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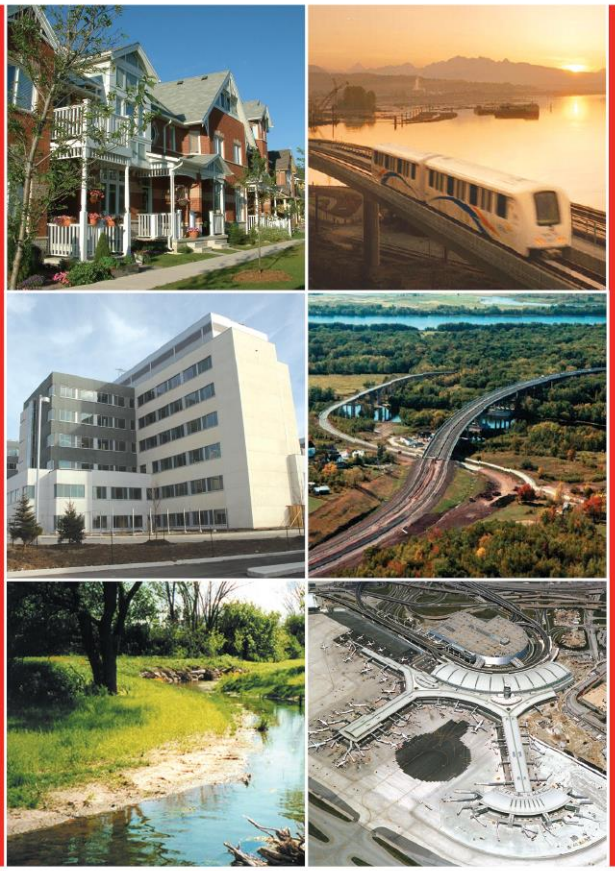

Environmental Implementation Report / Functional Servicing Study (Interim Submission)

Draft Plan of Subdivision (24T-11001)
Zoning By-law Amendment (Z.1333.01)1-SW1

COMMUNITIES
TRANSPORTATION
BUILDINGS
INFRASTRUCTURE

MMM GROUP

September, 2015

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6.0 Water Resources

6.1 Introduction

This chapter primarily discusses the hydrology and hydraulics of the study area under pre- and post-development conditions. The study area contains the part of the West Branch of Fourteen Mile Creek which flow generally from west to east. The headwaters enter the development area via five (5) culverts (FM1, FM2, FM3, FM4 and FM5) located under Highway 407 and exit the subject property through two culverts (FM-D3 and FM-D4) located under Dundas Street West.

It should be noted that the purpose of this submission is to prepare revised portions of sections 6 & 7 of the EIR/FSS (November, 2014 submission) to specifically address the issues to support Draft Plan Approval and issues communicated to the design team by MNRF. Therefore, special focus has been directed toward key issues to define development limits including:

- Regional flood impact on downstream areas
- Impact of development on flow regime, including sedimentary and ecological processes, specifically with respect to development phases, and
- Erosion thresholds downstream of the development.

It has been emphasized by Conservation Halton and the Town of Oakville that these key issues need to be addressed based on a phasing plan that is anticipated to include three interim stages. Throughout Chapter 6 (and Chapter 7), impact assessment has been conducted based on this understanding. The information presented herein will be incorporated into the 4th submission of the EIR/FSS.

The process undertaken to cover the hydrology and hydraulics include the following key components:

- Criteria and requirements
- Hydrology, including
    - Catchment delineation and drainage schematics
    - Modeling results for pre- and post-development conditions
    - Flow regime
- Hydraulics, including
    - Regional flood analysis
    - Erosion thresholds
- Corridor width delineation

6.2 Criteria and Requirements

The study criteria are multidisciplinary and follow technical direction from North Oakville Creeks Subwatershed Study (NOCSS), 2006, in addition to policy direction and guidance from Conservation Halton, MOECC, MNRF, and other agencies. Specific references to these criteria are cross-referenced throughout Chapter 6 to aid in understanding the overall context of the documented analyses and conclusions.

6.3 Hydrology

6.3.1 Proposed Development and Changes to Hydrology

Changes on the hydrologic features and functions within the Subject Property has been analyzed based on the following phasing plan:

1. Existing (i.e. pre-development)
2. Interim Conditions Phase 1A
3. Interim Conditions Phase 1B
4. Interim Conditions Phase 2
5. Ultimate Conditions

Drainage boundaries and flow nodes have been delineated and drainage schematics have been developed to clearly illustrate drainage pathways under all scenarios (Figure 6.1, 6.2, and 6.3).

6.3.2 Hydrologic Model Results

Event-based hydrologic simulation has been carried out under all development scenarios. Table 6.1 summarizes the hydrologic model results for Node 4 located downstream of Dundas Street. The rest of the results corresponding to culverts and reference nodes are summarized in Table 6.2

Table 6.1 Peak Flows under all Development Scenarios

Return Period	Existing Peak Flows (cms)	Existing Peak Flow (cms)	Interim P1A - Peak Flow (cms)	Interim P1B - Peak Flow (cms)	Interim P2 - Peak Flow (cms)	Ultimate Peak Flow (cms)
Gawser ID	**UFR with MMM Revised Catchment**	**2444**	**See Note ***	**See Note ***	**See Note ***	**See Note ***
Drainage Area (ha)	**402.03**	**402.02**	**401.69**	**398.75**	**411.73**	**397.77**
2-Yr	2.41	2.54	2.35	2.38	2.37	1.91
5-Yr	4.02	4.01	3.72	3.84	3.82	3.08
10-Yr	4.82	4.89	4.53	4.73	4.70	3.78
25-Yr	6.03	6.22	5.77	6.05	6.02	4.83
50-Yr	7.24	7.11	6.59	6.94	6.90	5.54
100-Yr	8.04	8.03	7.45	7.87	7.82	6.29
Regional	19.70	19.99	20.00	20.52	21.42	19.92

*Node 4 is located downstream of Culvert FM-D4. In the pre-development condition at Node 4 it is assumed that 100% of the runoff from FM-D3 will be conveyed to FM-D4. In the post-development condition, no runoff is conveyed through FM-D3, resulting in no change of flow conditions downstream of Culvert FM-D4.

*Interim P2 Scenario - Drainage Area to Node 3 includes Catchment 3000 which will be directed to SWM Pond 1.

Table 6.2. Peak Flows at Culverts and Reference Flow Nodes

EIR Nodes **FM-D2**

Return Period	Existing Peak Flows (cms)	Existing Peak Flow (cms)	Interim P1A - Peak Flow (cms)	Interim P1B - Peak Flow (cms)	Interim P2 - Peak Flow (cms)	Ultimate Peak Flow (cms)
Gawser ID	**UFR with MMM Revised Catchment**	**1102**	**1102**	**3300**	**3300**	**4000**
Drainage Area (ha)	**28.87**	**28.87**	**28.87**	**28.87**	**27.30**	**38.92**
25 mm 24 hr		0.05	0.05	0.05	0.04	0.01
2-Yr	0.20	0.20	0.20	0.20	0.19	0.06
5-Yr	0.32	0.32	0.32	0.32	0.30	0.14
10-Yr	0.38	0.39	0.39	0.39	0.37	0.19
25-Yr	0.49	0.50	0.50	0.50	0.48	0.26
50-Yr	0.58	0.58	0.58	0.58	0.55	0.30
100-Yr	0.64	0.66	0.66	0.65	0.62	0.34
Regional	1.56	1.56	1.56	1.56	1.47	1.10

EIR Nodes **FM-D3**

Return Period	Existing Peak Flows (cms)	Existing Peak Flow (cms)
Gawser ID	**UFR with MMM Revised Catchment**	**1103**
Drainage Area (ha)	**14.36**	**14.36**
25 mm 24 hr		0.03
2-Yr	0.14	0.15
5-Yr	0.23	0.23
10-Yr	0.29	0.27
25-Yr	0.34	0.34
50-Yr	0.39	0.39
100-Yr	0.45	0.44
Regional	0.93	0.93

EIR Nodes **FM-D4**

Return Period	Existing Peak Flows (cms)	Existing Peak Flow (cms)	Interim P1A - Peak Flow (cms)	Interim P1B - Peak Flow (cms)	Interim P2 - Peak Flow (cms)	Ultimate Peak Flow (cms)
Gawser ID	**UFR with MMM Revised Catchment**	**2034**	**1098**	**1098**	**1098**	**2034**
Drainage Area (ha)	**387.66**	**387.66**	**417.21**	**398.75**	**410.93**	**397.77**
25 mm 24 hr		0.50	0.49	0.52	0.53	0.44
2-Yr	2.33	2.40	2.35	2.38	2.37	1.91
5-Yr	3.88	3.81	3.72	3.84	3.82	3.08
10-Yr	4.65	4.64	4.53	4.73	4.70	3.78
25-Yr	5.82	5.91	5.77	6.05	6.02	4.83
50-Yr	6.98	6.75	6.59	6.94	6.90	5.54
100-Yr	7.75	7.63	7.45	7.87	7.82	6.29
Regional	19.00	19.13	20.00	20.52	21.42	19.92

EIR Nodes **FM-D4A**

Return Period	Existing Peak Flows (cms)	Existing Peak Flow (cms)	Interim P1A - Peak Flow (cms)	Interim P1B - Peak Flow (cms)	Interim P2 - Peak Flow (cms)	Ultimate Peak Flow (cms)
Gawser ID	**UFR with MMM Revised Catchment**	**1106**	**1106**	**1106**	**1106**	**1106**
Drainage Area (ha)	**15.19**	**15.19**	**15.19**	**15.19**	**12.97**	**12.97**
25 mm 24 hr		0.04	0.04	0.04	0.04	0.04
2-Yr	0.09	0.20	0.20	0.20	0.17	0.17
5-Yr	0.15	0.31	0.31	0.31	0.26	0.26
10-Yr	0.20	0.37	0.37	0.37	0.32	0.32
25-Yr	0.26	0.46	0.46	0.46	0.40	0.40
50-Yr	0.29	0.53	0.53	0.53	0.45	0.45
100-Yr	0.33	0.59	0.59	0.59	0.51	0.51
Regional	0.84	1.11	1.11	1.11	0.95	0.95

EIR Nodes FM-D5

Return Period	Existing Peak Flows (cms)	Existing Peak Flow (cms)	Interim P1A - Peak Flow (cms)	Interim P1B - Peak Flow (cms)	Interim P2 - Peak Flow (cms)	Ultimate Peak Flow (cms)
Gawser ID	**UFR with MMM Revised Catchment**	**2061**	**2061**	**2061**	**2061**	**2061**
Drainage Area (ha)	**343.4**	**343.3**	**343.3**	**343.3**	**338.85**	**338.85**
25 mm 24 hr		0.41	0.41	0.41	0.40	0.40
2-Yr	2.06	2.01	2.01	2.01	1.97	1.97
5-Yr	3.43	3.43	3.43	3.43	3.37	3.37
10-Yr	4.46	4.34	4.34	4.34	4.27	4.27
25-Yr	5.84	5.68	5.68	5.68	5.59	5.59
50-Yr	6.52	6.59	6.59	6.59	6.49	6.49
100-Yr	7.55	7.56	7.56	7.56	7.45	7.45
Regional	18.89	18.79	18.79	18.79	18.52	18.52

Reference Nodes 1

Return Period	Existing Peak Flows (cms)	Existing Peak Flow (cms)	Interim P1A - Peak Flow (cms)	Interim P1B - Peak Flow (cms)	Interim P2 - Peak Flow (cms)	Ultimate Peak Flow (cms)
Gawser ID	**UFR with MMM Revised Catchment**	**1999**	**3002**	**3999**	**3999**	**1999**
Drainage Area (ha)	**217.21**	**217.2**	**197.5**	**330.71**	**331.00**	**323.77**
25 mm 24 hr		0.29	0.26	0.48	0.48	0.38
2-Yr	1.30	1.43	1.30	2.27	2.27	1.81
5-Yr	2.17	2.24	2.04	3.67	3.67	2.93
10-Yr	2.61	2.71	2.46	4.51	4.52	3.60
25-Yr	3.26	3.43	3.12	5.79	5.79	4.60
50-Yr	3.91	3.90	3.55	6.63	6.64	5.28
100-Yr	4.34	4.41	4.01	7.52	7.52	6.00
Regional	10.64	10.87	9.89	17.30	17.32	16.58

Reference Nodes **1A**

Return Period	Existing Peak Flows (cms)	Existing Peak Flow (cms)	Interim P1A - Peak Flow (cms)	Interim P1B - Peak Flow (cms)	Interim P2 - Peak Flow (cms)	Ultimate Peak Flow (cms)
Gawser ID	**UFR with MMM Revised Catchment**	**3002**	**3002**	**2999**	**2999**	**2014**
Drainage Area (ha)	**199.4**	**199.39**	**197.5**	**197.86**	**197.86**	**190.63**
25 mm 24 hr		0.26	0.26	0.35	0.35	0.24
2-Yr	1.20	1.31	1.30	1.63	1.63	1.11
5-Yr	1.99	2.06	2.04	2.60	2.60	1.79
10-Yr	2.39	2.48	2.46	3.18	3.18	2.18
25-Yr	2.99	3.15	3.12	4.06	4.06	2.77
50-Yr	3.59	3.59	3.55	4.65	4.65	3.18
100-Yr	3.99	4.05	4.01	5.26	5.26	3.60
Regional	9.77	9.99	9.89	11.28	11.28	10.43

Reference Nodes **1B**

Return Period	Existing Peak Flows (cms)	Existing Peak Flow (cms)	Interim P1A - Peak Flow (cms)	Interim P1B - Peak Flow (cms)	Interim P2 - Peak Flow (cms)	Ultimate Peak Flow (cms)
Gawser ID	**UFR with MMM Revised Catchment**	**3001**	**3001**	**1999**	**1999**	**2013**
Drainage Area (ha)	**161.22**	**161.21**	**161.21**	**159.1**	**159.10**	**156.18**
25 mm 24 hr		0.205	0.205	0.202	0.202	0.200
2-Yr	0.967	1.056	1.056	0.972	0.972	0.964
5-Yr	1.612	1.659	1.659	1.571	1.571	1.547
10-Yr	1.935	2.007	2.007	1.926	1.926	1.889
25-Yr	2.418	2.547	2.547	2.473	2.473	2.418
50-Yr	2.902	2.904	2.904	2.840	2.840	2.772
100-Yr	3.224	3.280	3.280	3.222	3.222	3.141
Regional	7.900	8.095	8.095	8.120	8.120	7.844

Reference Nodes **2**

Return Period	Existing Peak Flows (cms)	Existing Peak Flow (cms)	Interim P1A - Peak Flow (cms)	Interim P1B - Peak Flow (cms)	Interim P2 - Peak Flow (cms)	Ultimate Peak Flow (cms)
Gawser ID	**UFR with MMM Revised Catchment**	**2033**	**2033**	**1086**	**1086**	**1089**
Drainage Area (ha)	**170.46**	**170.46**	**170.46**	**2.56**	**2.56**	**2.56**
25 mm 24 hr		0.21	0.21	0.03	0.03	0.03
2-Yr	1.02	0.99	0.99	0.05	0.05	0.05
5-Yr	1.70	1.59	1.59	0.07	0.07	0.07
10-Yr	2.05	1.96	1.96	0.08	0.08	0.08
25-Yr	2.56	2.52	2.52	0.09	0.09	0.09
50-Yr	3.07	2.89	2.89	0.10	0.10	0.10
100-Yr	3.41	3.28	3.28	0.11	0.11	0.11
Regional	8.35	8.32	8.32	0.19	0.19	0.19

Reference Nodes **3A**

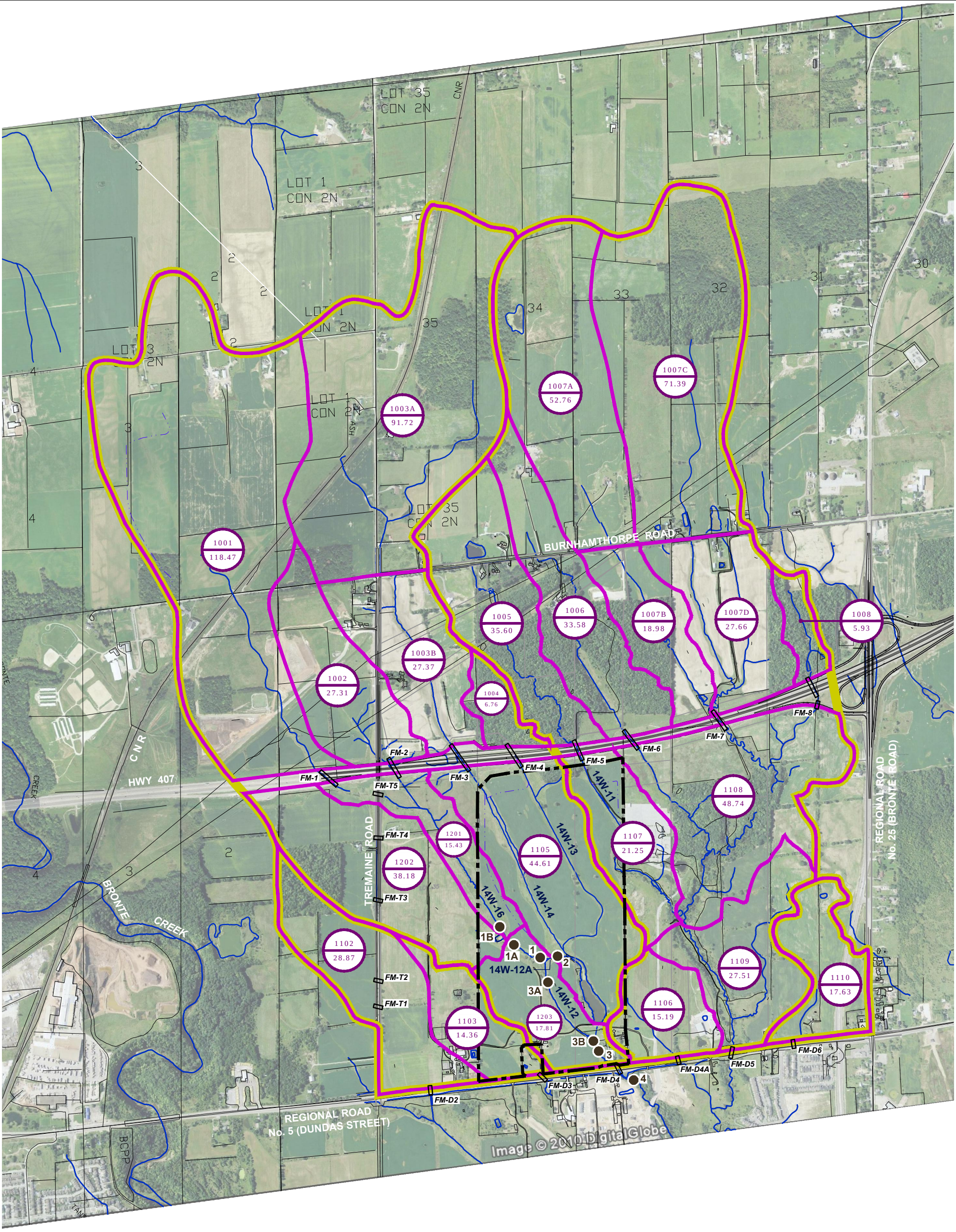
Return Period	Existing Peak Flows (cms)	Existing Peak Flow (cms)	Interim P1A - Peak Flow (cms)	Interim P1B - Peak Flow (cms)	Interim P2 - Peak Flow (cms)	Ultimate Peak Flow (cms)
Gawser ID	**UFR with MMM Revised Catchment**	**2034**	**2034**	**1087**	**1087**	**85**
Drainage Area (ha)	**387.67**	**387.66**	**367.96**	**333.27**	**333.56**	**326.33**
25 mm 24 hr		0.50	0.47	0.51	0.51	0.41
2-Yr	2.33	2.40	2.27	2.32	2.32	1.86
5-Yr	3.88	3.81	3.60	3.73	3.73	3.00
10-Yr	4.65	4.64	4.40	4.58	4.59	3.67
25-Yr	5.82	5.91	5.61	5.87	5.87	4.69
50-Yr	6.98	6.75	6.41	6.72	6.73	5.38
100-Yr	7.75	7.63	7.24	7.62	7.62	6.10
Regional	19.00	19.13	18.16	17.49	17.51	16.77

Reference Nodes **3B**

Return Period	Existing Peak Flows (cms)	Existing Peak Flow (cms)	Interim P1A - Peak Flow (cms)	Interim P1B - Peak Flow (cms)	Interim P2 - Peak Flow (cms)	Ultimate Peak Flow (cms)
Gawser ID	**UFR with MMM Revised Catchment**	**2034**	**90**	**2140**	**2040**	**2040**
Drainage Area (ha)	**387.67**	**387.66**	**376.98**	**374.04**	**383.25**	**376.37**
25 mm 24 hr		0.50	0.48	0.51	0.52	0.43
2-Yr	2.33	2.40	2.33	2.36	2.35	1.89
5-Yr	3.88	3.81	3.70	3.82	3.80	3.06
10-Yr	4.65	4.64	4.51	4.71	4.68	3.76
25-Yr	5.82	5.91	5.75	6.03	6.00	4.80
50-Yr	6.98	6.75	6.56	6.92	6.88	5.52
100-Yr	7.75	7.63	7.42	7.84	7.80	6.27
Regional	19.00	19.13	18.60	19.17	19.74	18.73

