Halton REGION

MMM Group Limited

Trafalgar Road Transportation Corridor Improvements, From Steeles Avenue to Highway 7

Class Environmental Assessment Study

Drainage and Stormwater Management Report

COMMUNITIES

TRANSPORTATION

BUILDINGS

INFRASTRUCTURE

May 2016 | 3214006-000

MMM GROUP

Class Environmental Assessment (EA) Study for Trafalgar Road Transportation Corridor Improvements

From Steeles Avenue to Highway 7

Halton Region, Ontario

Drainage and Stormwater Management Report

FINAL

Prepared for:

Halton Region

MMM Group Limited

May 2016

3214006

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1.0 INTRODUCTION

The Regional Municipality of Halton is carrying out a Class Environmental Assessment (EA) Study for road improvements to Trafalgar Road between Steeles Avenue and Highway 7, within the jurisdictions of Conservation Halton (CH) and Credit Valley Conservation (CVC). The Class EA Study is being undertaken in accordance with Schedule 'C' of the Municipal Class Environmental Assessment process. The Region initiated the study in 2013 and MMM Group Limited was retained to carry out the study.

Trafalgar Road between Steeles Avenue and Highway 7 is generally a two-lane, north-south, rural Regional arterial road. The existing land use on both sides of Trafalgar Road between Steeles Avenue and 15 Side Road is mainly agriculture with some forest, meadow, and isolated residential features. North of 15 Side Road to Highway 7, Trafalgar Road has a semi-urban characteristics as part of Stewarttown and Georgetown.

Halton Region identified the need for improvements along Trafalgar Road to provide additional north-south traffic capacity, to accommodate growth, as well as to improve network connectivity and operational safety.

The purpose of the Class EA and Preliminary Design study is to:

- Provide the need and justification for the proposed Improvements;
- Assess alignment alternatives with respect to potential environmental, socio-economic, and cultural effects;
- Identify the preferred alignment design concept; and
- Confirm potential environmental impacts and mitigation measures based on the preliminary design.

1.1 Purpose

The purpose of the Drainage and Stormwater Management Report is to provide a clear and traceable decision-making process for the proposed watercourse crossing design, and drainage and stormwater management design concept within the study limits. The report is used to seek 'approval in principle' on preliminary design aspects from relevant regulatory agencies including: Conservation Halton (CH), Credit Valley Conservation (CVC), and Ontario Ministry of Natural Resources and Forestry (MNRF).

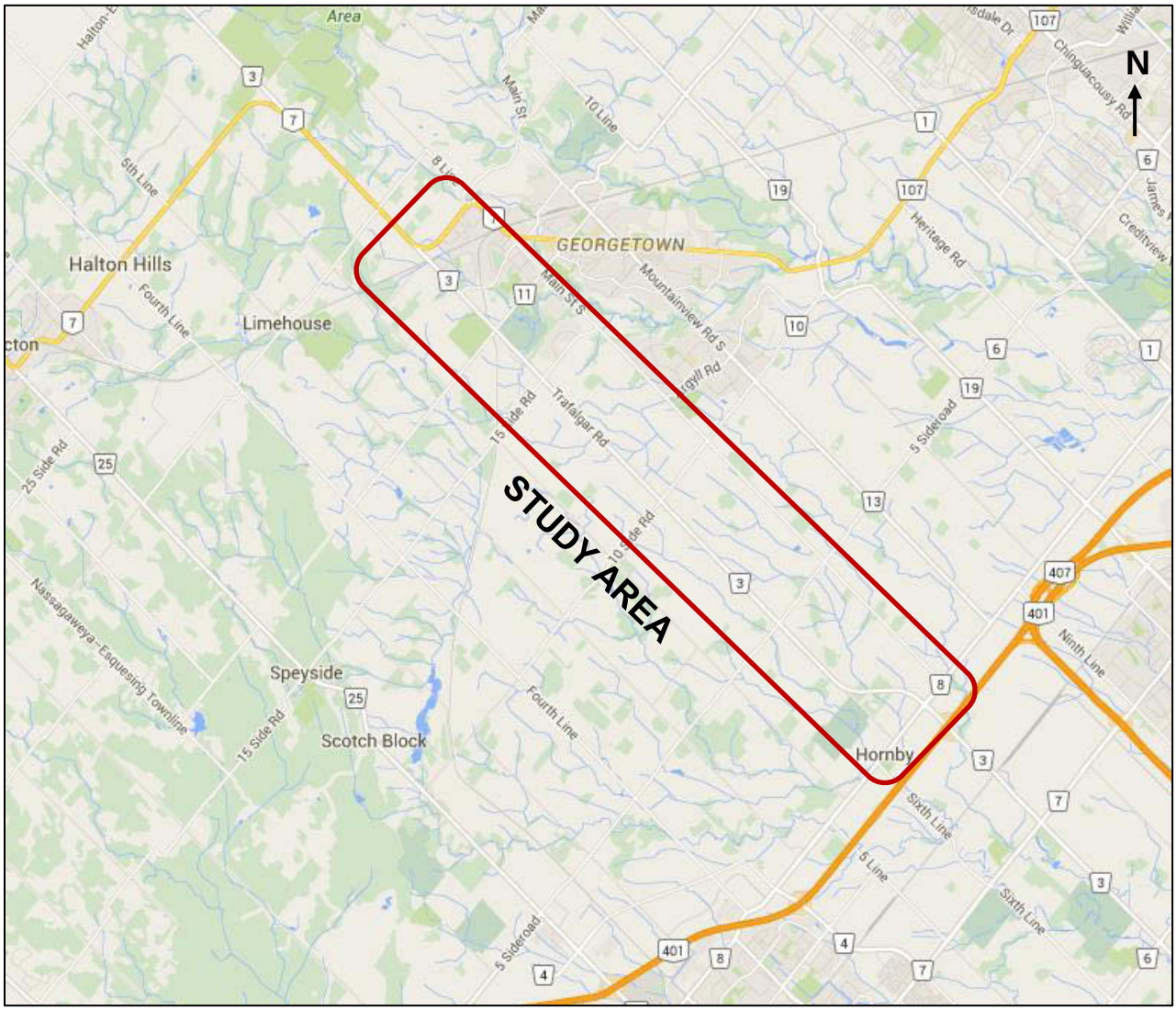
CH jurisdiction limits within the study area is between Steeles Avenue and just south of 15 Side Road. CVC jurisdiction limits within the study is between south of 15 Side Road and Highway 7.

This Drainage and Stormwater Management Report documents the existing drainage characteristics, hydrologic and hydraulic analyses, issues related to drainage and stormwater management conditions, preliminary fluvial geomorphic assessments, wildlife and fish considerations, acceptable opening sizes of major crossing structures, and feasible stormwater management systems for the proposed roadway.

1.2 Study Area

The study limits of the Trafalgar Road improvements extend approximately 13 km, from Steeles Avenue northerly to Highway 7. The study area is located within 16 Mile Creek watershed and Black Creek watershed and these watersheds are within the CH and CVC jurisdictions, respectively. The study area limits are shown in Exhibit 1.

Exhibit 1: Study Area



1.3 Scope of Work

The scope of work entails the following:

- Estimating the storm runoff from the Trafalgar Road right-of-way (ROW) and contributing external areas, under existing and proposed conditions;
- Hydraulic analysis of culverts and one bridge under existing and proposed conditions; and
- Determining a stormwater management strategy for quantity and quality control of roadway runoff.

1.4 Potential Drainage Impacts

Road expansion projects can affect drainage patterns and watercourse characteristics due to increased impervious areas, culvert extensions, culvert replacements, and other roadway works. Some potential impacts include:

- Increased runoff (affecting peak flow rate and the erosion potential of the receiving watercourse);
- Increased pollutant and sediment loading within stormwater and meltwater runoff;
- Physical changes to watercourse morphology (i.e. base flows, flooding levels, and water quality);
- Physical changes to drainage boundaries; and
- Physical changes to hydrologically significant features (i.e. existing ponding areas, dams, zones of infiltration, etc.).

1.5 Background Information and Reports

MMM obtained relevant information and mapping from Halton Region, CH, CVC and Town of Halton Hills, The following documents were reviewed and used in the assessments of this study:

- 2003 AutoCAD files from Halton Region including: Base Mapping; ESR Study Area; ESR Watersheds; Streams; Study Map; Utilities; Watersheds; and MOE Waterwells.
- Aquatic and terrestrial ecology information from CH;
- HEC-RAS models of relevant tributaries from CH;
- Fish collection record data and integrated watershed monitoring program data from CVC;
- 2014 Black Creek, Silver Creek, and Snow's Creek Floodplain maps from CVC;
- 2013 Black Creek Hydrology Study and Hydraulic Models from CVC;
- Ontario Soil Survey map for Halton County (Soil Survey Report # 43); and
- Structure Inspection Report for Culverts C1, C2 and Bridge B1, prepared by AECOM for Halton Region, October 2012;

Other information reviewed as a part of the study includes:

- MOECC Stormwater Planning and Design Manual, 2003.
- Field survey of study area, May 2014; and
- Additional site photographs, January 2015.

