City of Mississauga

Creditview Road Class Environmental Assessment, Bancroft Drive to Old Creditview Road

Stormwater Drainage Assessment Report

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1. Introduction

AECOM Canada Limited (AECOM) was retained by the City of Mississauga (City) to complete an Environmental Assessment (EA) for improvements to Creditview Road from the north limit of Old Creditview Road to the south limit of Bancroft Drive. This Stormwater Drainage Assessment Report has been prepared in support of the EA to examine existing drainage conditions, evaluate the impact of the preferred roadway improvements on stormwater quality, quantity and flooding, and recommend measures to mitigate any impacts associated with the preferred road design alternative.

The Study Area is located within the City and falls entirely within the jurisdiction of Credit Valley Conservation (CVC) Authority. As illustrated in Figure 1.1, the entire study area drains to the Credit River and is located within the Norval to Port Credit Subwatershed. The drainage of the bridge over the Credit River is not assessed at this phase of the project because the improvements to this bridge were undertaken under a separate Class EA study, which has received approval. The drainage on the Highway 401 bridge improvements (i.e. deck spread calculations for flow in gutter) was undertaken by AECOM as part of preliminary design for the structure; these Highway 401 bridge improvements have also already received EA approval.

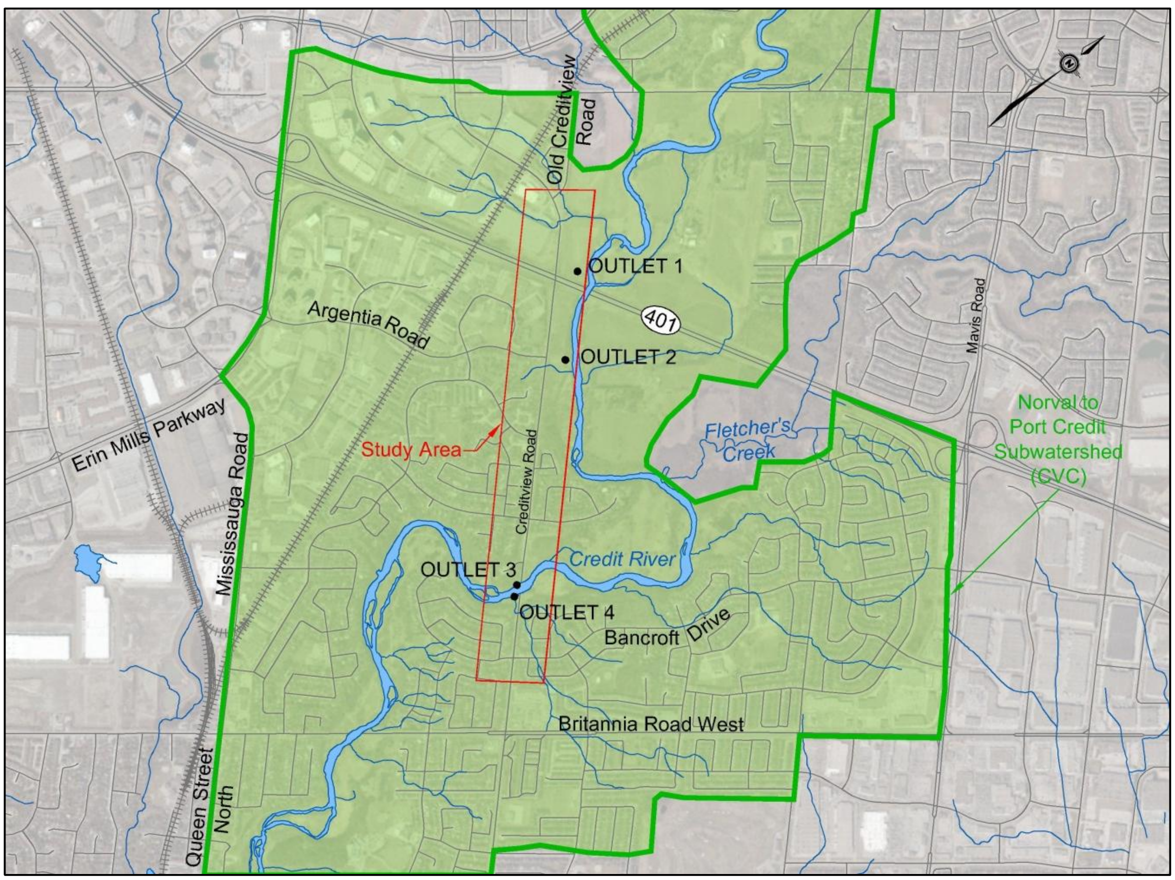


Figure 1.1 Study Area

1.1 Background

Creditview Road is classified as a Major Collector by the City's Official Plan Schedule 5 (Long Term Road Network) as approved in January of 2011. Runoff from the Creditview Road right-of-way (ROW) in the Study Area is currently conveyed by the existing storm sewer system discharging directly into the Credit River at the four outlets shown on Figure 1.1. Trunk storm sewers cross Creditview Road at Argentia Road and south of Old Creditview Road. In addition, a culvert crossing Creditview Road from east to west is also located south of the Creditview Road Bridge over the Credit River.

Numerous studies have been completed or are underway to support improvements to transportation infrastructure, drainage conditions, erosion control, and parklands near the Study Area. Improvements for the two bridges within the Study Area limits are in progress, as follows:

- *Creditview Road bridge over Credit River*: Class EA for improvements completed (IBI, 2013), progressing through detailed design (construction expected 2016); and
- *Creditview Road bridge over Highway 401*: Class EA completed for Highway 401 Improvements, From East of Credit River to Trafalgar Road (MTO, 2013), and preliminary design of the bridge is in progress (AECOM)

In addition, the following two studies were completed in support of the proposed sanitary trunk sewer to cross Harris Farm located east of Argentia Road and to identify rehabilitation strategies for the Credit River:

- West Trunk Sewer Harris Farm Heritage Impact Statement, August 2012; and
  - Credit River Adaptive Management Strategy: Development of a Rehabilitation Plan (City of Mississauga, 2005)

In addition, the Region of Peel are undertaking a Class EA for East-West Diversion of their trunk sanitary sewer systems, and have undertaken corresponding design for proposed works on the West Trunk Sewer, western adjacent to the Creditview Road bridge over Highway 401. The details include the working easement, location of the sewer, and associated chambers. The sanitary details have relevance for the proposed Creditview bridge works, but to not impact the drainage and stormwater management requirements.

Improvements to the following three parks adjacent to the Study Area were proposed in the City's *Credit River Parks Strategy* (2012):

- Sanford Farm, P-122 (lands in private ownership) is located east of Creditview Road and north of Highway 401;
- P-505 (not yet named, former Harris Lands) is located east of Creditview Road between Falconer Drive and Argentia Road has been identified as of historical interest; and
- Credit Meadows Park is located east of Creditview Road along the Credit River

The concept plans presented in the strategy report propose a new parking area adjacent to Creditview Road on the former Harris Lands, reforested areas and a wetland to the east in Credit Meadows Park, and a stormwater management (SWM) pond (Pond 4506) on the east side of Old Creditview Road in the vicinity of the former laneway on the Sandford Farm lands.

As part of the Creditview River bridge replacement detailed design, fluvial geomorphological studies have been conducted; these are not expected to be relevant to the proposed Creditview Road improvements. In addition, the City is currently updating the Mississauga Stormwater Quality Control Strategy which may include SWM ponds near

Argentia Road and Old Creditview Road; AECOM currently has no details of proposed measures which may provide treatment of Creditview Road drainage.

The above information was augmented with the following additional information to gain a comprehensive understanding of drainage and stormwater management (SWM) within the Study Area:

- Available soils mapping;
- Aerial photography, survey, and GIS data provided by the City; and
- Site visit on October 25, 2013 to investigate existing drainage conditions within the Study Area

1.2 Objectives

The objective of this report is to provide preliminary recommendations for managing storm runoff for the preferred Creditview Road improvement alternative in compliance with design criteria defined by the City, CVC, and the Ministry of Environment and Climate Change (MOECC). Overall, treatment is required for all new impervious area and, where possible, the existing road surface. The criteria for managing stormwater in the Study Area were confirmed in a meeting with the City and CVC on October 24, 2013 and are described in the following sections.

1.2.1 Flood Protection

The Ontario Ministry of the Environment (MOE) outlined several design criteria for this study in a memo to the City of Mississauga dated October 1, 2013. The memo states that "…quantity control measures to treat stormwater runoff should be considered for all new impervious areas and, where possible, existing surfaces." The memo also states that the study "must include a sufficient level of information to demonstrate that there will be no negative impacts on the natural features or ecological functions of any watercourses within the study area." The CVC clarified on October 25, 2013 in a meeting with AECOM that quantity control is not required because the site is discharging directly into the Credit River. This requirement is also provided in the CVC *SWM Criteria* document which states (in Table 3-1 of that document, for the Credit River from Norval to Port Credit) that control of post-development peak flows to pre-development levels is not required in Subwatershed #9. Subwatershed #9 is illustrated in Figure 3-2 of the CVC *SWM Criteria* document, and encompasses the study area.

The proposed changes to Creditview Road will increase runoff volume and peak flow being conveyed by the stormwater management systems. The drainage system along Creditview Road will need to meet the capacity requirements defined in the City's *Development Requirements Manual* (2009). The manual requires that storm sewer systems and trunk sewer systems shall accommodate a 10-year and 25-year storm, respectively.

If the existing storm sewer system does not meet the above criteria under proposed conditions, a preliminary design concept will be required to accommodate additional flow.

As shown on Figure 2, the CVC regulation limit crosses Creditview Road at four locations within the study area limits. Any changes within the floodplain and regulation limit must be in accordance with the CVC *Watershed Planning and Regulation Policies* (2010) and the *Development, Interference with Wetlands, and Alterations to Shorelines and Watercourses Regulation* (Ontario Regulation 160/06). Permit requirements for proposed roadworks within this regulated area will be reviewed with CVC, and may include proposed improvements where the regulation limit crosses Creditview Road between Argentia Road and Falconer Road, and proposed improvements near both bridge crossings (Credit River and Highway 401 bridges). The limits of the proposed works will be reviewed with CVC.

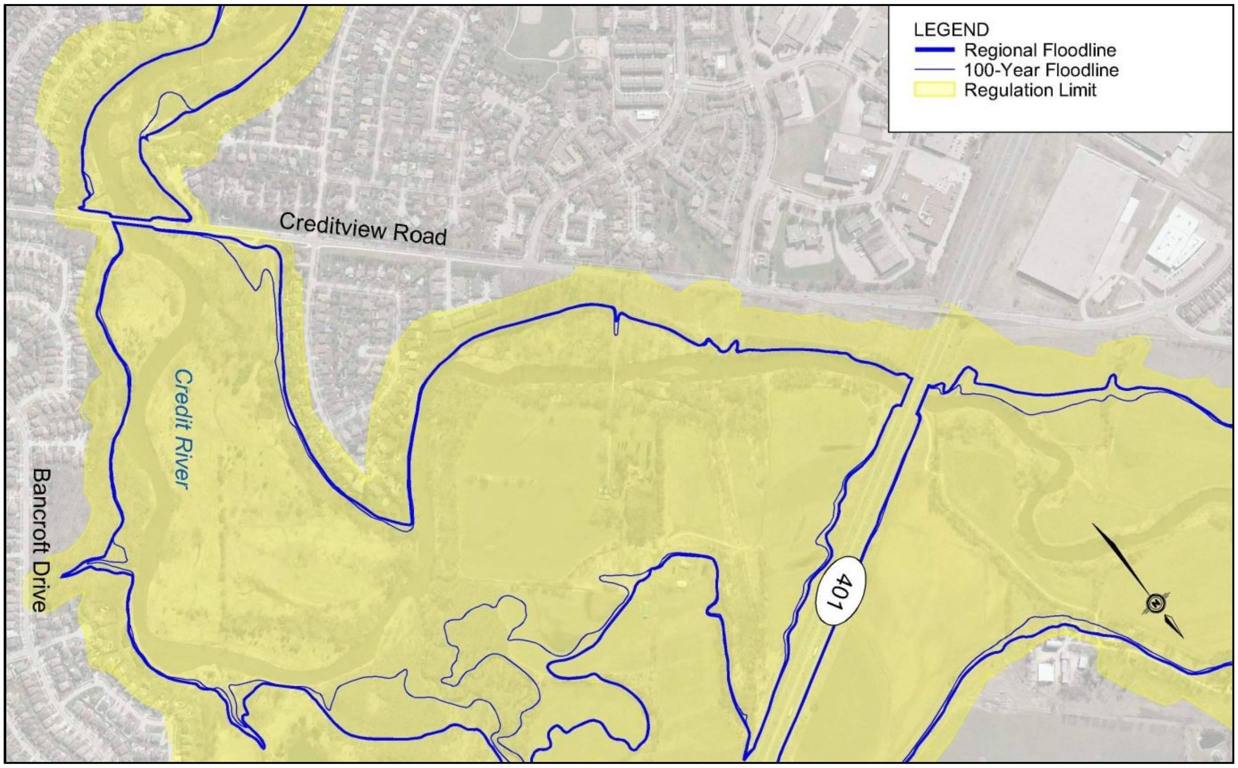


Figure 1.2 CVC Regulation Limit and Credit River Floodlines

1.2.2 Erosion Control

This study will provide preliminary storage calculations to detain the minimum of 5 mm of runoff from the new and, where possible, existing impervious area on site as defined in Section 4.2 of the CVC *SWM Criteria* guidelines. This is the minimum erosion control requirement for all watercourses within CVC's jurisdiction.

A fluvial geomorphologic assessment is not required for this study because the City has already undertaken an assessment of the Credit River near the Study Area as part of another study, and the bridge crossing improvements are part of a separate design project. A review of the *Credit River Adaptive Management Strategy: Development of a Rehabilitation Plan* (City of Mississauga, 2005) identified several areas recommended for rehabilitation upstream and downstream of the Creditview Road Bridge over the Credit River that should be addressed during detailed design of the bridge crossing, underway as a separate project and slated for construction in 2016.

During detailed design, as per MOE requirements, preliminary recommendations for erosion and sediment control will also be provided for the construction phase of the project.

1.2.3 Water Quality

As outlined in the CVC *SWM Criteria* guidelines and the CVC memo responding to the Notice of Commencement of this study (Marray, 2013), enhanced level of protection (i.e., 80% TSS removal) is required for runoff from the new and, where possible, existing paved surfaces in the Study Area. The enhanced level of protection is to be provided as per the MOE *SWM Planning and Design Manual* (2003) and to prevent impacts on fish or fish habitat as prohibited by the federal *Fisheries Act*. In addition, recommendations for preliminary preventative and mitigation measures should be provided to minimize thermal impacts as discussed in the document, *Thermal Impacts of Urbanization including Preventative and Mitigation Techniques* (CVC, 2011).

1.2.4 Water Balance

The majority of the Study Area is classified as a Low Volume Groundwater Recharge Area (LGRA) as shown on Figure B10 of the CVC *SWM Criteria* guideline. The minimum water balance requirement for an LGRA is to provide post-development recharge of the first 3 mm of runoff from the new and, where possible, existing impervious area for any precipitation event as defined in the CVC *SWM Criteria* guidelines. The CVC confirmed in a meeting with AECOM that low impact development (LID) infiltration measures are to be applied to provide 3 mm of recharge and that a detailed water balance is not required for this study. A geotechnical analysis for this Class EA has been prepared, and will be reviewed in context of any SWM alternative that incorporates the infiltration of stormwater.

As noted in the *SWM Criteria* document, the erosion target of 5 mm and the water balance target of 3 mm are not cumulative. As such, an overall site target of detaining 5 mm of runoff from the new and, where possible, existing impervious area through infiltration will address both erosion and water balance criteria.

2. Existing Conditions

2.1 Existing Environment

In addition to field reconnaissance, several sources of information were used to characterize the Study Area including the following:

- Survey and GIS data provided by the City
- Design and as-built drawings provided by the City
- 1:10,000 scale Ontario Base Maps (OBM)
- Aerial photography provided by the City
- Soil Survey of Peel County (Report Number 18 of the Ontario Soil Survey)
- Physiographic Maps (Chapman & Putnam)

2.1.1 Roadway Configuration

Creditview Road is primarily an urban roadway with a mix of undivided sections and, in some locations, a centre turning lane. At the southern limit of the study area, Creditview Road is a four-lane roadway and then decreases to two lanes approximately 140 m north of Bancroft Drive that continues north with occasional turning lanes at intersections until expanding to a five-lane roadway at Old Creditview Road. Two short rural sections are located along the approaches to the bridge over Highway 401 with gravel shoulders draining to roadside ditches.

2.1.2 Land Use

There is a wide range of land uses throughout the study area. Land use is primarily residential west of Creditview Road and south of Argentia Road. The east side of Creditview Road has two residential neighbourhoods to the north and south of Credit Meadows Park. Additional park land will replace the agricultural land north and south of Highway 401 to the east of Creditview Road. An industrial development area extends across the remaining land northwest of Creditview Road and Argentia Road.