Reference Nodes **3**

Return Period	Existing Peak Flows (cms)	Existing Peak Flow (cms)	Interim P1A - Peak Flow (cms)	Interim P1B - Peak Flow (cms)	Interim P2 - Peak Flow (cms)	Ultimate Peak Flow (cms)
Gawser ID	**UFR with MMM Revised Catchment**	**2034**	**1098**	**1098**	**1098**	**2034**
Drainage Area (ha)	**387.67**	**387.66**	**401.69**	**398.75**	**411.73**	**397.77**
25 mm 24 hr		0.50	0.49	0.52	0.53	0.44
2-Yr	2.33	2.40	2.35	2.38	2.37	1.91
5-Yr	3.88	3.81	3.72	3.84	3.82	3.08
10-Yr	4.65	4.64	4.53	4.73	4.70	3.78
25-Yr	5.82	5.91	5.77	6.05	6.02	4.83
50-Yr	6.98	6.75	6.59	6.94	6.90	5.54
100-Yr	7.75	7.63	7.45	7.87	7.82	6.29
Regional	19.00	19.13	20.00	20.52	21.42	19.92



Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

Existing Drainage Boundaries and Reference Nodes (Revised from NOCSS by MMM)

LEGEND

- SUBJECT PROPERTY
- SUB-CATCHMENT BOUNDARY
- EIR SUB-CATCHMENT BOUNDARY
- EXISTING CREEK
- CULVERTS (EIR NODES)
- 1001 / 118.47 — SUB-CATCHMENT No. / AREA (ha)
- 1 — REFERENCE NODE

Scale: 1 : 15000 (0 0.1 0.25 0.5 0.75km)

Client: Bentall Kennedy

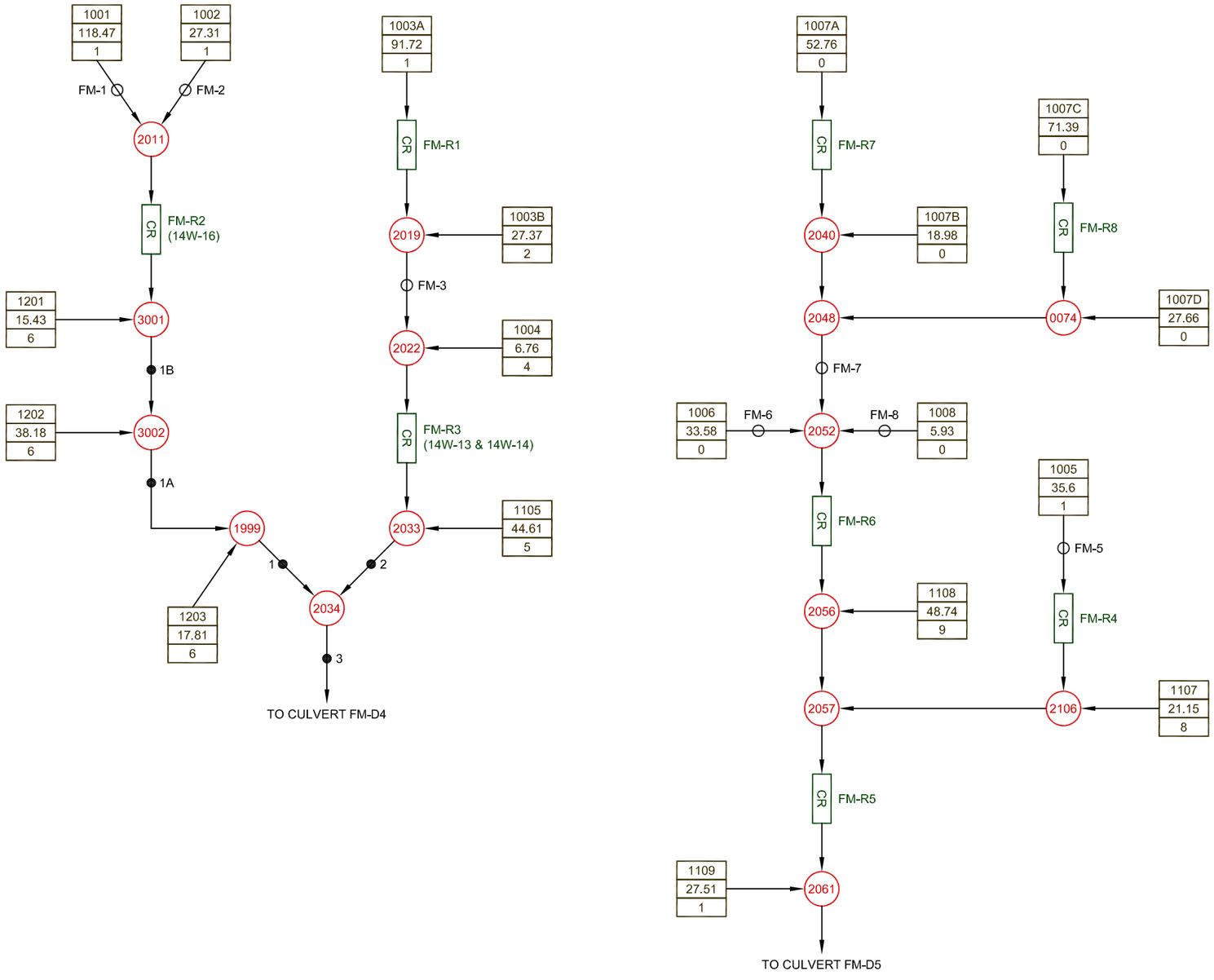
Prepared by: MMM GROUP

Date: September 2015

Project No.: 14-09222-001-WR1

Aerial Photo: © DigitalGlobe 2010, Google 2009

Figure 6.1



Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

Modelling Schematic - Existing Conditions

LEGEND

- 1105 / 44.61 / 5 — CATCHMENT ID. / CATCHMENT AREA (ha) / CATCHMENT IMPERVIOUSNESS (%)
- ADDHYD
- CR — CHANNEL ROUTING
- ROUTE RESERVOIR
- DIV — DIVERSION
- CULVERT (EIR NODE)
- REFERENCE NODE

Scale: N.T.S.

Client: Bentall Kennedy

Prepared by: MMM GROUP

Date: September 2015

Project No.: 14-09222-001-WR1

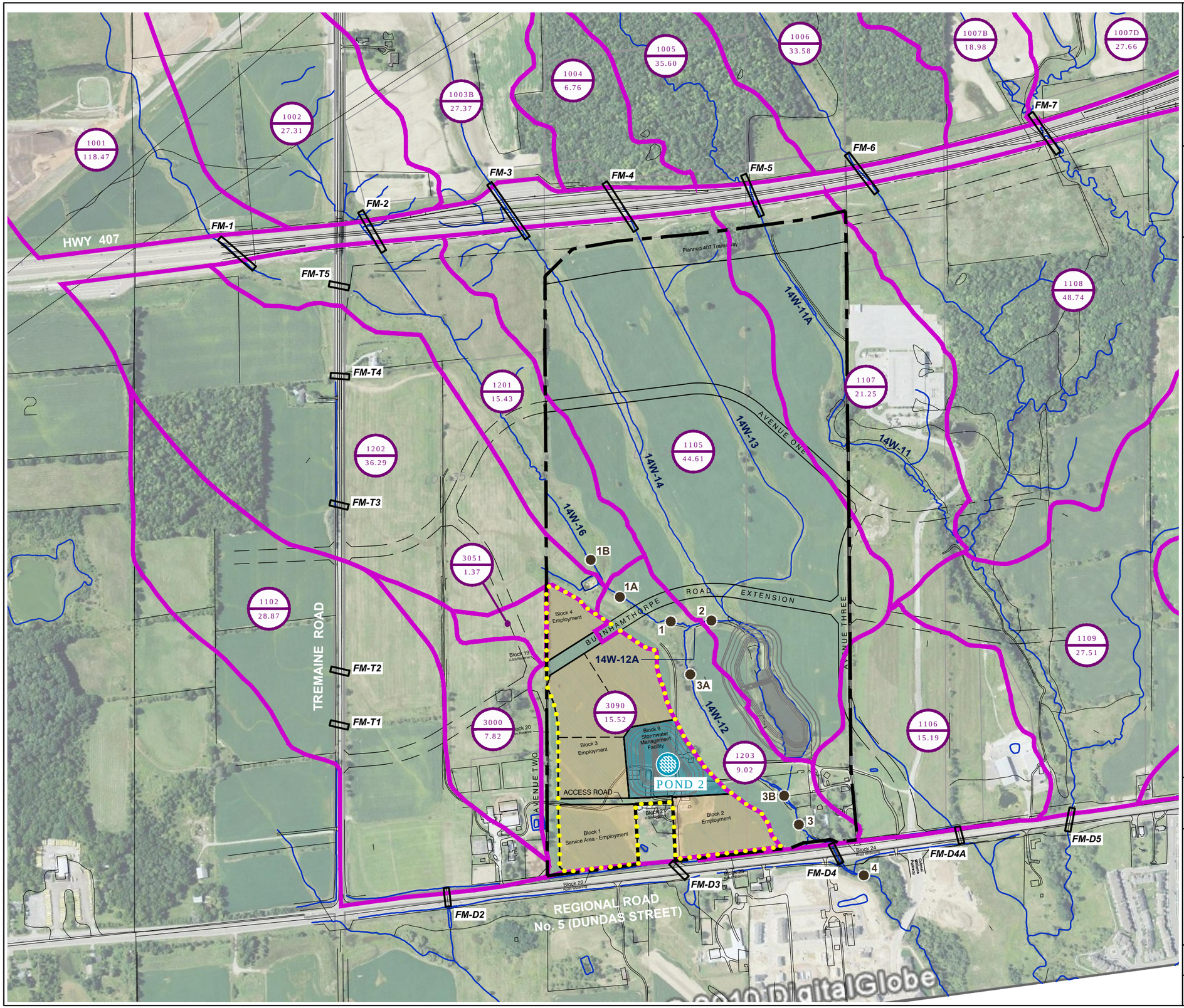
Aerial Photo

Figure 6.1-SCH

FIGURE SCHEMATICS.dwg FIGURE 6.1-SCH - Modelling Schematic - Existing Conditions S:\14-41\14\09222-001-WR1\REPORT 10 SEPTEMBER 2015\ Sep 16, 2015 - 3:04pm

Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

Interim Phase 1A Drainage Boundaries and Reference Nodes



LEGEND

- SUBJECT PROPERTY
- SUB-CATCHMENT BOUNDARY
- EXISTING CREEK
- PROPOSED REALIGNED CREEK
- CULVERTS (EIR NODES)
- SUB-CATCHMENT No. / AREA (ha) (e.g. 3000 / 7.82)
- PROPOSED SWM POND (INTERIM)
- 1 REFERENCE NODE
- DEVELOPMENT BOUNDARY
- DEVELOPMENT BLOCKS
- SWM BLOCK

Scale: 1 : 7500 (0, 100, 200, 300, 400m)

Client: Bentall Kennedy

Prepared by: MMM GROUP

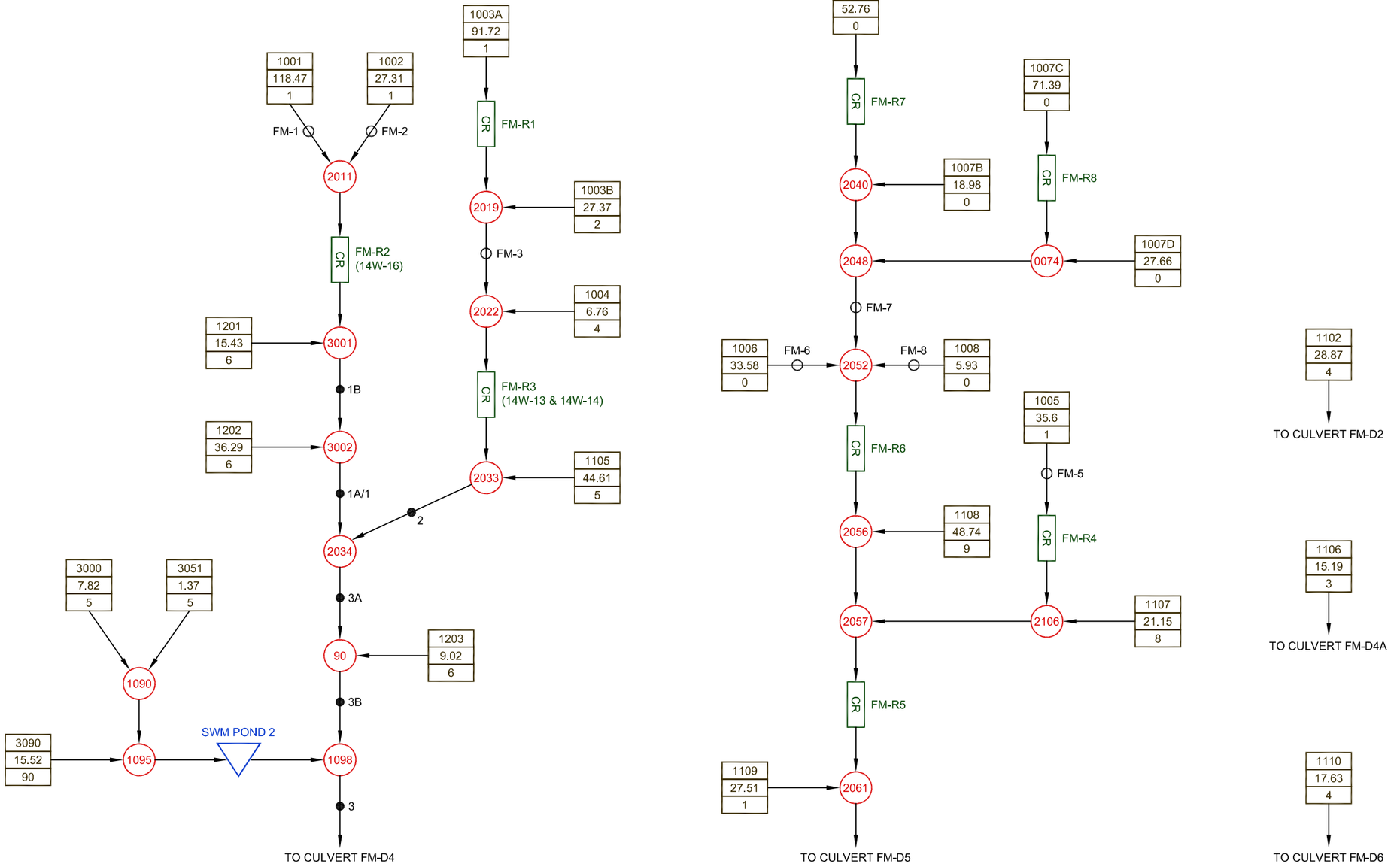
Date: September 2015

Project No.: 14-09222-001-WR1

Aerial Photo: © DigitalGlobe 2010, Google 2009

Figure 6.2-1A

FIGURE 6.2-1A.dwg - Interim Phase 1A Drainage Boundaries & Reference Nodes S:\14411\14009222-001-WR1\REPORT 10 SEPTEMBER 2015\ Sep 24, 2015 - 7:54pm



Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

Modelling Schematic - Interim Phase 1A Conditions

LEGEND

- 1105 / 44.61 / 5 — CATCHMENT ID. / CATCHMENT AREA (ha) / CATCHMENT IMPERVIOUSNESS (%)
- ADDHYD
- CR — CHANNEL ROUTING
- ROUTE RESERVOIR
- DIV — DIVERSION
- CULVERT (EIR NODE)
- REFERENCE NODE

Scale: N.T.S.

Client: Bentall Kennedy

Prepared by: MMM GROUP

Date: September 2015

Project No.: 14-09222-001-WR1

Aerial Photo

Figure 6.2-1A-SCH

FIGURE SCHEMATICS.dwg FIGURE 6.2-1A-SCH - Modelling Schematic - Interim Phase 1A Conditions S:\14-411\409222-001-WR1\REPORT 10 SEPTEMBER 2015\ Sep 16, 2015 - 3:09pm

Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

Interim Phase 1B Drainage Boundaries and Reference Nodes

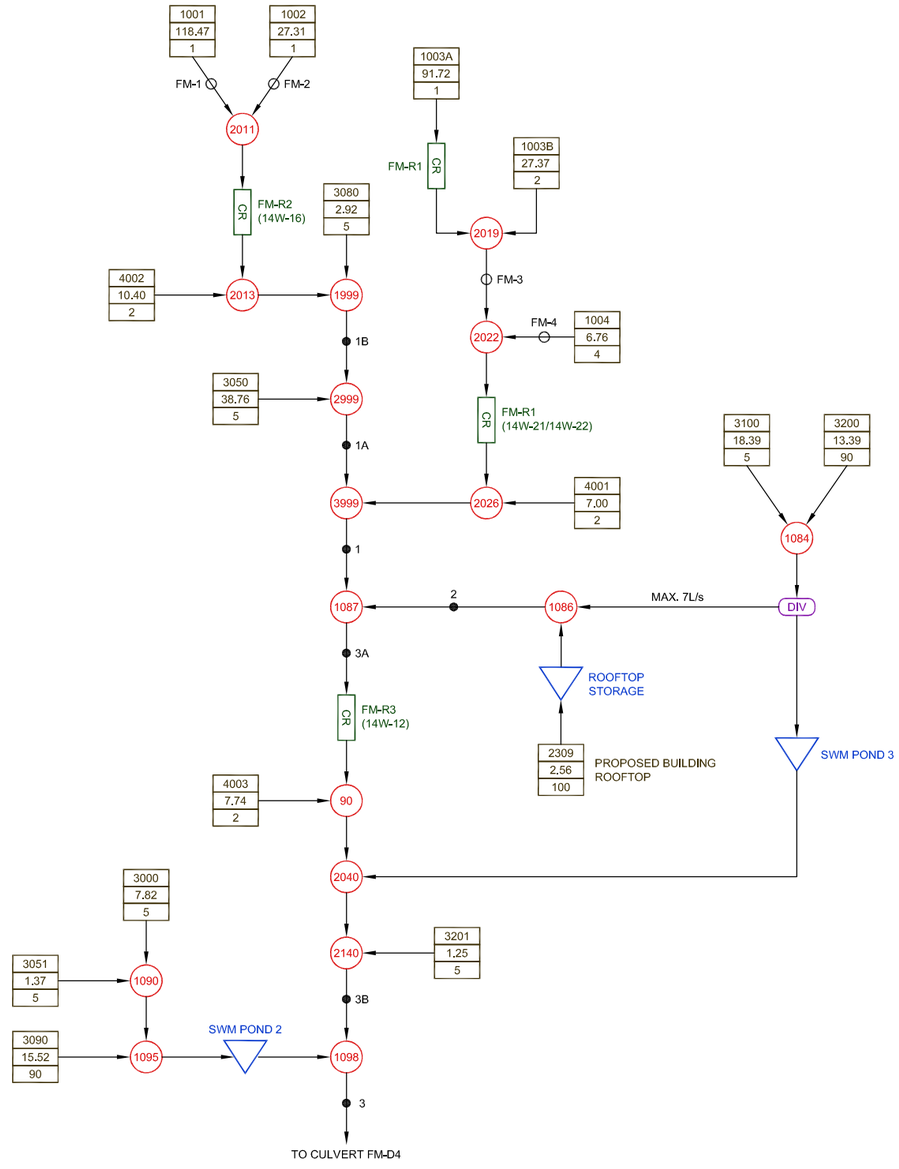
LEGEND

- SUBJECT PROPERTY
- SUB-CATCHMENT BOUNDARY
- EXISTING CREEK
- PROPOSED REALIGNED CREEK
- CULVERTS (EIR NODES)
- SUB-CATCHMENT No. / AREA (ha) (e.g. 3000 / 7.82)
- PROPOSED SWM POND (INTERIM)
- REFERENCE NODE (e.g. 1)
- DEVELOPMENT BOUNDARY
- DEVELOPMENT BLOCKS
- SWM BLOCKS

Scale: 1 : 7500 (0, 100, 200, 300, 400m)

Client	Prepared by
Bentall Kennedy	MMM GROUP
Date: September 2015	Project No.: 14-09222-001-WR1
Aerial Photo: © DigitalGlobe 2010, Google 2009	**Figure 6.2-1B**

FIGURE 6.2-1B.dwg - Interim Phase 1B Drainage Boundaries & Reference Nodes S:\14-411\14009222-001-WR1\REPORT 10 SEPTEMBER 2015\ Sep 24, 2015 - 9:00pm



Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

Modelling Schematic - Interim Phase 1B Conditions

LEGEND

- 1105 / 44.61 / 5 — CATCHMENT ID. / CATCHMENT AREA (ha) / CATCHMENT IMPERVIOUSNESS (%)
- ADDHYD
- CR — CHANNEL ROUTING
- ROUTE RESERVOIR
- DIV — DIVERSION
- CULVERT (EIR NODE)
- REFERENCE NODE

Scale: N.T.S.