1.6 Site Investigations

The site investigation of the study area and existing drainage features was conducted by MMM staff on May 29, 2014. Table 1 provides the general condition inspection of the existing crossing structures along Trafalgar Road between Steeles Avenue and Highway 7.

A photographic inventory of the site investigation is provided in Appendix A.

Table 1: Characteristics of Existing Structures and General Condition

Culvert ID	Station	Culvert Dimension, per Field verification		Type / Material	Upstream Invert (m)	Downstream Invert (m)	Flow Direction	Comments / Conditions Summary
		Size	Length (m)					
Conservation Halton Jurisdiction								
C1	0+400	3.05 m x 2.45 m	28.1	Single cell concrete box culvert,	201.36	201.24	E to W	Good condition
C2	1+080	2.75 m x 2.25 m (x2)	36.4	Double cell concrete box culvert	200.06	199.96	N to S	Good condition
C3	2+755	500 mm diameter	21.7	Circular, CSP	233.26	232.21	E to W	Corroded on bottom. Downstream end damaged.
C4	3+506	600 mm diameter	18.5	Circular, CSP	244.06	244.02	W to E	Good condition
C5	4+068	600 mm diameter	20.6	Circular, CSP	241.24	240.93	W to E	Upstream end damaged. Corroded on bottom.
C6	4+228	900 mm diameter	23.3	Circular, CSP	241.07	240.42	W to E	Moderate corrosion on bottom. Downstream is perched, approximately 0.30 m.
C7	4+950	1.40 m x 0.90 m	26.5	Arc CSP	245.39	245.27	W to E	Approx. 10 cm sediment build up upstream. Moderate corrosion. Some distortion on downstream face.
C8	6+266	600 mm diameter	21	Circular, CSP	253.59	253.52	W to E	Minor corrosion on bottom. Condition fair.
C9	6+852	900 mm diameter	22.9	Circular, CSP	251	250.83	W to E	Some of downstream end is embedded and damaged
C10	7+285	700 mm diameter	26.5	Circular, CSP	252.32	252.24	W to E	Approx. 10 cm sediment layer on bottom. Highly corroded, bottom of pipe is rusted throughout. Moderate distortion on upstream face.
C11	7+927	750 mm diameter	25.5	HDPE liner in a CSP	255.49	255.31	W to E	Good condition, smooth inside. Concrete filled between CSP and HDPE pipe. Light corrosion on outer CSP. Erosion on downstream channel.

Culvert ID	Station	Culvert Dimension, per Field verification		Type / Material	Upstream Invert (m)	Downstream Invert (m)	Flow Direction	Comments / Conditions Summary
		Size	Length (m)					
C12	8+635	900 mm diameter	26.4	Circular, CSP	260.74	260.42	W to E	Bottom corroded away. Upstream face distorted.
Credit Valley Conservation Jurisdiction								
B1	9+940	9.25 m x 3.0 m	13	Single span bridge over Black Creek	238.41	238.25	W to E	Good condition
C13	11+020	525 mm diameter	23.2	HDPE liner in a CSP	266.84	266.37	W to E	Good condition; smooth inside. Concrete filled between CSP and HDPE pipe.
C14	11+145	900 mm diameter	24.1	HDPE liner in a CSP	267.92	267.64	W to E	Good condition; smooth inside. Concrete filled between CSP and HDPE pipe.
C15	11+880	600 mm diameter	28.3	HDPE liner in a CSP	269.67	268.68	W to E	Good condition; smooth inside. Concrete filled between CSP and HDPE pipe.
S1	12+245	750 mm diameter	25.6	HDPE (storm inlet, d/s at MH)	272.09	271.898	W to E	Good. Upstream end open and downstream end at CB manhole (a storm inlet). Culvert drains to residential division storm sewer system.
C16	12+460	1800 mm diameter	50.2	Circular, CSP	269.48	269.29	W to E	Bottom corroded severely
C17	12+780	900 mm diameter	65.5	Circular, CSP	274.46	273.5	W to E	Good condition
C18	20+100 (20 Side Road)	1800 mm diameter	49.2	Circular, CSP	270.50*	270.50*	W to E	Bottom corroded severely

*Note: Inverts for C18 were estimated from available contour map.

2.0 SWM DESIGN CRITERIA, GUIDELINES AND STANDARDS

2.1 SWM Design Criteria and Guidelines

The following stormwater management (SWM) criteria were considered in the preliminary design of Trafalgar Road as part of the EA Study. These criteria were based on the Conservation Halton's (CH) and Credit Valley Conservation's (CVC) SWM criteria, as well as the Ministry of the Environment and Climate Change's (MOECC) SWM Planning and Design Manual (2003):

- **SWM Quality Control Criteria:** According to the MOECC SWM Planning and Design Manual (2003), the highest level of water quality treatment is the Enhanced level. Runoff from the road ROW shall be treated to the Enhanced level of treatment.

- **SWM Quantity Control Criteria:** CH and CVC SWM criteria state that the post-development flows shall be controlled to pre-development levels for the 2-yr, 5-yr, 10-yr, 25-yr, 50-yr and 100-yr storm events.

- **Extended Detention/Erosion Control Criteria:** SWM facilities shall include an additional storage volume for extended detention to reduce/mitigate the potential erosion impact on the receiving watercourse. Where appropriate, extended detention shall be included in the SWM facilities.

2.1.1 Ministry of Transportation Highway Drainage Design Standards

The Ministry of Transportation (MTO) has prepared a number of directives and manuals that outline the approach and guidelines to be used in the assessment of drainage systems for highway projects. The guidelines and policies used in the assessment of the drainage system include:

- MTO's *Drainage Management Manual* (1997); and
- MTO's *Highway Drainage Design Standards* (2008).

The MTO's *Highway Drainage Design Standards* prescribe standards for designing Surface Drainage Systems (SD) and Water Crossings (WC). The standards that are relevant to this study are as follows:

a) **SD-1 Design Flows for Surface Drainage Systems:** This standard identifies the minimum design flows that should be used for the sizing of road surface drainage systems.

b) **SD-12 Freeboard above Adjacent Watercourse or Water Bodies:** This standard identifies the minimum required freeboard for roadways that are constructed adjacent to watercourses or waterbodies.

c) **SD-13 Design Flow and Freeboard for a Culvert not on Watercourse:** This standard identifies the design flow and the required minimum freeboard for culverts associated with runoff from roadways and local external catchments.

d) **WC-1 Design Flows (Bridges and Culverts):** This standard identifies the minimum design flows for the sizing of bridges and culverts for flow conveyance on regulated and non-regulated watercourses. It stipulates that an urban arterial road with a watercourse crossing and span of less than or equal to 6.0 m should be designed to convey the flow generated during a 50-year design storm. For spans greater than 6.0 m the watercourse crossing should be designed to convey the flow generated during a 100-year design storm.

e) **WC-7 Culvert Crossings on a Watercourse:** This standard identifies freeboard, minimum clearance and the maximum flood depth at culvert crossings.

- *Minimum Freeboard* of 1.0 m measured vertically from the High Water Level for the design flow to the edge of the travelled lane at the low point.
- *Minimum Clearance* of 1.0 m measured vertically from the High Water Level for the design flow to the minimum soffit elevation of the bridge or the average soffit elevation of an arch culvert.
- The *Flood Depth to Rise Ratio* at culverts with a rise less than 3.0 m should not exceed 1.5 times the diameter or rise of the culvert at the upstream face. For culverts with a rise between 3.0 m and 4.5 m the flood depth to rise ratio at the upstream face must not exceed 4.5 m. This standard applies to closed footing culverts and open footing culverts with non-erodible bottoms.
- In addition to these design standards, the culverts within the study limits will be analyzed for overtopping during the 100-year and Regional Storm events.

The following design objectives were established to minimize the potential impacts of the proposed road widening on the surrounding environment, based on the prevailing policy framework:

- Provide an effective/efficient drainage system;
- Minimize risk to public safety;
- Maintain flow paths for upstream lands;
- Maintain or enhance the quality of storm runoff;
- Maintain or reduce flood risk for lands within and surrounding the transportation corridor;
- Minimize future maintenance requirements; and
- Situate SWM measures on lands available in the transportation corridor.

3.0 HYDROLOGIC ANALYSES

3.1 Existing Land use and Drainage

The study area includes portions of the Sixteen Mile Creek watershed and the Black Creek watershed, under the jurisdiction of CH and CVC, respectively. Four (4) of the twelve (12) watercourses within the study area are regulated, and they are Black Creek (Bridge B1), Sixteen Mile Creek Mideast Reach 1 North (Culvert C11), Sixteen Mile Creek Mideast Reach 13 Main (Culvert C2) and Sixteen Mile Creek Mideast Reach 13 Tributary (Culvert C1).