2.1.3 Soils

Based on soils mapping, the predominant soils through the Study Area are Oneida Clay Loam and Chinguacousy Clay Loam. Both soils are typical of the Halton Till and have limited infiltration capacity. Chinguacousy Clay Loam is classified as Hydrologic Soil Group C in the US Soil Conservation Service (SCS) system, and Oneida Clay Loam falls under soil group D. The Ontario Soil Survey Report Number 18 of Peel County (1953) indicates small areas where Fox and Berrien Sandy Loams are more predominant.

Additional soils information has been provided by a detailed geotechnical analysis for this Class EA completed by SPL Consultants. Boreholes along the ROW indicate an upper layer of fill material (generally 1 to 2 m) overlying native clayey silt till. The shallow fill material is heterogeneous, but generally will not create a restriction to the use of infiltration practices in the ROW. The deeper clayey silt will generally be the constraint for any measures that consider infiltrating stormwater to the deeper groundwater; while the clayey silt soils have limited infiltration capacity, these soils will not necessarily preclude the use of infiltration based LID practices.

2.1.4 Physiography and Topography

The majority of the study area lies within the Peel Plain Physiographic Region (Chapman and Putnam, 1984). The Peel Plain is a level to undulating tract of clay with limited areas where sandy alluvium borders stream valleys. The study area generally slopes southward toward Lake Ontario.

2.2 Roadway Drainage System

The existing roadway drainage system is described in the following sections and the capacity of the system is assessed under both existing conditions and with the proposed road improvements as per the City's *Development Requirements Manual*. The survey, GIS, design drawings, and as-built drawings provided by the City were used to determine the properties of the existing storm sewer system. The existing roadway drainage system is illustrated on Drawing 1 and the areas draining to the system are delineated on Drawing 2.

The existing roadway drainage system is described in the following sections and the capacity of the system is analyzed using the Rational Method and storm design sheets in Appendix B. As per the City's *Development Requirements Manual*, the existing storm sewer system may be inadequately sized to convey the 10-year storm at several locations throughout the Study Area under existing conditions.

2.2.1 Old Creditview Road to Bridge over Highway 401

The section of the Study Area between Old Creditview Road and Highway 401 is drained by a storm sewer system to a low point located south of Old Creditview Road. The approach to the bridge over Highway 401 drains to roadside ditches, as shown on Figure 2.1, which drain to the storm sewer system. External drainage is also collected from the roadways, industrial areas, and residential neighbourhood located northwest of this section. The storm sewer drains to the east and then to the south before discharging directly to the Credit River. The vegetated area east of the Old Creditview Road and Creditview Road intersection drains to a lined ditch to an inlet that connects to the Creditview Road storm sewer.

Figure 2.1 Roadside Ditch Northeast of Highway 401 Bridge

The north half of the Highway 401 Bridge drains to two catchbasins located north of the bridge deck. It is assumed that the catchbasins discharge to the drainage ditch running west to east along the north side of the highway.

2.2.2 Bridge over Highway 401 to Falconer Drive

South of Highway 401, Creditview Road changes from a rural cross section draining to roadside ditches along the bridge approach to an urban section draining to a storm sewer system. The storm sewers convey runoff to Argentia Road, where the system then drains to the east and discharges directly to the Credit River. The section of Creditview Road from Falconer Drive to Argentia Road also drains to the storm sewer system connecting at Argentia Road. External drainage from the residential and industrial area to the east of the Study Area is conveyed by a trunk storm sewer connecting at Argentia Road. The park southwest of Argentia Road and Creditview Road is drained by a bird cage inlet connecting to the storm sewer system, as shown on Figure 2.2. Another inlet is located on the west side of Creditview Road and drains a local area along the sidewalk.

Figure 2.2 Inlet Southwest of Creditview Road and Argentia Road

The south half of the Highway 401 Bridge drains to two catchbasins located south of the bridge deck. It is assumed that the catchbasins discharge to the drainage ditch running west to east along the south side of the highway. Curb cuts drain the southern bridge approach to roadside ditches, as shown on Figure 2.3 .

Figure 2.3 Southwest Curb Cut at Approach to Highway 401 Bridge

2.2.3 Falconer Drive to Bridge over Credit River

Creditview Road has an urban section between Falconer Drive and the Credit River Bridge with a storm sewer outlet northwest of the bridge discharging to the Credit River at the outlet shown on Figure 2.4. Several ditch inlets collect drainage from residential areas backing onto Creditview Road. The storm sewer system also collects external drainage from the residential area west of Creditview Road with sewer connections at Falconer Drive and Velebit Court.

Figure 2.4 Storm Sewer Outlet Northwest of Credit River Bridge

2.2.4 Bridge over Credit River to Bancroft Drive/Sir Monty's Drive

Creditview Road has an urban section between the Credit River Bridge and Bancroft Drive with a storm sewer outlet southwest of the bridge discharging to the Credit River. A small roadside ditch is located along the east side of Creditview Road north of Bancroft Drive that is captured by the ditch inlet shown on Figure 2.5. The storm sewer system also collects drainage external to the study area from Creditview Road (to the southern limit located approximately 400 m south of Britannia Road) and a short section of Britannia Road west of Creditview Road. A separate storm sewer system draining the residential area east of Creditview Road crosses the study area south of Culvert 4 and discharges to the Credit River downstream of Outlet 4.

Figure 2.5 Ditch Inlet North of Bancroft Drive, Looking South

2.3 Stormwater Management

As discussed in Section 1.2, quantity control is not required for this study area because it discharges directly into the Credit River. There are no existing SWM controls to manage runoff from Creditview Road between Old Creditview Road and Bancroft Drive except for roadside ditches. Future requirements for erosion/water balance retention and/or water quality controls are related to any increase in paved areas associated with the preferred alternative. As a baseline comparison, the existing ROW catchment areas and impervious areas are summarized in Table 2.1 and illustrated on Drawing 3.

Table 2.1 Existing Impervious Area

Catchment No.	Drainage Area (ha)	Impervious Area (%)
1	1.89	33
2	2.54	29
3	1.05	47
4	1.51	46
5	0.78	47
6	0.61	70

In section 3 of this report, the above existing paved areas are compared to the paved areas under the preferred alternative (widening from Argentia Road to Old Creditview River, with intersection improvements).

2.4 Mainline and Entrance Crossing Culverts

There is one mainline culvert crossing Creditview Road and three entrance culverts within the Study Area as illustrated on Drawing 1. The following sections summarize the existing properties of the culverts within the study area as determined by field investigation and hydraulic analysis completed to assess the ability of the mainline culvert to safely convey the applicable peak flow under existing conditions.

2.4.1 Culvert Inspection

A site visit was completed on October 25, 2013 to investigate the existing conditions of the four culverts in the Study Area. Interior and exterior photographs were taken at both ends of each culvert in addition to documenting material condition, presence and severity of deformation, water levels, sediment depth, and inlet/outlet configuration. The size and shape of each culvert was also verified. Using the documented observations, each culvert was assessed and rated as ‘good’, ‘acceptable’, ‘poor’, or ‘very poor’. The following subsections describe the detailed findings of the field investigation.

2.4.1.1 Mainline Crossing Culvert

The mainline crossing culvert (Culvert 4) is located south of the bridge over the Credit River. The culvert conveys a small ditch from east to west. The culvert is a corrugated steel pipe (CSP) with a diameter of 975 mm and was found to be in very poor condition overall due to deformation at the downstream end and a large puncture through the top of the culvert at the upstream end, as illustrated in Figure 2.6. Significant vegetation growth and approximately 150 mm of sedimentation was found at the upstream end while approximately 100 mm of sedimentation was found at the downstream end, as illustrated in Figure 2.6. This culvert was found to be dry throughout its length and appears to have been abandoned. It conveys runoff from the small ditch on the east side of Creditview Road.

East Face (Inlet)

West Face (Outlet)

Figure 2.6 Culvert 4

2.4.1.2 Entrance Culverts

The design and as built drawings provided by the City indicated that three entrance culverts are located along Creditview Road in the Study Area.

Culvert 1

The culvert located on the east side of Creditview Road south of Old Creditview Road was found to have been removed from the ditch draining towards Old Creditview Road, as illustrated in Figure 2.7.

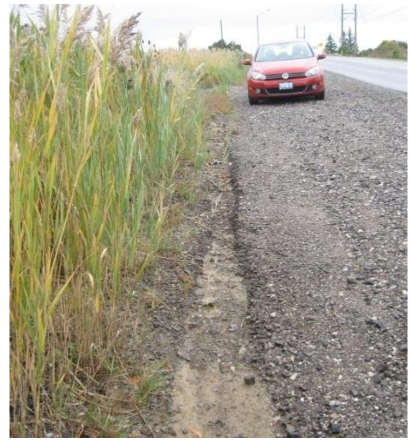
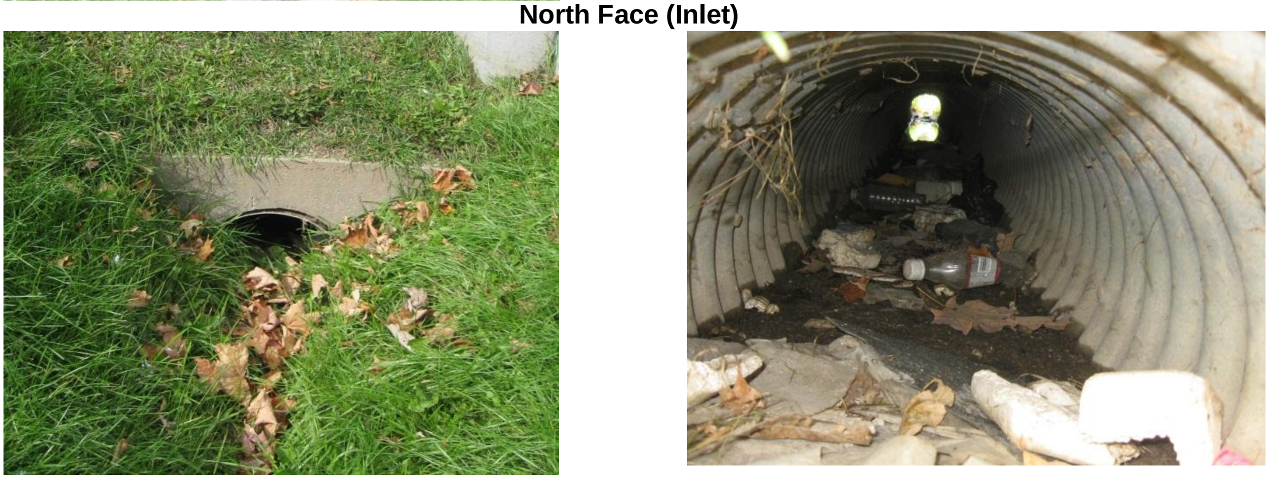


Figure 2.7 Culvert 1 (Does not Exist)

Culvert 2

This 450 mm CSP culvert crosses an old entrance driveway located north of Velebit Court on the west side of Creditview Road. Physical assessment of this culvert determined that the material was in very good condition and the degree of deformation was found to be very good. A significant accumulation of sediment was found within the culvert at both ends. No water was found in the culvert, as shown on Figure 2.8. Both upstream and downstream ends of the CSP culvert were found to be overgrown with grass.

North Face (Inlet)



South Face (Outlet)
Figure 2.8 Culvert 2

Culvert 3

The entrance culvert southeast of the Creditview Road Bridge over the Credit River is a CSP culvert. Physical assessment of this culvert determined that the material was in good condition with only minor corrosion in the middle of the culvert no corrosion as shown in Figure 2.9. The degree of deformation was found to be poor due to minor deformation of the upstream (south) end. As shown in Figure 2.9, an accumulation of sediment and garbage was found throughout the length of the culvert. Both upstream and downstream ends of the CSP culvert were found to be overgrown with vegetation.

North Face (Outlet)

South Face (Inlet)

Figure 2.9 Culvert 3

2.4.1.3 Summary of Culvert Inspection Results

The results of the culvert inspection and existing properties of each culvert are summarized in Table 2.2. Hydraulic analysis of the culverts is not necessary as they all appear to have been abandoned and only provide drainage for local areas.

Table 2.2 Culvert Crossing Condition Summary

Culvert ID	Material and Size	Overall Condition Rating
1	DNE	DNE
2	CSP	Poor
3	CSP	Good
4	975 mm diameter CSP	Very Poor

3. Proposed Conditions

3.1 Proposed Environment

3.1.1 Proposed Roadway Improvements

The development and evaluation of alternative design concepts for the improvements to Creditview Road are documented in the Environmental Study Report. The recommended preferred alternative design is:

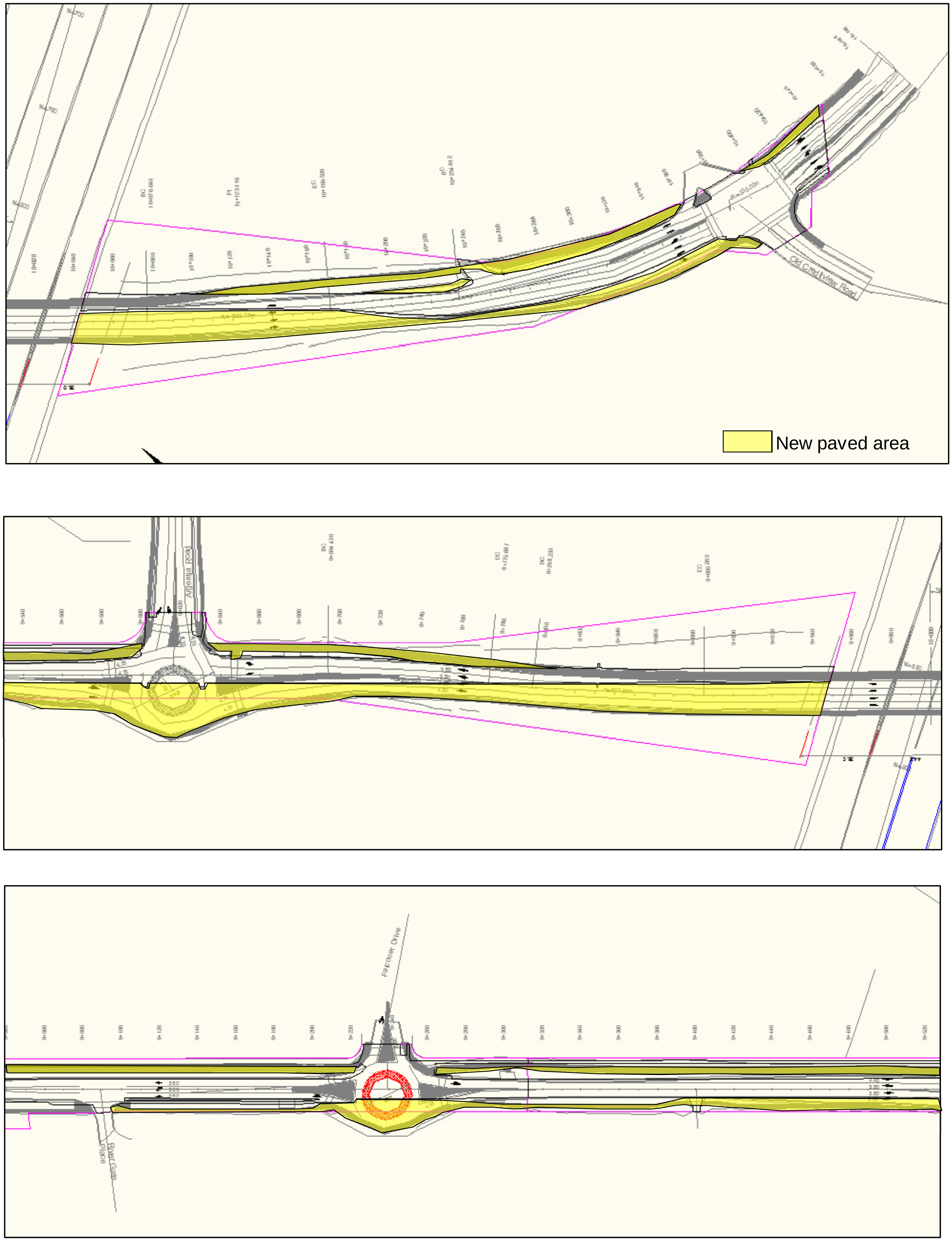
- Two lanes from Bancroft to Argentia;
- Four lanes from Argentia to Old Creditview;
- Additional turning lanes in various locations;
- Single lane roundabout intersections at Kenninghail Blvd and Falconer Drive, and a two land roundabout at Argentia Road; and
- Multi-use trail on the west side, sidewalk on the east side.