Client: Bentall Kennedy

Prepared by: MMM GROUP

Date: September 2015

Project No.: 14-09222-001-WR1

Aerial Photo

Figure 6.2-1B-SCH

FIGURE SCHEMATICS.dwg FIGURE 6.2-1B-SCH - Modelling Schematic - Interim Phase 1B Conditions S:\14-411\14\09222-001-WR1\REPORT 10 SEPTEMBER 2015\ Sep 16, 2015 - 3:11pm

Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

Interim Phase 2 Drainage Boundaries and Reference Nodes

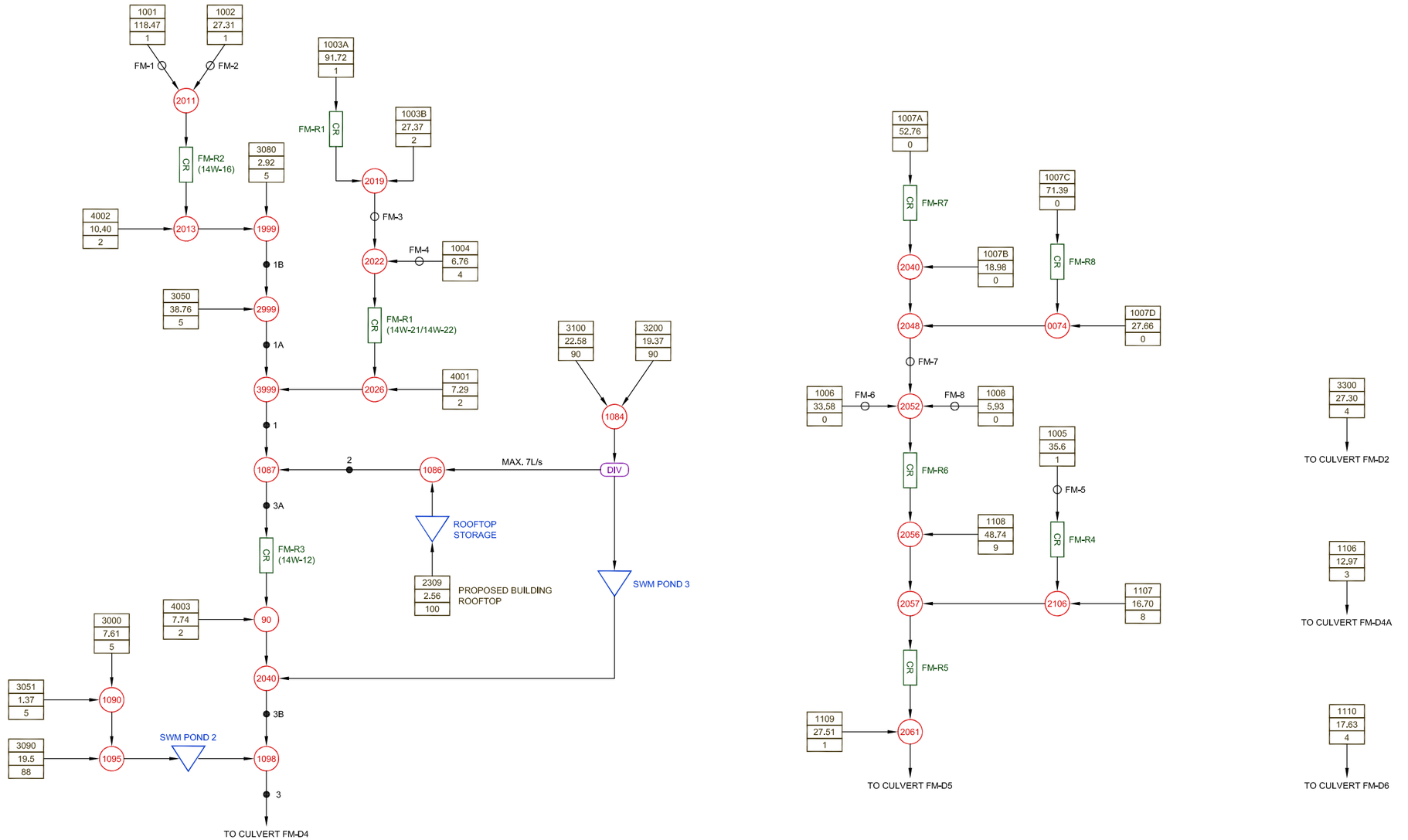
LEGEND

- SUBJECT PROPERTY
- SUB-CATCHMENT BOUNDARY
- EXISTING CREEK
- PROPOSED REALIGNED CREEK
- CULVERTS (EIR NODES)
- 3000 / 7.61 — SUB-CATCHMENT No. / AREA (ha)
- PROPOSED SWM POND (INTERIM)
- 1 — REFERENCE NODE
- DEVELOPMENT BOUNDARY
- DEVELOPMENT BLOCKS
- SWM BLOCKS

Scale: 1 : 7500 (0, 100, 200, 300, 400m)

Client	Prepared by
Bentall Kennedy	MMM GROUP
Date: September 2015	Project No.: 14-09222-001-WR1
Aerial Photo: © DigitalGlobe 2010, Google 2009	**Figure 6.2-2**

FIGURE 6.2-2.dwg - Interim Phase 2 Drainage Boundaries & Reference Nodes S:\14-41\14\09222-001-WR1\REPORT 10 SEPTEMBER 2015\ Sep 24, 2015 - 9:59pm



Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

Modelling Schematic - Interim Phase 2 Conditions

LEGEND

- 1105 / 44.61 / 5 — CATCHMENT ID. / CATCHMENT AREA (ha) / CATCHMENT IMPERVIOUSNESS (%)
- ADDHYD
- CR — CHANNEL ROUTING
- ROUTE RESERVOIR
- DIV — DIVERSION
- CULVERT (EIR NODE)
- REFERENCE NODE

Scale: N.T.S.

Client: Bentall Kennedy

Prepared by: MMM GROUP

Date: September 2015

Project No.: 14-09222-001-WR1

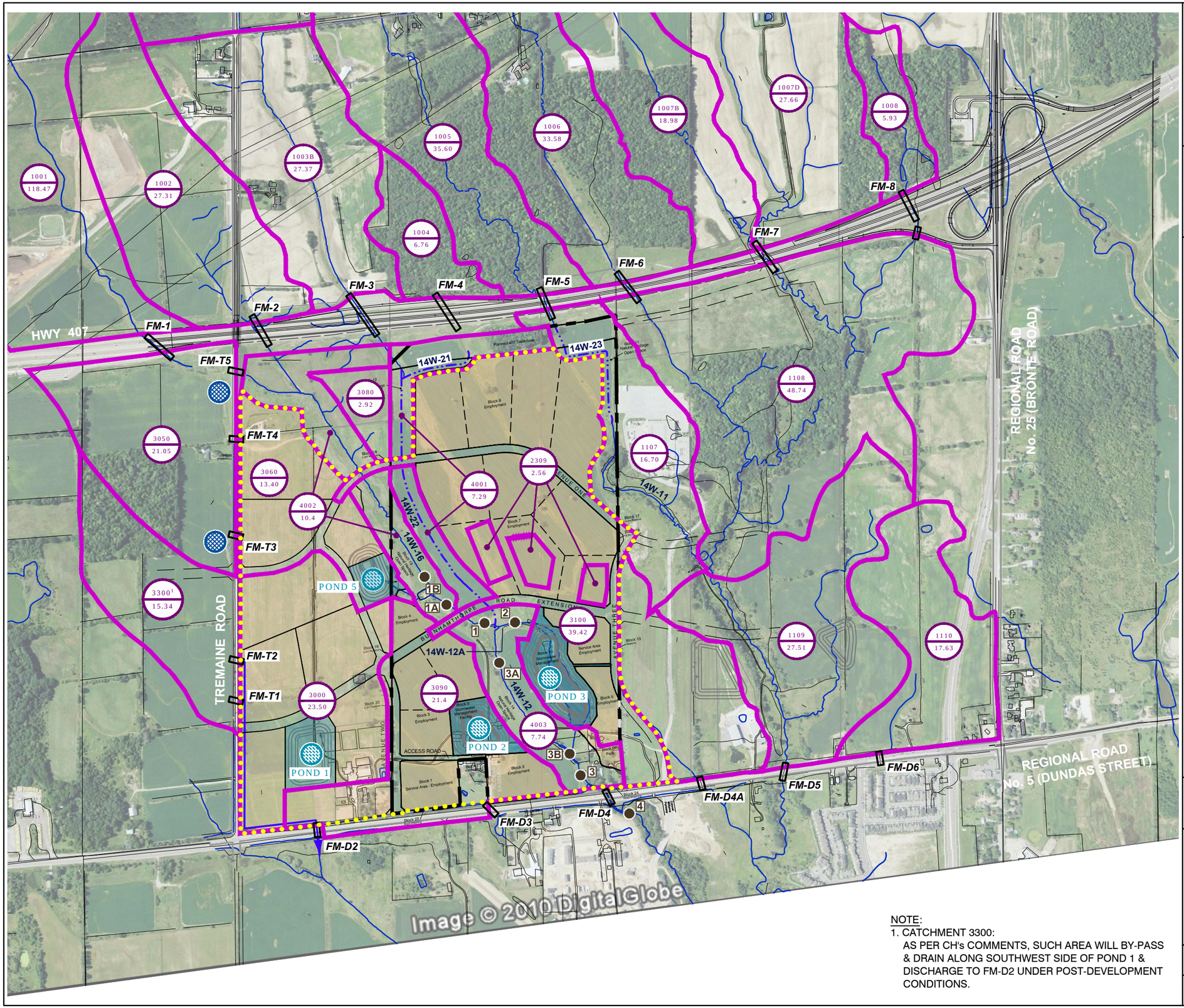
Aerial Photo

Figure 6.2-2-SCH

FIGURE SCHEMATICS.dwg FIGURE 6.2-2-SCH - Modelling Schematic - Interim Phase 2 Conditions S:\14-4\1\14\09222-001-WR1\REPORT 10 SEPTEMBER 2015\ Sep 16, 2015 - 3:13pm

Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

Ultimate Drainage Boundaries and Reference Nodes



NOTE:
1. CATCHMENT 3300:
AS PER CH's COMMENTS, SUCH AREA WILL BY-PASS & DRAIN ALONG SOUTHWEST SIDE OF POND 1 & DISCHARGE TO FM-D2 UNDER POST-DEVELOPMENT CONDITIONS.

LEGEND

- SUBJECT PROPERTY
- SUB-CATCHMENT BOUNDARY
- EXISTING CREEK
- PROPOSED REALIGNED CREEK
- CULVERTS (EIR NODES)
- 3100 / 39.42 — SUB-CATCHMENT No. / AREA (ha)
- PROPOSED SWM POND (ULTIMATE)
- PROPOSED SWM POND (ULTIMATE) (TREMAINE AND DUNDAS SECONDARY PLAN SUBWATERSHED STUDY, 2009)
- 1 REFERENCE NODE
- DEVELOPMENT BOUNDARY
- DEVELOPMENT BLOCKS
- SWM BLOCKS

Scale: 1 : 10000 (0 0.1 0.2 0.3 0.4 0.5km)

Client: Bentall Kennedy

Prepared by: MMM GROUP

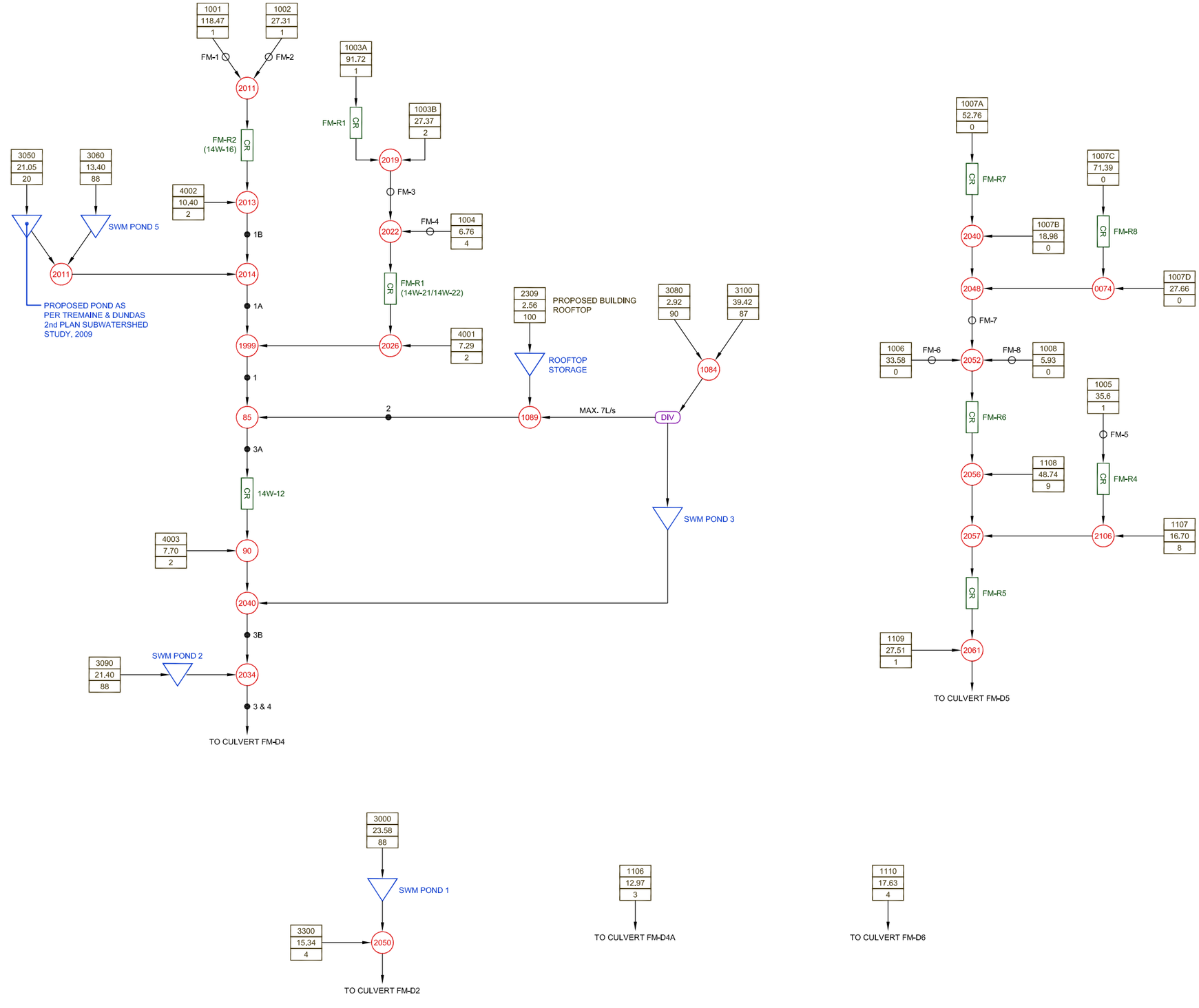
Date: September 2015

Project No.: 14-09222-001-WR1

Aerial Photo: © DigitalGlobe 2010, Google 2009

Figure 6.3

FIGURE 6.3.dwg - Ultimate Drainage Boundaries & Reference Nodes S:\14-4-11\14\09222-001-WR1\REPORT 10 SEPTEMBER 2015\ Sep 25, 2015 - 8:19am



Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

Modelling Schematic - Ultimate Conditions

LEGEND

- 1105 / 44.61 / 5 — CATCHMENT ID. / CATCHMENT AREA (ha) / CATCHMENT IMPERVIOUSNESS (%)
- ADDHYD
- CR — CHANNEL ROUTING
- ROUTE RESERVOIR
- DIV — DIVERSION
- CULVERT (EIR NODE)
- REFERENCE NODE

Scale: N.T.S.

Client: Bentall Kennedy

Prepared by: MMM GROUP

Date: September 2015

Project No.: 14-09222-001-WR1

Aerial Photo

Figure 6.3-SCH

FIGURE SCHEMATICS.dwg FIGURE 6.3-SCH - Modelling Schematic - Ultimate Conditions S:\14-41\14\09222-001-WR1\REPORT 10 SEPTEMBER 2015\ Sep 16, 2015 - 3:16pm

6.4 Hydraulics

6.4.1 Background

To demonstrate a functioning flood plain system associated with the creek corridors, creek channel corridors were modelled with the HEC-RAS hydraulic modelling software. Existing and Ultimate condition flood plain extents are illustrated in Figures 6.4.1 and 6.4.2. Interim conditions were also modelled. In all interim conditions, flood elevations were found to be lower in elevation than ultimate conditions. Therefore, mapping of interim conditions is covered by Figure 6.4.2, which illustrates sufficient creek corridor limits to contain all flood impacted areas through all stages of development. The HEC-RAS model for the reaches of the West Branch of Fourteen Mile Creek within our study limits were obtained from Conservation Halton (CH). The HEC-RAS model obtained from CH extended up to Lake Ontario (including HEC RAS model prepared for NOCSS and for the Flood Damage Assessment Study, Revised May, 1992).

6.4.2 Regional Flood Analysis

To determine the hydraulic impact of the proposed development within the study limits on the downstream properties along the Fourteen Mile Creek, the two models (HEC-RAS model prepared for NOCSS and new HEC-RAS model created from HEC-2) were combined, referred to hereinafter as the MMM hydraulic model. Additional information on the Colonel William Parkway Bridge, located approximately 170 m downstream of the Dundas Street culvert crossing was obtained from the Region of Halton for replicating the bridge crossing in the finalized existing and proposed condition MMM hydraulic models.

Table 6.3

Reach 14W-11 Existing Conditions. Please see Figure 6.4.1

HEC-RAS Plan: Existing SEP15 River: RIVER-3 Reach: Reach-1 Profile: Regional

Reach 14W-11

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Volume
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)		(1000 m3)
Reach-1	16	Regional	1.84	157.00	157.36	157.28	157.39	0.004764	0.73	2.52	14.07	0.55	15.36
Reach-1	15	Regional	1.84	156.92	157.06	157.06	157.11	0.022770	1.05	1.80	20.10	1.08	15.30
Reach-1	14	Regional	1.84	155.00	155.30		155.33	0.003677	0.78	2.34	9.63	0.51	14.98
Reach-1	13	Regional	2.80	154.97	155.24	155.14	155.25	0.002835	0.58	4.85	26.08	0.43	14.90
Reach-1	12	Regional	2.80	153.95	154.07	154.07	154.13	0.028240	1.12	2.55	29.81	1.20	14.27
Reach-1	11	Regional	2.80	152.00	152.68		152.68	0.000040	0.16	19.84	34.35	0.06	10.84
Reach-1	10	Regional	2.80	150.20	152.68		152.68	0.000002	0.09	53.53	36.75	0.02	2.17
Reach-1	9	Regional	2.80	149.70	152.67	150.68	152.68	0.002404	0.51	5.45	30.10	0.39	1.02
Reach-1	8.5		Culvert										
Reach-1	8	Regional	2.80	149.30	150.29	150.29	150.79	0.008925	3.13	0.89	22.22	1.00	0.21
Reach-1	7	Regional	2.80	147.50	147.80	147.73	147.84	0.005401	0.89	3.15	14.40	0.61	

Reach 14W-11 / Reach 14W-23 Proposed Conditions. Please see Figure 6.4.2

HEC-RAS Plan: Proposed SEP15 River: RIVER-3 Reach: Reach-1 Profile: Regional

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Volume
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)		(1000 m3)
Reach-1	16	Regional	1.84	157.00	157.36	157.28	157.39	0.004647	0.72	2.54	14.14	0.54	14.57
Reach-1	15	Regional	1.84	156.92	157.06	157.06	157.11	0.022770	1.05	1.80	20.10	1.08	14.51
Reach-1	14	Regional	1.84	155.00	155.45		155.46	0.000825	0.47	3.93	11.37	0.25	14.07
Reach-1	13	Regional	3.10	154.97	155.44		155.45	0.000325	0.28	11.10	34.98	0.16	13.90
Reach-1	12.9	Regional	3.10	154.70	155.34		155.40	0.005486	1.59	4.36	11.57	0.69	13.51
Reach-1	12.8	Regional	3.10	154.41	155.05	154.93	155.10	0.005352	1.58	4.40	11.61	0.69	13.27
Reach-1	12.7	Regional	3.10	154.11	154.74	154.63	154.80	0.005525	1.60	4.36	11.58	0.70	13.03
Reach-1	12.6	Regional	3.10	153.78	154.41		154.47	0.005707	1.61	4.31	11.56	0.71	12.77
Reach-1	12.5	Regional	3.10	153.44	154.08	153.95	154.13	0.005273	1.57	4.43	11.62	0.68	12.50
Reach-1	12.4	Regional	3.10	153.19	153.83	153.71	153.88	0.005288	1.57	4.42	11.62	0.68	12.29
Reach-1	12.3	Regional	3.10	152.96	153.66	153.47	153.70	0.003353	1.35	5.19	12.10	0.55	12.09
Reach-1	12.2	Regional	3.10	152.46	152.97	152.97	153.10	0.016362	2.31	2.99	10.85	1.15	11.71
Reach-1	11	Regional	3.10	152.00	152.69		152.69	0.000046	0.18	20.17	34.50	0.07	10.96
Reach-1	10	Regional	3.10	150.20	152.69		152.69	0.000003	0.10	53.87	36.85	0.02	2.21
Reach-1	9	Regional	3.10	149.70	152.67	150.75	152.69	0.002598	0.55	5.67	30.15	0.40	1.05
Reach-1	8.5		Culvert										
Reach-1	8	Regional	3.10	149.30	150.36	150.36	150.90	0.008745	3.24	0.96	22.98	1.01	0.24
Reach-1	7	Regional	3.10	147.50	147.82	147.74	147.86	0.005401	0.92	3.38	14.73	0.61	