Black Creek and Sixteen Mile Creek Mideast Reach 13 are permanent watercourses directly supporting fish, and both contain high quality fish habitat in the vicinity of Trafalgar Road. The other watercourses, including the Sixteen Mile Creek Mideast Reach 1 North and Sixteen Mile Creek Mideast Reach 13 Tributary, are intermittent or ephemeral. Drainage from the roadway is being conveyed by roadside ditches and crossing culverts to the receiving watercourses. In general, the drainage pattern is from west to east.

The existing land use on both sides of Trafalgar Road is mainly agriculture with some forest, meadow, and residential features. The soil types in the area include: Chinguacousy Clay Loam, Chinguacousy Silt Loam, Farmington Loam, Fox Sandy Loam, Font Sandy Loam, Grimbsy Sandy Loam, Guelph Loam, Jeddo Clay Loam, London Loam, Lockport Clay, Oneida Silt Loam, and Oneida Clay Loam. The general topography slopes from west to east.

There are eighteen (18) culverts (Culverts C1 to C18) and one (1) bridge (Bridge B1) within the study area. There are also two (2) storm inlets. Culverts C1 through C12, between Steeles Avenue and south of 15 Side Road are located within the CH jurisdiction. Bridge B1, Culverts C13 through C18 and the two (2) storm inlets, between 15 Side Road and Highway 7, are located within the CVC jurisdiction. The majority of culverts drain from west to east with the exception of Culverts C1 and C3 which drain from east to west and Culvert C2 that drains from north to south. The existing conditions drainage mosaics are provided in Exhibits 2 to 15.

Under CH jurisdiction Catchments 100, 110, 135, 140, 145, 150, and 155 are conveyed through Culverts C1, C3, C8, C9, C10, C11, and C12, respectively. Catchments 115, 120, 125, and 130 are conveyed through Culverts C4, C5, C6, and C7, respectively. Flows from these four culverts combine and are routed through a channel before combining with flows from Catchment 105, ultimately discharging through Culvert C2. Culvert C4 drains a small roadway area only. This culvert will be eliminated in proposed conditions and the runoff will be directed south via the west side ditch.

Under CVC jurisdiction, west of Trafalgar Road (i.e. west of Sixth Line), Black Creek flows in a north to south direction and changes to an easterly direction from the CN railway crossing, crosses Trafalgar Road and joins Silver Creek approximately 2.2 km downstream of Trafalgar Road.

Catchment 200 (10.5 ha area) consists mainly of subdivision area. Minor system runoff are captured and conveyed to the stormwater management facility in the subdivision; however, the major system runoff

drains westerly toward Trafalgar Road and ultimately drains to the Black Creek. Both major and minor system flows ultimately drain to Black Creek.

Minor system runoff from Catchments 205, 210 and 215 are conveyed by storm sewers to Black Creek and the major system runoff drains overland to Black Creek. Land use in these catchments is mainly residential. Catchment 220, which has a drainage area of 21.0 ha, consists of mainly playground/lawns (part of Trafalgar Sports Park). It drains to an existing stormwater management (SWM) facility. The outflows from the SWM facility are directed to the CNR ditch on the east side by a 700 mm diameter corrugated pipe. The ditch discharges to the Trafalgar Road storm sewer via a ditch inlet and the storm sewer ultimately drains to Black Creek. There is no survey information for the SWM facility and details of the outlet control structure are not available. Therefore, it is assumed that the outflows are controlled to the 5-year level for all the storm events. It is recommended that a detailed survey of the SWM facility and outlet control structure be carried out so that reservoir routing can be performed during the detailed design phase.

Catchment 225 includes the existing conditions area for the proposed alignment. Catchment 230 includes a small roadway area of 0.81 ha drained by Culvert C13. Both Catchments 225 and 230 drain overland in an easterly direction to a tributary (Tributary 1) of Black Creek. Culvert C13 drains an insignificant area, and as such, the culvert will be removed or abandoned under the proposed conditions based on the preferred alignment of Trafalgar Road at the CNR crossing.

Flows from Catchments 235 and 240 are conveyed through Culverts C14 and C15, respectively. Flows from Catchment 245 drain to an open-end storm inlet which conveys the flows to the existing storm sewers located in the residential subdivision.

The headwater of another Black Creek tributary (Tributary 2) originates in Catchment 260. Combined flows from Catchments 255 and 260 are conveyed through Culvert C18 on 20 Side Road. The flows from Culvert C18 combine with flows from Catchments 250 and 265, to discharge through Culvert C16. This tributary ultimately drains to Black creek

Flows from Catchments 270 and 275 combine and discharge through Culvert C17.

STEELES AVENUE

C1

C2

C3

C4

C5

C6

C7

REACH 13 TRIBUTARY

16 MILE CREEK MIDEAST REACH 13 MAIN

TRAFALGAR ROAD

100
89.3 ha

105
714 ha

110
5.73 ha

115
0.82 ha

120
5.72 ha

125
24.5 ha

130
25.6 ha

LEGEND

- DRAINAGE BOUNDARY
- CULVERT
- FLOW DIRECTION
- C1 — CULVERT ID
- B1 — BRIDGE ID
- 255 / 29.4 ha — CATCHMENT ID / CATCHMENT AREA

Metric Scale
100m 0 200m
Horizontal

MMM GROUP

EXISTING CONDITIONS DRAINAGE MOSAIC

TRAFALGAR ROAD EA, FROM STEELES AVENUE TO HIGHWAY 7

EXHIBIT
2

LEGEND

- DRAINAGE BOUNDARY
- CULVERT
- FLOW DIRECTION
- C1 — CULVERT ID
- B1 — BRIDGE ID
- 255 / 29.4 ha — CATCHMENT ID / CATCHMENT AREA

Metric Scale
25m 0 50m
Horizontal

STEELES AVENUE

16 MILE CREEK MIDEAST REACH 13 TRIBUTARY

16 MILE CREEK MIDEAST REACH 13 MAIN

TRAFALGAR ROAD

C1

C2

100
89.3 ha

105
714 ha

0+000 0+100 0+200 0+300 0+400 0+500 0+600 0+700 0+800 0+900 1+000 1+100

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DRAWING NAME: I:\DRAWINGS\WATERRES\3214006\DRAINAGE\3214006 TRAFALGAR ROAD EA – DRAINAGE MOSAIC EXISTING – VER 03.DWG

MMM GROUP

EXISTING CONDITIONS DRAINAGE MOSAIC

TRAFALGAR ROAD EA, FROM STEELES AVENUE TO HIGHWAY 7

EXHIBIT

3

LEGEND

- DRAINAGE BOUNDARY
- CULVERT
- FLOW DIRECTION
- C1 — CULVERT ID
- B1 — BRIDGE ID
- 255 / 29.4 ha — CATCHMENT ID / CATCHMENT AREA

Metric Scale
25m 0 50m
Horizontal

HORNBY ROAD

TRAFALGAR ROAD

1+500

1+600

1+700

1+800

1+900

1+999

2+000

2+100

2+200

2+300

105
714 ha

16 MILE CREEK MIDEAST REACH 13 MAIN

MMM GROUP

EXISTING CONDITIONS DRAINAGE MOSAIC

TRAFALGAR ROAD EA, FROM STEELES AVENUE TO HIGHWAY 7

EXHIBIT
4

LEGEND

- DRAINAGE BOUNDARY
- CULVERT
- FLOW DIRECTION
- C1 — CULVERT ID
- B1 — BRIDGE ID
- 255 / 29.4 ha — CATCHMENT ID / CATCHMENT AREA

Metric Scale
25m 0 50m
Horizontal

C3

2+400 2+500 2+600 2+700 2+800 2+900 3+000 3+100 3+200 3+300 3+400 3+500

TRAFALGAR ROAD

110
5.73 ha

105
714 ha

5 SIDEROAD

C4

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EXISTING CONDITIONS DRAINAGE MOSAIC

TRAFALGAR ROAD EA, FROM STEELES AVENUE TO HIGHWAY 7

EXHIBIT

5

LEGEND

- DRAINAGE BOUNDARY
- CULVERT
- FLOW DIRECTION
- C1 — CULVERT ID
- B1 — BRIDGE ID
- 255 / 29.4 ha — CATCHMENT ID / CATCHMENT AREA

