROW for other purposes.

For the EIR/FSS Update and Response Document dated April 30, 2014, Attachment A – Response to March 13th, 2014 CH Comments, Item 8 notes the following:

8. Trafalgar Road Widening – It is our understanding from Regional Staff that the future Trafalgar Road ROW may not be accurately reflected on the drawings. This issue must be resolved prior to staff endorsing any concept. Response: Halton Region has provided a preliminary drawing for the ultimate Trafalgar Road ROW. This drawing was used to update the base plans and has been incorporated into this submission.

AECOM: It is unknown which base plan was provided by Halton Region; however, it appears it is a plan that includes a median rapid transit lane rather than a curb BRT/HOV lane. This plan is not the ultimate Trafalgar Road plan as determined by the Trafalagar Road EA study. Drawings that show the median rapid transit lane includes the following: Figure 10, Figure 3a, Figure 3c, Figure 9.4, Drawing 2, Drawing 7.1a, Drawing 7.2a, Drawing 7.2b, and Drawing 9.2.

For the EIR/FSS Update and Response Document dated April 30, 2014, Attachment B – Response to Town of Oakville Comments dated March 12, 2014, Item B.e. notes the following:

B- Appendix A-4, Revised Channel Design
e. Trafalgar Road Right-of-Way – an email from the Region (M. Krusto, February 26, 2014) indicated that the future 50m Trafalgar Road right-of-way and far-side transit stop locations (additional 50 x 5m blocks) are not accurately reflected in the recent EIR/FSS submission. We note that the proposed transit stop location in the south-west side of the roadway intersection with future Street B may impact the available pond block size for Pond 30 and the realigned channel MOC-2/2b. The next EIR/FSS submission should reflect the accurate right-of-way for Trafalgar Road and the SWM Plan, proposed channel design drawings and associated modelling should be revised accordingly. Response: The

Region of Halton comments were not circulated to the proponent at the time of the previous submission. The Region has since provided a preliminary road widening layout, but no storm drainage information. The Trafalgar Road ROW and SWM will be reflected in the final EIR/FSS documentation.

AECOM: It is suggested that the Region confirm that the most recent preliminary design drawings have been provided for use in the assessment.

3. Fluvial Geomorphology and Natural Environment Review

A review of the comments made by the Town of Oakville and Conservation Halton, in response to the Dundas-Trafalgar Inc., North Oakville Environmental Implementation Report (EIR) / Functional Servicing Study (FSS) Update and Response Document (January 2014), has been undertaken in the context of AECOM's previous review of this submission (issued March 11, 2014).

3.1. Channel Realignment

Flow Regime:

- CH have stated they will not approve the channel design until the proposed flow regime is finalized (the design flow value of $0.20m^3/s$ has not yet been confirmed and is therefore subject to change).
- The design of the new Trafalgar Road culvert (including its width) depends on the design flows being agreed - AECOM's comments are therefore based on the current design flows and associated channel and culvert designs.

Comment 5.iii (Conservation Halton)

- Conservation Halton has identified concerns with the flow rates being assumed elsewhere in the submission. Therefore, the design discharge of 0.20 m3/s for the bankfull channel design must be revisited in conjunction with addressing CH comments on the project's hydrologic and flow regime analysis.

Comment 21.a. (Conservation Halton)

- Conservation Halton will revisit this section once the proposed flow regime in the watercourse has been updated.

- Minto's response states that the proposed flow regime in the watercourse has been updated in this submission according to the method agreed upon by CH and Town staff.

- AECOM assumes that flow rates have been updated based on NOCSS

Culvert Width:

- As noted in the previous memo, proposed culvert widths are more than 3 times the bankfull width, based on preliminary design bankfull widths of 1.2-1.3m for riffles and 2-2.2m for pools,

- CH have indicated that they are prepared to accept culvert widths of 3 times the bankfull width.
- AECOM supports the proposed culvert dimensions for the new Trafalgar Road culvert (7.3m wide x 1.25m high) as being sufficient for geomorphological purposes.