Reach 14W-11 Reach 14W-23

Reach 14W-14 / Reach 14W-16 / Reach 14W-12 Existing & Proposed Conditions. Please see Figure 6.4.1 & Figure 6.4.2

HEC-RAS Profile: Regional

River	Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
					(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
RIVER-2	Reach-2A	228	Regional	UltimateSEP15	5.95	153.98	154.19		154.22	0.006415	0.78	7.60	47.92	0.63
RIVER-2	Reach-2A	228	Regional	MMM ECUltSEP15	5.95	153.98	154.19		154.22	0.006392	0.78	7.61	47.94	0.63
RIVER-2	Reach-2A	227	Regional	UltimateSEP15	5.95	153.04	153.30	153.29	153.37	0.011802	1.22	5.18	32.09	0.88
RIVER-2	Reach-2A	227	Regional	MMM ECUltSEP15	5.95	153.04	153.30	153.29	153.37	0.011851	1.22	5.17	32.08	0.88
RIVER-2	Reach-2A	226	Regional	UltimateSEP15	5.95	152.44	152.70		152.72	0.003980	0.71	8.39	42.83	0.51
RIVER-2	Reach-2A	226	Regional	MMM ECUltSEP15	5.95	152.44	152.70		152.72	0.003920	0.71	8.43	42.90	0.51
RIVER-2	Reach-2A	225	Regional	UltimateSEP15	5.95	151.75	152.21		152.26	0.005224	1.15	8.84	49.03	0.64
RIVER-2	Reach-2A	225	Regional	MMM ECUltSEP15	5.95	151.75	152.21		152.26	0.005338	1.16	8.75	48.79	0.64
RIVER-2	Reach-2A	224	Regional	UltimateSEP15	5.95	151.25	151.64	151.59	151.71	0.005916	1.33	7.83	35.49	0.69
RIVER-2	Reach-2A	224	Regional	MMM ECUltSEP15	5.95	151.25	151.65	151.59	151.71	0.005760	1.32	7.92	35.65	0.69
RIVER-2	Reach-2A	223	Regional	UltimateSEP15	5.95	150.26	150.93	150.93	151.02	0.007958	1.67	7.14	31.94	0.80
RIVER-2	Reach-2A	223	Regional	MMM ECUltSEP15	5.95	150.26	150.92	150.92	151.02	0.008218	1.69	7.05	31.90	0.82
RIVER-2	Reach-2A	222	Regional	UltimateSEP15	5.95	149.74	150.27	150.23	150.33	0.005425	1.37	9.60	48.89	0.67
RIVER-2	Reach-2A	222	Regional	MMM ECUltSEP15	5.95	149.74	150.28		150.33	0.004869	1.32	10.05	49.62	0.64
RIVER-2	Reach-2A	221	Regional	UltimateSEP15	5.95	149.23	149.68	149.63	149.76	0.006001	1.38	6.83	32.64	0.70
RIVER-2	Reach-2A	221	Regional	MMM ECUltSEP15	5.95	149.23	149.67	149.63	149.76	0.006948	1.45	6.38	31.44	0.75
RIVER-2	Reach-2A	220	Regional	UltimateSEP15	5.95	148.25	149.04	149.04	149.14	0.006488	1.46	7.54	58.71	0.73
RIVER-2	Reach-2A	220	Regional	MMM ECUltSEP15	5.95	148.25	149.06	149.06	149.14	0.005610	1.37	8.28	59.28	0.68
RIVER-2	Reach-1A	210.5	Regional	UltimateSEP15	7.33	155.11	155.52	155.47	155.54	0.006628	0.67	10.99	90.48	0.61
RIVER-2	Reach-1A	210.5	Regional	MMM ECUltSEP15	7.84	155.11	155.53	155.48	155.55	0.006408	0.67	11.66	92.50	0.60
RIVER-2	Reach-1A	210	Regional	UltimateSEP15	7.33	154.96	155.24	155.20	155.28	0.007917	0.92	7.96	45.95	0.71
RIVER-2	Reach-1A	210	Regional	MMM ECUltSEP15	7.84	154.96	155.25	155.20	155.29	0.007869	0.94	8.37	46.90	0.71
RIVER-2	Reach-1A	209	Regional	UltimateSEP15	7.33	154.46	154.71		154.74	0.003408	0.75	14.03	73.98	0.49
RIVER-2	Reach-1A	209	Regional	MMM ECUltSEP15	7.84	154.46	154.72		154.75	0.003412	0.77	14.69	74.48	0.49
RIVER-2	Reach-1A	208.3	Regional	UltimateSEP15	7.33	152.95	153.37	153.37	153.47	0.015056	1.38	5.32	27.17	0.99
RIVER-2	Reach-1A	208.3	Regional	MMM ECUltSEP15	7.84	152.95	153.39	153.39	153.48	0.014937	1.40	5.61	27.91	0.99
RIVER-2	Reach-1A	208.2	Regional	UltimateSEP15	7.33	152.50	152.94		152.99	0.005289	0.99	7.44	28.60	0.62
RIVER-2	Reach-1A	208.2	Regional	MMM ECUltSEP15	7.84	152.50	152.96		153.01	0.005344	1.01	7.79	29.27	0.62
RIVER-2	Reach-1A	208.1	Regional	UltimateSEP15	7.33	152.50	152.84		152.87	0.002321	0.75	10.91	41.13	0.42
RIVER-2	Reach-1A	208.1	Regional	MMM ECUltSEP15	7.84	152.50	152.84		152.87	0.002630	0.80	10.95	41.17	0.45
RIVER-2	Reach-1A	208	Regional	UltimateSEP15	8.09	151.00	152.20	152.20	152.41	0.009637	2.10	4.70	15.96	0.91
RIVER-2	Reach-1A	208	Regional	MMM ECUltSEP15	7.84	151.00	152.19	152.19	152.40	0.009412	2.06	4.61	15.78	0.89
RIVER-2	Reach-1A	207	Regional	UltimateSEP15	8.09	150.25	151.00		151.03	0.002794	0.91	15.11	54.44	0.48
RIVER-2	Reach-1A	207	Regional	MMM ECUltSEP15	10.43	150.25	151.04		151.08	0.003277	1.05	17.06	55.52	0.52
RIVER-2	Reach-1A	206.3	Regional	UltimateSEP15	9.99	149.49	150.46	150.44	150.64	0.005963	2.07	8.96	27.10	0.76
RIVER-2	Reach-1A	206.3	Regional	MMM ECUltSEP15	10.43	149.49	150.46	150.45	150.65	0.006473	2.16	8.97	27.12	0.80
RIVER-2	Reach-1A	206.2	Regional	UltimateSEP15	9.99	149.25	150.24		150.34	0.005750	1.42	8.92	27.90	0.69
RIVER-2	Reach-1A	206.2	Regional	MMM ECUltSEP15	10.43	149.25	150.39		150.44	0.002196	1.06	13.35	34.58	0.45
RIVER-2	Reach-1A	206.1	Regional	UltimateSEP15	10.87	149.00	150.01		150.10	0.004858	1.45	10.15	30.36	0.65
RIVER-2	Reach-1A	206.1	Regional	MMM ECUltSEP15	16.58	149.00	150.06	150.02	150.23	0.007617	1.95	11.92	32.58	0.83
RIVER-2	Reach-1	205	Regional	UltimateSEP15	19.13	147.24	148.41	148.41	148.76	0.010678	2.63	7.27	10.54	1.01
RIVER-2	Reach-1	205	Regional	MMM ECUltSEP15	16.77	147.24	148.34	148.34	148.67	0.011014	2.55	6.56	10.19	1.02
RIVER-2	Reach-1	204.75	Regional	UltimateSEP15	19.13	146.00	147.95		148.03	0.001075	1.34	21.88	31.28	0.36
RIVER-2	Reach-1	204.75	Regional	MMM ECUltSEP15	16.77	146.00	147.92		147.98	0.000900	1.21	20.96	30.73	0.33
RIVER-2	Reach-1	204.7	Regional	UltimateSEP15	19.13	145.89	147.92	147.34	147.96	0.000441	0.99	31.20	45.78	0.24
RIVER-2	Reach-1	204.7	Regional	MMM ECUltSEP15	18.73	145.89	147.88	147.32	147.93	0.000460	1.00	29.66	43.93	0.25
RIVER-2	Reach-1	204.55	Regional	UltimateSEP15	19.13	145.49	147.03	147.03	147.74	0.007968	3.74	5.11	35.21	1.00
RIVER-2	Reach-1	204.55	Regional	MMM ECUltSEP15	18.73	145.49	147.01	147.01	147.71	0.007952	3.71	5.05	34.72	1.00
RIVER-2	Reach-1	204.5	Regional	UltimateSEP15	19.13	145.36	146.52	146.52	146.77	0.010698	2.25	8.94	22.62	0.98
RIVER-2	Reach-1	204.5	Regional	MMM ECUltSEP15	18.73	145.36	146.51	146.51	146.76	0.010775	2.23	8.76	22.44	0.98
RIVER-2	Reach-1	204.25	Regional	UltimateSEP15	19.13	145.11	146.28	146.28	146.51	0.009262	2.40	13.04	30.66	0.94
RIVER-2	Reach-1	204.25	Regional	MMM ECUltSEP15	18.73	145.11	146.27	146.27	146.50	0.009229	2.39	12.85	30.60	0.94
RIVER-2	Reach-1	204	Regional	UltimateSEP15	19.13	144.05	146.04		146.07	0.000364	0.93	42.62	34.68	0.22
RIVER-2	Reach-1	204	Regional	MMM ECUltSEP15	19.92	144.05	145.20		145.36	0.004797	2.20	17.27	26.01	0.72
RIVER-2	Reach-1	203	Regional	UltimateSEP15	19.13	142.50	146.05		146.06	0.000043	0.41	84.94	53.09	0.08
RIVER-2	Reach-1	203	Regional	MMM ECUltSEP15	19.92	142.50	145.26		145.28	0.000195	0.69	47.23	42.56	0.16
RIVER-2	Reach-1	202.75	Regional	UltimateSEP15	19.13	142.49	145.92	143.85	146.02	0.000369	1.45	13.15	47.26	0.25
RIVER-2	Reach-1	202.75	Regional	MMM ECUltSEP15	19.92	142.49	144.99	143.89	145.21	0.001140	2.07	9.61	38.33	0.42
RIVER-2	Reach-1	202.5			Culvert									
RIVER-2	Reach-1	202.25	Regional	UltimateSEP15	19.99	142.41	144.37	144.37	145.07	0.009707	3.71	5.38	16.60	1.00
RIVER-2	Reach-1	202.25	Regional	MMM ECUltSEP15	19.92	142.41	144.37	144.37	145.06	0.009675	3.71	5.38	16.59	1.00
RIVER-2	Reach-1	202	Regional	UltimateSEP15	19.99	142.20	143.04		143.17	0.005059	1.90	19.36	47.65	0.72
RIVER-2	Reach-1	202	Regional	MMM ECUltSEP15	19.92	142.20	143.03		143.17	0.005083	1.90	19.28	47.64	0.72

Reach 14W-14

Reach 14W-16

Reach 14W-12

Downstream Reaches

14 Mile Creek West System Downstream of Lazy Pat Site - Existing & Proposed Conditions.

HEC-RAS Profile: Regional (Continued)

Downstream Reaches

River	Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
					(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
RIVER-2	Reach-1	201	Regional	UltimateSEP15	19.99	141.65	142.99		143.05	0.001145	1.29	28.53	38.15	0.37
RIVER-2	Reach-1	201	Regional	MMM ECUltSEP15	19.92	141.65	142.99		143.05	0.001144	1.29	28.47	38.14	0.37
RIVER-2	Reach-1	171	Regional	UltimateSEP15	19.99	141.65	142.79	142.55	142.90	0.002339	1.65	21.36	34.99	0.52
RIVER-2	Reach-1	171	Regional	MMM ECUltSEP15	19.92	141.65	142.79	142.55	142.89	0.002335	1.65	21.31	34.97	0.51
RIVER-2	Reach-1	170			Bridge									
RIVER-2	Reach-1	169	Regional	UltimateSEP15	19.99	141.65	142.55	142.55	142.80	0.006981	2.39	13.44	31.14	0.85
RIVER-2	Reach-1	169	Regional	MMM ECUltSEP15	19.92	141.65	142.55	142.55	142.79	0.007021	2.39	13.37	31.10	0.85
RIVER-2	Reach-1	164	Regional	UltimateSEP15	19.99	138.30	139.10		139.19	0.005981	1.12	14.94	19.54	0.53
RIVER-2	Reach-1	164	Regional	MMM ECUltSEP15	19.92	138.30	139.10		139.19	0.005970	1.12	14.91	19.51	0.53
RIVER-2	Reach-1	163	Regional	UltimateSEP15	19.99	137.20	138.35		138.43	0.005213	1.78	23.33	58.65	0.57
RIVER-2	Reach-1	163	Regional	MMM ECUltSEP15	19.92	137.20	138.35		138.43	0.005214	1.78	23.28	58.64	0.57
RIVER-2	Reach-1	162	Regional	UltimateSEP15	19.99	135.60	136.62	136.62	136.84	0.017815	2.80	12.12	28.42	1.01
RIVER-2	Reach-1	162	Regional	MMM ECUltSEP15	19.92	135.60	136.62	136.62	136.84	0.017815	2.80	12.09	28.39	1.01
RIVER-2	Reach-1	161	Regional	UltimateSEP15	19.99	134.10	135.21	135.11	135.26	0.005243	1.58	25.60	66.83	0.55
RIVER-2	Reach-1	161	Regional	MMM ECUltSEP15	19.92	134.10	135.20	135.11	135.26	0.005271	1.58	25.50	66.82	0.55
RIVER-2	Reach-1	160	Regional	UltimateSEP15	19.99	132.50	133.83		133.87	0.003858	1.46	25.76	53.91	0.45
RIVER-2	Reach-1	160	Regional	MMM ECUltSEP15	19.92	132.50	133.83		133.87	0.003829	1.46	25.77	53.92	0.45
RIVER-1	Reach-1	79	Regional	UltimateSEP15	22.90	140.10	141.27	141.27	141.39	0.012768	2.31	19.94	67.81	0.83
RIVER-1	Reach-1	79	Regional	MMM ECUltSEP15	22.90	140.10	141.27	141.27	141.39	0.012768	2.31	19.94	67.81	0.83
RIVER-1	Reach-1	78	Regional	UltimateSEP15	22.90	137.50	138.75		138.81	0.003402	1.58	26.76	54.77	0.47
RIVER-1	Reach-1	78	Regional	MMM ECUltSEP15	22.90	137.50	138.75		138.81	0.003410	1.58	26.73	54.74	0.47
RIVER-1	Reach-1	77	Regional	UltimateSEP15	22.90	136.60	137.67	137.63	137.83	0.010647	2.46	16.87	40.74	0.80
RIVER-1	Reach-1	77	Regional	MMM ECUltSEP15	22.90	136.60	137.67	137.63	137.83	0.010592	2.46	16.90	40.79	0.80
RIVER-1	Reach-1	76	Regional	UltimateSEP15	22.90	134.60	135.69		135.82	0.012666	2.56	17.41	43.44	0.85
RIVER-1	Reach-1	76	Regional	MMM ECUltSEP15	22.90	134.60	135.69		135.82	0.012738	2.56	17.37	43.39	0.85
RIVER-1	Reach-1	75	Regional	UltimateSEP15	22.90	133.00	134.32	134.23	134.39	0.005838	1.79	24.91	64.81	0.57
RIVER-1	Reach-1	75	Regional	MMM ECUltSEP15	22.90	133.00	134.32	134.23	134.39	0.005810	1.79	24.95	64.84	0.57
RIVER-1	Reach-2	74	Regional	UltimateSEP15	22.88	130.40	131.51	131.51	131.69	0.012682	2.62	16.36	45.15	0.87
RIVER-1	Reach-2	74	Regional	MMM ECUltSEP15	23.06	130.40	131.51	131.51	131.69	0.012690	2.63	16.46	45.30	0.87
RIVER-1	Reach-2	73	Regional	UltimateSEP15	22.88	129.70	131.43		131.43	0.000423	0.70	58.60	67.93	0.17
RIVER-1	Reach-2	73	Regional	MMM ECUltSEP15	23.06	129.70	131.43		131.44	0.000423	0.70	58.90	68.03	0.17
RIVER-1	Reach-2	72	Regional	UltimateSEP15	22.88	128.50	131.42	130.90	131.43	0.000038	0.41	68.80	70.63	0.08
RIVER-1	Reach-2	72	Regional	MMM ECUltSEP15	23.06	128.50	131.42	130.90	131.43	0.000039	0.41	69.11	70.81	0.08
RIVER-1	Reach-2	71.5			Bridge									
RIVER-1	Reach-2	71	Regional	UltimateSEP15	22.88	128.50	130.30	130.30	130.51	0.003104	2.50	11.88	28.37	0.66
RIVER-1	Reach-2	71	Regional	MMM ECUltSEP15	23.06	128.50	130.30	130.30	130.52	0.003153	2.52	11.88	28.37	0.67
RIVER-1	Reach-2	70	Regional	UltimateSEP15	22.88	127.90	129.40	129.40	129.76	0.010512	2.76	10.25	18.95	0.78
RIVER-1	Reach-2	70	Regional	MMM ECUltSEP15	23.06	127.90	129.41	129.41	129.77	0.010559	2.77	10.31	19.05	0.78
RIVER-1	Reach-2	69	Regional	UltimateSEP15	22.88	126.50	128.15		128.30	0.003995	2.03	17.02	24.14	0.53
RIVER-1	Reach-2	69	Regional	MMM ECUltSEP15	23.06	126.50	128.16		128.31	0.003949	2.03	17.24	24.46	0.52
RIVER-1	Reach-2	68	Regional	UltimateSEP15	22.88	124.80	128.24		128.24	0.000009	0.15	226.92	108.58	0.03
RIVER-1	Reach-2	68	Regional	MMM ECUltSEP15	23.06	124.80	128.25		128.25	0.000009	0.15	227.85	108.68	0.03
RIVER-1	Reach-2	67	Regional	UltimateSEP15	89.70	123.70	127.96	125.78	128.21	0.000139	2.22	40.47	30.42	0.34
RIVER-1	Reach-2	67	Regional	MMM ECUltSEP15	89.93	123.70	127.97	125.79	128.22	0.000139	2.22	40.54	30.46	0.34
RIVER-1	Reach-2	66.5			Bridge									
RIVER-1	Reach-2	66	Regional	UltimateSEP15	89.70	123.70	126.91	125.79	127.35	0.000357	2.94	30.54	25.29	0.52
RIVER-1	Reach-2	66	Regional	MMM ECUltSEP15	89.93	123.70	126.92	125.79	127.36	0.000358	2.94	30.55	25.30	0.52
RIVER-1	Reach-2	65	Regional	UltimateSEP15	89.70	123.50	126.96		127.16	0.001765	2.26	60.79	40.45	0.40
RIVER-1	Reach-2	65	Regional	MMM ECUltSEP15	89.93	123.50	126.96		127.16	0.001768	2.26	60.89	40.49	0.40
RIVER-1	Reach-2	64	Regional	UltimateSEP15	89.70	122.10	127.02		127.03	0.000095	0.66	247.45	87.76	0.10
RIVER-1	Reach-2	64	Regional	MMM ECUltSEP15	89.93	122.10	127.02		127.03	0.000095	0.66	247.66	87.77	0.10
RIVER-1	Reach-2	63	Regional	UltimateSEP15	89.70	120.50	127.02	122.89	127.03	0.000006	0.60	291.43	105.98	0.08
RIVER-1	Reach-2	63	Regional	MMM ECUltSEP15	89.93	120.50	127.02	122.89	127.03	0.000006	0.60	291.69	106.05	0.08
RIVER-1	Reach-2	62.5			Bridge									
RIVER-1	Reach-2	62	Regional	UltimateSEP15	89.70	120.50	122.89	122.89	124.06	0.001448	4.79	18.73	28.62	1.00
RIVER-1	Reach-2	62	Regional	MMM ECUltSEP15	89.93	120.50	122.89	122.89	124.07	0.001449	4.80	18.75	28.65	1.00
RIVER-1	Reach-2	61	Regional	UltimateSEP15	89.70	120.50	122.73	122.73	123.11	0.011140	4.08	45.55	56.90	0.93
RIVER-1	Reach-2	61	Regional	MMM ECUltSEP15	89.93	120.50	122.73	122.73	123.12	0.011140	4.08	45.65	56.96	0.93
RIVER-1	Reach-2	60	Regional	UltimateSEP15	139.60	114.50	119.14	119.14	119.56	0.003354	3.98	99.97	101.37	0.61
RIVER-1	Reach-2	60	Regional	MMM ECUltSEP15	139.78	114.50	119.14	119.14	119.56	0.003357	3.98	100.06	101.37	0.61
RIVER-1	Reach-5	59	Regional	UltimateSEP15	123.40	114.00	117.88	117.88	118.25	0.005428	3.92	85.15	103.89	0.68