Metric Scale
25m 0 50m
Horizontal

115 / 0.82 ha

120 / 5.72 ha

125 / 24.5 ha

105 / 714 ha

C4 C5 C6

3+600 3+700 3+800 3+900 4+000 4+100 4+200 4+300 4+400 4+500 4+600

TRAFALGAR ROAD

MMM GROUP

EXISTING CONDITIONS DRAINAGE MOSAIC

TRAFALGAR ROAD EA, FROM STEELES AVENUE TO HIGHWAY 7

EXHIBIT

6

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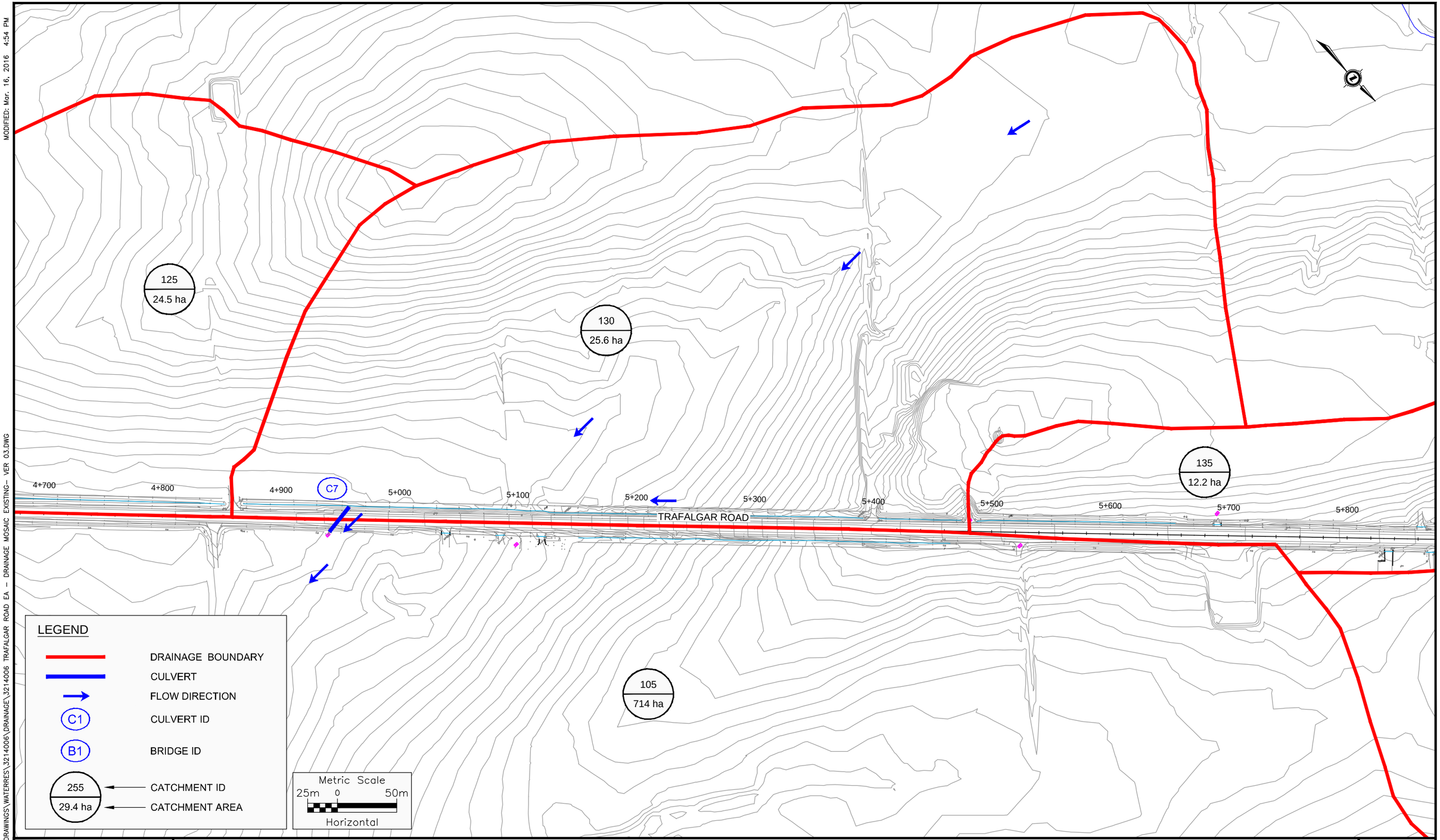


MMM GROUP

EXISTING CONDITIONS DRAINAGE MOSAIC

TRAFALGAR ROAD EA, FROM STEELES AVENUE TO HIGHWAY 7

EXHIBIT

7

LEGEND

- DRAINAGE BOUNDARY
- CULVERT
- FLOW DIRECTION
- C1 — CULVERT ID
- B1 — BRIDGE ID
- 255 / 29.4 ha — CATCHMENT ID / CATCHMENT AREA

Metric Scale
25m 0 50m
Horizontal

135
12.2 ha

140
30.2 ha

C8

C9

5+900 6+000 6+100 6+200 6+300 6+400 6+500 6+600 6+700 6+800 6+900 7+000

TRAFALGAR ROAD

10 SIDEROAD

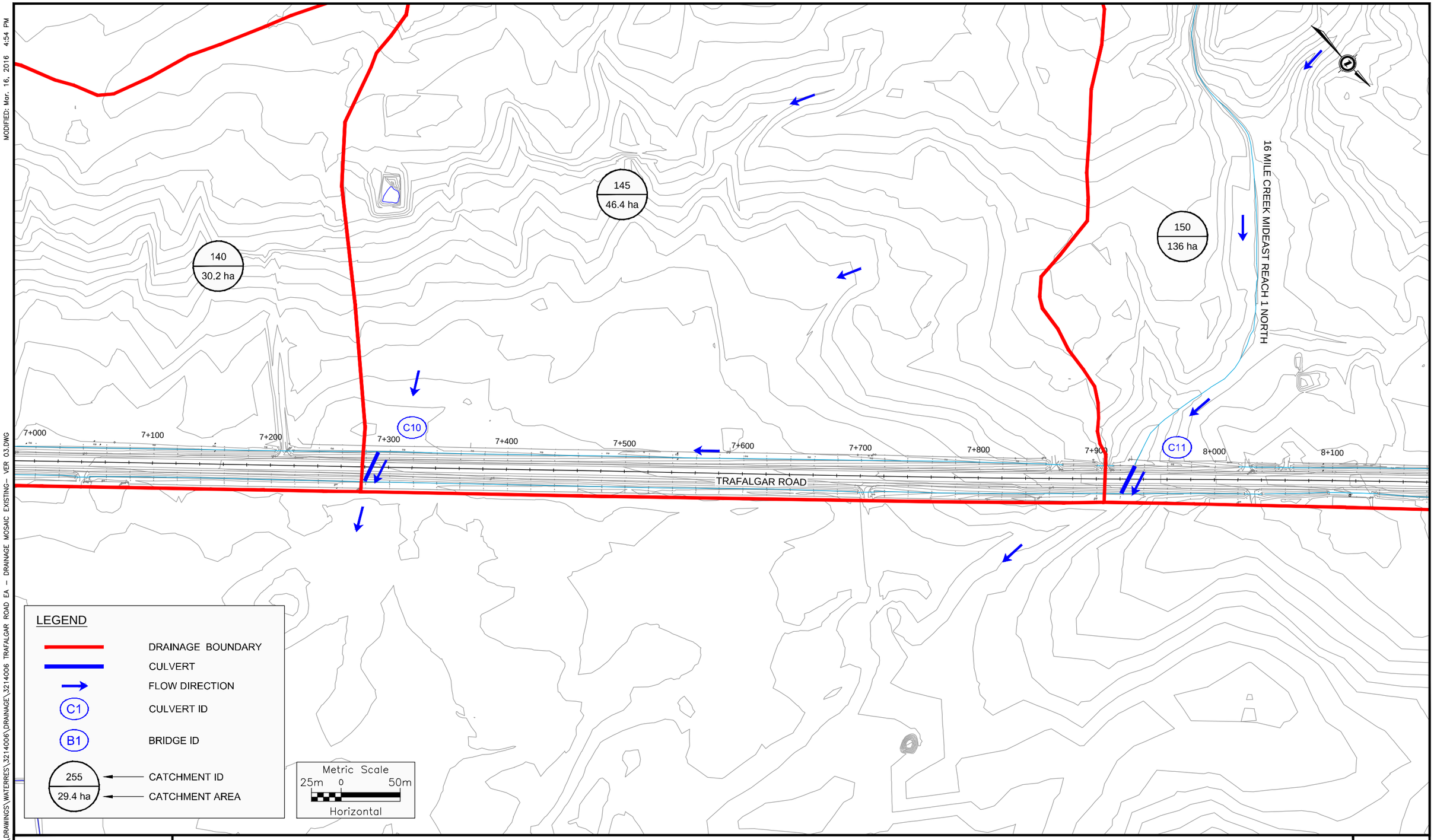
MMM GROUP

EXISTING CONDITIONS DRAINAGE MOSAIC

TRAFALGAR ROAD EA, FROM STEELES AVENUE TO HIGHWAY 7

EXHIBIT

8



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EXISTING CONDITIONS DRAINAGE MOSAIC

TRAFALGAR ROAD EA, FROM STEELES AVENUE TO HIGHWAY 7

EXHIBIT

9

LEGEND

- DRAINAGE BOUNDARY
- CULVERT
- FLOW DIRECTION
- C1 — CULVERT ID
- B1 — BRIDGE ID
- 255 / 29.4 ha — CATCHMENT ID / CATCHMENT AREA