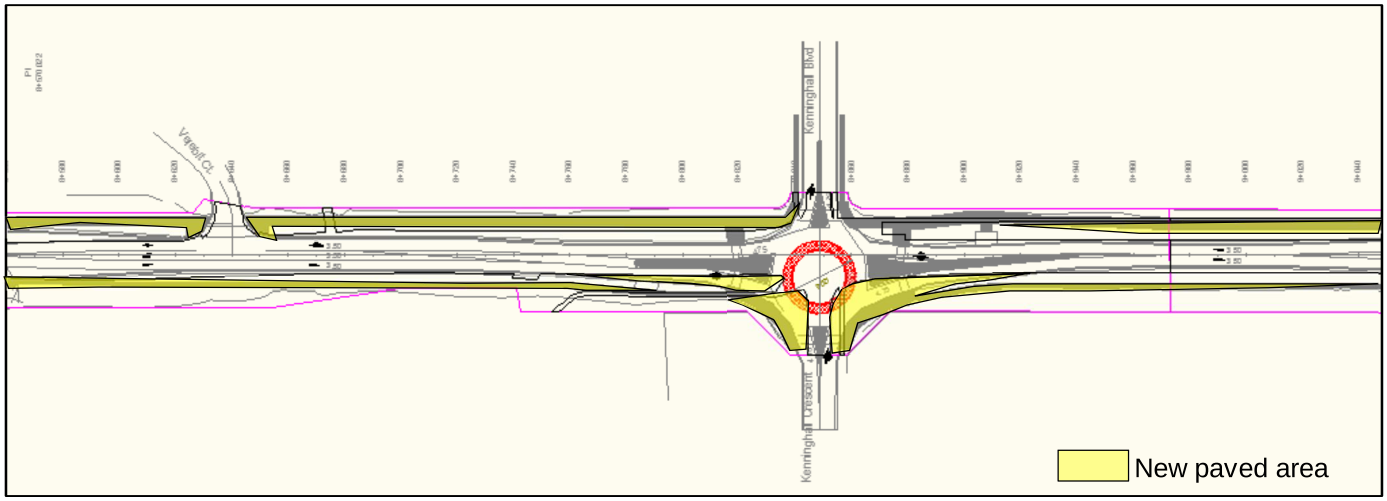
As a result, the increase in impervious area is generally limited to:

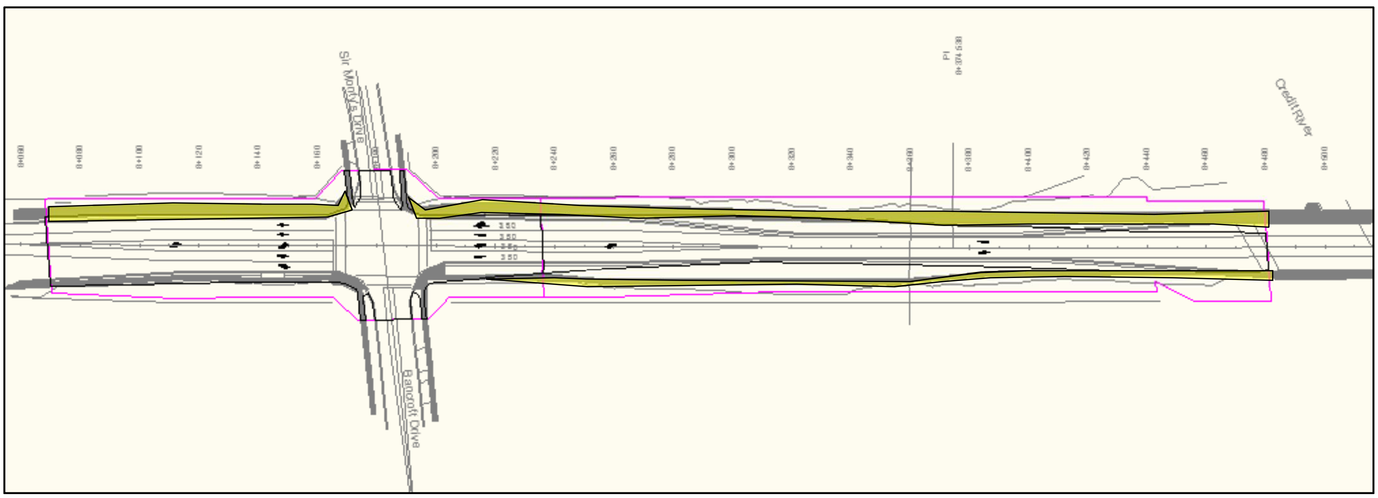
- Two additional lanes from Argentia to Old Creditview, and a wider bridge;
- Additional paved areas in the three new roundabout intersections; and
- New multi-use train and sidewalks.

The increase in paved areas is illustrated on the below sketches.

Figure 3.1 Increase in Impervious Areas with Preferred Alternative




Kenninghal Blvd
Kenninghal Crescent
New paved area


Sir Monty's Drive
Bancroft Drive
Credit River

3.2 Roadway Drainage System

3.2.1 Storm Sewer Design

As discussed in Section 1.2.1, peak flow control is not required for the widened portions of the roadway, since the study area drains directly into the Credit River. The primary conveyance concern is whether the existing storm sewers are large enough to service the new road corridor.

AECOM first assessed the adequacy of the existing storm sewers to convey the 10-year design storm. The storm sewer network, storm catchments, and rational method calculations are provided in the report Appendix. The results show that:

- Existing storm sewers from T3 to T2 are significantly undersized for the 10-year flow under existing conditions. The storm sewers are 375 mm in diameter, and only have approximately a third of the capacity required to convey the 10-year flow from the external 8.1 ha draining to the road corridor. The existing ROW (0.51 ha, 0.07 ha impervious area) in this catchment contributes a negligible flow to this sewer. This reach has the capacity of approximately half of the 2-year flow.

- Existing storm sewers from MH10 to MH8 are undersized for the 10-year flow under existing conditions. The storm sewers are 300/375 mm in diameter, and have approximately half to one third of the capacity required to convey the 10-year flow from the 0.37 ha catchment of the road ROW.

- Existing storm sewers from MH13 to MH8 are undersized for the 10-year flow under existing conditions. The storm sewers are 300/375 mm in diameter, and have approximately 70% to 90% of the capacity required to convey the 10-year flow. The capacity of these sewers is approximately equal to the 2-year to 5-year flow.

- Existing storm sewers from MH24 to MH15 (outlet 3) are undersized for the 10-year flow under existing conditions. The storm sewers are 675/750 mm in diameter, and have approximately 70% to 90% of the capacity required to convey the 10-year flow. The capacity of these sewers is approximately equal to the 2-year to 5-year flow.

- Existing storm sewers from MH30 to MH27, and from MH 26 to MH25 (outlet 4) are undersized for the 10-year flow under existing conditions. The storm sewers are 600/750 mm in diameter, and have approximately 40% to 90% of the capacity required to convey the 10-year flow. The capacity of these sewers is approximately equal to the 2-year to 5-year flow.

AECOM has updated the storm sewer design sheets to reflect the widened roadway under the preferred alternative. The results show that the widening only has a small effect on peak flows, and does not significantly contribute to the requirement to upsize the storm sewers.

Table 3.1 Storm Sewer Sizing

From MH	To MH	Existing Size (mm)	Length (m)	Existing Capacity (L/s)	Existing Conditions 2-yr flow (L/s)	Existing Conditions 10-yr flow (L/s)	Proposed Conditions 2-yr flow (L/s)	Proposed Conditions 10-yr flow (L/s)	Required Upsizing, 10-year flow (assume replacement as opposed to twinning)
Ext. Area	MH7	375	41.1	180	90	140	90	140	
Ext. Area	MH7	750	43.3	1170	460	750	460	750	
MH7	MH6	825	87	1110	570	950	570	950	
MH6	T4	825	9	1070	590	970	600	990	
MH5	T3	375	36.4	250	0	0	0	0	
T3	T5	375	58.4	250	540	890	550	900	675
T5	MH4	375	5.7	250	550	920	560	930	675
MH4	T2	375	7	280	550	920	560	930	675
MH3	T4	2400	3.8	13190	5270	8730	5270	8730	
T4	T2	2400	10.8	13190	5760	9530	5760	9540	
T2	T1	2400	34.3	13190	6240	10330	6260	10360	
T1	MH2	2400	68.1	13190	6220	10310	6240	10340	
MH2	MH1	2400	168	13190	6170	10210	6180	10240	
MH1	OUTLET 1	2400	39	13190	6030	9980	6040	10010	
MH10	MH9	300	61.0	80	150	250	170	280	525
MH9	MH8	375	61.0	150	170	290	200	340	525
MH13	MH12	300	92.3	90	80	130	120	200	450
MH12	MH11	375	59.7	170	120	190	170	290	525
MH11	MH8	375	32.3	190	170	280	220	370	525
MH14	MH8	2250	17.2	13540	90	140	90	140	
MH8	OUTLET 2	2250	94.1	13540	340	560	400	670	
Ext. Area	MH24	675	44	840	650	1070	650	1070	750
MH24	MH23	675	89.9	810	660	1100	660	1100	825
MH23	MH22	675	89.9	830	670	1100	670	1110	825
MH22	MH21	750	93.3	890	750	1250	760	1260	900
MH21	MH20	750	90.8	1110	750	1240	760	1250	900
MH20	MH19	750	91.4	1100	850	1400	860	1420	900
MH19	MH18	750	91.4	1300	860	1420	870	1440	900
MH18	MH17	750	24.9	1140	860	1420	870	1440	900
MH17	MH16	750	24.5	1140	850	1410	870	1430	900
MH16	MH15	750	27.4	1190	860	1420	870	1440	900
Ext. Area	MH15	300	21.6	220	250	410	250	420	450
MH15	OUTLET 3	900	77.7	1130	1050	1740	1070	1770	1200
MH30	MH29	600	89.62	470	720	1200	730	1200	900
MH29	MH28	675	92.1	680	700	1170	710	1170	900
MH28	MH27	750	89.6	920	690	1140	690	1140	900
MH27	MH26	750	62.1	1750	710	1180	720	1190	900
MH26	MH25	750	91.1	1090	720	1190	720	1200	900
MH25	OUTLET 4	750	14.4	2800	710	1170	710	1180	900

3.3 Stormwater Management

The potential impact of transportation infrastructure on the quantity and quality of runoff delivered to the receiving water bodies is well documented (MTO, 1997). Relative to natural ground cover, the paved surfaces of highways and roadways generate significantly greater volumes of runoff from the same storm event. Associated drainage infrastructure such as ditches and storm sewers have the potential to deliver the runoff to the receiving system much earlier relative to natural, sheet flow conditions. The above have the potential to increase the peak flow delivered to the receiving water body, and can lead to increased flooding and erosion in the receiving watercourse.

Vehicular traffic on transportation infrastructure deposit materials such as oil, grease, trace organics, trace metals and other pollutants on the roadway surface, which are then potentially washed off during storm events and delivered to the receiving water body. In addition, sand, salt and other de-icing chemicals are typically applied to roadways during the winter months, which are subsequently washed off during snowmelt and rainfall events and delivered to the receiving water body. These pollutants have the potential to impair water quality in the receiving systems, with associated impacts to aquatic habitat and other water users.

The proposed improvements to Creditview Road are expected to have an impact on the quality of runoff delivered to the receiving watercourses. The total area of asphalt through the study area will increase due to the preferred alternative. Therefore, the volume, rate and timing of delivery of roadway runoff to the receiving watercourses will be impacted by the proposed improvements. As the paved area and the rate and volume of runoff generated by the road are expected to increase, a corresponding increase in pollutant loadings delivered to the receiving watercourses is also expected.

3.3.1 Storage Requirement Calculations – Quality Control

The change in impervious area is summarized in Table 3.2 for each catchment within the ROW.

Table 3.2 Change in Impervious Area within ROW

Catchments		Impervious Area in ROW				
Catchment No.	**Drainage Area In ROW**	**Existing (ha)**	**Existing (%)**	**Proposed (ha)**	**Proposed (%)**	**Increase (ha)**
1	1.89	0.62	32%	1.12	59%	0.50
2	2.54	0.76	30%	1.54	61%	0.78
3	1.05	0.49	47%	0.71	68%	0.22
4	1.51	0.71	47%	1.03	68%	0.32
5	0.78	0.37	47%	0.46	59%	0.09
6	0.61	0.42	69%	0.49	80%	0.07
Total	8.38	3.37	40%	5.35	64%	1.98

Due to the limited open space along the corridor, OGS facilities or LID approaches will likely be required to treat runoff from this area.

3.3.2 Alternative Mitigation Measures

A wide range of best management practices are available to mitigate the impacts of road runoff on receiving watercourses. These are generally classified into source, conveyance and end-of-pipe treatment alternatives. The alternatives considered in this report are based on detailed descriptions and design criteria published in the following documents:

- *SWM Planning and Design Manual* (MOE, 2003);
- *Low Impact Development SWM Planning and Design Guide* (Credit Valley Conservation Authority (CVC) and the Toronto and Region Conservation Authority (TRCA), 2010);
- *Guidance Specifying Management Measures for Sources of Non-Point Pollution in Coastal Waters* (United States Environmental Protection Agency (US EPA), 1993); and
- *CVC Road Retrofit LID Guide.*

The available soils information indicates the soils throughout the study area have low infiltration capacity and, as such, limit the application of infiltration measures. However, in accordance with the NOCSS, detailed consideration of the feasibility of infiltration facilities should be made at the detailed design stage of the project using site specific information, best-management practices described in current guidance documents, and recognition that modifications to facilities may be required to account for the site's soils.

3.3.2.1 LID Practices:

The following LID practice options are best suited to Road Retrofits as outlined in the LID Retrofit Guide (CVC, 2013):

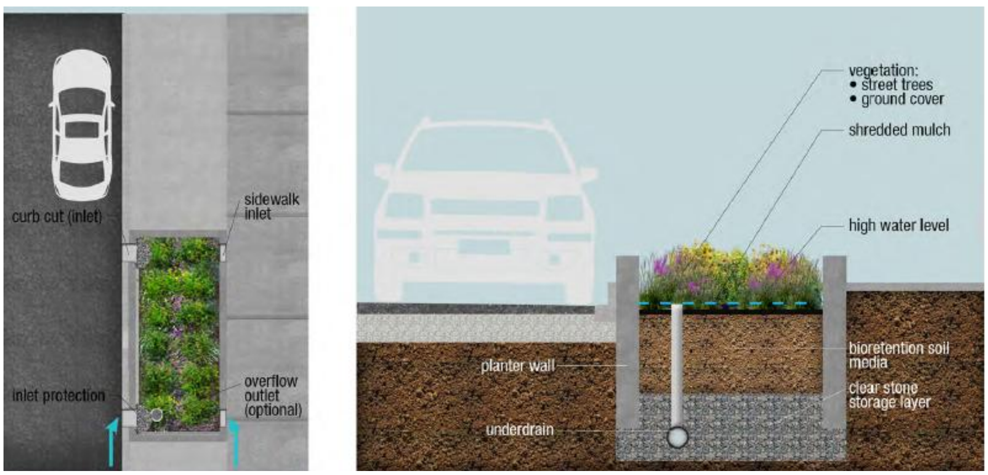
- Bioretention
  - Planters
  - Curb Extensions
  - Boulevard units
- Swales
  - Enhanced grass
  - Bioswales
  - Perforated pipe
- Permeable pavement
  - Pervious concrete
  - Porous asphalt
  - Permeable pavers
- Prefabricated modules
  - Precast tree planters
  - Soil support systems
  - Proprietary stormwater treatment devices

The subsequent sections describe each practice and discuss the suitability to the Creditview Road improvements.

Bioretention

Bioretention Planters

Bioretention planters are typically elongated concrete planter boxes running adjacent to the roadway. An enclosed box is used to maximize the bioretention space within the confined ROW. As a result, the planters are most suitable for urbanized streetscapes. Stormwater enters the planter via a curb cut inlet, and is allowed to flow over the surface of the planter box. Stormwater is retained through evapotransporation, and a portion of the stormwater filters through the media to a subdrain.



Source: *Grey to Green- Road Retrofits* , Credit Valley Conservation Authority and Toronto and Region Conservation Authority

Figure 3.2 Bioretention Planters

Bioretention Curb Extensions

Bioretention curb extensions operate in an identical way as bioretention planters, but they extend into the roadway in curb bump-outs. As a result, they can more readily be used in residential areas where the curb bump-out is also used for traffic calming, or where the form of the curb extension has other benefits such as aesthetics, streetscaping, landscaping, and pedestrian movement.

Boulevard Bioretention Units

Boulevard bioretention areas are shallow depressions located beside the curb, elongated along the length of the roadway. The also operate the same way as the previous two bioretention facilities, with stormwater initially draining to the surface, stormwater retained through evapotransporation with the biomass growth, and a portion of the stormwater infiltrating through the media to a subdrain. Since they are graded from the surface, they typically take up slight more space than planters or curb extensions, and are often suited for residential areas, especially if a rural cross section is employed.

Swales

Enhanced Grass Swales

Where property is available, enhanced vegetated swales can be constructed along one or both sides of the roadway. The swales are typically constructed with a wide, flat base to reduce flow velocity and maximize infiltration, filtration through vegetation and nutrient uptake by vegetation. As illustrated in Figure 3.2, stormwater treatment can be further enhanced by adding rock check dams to slow and/or pond water in the swales, soil amendments to improve growing conditions and hold water for infiltration/evapotranspiration, and granular trenches below the swale to promote infiltration and cooling before it is released to the receiving drainage course. This SWM measure should only be applied where groundwater levels are deeper than 1 m year-round. Enhanced vegetated swales can achieve an average removal rate of 76% TSS and 55% TP (CVC and TRCA, 2010). Pre-treatment is recommended for road runoff and alternatives include a pea gravel diaphragm, vegetated filter strips, and sedimentation forebays. Enhanced vegetated swales can also provide partial water quantity improvements through evaporation and infiltration.