14 Mile Creek West System Downstream of Lazy Pat Site - Existing & Proposed Conditions.

HEC-RAS Profile: Regional (Continued)

Downstream Reaches

River	Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
					(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
RIVER-1	Reach-5	59	Regional	MMM ECUltSEP15	123.40	114.00	117.88	117.88	118.25	0.005428	3.92	85.15	103.89	0.68
RIVER-1	Reach-5	58	Regional	UltimateSEP15	123.40	113.00	116.57		116.75	0.002826	3.02	102.04	82.78	0.54
RIVER-1	Reach-5	58	Regional	MMM ECUltSEP15	123.40	113.00	116.57		116.75	0.002826	3.02	102.04	82.78	0.54
RIVER-1	Reach-5	57	Regional	UltimateSEP15	123.40	112.00	115.37	115.37	115.73	0.005447	4.01	81.78	90.54	0.74
RIVER-1	Reach-5	57	Regional	MMM ECUltSEP15	123.40	112.00	115.37	115.37	115.73	0.005447	4.01	81.78	90.54	0.74
RIVER-1	Reach-5	56	Regional	UltimateSEP15	123.40	110.00	113.83		113.94	0.002269	2.51	117.64	95.37	0.44
RIVER-1	Reach-5	56	Regional	MMM ECUltSEP15	123.40	110.00	113.83		113.94	0.002265	2.51	117.72	95.37	0.44
RIVER-1	Reach-5	55	Regional	UltimateSEP15	123.40	109.00	113.61		113.68	0.001035	1.94	137.92	76.08	0.30
RIVER-1	Reach-5	55	Regional	MMM ECUltSEP15	123.40	109.00	113.61		113.68	0.001032	1.94	138.02	76.09	0.30
RIVER-1	Reach-5	54	Regional	UltimateSEP15	192.41	108.00	112.36		112.82	0.006112	4.53	94.40	62.34	0.73
RIVER-1	Reach-5	54	Regional	MMM ECUltSEP15	192.67	108.00	112.36		112.82	0.006109	4.53	94.53	62.39	0.73
RIVER-1	Reach-5	53	Regional	UltimateSEP15	192.41	106.50	111.36		111.65	0.002254	3.44	117.10	53.67	0.51
RIVER-1	Reach-5	53	Regional	MMM ECUltSEP15	192.67	106.50	111.36		111.65	0.002255	3.44	117.21	53.67	0.51
RIVER-1	Reach-5	52	Regional	UltimateSEP15	192.41	105.50	109.88	109.85	110.65	0.006233	5.09	76.10	45.09	0.81
RIVER-1	Reach-5	52	Regional	MMM ECUltSEP15	192.67	105.50	109.88	109.85	110.65	0.006233	5.09	76.19	45.11	0.81
RIVER-1	Reach-5	51	Regional	UltimateSEP15	192.41	104.70	108.95		109.35	0.003708	3.97	99.79	54.57	0.63
RIVER-1	Reach-5	51	Regional	MMM ECUltSEP15	192.67	104.70	108.95		109.35	0.003716	3.98	99.81	54.57	0.64
RIVER-1	Reach-3	50	Regional	UltimateSEP15	134.40	104.00	108.46		108.61	0.001218	2.48	110.57	49.87	0.38
RIVER-1	Reach-3	50	Regional	MMM ECUltSEP15	134.40	104.00	108.46		108.61	0.001218	2.48	110.57	49.87	0.38
RIVER-1	Reach-3	49	Regional	UltimateSEP15	134.40	103.92	108.41		108.50	0.000560	1.56	116.43	47.74	0.26
RIVER-1	Reach-3	49	Regional	MMM ECUltSEP15	134.40	103.92	108.41		108.50	0.000560	1.56	116.43	47.74	0.26
RIVER-1	Reach-3	48	Regional	UltimateSEP15	134.40	103.63	108.39	105.97	108.48	0.000544	1.36	149.89	221.73	0.24
RIVER-1	Reach-3	48	Regional	MMM ECUltSEP15	134.40	103.63	108.39	105.97	108.48	0.000544	1.36	149.89	221.73	0.24
RIVER-1	Reach-3	47.5			Bridge									
RIVER-1	Reach-3	47	Regional	UltimateSEP15	134.40	103.63	105.97	105.97	106.85	0.010773	4.14	32.45	18.56	1.00
RIVER-1	Reach-3	47	Regional	MMM ECUltSEP15	134.40	103.63	105.97	105.97	106.85	0.010773	4.14	32.45	18.56	1.00
RIVER-1	Reach-3	46	Regional	UltimateSEP15	134.40	102.40	105.70		105.83	0.001382	1.97	100.02	57.32	0.38
RIVER-1	Reach-3	46	Regional	MMM ECUltSEP15	134.40	102.40	105.70		105.83	0.001382	1.97	100.02	57.32	0.38
RIVER-1	Reach-3	45	Regional	UltimateSEP15	134.40	101.48	104.46	104.46	105.37	0.009841	4.38	34.20	19.71	0.96
RIVER-1	Reach-3	45	Regional	MMM ECUltSEP15	134.40	101.48	104.46	104.46	105.37	0.009841	4.38	34.20	19.71	0.96
RIVER-1	Reach-3	44	Regional	UltimateSEP15	134.40	100.57	103.49	103.49	103.87	0.005837	3.40	76.33	95.30	0.73
RIVER-1	Reach-3	44	Regional	MMM ECUltSEP15	134.40	100.57	103.49	103.49	103.87	0.005837	3.40	76.33	95.30	0.73
RIVER-1	Reach-3	43	Regional	UltimateSEP15	134.40	100.28	103.16	102.33	103.59	0.002695	2.90	46.31	18.64	0.59
RIVER-1	Reach-3	43	Regional	MMM ECUltSEP15	134.40	100.28	103.16	102.33	103.59	0.002695	2.90	46.31	18.64	0.59
RIVER-1	Reach-3	42.5			Bridge									
RIVER-1	Reach-3	42	Regional	UltimateSEP15	134.40	100.28	102.33	102.33	103.26	0.008405	4.27	31.50	17.16	1.01
RIVER-1	Reach-3	42	Regional	MMM ECUltSEP15	134.40	100.28	102.33	102.33	103.26	0.008405	4.27	31.50	17.16	1.01
RIVER-1	Reach-3	41	Regional	UltimateSEP15	134.40	99.59	102.16		102.25	0.001507	1.87	139.83	136.34	0.44
RIVER-1	Reach-3	41	Regional	MMM ECUltSEP15	134.40	99.59	102.16		102.25	0.001507	1.87	139.83	136.34	0.44
RIVER-1	Reach-3	40	Regional	UltimateSEP15	134.40	98.66	101.42	101.42	101.86	0.006210	3.50	59.90	65.43	0.77
RIVER-1	Reach-3	40	Regional	MMM ECUltSEP15	134.40	98.66	101.42	101.42	101.86	0.006210	3.50	59.90	65.43	0.77
RIVER-1	Reach-3	39	Regional	UltimateSEP15	134.40	97.59	100.02	100.02	100.39	0.007927	3.42	60.64	81.62	0.82
RIVER-1	Reach-3	39	Regional	MMM ECUltSEP15	134.40	97.59	100.02	100.02	100.39	0.007927	3.42	60.64	81.62	0.82
RIVER-1	Reach-3	38	Regional	UltimateSEP15	134.40	96.42	100.10		100.11	0.000167	0.70	261.94	143.48	0.13
RIVER-1	Reach-3	38	Regional	MMM ECUltSEP15	134.40	96.42	100.10		100.11	0.000167	0.70	261.94	143.48	0.13
RIVER-1	Reach-3	37	Regional	UltimateSEP15	134.40	96.16	99.87	98.22	100.05	0.001623	1.87	71.88	26.65	0.36
RIVER-1	Reach-3	37	Regional	MMM ECUltSEP15	134.40	96.16	99.87	98.22	100.05	0.001623	1.87	71.88	26.65	0.36
RIVER-1	Reach-3	36.5			Bridge									
RIVER-1	Reach-3	36	Regional	UltimateSEP15	134.40	96.16	98.75		99.22	0.006235	3.02	44.47	22.25	0.68
RIVER-1	Reach-3	36	Regional	MMM ECUltSEP15	134.40	96.16	98.75		99.22	0.006235	3.02	44.47	22.25	0.68
RIVER-1	Reach-3	35	Regional	UltimateSEP15	134.40	95.39	98.67		98.79	0.001800	1.89	105.27	58.80	0.37
RIVER-1	Reach-3	35	Regional	MMM ECUltSEP15	134.40	95.39	98.67		98.79	0.001800	1.89	105.27	58.80	0.37
RIVER-1	Reach-3	34	Regional	UltimateSEP15	134.40	94.69	97.89		98.49	0.007246	3.43	39.15	15.89	0.70
RIVER-1	Reach-3	34	Regional	MMM ECUltSEP15	134.40	94.69	97.89		98.49	0.007246	3.43	39.15	15.89	0.70
RIVER-1	Reach-3	33	Regional	UltimateSEP15	134.40	94.49	97.90	96.80	98.27	0.002807	2.69	55.29	74.25	0.52
RIVER-1	Reach-3	33	Regional	MMM ECUltSEP15	134.40	94.49	97.90	96.80	98.27	0.002807	2.69	55.29	74.25	0.52
RIVER-1	Reach-3	32.5			Bridge									
RIVER-1	Reach-3	32	Regional	UltimateSEP15	134.40	94.49	96.80	96.80	97.78	0.011257	4.39	30.64	15.81	1.01
RIVER-1	Reach-3	32	Regional	MMM ECUltSEP15	134.40	94.49	96.80	96.80	97.78	0.011257	4.39	30.64	15.81	1.01
RIVER-1	Reach-3	31	Regional	UltimateSEP15	134.40	93.86	95.81	95.81	96.52	0.011652	3.71	36.20	26.34	1.01
RIVER-1	Reach-3	31	Regional	MMM ECUltSEP15	134.40	93.86	95.81	95.81	96.52	0.011652	3.71	36.20	26.34	1.01

14 Mile Creek West System Downstream of Lazy Pat Site - Existing & Proposed Conditions.

HEC-RAS Profile: Regional (Continued)

Downstream Reaches

River	Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
					(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
RIVER-1	Reach-3	30	Regional	UltimateSEP15	134.40	92.84	95.17		95.27	0.001868	1.48	97.41	67.77	0.41
RIVER-1	Reach-3	30	Regional	MMM ECUltSEP15	134.40	92.84	95.17		95.27	0.001868	1.48	97.41	67.77	0.41
RIVER-1	Reach-3	29	Regional	UltimateSEP15	134.40	91.98	94.41	94.41	94.84	0.006630	3.23	56.81	64.43	0.79
RIVER-1	Reach-3	29	Regional	MMM ECUltSEP15	134.40	91.98	94.41	94.41	94.84	0.006630	3.23	56.81	64.43	0.79
RIVER-1	Reach-3	28	Regional	UltimateSEP15	134.40	91.01	94.32		94.36	0.000601	1.21	159.66	98.40	0.25
RIVER-1	Reach-3	28	Regional	MMM ECUltSEP15	134.40	91.01	94.32		94.36	0.000601	1.21	159.66	98.40	0.25
RIVER-1	Reach-3	27	Regional	UltimateSEP15	134.40	90.13	94.29	92.54	94.32	0.000220	0.94	224.65	122.54	0.16
RIVER-1	Reach-3	27	Regional	MMM ECUltSEP15	134.40	90.13	94.29	92.54	94.32	0.000220	0.94	224.65	122.54	0.16
RIVER-1	Reach-6	26	Regional	UltimateSEP15	210.40	89.76	93.60	92.34	94.13	0.002755	3.22	68.71	64.15	0.54
RIVER-1	Reach-6	26	Regional	MMM ECUltSEP15	210.40	89.76	93.60	92.34	94.13	0.002755	3.22	68.71	64.15	0.54
RIVER-1	Reach-6	25.5			Bridge									
RIVER-1	Reach-6	25	Regional	UltimateSEP15	210.40	89.76	92.34	92.34	93.58	0.009796	4.93	42.66	17.41	1.01
RIVER-1	Reach-6	25	Regional	MMM ECUltSEP15	210.40	89.76	92.34	92.34	93.58	0.009796	4.93	42.66	17.41	1.01
RIVER-1	Reach-6	24	Regional	UltimateSEP15	210.40	89.23	91.32	91.32	91.69	0.013241	3.89	87.05	106.49	1.08
RIVER-1	Reach-6	24	Regional	MMM ECUltSEP15	210.40	89.23	91.32	91.32	91.69	0.013241	3.89	87.05	106.49	1.08
RIVER-1	Reach-6	23	Regional	UltimateSEP15	210.40	88.54	91.12		91.17	0.001238	1.31	212.88	155.43	0.31
RIVER-1	Reach-6	23	Regional	MMM ECUltSEP15	210.40	88.54	91.12		91.17	0.001238	1.31	212.88	155.43	0.31
RIVER-1	Reach-6	22	Regional	UltimateSEP15	210.40	88.39	90.49	90.05	90.97	0.004992	3.07	68.46	34.71	0.70
RIVER-1	Reach-6	22	Regional	MMM ECUltSEP15	210.40	88.39	90.49	90.05	90.97	0.004992	3.07	68.46	34.71	0.70
RIVER-1	Reach-6	21.5			Bridge									
RIVER-1	Reach-6	21	Regional	UltimateSEP15	210.40	88.39	90.11	90.05	90.84	0.009803	3.81	55.23	33.93	0.95
RIVER-1	Reach-6	21	Regional	MMM ECUltSEP15	210.40	88.39	90.11	90.05	90.84	0.009803	3.81	55.23	33.93	0.95
RIVER-1	Reach-6	20	Regional	UltimateSEP15	210.40	87.75	90.11		90.22	0.002772	2.19	156.09	124.30	0.57
RIVER-1	Reach-6	20	Regional	MMM ECUltSEP15	210.40	87.75	90.11		90.22	0.002772	2.19	156.09	124.30	0.57
RIVER-1	Reach-6	19	Regional	UltimateSEP15	210.40	86.37	89.78		89.96	0.002830	2.78	152.23	135.23	0.58
RIVER-1	Reach-6	19	Regional	MMM ECUltSEP15	210.40	86.37	89.78		89.96	0.002830	2.78	152.23	135.23	0.58
RIVER-1	Reach-6	18	Regional	UltimateSEP15	210.40	85.48	89.12	89.12	89.61	0.004379	3.91	104.16	95.96	0.77
RIVER-1	Reach-6	18	Regional	MMM ECUltSEP15	210.40	85.48	89.12	89.12	89.61	0.004379	3.91	104.16	95.96	0.77
RIVER-1	Reach-6	17	Regional	UltimateSEP15	210.40	84.02	88.73		88.86	0.000634	1.82	195.77	130.69	0.31
RIVER-1	Reach-6	17	Regional	MMM ECUltSEP15	210.40	84.02	88.73		88.86	0.000634	1.82	195.77	130.69	0.31
RIVER-1	Reach-6	16	Regional	UltimateSEP15	210.40	83.02	87.90	87.90	88.65	0.004232	4.56	81.68	53.56	0.67
RIVER-1	Reach-6	16	Regional	MMM ECUltSEP15	210.40	83.02	87.90	87.90	88.65	0.004232	4.56	81.68	53.56	0.67
RIVER-1	Reach-6	15	Regional	UltimateSEP15	210.40	82.84	87.11		87.61	0.003831	3.98	83.26	38.91	0.62
RIVER-1	Reach-6	15	Regional	MMM ECUltSEP15	210.40	82.84	87.11		87.61	0.003831	3.98	83.26	38.91	0.62
RIVER-1	Reach-6	14	Regional	UltimateSEP15	210.40	82.66	86.82	86.30	87.15	0.003024	3.50	111.76	66.94	0.55
RIVER-1	Reach-6	14	Regional	MMM ECUltSEP15	210.40	82.66	86.82	86.30	87.15	0.003024	3.50	111.76	66.94	0.55
RIVER-1	Reach-6	13	Regional	UltimateSEP15	210.40	82.60	86.85	84.76	87.00	0.000834	1.71	125.22	88.25	0.31
RIVER-1	Reach-6	13	Regional	MMM ECUltSEP15	210.40	82.60	86.85	84.76	87.00	0.000834	1.71	125.22	88.25	0.31
RIVER-1	Reach-6	12.5			Bridge									
RIVER-1	Reach-6	12	Regional	UltimateSEP15	210.40	82.60	85.72		86.06	0.002723	2.59	81.13	34.23	0.54
RIVER-1	Reach-6	12	Regional	MMM ECUltSEP15	210.40	82.60	85.72		86.06	0.002723	2.59	81.13	34.23	0.54
RIVER-1	Reach-6	11	Regional	UltimateSEP15	210.40	81.62	85.07	85.07	85.67	0.005469	3.64	67.95	56.41	0.76
RIVER-1	Reach-6	11	Regional	MMM ECUltSEP15	210.40	81.62	85.07	85.07	85.67	0.005469	3.64	67.95	56.41	0.76
RIVER-1	Reach-6	10	Regional	UltimateSEP15	210.40	80.96	84.23	84.20	85.07	0.008790	4.09	52.85	33.34	0.92
RIVER-1	Reach-6	10	Regional	MMM ECUltSEP15	210.40	80.96	84.23	84.20	85.07	0.008790	4.09	52.85	33.34	0.92
RIVER-1	Reach-6	9	Regional	UltimateSEP15	210.40	79.59	82.57	82.57	83.49	0.013953	4.25	49.46	27.26	1.01
RIVER-1	Reach-6	9	Regional	MMM ECUltSEP15	210.40	79.59	82.57	82.57	83.49	0.013953	4.25	49.46	27.26	1.01
RIVER-1	Reach-6	8	Regional	UltimateSEP15	210.40	78.40	81.91		82.48	0.003749	3.34	63.06	28.33	0.71
RIVER-1	Reach-6	8	Regional	MMM ECUltSEP15	210.40	78.40	81.91		82.48	0.003749	3.34	63.06	28.33	0.71
RIVER-1	Reach-6	7	Regional	UltimateSEP15	210.40	77.43	82.22	80.01	82.25	0.000282	0.92	263.34	140.81	0.16
RIVER-1	Reach-6	7	Regional	MMM ECUltSEP15	210.40	77.43	82.22	80.01	82.25	0.000282	0.92	263.34	140.81	0.16
RIVER-1	Reach-6	6	Regional	UltimateSEP15	210.40	77.24	82.05	79.66	82.21	0.000562	1.78	142.24	152.44	0.30
RIVER-1	Reach-6	6	Regional	MMM ECUltSEP15	210.40	77.24	82.05	79.66	82.21	0.000562	1.78	142.24	152.44	0.30
RIVER-1	Reach-6	5.5			Bridge									
RIVER-1	Reach-6	5	Regional	UltimateSEP15	210.40	77.24	79.69	79.66	80.65	0.007265	4.34	48.53	24.55	0.98
RIVER-1	Reach-6	5	Regional	MMM ECUltSEP15	210.40	77.24	79.69	79.66	80.65	0.007265	4.34	48.53	24.55	0.98
RIVER-1	Reach-6	4	Regional	UltimateSEP15	210.40	76.51	79.39	79.39	80.02	0.007440	4.69	120.25	88.68	1.01
RIVER-1	Reach-6	4	Regional	MMM ECUltSEP15	210.40	76.51	79.39	79.39	80.02	0.007440	4.69	120.25	88.68	1.01
RIVER-1	Reach-6	3	Regional	UltimateSEP15	210.40	75.06	77.79	77.79	78.36	0.007813	4.66	129.56	111.08	1.03
RIVER-1	Reach-6	3	Regional	MMM ECUltSEP15	210.40	75.06	77.79	77.79	78.36	0.007813	4.66	129.56	111.08	1.03
RIVER-1	Reach-6	2	Regional	UltimateSEP15	210.40	73.69	76.70		77.11	0.004027	3.45	148.20	120.23	0.76
RIVER-1	Reach-6	2	Regional	MMM ECUltSEP15	210.40	73.69	76.70		77.11	0.004048	3.46	147.89	120.20	0.76

14 Mile Creek West System Downstream of Lazy Pat Site - Existing & Proposed Conditions.

Downstream Reaches

HEC-RAS Profile: Regional (Continued)