Metric Scale
25m 0 50m
Horizontal

155
39.3 ha

8+200 8+300 8+400 8+500 8+600 C12 8+700 8+800 8+900 9+000 9+100 9+200 9+300

TRAFALGAR ROAD

MMM GROUP

EXISTING CONDITIONS DRAINAGE MOSAIC

TRAFALGAR ROAD EA, FROM STEELES AVENUE TO HIGHWAY 7

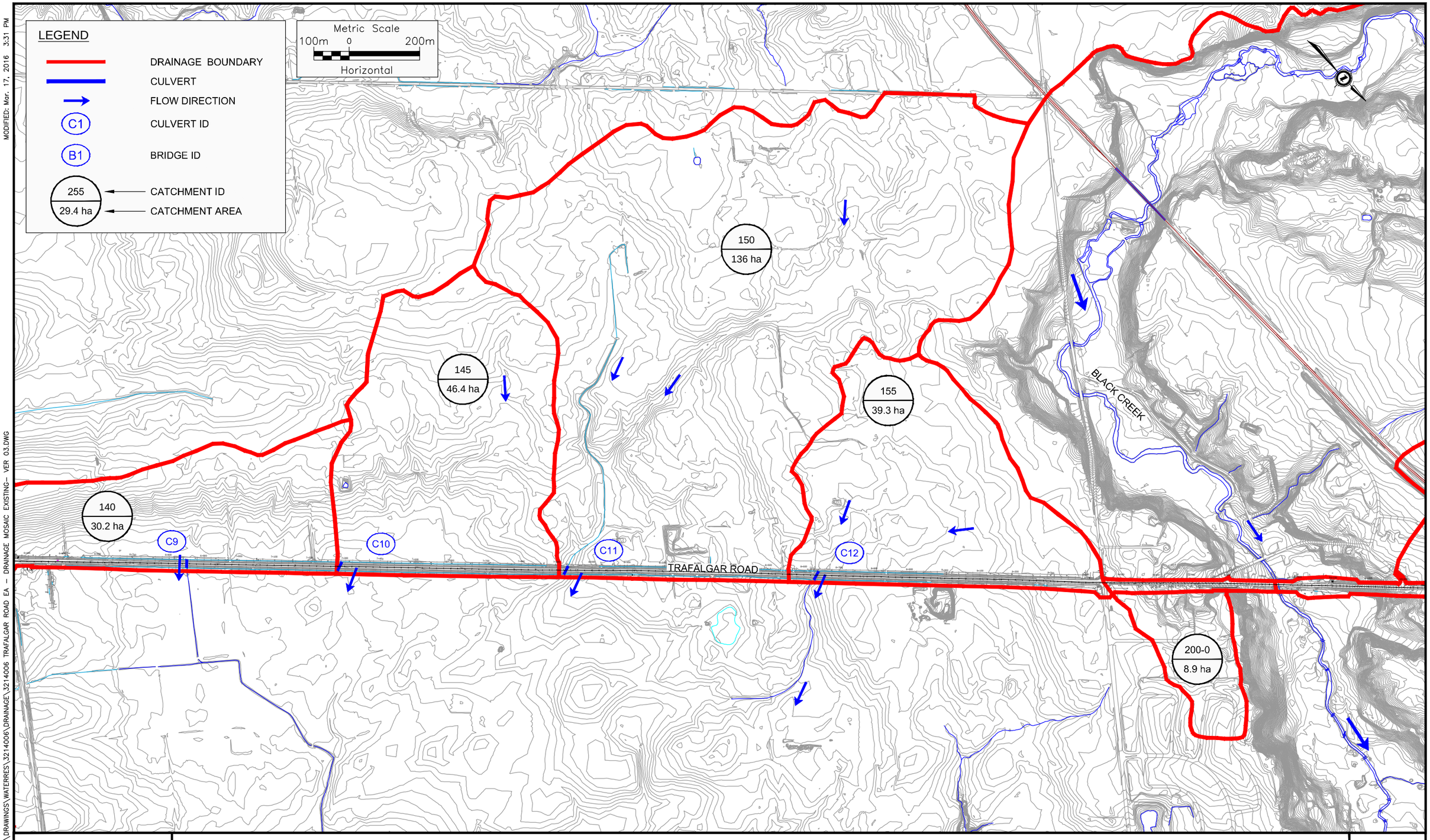
EXHIBIT

10

LEGEND

- DRAINAGE BOUNDARY
- CULVERT
- FLOW DIRECTION
- C1 — CULVERT ID
- B1 — BRIDGE ID
- 255 / 29.4 ha — CATCHMENT ID / CATCHMENT AREA