Comment 13 (Conservation Halton)

- Conservation Halton have indicated that they are prepared to accept culvert widths of 3 times the bankfull width. The design bankfull width has not yet been established to the satisfaction of Conservation Halton, and therefore culvert widths are still subject to revision. This can be deferred to a condition of Draft Plan approval as the proponent has indicated that they are willing to refine culvert sizes at the detailed design stage if necessary.

- Minto has recorded this as acknowledged.

- As mentioned previously, AECOM supports the proposed culvert dimensions for the new Trafalgar Road culvert (7.3m wide x 1.25m high) as being sufficient for geomorphological purposes. If changes to the culvert width are made at the detailed design stage then the geomorphological impacts will be reviewed at that time.

Culvert Length:

- CH indicate that they accept the culvert length proposed for the new Trafalgar Road culvert - Comment 47 (April 11, 2013) is recorded as "addressed".

Utility Crossings:

- The January 2014 submission confirms that a minimum cover of 1.5m, as requested by CH, can be achieved for the proposed road crossings; AECOM notes that this level of cover is acceptable.

Fish Passage:

- CH indicate that "a fish passage specialist will be required to maximise fish passage through all three road culverts (i.e. including the new Trafalgar Road culvert) under as many types of water flow as feasible at the detailed design stage"; AECOM supports this viewpoint.

Slopes:

- CH remaining concerns regarding channel slopes are with the Street C culvert and upstream, therefore they do not directly concern the new Trafalgar Road culvert.
- Town of Oakville are in acceptance of proposed channel gradients.

Channel Length:

- CH reach the same conclusions as our previous memo regarding channel lengths (AECOM, March 2014, Table 2). CH are prepared to accept the decreases in channel length, provided "overall benefit" to the watercourse system is demonstrated. Demonstration of "overall benefit" pertains to the proposed watercourse system in this area, not just the new Trafalgar Road culvert.

- As mentioned in the previous memo response, demonstration of the "overall benefit" pertains to the proposed watercourse system in this area, not just the new Trafalgar Road culvert.

Minto has provided a list of benefits to the watercourse and has created a figure to illustrate the open and closed/piped lengths of the channel

Additional Comments on New Drawing 3

Comment E (Conservation Halton)

- It is requested from Conservation Halton that the design of the channel from 0+100 to 0+340, and from 0+560 to 0+760 be designed with u-shaped channel cross sections complimented with native grass planting for the first 3 meters back from each bank

- Minto has stated that given the flow regime, gradients, and intermittent nature of the channel the dimensions have been modified to the extent possible and that minor modifications in the channel dimensions and associated bioengineering elements can be completed at the detail design stage.

- Trafalgar Road Culvert chainage is 0+515 to 0+611. AECOM is recommending open bottom culverts. A low flow channel within the U-shaped cross section for fish passage should be included in the cross section design. Native grass plantings will obviously not be possible within the culvert.

Appendix B, Response to CH Comments (April 11, 2013) – Original EIR/FSS Comment 13 (Conservation Halton)

Comment 11 (Conservation Halton)

- MOC-2 is a grassed swale with discernable widths and depths provided. Question whether they were surveyed results, and if so why bankfull discharge, velocity, and average unit stream power cannot be provided for Reach MOC-2. Staff could not reproduce the tractive force value provided.

- Minto states the provided channel geometries were based on field surveys. They note that a defined channel was not identified and that bankfull parameters refer to the entire swale feature. They state that these values should not be used for the design criteria of a bankfull channel.

- Reach MOC-2 is directly upstream from the Trafalgar Road culvert. Existing channel geometries are used to design proposed conditions, such as bankfull width and depth, which then relate back to the proposed culvert size at Trafalgar Road. Minto should clarify on why the existing channel geometries cannot be used for design discharge, velocity, and average unit stream power.

Meander Belt Width

Comment 13

- Conservation Halton asks why a bankfull width of 2.2m is selected for MOC-2 considering 2.2m is on the lower end of the measured widths. They do note that the 25m should be sufficient and are satisfied.