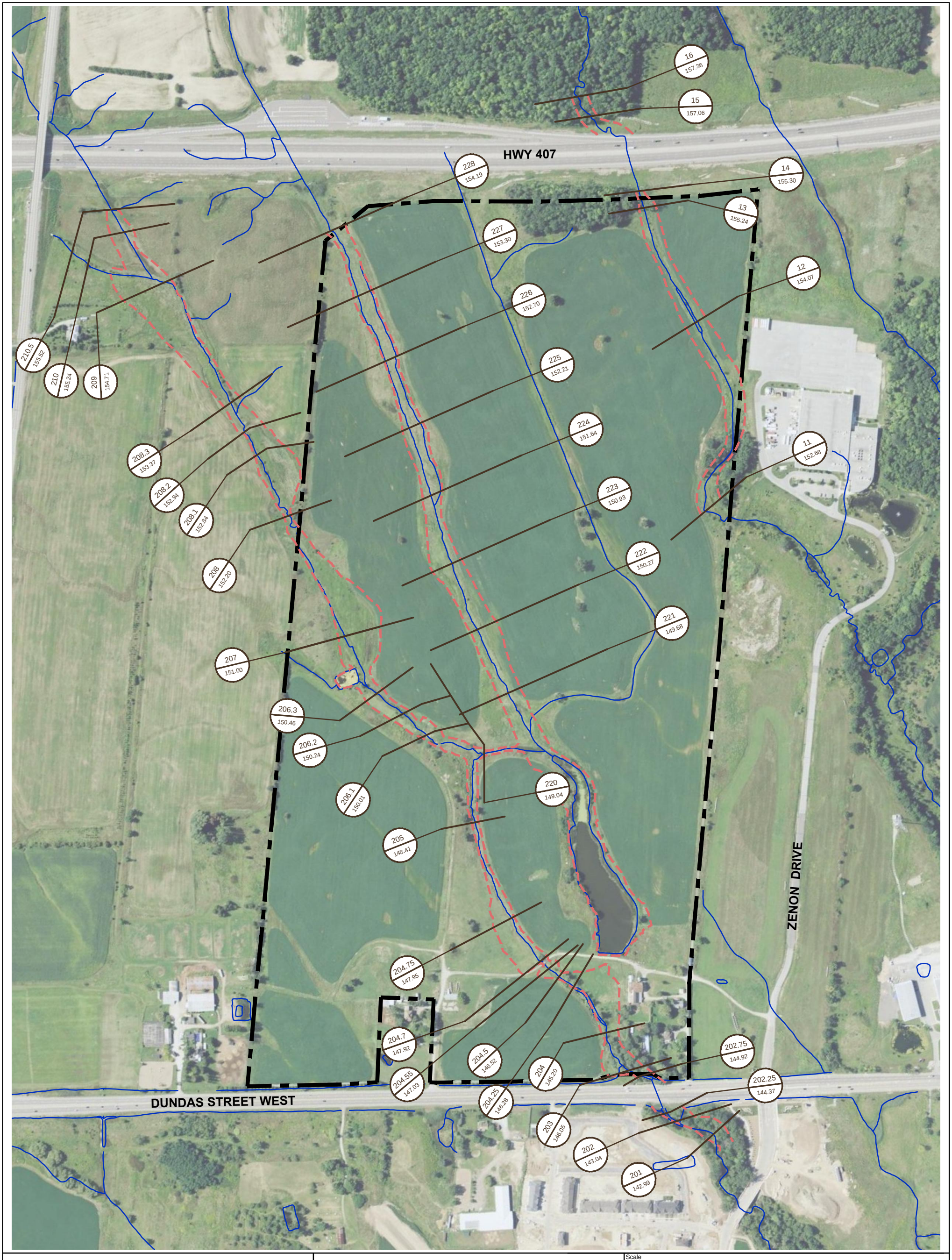
River	Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
					(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
RIVER-1	Reach-6	1	Regional	UltimateSEP15	242.96	73.15	76.00	75.97	76.78	0.007049	3.93	66.13	45.81	0.96
RIVER-1	Reach-6	1	Regional	MMM ECUltSEP15	243.14	73.15	76.00	75.97	76.78	0.007059	3.94	66.13	45.81	0.96

Reach 14W-22

Reach 14W-22 Proposed Conditions. Please see Figure 6.4.2

HEC-RAS River: RIVER-2 Reach: FM3-FM4 Channel Profile: Regional

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Volume
				(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)		(1000 m3)
FM3-FM4 Channel	305	Regional	Full_Proposed	5.91	152.12	153.27	153.27	153.43	0.006367	1.96	6.04	30.22	0.74	5.72
FM3-FM4 Channel	305	Regional	PCMMMUltimate	6.26	152.12	153.29	153.29	153.44	0.006079	1.95	6.72	32.39	0.73	6.09
FM3-FM4 Channel	304	Regional	Full_Proposed	5.91	151.63	153.01	152.78	153.04	0.001077	0.98	15.20	39.47	0.32	4.45
FM3-FM4 Channel	304	Regional	PCMMMUltimate	6.26	151.63	153.04	152.79	153.07	0.000989	0.96	16.47	39.67	0.31	4.70
FM3-FM4 Channel	303	Regional	Full_Proposed	5.91	151.46	152.57	152.57	152.86	0.010563	2.44	2.67	27.14	0.95	4.04
FM3-FM4 Channel	303	Regional	PCMMMUltimate	6.26	151.46	152.59	152.59	152.90	0.010439	2.49	2.79	29.60	0.95	4.26
FM3-FM4 Channel	302.5			Culvert										
FM3-FM4 Channel	302	Regional	Full_Proposed	5.91	151.29	152.53	152.40	152.73	0.005827	2.03	3.27	38.54	0.73	3.79
FM3-FM4 Channel	302	Regional	PCMMMUltimate	6.26	151.29	152.54	152.43	152.76	0.006023	2.09	3.36	38.65	0.74	3.99
FM3-FM4 Channel	301	Regional	Full_Proposed	5.91	150.79	151.98	151.93	152.09	0.004437	1.71	7.69	35.30	0.63	2.80
FM3-FM4 Channel	301	Regional	PCMMMUltimate	6.26	150.79	151.99	151.95	152.11	0.004438	1.73	8.25	36.86	0.63	2.93
FM3-FM4 Channel	300	Regional	Full_Proposed	5.91	150.40	151.63	151.55	151.72	0.003503	1.56	8.83	38.32	0.56	2.03
FM3-FM4 Channel	300	Regional	PCMMMUltimate	6.26	150.40	151.64	151.57	151.73	0.003546	1.59	9.32	38.57	0.57	2.11
FM3-FM4 Channel	299	Regional	Full_Proposed	5.91	150.05	151.23	151.20	151.36	0.005144	1.81	6.95	33.09	0.67	1.36
FM3-FM4 Channel	299	Regional	PCMMMUltimate	6.26	150.05	151.25	151.22	151.37	0.004994	1.81	7.62	35.06	0.67	1.39
FM3-FM4 Channel	298	Regional	Full_Proposed	5.91	149.76	151.04		151.10	0.002301	1.32	10.89	38.81	0.46	0.73
FM3-FM4 Channel	298	Regional	PCMMMUltimate	6.26	149.76	151.04		151.11	0.002538	1.39	10.98	38.82	0.48	0.73



Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

Hec-Ras Cross-Sections Existing Conditions

LEGEND

- SUBJECT PROPERTY
- EXISTING REGIONAL FLOODLINE
- HEC-RAS CROSS-SECTION
- 1 / 142.99 — MMM HEC-RAS CROSS-SECTION ID. / REGIONAL FLOOD ELEVATION (masl)

Scale: 1 : 5000 (0, 50, 100, 150, 200, 250m)

Client: Bentall Kennedy

Prepared by: MMM GROUP

Date: September 2015

Project No.: 14-09222-001-WR1

Aerial Photo: © DigitalGlobe 2010, Google 2009

Figure 6.4.1

Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

Hec-Ras Cross-Sections Ultimate Conditions

LEGEND

- SUBJECT PROPERTY
- POST-DEVELOPMENT REGIONAL FLOODLINE
- HEC-RAS CROSS-SECTION
- 1 / 143.05 — MMM HEC-RAS CROSS-SECTION ID. / REGIONAL FLOOD ELEVATION (masl)

Scale: 1 : 5000 (0, 50, 100, 150, 200, 250m)

Client: Bentall Kennedy

Prepared by: MMM GROUP

Date: September 2015

Project No.: 14-09222-001-WR1

Aerial Photo: © DigitalGlobe 2010, Google 2009

Figure 6.4.2

6.4.3 Riparian Storage

To evaluate and compare the riparian storage volumes for both existing and proposed conditions, HEC-RAS simulations were undertaken for various flow conditions.

Regional Flood volumes were calculated based on flows generated using the GAWSER model (Table 6.2). The flows were embedded into the HEC RAS model and stored volumes from the right and left of stream banks were calculated for each reach.

Results of the riparian storage analysis are summarized in Table 6.4 to illustrate the volume of water stored within the channel corridors during regional storm conditions.

Table 6.4 – Comparison of Pre-Development and Ultimate Conditions Riparian Storage of Regional Flood Volume

Return Period (Year)	Station	Reach	Floodplain Storage Volume (m^3)	
			Existing	Ultimate
Regional	305 to 298	14W-22	2660	4000
Regional	210.5 to 205	14W-16	3800	3340
Regional	205 to 203	14W-12	3910	6580
Regional	13 to 11	14W-23	0	100

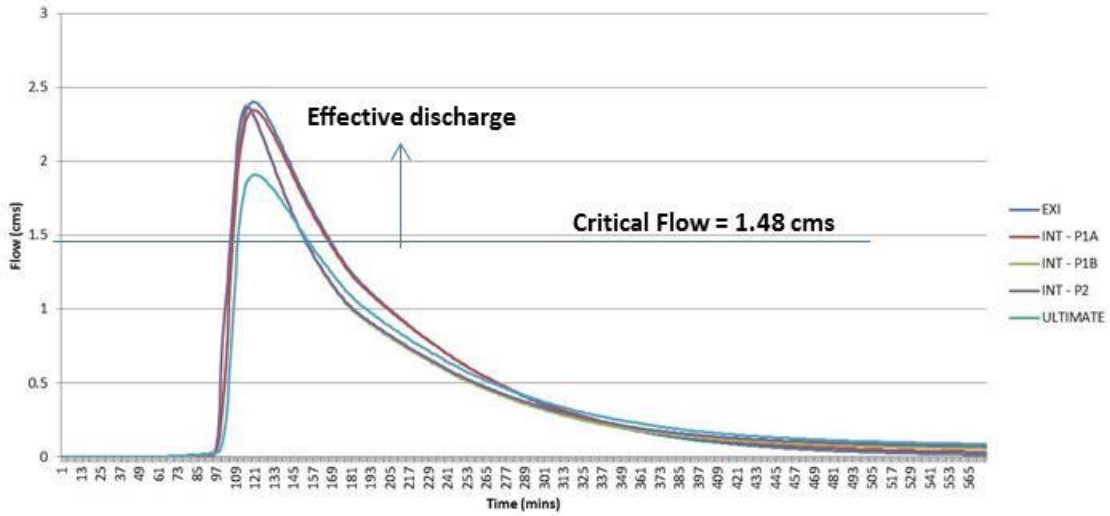
6.4.4 Erosion Thresholds

In order to perform erosion threshold analysis, a continuous flow model was setup using a rainfall record from 1962 to 1992. Erosion exceedance analysis has been conducted using a critical flow of 1.48 m^3/s for the reach immediately upstream of Dundas Street (Reference Node 3). This is based on the recommendations of the Fluvial Geomorphological and Erosion Threshold Assessment (Water Edge, 2013). The critical flow values was embedded in the GAWSER model and a 30-year run was carried out. The results show that high flows are lower under all development phases, and the time (Hours) that the critical flow is exceeded are lower than existing conditions as well. Therefore, it can be concluded that under all phasing plan conditions, post development conditions are not going to negatively impact erosion thresholds downstream of the development.

Table 6.6. Erosion Exceedance Downstream of the Development (Flow Node 3)

Development Phase	Flow Highest	EXCEEDANCE			
	(m^3/s)	Hours	PCT	Pulses	Duration (hrs)
Existing	4.218	265	0.1	44	6
Interim Phase 1A	4.119	258	0.1	42	6.1
Interim Phase 1B	3.819	207	0.1	38	5.4
Interim Phase 2	3.812	210	0.1	38	5.5
Ultimate	3.433	179	0.1	33	5.4

For further analysis of the effective flows, the 2-year flow (which is often cited as a surrogate to bankfull flow) was plotted under all phasing plan conditions. It is noticed that the 2-year flow magnitude under ultimate and interim conditions is lower than that under existing conditions. Moreover, the rising and falling limbs of the hydrographs under proposed conditions are milder in slope than that under existing conditions, indicating less susceptibility to channel and stream bank erosion.



A preference was noted by Conservation Halton and the Town of Oakville to apply cumulative effective work index or cumulative erosion index similar to CVC requirements. However, an analysis of this sort would need a hydrodynamic model that combines hydrology and hydraulics. Since the study has used the GAWSER model (which is a hydrologic model) and HEC RAS (which is primarily a hydraulic model without complex hydrological routines), the calculation of an array of instantaneous boundary shear stresses and critical shear stresses was rendered unachievable. It is believed that the exceedance analysis and the 2-year flow chart are sufficient to show that erosion thresholds under future conditions are equal or lower than existing conditions.

6.5 Corridor Width

The NOCSS and its related addendum set out the approach for the delineation of stream corridor widths. The corridor widths of the high and medium constraint streams and the end points of the reach delineations are required to be refined as part of the EIR/FSS study. High constraint streams are required to preserve their form and function, while medium constraint streams are required to preserve their current functions. Low constraint streams can be replaced through infrastructure or stormwater management (SWM) practices. The factors to be considered in the refinement of the corridor widths include:

- Regulatory floodplain;
- Stable slope top of bank;
- Setbacks, buffers, and fish habitat protection requirements;
- Meander belts and;
- Erosion Allowance.

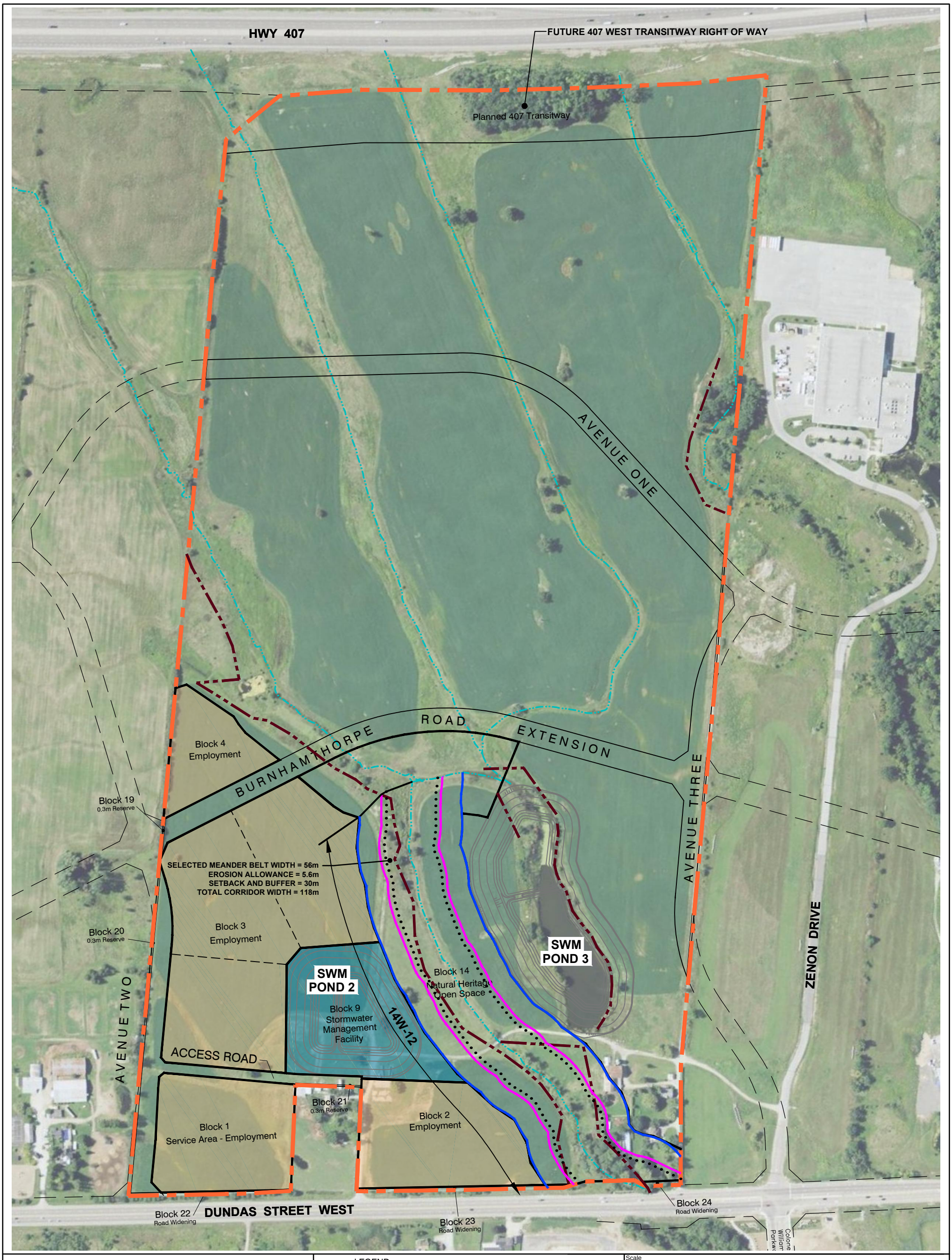
Table 6.7 and Figure 6.5 show the results of corridor width estimates. The estimates cover all phasing considerations. Table 6.7 provides corridor widths from the 3rd submission of the EIR/FSS for comparison.

Table 6.7 Corridor Width Estimates under the Phasing Plan

Development Phasing	Reach	Reference Node	Corridor Width (3rd EIR/FSS)	Area (ha)	2yr flow	Parish Method	Annable Method	Selected Meander Belt Width	Erosion Allowance	Setback and Buffer	Corridor Width	Redside Dace/widened coridor	Total Corridor Width (m)
Interim P1A	14W-12	3	117	401.69	2.35	57.40	52.44	57	5.7	30	83.4	117	**117**
Interim P1B	14W-12	3	117	398.75	2.38	57.44	52.62	57	5.7	30	83.4	117	**117**
	14W-12A	2	92	2.56	0.05	-	7.19	7	3	30	28	-	**73**[2]
	14W-16	1	105	330.71	2.27	52.06	51.28	52	5.2	30	77.4	112	**112**
	14W-21	-	29	6.76	0.01	-	2.15	2	3	7.5	23	17	**23**
	14W-22	-	61	132.85	0.69	37.01	27.27	37	3.7	15	59.4	67	**67**
Interim P2	14W-12	3	117	411.73	2.37	57.68	52.52	58	5.8	30	84.6	118	**118**[1]
	14W-12A	2	92	2.56	0.05	-	7.19	7	3	30	28	67	**67**[2]
	14W-16	1	105	331	2.27	52.07	51.28	52	5.2	30	77.4	112	**112**
	14W-21	-	29	6.76	0.01	-	2.15	2	3	7.5	23	17	**23**[2]
	14W-22	-	61	133.14	0.69	37.03	27.28	37	3.7	15	59.4	67	**67**
	14W-23	-	43	38.7	0.29	-	17.06	17	3	7.5	38	-	**38**[2]
Ultimate	14W-12	3	117	397.77	1.91	55.59	46.85	56	5.6	30	82.2	116	**116**
	14W-12A	2	92	2.56	0.05	-	7.19	7	3	30	28	67	**67**[2]
	14W-16	1	105	323.77	1.81	49.99	45.45	50	5	30	75	110	**110**
	14W-21	-	29	6.76	0.01	-	2.15	2	3	7.5	23	17	**23**[2]
	14W-22	-	61	133.14	0.69	37.03	27.28	37	3.7	15	59.4	67	**67**
	14W-23	-	43	38.7	0.29	-	17.06	17	3	7.5	38	-	**38**[2]

1:The maximum corridor width for all phases has been utilized as the development limit line in the Draft Plan of Subdivision.