Metric Scale
100m 0 200m
Horizontal

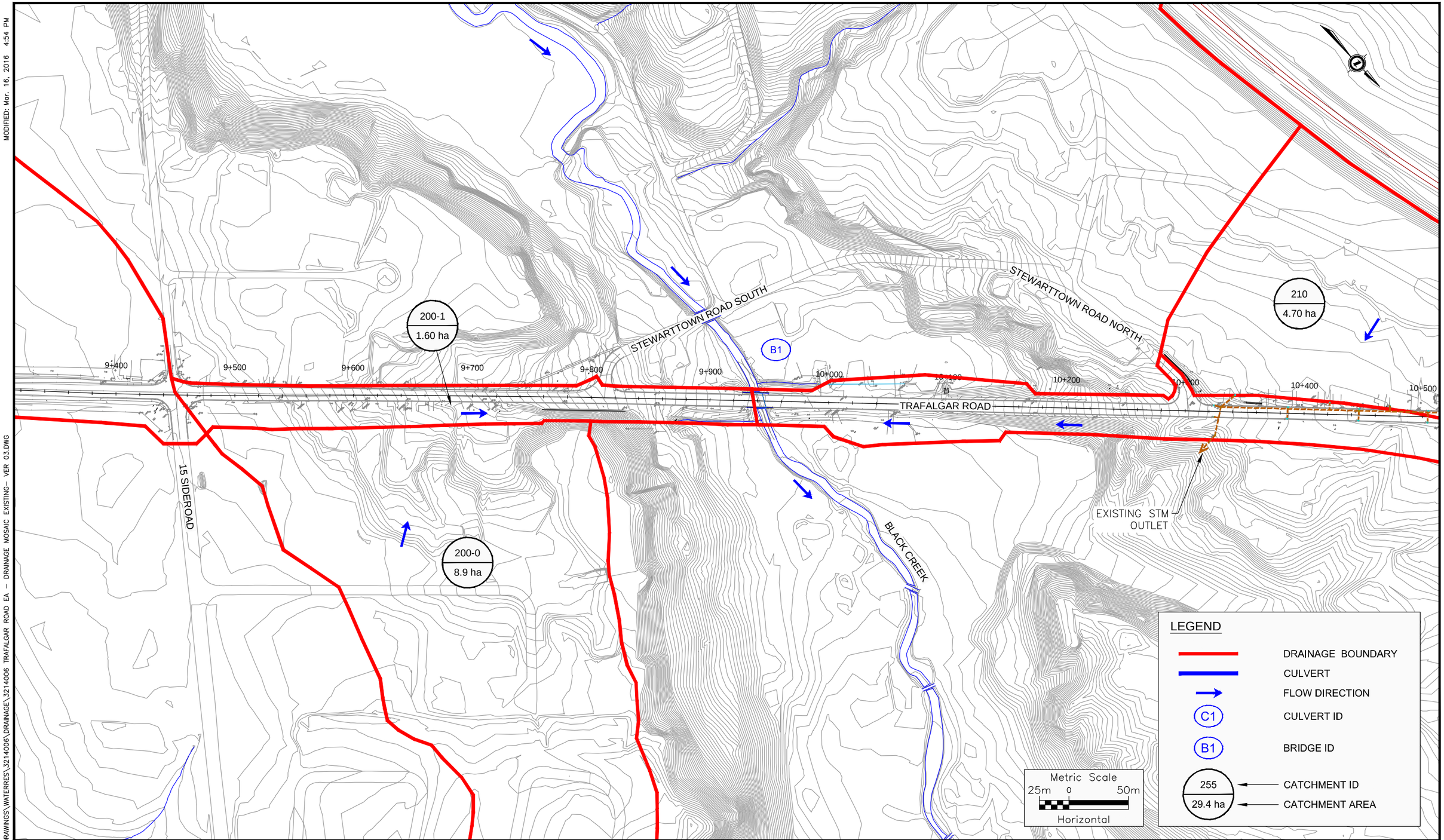


MMM GROUP

EXISTING CONDITIONS DRAINAGE MOSAIC

TRAFALGAR ROAD EA , FROM STEELES AVENUE TO HIGHWAY 7

EXHIBIT 11



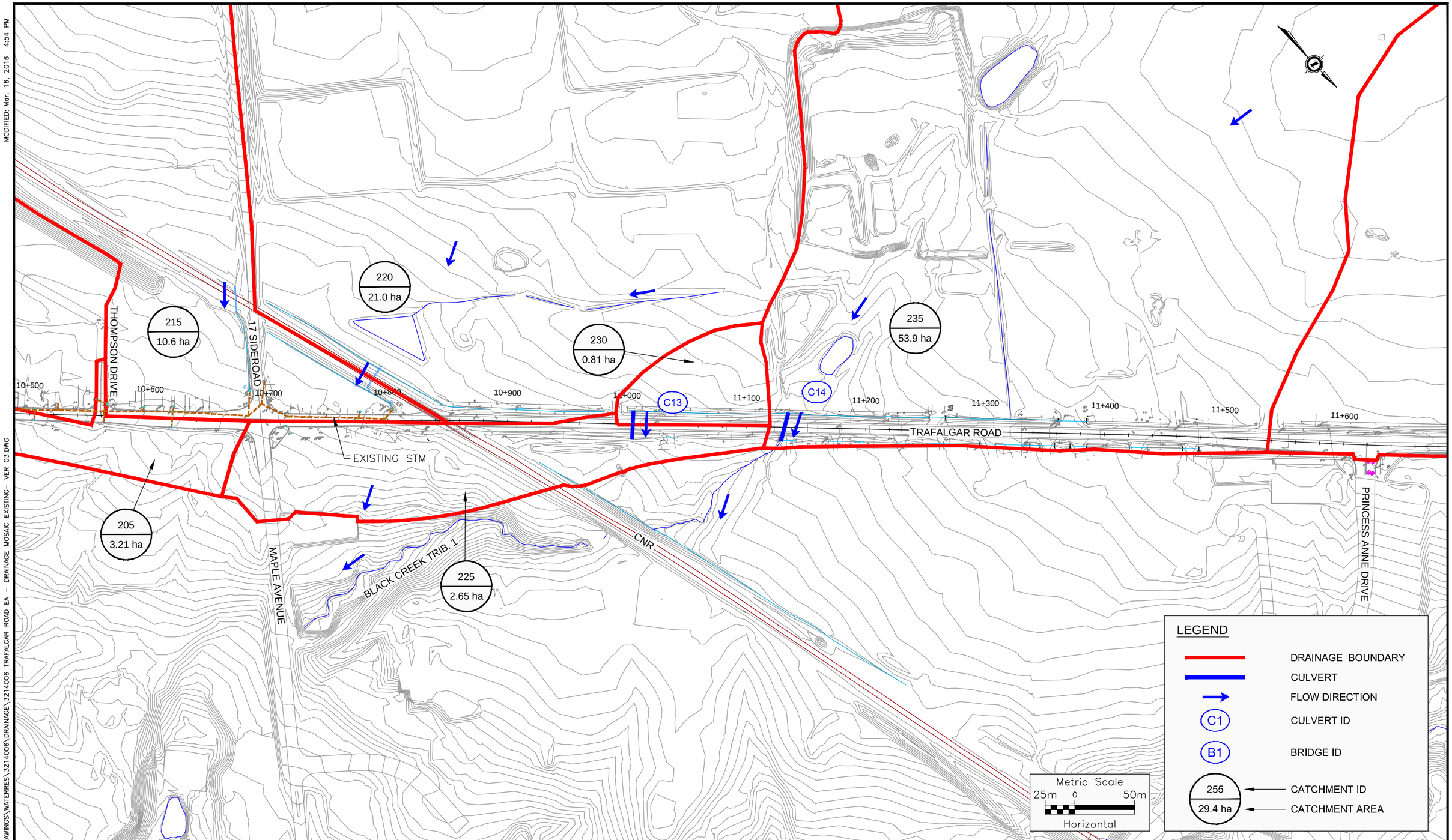
MMM GROUP

EXISTING CONDITIONS DRAINAGE MOSAIC

TRAFALGAR ROAD EA, FROM STEELES AVENUE TO HIGHWAY 7

EXHIBIT

12



MMM GROUP

EXISTING CONDITIONS DRAINAGE MOSAIC

TRAFALGAR ROAD EA, FROM STEELES AVENUE TO HIGHWAY 7

EXHIBIT

13

LEGEND

- DRAINAGE BOUNDARY
- CULVERT
- FLOW DIRECTION
- C1 — CULVERT ID
- B1 — BRIDGE ID
- 255 / 29.4 ha — CATCHMENT ID / CATCHMENT AREA

Metric Scale
25m 0 50m
Horizontal

240
41.0 ha

245
10.0 ha

255
29.4 ha

260
71.5 ha

270
18.3 ha

250
1.56 ha

265
1.50 ha

275
0.40 ha

C15 C16 C17 C18 S1

11+700 11+800 11+900 12+000 12+100 12+200 12+300 12+400 12+500 12+600 12+700

TRAFALGAR ROAD

20 SIDEROAD

BERTON BOULEVARD

LINDSAY COURT

GEXR

HIGHWAY 7

TO EXISTING STM

BLACK CREEK TRIBUTARY 2

MMM GROUP

EXISTING CONDITIONS DRAINAGE MOSAIC

TRAFALGAR ROAD EA, FROM STEELES AVENUE TO HIGHWAY 7

EXHIBIT 14

DRAWING NAME: I:\ DRAWINGS\WATERRES\3214006\DRAINAGE\3214006 TRAFALGAR ROAD EA – DRAINAGE MOSAIC EXISTING – VER 03.DWG

MODIFIED: Mar. 17, 2016 11:36 AM

LEGEND

- DRAINAGE BOUNDARY
- CULVERT
- FLOW DIRECTION
- C1 — CULVERT ID
- B1 — BRIDGE ID
- 255 / 29.4 ha — CATCHMENT ID / CATCHMENT AREA

Metric Scale
100m 0 200m
Horizontal

215 — 10.6 ha
220 — 21.0 ha
235 — 53.9 ha
240 — 41.0 ha
255 — 29.4 ha
260 — 71.5 ha
270 — 18.3 ha

C14
C15
C16
C17
C18
S1

TRAFALGAR ROAD
HIGHWAY 7

MMM GROUP

EXISTING CONDITIONS DRAINAGE MOSAIC

TRAFALGAR ROAD EA, FROM STEELES AVENUE TO HIGHWAY 7

EXHIBIT
15

MODIFIED: Mar. 17, 2016 8:49 AM

DRAWING NAME: i:\DRAWINGS\WATERRES\3214006\DRAINAGE\3214006 TRAFALGAR ROAD EA – DRAINAGE MOSAIC EXISTING– VER 03.DWG

3.2 Existing Conditions Hydrologic Modelling

A SWMHYMO hydrologic model was developed to estimate localized runoff from the roadway and external areas under existing conditions. The flows at each culvert were generated as follows:

- SWMHYMO modelling using the 12-hour Chicago, 24-hour Chicago and 24-hour SCS (Soil Conservation Service) storm distributions to determine the various return period and Regional Storm (Hurricane Hazel) peak flows; and
- Additionally, GAWSER flows of Catchment 7, as described in the Black Creek Hydrology Study Report, were provided by CVC and were transposed to various points of interest (Culvert C13 to C17) using MTO's Transposition of Flood Discharges Formula. The drainage areas of Culvert C13 to C17 are subcatchments of Catchment 7 which has a drainage area of approximately 503 ha.

The summary of hydrological parameters, model schematics, and SWMHYMO output files are provided in Appendix A. The CVC's Standard Parameter's guidelines were used when determining the hydrological parameters for both watersheds. The rainfall hyetographs for the 12-hour Chicago, 24-hour Chicago and 24-hour SCS were prepared from the rainfall IDF values provided in the Black Creek Hydrology Study Report.

Table 2 and Table 3 provide a comparison of flows obtained for each storm distribution at each culvert under CH and CVC jurisdiction respectively.

As shown in Table 2 and Table 3, the 24-hour SCS storm distribution generated the highest flows at most culvert locations. Therefore, the flows obtained from the 24-hour SCS storm distribution were carried forward for hydraulic analysis of the culverts to provide the most conservative results. The results of the hydrologic modelling for the drainage areas under CVC jurisdiction were sent to CVC for their review and comments. CVC reviewed the hydrologic modelling information and agreed that the flows obtained from the 24-hour SCS storm distribution be carried forward for hydraulic analysis.