- Minto provides the equations and dimensions used.

- The following is AECOM's previous response to the meander belt which agrees that 25m appears reasonable and it also requires that it be noted that the meander belt is tapered on entry and exit to the watercourse crossings. "A meander belt width of 25m was determined in the original submission (December 2012), which is very similar to that calculated in AECOM's fluvial geomorphological assessment for the Trafalgar Road Improvements Class EA. The valley bottom allowance along the stream corridor is 25m to reflect the meander belt width, which appears reasonable. However, it should be noted that this is tapered on entry and exit to the watercourse crossings."

Channel Bed

Comment 21 j (Conservation Halton)

- Conservation Halton states that the response does not discuss fluvial implications of constructing within shale. The existing watercourse is not a shale system and consideration should be given to over excavation of the entire channel corridor and backfilling with material that can provide a suitable substrate as the channel meanders.

- Minto states that morpho-sedimentary features to address the shale in the corridor will be gained through the development of soil horizons naturally found above the shale parent material and characteristic of those produced through soil forming processes. Replication of the natural processes ensures long term stability by providing an enhanced medium for vegetation growth and sources of sediment for the watercourse. Specific corridor design details may include over-excavation of the shale in the corridor approx. 200-300mm below the proposed channel bed and replaced with a mix of granular and native soils. The drawings have been updated and attached to this submission

- If shale is located upstream or within the Trafalgar Road boundary then consideration should be given to the fact that channels adjust their boundaries to maintain a balance between the forces exerted by the flowing water and the sediment load they transport downstream. Alteration to sediment regimes within a watercourse can result in the channel adjusting its form through erosion of bed and bank material. If suitable substrate is not present within the channel corridor as the channel meanders it could result in erosion at the Trafalgar Road crossings, which then may require mitigation measures such as bed and bank protection. .

3.2. Conclusions

The current channel design and new culvert design under Trafalgar Road is acceptable in terms of its geomorphological provisions.

Once design flows for the channel realignment are agreed with CH, bankfull widths and culvert widths under the proposed new Trafalgar Road culvert can be confirmed.

As agreed by CH, fish passage issues through the new Trafalgar Road culvert will be addressed by a fish passage specialist at the detailed design stage.

4. SWM Review

The area proposed for development by Dundas-Trafalgar Inc. (formerly Minto & Shieldbay Inc.) is located north of Dundas Street East/Highway 5 between Trafalgar Road and Eighth Line. The SWM features proposed for the EIR/FSS Study Area include Pond 32 (Figure 1) and two culverts along the east tributary of East Morrison Creek at the new proposed residential road crossings. The update to the EIR/FSS proposes realignment of the east tributary. In particular, the tributary is realigned downstream of culvert ME-T3 along the south side of SWM Pond 30 proposed by Green Ginger Developments and joins the west tributary upstream of the existing confluence.

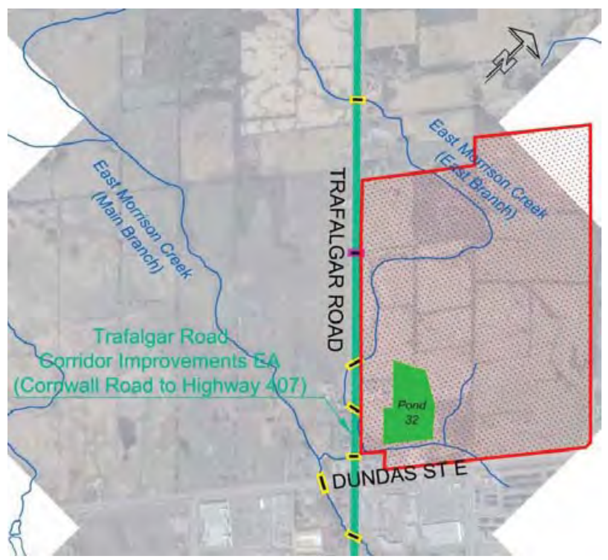

Figure 1: Proposed SWM Ponds Adjacent to Trafalgar Road

The following list summarizes the findings of the preliminary review that are of interest or may have impacts either within the vicinity of, or within the Trafalgar Road ROW.