2:Some corridor widths, particularly Reaches 14W-12A and 14W-23 have been reduced to reanalyzed flows and recalculated meander belt widths



Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

Corridor Delineation - Interim Phase 1A Conditions

LEGEND

- SUBJECT PROPERTY
- EXISTING CREEK
- PROPOSED DIVERSION
- MEANDER BELT WIDTH
- EROSION ALLOWANCE
- TOP OF BANK
- ENVIRONMENTAL SETBACK / TOTAL CORRIDOR WIDTH

Scale: 1 : 4000 (0, 50, 100, 150, 200m)

Client: Bentall Kennedy

Prepared by: MMM GROUP

Date: September 2015

Project No.: 14-09222-001-WR1

Aerial Photo: © DigitalGlobe 2010, Google 2009

Figure 6.5.1

HWY 407

FUTURE 407 WEST TRANSITWAY RIGHT OF WAY

Planned 407 Transitway

Block 12
Natural Heritage Open Space

14W-21

SELECTED MEANDER BELT WIDTH = 2m
EROSION ALLOWANCE = 3m
SETBACK AND BUFFER = 7.5m
TOTAL CORRIDOR WIDTH = 23m

Block 18
0.3m Reserve

SELECTED MEANDER BELT WIDTH = 37m
EROSION ALLOWANCE = 3.7m
SETBACK AND BUFFER = 15m
TOTAL CORRIDOR WIDTH = 67m

14W-22

AVENUE ONE

14W-16

Block 7
Employment

Block 17
0.3m Reserve

Block 16
0.3m Reserve

Block 13
Natural Heritage Open Space

Block 25
Stormwater Management Facility

SELECTED MEANDER BELT WIDTH = 7m
EROSION ALLOWANCE = 3m
SETBACK AND BUFFER = 30m
TOTAL CORRIDOR WIDTH = 73m

14W-12A

SELECTED MEANDER BELT WIDTH = 50m
EROSION ALLOWANCE = 5m
SETBACK AND BUFFER = 30m
TOTAL CORRIDOR WIDTH = 112m

BURNHAMTHORPE ROAD EXTENSION

Block 4
Employment

Block 19
0.3m Reserve

Block 6
Service Area Employment

AVENUE THREE

Block 15
Reserve

SELECTED MEANDER BELT WIDTH = 56m
EROSION ALLOWANCE = 5.6m
SETBACK AND BUFFER = 30m
TOTAL CORRIDOR WIDTH = 118m

Block 10
Stormwater Management Facility

SWM POND 3

Block 20
0.3m Reserve

Block 3
Employment

SWM POND 2

Block 9
Stormwater Management Facility

Block 14
Natural Heritage Open Space

14W-12

ZENON DRIVE

ACCESS ROAD

AVENUE TWO

Block 21
0.3m Reserve

Block 1
Service Area - Employment

Block 2
Employment

Block 22
Road Widening

DUNDAS STREET WEST

Block 23
Road Widening

Block 24
Road Widening

Colonel William Parkway

LEGEND

- SUBJECT PROPERTY
- EXISTING CREEK
- PROPOSED DIVERSION
- MEANDER BELT WIDTH
- EROSION ALLOWANCE
- TOP OF BANK
- ENVIRONMENTAL SETBACK / TOTAL CORRIDOR WIDTH

Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

Corridor Delineation - Interim Phase 1B Conditions

Scale
1 : 4000
0 50 100 150 200m

Client
Bentall Kennedy

Prepared by
MMM GROUP

Date
September 2015

Project No.
14-09222-001-WR1

Aerial Photo

Figure 6.5.2

HWY 407

FUTURE 407 WEST TRANSITWAY RIGHT OF WAY

Planned 407 Transitway

Block 12
Natural Heritage Open Space

14W-21

SELECTED MEANDER BELT WIDTH = 2m
EROSION ALLOWANCE = 3m
SETBACK AND BUFFER = 7.5m
TOTAL CORRIDOR WIDTH = 23m

Block 8
Employment

SELECTED MEANDER BELT WIDTH = 17m
EROSION ALLOWANCE = 3m
SETBACK AND BUFFER = 7.5m
TOTAL CORRIDOR WIDTH = 38m

14W-23

Block 11
Natural Heritage Open Space

Block 18
0.3m Reserve

SELECTED MEANDER BELT WIDTH = 16m
EROSION ALLOWANCE = 6m
REDSIDE DACE HABITAT SETBACK = 30m
TOTAL CORRIDOR WIDTH = 76m

14W-11

SELECTED MEANDER BELT WIDTH = 37m
EROSION ALLOWANCE = 3.7m
SETBACK AND BUFFER = 15m
TOTAL CORRIDOR WIDTH = 67m

AVENUE ONE

14W-22

Block 7
Employment

14W-16

Block 17
0.3m Reserve

Block 16
0.3m Reserve

Block 13
Natural Heritage Open Space

Block 25
Stormwater Management Facility

SELECTED MEANDER BELT WIDTH = 7m
EROSION ALLOWANCE = 3m
SETBACK AND BUFFER = 30m
TOTAL CORRIDOR WIDTH = 73m

14W-12A

SELECTED MEANDER BELT WIDTH = 50m
EROSION ALLOWANCE = 5m
SETBACK AND BUFFER = 30m
TOTAL CORRIDOR WIDTH = 112m

BURNHAMTHORPE ROAD EXTENSION

Block 4
Employment

AVENUE THREE

Block 19
0.3m Reserve

Block 6
Service Area Employment

Block 15
Reserve

SELECTED MEANDER BELT WIDTH = 56m
EROSION ALLOWANCE = 5.6m
SETBACK AND BUFFER = 30m
TOTAL CORRIDOR WIDTH = 118m

Block 10
Stormwater Management Facility

SWM POND 3

Block 20
0.3m Reserve

Block 3
Employment

SWM POND 2

Block 14
Natural Heritage Open Space

Block 5
Employment

ZENON DRIVE

Block 9
Stormwater Management Facility

14W-12

ACCESS ROAD

AVENUE TWO

Block 21
0.3m Reserve

Block 26
Park

Block 1
Service Area - Employment

Block 2
Employment

Block 24
Road Widening

Block 22
Road Widening

DUNDAS STREET WEST

Block 23
Road Widening

Colonel William Parkway

Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

Corridor Delineation - Interim Phase 2 Conditions

LEGEND

- SUBJECT PROPERTY
- EXISTING CREEK
- PROPOSED DIVERSION
- MEANDER BELT WIDTH
- EROSION ALLOWANCE
- TOP OF BANK
- ENVIRONMENTAL SETBACK / TOTAL CORRIDOR WIDTH

Scale
1 : 4000
0 50 100 150 200m

Client
Bentall Kennedy

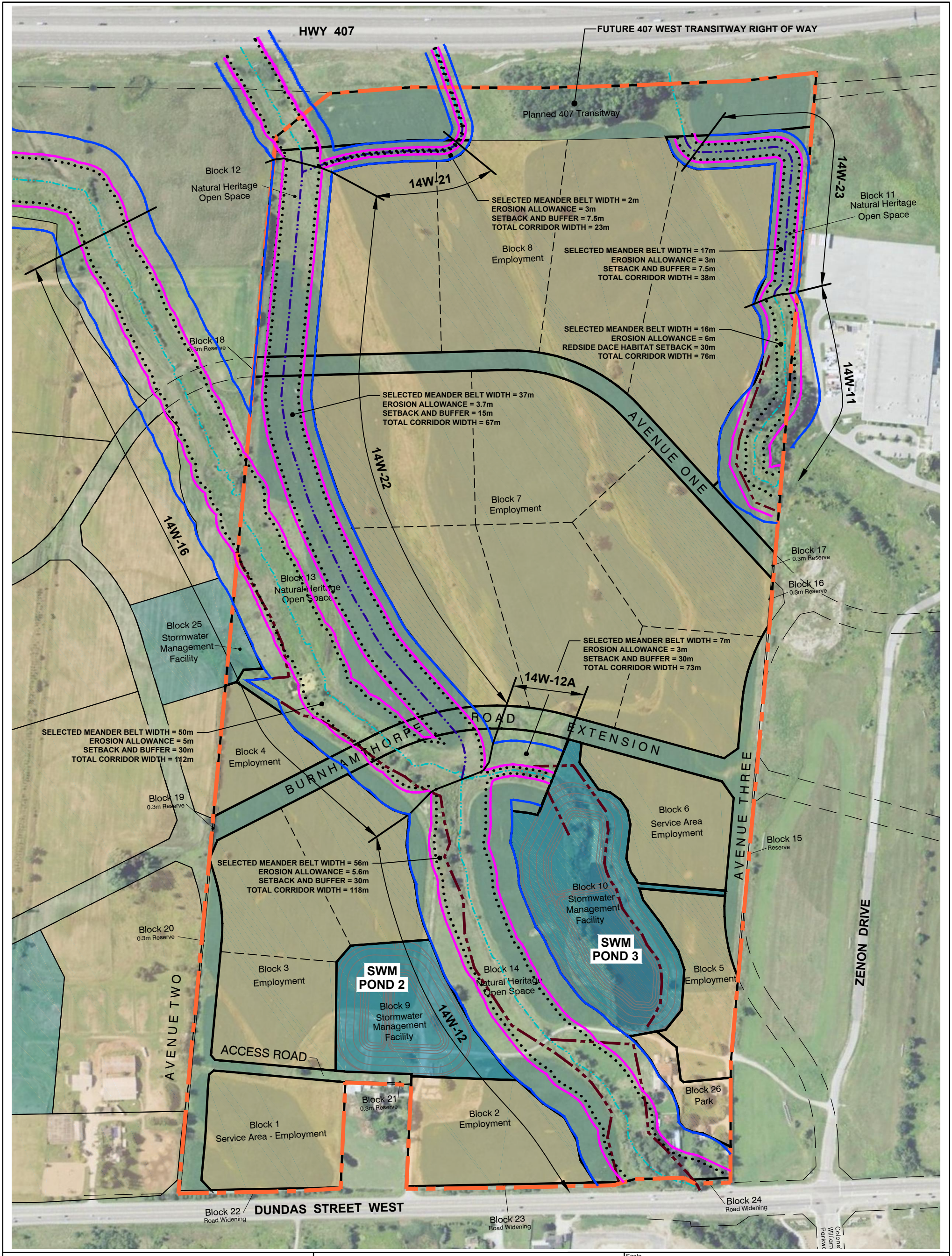
Prepared by
MMM GROUP

Date
September 2015

Project No.
14-09222-001-WR1

Aerial Photo

Figure 6.5.3



Environmental Implementation Report / Functional Servicing Study for 14 Mile Creek West and the Lazy Pat Farm Property

Corridor Delineation - Ultimate Conditions

LEGEND

- SUBJECT PROPERTY
- EXISTING CREEK
- PROPOSED DIVERSION
- MEANDER BELT WIDTH
- EROSION ALLOWANCE
- TOP OF BANK
- ENVIRONMENTAL SETBACK / TOTAL CORRIDOR WIDTH

Scale: 1 : 4000 (0, 50, 100, 150, 200m)

Client: Bentall Kennedy

Prepared by: MMM GROUP

Date: September 2015

Project No.: 14-09222-001-WR1

Aerial Photo: © DigitalGlobe 2010, Google 2009

Figure 6.5.4

6.6 Top of Bank Delineation

With respect to top of bank limits, remaining concerns with the slope stability analysis in Reach 14W-11 were identified, as well as an area of steep slopes on the south side of the farm pond adjacent to Reach 14W-12. A site visit with CH staff (J. Brenner) was conducted on June 24, 2015 to investigate these locations. To address these areas, we would like to point out the following with respect to comment provided by Conservation Halton:

1. With respect to comments requesting planning information be added to the slope stability report, we note that the EXP Report is a specialized geotechnical investigation intended to provide the technical basis for its conclusions. As the information scope on DWG #1 in the report's appendix is limited to a borehole location plan, it is not required to incorporate the requested modifications. The requested information may be found on Figure 6.5.3.

2. The 'top of slope' referenced in the noted section is interpreted as a simple note on the highest point of land adjacent to the valley feature and not a reference to 'top of bank' needed for planning recommendations. The top of bank limits were staked and reviewed with CH personnel in 2012 as part of the original fieldwork component for previous submissions of the EIR/FSS. In addition we note the phrasing in the EXP report that "the top of the slope is about 158m and the elevation of the base is at about 152m". These elevations are the opinion of the professionals signing the report and related to their specific observations made in the scope of their analysis. MMM has incorporated EXP's analysis into our management recommendations for the reach. As all development limits have been established well beyond the slope areas recommended by the EXP report, the top of bank has been properly staked and the stable top of slope has been protected within appropriate buffers and protected by the relevant buffers as shown in Figure 6.5.3, it is our opinion that the comments related to the EXP slope stability analysis have been adequately addressed.

3. To address these issues, MMM conducted a site visit with CH staff (J. Brenner) on June 24, 2015 to familiarize CH with this specific location. During the visit, no areas of active erosion or historic erosion (slope failures, downcutting, etc.) were observed and the valley feature was heavily vegetated. Areas of past flow events were observed; however, the channel was difficult to locate in certain areas due to the dense vegetation at the toe of the slope. CH staff recorded their own photographs of the channel and valley composition. In MMM's opinion, the channel is not currently under active erosion stress and as the sole modification to Reach 14W-11 is a rerouting of flow to the property corner outside the valley system in reach 14W-23 as shown on Figure 6.5.3, maintaining the same connection point to the valley system, it is not likely to transition from its current state as a result of the development plan. Therefore, MMM does not see any valid technical challenges to EXP's analysis and conclusions.

6.7 Flow Regime

The following memo has been prepared by MMM's fluvial geomorphologist. The memo addresses Conservation Halton's concern regarding reach 14W-12A under future conditions, and it's fluvial geomorphic processes.

MMM GROUP

INTER OFFICE MEMO

To:	Ashraf Zaghal, Ph.D., P.Eng.	Date:	September 18, 2015
From:	Scott Cowan, GIT, CTech. Mark Hartley, B.Sc.(Fisheries), M.Sc., P.Eng.	Job No.:	1409222-001
Subject:	Fluvial Geomorphological Field Assessment of Reach 14W-12A	CC:	Steve van Haren, P.Eng., P.E.

1.0 INTRODUCTION

MMM Group Limited (MMM Group) was retained by Bentall Kennedy (Canada) LP – Lazy Pat Farms to develop an Environmental Implementation Report / Functional Servicing Study (EIR/FSS) for 14 Mile Creek West and the Lazy Pat Farms Property, North Oakville West. The EIR/FSS proposed a drainage plan developed, which included creek work developed based on the principles of Natural Channel Design and the North Oakville Creeks Subwatershed Study (NOCSS) requirements, which alters the flow regime of Reach 14W-12A (the Reach). Upon review of the EIR/FSS, Conservation Halton (CH) provided comments, with a specific request for additional assessment to determine whether the alterations to the Reach's flow regime will negatively impact the existing geomorphic form and function of the Reach (item 1(d) from the August 11, 2015 meeting minutes).

This memorandum summarizes the existing background information in the EIR/FSS relevant to the Reach, and outlines the results of a geomorphological field assessment undertaken to determine the contribution the existing flow regime has on maintaining the existing form and function of the Reach.

2.0 BACKGROUND

2.1 SITE LOCATION

The Reach is located within the western portion of North Oakville West Secondary Plan (NOWSP) area, which has been defined as the 407 West Employment Area. The Reach is located on the north side of Dundas Street West, generally mid-way between Tremaine road and Zenon Drive, in the Town of Oakville (see Figure 1 below).

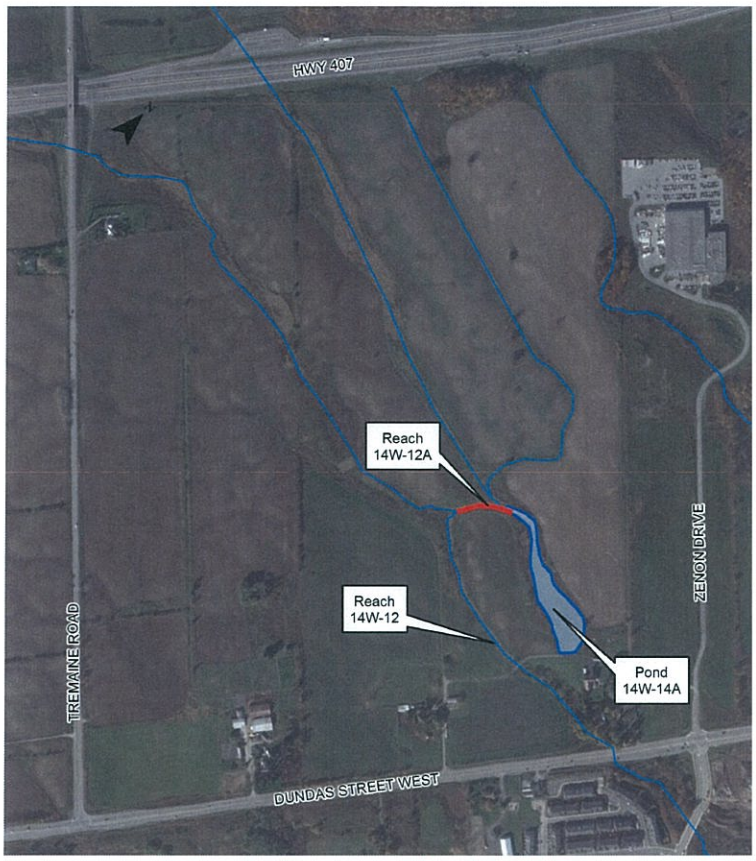


Figure 1 – Location of Reach 14W-12A

2.2 REVIEW OF EIR/FSS

An EIR/FSS for 14 Mile Creek West and the Lazy Pat Farms Property, North Oakville West was prepared by MMM Group and submitted to Bentall Kennedy in November 2014. The EIR/FSS identifies the Reach as a 125 m long watercourse with a trapezoidal cross-section that appears in the historic record between 1934 and 1960 (see Figure 6.2 from the EIR/FSS). The EIR/FSS determined that the Reach was constructed to allow outflows from pond 14W-14A (which was constructed at the same time) to flow back out into Reach 14W-12. The Reach contains a narrow incised channel which receives diffuse flow through cattails which extend downstream of the pond inlet/outlet for approximately 75 m. As a component of the EIR/FSS, a Fluvial Geomorphological and Erosion Threshold Assessment of the 14 Mile Creek tributaries immediately north and south of Dundas Street was completed by Water's Edge in October 2013.This assessment included a high-level inventory of existing geomorphic conditions, including the completion of a Rapid Stream Assessment Technique (RSAT) and Rapid Geomorphic Assessment (RGA). The EIR/FSS defines a meander belt width, erosion allowance, and overall corridor width for the Reach. The report does not assess the contribution the existing flow regime has on maintaining the existing form and function of the Reach.

2.3 PHYSIOGRAPHY AND GEOLOGY

The Reach and surrounding area are situated in the South Slope physiographic region as defined by Chapman and Putman, (1984). Surficial geology of the reach consists of the reddish coloured clay-silt

Halton Till which is locally derived from the underlying bedrock. The underlying bedrock in the area is Upper Ordovician Red Shale and interbedded Limestone of the Queenston Formation.

3.0 GEOMORPHOLOGICAL FIELD ASSESSMENT

a site visit was completed by MMM Group on September 11, 2015 to determine the contribution the existing flow regime has on maintaining the existing form and function of the Reach. For the purposes of the site visit the following were undertaken:

1. Overview of reach characteristics,
2. typical cross-section survey and long profile, and
3. photographic record of the site.

At the time of the site visit the weather was warm and dry, with no precipitation during, or 24 hours prior to the assessment. There was no observed flow during the site visit.

3.1 OVERVIEW OF REACH CHARACTERISTICS

The Reach is approximately 125 m in length originating upstream at the inlet/outlet to pond 14W-14A (the Pond) and terminating downstream at its confluence with reach 14W-12. The cross-section of the Reach is typified by a trapezoidal geometry with a flat bottom, typical of a constructed channel. The Reach is heavily vegetated with shrubs and tall grasses along its entire length and throughout the entire cross-section. The watercourse bottom is dominated by cattails for the majority of the reach length (extending approximately 75 m downstream from the upstream limit and 20 m upstream from the downstream limit). There is no channel definition within the cattails. Where cattails are not present, the watercourse bottom is dominated by well-established shrubs and tall grasses. A small poorly-defined incised channel was observed in this section. There was no significant alluvium deposits found within the incised channel or within the cattails. Banks along the entire length of the Reach are dominated by shrubs and tall grasses. Soils within the Reach consist of silts and clays with some organics. Bank slopes (sta. 2 – 5 m and sta. 11 – 14 m) appear to be stable along the entire length with no indications of toe erosion, slumping, or other failure. No indicators of aggradation, degradation, widening, planimetric form adjustment, or instability were identified within the cattails, adjacent to the low flow channel, or along the banks of the creek.

3.2 CROSS SECTION SURVEY & LONG PROFILE

A typical cross-section was surveyed, approximately 90 m downstream from the Pond outlet and 35 m upstream of the Reach outlet into 14W-12 (Figure 2). The cross-section survey confirms the general trapezoidal form of the reach. The left bank and right bank are approximately 2.0 m and 1.6 m high, respectively, with a bank slope of approximately 2:1. Reach bottom width and top width are 5.0 m and 12.0 m, respectively. A small poorly-defined incised channel (0.20 m deep and 0.35 m wide) is located at sta. 8.0 m. This incised channel does not exist within regions vegetated by cattails although overall cross-sectional geometry is similar. Photo 6 was taken of the poorly-defined incised channel in the surveyed cross-section. Photos 3, 4, and 5 represent the typical cross-section and capture the thick vegetation, cross-sectional geometry, and lack of low flow channel definition within the Reach.

