Airport Road Improvements










APPENDICES ESR 1

Municipal Class Environmental Assessment
Airport Road
from 1.0km north of Mayfield Road to 0.6km north of King Street

October 2015

Region of Peel
Working for you

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DRAINAGE & STORMWATER

The Regional Municipality of Peel

CLASS ENVIRONMENTAL ASSESSMENT
AIRPORT ROAD IMPROVEMENTS
FROM MAYFIELD ROAD TO KING STREET
IBI GROUP REF: 24RX120105

STORMWATER MANAGEMENT REPORT

AUGUST 2014

IBI Group Professional Engineering services

The Regional Municipality of Peel
CLASS ENVIRONMENTAL ASSESSMENT
AIRPORT ROAD IMPROVEMENTS
FROM MAYFIELD ROAD TO KING STREET
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1. INTRODUCTION

1.1 Background

IBI Group has been retained by Region of Peel to conduct a Stormwater Management Study as part of Class Environmental Assessment assignment being conducted by the Region of Peel for Airport Road Improvements. The study area is located between approximately 300 m north Mayfield Road to approximately 100 m north of King Street, a distance of approximately 6.0 km. The location of the project is shown on **Figure 1**.

Airport Road is a two-lane, undivided, rural roadway which supports a considerable volume of commuter and truck traffic. South of the study area, Airport Road has been widened from a two-lane road to a four-lane road. These improvements were made to accommodate increased traffic for new industrial development.

The purpose of this EA is to study the following:

- Identify and evaluate a variety of reconstruction and intersection improvement alternatives that will satisfy future travel demands.

- Analyze the potential replacement of three major watercourse crossings of Salt Creek.

This Stormwater Management Report (SWMR) is a supporting document to the Class EA for the reconstruction of Airport Road from Mayfield Road to King Street.

The objective of this report (SWMR) is to summarize the drainage and stormwater management conditions that currently exist within the study limits and plan a stormwater management strategy to convey external and internal runoff across the widened Airport Road in order to mitigate the possible impacts of the proposed improvements to Airport Road on receiving drainage systems.

1.2 Existing Drainage Infrastructure

As part of Airport Road EA the following drainage component were identified:

- There are nine (9) CSP culverts, two structural culverts and one bridge crossing that convey external flows across Airport Road. All CSP culverts are approximately 800 mm in diameter.
- The existing road side ditches provide water quality/quantity control to Airport Road runoff before discharging to receiving systems.
- Storm runoff approximately 250m north and south of the Bridge (Norris Bridge) is collected by storm sewers and conveyed to Salt Creek beneath Airport Road.
- Most of the watercourses convey flow through rural or agricultural areas. Some pockets of estate / residential uses are also located adjacent to Airport Road.
- There are five low points located at Airport Road which provide overland flow route to major system runoff.
- There are no storm water management facilities adjacent to the project corridor.

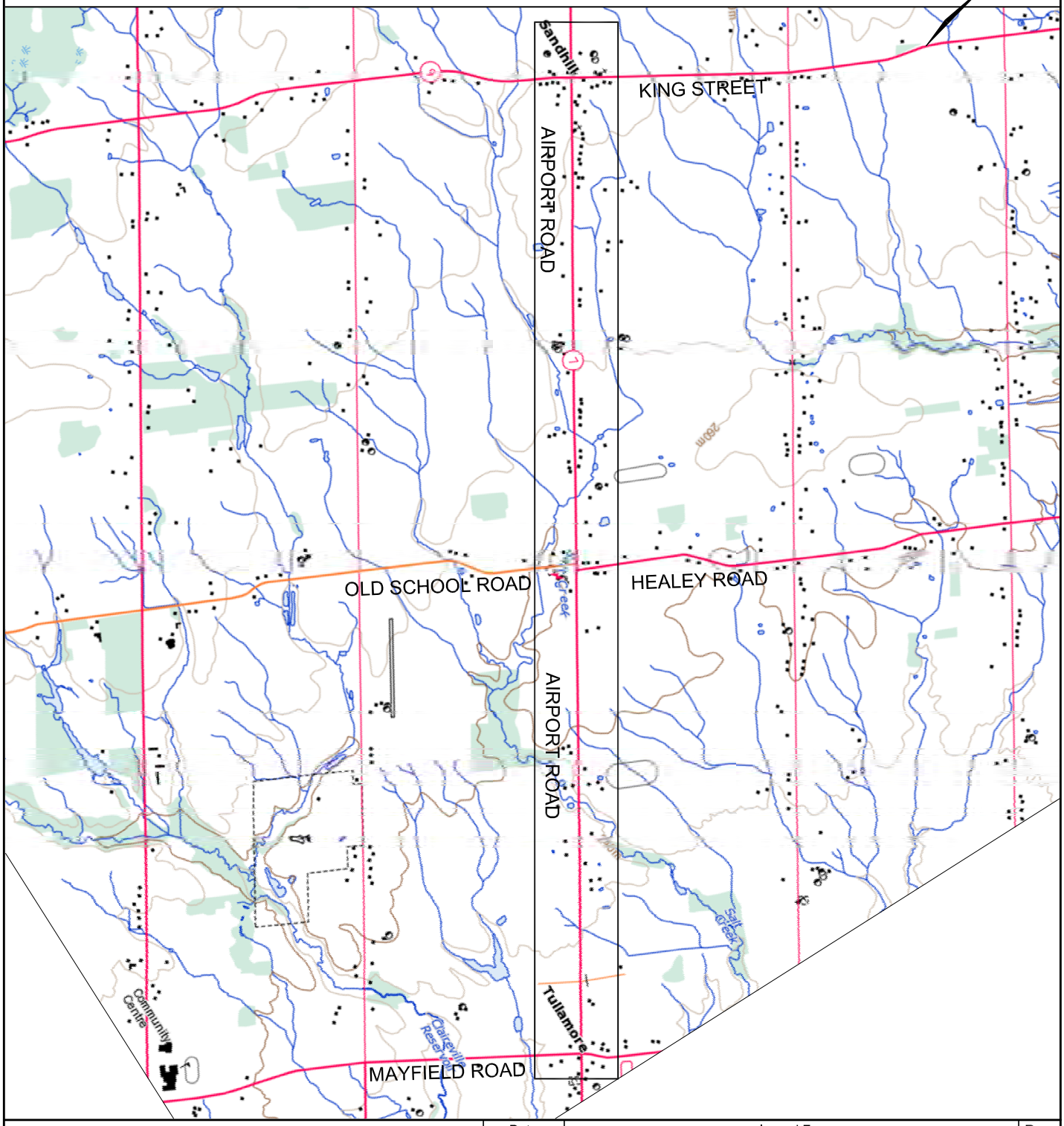
1.3 Proposed Roadway Improvements

As part of Airport Road EA the following preferred improvements were investigated:

Preferred Roadway Improvements

- Widening of Airport Road from approximately 300 m north Mayfield Road to approximately 100 m north of King Street from the 2-lane rural section to a 4-lane urban road plus 5.5m wide central turn lane/median. Typical roadway section are presented in **Appendix E**.
- The section of road immediately east and west of Norris Bridge will require significant grade change to accommodate higher design speeds and the wider road platform.
- Widening and reconstruction of Airport Road will be along the existing centreline alignment and improvements to road profile grade throughout the study area.
- Roundabouts are recommended at King Street and Old School Road/Healey Road intersections.
- 2.0m wide shoulders are provided on both side between Purdue Court and ± 610m south of King Street.
- 1.5 - 2.0m wide sidewalk are provided on both side between ± 610m south of King Street to the northern end of study limit.
- All residential, commercial, and field driveways will be modified as required to support the proposed road improvements.

AIRPORT ROAD STUDY AREA



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Project AIRPORT ROAD IMPROVEMENTS

Drawing Title
KEY PLAN

Project No.
24RX12.0105

Drawing No.
FIGURE 1

2. SITE DESCRIPTION

2.1 Study Area

Airport Road from 1 km north of Mayfield Road to 0.6 km north of King Street generally features a two lane paved road with wide gravel shoulders and grassy ditches on both sides of the right-of-way. At the intersection with King Street, the right-of-way has been widened and improved to include turning lanes, curbs, and paved shoulders. However, the intersection with Old School Road/Healy Road has not been improved. Airport Road is straight throughout and follows the generally flat topography. The topography rises slightly toward the north and gently undulates at creek crossings.

The landscape on either side of Airport Road is generally characterized by active agricultural fields and meadows that are part of large farm complexes many of which are bounded by post-and-wire fencing. A number of former agricultural properties have been transformed into commercial/industrial properties, some of which still retain early farmhouses. The study corridor also features small pockets homes that occupy small residential lots that were severed from the larger agricultural properties.

In terms of water sources, the study area falls within the Humber River Watershed *(TRCA 2012,The Humber River Watershed).* The headwaters for the Humber River Watershed originate on the Niagara Escarpment and Oak Ridges Moraine and then flow down to Lake Ontario. Overall, this watershed includes 1800 km of waterways and over 600 bodies of water *(TRCA 2012, The Humber River Watershed)*. Several tributaries of the West Humber River are located in close proximity to the Airport Road study area. Salt Creek runs along the length of the study area and crosses Airport Road at three locations.

2.2 Existing Drainage Conditions

The study area is located within the West Humber River Subwatershed, which is part of the Humber River watershed. Salt Creek, a tributary of the West Humber River, and tributaries of Salt Creek cross Airport Road at a number of locations.

Based on a review of Toronto Region Conservation Authority sub-watershed mapping, a total of nine watercourse crossings were identified within the study limits. TRCA mapping is presented in **Appendix F**. However, this report has indentified a total of 12 cross-drainage watercourses. The location of watercourses is shown in **Figure 2**. It is to be noted, the crossing TRCA ID 1 identified north of Mayfield Road, was not determined to be a watercourse by the TRCA. This crossing was removed as part of industrial development at this location.

The general slope of Airport Road, within the project limits, is from north to south, with five low points (sag) at the road.

Salt Creek crossings C2, C6 and C7 convey permanent flows with localized areas of permanent fish habitat and have associated flood plains. Both the TRCA and the MNR consider Salt Creek to be coldwater system and red side dace occupied reach. The other tributary of Salt Creek (i.e. CSP culverts) are currently not classified.

Within the study area, Airport Road is a two-lane, rural roadway, approximately 7.8 meters wide with gravel shoulders varying in width between 2.1 meters to 3.0 meters. In general, the road presently has a rural cross-section throughout the entire length and stormwater is managed through roadside ditches/swales, rather than through storm sewers, and there are no curbs or pedestrian sidewalks with exception of intersections. Roadside ditches/swales run along each side of the road and range from 3-7 metres in width and 0.5 to 2 metres in depth. Corrugated steel pipe (CSP) culverts of varying diameters and lengths convey stormwater under driveways and street entrances on both sides of the road and eventual discharge to the Salt Creek Watershed.

The location of the crossings and drainage catchments, associated with these crossings are illustrated on **Figures 2**. These crossings convey external and roadside ditching across Airport Road. The transverse drainage culverts/structures are labelled as C1 through C13 on **Figure 2**. **Table 1** denotes these tributaries/crossings from 1 to 13, numbered from south to north along Airport Road, and provides details of the hydrologic and physical conditions.

Most of the watercourses convey flow through rural or agricultural areas and some pockets of estate / residential uses are located adjacent to Airport Road.

2.3 Existing Drainage Areas

A review of available topographic, floodplain maps and Ontario base mapping was undertaken to determine drainage boundaries. Based on this assessment, and the combining of the drainage boundaries used in the information provided by the Region, delineations of drainage areas have been made to establish drainage boundaries. **Figure 2** shows location of sub-catchments and associated drainage areas. Roadside ditching has been used at most of the locations to direct drainage to nearest watercourse.