Table 2: Existing Conditions Peak Flow Comparison- CH Jurisdiction

Outlet	Hydro ID	Storm Distribution	Flow (m3/s)						
			2-year	5-year	10-year	25-year	50-year	100-year	Regional
C1	100	12-hr Chicago	1.33	2.23	2.84	3.74	4.35	5.01	9.19
		24-hr Chicago	1.62	2.58	3.33	4.37	5.15	5.79	
		24-hr SCS	**1.83**	**2.71**	**3.41**	**4.30**	**5.03**	**5.59**	
C2	505	12-hr Chicago	5.28	8.87	11.3	15.0	17.5	20.2	55.2
		24-hr Chicago	6.47	10.4	13.6	17.8	21.2	23.9	
		24-hr SCS	**7.21**	**10.9**	**13.9**	**17.8**	**21.0**	**23.5**	
C3	110	12-hr Chicago	0.171	0.293	0.376	0.497	0.579	0.667	0.761
		24-hr Chicago	0.209	0.338	0.437	0.573	0.672	0.758	
		24-hr SCS	**0.246**	**0.364**	**0.457**	**0.574**	**0.670**	**0.741**	
C4	115	12-hr Chicago	0.042	0.056	0.065	0.077	0.085	0.094	0.085
		24-hr Chicago	0.043	0.058	0.067	0.080	0.090	0.099	
		24-hr SCS	**0.040**	**0.051**	**0.060**	**0.071**	**0.081**	**0.089**	
C5	120	12-hr Chicago	0.104	0.185	0.242	0.328	0.388	0.453	0.706
		24-hr Chicago	0.129	0.217	0.287	0.387	0.463	0.529	
		24-hr SCS	**0.153**	**0.236**	**0.304**	**0.393**	**0.468**	**0.525**	
C6	125	12-hr Chicago	0.322	0.561	0.728	0.981	1.16	1.35	2.64
		24-hr Chicago	0.397	0.658	0.868	1.16	1.39	1.58	
		24-hr SCS	**0.460**	**0.704**	**0.902**	**1.16**	**1.38**	**1.55**	
C7	130	12-hr Chicago	0.347	0.605	0.786	1.06	1.25	1.46	2.79
		24-hr Chicago	0.428	0.711	0.937	1.26	1.50	1.71	
		24-hr SCS	**0.497**	**0.760**	**0.975**	**1.26**	**1.49**	**1.67**	
C8	135	12-hr Chicago	0.180	0.328	0.433	0.594	0.707	0.831	1.45
		24-hr Chicago	0.226	0.389	0.522	0.711	0.856	0.981	
		24-hr SCS	**0.272**	**0.427**	**0.555**	**0.725**	**0.867**	**0.977**	
C9	140	12-hr Chicago	0.497	0.885	1.16	1.56	1.85	2.15	3.52
		24-hr Chicago	0.620	1.04	1.38	1.85	2.21	2.51	
		24-hr SCS	**0.735**	**1.13**	**1.45**	**1.86**	**2.21**	**2.47**	
C10	145	12-hr Chicago	0.618	1.06	1.37	1.84	2.16	2.50	4.93
		24-hr Chicago	0.756	1.24	1.63	2.17	2.58	2.93	
		24-hr SCS	**0.869**	**1.32**	**1.68**	**2.16**	**2.55**	**2.85**	
C11	150	12-hr Chicago	1.01	1.73	2.23	2.99	3.52	4.10	11.0
		24-hr Chicago	1.24	2.04	2.68	3.58	4.29	4.86	
		24-hr SCS	**1.40**	**2.15**	**2.77**	**3.58**	**4.26**	**4.77**	
C12	155	12-hr Chicago	0.441	0.774	1.01	1.36	1.61	1.88	4.05
		24-hr Chicago	0.547	0.913	1.21	1.62	1.94	2.21	
		24-hr SCS	**0.633**	**0.975**	**1.26**	**1.62**	**1.93**	**2.17**	

Table 3: Existing Conditions Peak Flow Comparison- CVC Jurisdiction

Discharge To	Hydro-graph	Storm	Peak Flow (m^3/s)						
			2-year	5-year	10-year	25-year	50-year	100-year	Regional (Hazel)
Existing STM to Black Creek from North	520	12-hr Chicago	0.413	0.766	0.851	1.009	1.099	1.213	**2.288**
		24-hr Chicago	0.525	0.917	1.029	1.209	1.34	1.449	
		24-hr SCS	**0.639**	**1.019**	**1.146**	**1.388**	**1.584**	**1.695**	
B1	525	12-hr Chicago	0.763	1.203	1.596	2.322	2.886	3.268	**3.156**
		24-hr Chicago	0.626	1.068	1.362	1.874	2.393	2.873	
		24-hr SCS	**0.498**	**0.9**	**1.123**	**1.589**	**1.961**	**2.42**	
C13	230	12 hr Chicago	0.040	0.060	0.076	0.102	0.125	0.145	**0.114**
		24 hr Chicago	0.044	0.068	0.089	0.123	0.143	0.164	
		24 hr SCS	**0.051**	**0.076**	**0.100**	**0.135**	**0.160**	**0.179**	
		Transposed	0.026	0.040	0.051	0.067	0.079	0.089	0.197
C14	235	12 hr Chicago	0.335	0.596	0.782	1.066	1.268	1.488	**4.42**
		24 hr Chicago	0.420	0.711	0.952	1.292	1.563	1.786	
		24 hr SCS	**0.481**	**0.759**	**0.991**	**1.300**	**1.562**	**1.765**	
		Transposed	0.600	0.937	1.180	1.555	1.836	2.080	4.59
C15	240	12 hr Chicago	0.399	0.713	0.936	1.277	1.516	1.776	**4.14**
		24 hr Chicago	0.499	0.848	1.132	1.534	1.848	2.111	
		24 hr SCS	**0.583**	**0.912**	**1.183**	**1.543**	**1.845**	**2.078**	
		Transposed	0.488	0.763	0.961	1.267	1.496	1.694	3.74
S1	245	12-hr Chicago	0.153	0.283	0.376	0.518	0.618	0.728	**1.24**
		24-hr Chicago	0.194	0.337	0.454	0.621	0.75	0.861	
		24-hr SCS	0.236	0.373	0.487	0.638	0.765	0.864	
C16	540	12 hr Chicago	0.782	1.439	1.917	2.655	3.181	3.760	**10.23**
		24 hr Chicago	0.993	1.730	2.346	3.231	3.933	4.526	
		24 hr SCS	**1.172**	**1.878**	**2.474**	**3.276**	**3.959**	**4.491**	
		Transposed	0.981	1.533	1.932	2.545	3.005	3.404	7.51
C17	545	12 hr Chicago	0.221	0.408	0.543	0.754	0.902	1.067	**2.15**
		24 hr Chicago	0.280	0.488	0.661	0.909	1.104	1.272	
		24 hr SCS	**0.338**	**0.538**	**0.706**	**0.932**	**1.124**	**1.274**	
		Transposed	0.271	0.424	0.534	0.703	0.830	0.940	2.08
C18	535	12 hr Chicago	0.765	1.410	1.878	2.605	3.124	3.694	**9.98**
		24 hr Chicago	0.972	1.696	2.300	3.172	3.864	4.449	
		24 hr SCS	**1.149**	**1.842**	**2.429**	**3.220**	**3.894**	**4.419**	
		Transposed	0.960	1.499	1.889	2.489	2.939	3.329	7.35

3.3 Proposed Conditions Drainage

Trafalgar Road is proposed to be widened to four lanes from Steeles Avenue to Highway 7. A 3-m wide multi-use path is provided on the east side from Steeles Avenue to Highway 7 and a sidewalk is also provided on the east side between 15 Side Road and Trafalgar Sports Park entrance (north of 17 Side Road). The road configuration will be as follows:

- From Station 0+000 to 1+460 (approximately Steeles Avenue to Hornby Road), the road section consists of a semi-urban section, i.e. urban section on east side and rural on west side.
- From Station 1+460 to 6+240 (approximately Hornby Road to 10 Side Road), the roadway includes a combination of urban-rural section (semi-urban) and rural-rural section at different stretches of the roadway.
- From Station 6+240 to 9+460 (approximately 10 Side Road to 15 Side Road), the roadway includes an urban section for north bound lanes and semi-urban section for south bound lanes with raised median where feasible.
- From Station 9+460 to 11+140 (approximately 15 Side Road to Trafalgar Sports Park entrance), Trafalgar Road is an urban section with raised median where feasible.
- From Station 11+140 northerly to 12+780 (approximately Trafalgar Sports Park entrance to Highway 7), the roadway includes an urban section for north bound lanes and semi-urban section for south bound lanes with raised median where feasible.

Except for two culverts (Culverts C4 and C13), all the culvert locations within the study limits remain unchanged and there is no change in the drainage patterns.

Culvert C4 drains a small roadway area under existing conditions. This culvert will be eliminated under proposed conditions and runoff will be directed southerly toward SWM Pond N3. The pond will provide quantity control of the runoff and Enhanced grassed swale will provide quality treatment.

Similarly, Culvert C13 drains a small roadway area. Based on the preferred alignment of Trafalgar Road at the CN Rail crossing, this culvert will be abandoned and runoff from the catchment will be directed to the storm sewer proposed for the underpass area of Catchment 225.

The proposed conditions drainage mosaics are provided in Exhibit 16 to Exhibit 29.