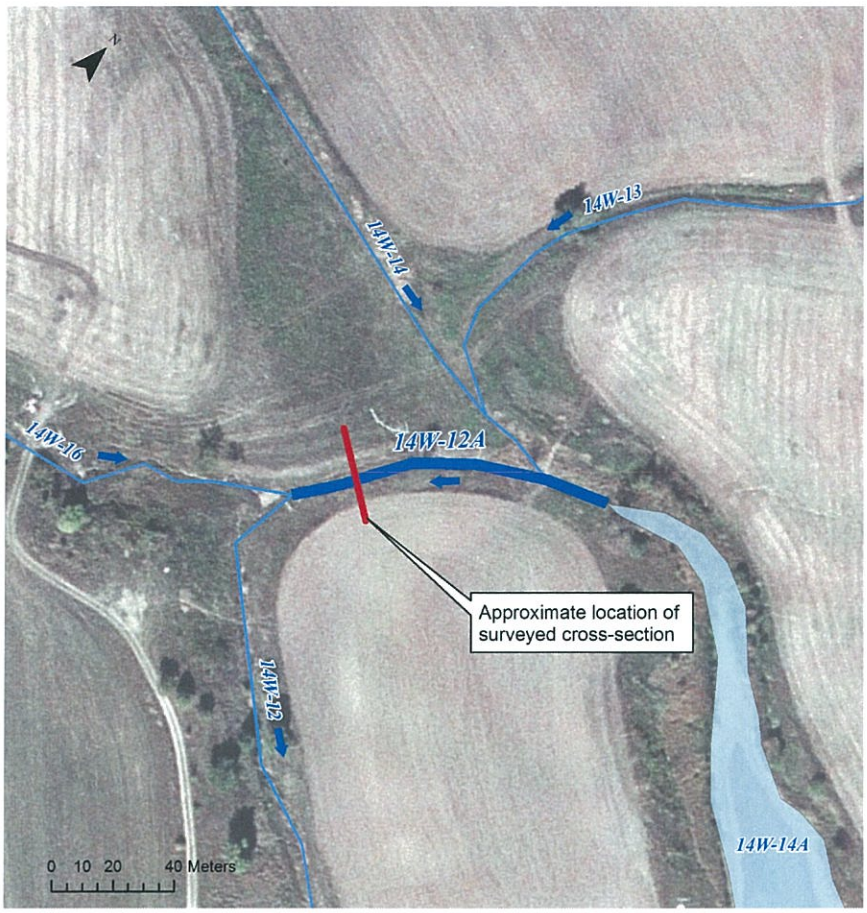


Figure 2 – Location of surveyed typical cross-section on Reach 14W-12A

The results of the cross-section survey are presented in Figure 3 below. Please note that the elevations indicated are relative only, and were developed assuming a datum on the left top of bank of 100 m.

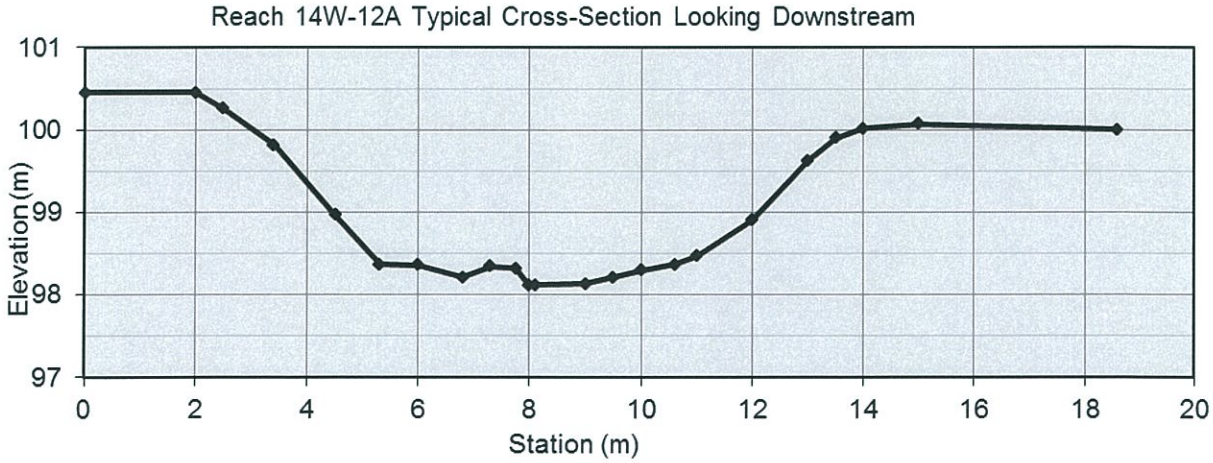


Figure 3 – Survey of typical cross-section of 14W-12A, looking downstream

A long profile survey of the channel bottom was completed extending approximately 30 m upstream and 15 m downstream of the surveyed cross-section to determine the approximate slope of the Reach invert. The results of the long profile survey indicate that the reach slope is approximately 0.85 %, draining towards 14W-12.

3.3 GEOMORPHIC PROCESSES

Clearly the origins of this open channel are anthropogenic; it was excavated between 1935 and 1960 for the purpose of conveying excess water from Reach 14W-14/14W-14A/14W-13 westwards towards Reach 14W-2. Recent topographic observations support this conclusion. The horizontal alignment of the Reach is east-west which is nearly perpendicular to the flow direction of the adjoining tributaries. The flow regime (time series and flow direction) is highly dependent upon the response of the upstream catchments and the water level in the on-line pond (Reach 14W-14A). The preferred flow path appears to be from north to south and only includes the Reach under high flow conditions; the magnitude of the flow split is difficult to determine.

4.0 SUMMARY AND CONCLUSION

The presence of thick vegetation, the absence of a continuous well-defined low flow channel, and the absence of geomorphic indicators (i.e. aggradation, degradation, widening, planimetric form adjustment, or instability) indicates that fluvial geomorphic processes are not occurring within the Reach. This also indicates that the Reach is not actively working to maintain or recover a natural form and function. Because geomorphic processes are not ongoing under the current flow regime, it can be concluded that the existing flow regime does not contribute to the maintenance of the existing form and function. Subsequently, modifications to the existing flow regime will not negatively impact the existing form and function of the Reach.

5.0 CLOSURE

We have based the foregoing assessment on our understanding of your present needs. Please contact the undersigned should you have any question about this work.

Yours truly,

MMM GROUP LTD.

Prepared by:

Scott Cowan, GIT, CTech.
Fluvial Geomorphologist
Water Resources

Reviewed by:

Mark Hartley, B.Sc.(Fisheries), M.Sc., P.Eng.
Senior Project Manager
Water Resources

Photo Appendix

Photo 1 – Outlet of Pond and upstream limit of Reach 14W-12A

Photo 2 – Upstream limit of Reach 14W-12A looking upstream to Pond. Heavy Cattail growth and no defined channel.

Photo 3 – Surveyed cross-section looking upstream at cattail growth, and eventual outlet from the pond.

Photo 4 – Surveyed cross-section looking downstream at cattail growth, and eventual outlet to reach 14W-12

	
Photo 5 – Surveyed cross-section looking downstream through heavily vegetated oversized trapezoidal channel bottom	**Photo 6** – Incised low flow channel within surveyed cross-section

7.0 Stormwater Management

7.1 Introduction

This section details the drainage and stormwater management requirements for the Subject Property within the 407 West Employment Area.

OPA 289 policy 8.4.5 states that, “The management of water resources within the North Oakville West Planning Area shall be undertaken in accordance with the directions established in the North Oakville Creeks Subwatershed Study (NOCSS). No amendments to the Secondary Plan shall be required to implement the recommendations of the Subwatershed Study or for changes to the number or location of stormwater management facilities in accordance with the policies of Section 8.6.2.2.a) of this Plan”.

Section 6.0 of the NOCSS presents the recommended Management Strategy for the North Oakville Creeks Subwatershed. It includes strategies for land use management, stormwater management, terrestrial and wetland resources management, riparian corridor management, rehabilitation, remediation and monitoring plans. The goals, objectives, and targets of the Management Strategy are set out in NOCSS Section 6.2.

The NOCSS Section 6.3.6 discusses the Stormwater Management component of the Management Strategy. It includes discussion on hydrology, peak flow control, hydrogeology, water quality, fisheries protection, low impact development, source pollution prevention and various types of SWM measures.

7.2 Criteria and Requirements

- **Water Quantity:** The NOCSS recommends that stormwater management targets include control of the peak flow to pre-development levels for the 2-year to 100-year return period events and the Regional Storm. OPA 289 Policy 8.4.13.2 and the NOCSS Addendum identify that future land use development applications may carry out an investigation of the potential increases to flood risk in downstream areas to confirm if Regional Storm controls are necessary. If the study finds (and the Town and Conservation Halton concur), that no increase in risk occurs to downstream landowners or public uses, these agencies may conclude that control of the Regional Storm level is not required (Refer to Section 6.4.2)
- **Infiltration:** The NOCSS recommends that infiltration levels be maintained as close to current levels as possible to reduce impacts on groundwater systems. The overall strategy is to provide as many opportunities for infiltration as possible in the developed areas. This can be achieved by various techniques that take advantage of physical settings (i.e. soil conditions and topography) as well as best available technology and management practices.
- **Water Quality:** The NOCSS recommends meeting MOE’s Enhanced Level of water quality protection (Level 1) when sizing stormwater management facilities for phosphorus control and fisheries protection. The Town requires that there be no-net increase in phosphorus loadings as a result of development. This objective will be met with the use of enhanced Level SWM ponds and as a result, there is no requirement to further analyze phosphorus loadings during development approvals. Temperature controls at SWM facility outlets can be provided through bottom draw outlets and rock filtration measures combined with shading.

- **Erosion Control SWM Facility Sizing:** The NOCSS recommends that detailed erosion threshold analyses be required as part of an EIR/FSS so that existing channel erosion or aggradation is not exacerbated by development.
- **Topographic Depressions:** The NOCSS recommends that the storage within the topographic depressions be refined and checked against the storage within proposed SWM ponds in the EIR subcatchment area to verify that the SWM pond storage accounts for the depression storage.
- **Stormwater Management Applications:** The NOCSS recommends the use of a hierarchy of stormwater controls with preference for source control, followed by conveyance system control, with less reliance on end-of-pipe control. In addition, where feasible, the use of infiltration measures, including the diversion of drainage to pervious surfaces as well as designed infiltration facilities, surface retention, and storage is encouraged, to help maintain pre-development water balance conditions. NOCSS identifies the requirement for end-of-pipe SWM facilities for water quality and quantity control, it also recommends that consideration be given to alternative management measures to meet the SWM objectives and targets. In this regard, the NOCSS discusses alternative low impact development techniques, various source pollution protection programs and alternative SWM practices to be considered.

7.32 Proposed Stormwater Management Approach

The hydrologic and hydraulic assessment under proposed conditions were discussed in Chapter 6. This Section presents information regarding pond sizing and foortprint, in addition to Low Impact Development measures that are proposed to help achieve infiltration targets.

7.3.1 Conveyance of Minor System Flows

The Subject Property will be serviced by a conventional storm sewer system designed in accordance with Town of Oakville standards. The storm sewers will be sized using a 5 year return frequency and the current Town of Oakville IDF curves.

7.3.2 Conveyance of Major Storm Flows

The current plan includes proposals for several stormwater management (SWM) ponds – the recommended locations of which are illustrated on the grading plan. The locations have been set based on the principle of maintaining existing drainage patterns and flow regimes in the undisturbed channel reaches to the extent practicable. There are two facilities located within the Subject Property (referred to as SWM Pond 2 and SWM Pond 3) and one facility (SWM Pond 5) located on the south-west side, immediately outside of the property boundary, as well as additional SWM facilities that are proposed to serve future phases of the development on adjacent property.

Since the regional flood was not appropriately controlled under the 100-year control specified in the previous submission, the stage-storage relationships for the three SWM ponds have been updated (Tables 7.1 to 7.6).

The SWM facilities were designed as ‘wet ponds’ in accordance with the Section 4.6.2 of the 2003 Ontario Ministry of the Environment (MOE) Stormwater Management Planning and Design Manual (SWMPDM). The specific SWM pond requirements provided in the Town of Oakville Development Engineering Procedures & Guidelines Manual were also adhered to. Major and minor stormwater flows will be conveyed to the pond facilities by the proposed storm sewer and overland flow system.

Table 7.1 Stage-Storage Relationship for SWM Pond 2

Elevation (m)	Cumulative Storage (m^3)			
	Forebay	Main Cell	Total PP	Active Storage
142.75	0	0	0	-
143.50	0	1,153	11,53	-
144.50	0	3,363	3,363	-
145.32	1,208	5,835	7,044	-
145.75	1,804	7,693	9,497	0
146.18	-	-	-	2,841
146.70	-	-	-	6,988
147.20	-	-	-	11,444
147.50	-	-	-	17,373
147.80	-	-	-	41,280

Table 7.2 SWM Pond 2 Controlled Flow

Description	**Elevation (m)**	**Depth to PP (m)**	**Active Storage (m^3)**	**Controlled Flow (m^3/s)**			
				Orifice	**DICB**	**Spillway**	**Total**
Permanent Pool	**145.75**	0.000	**0**	0.000	0.000	0.000	0.000
	146.00	0.250	1,652	0.010	0.000	0.000	0.010
	146.18	0.430	**2,841**	0.014	0.000	0.000	0.014
	146.25	0.500	3,645	0.015	0.000	0.000	0.015
Extended Detention	**146.30**	0.550	**4,220**	0.015	0.000	0.000	0.015
	146.50	0.750	5,604	0.018	0.000	0.000	0.018
	146.70	0.950	**6,988**	0.021	0.000	0.000	0.021
	146.95	1.200	9,216	0.024	0.000	0.000	0.024
	147.20	1.450	**11,444**	0.026	0.000	0.000	0.026
	147.35	1.600	14,409	0.027	0.000	0.000	0.027
Top of Pond	**147.50**	1.750	**17,373**	0.029	0.242	0.000	0.270
	147.60	1.850	25,342	0.029	0.598	0.054	0.681
	147.70	1.950	33,311	0.030	1.110	0.152	1.292
Freeboard	**147.80**	2.050	**41,280**	0.031	1.777	0.279	2.088

Table 7.3 Stage-Storage Relationship for SWM Pond 3

Elevation (m)	Cumulative Storage (m^3)			
	Forebay	Main Cell	Total PP	Active Storage
143.20	0	0	0	-
144.00	0	3,711	3,711	-
145.00	0	9,544	9,544	-
145.77	3,132	14,983	18,116	-
146.20	5,173	18,505	23,678	0
146.63	-	-	-	6,284
147.50	-	-	-	21,030
148.20	-	-	-	34,535
149.25	-	-	-	57,314
150.30	-	-	-	82,949

Table 7.4 SWM Pond 3 Controlled Flow

Description	Elevation (m)	Depth to PP (m)	Active Storage (m^3)	Controlled Flow (m^3/s)			
				Orifice	DICB	Spillway	Total
Permanent Pool	**146.20**	0.000	**0**	0.000	0.000	0.000	0.000
	146.45	0.250	3,653	0.021	0.000	0.000	0.021
	146.63	0.430	**6,284**	0.029	0.000	0.000	0.029
	146.70	0.500	7,470	0.032	0.000	0.000	0.032
Extended Detention	**146.79**	0.590	**8,996**	0.035	0.000	0.000	0.035
	146.95	0.750	11,707	0.041	0.000	0.000	0.041
	147.50	1.300	**21,030**	0.047	0.000	0.000	0.047
	148.20	2.000	34,535	0.053	0.000	0.000	0.053
	148.50	2.300	**41,043**	0.059	0.000	0.000	0.059
	148.75	2.550	46,467	0.064	0.000	0.000	0.064
Top of Pond	**149.00**	2.800	**51,890**	0.068	0.598	0.000	0.666
	149.10	2.900	54,060	0.070	1.110	0.054	1.233
	149.25	3.050	57,314	0.072	1.777	0.152	2.001
Freeboard	**150.30**	4.100	**82,949**	0.074	2.601	0.279	2.954

Table 7.5 Stage-Storage Relationship for SWM Pond 5

Elevation (m)	Cumulative Storage (m^3)			
	Forebay	Main Cell	Total PP	Active Storage
150.00	0	0	0	-
150.75	0	287	287	-
151.50	0	773	773	-
152.57	687	1,900	2,587	-
153.00	1,121	2,558	3,679	0
153.43	-	-	-	1,360
154.25	-	-	-	4,926
155.00	-	-	-	8,980
156.00	-	-	-	15,524
157.10	-	-	-	24,190

Table 7.6 SWM Pond 5 Controlled Flow

Description	Elevation (m)	Depth to PP (m)	Active Storage (m^3)	Controlled Flow (m^3/s)			
				Orifice	DICB	Spillway	Total
Permanent Pool	153.00	0.000	**0**	0.000	0.000	0.000	0.000
Extended Detention	153.43	0.430	1,360	0.015	0.000	0.000	0.015
	154.25	1.250	4,926	0.021	0.000	0.000	0.021
	155.00	2.000	8,980	0.026	0.000	0.000	0.026
Top of Pond	156.00	3.000	15,524	0.031	0.692	0.000	0.722
Freeboard	157.10	4.100	24,190	0.033	1.400	0.279	1.712

7.3.3 Low Impact Development Measures and Infiltration Targets

Low Impact Development measures including green roofs and vegetative buffers are recommended for implementation to promote infiltration and offset the impact of increased imperviousness due to development. Water budget calculations revealed that using different percentage coverage of green roofs over the subject area would lead to retaining rainfall in quantities that can be equal or above infiltration under existing conditions (Table 7.7). Specifically, infiltration under existing conditions is approximately 69 mm/year. Future development (i.e. Ultimate conditions) under no mitigation would bring this value down to 10 mm. However, with the use of 50% or 73.5% green roof coverage, the infiltration value would rise to approximately 84 mm/year, which is higher than that under existing conditions. Retention as percentage of total precipitation under future conditions would not be equal or above existing conditions. This is due to deficit in evapotranspiration values due to development. Since the evapotranspiration deficit is impractical and unrealistic to mimic, and since infiltration targets are the ones the NOCSS study focused upon, it is concluded that the LID green roofs are achieving their infiltration target.

Table 7.7 Infiltration Target under Different LID Green Roof Coverage Scenarios

Parameters	Pre-Development		Post-Development No Mitigation		Post-Development with Mitigation (3rd Sub)		Post-Development with 50% green roof		Post-Development with 73.5% green roof	
	mm/year	m^3/year	mm/year	m^3/year	mm/year	m^3/year	mm/year	m^3/year	mm/year	m^3/year
Precipitation	819.0	282,146	819.0	282,146	819.0	282,146	819.0	282,146	819.0	282,146
Total AET	607.0	209,112	127.3	43,858	53.6	18,465	155.0	53,381	202.6	69,791
Evaporative Lossess at 10% Precipitation	0.0	0	0.0	0	73.7	25,393	55.3	19,045	46.6	16,061
Infiltration (MOE Methodology)	69.3	23,874	9.8	3,376	84.4	29,089	84.4	29,089	84.4	29,089
Runoff (MOE Methodology)	140.7	48,471	681.6	234,808	607.0	209,095	524.0	180,528	485.1	167,101
Runoff as % of Total Precipitation	17.2%		83.2%		74.1%		64.0%		59.2%	
Retention as % of Total Precipitation	**82.8%**		**16.8%**		**25.9%**		**36.0%**		**40.8%**	
Retention as Rainfall Equivalent (mm)	**14.6 mm**		**1.2 mm**		**2.0 mm**		**3.2 mm**		**3.8 mm**	
Total Site Area (Developable Bentall Lands) (ha)	45.42		45.42		45.42		45.42		45.42	
Total Building Lot Area (ha)	**0.00**		**34.45**		**34.45**		**34.45**		**34.45**	
Total Roof Area (ha) 50%	0.00		17.23		17.23		17.23		17.23	
Roof Area for Infiltration (ha)	0.00		0.00		4.07		4.07		4.07	
Green Roof Area (ha)	1.00		0.00		0.00		7.75		11.39	
Remaining Roof Area (ha)	2.00		17.23		11.43		3.68		0.03	

7.4 Monitoring Programs

The following monitoring program is concerned with LID Monitoring and thermal regime monitoring. The discussion below may be revised during the detailed design stage to account for potential information that arises during the design.

7.4.1 LID Monitoring

Monitoring is important to confirm that LID practices are functioning and to identify maintenance or rehabilitation issues. For the first six months following construction, sites where LID measures are constructed should be inspected after each storm event greater than 10 mm. If staffing and budget allow, two inspections per year should be considered, one of which should occur after the spring freshet when snow has melted and the ground has thawed. At a minimum, annual inspections should be scheduled and conducted in the spring of each year. Monitoring of functionality of the Low Impact Development measure should also occur after all major rainfall events in excess of 60 mm.

The following monitoring considerations recommended by CVC and TRCA. Green roof maintenance is typically greatest in the first two years as plants are becoming established. Vegetation should be monitored to ensure dense coverage. Regular operation of a green roof typically includes irrigation during the establishment phase and leak detection. Watering should be based on actual soil moisture conditions as plants are designed to be drought tolerant. Electronic leak detection is recommended. This system, also used with traditional roofs, must be installed prior to the green roof. Ongoing maintenance should occur at least twice per year and

should include weeding to remove volunteer seedlings of trees and shrubs and debris removal. In particular, the overflow conveyance system should be kept clear.

7.4.2 Thermal Regime Monitoring

The sampling protocol will incorporate the specific requirements of the Town's guidelines in addition to the following items to meet the specific goals of the EIR/FSS. The following items are to be collected from the relevant pond outlet structures for the length of the monitoring program:

- Permanent Pool Temperature;
- Temperature at inlet and outlet. Temperature monitoring should be completed with automated temperature loggers. It is recommended that at a minimum, one logger be installed at the inlet to the pond and one at the outlet from the pond outlet structure to the receiving watercourse
- Total Suspended Solids;
- Dissolved Oxygen; and,
- Phosphorus concentration.

Grab samples taken from the outlet structure shall be collected on a regular basis with annual reports summarizing the dataset in tabular and graphical form. In addition, grab samples from Reach 14W-22 shall be collected for comparison to pond discharge samples.

Monitoring should continue for a minimum of two summers and one autumn-winter-fall seasonal cycle to allow the full range of temperature variability to be assessed. Depth/temperature loggers or depth/velocity loggers with an additional temperature sensor would allow for the estimation of the amount of thermal energy change there is within the pond system as well as the dilution possible for increased temperature stormwater in the receiving stream.