2.4 Existing Drainage Elements

2.4.1 CULVERTS

Currently, there are a total twelve (12) crossings within the study area and are detailed as follows:

Cross Drainage CSP Culverts

Nine CSP culverts currently exist under Airport Road. All CSP culverts are 800 mm in diameter with the exception of culvert C4 which is 500 mm.

Structural Culverts

Deans Culvert (C6)
The structure has a South-North orientation and is located on Airport Road 0.42 km North of Old School Road. The culvert carries 2 lanes of vehicular traffic across the Salt Creek in 1 continuous span with a crossing length of 6.5m and a rise of 2.2m. The deck has a travelled width of 6.8m and an overall width of 19.42m.

Salt Creek Culvert (C7)
The structure has a South-North orientation and is located on Airport Road 0.82 km North of Old School Road. This Culvert carries 2 lanes of vehicular traffic across the Salt Creek in 1 continuous span with a crossing length of 7.2m and a rise of 2.3m. The deck has a travelled width of 6.8m and an overall width of 22.4m.

Norris Bridge (C2)

The Norris Bridge was built in 1955. The structure has a South-North orientation and is located on Airport Road 1.6 km North of Mayfield Road. The Rigid Frame Bridge carries 2 lanes of vehicular traffic across the Salt Creek in 1 continuous span with a crossing length of 10.7m and a maximum clearance of 2.8m. The deck has a travelled width of 6.85m and an overall width of 17.2m.

Table 1 presents a summary of all crossings.

Table 1 - Summary of Existing Culverts / Crossings

Crossing/ Culvert	TRCA ID	Location	Type	Existing Size	Existing Length (m)	Surface Drainage Characteristics
C1	1	0+340	-	-	-	Removed as part on Industrial Development, Flows collected by ditch inlets and conveyed by Storm Sewers
C2	2	1+120 (1.5 km South of Old School Road)	Bridge	10.7 m single span	17.20	Salt Creek
C3	-	1+500	CSP	800mm	19.47	C3 flows are collected by a storm sewer located in the Airport Road east ditch system and conveyed to Norris Bridge Crossing (C2) at Salt Creek
C4	3	2+390	CSP	500mm	20.34	Trib. to Salt Creek
C5	-	2+860	CSP	800mm	19.85	Drainage Ditch
C6	4	3+040 (415 m North of Old School Road)	Open footing culvert	6.5m x 2.2m	19.42	Salt Creek
C7	5	3+440 (815 m North of Old School Road)	Box Culvert	7.15m x 2.3m	22.40	Salt Creek
C8	6	3+940 (1.3 km north of Old School Road)	CSP	800mm	18.56	Trib. to Salt Creek
C9	-	4+180	CSP	800mm	23.44	Drainage Ditch
C10	7	4+750	CSP	800mm	20.02	Trib. to Salt Creek, the culvert is perched at downstream
C11	8	5+450	CSP	800mm	22.00	Trib. to Salt Creek
C12	-	5+610	CSP	800mm	20.88	Drainage Ditch
C13	9	5+780 (105 m north of King Street)	CSP	800mm	23.51	Trib. to Salt Creek

Note: 1. Refer Figure 2 for crossing/culvert location.

2.4.2 STORM SEWERS

Under existing conditions, runoff from Airport Road at Norris Bridge is primarily collected by catchbasins and conveyed to roadside ditches. The size of storm sewers range from 300mm to

450mm.The location of storm sewers including outlet points are shown on **Figure 3**. The storm sewer system is located between station 0+900 and 1+400, and drains storm runoff to Salt Creek. This system include a 450 mm storm sewer that collects crossing C3 at east of Airport Road and conveys flows to Salt Creek Bridge crossing.

2.4.3 DRAINAGE DITCHES

V-shaped roadside ditches currently exist within the study area and eventually drain to Salt Creek system.

2.5 Existing Landuse, Soils and Physiography

The study area includes Airport Road and Healey Road, Old School Road, and King Street intersections. The majority of lands adjacent to these roads are rural in character and include a mix of agricultural fields, historic farmsteads, and recent residential and commercial developments. The sections of land beyond the road rights-of-way are low and wet and/or steeply sloping. The majority of lands beyond the study appeared relatively undisturbed.

The soils within the study limits include Chingacousey clay loam, Peel clay, and Bottom Lands (Hoffman and Richards 1953). Soils throughout the sub-watershed tend to be poorly drained clays and clay tills with relatively low infiltration capacity. As a result of low infiltration within the sub-watershed, and because there are few sources of groundwater discharge from regional aquifers, base flow in the Salt Creek and associated tributaries tends to be low, with even large tributaries often dry in summer months. The upper half of the watershed within the Town of Caledon remains primarily agricultural, while the majority of the lower half of the sub-watershed in Brampton has been or soon will be developed.

The study area is located within the South Slope physiographic region. This physiographic region occupies approximately 2,400 km^2 and extends from the Niagara Escarpment in the west to the Trent River in the east (Chapman and Putnam 1984). The South Slope predominately consists of shallow shale and till plains which slope gently in a southeasterly direction towards Lake Ontario. The topography is mostly subdued and includes low-relief drumlins and moraines.

3. DRAINAGE AND STORMWATER MANAGEMENT ISSUES

In general, the road presently has a rural cross-section throughout the entire length, meaning stormwater is managed through roadside ditches. The Region of Peel is proposing 4 laning configurations from Mayfield Road to King Street from the 2-lane rural section to a 4-lane urban. **Appendix E** presents typical rural and urban cross-sections of the proposed roadway.

Under proposed condition, at urban sections, the quantity of runoff resulting from major storms will be conveyed to existing watercourse crossings as roadway overland flow, while minor flows will be conveyed by storm sewers. At rural sections, both minor and major system flows will continue to be conveyed by roadside ditches/swales.

The proposed improvements will result in an increase in pavement area within the study corridor. Water quality control is required for all new additional paved areas associated with the proposed widening of the road as per Region of Peel objectives.

Most of the CSP culverts do not meet the current design standards/criteria and will require replacement. Under existing conditions, all structural culverts including the bridge have sufficient

capacity to convey the 100 year design storm. However, the Regional storm overtops Airport Road at crossings C2, C6 and C7.

There are no storm water management facilities adjacent to the project corridor.

Due to the nature of this facility (i.e. Airport Road being linear transportation corridor), limited space within the roadway right-of-way, implementation of wet pond will not be feasible for quantity and quality controls. Status of future wet ponds (to be located in surrounding developments) is not known. The implementation timing of future ponds will depend on plan of sub-divisions. Therefore, it was determined that there are only two possible SWM measures available for use, namely bio-swales and oil/grit separator systems.

Under future condition, it is preferred to retain the rural cross-section of the road as much as possible so as to continue with the existing approach of stormwater management. Runoff from the widened foot print of the roadway will be treated through flat bottom road side ditches/bio-swales. The proposed road design focuses on maintaining the grassed boulevard and drainage swales that presently exist.

4. DESIGN CRITERIA

In conformance with the Region of Peel current policies and guidelines, the following design criteria have been adopted in the development of drainage and stormwater management strategies for this project.

Culverts

According to the guidelines of MTO's Directive B-100, the design return period for urban structures with a span less than 6.0 m is 50-year. A structure with a span of over 6 m on an Urban Arterial road should be designed to convey the 100-year design storm at the required freeboard and soffit clearance. The following criterions were applied to evaluate hydraulic performance of the existing culverts.

Freeboard

Clause 1-10.8.2 of the Canadian Highway Bridge and Design Code (CHBDC) recommends a freeboard of 1.0 metre "….from the edge of through traffic lanes to the design high-water level ….." for the design storm. This freeboard is a recommended value although it is recognized that, due to site-specific considerations, it is not always feasible to provide this value.

Vertical Clearance to Soffit

The provision of vertical clearance is typically related to scour and debris. For low vulnerability bridges (rigid frame, internal abutment and slab) and for culverts less than 6.0 m in general, the requirement is a minimum of 0.30 m vertical clearance from the design flood. For structures greater than 6.0 m, the vertical clearance shall not be less than 1.0 m.

Changes in Upstream Water Levels

In accordance with good design practice, any increase in the upstream flood elevation resulting from the construction of a new structure should be kept to a minimum.

The Design target for upstream water level increases is zero. Minor increases may be accepted if:

i. They are contained within the lands owned by the proponent;
ii. The increase is in a valley system in which the flood line does not change appreciably in a horizontal direction;
iii. No structures are impacted by the flood level change;
iv. The increase is contained within municipally owned land or easement;
v. The increase is at the face of the existing structure and does not impact upstream/downstream lands;
vi. Written approval is obtained from the affected landowner.

Storm Sewer System

- Minor drainage system to be sized to convey runoff from a 10 year storm.

Major System Drainage

- Major system flows (i.e. storms in excess of a 10 year event) to be conveyed overland to receiving drainage watercourses.

Water Quality

- Oil/Grit separators are to be designed according to the Ministry of the Environment (MOE) 'Enhanced' Level Of Protection (i.e. 80 percent long-term suspended solid removal);

- Grass Swales are to be designed to meet the following MOE criteria for quality control:

Minimum length of swale:	5 m
Allowable velocity (25 mm 4-hour Chicago Storm):	0.5 m/s
Minimum bottom width of swale:	0.75 m
Maximum flow depth:	0.5m

Town of Caledon IDF curves are to be used for all hydrological analyses.

5. HYDROTECHNICAL ASSESSMENTS

5.1 General

Hydrologic analyses were undertaken to determine peak flow rates at the watercourses which cross Airport Road right-of-way. All watercourses within the study limit are part of Salt Creek watershed.

Hydraulic analyses were conducted to evaluate the performance of existing culverts and to determine appropriate culvert sizes for conveyance of external runoff across Airport according to current design standards.

5.2 Hydrologic Assessment

All surface watercourses contributing flows to Airport Road are located within the jurisdiction of Toronto Region Conservation Authority.

The hydrological analysis undertaken for peak flows was based on Rational Method for all creeks with the exception of Salt Creek Crossings C2, C6 and C7 for which flows were obtained from the HEC-RAS model provided by Toronto Region Conservation Authority. SWMHYMO modelling was used to establish the Regional Storm flows. The input parameters including pervious and impervious drainage areas, runoff coefficient, and catchment length were calculated based on the available topographic and drainage area mapping.

The time of concentration for each subcatchment area was calculated using "Tc Calculator" computer program. The time of concentration for each catchment was determined for flow computations. The input parameters are presented in **Appendix A**. The results of the flow calculations for all crossings are presented in **Table 2**.

5.3 Hydraulic Assessment

5.3.1 CULVERTS

The proposed widening of Airport Road will impact eleven (11) culverts and one (1) bridge crossing. To ensure that the existing culverts/structures have sufficient capacities, the hydraulic evaluation of 11 culverts and the bridge was undertaken. Evaluation was based on design year storm event in accordance with the MTO Design Flood Criteria (adopted by Region of Peel) requirements. Flows to the culverts were calculated using the Rational Method, as summarized in **Table 2**. All existing culverts are CSPs with the exception of Culverts C2, C6 and C7, which are concrete structures. **Table 3** presented results of hydraulic analysis of all existing culverts. As evident from **Table 3**, most of the CSP culverts do not meet current design criteria and will require replacement.

The hydraulic evaluation of existing culverts (non-structural) indicates that all culverts will require replacement due to inadequate hydraulic capacity. The results of proposed culverts sizing analysis are summarized in **Table 4**. The proposed culverts modification details are illustrated on **Figure 5**. The hydraulic assessment details of each culvert for 100 year and Regional storms are presented in **Appendix B**. Four (4) proposed culverts are CSPA while other four Culverts C3, C8 and C11 are concrete pipes.