4. A comparison of peak flows in the tributaries upstream of Dundas Street should be provided to illustrate impacts of the proposed drainage plan and demonstrate compliance with the North Oakville Creeks Subwatershed Study (NOCSS). This comparison of flows should illustrate the ability of watercourse conveyance infrastructure crossing Trafalgar Road (existing or proposed Trafalgar Road infrastructure, depending on construction timing) such as that located at ME-T1, ME-T2, ME-T3, ME-T4 (if still required) and ME-T5. It is noted that proposed watercourse crossing upgrades detailed in the Trafalgar Road EA are based on meeting requirements dictated within the NOCSS and any changes to these flows will impact the capacity of proposed water crossing infrastructure improvements.

   Table 2.2 includes a comparison of “Existing” and “Future” flows which are calculated based on NOCSS unit flow rates for the culvert located at Dundas Street, immediately west of Trafalgar Road (identified as “ME-D3”; note that this culvert is actually “ME-D2” as determined through GAWSER modeling in the NOCSS). These flows are to be used for determining SWM pond

volumes to control peak flows in proposed conditions, back to existing conditions and not for comparison of peak flows to conveyance infrastructure, such as those crossing Trafalgar Road. A comparison of peak flows should therefore be provided to illustrate the impacts of the proposed (interim and ultimate), drainage plan (in compliance with NOCSS) on existing conveyance crossing Trafalgar Road.

5. The proposed drainage plan included in Figures 3 & 4 notes that 2-year to Regional storm flows will discharge from SWM Pond 29 southerly to ME-T3 via a storm sewer within the Trafalgar Road ROW, whereas the extended detention flow is directed easterly to MOC-2. It will need to be determined if the proposed storm sewer by Minto is intended to accommodate both the roadway drainage and the pond drainage, or only the pond drainage (consideration will also need to be given to the design storms for these features). In addition, a discrepancy was found in that the hydrologic model directs all discharge from Pond 29 to ME-T3. A diversion element should be added to the hydrologic model to direct a portion of the discharge to MOC-2 or the note “2-yr to Regional Flow Directed South to Culvert Crossing South of Street B” should be removed from Figures 3 & 4.

   The EIR/FSS indicates that “the SWM Pond 29 connection to Trafalgar Road crossing near SWM Pond 30 was assessed and is functionally feasible”. The proponent needs to provide additional information to substantiate this assessment with consideration for other infrastructure within the ROW as well as the feasibility of gravity flow to appropriate outlet(s). The EIR/FSS also refers to Drawing 7.2R; this drawing was missing from the April 30th submission package. Additional information is required to provide further comments.

   The EIR/FSS recommends “that the Pond 29 outfall be discharged into the proposed channel extension west of Trafalgar Road and tied in with the proposed culvert crossing headwall”. This recommendation should be substantiated and include an evaluation of the impacts on form and function of the high constraint receiving watercourse downstream on the east side of Trafalgar Road, as this diversion of flow will reduce flows from existing conditions.

   The EIR/FSS also indicates that “this outfall pipe will likely accommodate drainage from the ultimate Trafalgar Road ROW to avoid multiple storm sewers within the ROW”. The proponent should clarify the recommended design storm for this outlet from Pond 29 and define the major overland flow path during less frequent rainfall events that may exceed the proposed infrastructure.

   In addition, the existing and proposed conditions peak flows at Point E (directing to the upstream end of MOC-2) should be clearly compared to illustrate impacts of diversion on the peak flows to MOC-2 and capacity of associated watercourse conveyance infrastructure crossing Trafalgar Road.

   The timing of construction between the proposed improvements to Trafalgar Road and adjacent development should be considered and include the scenario where adjacent development infrastructure precedes Trafalgar Road improvements. Interim solutions for adjacent development SWM may be required, such as that for Pond 29 that utilizes an outlet constructed with the Trafalgar Road ROW and is recommended to outlet into the proposed channel realignment on the west side of Trafalgar Road.