Within the roadway corridor, SWM facilities are provided in different locations, as required, to control the runoff from post-development to pre-development conditions. Enhanced grassed swales, bio-swales and oil-grit separators (OGSs) are provided in different locations will facilitate the quality treatment of runoff.

From Steeles Avenue to 15 Side Road – CH Jurisdiction:

Catchment areas from Steeles Avenue to 15 Side Road are located within the jurisdiction of CH; part of the Sixteen Mile Creek Subwatershed.

.Runoff from Catchment 100 drains through Culvert C1. Roadway runoff will be directed to Enhanced grassed swales and bio-swales on the west side via storm laterals to provide quality treatment.

Catchment 105 was further separated into four (4) sub-catchments. Uncontrolled flows from Catchments 120, 125, and 130 are conveyed through Culverts C5, C6, and C7, respectively. Flows from these three (3) culverts combine and are routed through Catchment 105-0 before combining with flows from Catchment 105-0. Flows from Catchment 105-1 will be directed to Pond 2N (southwest quadrant of Trafalgar Road / Hornby Road), via grassed ditch and two pipe culverts, which will provide quality treatment and over-control of the flows. Flows from Catchment 105-2 drain to Enhanced grassed swales and bio-swales to provide quality treatment. Flows from Catchment 105-3 are directed to linear facility Pond 2S to provide quantity control and quality treatment. The combined flows drain to Culvert C2.

Catchment 110 was further separated into three (3) sub-catchments. Flows from Catchments 115, 110-2 and 110-1 are directed via flat-bottom grassed swales to SWM facility Pond 3N to provide quantity control. The flat-bottom grassed swales and bio-swales will provide water quality treatment. Outflows from Pond 3N and flows from Catchment 110-0 discharge to Culvert C3. In Catchment 110-1, storm laterals will be used to drain catchbasins to the west side ditch.

As mentioned previously, flows from Catchments 120, 125 and 130 will discharge uncontrolled to the creek. Peak flow control will be accounted for by Pond 2N. Quality treatment of runoff from these catchments will be addressed using Enhanced grassed swales and bio-swales.

Catchment 135 was further separated into two (2) sub-catchments. Flows from Catchment 135-1 are directed to Enhanced grassed swales and bio-swales on the west side via storm laterals to provide quality treatment and eventually to a vegetative dry, linear facility, Pond 8S, to provide quantity control and additional quality treatment. Outflows from Pond 8S combine with flows from Catchment 135-0 before discharging to Culvert C8.

Catchment 140 was further separated into three (3) sub-catchments. Flows from Catchment 140-1 drain via storm sewers to an oil-grit separator (OGS) to provide quality treatment. The outflows drain to a linear facility, Pond 9S, to provide quantity control and additional quality treatment. Flows from Catchment 140-2 are directed to Enhanced grassed swales and bio-swales on the west side via storm laterals to provide quality treatment. Pavement runoff in Catchment 140-0 is also directed to Enhanced grassed swales to provide quality treatment. The combined flows discharge to Culvert C9. Pond 9S is proposed for the interim conditions until such time when SWM facilities have been identified and built as part of Vision Georgetown development. The interim facility Pond 9S can be incorporated into or be replaced with a larger SWM facility designed for the future development of “Vision Georgetown” to the east of Trafalgar Road.

Catchment 145 was further separated into two (2) sub-catchments. Flows from Catchment 145-1 drain via storm sewers to an OGS to provide quality treatment. The outflows drain to a linear facility, Pond 10N, to provide quantity control and additional quality treatment. Pavement runoff in Catchment 145-0 is directed

to Enhanced grassed swales and bio-swales to provide quality treatment. The combined flows discharge to Culvert C10. Pond 10N is proposed for the interim conditions. Similar to Pond 9S, the interim SWM facility Pond 10N can be incorporated into or be replaced with a larger SWM facility designed for the future development of “Vision Georgetown” to the east of Trafalgar Road.

Catchment 150 was further separated into two (2) sub-catchments. Flows from Catchment 150-1 drains via Enhanced grassed swales and bio-swales on the west side of the roadway and directed to an interim linear facility, Pond 11N, through a pipe culvert to provide quantity control and quality treatment. The combined flow from Catchment 150-0 and the outflows from the linear facility discharge to Culvert C11. Similar to Pond 9S and Pond 10N, the interim SWM facility Pond 11N can be incorporated into or be replaced with a larger SWM facility designed for the future development of “Vision Georgetown” to the east of Trafalgar Road.

Catchment 155 was further separated into two (2) sub-catchments. Flows from Catchment 155-1 drain via storm sewers to an OGS to provide quality treatment. The outflows drain to a linear facility, Pond 12N, to provide quantity control and additional quality treatment. Pavement runoff in Catchment 155-0 is directed to Enhanced grassed swales to provide quality treatment. The combined flows discharge to Culvert C12. Pond 12N is proposed for the interim conditions until such time when SWM facilities have been identified and built as part of Vision Georgetown development. Similar to Pond 9S, Pond 10N and Pond 11N, the interim SWM facility Pond 12N can be incorporated into or be replaced with a larger SWM facility designed for the future development of “Vision Georgetown” to the east of Trafalgar Road.

From 15 Side Road to Highway 7– CVC Jurisdiction

Catchment areas north of 15 Side Road are located within the jurisdiction of CVC; part of the Black Creek Subwatershed.

Catchment 200 was further separated into two (2) sub-catchments. Minor system flows (assumed as 5-year) from Catchment 200-0 drain to the existing storm sewers within the residential subdivision. Major system flows drain overland to Trafalgar Road, combine with flows from Catchment 200-1 and discharge to Black Creek. The minor system flows from Catchment 200-1 will be conveyed by separate storm sewers to discharge to Black Creek on the east side at approximately Station 9+920. An OGS is proposed to provide quality treatment and an outlet pool will be provided at the storm sewer outlet for the erosion control. Quantity control of the runoff is not feasible in this section of Trafalgar Road due to the steep grade and land constraints. It would not be feasible to construct pipe storage facilities due to significant cut. The surrounding lands on both sides of Trafalgar Road are located within the Regional Storm flood plain and therefore are not suitable locations to have a SWM facility.

Minor system flows from Catchment 220, 215 and 210 are conveyed by the existing storm sewers to discharge to Black Creek. Minor system flows from Catchment 205 will be conveyed by a separate storm sewer system and will be discharged to a ditch on the west side of Trafalgar Road at approximately Station 10+000. This approximately 40 m long ditch ultimately conveys the storm runoff to the Black creek.

An OGS is proposed to provide quality treatment and an outlet pool will be provided at the storm sewer outlet for the erosion control. As mentioned above quantity control of the runoff is not feasible in this section of Trafalgar Road due to the steep grade (significant cut for pipe storage facility) and land constraints (lands located within the Regional Storm flood plain). Major system flows from Catchments 215, 210, and 205, drain overland to Black Creek.

Flows from Catchments 225 (an underpass at CNR) and 230 are conveyed to a pipe storage facility, Facility 14S, which will provide quantity control. An OGS is proposed to provide quality treatment. Outflows discharge to a tributary of Black Creek.

Roadway runoff from Catchment 235 drains to Enhanced grassed swales and bio-swales on the west side via storm laterals to provide quality treatment. There is an increase in flow due to increase in drainage area. Quantity control of flows from Catchment 235 will not be provided. The flow from CNR underpass and this catchment drains to a tributary (Tributary 1) of Black Creek. An over-control of flows is provided by Facility 14S to balance the flows draining to Tributary 1 of Black Creek.

Roadway runoff from Catchment 240 drains to Enhanced grassed swales and bio-swales on the west side via storm laterals to provide quality treatment. Quantity control of flows from Catchment 240 is not required because a part of the roadway area is directed towards Culvert C14.

Flows from Catchment 245 drain to an open storm inlet. This storm inlet is connected to the existing storm sewer system within the residential subdivision. Drainage area under proposed conditions is less than under existing conditions; as such, quantity control of flows from Catchment 245 is not required. Enhanced grassed swale is provided on the west side for additional quality treatment.

Flows from Catchments 255 and 260 drain to Culvert C18 located under 20 Side Road. Flows from Catchments 265, 275 and 250 combine with flows from Culvert C18 to discharge to Culvert C16, which is located on the GO Kitchener Line underpass (Trafalgar Road realignment). Flows from Catchment 251 are conveyed by storm sewers to an OGS to provide quality treatment before discharging to Culvert C16. Culvert C16 drains to Tributary 2 of Black Creek. Bio-swale is provided on the west side of the roadway for quality treatment. Quantity control of runoff from Catchment 251 is not required due to different times to peak of the hydrographs).

Within the roadway corridor, SWM facilities are provided in different locations, as required, to control the runoff from post-development to pre-development conditions. Enhanced grassed swales, bio-swales and oil-grit separators (OGSs) provided in different locations will facilitate the quality treatment of runoff.