Table 2
Hydrologic Assessment of Culverts at Aiport Road

Drainage	Catchment	TRCA	Runoff	Catchment	Time of	Time of	2 Year Storm		5 Year Storm		10 Year Storm		25 Year Storm		50 Year Storm		100 Year Storm		Regional Storm
Outlet	Area	ID	Coefficient	Length	Conc.	Conc.	Intensity	Flow	Intensity	Flow	Intensity	Flow	Intensity	Flow	Intensity	Flow	Intensity	Flow	Flow
	No		C	L	T_C	T_C	I_2	Q_2	I_5	Q_5	I_{10}	Q_{10}	I_{25}	Q_{25}	I_{50}	Q_{50}	I_{100}	Q_{100}	QR
			-	m	min	hr	mm/hr	cms	mm/hr	cms	mm/hr	cms	mm/hr	cms	mm/hr	cms	mm/hr	cms	cms
Bridge	2	2						8.76		13.29		16.52		20.73		24.1		27.52	88.51
Culvert 3	3		0.31	460	47.0	0.78	32.09	0.13	44.94	0.19	54.82	0.23	67.07	0.28	76.10	0.32	85.71	0.36	0.56
Culvert 4	4	3	0.28	400	52.4	0.87	29.52	0.45	41.51	0.64	50.56	0.77	61.96	0.95	70.29	1.08	79.18	1.21	2.24
Culvert 5	5		0.40	400	18.0	0.30	61.97	0.42	82.59	0.56	101.23	0.68	120.75	0.81	136.57	0.92	153.10	1.03	0.73
Box Culvert 6	6	4						6.67		10.12		12.58		15.78		18.35		20.95	67.40
Box Culvert 7	7	5						5.88		8.92		11.09		13.92		16.18		18.48	59.44
Culvert 8	8	6	0.28	210	32.5	0.54	41.94	0.07	57.81	0.09	70.74	0.12	85.91	0.14	97.44	0.16	109.63	0.18	0.26
Culvert 9	9		0.27	560	54.4	0.91	28.71	0.24	40.42	0.34	49.21	0.41	60.33	0.50	68.44	0.57	77.10	0.64	1.25
Culvert 10	10	7	0.40	700	51.4	0.86	29.97	0.46	42.11	0.64	51.32	0.78	62.87	0.96	71.32	1.09	80.34	1.23	1.70
Culvert 11	11	8	0.27	160	29.1	0.48	45.35	0.08	62.16	0.11	76.11	0.14	92.17	0.17	104.50	0.19	117.52	0.21	0.31
Culvert 12	12		0.39	90	19.0	0.32	60.05	0.07	80.28	0.09	98.41	0.11	117.59	0.13	133.05	0.15	149.20	0.17	0.14
Culvert 13	13	9	0.39	590	48.5	0.81	31.31	0.13	43.90	0.18	53.53	0.22	65.52	0.27	74.34	0.30	83.74	0.34	0.44

Notes:	Q = 2.778*A*C*I			if C > 0.4, use Bransby Williams Equation															
Town of Caledon IDF	25 Year Storm:			50 Year Storm:		I50 = 3886 / (TC+16)^ 0.9495				10 Year Storm:		I10 = 2221 / (TC+12)^ 0.9080						
	100 Year Storm:			5 Year Storm:		I5 = 1593 / (TC+11)^ 0.8789				2 Year Storm:		I2 = 1070/ (TC+7.85)^ 0.8759						
	CA at Bridge is 1802.45ha			Flows at Bridge, Culver 6 and Culvert 7 are based on TRCA's HEC-RAS model (Transposed)															
	CA at Culvert 6 is 1238.79ha			Culvert 4A flow diverted to Culvert 4				Regional Flow, except Cuvlerts 6 & 7 and Bridge, are based on IBI modeling											

Table 3

Existing Condition - Culvert Design Summary -Design Storm										
Crossing / Structure	**Existing Size**	**u/s Invert**	**d/s Invert**	**Length**	**Design**	**Design**	**Design**	**Design**	**Design**	**Roadway**
	(Dia.)/(spanxrise)	**Existing**	**Existing**	**Existing**	**Return**	**Flow**	**H.W.**	**F.B.**	**V.C.**	**Exist. Elev.**
	(m)				**Period**	**m3/s**	**(m)**	**(m)**	**(m)**	**(m)**
Bridge		236.46	236.23	17.20	100 yr	27.52	238.65	2.05	0.95	240.70
C3	0.8	248.47	248.33	19.47	25 yr	0.28	248.93	0.87	0.29	249.80
C4	0.5	251.49	251.35	20.34	25 yr	0.95	256.96	-3.56	-4.72	253.40
C5	0.8	253.29	253.10	19.85	25 yr	0.81	254.38	0.08	-0.29	254.46
Box Culvert 6	6.5 x 2.2	251.32	251.22	19.42	100 yr	20.95	252.82	1.58	0.68	254.40
Box Culvert 7	7.15 x 2.3	254.10	254.06	22.40	100 yr	18.48	255.79	1.61	0.61	257.40
C8	0.8	261.63	261.46	18.56	25 yr	0.14	262.43	0.37	-0.05	262.80
C9	0.8	263.33	263.31	23.44	25 yr	0.50	264.16	0.64	-0.08	264.80
C10	0.8	266.88	266.82	20.02	25 yr	0.96	268.40	-0.30	-0.77	268.10
C11	0.8	272.32	272.30	22.00	25 yr	0.17	272.77	1.48	0.30	274.25
C12	0.8	273.30	273.11	20.88	25 yr	0.13	273.65	1.05	0.40	274.70
C13	0.8	274.536	274.259	23.51	25 yr	0.27	275.06	0.74	0.23	275.80

Notes: Culverts C3, C4, C5, C8, C9, C10 and C13 do not meet Freeboard Criteria.
Culverts C4 and C10 overtops the road during the design storm.

Table 4

Proposed Condition - Culvert Design Summary -Design Storm									
Crossing / Structure	**Proposed Size**	**u/s Invert**	**d/s Invert**	**Length**	**Design**	**Design**	**Design**	**Design**	**Roadway**
	(Dia.)/(spanxrise)	**Proposed**	**Proposed**	**Proposed**	**Return**	**Flow**	**H.W.**	**F.B.**	**Prop. Elev.**
	(m)				**Period**	**m^3/s**	**(m)**	**(m)**	**(m)**
C2 (Norris Bridge, ID2)	14.46m x3.66m	236.46	236.23	30.00	100 yr	27.52	238.57	2.50	241.07
C3	0.825	248.56	248.26	40.85	50 yr	0.32	249.04	1.06	250.10
C4	1.39x0.970 CSPA	251.56	251.26	43.83	50 yr	1.08	252.35	1.47	253.82
C5	1.39x0.970 CSPA	253.29	253.01	39.69	50 yr	0.92	253.99	1.11	255.10
C6 (Deans Culvert, ID4)	10.67m x 2.13m	251.35	251.19	32.32	100 yr	20.95	252.63	2.10	254.73
C7 (Salt Creek, ID5)	10.67m x 2.13m	254.11	254.05	34.90	100 yr	18.48	255.74	1.76	257.50
C8	0.825	261.81	261.32	53.27	50 yr	0.16	262.14	1.21	263.35
C9	1.39x0.970 CSPA	263.34	263.30	45.44	50 yr	0.57	264.00	1.16	265.16
C10	1.39x0.970 CSPA	266.91	266.79	37.72	50 yr	1.09	267.74	1.09	268.83
C11	0.825	272.34	272.30	42.16	50 yr	0.19	272.73	1.52	274.25
C12	Removed	-	-	-	-	-	-	-	-
C13	0.825	274.64	274.05	49.40	50 yr	0.30	275.11	1.11	276.22

Notes: All Culverts meet 1.0m FB from design storm.

A preliminary hydraulic analysis was undertaken using the HEC-RAS computer model to evaluate crossings C2, C6 and C7. TRCA's base model (HEC-RAS) was extended to incorporate crossing C6 and C7. It is to be noted that the TRCA base model starts at Old School Road crossings and do not include crossings C6 and C7. The base model includes the Norris Bridge crossing. The results of hydraulic analysis are presented below**.** Under existing conditions, the Regional storm overtops Airport Road at crossings C2, C6 and C7. However, all structural culverts (C2, C6 and C7) have enough capacity to convey the 100 year design storm.

Bridge Crossing C2 (Norris Bridge)

TRCA's base model (HEC-RAS) was used to evaluate crossing C2. The results of analysis are presented below**.**

Existing Condition

The existing condition regional flood elevation in the vicinity (i.e. upstream of the crossing) of the crossing is presented in **Table 5**.

Table 5 – Existing Water Surface Elevations Flood Elevations

Crossing	Water Surface Elevation (WSE) at station 7035.443 (m)				
	2 year	25 year	50 year	100 year	Regional
C2 (TRCA ID 2)	238.06	238.47	238.56	238.65	240.92

The top of existing road elevation at the centre line of Airport Road at culvert is approx. 240.7 m. Under current Regional storm condition, the flood elevation at the upstream face of culverts is at 240.92 m, indicates that the flood line is 0.22 m above the top of the roadway; which is less than the maximum allowable ponding depth of 0.30m.

Proposed Condition

Three sizing options were evaluated for the crossing C2. The three options are summarized in **Table 6**.

A detailed hydraulic evaluation was undertaken to assess floodplain associated impacts with the options.

Table 6 – Description of Crossing C2 (TRCA ID 2) Options

Options	Future Crossing Details	Hydraulic Analysis
Option 1	Extend the existing Bridge by 12.7m (6.35m each side)	Meets hydraulic design criteria. Overtopping continues.
Option 2	Replace with a 14.46 m x 3.66 m Con/Span (open footing pre-cast concrete con/span)	Overtopping eliminated. Accommodates 4-lane sections with sidewalks and bike lanes.
Option 3	Retain Existing Bridge (Provide Headwalls) 10.9 m span x 3.3m rise x 17.2m long	Meets hydraulic design criteria. Overtopping continues. Eliminates provision for 2x1.5m Bike Lanes.

The HEC-RAS model was updated for the crossing to reflect the proposed options. The proposed structure was added between the appropriate cross sections. Cross-sections associated with the immediate upstream and downstream stations were adjusted to incorporate the proposed structure to accurately reflect the cross-sectional data and/or structure geometry associated with the new structure.

The hydraulic results of three options are presented in **Table 7**.

Table 7 – Regional Flood Elevations

	Regional Flood Elevation				*Difference to Existing*		
River Station	*Existing*	*Option 1*	*Option 2*	*Option 3*	*Option 1*	*Option 2*	*Option 3*
Upstream (7035.443)	240.92	240.92	240.12	240.92	0.00	-0.80	0.00
Airport Road (7035.442)	*Existing Bridge*	Bridge Extension	New 14.46 m x 3.66 m Con/Span	Retain Existing Bridge by providing headwalls	-	-	
Downstream (7035.441)	239.53	239.51	239.34	239.53	-0.02	-0.19	0.00

Note: Hydraulics of Option 3 is same as the existing condition.

Culvert Crossing C6 (Deans Culvert)

TRCA's base model (HEC-RAS) was extended to incorporate crossing C6. The results of analysis are presented below**.**

Existing Condition

The existing condition regional flood elevation in the vicinity (i.e. upstream of the crossing) of the crossing is presented in **Table 8**.

Table 8 – Existing Water Surface Elevations Flood Elevations

Crossing	Water Surface Elevation (WSE) at station 7035.6 (m)				
	2 year	25 year	50 year	100 year	Regional
C2 (TRCA ID 4)	252.27	252.64	252.73	252.82	254.62

The top of existing road elevation at the centre line of Airport Road at culvert is approx. 254.4 m. Under current Regional storm condition, the flood elevation at the upstream face of culverts is at 254.62m, indicates that the flood line is 0.22 m above the top of the roadway; which is less than the maximum allowable ponding depth of 0.30m.