6. The proponent should confirm if there is an outlet from the storm sewer along Trafalgar Road to MOC-2 at Street C, as shown in Figures 3 & 4. If there is an outlet, this should be reflected in the hydrologic model and the impacts on flows towards ME-T3 should be further clarified.

7. Feasibility of Directing Trafalgar Road Drainage to SWM Pond 32: The total provided, used, and surplus storage volumes associated with Pond 32 are summarised in Table 1. The reported volumes indicate that a surplus volume of 3085 m^3 may be available in Pond 32 during the 100-Year storm. As part of the Trafalgar Road EA, a preliminary estimate of additional storage volume required to service the adjacent Trafalgar Road ROW between culverts ME-T2 and ME-T3 is approximately 573 m^3 during the 100-Year storm. This volume was estimated using the section of the Trafalgar Road ROW able to reach Pond 32 based on accessibility. On Page 4 of Appendix A-3, the proponent states that draining Trafalgar Road runoff to SWM Pond 32 is not feasible due to grading / infrastructure constraints. Further detail is requested from the proponent regarding the grading and infrastructure conflict constraints. Alternatively, overcontrol within Pond 32 could be considered to accommodate the increase in runoff associated with the widening of Trafalgar Road.

Table 1: Total and 100-Year Storage in Pond 32

Storage Type	Storage Volume (m^3)	Reference[1]
Total Volume of Pond (Provided Storage)	35,852	Appendix A-3 to Attachment A, Page 5, Second Table
100-Year Storm Storage (Used Storage)	32,767	Appendix A-3 to Attachment A, Page 5, First Table
Surplus Volume	3085	n/a

1 – All references taken from EIR/FSS Update and Response Document, EIR/FSS, Dundas-Trafalgar Inc., January, 2014

The updated EIR/FSS notes that "the Region of Halton is technically subject to the NOCSS SWM control criteria". AECOM recognizes this requirement and has included SWM recommendations within documentation for the EA based on requirements outlined in the NOCSS.

The EIR/FSS recommends that "Trafalgar Road cannot physically be drained to SWM Pond 32 east of Trafalgar Road and therefore must be controlled within the ROW, or within facilities west of Trafalgar Road". The proponent should consider overcontrol in Pond 32 given the surplus volume documented in Table 1 above.

Interim SWM recommendations made within the Trafalgar Road EA include superpipe storage for quantity control with oil-grit separator (OGS) units for quality control to treat runoff generated within the Trafalgar Road ROW (pending feasibility to be determined during detailed design). If Trafalgar Road is widened prior to adjacent development and associated SWM measures or that the integration of stormwater infrastructure or overcontrol is not feasible between Trafalgar Road

and adjacent infrastructure (such as Pond 32), utilization of the interim superpipes and OGS units in the interim could be considered for ultimate conditions.

8. Figures 3 & 4 indicate drainage areas,that include the Trafalgar Road ROW, and their outlets as follows:
   - Area T1 to be directed to MOC-2 – the proponent should further investigate feasibility of integrating Trafalgar Road ROW with SWM measures of adjacent development such as Pond 29. In the event that potential integration is reviewed and determined to not be feasible, superpipe storage and OGS units implemented for interim conditions (if required due to the widening of Trafalgar Road prior to adjacent development and pending feasibility to be determined during detailed design), may need to be maintained in ultimate conditions.
   - Area T2 to outlet at ME-T3 – the proponent should clarify intended SWM measures for this drainage area, including contributing areas beyond the Trafalgar Road ROW (i.e. access roads). Further investigation into directing Area T2 towards Pond 30 should be considered. If the integration of SWM for Area T2 with Pond 30 is not feasible, quality and quantity control using superpipe storage and OGS units could potentially be considered in ultimate conditions, as described above (pending feasibility to be determined during detailed design).
   - Area G to outlet directly into MOC-4 – it is unclear how runoff from the Trafalgar Road ROW will be directed to reach MOC-4 prior to reach MOC-2a. The Trafalgar Road EA also recognizes the potential for application of superpipe storage and OGS units for interim conditions which could potentially be maintained in proposed conditions, as described above (pending feasibility to be determined during detailed design). In addition, the south limit of Area G within the Trafalgar Road ROW should be verified so that it agrees with the high point in the road profile located south of Dundas Street.