Figure 3.3 Enhanced Grass Swales Featuring Check Dams to Temporarily Pond Runoff

Source: *Low Impact Development SWM Planning and Design Guide*, Credit Valley Conservation Authority and Toronto and Region Conservation Authority

Bioswales

Bioretention swales are specifically designed to filter stormwater and promote infiltration and evaporation. A typical cross-section through a bioretention swale is shown below in Figure 3.4. It generally consists of a surface swale to accept runoff from adjacent paved areas, which is underlain by a layer of planting soil. Stormwater passing through the planting soil will drain down through a layer of sandy soil, and a sub-drain is generally provided at the base of the trench to collect the filtered runoff. For the study area, these facilities should include an impermeable liner to prevent infiltration of road runoff with potentially high chloride levels. A separation barrier may be required to prevent saturation of the road's subbase. In addition, vegetation must be salt tolerant. With these design considerations, a bioretention can provide water quality improvements if sized for water quality storage requirements and partial volume reduction through evapotranspiration. Pre-treatment of road runoff is recommended to prevent premature clogging. A two-cell design can be used to settle sediment in a pre-treatment chamber. Additional options include vegetated filter strip, gravel diaphragm, rip-rap, dense vegetation, and gutter screens. Two types of bioretention facilities are stormwater planters and extended tree pits, as illustrated in Figure 3.5 and Figure 3.6, respectively. Stormwater planters differ from traditional landscaped areas because they receive runoff from other surfaces and are typically applied in dense urban areas. Runoff from the sidewalk or streets can be directed to extended tree pits through curb cuts and will bypass the pit if it is full (CVC and TRCA, 2010).

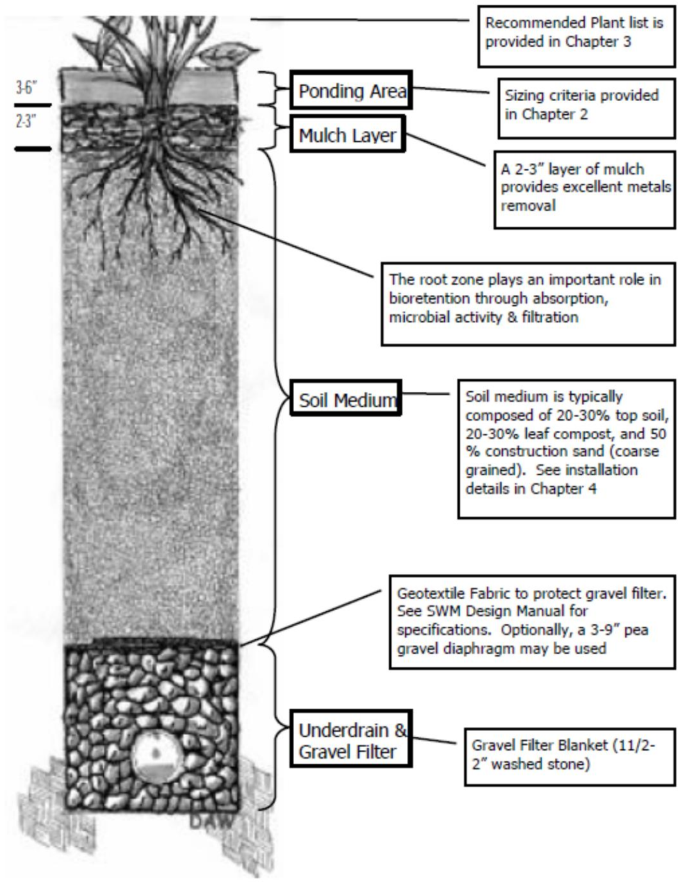


Figure 3.4: Typical Bioretention Swale Section

Source: *The Bioretention Manual*, Prince George's County, Maryland

Figure 3.5 Stormwater Planter

Source: *Low Impact Development SWM Planning and Design Guide*, Credit Valley Conservation Authority and Toronto and Region Conservation Authority

Figure 3.6 Extended Tree Pit

Source: *Low Impact Development SWM Planning and Design Guide*, Credit Valley Conservation Authority and Toronto and Region Conservation Authority

Perforated Pipe

These systems are constructed in place of or in addition to a traditional storm sewer system. Exfiltration systems include a perforated pipe within a stone trench under the roadway. Catchbasins are connected to the perforated pipe, and road runoff infiltrates into the soil surrounding the trench during and following rainfall events. A relief storm sewer conveys runoff from larger storm events to the outlet once the exfiltration trench is full. Exfiltration systems are generally not appropriate for heavily travelled urban arterials. Extensive pre-treatment is required to prevent the system from clogging, and there is an increased risk of contamination from spills and polluted runoff. Similar to infiltration trenches and soakaway pits, the study area soils do not meet the Ontario Ministry of Environment's minimum infiltration rate. Pervious pipe systems provide similar water quality and quantity benefits as infiltration trenches. An example is provided in Figure 3.7.

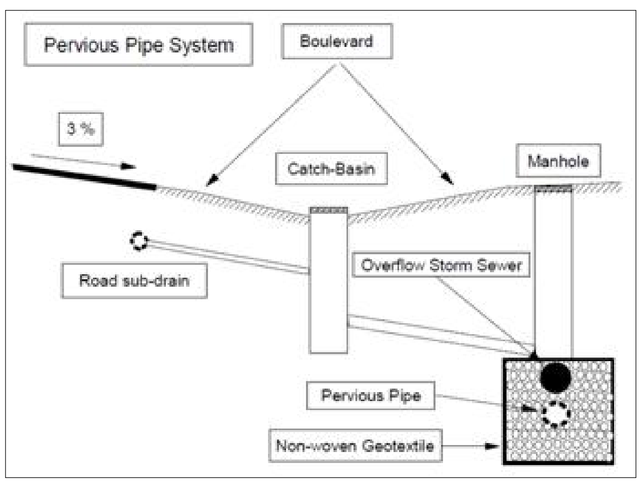


Figure 3.7 Pervious Pipe System

Source: *SWM Planning and Design Manual*, Ontario Ministry of Environment

Permeable Hard Surfaces

Permeable hard surfaces can take the form of pervious concrete, porous asphalt, or permeable pavers. Compared to traditional impervious pavement and walkways, these permeable hard surfaces drains water through the pavement into a stone reservoir and then is either infiltrated or temporarily detained.

As previously discussed, infiltration practices are not recommended for this study area due to the predominance of clay soils throughout. Therefore, an underdrain system would be required as illustrated by the Partial Infiltration with Flow Restrictor scenario in Figure 3.8. With these considerations, permeable pavement could be applied to sidewalks that meet the minimum building setback requirement of 4 m (MOE, 2003) and lay-by parking spaces. Examples of permeable pavers, permeable asphalt parking, and permeable concrete along a sidewalk are provided in Figure 3.9, **Error! Reference source not found.**, and Figure 3.10, respectively. Pre-treatment is not required for permeable pavement but periodic vacuum sweeping and preventing clogging from sand application during the winter is recommended. Winter operations, such as plowing and salt management, may need to be revised to maintain the performance of permeable lay-by parking spaces (CVC and TRCA, 2010). Permeable pavement can achieve an average removal rate of 90% TSS and 65% TP (US EPA, 1993).

If a subdrain is located at the bottom of the granular layer and no infiltration is provided, it will limit the water quantity benefit to volume reduction occurring through evaporation (CVC and TRCA, 2010). However, MOECC increasingly is recognizing that infiltration benefits can still be achieved in low permeability soils, so a design alternative is to raise the subdrain a distance above the bottom of the granular layer, allowing for some infiltration to occur.

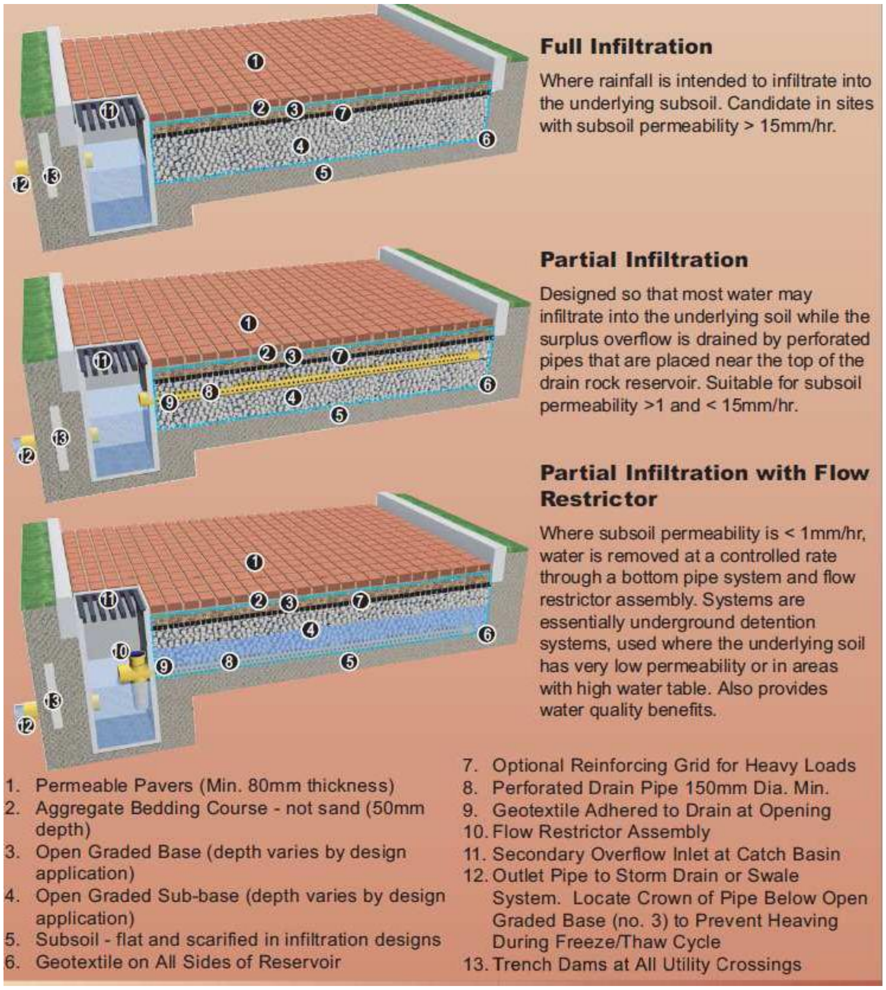


Figure 3.8 Permeable Pavement Cross Sections

Source: *Low Impact Development SWM Planning and Design Guide*, Credit Valley Conservation Authority and Toronto and Region Conservation Authority

Figure 3.9 Permeable Pavers

Source: *Beautifying City Streets with LID*, City of Toronto

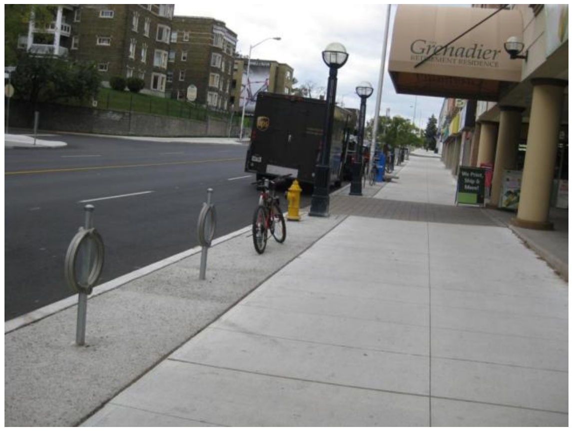


Figure 3.10 Permeable Concrete

Source: *Beautifying City Streets with LID*, City of Toronto

Figure 3.11 Permeable Asphalt Parking

Source: *Beautifying City Streets with LID*, City of Toronto

Prefabricated modules

Precast Tree Planters

Precast tree planters are similar to bioretention in its function, but utilizes a small footprint suitable for highly developed streetscapes. Stormwater enters the system through curb-inlet openings, and flows through a filter media in a landscaped concrete planter cell. The system provides pollutant capture in the media, incorporated into the biomass, and stormwater is taken up through evapotranspiration with the growing biomass. Stormwater eventually can drain through an underdrain at the bottom of the planter cell, and discharged to the storm sewer.

A typical type of precast tree planter is the Filterra system manufactured by Contech. A typical sketch of this system is shown below.

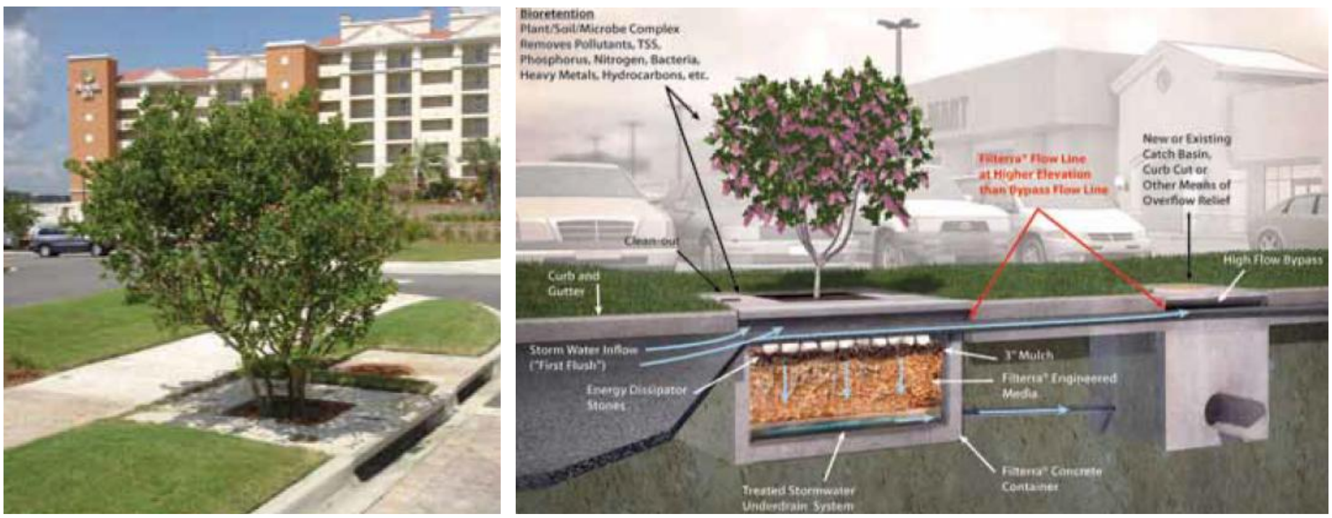


Figure 3.12 Precast Tree Planter – Filterra System

Source: *Filterra Bioretention System Solutions Guide*, Contech

Soil Support Systems

Silva Cells are an alternative low impact development measure similar to a tree pit for managing runoff from high traffic roads. As illustrated in Figure 3.11, the Silva Cell is a modular system of underground frames that support traffic loading while also providing uncompacted soil within the frames for large tree growth and SWM. The system provides SWM through absorption, evapotranspiration, and interception and achieves similar nutrient removal rates to a bioretention cell. Silva Cell systems can be located under sidewalks, parking lay-bys, or landscaped medians, but the frames cannot be positioned under travel lanes since they do not support lateral loads (Deep Root Canada Corporation, 2013).

A common limitation found in design guidelines for infiltration facilities is that they are not recommended for collecting runoff from busy roads that are salted during the winter. This is because chloride harms vegetation in the facilities and it is not recommended to encourage groundwater infiltration of water with high chloride concentrations. However, there is no such restriction in the design guidelines for Silva Cells. Through their many pilot projects, DeepRoot has not observed negative effects on trees growing in Silva Cells due to road salting. A hypothesis on why this does not occur is because the uncompacted soil allows consistent drainage and prevents salt from building up in the soil around roots. The system can also be lined with an impermeable liner and drained through a drainage pipe to prevent groundwater infiltration.

The modular nature of Silva Cells also provides flexibility in meeting site-specific requirements. For example, the cells allow easy navigation around existing and proposed. Utilities can be run through the frames or though utility corridors outside of the frames. The latter is an option for utilities that require offsets from surrounding infrastructure. Examples of running utilities through the frames and through external utility corridors are provided in Figure 3.13.

Figure 3.13 Running Utilities Through Silva Cells (Left) and External Utility Corridors (Right)

Proprietary Stormwater Treatment Devices

Oil-Grit Separators: These treatment devices are often installed to remove both sediments and floatables such as oil from storm runoff where space is not available for a SWM pond. They can be used in combination with other treatment measures to make up a treatment train approach and can be installed on-line on the storm sewer system. However, oil-grit separators do not have a significant storage volume, and are unable to reduce flow rates to mitigate potential flooding and erosion impacts. Oil grit separators can achieve an enhanced level of water quality treatment (80% TSS removal), but their performance varies based on design. Pre-treatment is not required.

3.3.3 Evaluation of Alternative Mitigation Measures

AECOM provides the following evaluation of these alternative mitigation measures for stormwater management. The evaluation considers the arterial nature of Creditview Road; the stormwater management objectives of the MOEE, CVC, and City of Mississauga; and the constraints and opportunities associated with future road design and streetscaping. An evaluation matrix is provided as Table 3.3.