Proposed Condition

Three sizing options were considered for the crossing C6. A detailed hydraulic evaluation was undertaken to assess floodplain impacts associated with Options 1 and 2. Option 3 did not require modeling as it was similar to the existing condition scenario. The three options that were assessed for the crossing are summarized in **Table 9**.

Table 9 – Description of Crossing C6 (TRCA ID 4) Options

Options	Future Crossing Details	Hydraulic Analysis
Option 1	Extend the existing culvert by 12.2m (6.1m each side)	Meets hydraulic design criteria. Overtopping continues.
Option 2	Replace with a 10.668m x 2.134m open footing pre-cast concrete culvert	Overtopping eliminated. Accommodates 4-lane sections with sidewalks and bike lanes.
Option 3	Retain Existing Culvert (Provide Headwalls) 6.5 m span x 2.2m rise x 19.42m length	Meets hydraulic design criteria. Overtopping continues. Eliminates provision for one 1.5 m wide Bike Lane.

The HEC-RAS base model was extended upstream of TRCA's base model to include upstream crossings to reflect the proposed options. The proposed options were added between the appropriate cross sections. Cross-sections associated with the immediate upstream and downstream stations were adjusted to incorporate the proposed structure to accurately reflect the cross-sectional data and/or structure geometry associated with the new structure.

The hydraulic results of three options are summarized in **Table 10**.

Table 10 – Regional Flood Elevations

	Regional Flood Elevation				*Difference to Existing*		
River Station	*Existing (IBI Extended Model)*	*Option 1*	*Option 2*	*Option 3*	*Option 1*	*Option 2*	*Option 3*
Upstream (7035.60)	254.62	254.61	253.49	254.62	-0.01	-1.13	0.00
Airport Road (7035.595)	*Existing Culvert*	Extended existing culvert	New 10.668m x 2.134m OF	Retain Existing culvert by providing headwalls	-	-	
Downstream (7035.59)	253.42	253.22	253.35	253.22	-0.20	-0.07	0.00

Note: Hydraulics of Option 3 is same as the existing condition.

Culvert Crossing C7 (Salt Creek Culvert)

TRCA's base model (HEC-RAS) was extended to incorporate crossing C7. The results of analysis are presented below**.**

Existing Condition

The existing condition regional flood elevation in the vicinity (i.e. upstream of the crossing) of the crossing is presented in **Table 11**.

Table 11 – Existing Water Surface Elevations Flood Elevations

Crossing	**Water Surface Elevation (WSE) at station 7035.63 (m)**				
	2 year	25 year	50 year	100 year	Regional
C7 (TRCA ID 5)	255.15	255.6	255.7	255.79	257.27

The top of existing road elevation at the centre line of Airport Road at culvert is approx. 257.03 m. Under current Regional storm condition, the flood elevation at the upstream face of culverts is at 257.27m, indicates that the flood line is 0.24 m above the top of the roadway; which is less than the maximum allowable ponding depth of 0.30m.

Proposed Condition

Three options were evaluated for the crossing C7. A detailed hydraulic evaluation was undertaken to assess floodplain impacts associated Options 1 and 2. Option 3 did not require modeling as it was similar to the existing condition scenario. The three scenarios that were assessed for the crossing are summarized in **Table 12**.

Table 12 – Crossing C7 (TRCA ID 5) Options

Options	Future Crossing Details	Hydraulic Analysis
Option 1	Extend the existing culvert by 12.1m (6.05m each side)	Meets design criteria. Overtopping of the Regional Storm continues.
Option 2	Replace the existing culvert with a 10.668 m x 2.134 m x 22.4m open footing pre-cast concrete culvert	Overtopping eliminated. Accommodates 4-lane sections with sidewalks and bike lanes.
Option 3	Retain the existing culvert (7.15m x 2.3m x 22.4m concrete arch)	Meets design criteria. Overtopping of the Regional Storm continues. The culvert is long enough to accommodate a 20.50m wide roadway section.

The HEC-RAS base model was extended upstream of TRCA's base model to include upstream crossings to reflect the proposed options. The proposed options were added between the appropriate cross sections. Cross-sections associated with the immediate upstream and downstream stations were adjusted to incorporate the proposed structure to accurately reflect the cross-sectional data and/or structure geometry associated with the new structure.

The hydraulic results of three options are summarized in **Table 13**.

Table 13 – Regional Flood Elevations

	Regional Flood Elevation				*Difference to Existing*		
River Station	*Existing (IBI Extended Model)*	*Option 1*	*Option 2*	*Option 3*	*Option 1*	*Option 2*	*Option 3*
Upstream (7035.63)	257.27	257.27	256.48	257.27	0.00	-0.79	0.00
Airport Road (7035.625)	Existing Culvert	Extend Existing Culvert	New 10.668m x 2.134m OF	Existing Culvert with Headwalls	-	-	
Downstream (7035.62)	256.57	256.56	256.42	256.57	-0.01	-0.15	0.00

Note: Hydraulics of Option 3 is same as the existing condition.

5.3.2 SUMMARY

As can be seen in **Tables 14**, the Option 2 eliminates overtopping completely at all three crossings. Based on the hydraulic results presented in above tables, it can be concluded that Option 2 performed hydraulically better and able to accommodate a full 4-lane roadway section with provisions of sidewalks and bike lanes.

General arrangement drawings associated with the Option 2 are provided in **Appendix H**.

Table 14 – Proposed Crossing Options

Options	Crossing C2 (TRCA ID2) Norris Bridge	Crossing C6 (TRCA ID4) Deans Culvert	Crossing C7 (TRCA ID5) Salt Creek Culvert	Hydraulic Analysis
Option 1	Extend the existing Bridge by 12.7m (6.35m each side)	Extend the existing culvert by 12.2m (6.1m each side)	Extend the existing culvert by 12.1m (6.05m each side)	Meets hydraulic design criteria. Overtopping continues
Option 2	Replace with a 14.46 m x 3.66 m Con/Span (open footing pre-cast concrete con/span)	Replace with a 10.668m x 2.134m open footing pre-cast concrete culvert	Replace the existing culvert with a 10.668 m x 2.134 m open footing pre-cast concrete culvert	Overtopping eliminated. Accommodates a 4-lane section with sidewalks and bike lanes
Option 3	Retain Existing Bridge (Provide Headwalls) 10.9 m span x 3.3m rise x 17.2m length	Retain Existing Culvert (Provide Headwalls) 6.5 m span x 2.2m rise x 19.42m length	Retain the existing culvert (7.15m x 2.3m x 22.4m concrete arch)-	Meets hydraulic design criteria. Overtopping continues. Eliminates provision for either Sidewalk/Bike Lanes or both. A minimum 20.5 m length is needed to accommodate a full 4-lane section.

For non-structural crossings, existing capacity assessment is provided in **Table 3**. As evident from **Table 3**, most of the CSP culverts will require replacement with bigger diameter pipes. **Table 4** presents recommended culvert sizes.

5.4 Meander Belt Assessment

A Meander Belt / 100 Year Erosion Rate study at the crossing location was conducted by Parish Geomorphic (Airport Road Class EA –Geomorphic Assessment, June 2013). The study is presented in **Appendix G**.

The study recommended that the existing structure opening at Salt Creek, Deans Culvert and the Norris Bridge could be maintained. The existing openings would likely support the long term form and function of each watercourse and limit risk to proposed infrastructure, provided that the channel form is restored at each site. Rather than increasing the structure width at each site, geomorphic function would benefit from improvements to the channel form. This can be achieved through installation of material within the culverts to define the channels and would mitigate both fish passage and sediment transport issues.

The hydraulic openings recommended in Option 2 in **Table 14** are much larger in span than the existing openings recommended to be retained in the meander belt study. The recommended hydraulic openings (Option 2) with increased spans are considered a net improvement. The proposed openings will support the long term form and function of each watercourse. It is recommended, with the replacement of existing structures, the channel form must be restored at each site including installation of appropriate channel materials within the openings to form a stable

natural channel. A qualified geomorphologist will be required to design a natural channel at each site (C2, C6 and C7) during detail design.

6. DESIGN FEATURES OF PROPOSED SWM SYSTEM

6.1 Proposed Drainage System

Roadway Drainage

The Region of Peel is proposing 4 laning configurations with improvements to road profile from approximately 1 km north of Mayfield Road to 0.6 km north of King Street.

The improvements include widening from the 2-lane rural section to a 4-lane road plus 5.5m wide median with left and right turn lanes. The section between approximately 800m south of King Street and 1.2km south of Old School Road will be a rural section with 5.5m wide median with left and right turn lanes, while the remaining section of Airport Road will be urban. Typical roadway sections are presented in **Appendix E**.

The preferred future roadway design is illustrated on the **Figure 5.**

The quantity of runoff resulting from major storms will be conveyed to existing watercourse crossings as overland flow. The general direction of roadway overland flow is shown on **Figure 5**. It is expected that the quantity of runoff from the improved section of the roadway will not result in a significant increase in runoff, and as such, specific techniques to reduce the quantity and rate of runoff are not considered warranted. This is due to the fact that the peak flows generated from the upstream rural catchments are much greater than the peak flows generated from smaller roadway paved areas, which occur earlier. Due to this lagging effect a small increase in the peak flow generated by the roadway does not result in an appreciable increase in the peak flow of the overall hydrograph. However, any minor increases in flows will be offset by proposed flat bottom ditches and enhanced bio-retention swales installed with rock checks.

Minor Drainage System

Roadway drainage from approximately 1.2km south of Old School Road to approximately 450m north of Davis Lane and 800m south of King Street to King Street roundabout will be conveyed by storm sewer systems. While, roadway runoff between 800m south of King Street and 1.2km south of Old School Road will continue to be collected by roadside ditches and will discharge directly to existing watercourse crossings. The storm sewer system at urban sections will be sized to accommodate flows generated within the right-of way with eventual discharge to existing watercourse crossings.

The proposed storm drainage system configuration is shown on **Figure 5**. The drainage infrastructure is detailed on the above drawings. All storm sewers will be designed to meet Region of Peel Standards and provided sufficient capacity to convey the 10-year storm event.

6.2 Water Quality Control Measures

Water quality control is required for all new additional paved areas associated with the proposed widening of the road as per Region of Peel objectives.

A number of stormwater quality control practices were reviewed and assessed for their applicability on this project. Due to the nature of this facility (i.e. linear transportation corridor), limited space

within the roadway right-of-way, it was determined that two possible SWM measures were applicable for use, namely bio-swales (flat bottom and V-ditches) and oil/grit separator systems with a train of treatment including LID measures such as bio-swales.

Best efforts have been made to accommodate the grassed boulevard, landscaped roundabouts and flat bottom ditches and enhanced bio-retention swales.

In general, the road presently has a rural cross-section throughout the entire length, meaning stormwater is managed through roadside ditches. The existing water quality control measures by means of grassed ditches between 800m south of King Street and 1.2km south of Old School Road will be maintained by further enhancing the ditches to flat-bottom bioswales.

At the areas from approximately 1.2km south of Old School Road to approximately 450m north of Davis Lane and 800m south of King Street to King Street roundabout where storm sewers have been proposed, oil and grit separator (OGS) units will be installed in combination with bio-swales.

OGS units are to provide 80% TSS removal and treatment to 90% of the total runoff volume. Filtered water from OGS units will be discharged onto enhanced bio-retention swales containing vegetation and rock checks. Rock check will reduce flow velocity of storm water. Proposed measures will provide enhanced level (level1) of protection

The stormwater management strategy recommended for this project will provide adequate water quality treatments to the project area.