9. The drainage divide between T1 and T2 shown on Figures 3 & 4 should be moved to the existing high point in the Trafalgar Road profile located 140 m south of ME-T5.

10. The hydrologic model currently considers the Trafalgar Road catchments to have an impervious area of 57%. The impervious area in the Trafalgar Road catchments should be estimated as 80% to reflect the widened road conditions proposed in the Region's EA.

    The updated EIR/FSS indicates that future flow factors were determined (such as those detailed in Table 2.2 of the EIR/FSS). The proponent should confirm if the future flows were determined based on an impervious area of 80% for the Trafalgar Road ROW to reflect the proposed roadway improvements.

11. Limiting Capacity of Existing Culverts under Interim Development Conditions: The East Morrison Creek culvert crossing Trafalgar Road south of Dundas Street is smaller than ME-D2 and all proposed culverts located farther upstream. Although this crossing will be sized appropriately for ultimate development conditions as part of the Region's Trafalgar Road EA, its existing limiting capacity should be considered at detailed design. Interim development scenario models should also be considered in the event that development adjacent to Trafalgar Road precedes the proposed improvements to Trafalgar Road.

12. The proposed Trafalgar Road ROW needs to be shown in Drawing 7.2R to more accurately reflect proposed drainage adjacent to the Trafalgar Road ROW.

In addition to the review of the updated EIR/FSS from Stonybrook Consulting (January, 2010), comments from the Town of Oakville and Conservation Halton were also reviewed.
Additional comments upon review of the Town of Oakville (Town) Memorandum dated March 12, 2014 are as follows:

Town Comment 10 – As seen in Appendix 2, Hydraulics, predevelopment flows at ME-T5 still appear to be based on URR at Dundas Street rather than derived from NOCSS Table 5.4.1.

Additional AECOM input to Town Comment 10 - Flows derived from the NOCSS for ME-T5 are higher than those documented in Appendix 2 of the updated EIR/FSS. Underestimated flows using those documented in Appendix 2 of the EIR/FSS will underestimate the required capacity of the culvert crossing Trafalgar Road (ME-T5), potentially resulting in underestimated crossing requirements and a reduced level of service (LOS).

The proponent's response detailed in the April 30th, 2014 EIR/FSS indicates that "No controls were assumed at this time for the Trafalgar Road ROW" and "this is a conservative assumption with respect to the Pond 32 design, as a degree of over-control is required.. Similarly, the proposed channel was designed to accommodate the post-development flows from the Trafalgar Road ROW". The proponent should clarify the degree of over-control designed within Pond 32 and confirm that an impervious area of 80% was applied to reflect the ROW recommendations with the Trafalgar Road EA.

Town Comment 11 – Notwithstanding comment 10, the Trafalgar Road Culvert Capacity Table 7.4 (December 2012) should be updated and expanded with the existing, interim and future culvert capacities and level of service.

Additional AECOM input to Town Comment 11 - Table 7.4 in the December 2012 EIR/FSS summarizes the existing culvert types, sizes, capacities, and levels of service. The proponent should clarify the following:

- What design criteria was used to determine the level of service of the existing culverts (i.e. freeboard, clearance and headwater-to-depth ratio, etc.)?
- Where is the spill elevation located for each culvert? Note that the sag or spill elevation in the road profile may not coincide with the location of the culvert crossing.