Table 3.3 Evaluation of Stormwater Management Alternatives

Practice		Suitability for Arterial Road Reconstruction	Cost Effective?	Streetscaping Benefits?	Water Balance Benefits? (5 mm)	Water Quality Benefits?	Recommended?
Bioretention	Bioretention planter	HIGH	Moderate	Moderate	YES	HIGH	Maybe – highest potential for local drainage in centre of roundabout
	Curb Extension	Moderate	Moderate	Moderate	YES	HIGH	Maybe- depending on ROW and road design
	Boulevard Bioretention	Low	Yes	Moderate	YES	HIGH	No
Swales	Bioswale	Low	Yes	Moderate	YES	HIGH	No
	Enhanced Grass Swale	Low	Yes	Moderate	YES	HIGH	No
	Perforated Pipe	Low	No	No	Moderate (soil restriction)	Moderate (soil restriction)	No
Permeable hard surface		Moderate (sidewalk and pathway only)	No	No	Moderate (soil restriction)	Moderate (soil restriction)	No
Prefabricated Units	Precast Tree Planters	HIGH	Moderate	HIGH	YES	HIGH	YES
	Soil Support System	HIGH	Moderate	HIGH	YES	HIGH	YES
	Oil Grit Separators	HIGH	Moderate	No	No	HIGH	Maybe- with other measures

Based on the above evaluation, AECOM recommends that the Creditview Road reconstruction incorporate prefabricated tree planter units, in the form of either pre-cast tree planters (e.g. Filterra units, as provided by Contech, or similar) or soil support systems (e.g. Silva Cells, as provided by DeepRoot Green Infrastructure, or similar).

From Table 3.2, the preferred alternative results in an increase in paved area of 1.98 ha. The minimum treatment requirements are as follows:

- To control erosion and promote water balance, retention of 5 mm of runoff is desired from an area equivalent to the new paved area. For 1.98 ha of paved area, this corresponds to retention of 99 m^3 of rainfall. To retain 99 m^3 of rainfall, the following minimum treated paved areas are provided, based on the amount of retention that can be accommodated using various LID practices.

Table 3.4 Minimum Treatment Areas for LID

Pavement area treated (ha)	Volume retained for each storm	
	(mm)	(m3)
1.98	5	99
0.99	10	99
0.66	15	99
0.50	20	99
0.40	25	99

The minimum required retention will be achieved in detailed design by

a) Determining the retention volume achieved by specific proposed LID practices;
b) Using Table 3.4, determining the minimum paved area that is required to be directed to the LID features to achieve an overall retention of 99 m^3 for each storm.

- Water quality treatment is required for an area equivalent to the new paved area. If the LID treatment area is less than 1.98 ha, additional treatment requirements will be determined by
  a) Obtaining the area treated by LID features (from the previous step).
  b) Determining the minimum remaining paved area to be treated (for a total of 1.98 ha).
  c) Determine the treatment practice and the percent removal of TSS achieved by that practice. If less than 80% removal is achieved, increase the treated area accordingly to achieve the same net TSS removal as 80% removal from the required treatment area.

For example, if LID features are designed to retain 25 mm of rainfall, the minimum paved area draining to the LID features would be 0.40 ha (based on Table 3.4). This leaves 1.98 – 0.40 = 1.58 ha remaining to be treated.

If a treatment measure for the remaining area is proposed that achieves less than 80% removal of TSS (for example, some OGS alternatives), the minimum required treatment area would be increased accordingly, as follows:

TSS removal %	Required pavement area to be treated (ha)
80	1.58
70	1.81
50	2.53

4. Sediment and Erosion Control

Appropriate sediment and erosion control measures must be implemented prior to the commencement of construction on the proposed roadway improvements and must be maintained during and following construction until all disturbed areas have been stabilized.

A sediment and erosion control plan will be prepared as the detailed design of the proposed roadway improvements is advanced. The sediment and erosion control plan should adhere to the guidelines established by the Greater Golden Horseshoe Area Conservation Authorities Erosion and Sediment Guideline for Urban Construction.

5. Conclusions and Recommendations

AECOM makes the following conclusions and recommendations, based on the stormwater drainage assessment for the preferred alternative for reconstruction of Creditview Road.

- The existing storm sewers are generally undersized for a 10-year design storm. The preferred alternative will widen portions of the road, and add additional impervious areas within the ROW associated with multi-use pathways and sidewalks. The result will be to increase impervious in the ROW from approximately 40% under existing conditions to approximately 60%. This will result in an increase in flows to the storm sewers, and the storm sewers will generally by further undersized for a 10-year design storm.
- AECOM has provided the required size for storm sewers to convey the 10-year storm under proposed conditions.
- AECOM has reviewed stormwater management requirements for the proposed preferred alternative for improvements to Creditview Road.
    - There is no peak flow control requirement for discharge to Credit River. The only peak flow concern is associated with sizing of the storm infrastructure in the ROW.
    - The main stormwater objectives for the road widening are to: (1) provide enhanced quality control for an area equivalent to the new paved area, and treat existing areas if practical and feasible; and (2) retain a stormwater volume equivalent to at least 5 mm over the new paved areas, to address erosion and water balance concerns.
- AECOM has reviewed stormwater management alternatives to address these requirements. AECOM has concluded that LID approaches within the ROW are practical and feasible, and represent the best practice to address the stormwater management requirements.
- Reviewing alternate stormwater LID measures, AECOM recommends the use of either prefabricated tree planter units, in the form of either pre-cast tree planters (e.g. Filterra units, as provided by Contech, or similar) or soil support systems (e.g. Silva Cells, as provided by DeepRoot Green Infrastructure, or similar). These devices will:
    - Retain a minimum of 5 mm of rainfall within the ROW;
    - Provide opportunities for enhanced water quality control for an area equivalent to the new paved area. If required during detailed design, water quality control could be further augmented by installation of oil grit separators in some areas;
    - Provide opportunities for enhanced streetscaping, incorporating additional trees and landscaping in the ROW, consistent with the form of the preferred road improvement alternative identified in the Class EA process.

  The locations of the LID features will be determined during detailed design, but must achieve a retention volume that is equivalent to 5 mm over the new paved area of 1.98 ha (see Table 3.4 for alternatives).
- Water quality controls are required to provide enhanced (80% TSS removal) water quality control for an area equivalent to the new paved area: 1.98 ha. If the area treated by stormwater LID measures is less than 1.98 ha, additional water quality control measures will be required (for example, oil grit separators at various locations along the corridor or bioretention in the roundabout interiors). The measures will be designed to provide a treatment rate and treated area sufficient to provide an equivalent treatment as 80% TSS removal over 1.98 ha. Alternatives are discussed on page 32.

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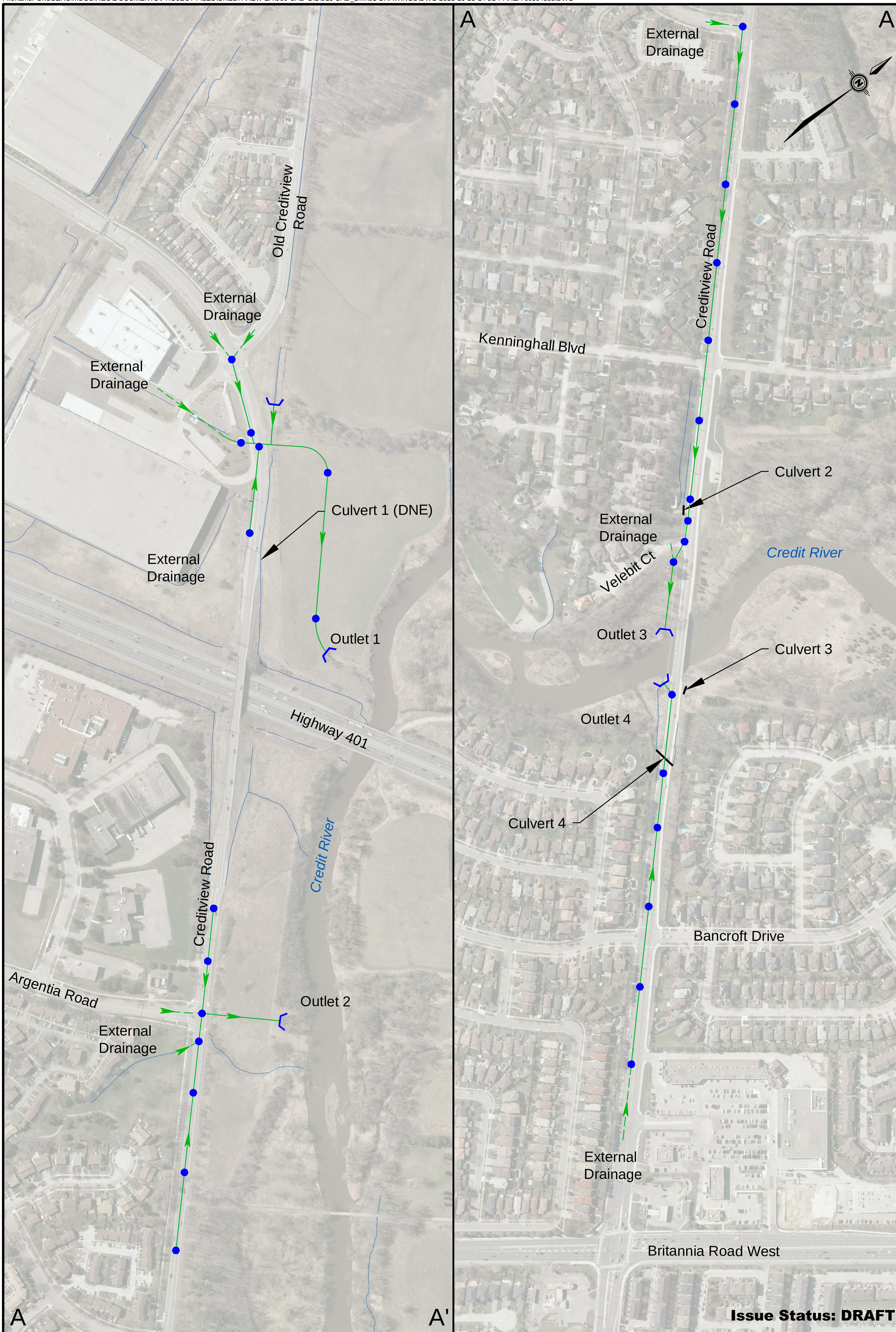
Appendix A

Creditview Road EA, Bancroft Drive to Old Creditview Road

DRAFT Stormwater Drainage Assessment Report

- **Drawings**



Creditview Road Class Environmental Assessment from Bancroft Drive to Old Creditview Road - Stormwater Drainage Assessment Report
Existing Roadway Drainage System
City of Mississauga, Mississauga
Project No.: 60304588 Date: 2013-12-11

AECOM

Drawing: 1

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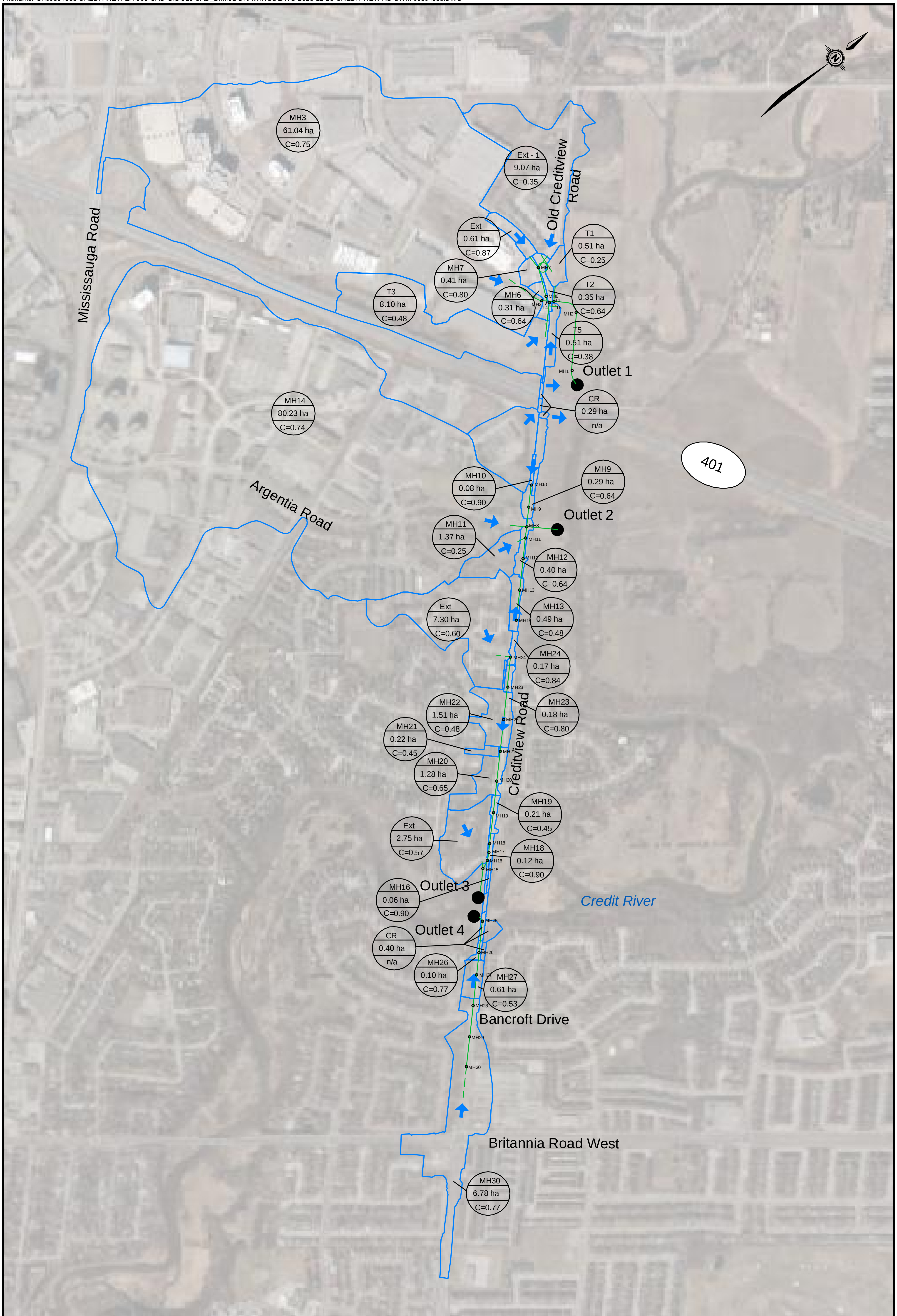
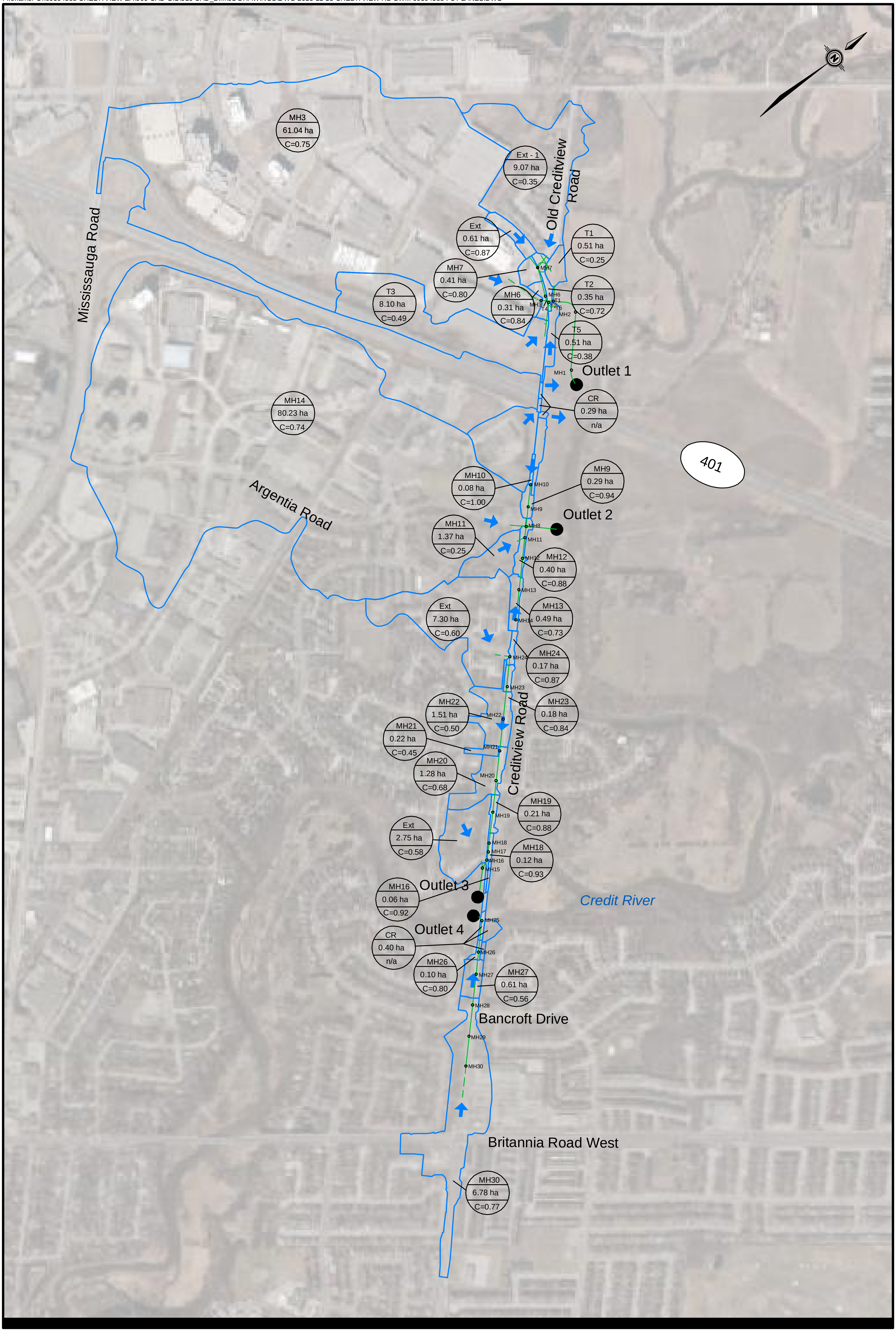