6.2.1 OIL/GRIT SEPARATORS

Four Oil/Grit Separators (OGS) units, two at Norris Bridge (TRCA ID 2), one at Culvert 10 (TRCA ID 7) and one at Culvert 11 (TRCA ID 8) are proposed between Mayfield Road and King Street. The location of the proposed Oil/Grit separators is shown on **Figure 5**. The sizing of OGS units will be based on the 4-lane roadway configuration. The OGS units will be designed to provide Enhanced Level (80% SS removal) of protection. The sizing calculations for the Oil and Grit Separators (OGS) will be completed during detail design.

Additional measures such as enhanced bio-retention swales in conjunction with OGS units are proposed to further enhance the water quality treatment.

6.2.2 GRASSED DITCHES / SWALES

The existing roadside ditches contributing flows to watercourse crossings between 800m south of King Street and 1.2km south of Old School Road will be enhanced to a flat bottom bio-swale. These swales will provide Enhanced Level (80% SS removal) of protection.

Wherever space constraints preclude the option of providing a flat bottom ditch, enhanced V-shaped ditches are provided. **Table 15** provides a summary of the proposed stormwater management features to be implemented throughout the project limit.

Figure 5 shows potential locations where water quality treatment will be provided either through flat bottom bio-swales or through the use of oil-grit separator systems.

Table 15 provides a summary of the proposed stormwater management measures to be implemented throughout the project limit.

A breakdown of road areas proposed to be treated by specific stormwater management measures is summarized below.

Table 15 – Summary of Treatment Measures to Paved Areas

Crossing/ Culvert	TRCA ID	Proposed Crossing Type	Proposed Treatment Measures	Drainage Watershed
C1	1	-	-	Municipal storm sewer system. Current drainage outlet is maintained.
C2	2	Bridge	OGS units and enhance bio-retention swales	Salt Creek
C3	-	Conc. Pipe	Flat Bottom ditch/bio-swale	C3 flows are collected by a storm sewer located in the Airport Road east ditch system and conveyed to Norris Bridge Crossing (C2) at Salt Creek
C4	3	CSPA	Flat Bottom ditch/bio-swale	Trib. to Salt Creek
C5	-	CSPA	Flat Bottom ditch/bio-swale	Drainage Ditch
C6	4	Structure	Flat Bottom ditch/bio-swale	Salt Creek
C7	5	Structure	Flat Bottom ditch/bio-swale	Salt Creek
C8	6	Conc. Pipe	Flat Bottom ditch/bio-swale	Trib. to Salt Creek
C9	-	CSPA	Flat Bottom ditch/bio-swale	Drainage Ditch
C10	7	CSPA	OGS and enhance bio-retention swale	Trib. to Salt Creek, the culvert is perched at downstream
C11	8	Conc. Pipe	OGS and enhance bio-retention swale	Trib. to Salt Creek
C12	-	Removed, flow diverted to C11	-	Drainage Ditch
C13	9	Conc. Pipe	Flat Bottom ditch/bio-swale	Trib. to Salt Creek

7. MITIGATION MEASURES

Mitigation measures for Salt Creek crossings C2, C6, and C7 will be required due to structures replacement and channel modification works at these watercourses. The following mitigation measures are recommended to offset negative impacts of the project on the terrestrial and aquatic features in the vicinity of the crossing.

- Detailed staging drawings, to minimize temporary effects to the watercourse during construction, will be provided in the detailed design stage;

- Water management plans will be developed to facilitate completion of works “in the dry” through the use of by-pass pumping, dam and flume, partial coffer dams or timing of the works during dry conditions in the ephemeral channels;

- An in-water construction timing restriction must be implemented; based on the recommendations provided by the TRCA;

- A detailed restoration plan will be prepared for channel and bank areas associated with the bridge, channel realignment or culvert extensions. The restoration plans will include erosion and sediment control, vegetation strategies, and permanent stabilization measures;

- All culvert replacements will maintain or improve the current hydraulics of the crossings and will be designed to maintain the current watercourse gradient with appropriate embedding to promote fish passage;

- Incorporate habitat diversity into the final structure design (i.e., bank diversity and substrate placement associated with any scour protection requirements);

- All materials and equipment used shall be operated and stored in such a manner that prevents any deleterious substance from entering watercourses, wetlands or other sensitive area;

- Work areas should be delineated with construction fencing to minimize the area of disturbance;

- Where cofferdams are to be employed, dewatering effluent should be treated prior to discharge to receiving watercourse. Dewatering must be discharged in a vegetated area 30 metres from the creek;

- Cofferdams should be constructed using pea gravel bags to isolate the work area and maintain flow;

- Fish isolated by construction activities should be captured and safely released to the watercourse. Fish capture and release to be conducted by fisheries professionals;

- Apply standard sediment and erosion control measures (e.g., silt fence, flow checks, silt curtain, sedimentation basins) consistent with Ontario Provincial Standards and Specifications (OPSS) to ensure no effects to the surface waters. The control measures shall be implemented prior to construction of the work and be maintained during construction and until disturbed areas have been effectively stabilized with permanent vegetation cover;

- All disturbed areas of the work site shall be stabilized and re-vegetated promptly, and/or treated with appropriate erosion protection materials. In riparian and aquatic habitats, all temporarily disturbed areas will be reinstated to original condition upon completion of works;

- Any stockpiled materials shall be stored and stabilized away from the water; and.

- Crossings which are within the TRCA regulated area will require TRCA permits.

8. EROSION AND SEDIMENT CONTROL

8.1 Introduction

If uncontrolled, the construction activity associated with Airport Road improvements could result in increased rates of erosion and sedimentation within and adjacent to the site area and Salt Creek Tributaries drainage systems. Erosion, for the purposes of this discussion, is described as the process whereby soil particles are detached from an exposed surface and transported by water, wind or some other agent. Sedimentation is defined as the deposition of (eroded) particles at a "downstream" point, typically a watercourse. The potential environmental impacts from increased erosion and sedimentation include: degradation of water quality; destruction of fisheries habitat; and, increased flooding potential.

Erosion and sedimentation processes are typically accelerated due to construction activities. Literature indicates that construction activities can increase erosion and sedimentation rates by 2 to 3 orders of magnitude over that expected from a natural forested area. Erosion and sedimentation control are therefore an integral and important component in the design and construction of any project.

8.2 Erosion and Sediment Control Measures

To minimize the potential environmental impacts, the following erosion and sedimentation control practices will serve to guide the design and implementation phase of the Erosion and Sedimentation Control Plan:

- limit size of disturbed area,
- limit duration of soil exposure,
- retain existing vegetation where feasible,
- limit slope length and gradient of disturbed areas,
- preserve overland sheet flow and micro-drainage (avoid concentrated channel flows),
- break and redirect flows to lower gradients,
- design and implement staged stripping,
- prevent disturbance of previously stripped and stabilized parcels, and
- stabilize stripped parcels with temporary vegetative controls.

Appropriate permanent/temporary erosion control measures to be considered in the design and implementation of the Erosion and Sedimentation Control Plan are:

Hydroseeding - One step application of seed and hydraulic slurry with adhesive binder (provides permanent stabilization for moderate to steep slopes).

Seed and Straw Mulch - Alternative two step application that will be applied to provide permanent/temporary vegetative stabilization of disturbed areas.

Mulch (straw, wood etc.) - Used to provide temporary erosion protection of exposed slopes during over-wintering and for disturbed areas inactive for greater than 45 days.

Sod - Utilized to provide quick permanent stabilization of disturbed areas. Applications include lateral ditches with gradients <5% and slopes with steep to moderate grades (i.e. 3% to 5%).

Erosion Control Blanket - Applied as temporary/permanent erosion protection for slopes greater than 2:1 or as a ditch liner. For permanent applications, seed will be applied prior to installation.

Aggregate Stone - Appropriate material, such as rip rap will be used to provide immediate permanent erosion protection of lateral ditches >5% gradient; and along chute/spillways. Geotextile fabric will be applied prior to placement of any aggregate material.

8.3 Sediment Control

The following elements should be included in the sediment control plan:

- provision of a series of temporary interceptor/conveyor ditches to direct runoff to the siltation/stormwater management pond;
- provision of rock or straw bale within drainage swales/ditches; and
- placement of a series of silt control fencing for the interception of sheet flow drainage.

All sediment control measures should not be removed until final stabilization of the site. In addition, any accumulated sediment shall be removed, as part of a maintenance program, from all control measures when accumulation reaches 50% of the height or volume of the control structure.

Environmental Inspection Process - As a component of erosion and sedimentation control, environmental inspections of the construction site will be conducted. Environmental inspections will be conducted to assess the performance of erosion and sedimentation control measures and identify any required maintenance. The frequent inspections will also permit the identification of localized erosion and sedimentation control issues that require site specific attention.

Implementation and Recommendation - A 200 m standby supply of prefabricated silt fence barrier, in addition to silt fence requirements, shall be maintained at the construction site prior to commencement of grading operations and throughout the duration of the contract.

Where interceptor ditches and/or subsurface drains are specified, they shall be constructed prior to commencement of any related cut or fill activities.

Cut and fill earth slopes and ditches, shall be treated with the specified cover material (seed and mulch, seed and erosion control blanket, seed and sod, rip rap, etc.) within 45 days from the commencement of the cut, fill or ditching operation. Commencement of a cut, fill or ditching operation shall be considered to have occurred when the original stabilizing cover has been removed, including grubbing, or has been covered with fill material.

Run-off from the site and stockpiles shall be controlled to the extent possible to minimize sediment entry to the adjacent watercourses.

Where dewatering is required, and where culverts are cleaned by hydraulic means, the effluent shall be discharged in a manner that prevents the entry of sediments to watercourses, or scouring and erosion at the outlet.

All erosion and sediment control measures will be clearly stated in the contract drawings and documents.

Erosion and sediment control plan for the project must adhere to Erosion and Sediment Control (ESC) Guidelines for Urban Construction, December 2006, Greater Golden Horseshoe Area Conservation Authorities.

9. CONCLUSION

This report documents the stormwater management aspects associated with the improvements to Airport Road. It outlines the proposed stormwater management strategy adopted for this project. Hydrological and hydraulic analyses were undertaken to determine the design features of all required drainage elements. A detailed presentation of the features of the recommended stormwater management system is provided. Erosion and sedimentation aspects of the development have been outlined and guidelines for the preparation of an erosion and sediment control plan prescribed.

The following summarizes findings of the stormwater management study completed in support of Airport Road EA:

- Most of the CSP culverts do not meet the current design standards/criteria and will require replacement. All structural culverts including the bridge have a sufficient capacity to convey the 100 year design storm. Under existing conditions, the Regional storm overtops Airport Road at structural crossings C2, C6 and C7.

- Replace Culverts C4, C5, C9, C10 and C13 due to insufficient hydraulic capacity. Replace Culverts C3, C8 and C11 due to physical condition;

- Remove culvert 12 (C12) and divert storm flows into a new storm sewer;

- Replace the existing 7.15 m span Salt Creek culvert (C7) with a 10.67 m single span open footing pre-cast concrete culvert;

- Replace the existing 6.5 m span Deans culvert (C6) with a 10.67 m single span open footing pre-cast concrete culvert;

- Replace the existing 10.9 m single span Norris Bridge (C2) with a 14.46 single span open footing pre-cast Con/Span;

- A natural channel design is required at Norris Bridge, Salt Creek Culvert and Deans Culvert due to the existing structures replacement and provided a stable channel form;

- Most of the existing ditch system from approximately 800m south of King Street to 1.2km south of Old School Road will be enhanced to a bio-swale. Bio-swales will provide water quality treatment to storm runoff before discharging to receiving drainage system;

- At urban sections (from 1.2km south of Old School Road to 450m north of Davis Lane and 800m south of King Street to King Street roundabout) storm sewers will be installed to convey minor system drainage directly to culverts / receiving drainage systems;

- Four units of oil and grit separator (OGS) unit will be installed before storm sewer outfalls to the receiving drainage system in order to provide runoff water quality control. Roadway runoff draining to Culverts C10 and C11, and Norris Bridge will be treated by new oil and grit separators; and

- Sediment and erosion control measures will be installed prior to construction.