Town Comment 16 – This study and the proposed stormwater servicing plan relies on the drainage exchange strategy between EM1/EM4/WM1 proposed on behalf of Star Oak Developments Inc.. As such, we note that the elimination of Pond 33 has not yet been accepted as Pond 29 does not meet the predevelopment flow regime at ME-T5 or form and function of MOC-6/PSW 25 within Core 10.

Additional AECOM input to Town Comment 16 – It is noted that proposed watercourse crossing upgrades detailed in the Trafalgar Road EA are based on meeting requirements dictated within the NOCSS and any changes to these flows will impact the capacity of proposed water crossing infrastructure improvements. More specifically, increases in flows to ME-T5 resulting from the elimination from drainage exchanges between EM1/EM4/WM1 with the elimination of Pond 33 will increase the expected flow rate above those required by the NOCSS and used in the design of improvements for ME-T5 recommended in the Trafalgar Road EA.

Additional Town Comments – Appendix A-2, Hydraulics (b) – The Town does not support the proposed reversed grade floodplain (RGF) as the best option for the newly design channel. We are open to further discussion on other ways of looking at the floodplain analysis, including the reliance on the future culvert crossing at ME-T3 as fixed culvert in perpetuity.

Additional AECOM input to above – Structural, geotechnical and/or hydrotechnical evaluation will be required for the consideration of reliance on ME-T3 and associated Trafalgar Road ROW embankment to provide storage and regulation for the proposed RGF. In addition, tailwater impacts of the proposed RGF will need to be incorporated into hydraulic analysis to determine potential impact of flow conveyance through drainage infrastructure crossing Trafalgar Road and associated watercourses. The reliance on ME-T3 to regulate the proposed RGF must also include consideration for road profile sags and potential flooding of the Trafalgar Road ROW.

Additional Town Comments – Appendix A-2, Hydraulics (c) – The resubmission does not address the capacity of ME-T1 relative to the revised Pond 32 outflows and remnant drainage Area G on Figure 4 under both interim and ultimate conditions.

Additional AECOM input to above - It is noted that proposed watercourse crossing upgrades detailed in the Trafalgar Road EA are based on meeting requirements dictated within the NOCSS and any changes to these flows will impact the capacity of proposed water crossing infrastructure improvements such as that for ME-T1, located downstream from Pond 32.

The April 30th EIR/FSS indicates that "Culvert ME-T1 has capacity for approximately 6.0 m^3/s (100-year flow) according to the existing conditions HEC-RAS model". The existing 100-year flow for culvert ME-T1 is 3.07 m^3/s as per the NOCSS unit rates, and documented in Table 2.1 of the April 30th, 2014 EIR/FSS. In addition, the proponent should clarify if this capacity considered relevant design requirements (i.e. freeboard, clearance and headwater-to-depth ratio, etc.) and note that the sag or spill elevation in the road profile may not coincide with the location of the culvert crossing.

The April 30th EIR/FSS also indicates that "emergency flows will be captured into large emergency grates situated at the Regional water level", and, that "these grates and the outfall pipe have been sized to convey the Regional uncontrolled flow of 8.5 m^3/s". The existing Regional flows based on the NOCSS unit rates are 7.55 m3/s, as documented in Table 2.1 of the EIR/FSS where the future Regional flows at ME-T1 are indicated as 9.90 m3/s in Table 2.2 of the EIR/FSS. AECOM notes that the determined level of service of the existing structure at ME-T1 to be the 100-year design storm event, associated with existing NOCSS flow of 3.07 m3/s. Flows exceeding the existing ME-T1 level of service may result in upstream and/or roadway flooding.

Additional Town Comments – Appendix A-4, Revised Channel Design (d) – We note an increase in elevation downstream of Point B in MOC-4 across all storm events, notwithstanding the change required to the peak flows in the channel which may result in greater increases in flood levels.

Additional AECOM input to above – Increases in flow elevations in MOC-4 (downstream from ME-T1 and ME-3) can impact the functionality/reduce LOS and capacity of upstream culverts due to increased tailwater elevations. Impacts on the increased flow elevations in MOC-4 should be evaluated for watercourse infrastructure crossing Trafalgar Road.