Creditview Road Class Environmental Assessment from Bancroft Drive to Old Creditview Road - Stormwater Drainage Assessment Report
Existing Drainage Areas
City of Mississauga, Mississauga
Project No.: 60304588 Date: 2013-12-11

AECOM

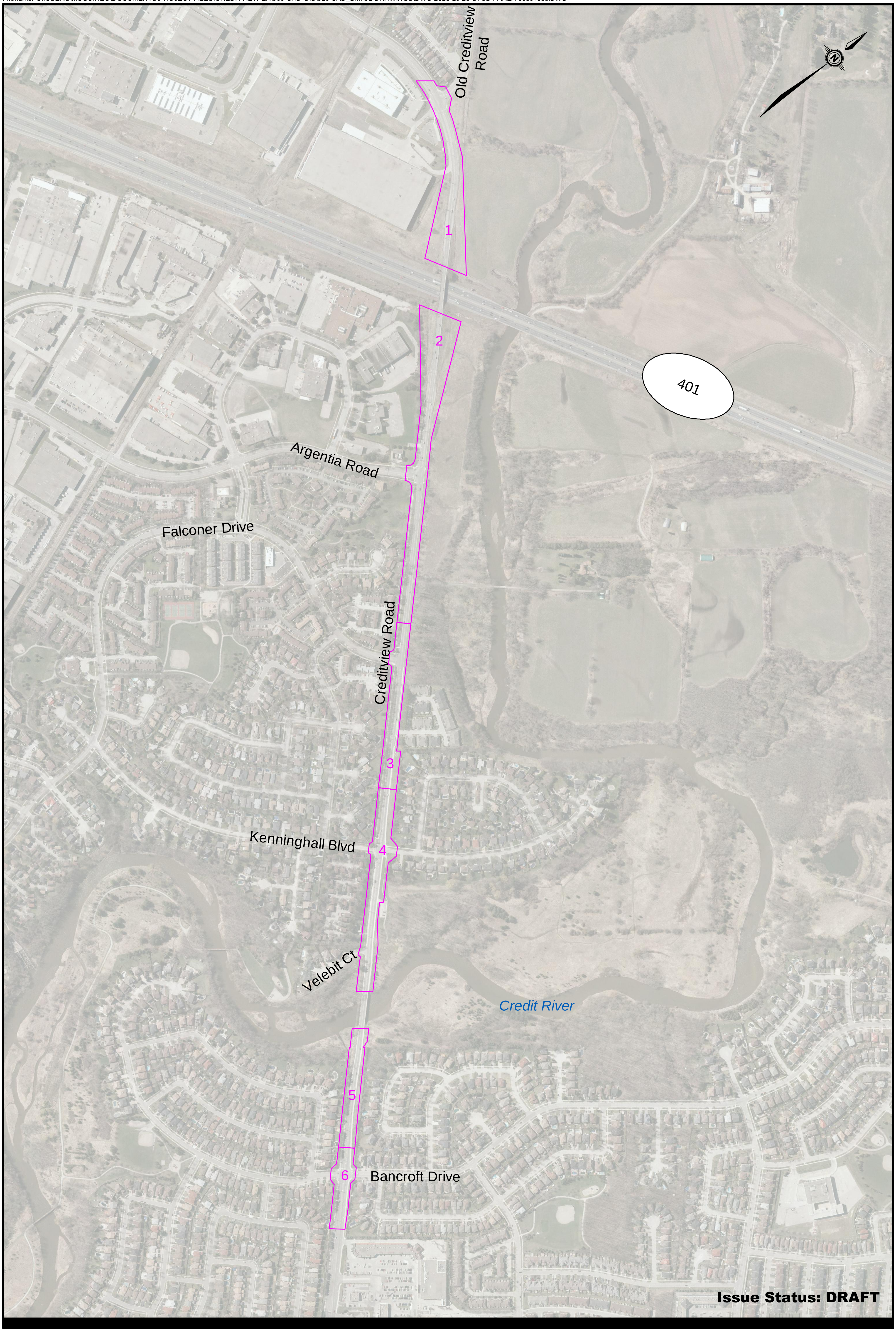
Storm Catchments, Existing Conditions



Creditview Road Class Environmental Assessment from Bancroft Drive to Old Creditview Road - Stormwater Drainage Assessment Report
Future Drainage Areas
City of Mississauga, Mississauga
Project No.: 60304588 Date: 2013-12-11

AECOM

Storm Catchments, Future Conditions



Creditview Road Class Environmental Assessment from Bancroft Drive to Old Creditview Road - Stormwater Drainage Assessment Report
Existing Right-of-Way Catchments
City of Mississauga, Mississauga
Project No.: 60304588 Date: 2013-12-11

AECOM
Drawing: 3

SUBDIVISION OLD CREDITVIEW ROAD

MAJOR DRAINAGE AREA Z-45E / 45W

CITY OF MISSISSAUGA

STORM DRAINAGE DESIGN CHART
FOR CIRCULAR DRAINS FLOWING FULL

SHEET No. 1 OF 1 DATE SEPT 2003

PROJECT No. 17111 03***

DESIGNED BY BORIS LENCE C.E.T.

LINE NO.	LOCATION	MH	MH	DRAINAGE AREA (ha)	RUN OFF COEFF	IMP AREA	ACCUMM DRAINAGE AREA	ACCUMM IMP AREA	TIME OF FLOW (min)	TIME OF ENTRY (min)	TIME OF CONC (min)	R/FALL INTENS (mm/hr)	EXP FLOW (m3/sec)	TYPE OF PIPE	MANN'G COEFF n	SLOPE S (%)	DIA D (mm)	LENGTH L (m)	VEL V (m/sec)	CAP Q (m3/sec)	UPSTREAM INVERT (m)	DSTREAM INVERT (m)	TIME IN SECTION (min)
1																							
2	Old Creditview Road (Adjacent West Property)	1		0.46																			
3	Old Creditview Road @ Old Derry Rd (ROW)		2	0.22	0.75	0.51	0.68	0.51	-	15.00	15.00	99	0.14	conc.	0.013	0.70	450	90.00	1.52	0.25	168.985	168.355	0.99
4																							
5	Old Creditview Road (Adjacent West Property)	2		0.78																			
6	Old Creditview Road (Right Of Way)		3	0.19	0.75	0.73	1.65	1.24	0.99	15.00	15.99	95	0.33	conc.	0.013	0.70	525	90.00	1.68	0.38	168.280	167.650	0.89
7																							
8	Old Creditview Road (Adjacent West Property)	3		0.17																			
9	Old Creditview Road (Right Of Way)		Exist 'A'	0.21	0.75	0.29	2.03	1.52	0.89	15.99	16.88	92	0.39	conc.	0.013	0.70	600	100.00	1.84	0.54	167.575	166.875	0.91
10																							
11																							
12																							
13																							
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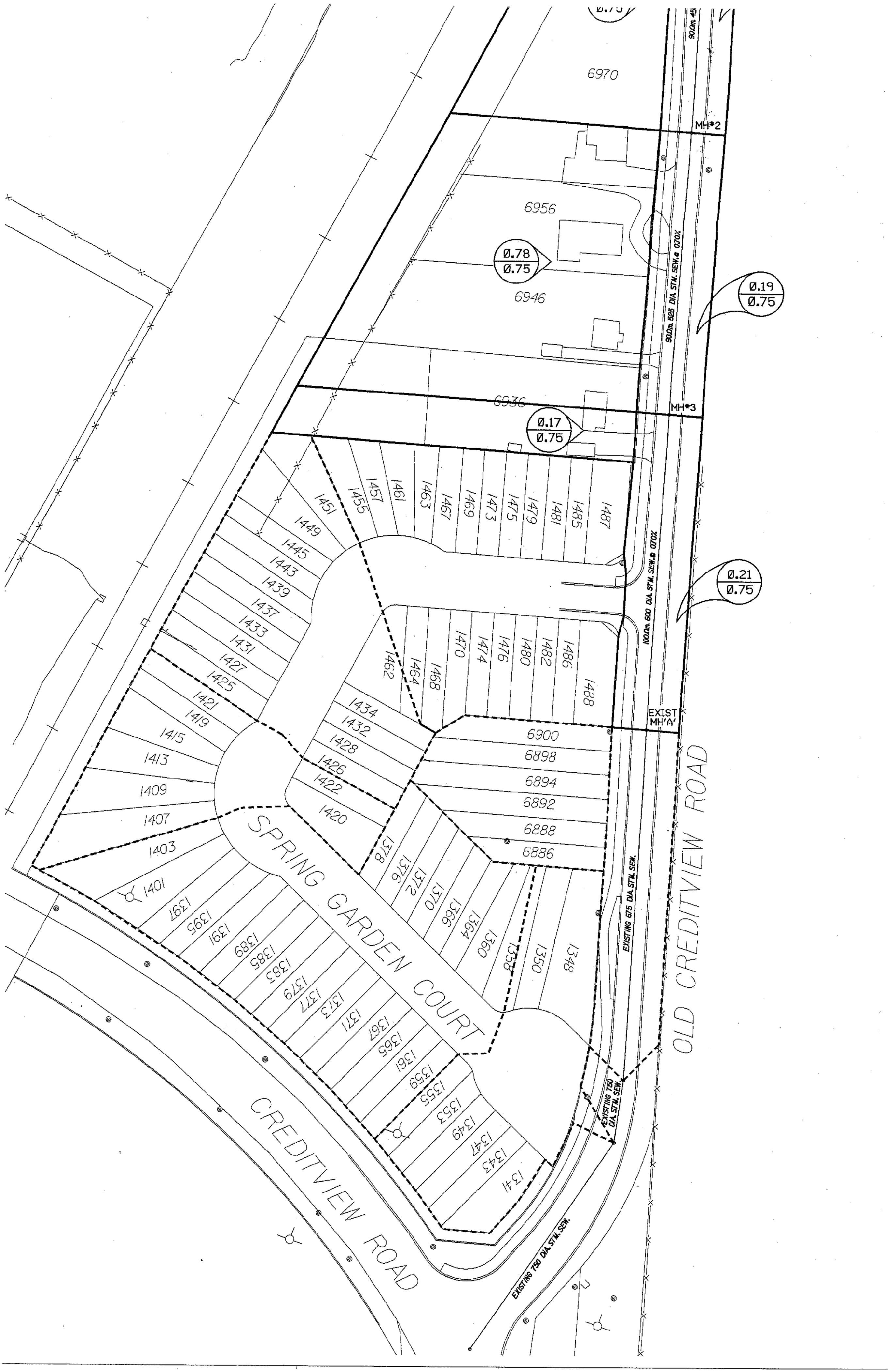
34																							