APPENDIX A

HYDOLOGIC INPUT PARAMETERS

Project Name: Airport Road
Municipality: Region of Peel
Project No.: 24RX12.0105
Date: 8-Jan-13

Time of Concentration Estimate

Location CULVERT 13

INPUT DATA

Catchment Length (m):	590
Catchment Slope (m/m):	0.017
Watershed Area (ha):	3.76
Rational Method Runoff Coefficient:	0.37

RESULTS

Kirpich Formula

$$t_c = 0.0078 \times L^{0.77} \times S^{-0.38S}$$

Tc= **12.71** min

where:

L = length of channel/ditch from headwater to outlet, ft
S = average watershed slope, ft/ft

Federal Aviation Administration - Airport Method

$$t_c = \frac{3.26 \times (1.1 - C) \times L^{0.5}}{S_w^{0.33}}$$

Tc= **48.52** min

where:

C = rational method runoff coefficient
L = length of overland flow, m
S = surface slope, m/m
C < 0.40

Bransby Williams Formula

$$t_c = \frac{0.057 \times L}{S_w^{0.2} \times A^{0.1}}$$

Tc= **26.49** min

where:

L = gross length of main channel head of basin, m
S = net slope of main channel, %
A = watershed area, ha
C > 0.40

Tc (Average)= **29** min

Project Name: Airport Road
Municipality: Region of Peel
Project No.: 24RX12.0105
Date: 8-Jan-13

Time of Concentration Estimate

Location CULVERT 12

INPUT DATA

Catchment Length (m):	90
Catchment Slope (m/m):	0.017
Watershed Area (ha):	1.05
Rational Method Runoff Coefficient:	0.37

RESULTS

Kirpich Formula

$$t_c = 0.0078 \times L^{0.77} \times S^{-0.38S}$$

Tc= **2.99** min

where:

L = length of channel/ditch from headwater to outlet, ft
S = average watershed slope, ft/ft

Federal Aviation Administration - Airport Method

$$t_c = \frac{3.26 \times (1.1 - C) \times L^{0.5}}{S_w^{0.33}}$$

Tc= **18.95** min

where:

C = rational method runoff coefficient
L = length of overland flow, m
S = surface slope, m/m
C < 0.40

Bransby Williams Formula

$$t_c = \frac{0.057 \times L}{S_w^{0.2} \times A^{0.1}}$$

Tc= **4.59** min

where:

L = gross length of main channel head of basin, m
S = net slope of main channel, %
A = watershed area, ha
C > 0.40

Tc (Average)= **9** min

Project Name: Airport Road
Municipality: Region of Peel
Project No.: 24RX12.0105
Date: 8-Jan-13

Time of Concentration Estimate

Location CULVERT 11

INPUT DATA

Catchment Length (m):	160
Catchment Slope (m/m):	0.017
Watershed Area (ha):	2.4
Rational Method Runoff Coefficient:	0.26

RESULTS

Kirpich Formula

$$t_c = 0.0078 \times L^{0.77} \times S^{-0.38S}$$

Tc= **4.65** min

where:

L = length of channel/ditch from headwater to outlet, ft
S = average watershed slope, ft/ft

Federal Aviation Administration - Airport Method

$$t_c = \frac{3.26 \times (1.1 - C) \times L^{0.5}}{S_w^{0.33}}$$

Tc= **29.07** min

where:

C = rational method runoff coefficient
L = length of overland flow, m
S = surface slope, m/m
C < 0.40

Bransby Williams Formula

$$t_c = \frac{0.057 \times L}{S_w^{0.2} \times A^{0.1}}$$

Tc= **7.51** min

where:

L = gross length of main channel head of basin, m
S = net slope of main channel, %
A = watershed area, ha
C > 0.40

Tc (Average)= **14** min

Project Name: Airport Road
Municipality: Region of Peel
Project No.: 24RX12.0105
Date: 8-Jan-13

Time of Concentration Estimate

Location CULVERT 10

INPUT DATA

Catchment Length (m):	700
Catchment Slope (m/m):	0.017
Watershed Area (ha):	13.73
Rational Method Runoff Coefficient:	0.4

RESULTS

Kirpich Formula

$$t_c = 0.0078 \times L^{0.77} \times S^{-0.38S}$$

Tc= **14.50** min

where:

L = length of channel/ditch from headwater to outlet, ft
S = average watershed slope, ft/ft

Federal Aviation Administration - Airport Method

$$t_c = \frac{3.26 \times (1.1 - C) \times L^{0.5}}{S_w^{0.33}}$$

Tc= **50.68** min

where:

C = rational method runoff coefficient
L = length of overland flow, m
S = surface slope, m/m
C < 0.40

Bransby Williams Formula

$$t_c = \frac{0.057 \times L}{S_w^{0.2} \times A^{0.1}}$$

Tc= **27.61** min

where:

L = gross length of main channel head of basin, m
S = net slope of main channel, %
A = watershed area, ha
C > 0.40

Tc (Average)= **31** min

Project Name: Airport Road
Municipality: Region of Peel
Project No.: 24RX12.0105
Date: 8-Jan-13

Time of Concentration Estimate

Location CULVERT 9

INPUT DATA

Catchment Length (m):	560
Catchment Slope (m/m):	0.017
Watershed Area (ha):	11.06
Rational Method Runoff Coefficient:	0.26

RESULTS

Kirpich Formula

$$t_c = 0.0078 \times L^{0.77} \times S^{-0.38S}$$

Tc= **12.21** min

where:

L = length of channel/ditch from headwater to outlet, ft
S = average watershed slope, ft/ft

Federal Aviation Administration - Airport Method

$$t_c = \frac{3.26 \times (1.1 - C) \times L^{0.5}}{S_w^{0.33}}$$

Tc= **54.39** min

where:

C = rational method runoff coefficient
L = length of overland flow, m
S = surface slope, m/m
C < 0.40

Bransby Williams Formula

$$t_c = \frac{0.057 \times L}{S_w^{0.2} \times A^{0.1}}$$

Tc= **22.57** min

where:

L = gross length of main channel head of basin, m
S = net slope of main channel, %
A = watershed area, ha
C > 0.40

Tc (Average)= **30** min

Project Name: Airport Road
Municipality: Region of Peel
Project No.: 24RX12.0105
Date: 8-Jan-13

Time of Concentration Estimate

Location CULVERT 8 (TRCA ID 6)

INPUT DATA

Catchment Length (m):	210
Catchment Slope (m/m):	0.017
Watershed Area (ha):	2.08
Rational Method Runoff Coefficient:	0.28

RESULTS

Kirpich Formula

$$t_c = 0.0078 \times L^{0.77} \times S^{-0.38S}$$

Tc= **5.74** min

where:

L = length of channel/ditch from headwater to outlet, ft
S = average watershed slope, ft/ft

Federal Aviation Administration - Airport Method

$$t_c = \frac{3.26 \times (1.1 - C) \times L^{0.5}}{S_w^{0.33}}$$

Tc= **32.52** min

where:

C = rational method runoff coefficient
L = length of overland flow, m
S = surface slope, m/m
C < 0.40

Bransby Williams Formula

$$t_c = \frac{0.057 \times L}{S_w^{0.2} \times A^{0.1}}$$

Tc= **10.00** min

where:

L = gross length of main channel head of basin, m
S = net slope of main channel, %
A = watershed area, ha
C > 0.40

Tc (Average)= **16** min

Project Name: Airport Road
Municipality: Region of Peel
Project No.: 24RX12.0105
Date: 8-Jan-13

Time of Concentration Estimate

Location CULVERT 5

INPUT DATA

Catchment Length (m):	400
Catchment Slope (m/m):	0.013
Watershed Area (ha):	6.05
Rational Method Runoff Coefficient:	0.43

RESULTS

Kirpich Formula

$$t_c = 0.0078 \times L^{0.77} \times S^{-0.38S}$$

Tc= **10.45** min

where:

L = length of channel/ditch from headwater to outlet, ft
S = average watershed slope, ft/ft

Federal Aviation Administration - Airport Method

$$t_c = \frac{3.26 \times (1.1 - C) \times L^{0.5}}{S_w^{0.33}}$$

Tc= **40.06** min

where:

C = rational method runoff coefficient
L = length of overland flow, m
S = surface slope, m/m
C < 0.40

Bransby Williams Formula

$$t_c = \frac{0.057 \times L}{S_w^{0.2} \times A^{0.1}}$$

Tc= **18.07** min

where:

L = gross length of main channel head of basin, m
S = net slope of main channel, %
A = watershed area, ha
C > 0.40

Tc (Average)= **23** min

Project Name: Airport Road
Municipality: Region of Peel
Project No.: 24RX12.0105
Date: 8-Jan-13

Time of Concentration Estimate

Location CULVERT 4 (TRCA ID 3)

INPUT DATA

Catchment Length (m):	400
Catchment Slope (m/m):	0.011
Watershed Area (ha):	19.68
Rational Method Runoff Coefficient:	0.27

RESULTS

Kirpich Formula

$$t_c = 0.0078 \times L^{0.77} \times S^{-0.38S}$$

Tc= **11.14** min

where:

L = length of channel/ditch from headwater to outlet, ft
S = average watershed slope, ft/ft

Federal Aviation Administration - Airport Method

$$t_c = \frac{3.26 \times (1.1 - C) \times L^{0.5}}{S_w^{0.33}}$$

Tc= **52.44** min

where:

C = rational method runoff coefficient
L = length of overland flow, m
S = surface slope, m/m
C < 0.40

Bransby Williams Formula

$$t_c = \frac{0.057 \times L}{S_w^{0.2} \times A^{0.1}}$$

Tc= **16.61** min

where:

L = gross length of main channel head of basin, m
S = net slope of main channel, %
A = watershed area, ha
C > 0.40

Tc (Average)= **27** min

Project Name: Airport Road
Municipality: Region of Peel
Project No.: 24RX12.0105
Date: 8-Jan-13

Time of Concentration Estimate

Location CULVERT 3

INPUT DATA

Catchment Length (m):	460
Catchment Slope (m/m):	0.017
Watershed Area (ha):	4.81
Rational Method Runoff Coefficient:	0.3

RESULTS

Kirpich Formula

$$t_c = 0.0078 \times L^{0.77} \times S^{-0.38S}$$

Tc= **10.49** min

where:

L = length of channel/ditch from headwater to outlet, ft
S = average watershed slope, ft/ft

Federal Aviation Administration - Airport Method

$$t_c = \frac{3.26 \times (1.1 - C) \times L^{0.5}}{S_w^{0.33}}$$

Tc= **46.95** min

where:

C = rational method runoff coefficient
L = length of overland flow, m
S = surface slope, m/m
C < 0.40

Bransby Williams Formula

$$t_c = \frac{0.057 \times L}{S_w^{0.2} \times A^{0.1}}$$

Tc= **20.15** min

where:

L = gross length of main channel head of basin, m
S = net slope of main channel, %
A = watershed area, ha
C > 0.40

Tc (Average)= **26** min

Project No.											
Project Decription		Airport Road									
Prepared by											
Checked by											
Date		19-Feb-13									
						Old School Road Crossing			**Bridge/ TRCA ID 2**		
Culvert 6/ TRCA ID 4			**Culvert 7/ TRCA ID 5**			**TRCA HEC-RAS Model**			**TRCA HEC-RAS Model**		
						7035.57	HEC-RAS SECTION		7035.46	HEC-RAS SECTION	
Revised Area	1227.42	hectares	**Revised A**	1038	hectares	**Area =**	1349.4	hectares	**Area =**	1791.08	hectares
	Tranposed			Tranposed							
Storm	Peak Flow (cms)		Storm	Peak Flow (cms)		Storm	Peak Flow (cms)		Storm	Peak Flow (cms)	
2 Year	6.67		2 Year	5.88		2 Year	7.24		2 Year	8.76	
5 Year	10.12		5 Year	8.92		5 Year	10.98		5 Year	13.29	
10 Year	12.58		10 Year	11.09		10 Year	13.65		10 Year	16.52	
25 Year	15.78		25 Year	13.92		25 Year	17.13		25 Year	20.73	
50 Year	18.35		50 Year	16.18		50 Year	19.92		50 Year	24.1	
100 Year	20.95		100 Year	18.48		100 Year	22.74		100 Year	27.52	
Regional	67.40		Regional	59.44		Regional	73.15		Regional	88.51	

APPENDIX B

CULVERT MASTER OUTPUT

EXISTING CONDITION - DESIGN STORM

Culvert Analysis Report
C3 - Existing

Analysis Component			
Storm Event	Design	Discharge	0.2800 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.2800 m³/s	Check Discharge	0.3200 m³/s

Tailwater properties: Trapezoidal Channel

Tailwater conditions for Design Storm.			
Discharge	0.2800 m³/s	Bottom Elevation	248.39 m
Depth	0.38 m	Velocity	0.35 m/s

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-750 mm Circular	0.2800 m³/s	248.93 m	1.01 m/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
C3 - Existing

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	248.93 m	Discharge	0.2800 m³/s
Inlet Control HW Elev.	248.90 m	Tailwater Elevation	248.77 m
Outlet Control HW Elev.	248.93 m	Control Type	Entrance Control
Headwater Depth/Height	0.61		

Grades			
Upstream Invert	248.46 m	Downstream Invert	248.32 m
Length	19.47 m	Constructed Slope	0.006934 m/m

Hydraulic Profile			
Profile	CompositeS1S2	Depth, Downstream	0.44 m
Slope Type	Steep	Normal Depth	0.28 m
Flow Regime	N/A	Critical Depth	0.32 m
Velocity Downstream	1.01 m/s	Critical Slope	0.004281 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	0.76 m
Section Size	750 mm	Rise	0.76 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	248.93 m	Upstream Velocity Head	0.12 m
Ke	0.20	Entrance Loss	0.02 m

Inlet Control Properties			
Inlet Control HW Elev.	248.90 m	Flow Control	N/A
Inlet Type	Groove end projecting	Area Full	0.5 m²
K	0.00450	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	3
C	0.03170	Equation Form	1
Y	0.69000		

Culvert Analysis Report
C4 - Existing

Analysis Component			
Storm Event	Design	Discharge	0.9500 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.9500 m³/s	Check Discharge	1.0800 m³/s

Tailwater properties: Trapezoidal Channel

Tailwater conditions for Design Storm.

Discharge	0.9500 m³/s	Bottom Elevation	251.38 m
Depth	0.72 m	Velocity	0.48 m/s

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-525 mm Circular	0.9500 m³/s	256.96 m	4.25 m/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
C4 - Existing

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	256.96 m	Discharge	0.9500 m³/s
Inlet Control HW Elev.	255.06 m	Tailwater Elevation	252.10 m
Outlet Control HW Elev.	256.96 m	Control Type	Outlet Control
Headwater Depth/Height	10.25		

Grades			
Upstream Invert	251.49 m	Downstream Invert	251.35 m
Length	20.34 m	Constructed Slope	0.006883 m/m

Hydraulic Profile			
Profile	PressureProfile	Depth, Downstream	0.75 m
Slope Type	N/A	Normal Depth	N/A m
Flow Regime	N/A	Critical Depth	0.53 m
Velocity Downstream	4.25 m/s	Critical Slope	0.139378 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	0.53 m
Section Size	525 mm	Rise	0.53 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	256.96 m	Upstream Velocity Head	0.92 m
Ke	0.90	Entrance Loss	0.83 m

Inlet Control Properties			
Inlet Control HW Elev.	255.06 m	Flow Control	Submerged
Inlet Type	Projecting	Area Full	0.2 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
C5 - Existing

Analysis Component			
Storm Event	Design	Discharge	0.8100 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.8100 m³/s	Check Discharge	0.9200 m³/s

Tailwater properties: Trapezoidal Channel

Tailwater conditions for Design Storm.

Discharge	0.8100 m³/s	Bottom Elevation	253.10 m
Depth	0.62 m	Velocity	0.46 m/s

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-750 mm Circular	0.8100 m³/s	254.38 m	2.04 m/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
C5 - Existing

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	254.38 m	Discharge	0.8100 m³/s
Inlet Control HW Elev.	254.29 m	Tailwater Elevation	253.72 m
Outlet Control HW Elev.	254.38 m	Control Type	Outlet Control
Headwater Depth/Height	1.43		

Grades			
Upstream Invert	253.29 m	Downstream Invert	253.10 m
Length	19.85 m	Constructed Slope	0.009521 m/m

Hydraulic Profile			
Profile	CompositeM2PressureProfile	Depth, Downstream	0.62 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.56 m
Velocity Downstream	2.04 m/s	Critical Slope	0.021299 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	0.76 m
Section Size	750 mm	Rise	0.76 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	254.38 m	Upstream Velocity Head	0.16 m
Ke	0.90	Entrance Loss	0.14 m

Inlet Control Properties			
Inlet Control HW Elev.	254.29 m	Flow Control	Transition
Inlet Type	Projecting	Area Full	0.5 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
C8 - Existing

Analysis Component			
Storm Event	Design	Discharge	0.1400 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.1400 m³/s	Check Discharge	0.1600 m³/s

Tailwater properties: Trapezoidal Channel

Tailwater conditions for Design Storm.

Discharge	0.1400 m³/s	Bottom Elevation	262.10 m
Depth	0.31 m	Velocity	0.29 m/s

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-750 mm Circular	0.1400 m³/s	262.43 m	0.31 m/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
C8 - Existing

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	262.43 m	Discharge	0.1400 m³/s
Inlet Control HW Elev.	262.41 m	Tailwater Elevation	262.41 m
Outlet Control HW Elev.	262.43 m	Control Type	Outlet Control
Headwater Depth/Height	1.05		

Grades			
Upstream Invert	261.63 m	Downstream Invert	261.46 m
Length	18.56 m	Constructed Slope	0.009159 m/m

Hydraulic Profile			
Profile	PressureProfile	Depth, Downstream	0.95 m
Slope Type	N/A	Normal Depth	0.25 m
Flow Regime	N/A	Critical Depth	0.22 m
Velocity Downstream	0.31 m/s	Critical Slope	0.014101 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	0.76 m
Section Size	750 mm	Rise	0.76 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	262.43 m	Upstream Velocity Head	0.00 m
Ke	0.90	Entrance Loss	0.00 m

Inlet Control Properties			
Inlet Control HW Elev.	262.41 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	0.5 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
C9 - Existing

Analysis Component			
Storm Event	Design	Discharge	0.5000 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.5000 m³/s	Check Discharge	0.5700 m³/s

Tailwater properties: Trapezoidal Channel

Tailwater conditions for Design Storm.

Discharge	0.5000 m³/s	Bottom Elevation	263.31 m
Depth	0.55 m	Velocity	0.41 m/s

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-750 mm Circular	0.5000 m³/s	264.16 m	1.43 m/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
C9 - Existing

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	264.16 m	Discharge	0.5000 m³/s
Inlet Control HW Elev.	264.03 m	Tailwater Elevation	263.85 m
Outlet Control HW Elev.	264.16 m	Control Type	Outlet Control
Headwater Depth/Height	1.10		

Grades			
Upstream Invert	263.33 m	Downstream Invert	263.31 m
Length	23.44 m	Constructed Slope	0.000853 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.55 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.43 m
Velocity Downstream	1.43 m/s	Critical Slope	0.016520 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	0.76 m
Section Size	750 mm	Rise	0.76 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	264.16 m	Upstream Velocity Head	0.06 m
Ke	0.90	Entrance Loss	0.06 m

Inlet Control Properties			
Inlet Control HW Elev.	264.03 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	0.5 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
C10 - Existing

Analysis Component			
Storm Event	Design	Discharge	0.9600 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.9600 m³/s	Check Discharge	1.0900 m³/s

Tailwater properties: Trapezoidal Channel

Tailwater conditions for Design Storm.			
Discharge	0.9600 m³/s	Bottom Elevation	266.70 m
Depth	0.56 m	Velocity	0.47 m/s

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-750 mm Circular	0.9600 m³/s	268.40 m	2.48 m/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
C10 - Existing

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	268.40 m	Discharge	0.9600 m³/s
Inlet Control HW Elev.	268.09 m	Tailwater Elevation	267.26 m
Outlet Control HW Elev.	268.40 m	Control Type	Outlet Control
Headwater Depth/Height	1.99		

Grades			
Upstream Invert	266.88 m	Downstream Invert	266.82 m
Length	20.02 m	Constructed Slope	0.003047 m/m

Hydraulic Profile			
Profile	CompositeM2PressureProfile	Depth, Downstream	0.60 m
Slope Type	Mild	Normal Depth	N/A m
Flow Regime	Subcritical	Critical Depth	0.60 m
Velocity Downstream	2.48 m/s	Critical Slope	0.024863 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	0.76 m
Section Size	750 mm	Rise	0.76 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	268.40 m	Upstream Velocity Head	0.23 m
Ke	0.90	Entrance Loss	0.20 m

Inlet Control Properties			
Inlet Control HW Elev.	268.09 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	0.5 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
C11 - Existing

Analysis Component			
Storm Event	Design	Discharge	0.1700 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.1700 m³/s	Check Discharge	0.1900 m³/s

Tailwater properties: Trapezoidal Channel

Tailwater conditions for Design Storm.			
Discharge	0.1700 m³/s	Bottom Elevation	272.32 m
Depth	0.30 m	Velocity	0.30 m/s

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-750 mm Circular	0.1700 m³/s	272.77 m	0.95 m/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
C11 - Existing

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	272.77 m	Discharge	0.1700 m³/s
Inlet Control HW Elev.	272.67 m	Tailwater Elevation	272.62 m
Outlet Control HW Elev.	272.77 m	Control Type	Outlet Control
Headwater Depth/Height	0.58		

Grades			
Upstream Invert	272.32 m	Downstream Invert	272.30 m
Length	22.00 m	Constructed Slope	0.000909 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.32 m
Slope Type	Mild	Normal Depth	0.56 m
Flow Regime	Subcritical	Critical Depth	0.25 m
Velocity Downstream	0.95 m/s	Critical Slope	0.014123 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	0.76 m
Section Size	750 mm	Rise	0.76 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	272.77 m	Upstream Velocity Head	0.03 m
Ke	0.90	Entrance Loss	0.02 m

Inlet Control Properties			
Inlet Control HW Elev.	272.67 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	0.5 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
C12 Existing

Analysis Component			
Storm Event	Design	Discharge	0.1300 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.1300 m³/s	Check Discharge	0.1500 m³/s

Tailwater properties: Trapezoidal Channel

Tailwater conditions for Design Storm.