45E



6970
MH*2
6956
Ø.78
Ø.75
6946
Ø.19
Ø.75
90.0m 525 DIA. STM. SEW.@ 070%
6936
MH*3
Ø.17
Ø.75
1451
1455
1457
1461
1463
1467
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1415
1413
1409
1407
1403
1401
Ø.21
Ø.75
100.0m 600 DIA. STM. SEW.@ 070%
1462
1464
1468
1470
1474
1476
1480
1482
1486
1488
1434
1432
1428
1426
1422
1420
EXIST
MH'A'
6900
6898
6894
6892
6888
6886
SPRING GARDEN COURT
OLD CREDITVIEW ROAD
1378
1376
1372
1370
1366
1364
1360
1358
1350
1348
EXISTING 675 DIA. STM. SEW.
1397
1395
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1371
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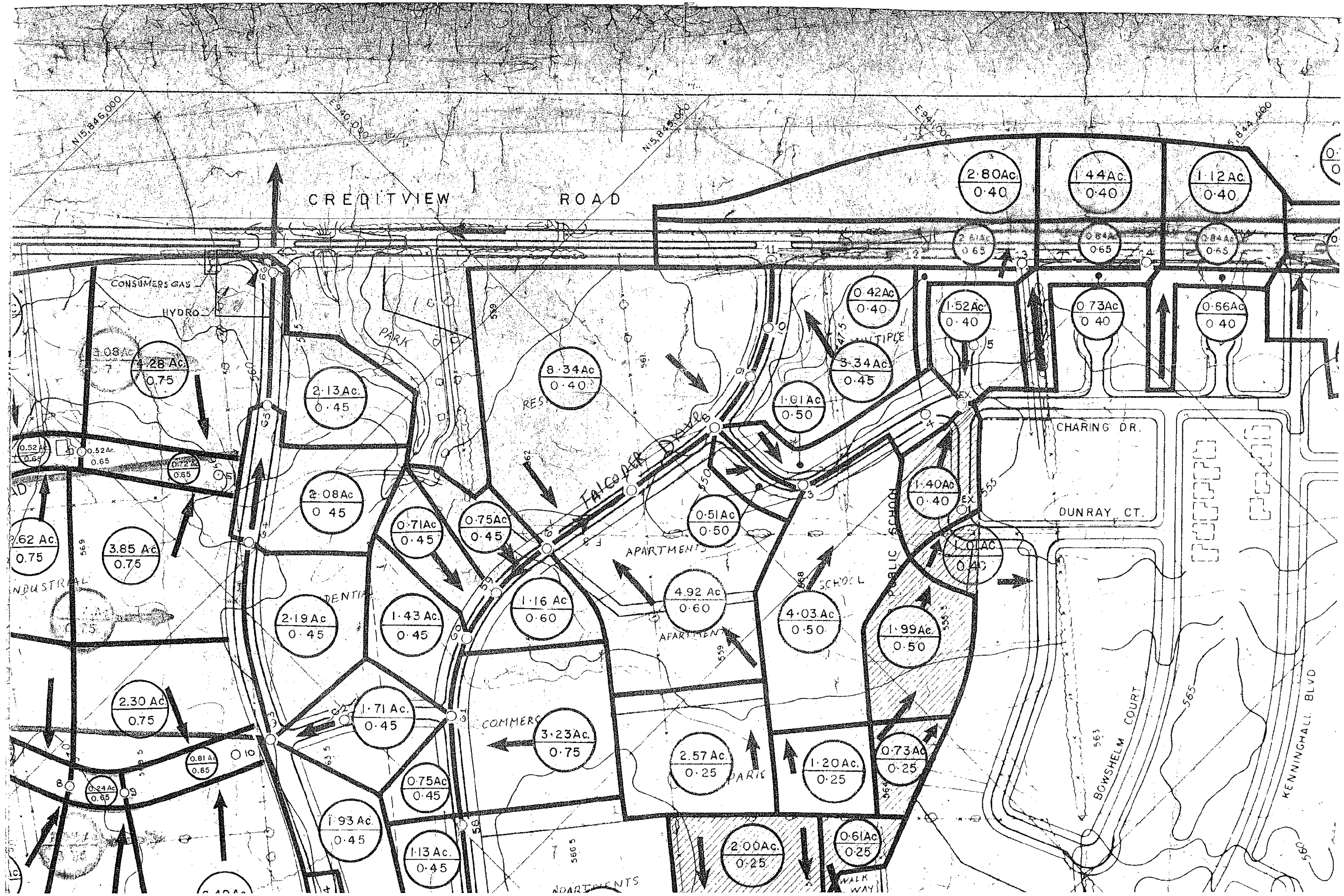
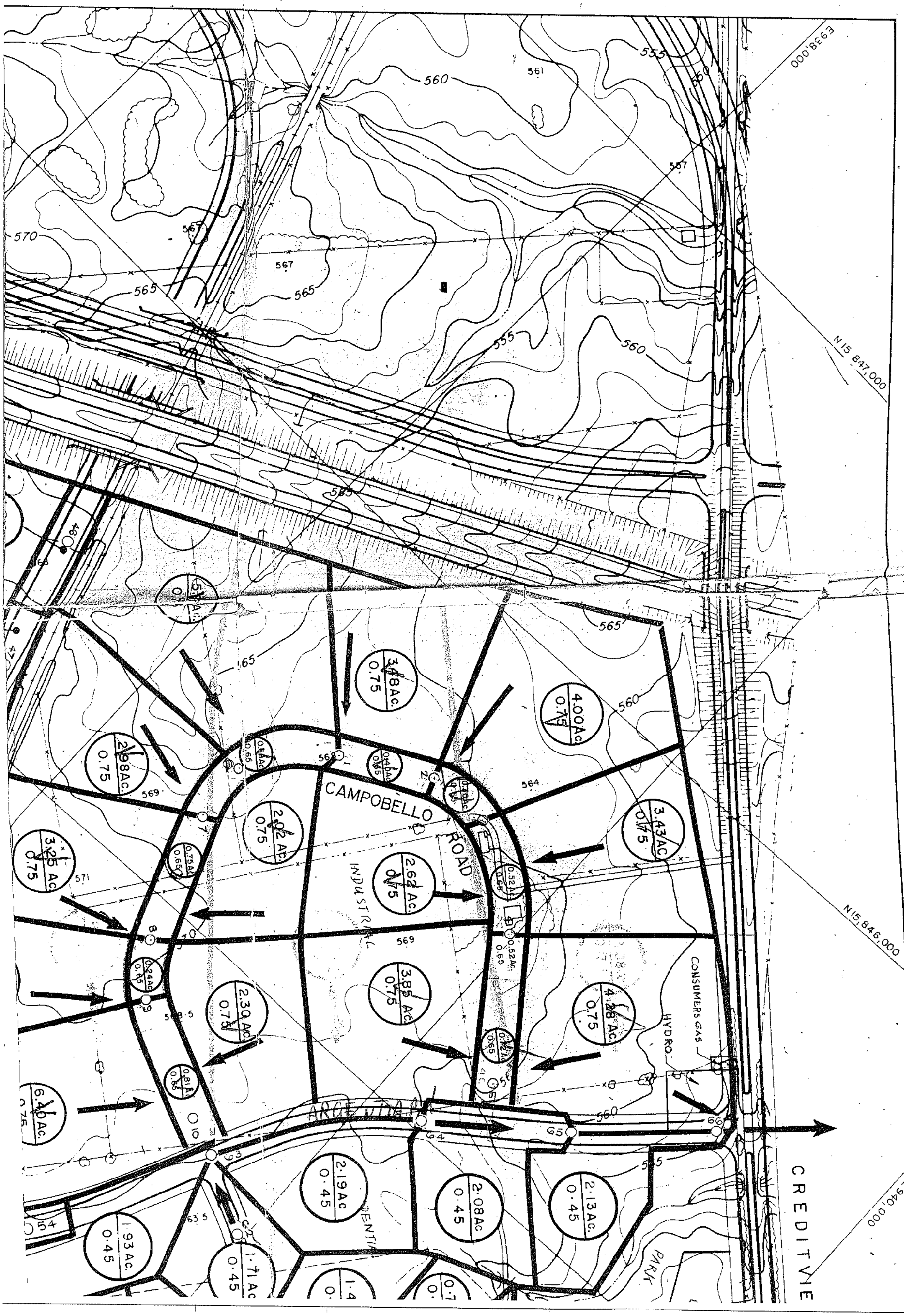
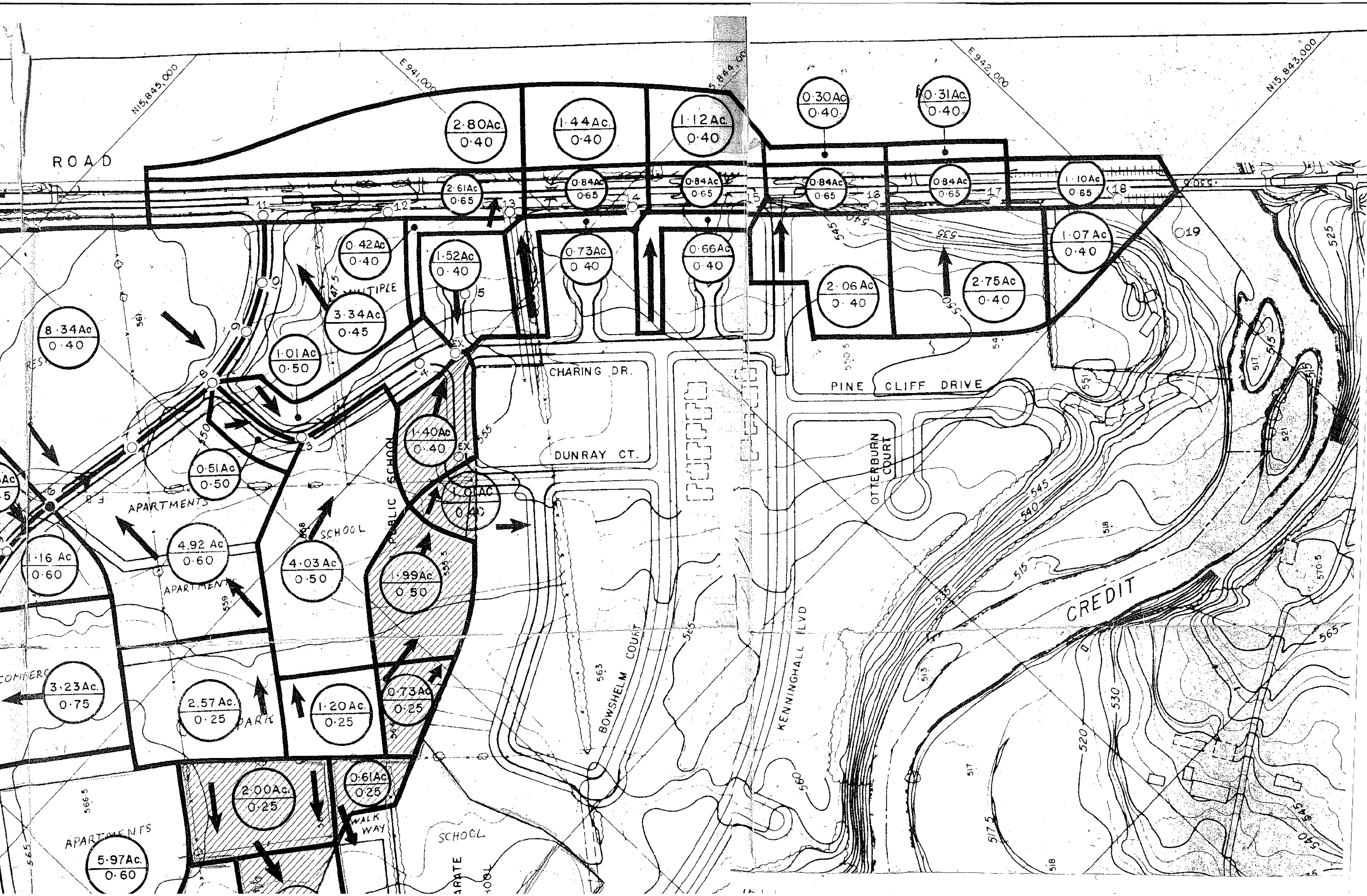
1343
1341
EXISTING 750 DIA. STM. SEW.
CREDITVIEW ROAD


CREDITVIEW ROAD
FALCONER DRIVE
CHARING DR.
DUNRAY CT.
BOWSHELM COURT
KENNINGHALL BLVD
CONSUMERS GAS
HYDRO
PARK
RES
INDUSTRIAL
APARTMENTS
COMMERS
MULTIPLE
PUBLIC SCHOOL
SCHOOL
WALK WAY


CAMPOBELLO ROAD
INDUSTRIAL
CONSUMERS GAS
HYDRO
CREDITVIE
PARK
N15,847,000
N15,846,000
E938,000
E940,000
3.48Ac. 0.75
4.00Ac. 0.75
2.98Ac. 0.75
2.02Ac. 0.75
3.43Ac. 0.75
3.25Ac. 0.75
2.62Ac. 0.75
3.85Ac. 0.75
2.30Ac. 0.75
4.28Ac. 0.75
2.19Ac. 0.45
2.08Ac. 0.45
2.13Ac. 0.45
1.93Ac. 0.45
1.71Ac. 0.45


ROAD
N15,845,000
E941,000
E942,000
N15,843,000
2·80Ac. 0·40
1·44Ac. 0·40
1·12Ac. 0·40
0·30Ac. 0·40
0·31Ac. 0·40
2·61Ac 0·65
0·84Ac 0·65
1·10Ac 0·65
0·42Ac 0·40
1·52Ac 0·40
0·73Ac 0·40
0·66Ac 0·40
2·06Ac 0·40
2·75Ac 0·40
1·07Ac 0·40
8·34Ac 0·40
1·01Ac 0·50
3·34Ac 0·45
MULTIPLE
0·51Ac 0·50
1·40Ac 0·40
1·01Ac 0·40
APARTMENTS
4·92Ac 0·60
4·03Ac 0·50
SCHOOL
PUBLIC SCHOOL
1·99Ac 0·50
1·16Ac 0·60
3·23Ac. 0·75
2·57Ac. 0·25
PARK
1·20Ac. 0·25
0·73Ac 0·25
2·00Ac. 0·25
0·61Ac 0·25
WALK WAY
5·97Ac. 0·60
CHARING DR.
DUNRAY CT.
BOWSHELM COURT
KENNINGHALL BLVD
PINE CLIFF DRIVE
OTTERBURN COURT
CREDIT

Appendix B

- **Storm Sewer Design Sheets**

EXISTING CONDITIONS

Development Creditview Road Class EA (Old Creditview Rd to Bancroft Rd)
Consultant AECOM
Major Drainage Area Norval to Port Credit Subwatershed
Return Period 10 -year

Storm Drainage Design Chart
For Circular Drains Flowing Full

Sheet No. ______ of ______
Designed By Brian Richert
Checked By ____________

Date 9/15/2015

LOCATION OF SITE	FROM UPSTREAM MH#	TO DOWNSTREAM MH#	CATCHMENT AREA A_A (ha)	ROW PORTION (ha)	ROW IMPERVIOUS AREA (ha)		RUNOFF COEFFICIENT C_A	AREA TIMES RUNOFF COEFFICIENT $A_A \times C_A$	ACCUMULATIVE AREA DRAINED BY SECTION ΣA_A (ha)	ACCUMULATIVE AREA TIMES RUNOFF COEFFICIENT $\Sigma A_A \times C_A$	FLOW TIME TO SECTIONFROM UPSTREAM INLET tc_f (min)	INITIAL TIME OF CONCENTRATION AT EXTREME UPSTREAM INLET tc_i (min)	TIME OF CONCENTRATION UPSTREAM END OF SECTION $tc = tc_f + tc_i$ (min)	INTENSITY OF RAINFALL i (mm/hr)	QUANTITY OF FLOW TO BE ACCOMODATED IN SECTION $Q = {}^{iAC}/_{360}$ (m^3/s)	TYPE OF PIPE	MANNING'S ROUGHNESS COEFFICIENT n	SLOPE s (%)	DIAMETER D (mm)	LENGTH OF SECTION L (m)	VELOCITY OF FLOW WITH PIPE FLOWING FULL V (m/s)	CAPACITY OF PIPE FLOWING FULL Q (m^3/s)	% Full (%)	PIPE INVERT AT UPSTREAM END (m)	PIPE INVERT AT DOWNSTREAM END (m)	TIME OF FLOW IN SECTION $t = {}^L/_{V \times 60}$ (min)
Creditview Rd North of Highway 401																										
Creditview Road West of Old Creditview Road	Ext. Area	MH7	0.61	0.05	0.04		0.87	0.53	0.61	0.53	0.00	15.00	15.00	99.2	0.145	conc	0.013	1.00%	375	41.1	1.59	0.175	83%	167.41	167.00	0.43
Old Creditview Road	Ext. Area	MH7	9.07				0.35	3.18	9.07	3.18	4.13	15.00	19.13	85.4	0.754	conc	0.013	1.10%	750	43.3	2.64	1.168	65%	165.63	165.15	0.27
Creditview Road @ Old Creditview Road	MH7	MH6	0.41	0.11	0.09		0.80	0.33	10.09	4.03	4.40	15.00	19.40	84.7	0.948	conc	0.013	0.60%	825	87.0	2.08	1.110	85%	165.03	164.51	0.70
	MH6	T4	0.31	0.18	0.10		0.64	0.20	10.40	4.23	5.10	15.00	20.10	82.8	0.974	conc	0.013	0.56%	825	9.0	2.00	1.070	91%	164.48	164.43	0.07
Creditview Road @ North Approach to HWY 401 Bridge	MH5	T3														conc	0.013	2.00%	375	36.4	2.25	0.248		167.55	166.82	0.27
	T3	T5	8.10	0.51	0.07		0.48	3.87	8.10	3.87	5.21	15.00	20.21	82.5	0.887	conc	0.013	2.00%	375	58.4	2.25	0.248	358%	166.82	165.65	0.43
	T5	MH4	0.51				0.38	0.19	8.61	4.06	5.64	15.00	20.64	81.4	0.919	conc	0.013	2.00%	375	5.7	2.25	0.248	370%	165.65	165.54	0.04
	MH4	T2							8.61	4.06	5.68	15.00	20.68	81.3	0.917	conc	0.013	2.57%	375	7.0	2.55	0.281	326%	165.04	164.86	0.05
Industrial Areas to West at Trunk Sewer Crossing	MH3	T4	61.04				0.75	45.78	61.04	45.78	11.81	15.00	26.81	68.6	8.729	conc	0.013	0.28%	2400	3.8	2.92	13.191	66%	163.17	163.16	0.02
Creditview Road @ Trunk Sewer Crossing	T4	T2							71.44	50.01	11.83	15.00	26.83	68.6	9.531	conc	0.013	0.28%	2400	10.8	2.92	13.191	72%	163.16	163.13	0.06
	T2	T1	0.35	0.30	0.21		0.64	0.22	80.40	54.29	11.89	15.00	26.89	68.5	10.332	conc	0.013	0.28%	2400	34.3	2.92	13.191	78%	163.13	163.03	0.20
	T1	MH2	0.51	0.45	0.11		0.25	0.13	80.90	54.42	12.09	15.00	27.09	68.2	10.306	conc	0.013	0.28%	2400	68.1	2.92	13.191	78%	163.03	162.84	0.39
	MH2	MH1							80.90	54.42	12.48	15.00	27.48	67.5	10.208	conc	0.013	0.28%	2400	168.0	2.92	13.191	77%	162.84	162.36	0.96
Outfall to Credit River North of HWY 401	MH1	**OUTLET 1**		1.60	0.62				80.90	54.42	13.44	15.00	28.44	66.0	9.976	conc	0.013	0.28%	2400	39.0	2.92	13.191	76%	162.36	162.25	0.22
ROW draining directly to Credit River				0.29																						
Total Area				1.89																						
Creditview Rd Between Highway 401 & Falconer Dr																										
Creditview Road @ Southern Approach to Highway 401	MH10	MH9	0.08	0.08	0.08		0.90	0.07	0.08	0.90	0.00	15.00	15.00	99.2	0.248	SS	0.013	0.61%	300	61.0	1.06	0.075	330%	167.34	166.97	0.95
	MH9	MH8	0.29	0.25	0.13		0.64	0.19	0.37	1.09	0.95	15.00	15.95	95.6	0.288	SS	0.013	0.78%	375	61.0	1.40	0.154	187%	166.94	166.46	0.73
Creditview Road @ North Of Falconer Drive	MH13	MH12	0.49	0.38	0.16		0.48	0.23	0.49	0.48	0.00	15.00	15.00	99.2	0.132	SS	0.013	0.95%	300	92.3	1.34	0.094	139%	167.43	166.54	1.15
Catchbasins at low point south of Argentia Road	MH12	MH11	0.40	0.34	0.21		0.64	0.26	0.89	0.74	1.15	15.00	16.15	94.8	0.194	SS	0.013	0.95%	375	59.7	1.55	0.171	113%	166.52	165.95	0.64
External area draining to birdcage inlet west of Creditview Rd	MH11	MH8	1.37	0.02	0.00		0.25	0.34	2.27	1.08	1.79	15.00	16.79	92.6	0.278	SS	0.013	1.20%	375	32.3	1.74	0.192	145%	165.94	165.55	0.31
Creditview Road @ Argentia Rd Trunk Sewer Crossing	MH14	MH8	80.23	0.09	0.07		0.74	58.97	80.23	0.74	10.92	15.00	25.92	70.2	0.143	conc	0.013	0.42%	2250	17.2	3.40	13.538	1%	162.50	162.43	0.08
Outfall to Credit River East of Argentia Road	MH8	**OUTLET 2**		1.16	0.65				82.87	2.90	11.00	15.00	26.00	70.1	0.564	conc	0.013	0.42%	2250	94.1	3.40	13.538	4%	162.43	162.035	0.46
ROW draining directly to Credit River				1.38	0.11																					
Total Area				2.54	0.76																					
Creditview Road Between Flaconer Rd & Credit River																										
External Drainage @ Falconer Drive	Ext. Area	MH24	7.30	0.10	0.06		0.60	4.38	7.30	4.38	3.21	15.00	18.21	88.1	1.072	conc	0.013	1.00%	675	44.0	2.35	0.840	128%	163.89	163.45	0.31
Creditview Road @ North Of Falconer Drive	MH24	MH23	0.17	0.17	0.11		0.84	0.14	7.47	4.52	3.52	15.00	18.52	87.2	1.095	conc	0.013	0.93%	675	89.9	2.27	0.813	135%	163.29	162.45	0.66
	MH23	MH22	0.18	0.18	0.09		0.80	0.14	7.65	4.66	4.18	15.00	19.18	85.3	1.105	conc	0.013	0.97%	675	89.9	2.31	0.828	133%	162.43	161.56	0.65
	MH22	MH21	1.51	0.58	0.19		0.48	0.72	9.16	5.38	4.83	15.00	19.83	83.5	1.249	conc	0.013	0.63%	750	93.3	2.01	0.886	141%	161.53	160.93	0.77
	MH21	MH20	0.22	0.03	0.00		0.45	0.10	9.38	5.48	5.60	15.00	20.60	81.5	1.241	conc	0.013	0.99%	750	90.8	2.51	1.110	112%	160.93	160.03	0.60
Creditview Road @ Kenninghall Blvd	MH20	MH19	1.28	0.39	0.21		0.65	0.84	10.66	6.32	6.21	15.00	21.21	80.0	1.404	conc	0.013	0.97%	750	91.4	2.49	1.098	128%	160.02	159.13	0.61
	MH19	MH18	0.21	0.21	0.18		0.84	0.18	10.88	6.50	6.82	15.00	21.82	78.6	1.418	conc	0.013	1.36%	750	91.4	2.94	1.300	109%	159.11	157.87	0.52
	MH18	MH17	0.12	0.12	0.12		0.90	0.10	10.99	6.60	7.34	15.00	22.34	77.4	1.419	conc	0.013	1.05%	750	24.9	2.58	1.141	124%	157.85	157.59	0.16
	MH17	MH16							10.99	6.60	7.50	15.00	22.50	77.0	1.412	conc	0.013	1.05%	750	24.5	2.58	1.140	124%	157.59	157.33	0.16
Creditview Road @ Velebit Ct	MH16	MH15	0.06	0.06	0.06		0.90	0.06	11.06	6.66	7.66	15.00	22.66	76.7	1.418	conc	0.013	1.14%	750	27.4	2.70	1.191	119%	157.33	157.02	0.17
External Drainage @ Velebit Ct	Ext. Area	MH15	2.75	0.21	0.08		0.57	1.57	2.75	1.57	1.08	15.00	16.08	95.1	0.414	conc	0.013	5.00%	300	21.6	3.06	0.216	191%	158.10	157.02	0.12
Outfall to Credit River East of Argentia Road	MH15	**OUTLET 3**		2.06	1.10				13.80	8.23	7.83	15.00	22.83	76.3	1.744	conc	0.013	0.39%	900	77.7	1.77	1.127	155%	156.91	156.61	0.73
ROW draining directly to Credit River				0.50	0.10																					
Total Area				2.56	1.20																					
Creditview Road Between Bancroft Dr & Credit River																										
Creditview Road @ Study Area Limit	MH30	MH29	6.78	0.54	0.38		0.77	5.24	6.78	5.24	5.25	15.00	20.25	82.4	1.199	conc	0.013	0.60%	600	89.6	1.68	0.474	253%	163.21	162.68	0.89
	MH29	MH28							6.78	5.24	6.14	15.00	21.14	80.2	1.167	conc	0.013	0.65%	675	92.1	1.89	0.675	173%	162.58	161.99	0.81
Creditview Road @ Bancroft Drive / Sir Monty's Drive	MH28	MH27							6.78	5.24	6.95	15.00	21.95	78.3	1.139	conc	0.013	0.68%	750	89.6	2.08	0.919	124%	161.88	161.27	0.72
	MH27	MH26	0.61	0.36	0.18		0.53	0.32	7.39	5.56	7.67	15.00	22.67	76.6	1.183	conc	0.013	2.46%	750	62.1	3.96	1.748	68%	161.22	159.69	0.26
	MH26	MH25	0.10	0.09	0.08		0.77	0.08	7.50	5.64	7.93	15.00	22.93	76.1	1.192	conc	0.013	0.97%	750	91.1	2.48	1.094	109%	159.60	158.72	0.61
Outfall to Credit River Southwest of Credit River Bridge	MH25	**OUTLET 4**		0.99	0.64				7.50	5.64	8.55	15.00	23.55	74.8	1.171	conc	0.013	6.31%	750	14.4	6.33	2.797	42%	158.20	157.29	0.04
ROW draining directly to Credit River				0.40	0.15																					
Total Area				1.39	0.79																					

PROPOSED CONDITIONS - Preferred Alternative

Development Creditview Road Class EA (Old Creditview Rd to Bancroft Rd)

Consultant AECOM

Major Drainage Area Norval to Port Credit Subwatershed

Return Period 10 -year

Storm Drainage Design Chart
For Circular Drains Flowing Full

Sheet No. ______ of ______

Date 9/15/2015

Designed By Olivia McGuire, Brian Richert

Checked By ____________

LOCATION OF SITE	FROM UPSTREAM	TO DOWNSTREAM	CATCHMENT AREA	ROW PORTION	EXISTING ROW IMPERVIOUS AREA	ROW IMPERVIOUS AREA with WIDENING	EXISTING RUNOFF COEFFICIENT	RUNOFF COEFFICIENT	AREA TIMES RUNOFF COEFFICIENT	ACCUMULATIVE AREA DRAINED BY SECTION	ACCUMULATIVE AREA TIMES RUNOFF COEFFICIENT	FLOW TIME TO SECTIONFROM UPSTREAM INLET	INITIAL TIME OF CONCENTRATION AT EXTREME UPSTREAM INLET	TIME OF CONCENTRATION UPSTREAM END OF SECTION	INTENSITY OF RAINFALL	QUANTITY OF FLOW TO BE ACCOMODATED IN SECTION	TYPE OF PIPE	MANNING'S ROUGHNESS COEFFICIENT	SLOPE	DIAMETER	LENGTH OF SECTION	VELOCITY OF FLOW WITH PIPE FLOWING FULL	CAPACITY OF PIPE FLOWING FULL	% Full	PIPE INVERT AT UPSTREAM END	PIPE INVERT AT DOWNSTREAM END	TIME OF FLOW IN SECTION
	MH#	MH#	A_A				CA	C_A	A_A X C_A	Σ A_A	Σ A_A X C_A	tc_f	tc_i	$tc = tc_f + tc_i$	i	$Q = {}^{iAC}/_{360}$		n	s	D	L	V	Q				$t = {}^{L}/_{V \times 60}$
			ha	ha	ha	ha				ha		min	min	min	mm/hr	m^3/s			%	mm	m	m/s	m^3/s	%	m	m	min
Creditview Rd North of Highway 401																											
Creditview Road West of Old Creditview Road	Ext. Area	MH7	0.61	0.05	0.04	0.04	0.87	0.87	0.53	0.61	0.53	0.00	15.00	15.00	99.2	0.145	conc	0.013	1.00%	375	41.1	1.59	0.175	83%	167.41	167.00	0.43
Old Creditview Road	Ext. Area	MH7	9.07				0.35	0.35	3.18	9.07	3.18	4.13	15.00	19.13	85.4	0.754	conc	0.013	1.10%	750	43.3	2.64	1.168	65%	165.63	165.15	0.27
Creditview Road @ Old Creditview Road	MH7	MH6	0.41	0.11	0.09	0.09	0.80	0.80	0.33	10.09	4.03	4.40	15.00	19.40	84.7	0.948	conc	0.013	0.60%	825	87.0	2.08	1.110	85%	165.03	164.51	0.70
	MH6	T4	0.31	0.18	0.10	0.30	0.64	0.84	0.26	10.40	4.29	5.10	15.00	20.10	82.8	0.988	conc	0.013	0.56%	825	9.0	2.00	1.070	92%	164.48	164.43	0.07
Creditview Road @ North Approach to HWY 401 Bridge	MH5	T3															conc	0.013	2.00%	375	36.4	2.25	0.248		167.55	166.82	0.27
	T3	T5	8.10	0.51	0.07	0.22	0.48	0.49	3.94	8.10	3.94	5.21	15.00	20.21	82.5	0.903	conc	0.013	2.00%	375	58.4	2.25	0.248	364%	166.82	165.65	0.43
	T5	MH4	0.51				0.38	0.38	0.19	8.61	4.13	5.64	15.00	20.64	81.4	0.935	conc	0.013	2.00%	375	5.7	2.25	0.248	377%	165.65	165.54	0.04
	MH4	T2								8.61	4.13	5.68	15.00	20.68	81.3	0.933	conc	0.013	2.57%	375	7.0	2.55	0.281	332%	165.04	164.86	0.05
Industrial Areas to West at Trunk Sewer Crossing	MH3	T4	61.04				0.75	0.75	45.78	61.04	45.78	11.81	15.00	26.81	68.6	8.729	conc	0.013	0.28%	2400	3.8	2.92	13.191	66%	163.17	163.16	0.02
Creditview Road @ Trunk Sewer Crossing	T4	T2								71.44	50.07	11.83	15.00	26.83	68.6	9.543	conc	0.013	0.28%	2400	10.8	2.92	13.191	72%	163.16	163.13	0.06
	T2	T1	0.35	0.30	0.21	0.30	0.64	0.72	0.25	80.40	54.46	11.89	15.00	26.89	68.5	10.362	conc	0.013	0.28%	2400	34.3	2.92	13.191	79%	163.13	163.03	0.20
	T1	MH2	0.51	0.45	0.11		0.25	0.25	0.13	80.90	54.58	12.09	15.00	27.09	68.2	10.337	conc	0.013	0.28%	2400	68.1	2.92	13.191	78%	163.03	162.84	0.39
	MH2	MH1								80.90	54.58	12.48	15.00	27.48	67.5	10.238	conc	0.013	0.28%	2400	168.0	2.92	13.191	78%	162.84	162.36	0.96
Outfall to Credit River North of HWY 401	MH1	**OUTLET 1**		1.60	0.62					80.90	54.58	13.44	15.00	28.44	66.0	10.006	conc	0.013	0.28%	2400	39.0	2.92	13.191	76%	162.36	162.25	0.22
ROW draining directly to Credit River				0.29																							
Total Area				1.89																							
Creditview Rd Between Highway 401 & Falconer Dr																											
Creditview Road @ Southern Approach to Highway 401	MH10	MH9	0.08	0.08	0.08	0.31	0.90	1.00	0.08	0.08	1.00	0.00	15.00	15.00	99.2	0.275	SS	0.013	0.61%	300	61.0	1.06	0.075	366%	167.34	166.97	0.95
	MH9	MH8	0.29	0.25	0.13	0.41	0.64	0.94	0.27	0.37	1.27	0.95	15.00	15.95	95.6	0.338	SS	0.013	0.78%	375	61.0	1.40	0.154	219%	166.94	166.46	0.73
Creditview Road @ North Of Falconer Drive	MH13	MH12	0.49	0.38	0.16	0.42	0.48	0.73	0.36	0.49	0.73	0.00	15.00	15.00	99.2	0.201	SS	0.013	0.95%	300	92.3	1.34	0.094	213%	167.43	166.54	1.15
Catchbasins at low point south of Argentia Road	MH12	MH11	0.40	0.34	0.21	0.52	0.64	0.88	0.35	0.89	1.08	1.15	15.00	16.15	94.8	0.285	SS	0.013	0.95%	375	59.7	1.55	0.171	167%	166.52	165.95	0.64
External area draining to birdcage inlet west of Creditview Rd	MH11	MH8	1.37	0.02	0.00		0.25	0.25	0.34	2.27	1.43	1.79	15.00	16.79	92.6	0.367	SS	0.013	1.20%	375	32.3	1.74	0.192	191%	165.94	165.55	0.31
Creditview Road @ Argentia Rd Trunk Sewer Crossing	MH14	MH8	80.23	0.09	0.07		0.74	0.73	58.96	80.23	0.73	10.92	15.00	25.92	70.2	0.143	conc	0.013	0.42%	2250	17.2	3.40	13.538	1%	162.50	162.43	0.08
Outfall to Credit River East of Argentia Road	MH8	**OUTLET 2**		1.16	0.65					82.87	3.43	11.00	15.00	26.00	70.1	0.668	conc	0.013	0.42%	2250	94.1	3.40	13.538	5%	162.43	162.035	0.46
ROW draining directly to Credit River				1.38	0.11																						
Total Area				2.54	0.76																						
Creditview Road Between Flaconer Rd & Credit River																											
External Drainage @ Falconer Drive	Ext. Area	MH24	7.30	0.10	0.06		0.60	0.60	4.38	7.30	4.38	3.21	15.00	18.21	88.1	1.072	conc	0.013	1.00%	675	44.0	2.35	0.840	128%	163.89	163.45	0.31
Creditview Road @ North Of Falconer Drive	MH24	MH23	0.17	0.17	0.11	0.17	0.84	0.87	0.15	7.47	4.53	3.52	15.00	18.52	87.2	1.097	conc	0.013	0.93%	675	89.9	2.27	0.813	135%	163.29	162.45	0.66
	MH23	MH22	0.18	0.18	0.09	0.14	0.80	0.84	0.15	7.65	4.68	4.18	15.00	19.18	85.3	1.108	conc	0.013	0.97%	675	89.9	2.31	0.828	134%	162.43	161.56	0.65
	MH22	MH21	1.51	0.58	0.19	0.29	0.48	0.50	0.76	9.16	5.44	4.83	15.00	19.83	83.5	1.262	conc	0.013	0.63%	750	93.3	2.01	0.886	142%	161.53	160.93	0.77
	MH21	MH20	0.22	0.03	0.00	0.00	0.45	0.45	0.10	9.38	5.54	5.60	15.00	20.60	81.5	1.254	conc	0.013	0.99%	750	90.8	2.51	1.110	113%	160.93	160.03	0.60
Creditview Road @ Kenninghall Blvd	MH20	MH19	1.28	0.39	0.21	0.32	0.65	0.68	0.87	10.66	6.41	6.21	15.00	21.21	80.0	1.424	conc	0.013	0.97%	750	91.4	2.49	1.098	130%	160.02	159.13	0.61
	MH19	MH18	0.21	0.21	0.18	0.27	0.84	0.88	0.19	10.88	6.60	6.82	15.00	21.82	78.6	1.440	conc	0.013	1.36%	750	91.4	2.94	1.300	111%	159.11	157.87	0.52
	MH18	MH17	0.12	0.12	0.12	0.18	0.90	0.93	0.11	10.99	6.70	7.34	15.00	22.34	77.4	1.441	conc	0.013	1.05%	750	24.9	2.58	1.141	126%	157.85	157.59	0.16
	MH17	MH16								10.99	6.70	7.50	15.00	22.50	77.0	1.434	conc	0.013	1.05%	750	24.5	2.58	1.140	126%	157.59	157.33	0.16
Creditview Road @ Velebit Ct	MH16	MH15	0.06	0.06	0.06	0.09	0.90	0.92	0.06	11.06	6.76	7.66	15.00	22.66	76.7	1.440	conc	0.013	1.14%	750	27.4	2.70	1.191	121%	157.33	157.02	0.17
External Drainage @ Velebit Ct	Ext. Area	MH15	2.75	0.21	0.08	0.12	0.57	0.58	1.58	2.75	1.58	1.08	15.00	16.08	95.1	0.418	conc	0.013	5.00%	300	21.6	3.06	0.216	193%	158.10	157.02	0.12
Outfall to Credit River East of Argentia Road	MH15	**OUTLET 3**		2.06	1.10					13.80	8.35	7.83	15.00	22.83	76.3	1.769	conc	0.013	0.39%	900	77.7	1.77	1.127	157%	156.91	156.61	0.73
ROW draining directly to Credit River				0.50	0.10																						
Total Area				2.56	1.20																						
Creditview Road Between Bancroft Dr & Credit River																											
Creditview Road @ Study Area Limit	MH30	MH29	6.78	0.54	0.38	0.48	0.77	0.77	5.26	6.78	5.26	5.25	15.00	20.25	82.4	1.203	conc	0.013	0.60%	600	89.6	1.68	0.474	254%	163.21	162.68	0.89
	MH29	MH28								6.78	5.26	6.14	15.00	21.14	80.2	1.171	conc	0.013	0.65%	675	92.1	1.89	0.675	173%	162.58	161.99	0.81
Creditview Road @ Bancroft Drive / Sir Monty's Drive	MH28	MH27								6.78	5.26	6.95	15.00	21.95	78.3	1.142	conc	0.013	0.68%	750	89.6	2.08	0.919	124%	161.88	161.27	0.72
	MH27	MH26	0.61	0.36	0.18	0.23	0.53	0.56	0.34	7.39	5.59	7.67	15.00	22.67	76.6	1.191	conc	0.013	2.46%	750	62.1	3.96	1.748	68%	161.22	159.69	0.26
	MH26	MH25	0.10	0.09	0.08	0.10	0.77	0.80	0.08	7.50	5.68	7.93	15.00	22.93	76.1	1.200	conc	0.013	0.97%	750	91.1	2.48	1.094	110%	159.60	158.72	0.61
Outfall to Credit River Southwest of Credit River Bridge	MH25	**OUTLET 4**		0.99	0.64					7.50	5.68	8.55	15.00	23.55	74.8	1.180	conc	0.013	6.31%	750	14.4	6.33	2.797	42%	158.20	157.29	0.04
ROW draining directly to Credit River				0.40	0.15																						
Total Area				1.39	0.79																						