Discharge	0.1300 m³/s	Bottom Elevation	273.10 m
Depth	0.28 m	Velocity	0.29 m/s

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-750 mm Circular	0.1300 m³/s	273.65 m	0.88 m/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
C12 Existing

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	273.65 m	Discharge	0.1300 m³/s
Inlet Control HW Elev.	273.60 m	Tailwater Elevation	273.38 m
Outlet Control HW Elev.	273.65 m	Control Type	Outlet Control
Headwater Depth/Height	0.46		

Grades			
Upstream Invert	273.30 m	Downstream Invert	273.11 m
Length	20.88 m	Constructed Slope	0.009100 m/m

Hydraulic Profile			
Profile	M1	Depth, Downstream	0.27 m
Slope Type	Mild	Normal Depth	0.24 m
Flow Regime	Subcritical	Critical Depth	0.22 m
Velocity Downstream	0.88 m/s	Critical Slope	0.014110 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	0.76 m
Section Size	750 mm	Rise	0.76 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	273.65 m	Upstream Velocity Head	0.06 m
Ke	0.90	Entrance Loss	0.05 m

Inlet Control Properties			
Inlet Control HW Elev.	273.60 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	0.5 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

Culvert Analysis Report
C13 Existing

Analysis Component			
Storm Event	Design	Discharge	0.2700 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.2700 m³/s	Check Discharge	0.3000 m³/s

Tailwater properties: Trapezoidal Channel

Tailwater conditions for Design Storm.

Discharge	0.2700 m³/s	Bottom Elevation	273.11 m
Depth	0.42 m	Velocity	0.35 m/s

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-750 mm Circular	0.2700 m³/s	275.06 m	1.52 m/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
C13 Existing

Component:Culvert-1

Culvert Summary			
Computed Headwater Elevation	275.06 m	Discharge	0.2700 m³/s
Inlet Control HW Elev.	275.00 m	Tailwater Elevation	273.53 m
Outlet Control HW Elev.	275.06 m	Control Type	Outlet Control
Headwater Depth/Height	0.69		

Grades			
Upstream Invert	274.54 m	Downstream Invert	274.26 m
Length	23.51 m	Constructed Slope	0.011782 m/m

Hydraulic Profile			
Profile	M2	Depth, Downstream	0.31 m
Slope Type	Mild	Normal Depth	0.33 m
Flow Regime	Subcritical	Critical Depth	0.31 m
Velocity Downstream	1.52 m/s	Critical Slope	0.014531 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	0.76 m
Section Size	750 mm	Rise	0.76 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	275.06 m	Upstream Velocity Head	0.10 m
Ke	0.90	Entrance Loss	0.09 m

Inlet Control Properties			
Inlet Control HW Elev.	275.00 m	Flow Control	N/A
Inlet Type	Projecting	Area Full	0.5 m²
K	0.03400	HDS 5 Chart	2
M	1.50000	HDS 5 Scale	3
C	0.05530	Equation Form	1
Y	0.54000		

PROPOSED CONDITION- DESIGN STORM

Culvert Analysis Report
C10 <CSPA>

Analysis Component			
Storm Event	Design	Discharge	1.0900 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	1.0900 m³/s	Check Discharge	1.2300 m³/s

Tailwater properties: Trapezoidal Channel

Tailwater conditions for Design Storm.			
Discharge	1.0900 m³/s	Bottom Elevation	266.79 m
Depth	0.60 m	Velocity	0.48 m/s

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-1390 x 970 mm Arch	1.0900 m³/s	267.74 m	1.41 m/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
C10 <CSPA>

Component:Culvert-1

Culvert Summary					
Computed Headwater Elevation	267.74	m	Discharge	1.0900	m³/s
Inlet Control HW Elev.	267.63	m	Tailwater Elevation	267.39	m
Outlet Control HW Elev.	267.74	m	Control Type	Outlet Control	
Headwater Depth/Height	0.86				

Grades					
Upstream Invert	266.91	m	Downstream Invert	266.79	m
Length	37.72	m	Constructed Slope	0.003181	m/m

Hydraulic Profile					
Profile	M2		Depth, Downstream	0.60	m
Slope Type	Mild		Normal Depth	0.78	m
Flow Regime	Subcritical		Critical Depth	0.44	m
Velocity Downstream	1.41	m/s	Critical Slope	0.013319	m/m

Section			
Section Shape	Arch	Mannings Coefficient	0.025
Section Material	Steel and Aluminum Var CR	Span	1.45 m
Section Size	1390 x 970 mm	Rise	0.97 m
Number Sections	1		

Outlet Control Properties					
Outlet Control HW Elev.	267.74	m	Upstream Velocity Head	0.08	m
Ke	0.90		Entrance Loss	0.07	m

Inlet Control Properties					
Inlet Control HW Elev.	267.63	m	Flow Control	Unsubmerged	
Inlet Type	Thin wall projecting		Area Full	1.1	m²
K	0.03400		HDS 5 Chart	34	
M	1.50000		HDS 5 Scale	3	
C	0.04960		Equation Form	1	
Y	0.57000				

Culvert Analysis Report
C11

Analysis Component				
Storm Event	Design	Discharge	0.1900	m³/s

Peak Discharge Method: User-Specified				
Design Discharge	0.1900 m³/s	Check Discharge	0.2100	m³/s

Tailwater properties: Trapezoidal Channel

Tailwater conditions for Design Storm.				
Discharge	0.1900 m³/s	Bottom Elevation	272.30	m
Depth	0.31 m	Velocity	0.31	m/s

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-825 mm Circular	0.1900 m³/s	272.73 m	1.01 m/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
C11

Component:Culvert-1

Culvert Summary					
Computed Headwater Elevation	272.73	m	Discharge	0.1900	m³/s
Inlet Control HW Elev.	272.69	m	Tailwater Elevation	272.61	m
Outlet Control HW Elev.	272.73	m	Control Type	Outlet Control	
Headwater Depth/Height	0.47				

Grades					
Upstream Invert	272.34	m	Downstream Invert	272.30	m
Length	42.16	m	Constructed Slope	0.000949	m/m

Hydraulic Profile					
Profile	M2		Depth, Downstream	0.31	m
Slope Type	Mild		Normal Depth	0.37	m
Flow Regime	Subcritical		Critical Depth	0.25	m
Velocity Downstream	1.01	m/s	Critical Slope	0.004008	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	0.84	m
Section Size	825 mm		Rise	0.84	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	272.73	m	Upstream Velocity Head	0.04	m
Ke	0.20		Entrance Loss	0.01	m

Inlet Control Properties					
Inlet Control HW Elev.	272.69	m	Flow Control	Unsubmerged	
Inlet Type	Groove end projecting		Area Full	0.6	m²
K	0.00450		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	3	
C	0.03170		Equation Form	1	
Y	0.69000				

Culvert Analysis Report
C13

Analysis Component				
Storm Event	Design	Discharge	0.3000	m³/s

Peak Discharge Method: User-Specified				
Design Discharge	0.3000 m³/s	Check Discharge	0.3400	m³/s

Tailwater properties: Trapezoidal Channel

Tailwater conditions for Design Storm.				
Discharge	0.3000 m³/s	Bottom Elevation	274.05	m
Depth	0.44 m	Velocity	0.36	m/s

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-825 mm Circular	0.3000 m³/s	275.11 m	1.03 m/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
C13

Component:Culvert-1

Culvert Summary					
Computed Headwater Elevation	275.11	m	Discharge	0.3000	m³/s
Inlet Control HW Elev.	275.08	m	Tailwater Elevation	274.49	m
Outlet Control HW Elev.	275.11	m	Control Type	Entrance Control	
Headwater Depth/Height	0.56				

Grades					
Upstream Invert	274.64	m	Downstream Invert	274.05	m
Length	49.40	m	Constructed Slope	0.011943	m/m

Hydraulic Profile					
Profile	CompositeS1S2		Depth, Downstream	0.44	m
Slope Type	Steep		Normal Depth	0.24	m
Flow Regime	N/A		Critical Depth	0.32	m
Velocity Downstream	1.03	m/s	Critical Slope	0.004079	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	0.84	m
Section Size	825 mm		Rise	0.84	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	275.11	m	Upstream Velocity Head	0.12	m
Ke	0.20		Entrance Loss	0.02	m

Inlet Control Properties					
Inlet Control HW Elev.	275.08	m	Flow Control	Unsubmerged	
Inlet Type	Groove end w/headwall		Area Full	0.6	m²
K	0.00180		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	2	
C	0.02920		Equation Form	1	
Y	0.74000				

Culvert Analysis Report
C3

Analysis Component				
Storm Event	Design	Discharge	0.3200	m³/s

Peak Discharge Method: User-Specified				
Design Discharge	0.3200 m³/s	Check Discharge	0.3600	m³/s

Tailwater properties: Trapezoidal Channel

Tailwater conditions for Design Storm.				
Discharge	0.3200 m³/s	Bottom Elevation	248.26	m
Depth	0.40 m	Velocity	0.36	m/s

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-825 mm Circular	0.3200 m³/s	249.04 m	1.22 m/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
C3

Component:Culvert-1

Culvert Summary					
Computed Headwater Elevation	249.04	m	Discharge	0.3200	m³/s
Inlet Control HW Elev.	249.02	m	Tailwater Elevation	248.66	m
Outlet Control HW Elev.	249.04	m	Control Type	Entrance Control	
Headwater Depth/Height	0.58				

Grades					
Upstream Invert	248.56	m	Downstream Invert	248.26	m
Length	40.85	m	Constructed Slope	0.007344	m/m

Hydraulic Profile					
Profile	CompositeS1S2		Depth, Downstream	0.40	m
Slope Type	Steep		Normal Depth	0.29	m
Flow Regime	N/A		Critical Depth	0.33	m
Velocity Downstream	1.22	m/s	Critical Slope	0.004102	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	0.84	m
Section Size	825 mm		Rise	0.84	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	249.04	m	Upstream Velocity Head	0.12	m
Ke	0.20		Entrance Loss	0.02	m

Inlet Control Properties					
Inlet Control HW Elev.	249.02	m	Flow Control	Unsubmerged	
Inlet Type	Groove end w/headwall		Area Full	0.6	m²
K	0.00180		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	2	
C	0.02920		Equation Form	1	
Y	0.74000				

Culvert Analysis Report
C4 <CSPA>

Analysis Component			
Storm Event	Design	Discharge	1.0800 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	1.0800 m³/s	Check Discharge	1.2100 m³/s

Tailwater properties: Trapezoidal Channel

Tailwater conditions for Design Storm.			
Discharge	1.0800 m³/s	Bottom Elevation	251.26 m
Depth	0.76 m	Velocity	0.49 m/s

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-1390 x 970 mm Arch	1.0800 m³/s	252.35 m	1.13 m/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
C4 <CSPA>

Component:Culvert-1

Culvert Summary					
Computed Headwater Elevation	252.35	m	Discharge	1.0800	m³/s
Inlet Control HW Elev.	252.27	m	Tailwater Elevation	252.02	m
Outlet Control HW Elev.	252.35	m	Control Type	Outlet Control	
Headwater Depth/Height	0.82				

Grades					
Upstream Invert	251.56	m	Downstream Invert	251.26	m
Length	43.83	m	Constructed Slope	0.006845	m/m

Hydraulic Profile					
Profile	M1		Depth, Downstream	0.76	m
Slope Type	Mild		Normal Depth	0.54	m
Flow Regime	Subcritical		Critical Depth	0.43	m
Velocity Downstream	1.13	m/s	Critical Slope	0.013290	m/m

Section					
Section Shape	Arch		Mannings Coefficient	0.025	
Section Material	Steel and Aluminum Var CR		Span	1.45	m
Section Size	1390 x 970 mm		Rise	0.97	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	252.35	m	Upstream Velocity Head	0.10	m
Ke	0.90		Entrance Loss	0.09	m

Inlet Control Properties					
Inlet Control HW Elev.	252.27	m	Flow Control	Unsubmerged	
Inlet Type	Thin wall projecting		Area Full	1.1	m²
K	0.03400		HDS 5 Chart	34	
M	1.50000		HDS 5 Scale	3	
C	0.04960		Equation Form	1	
Y	0.57000				

Culvert Analysis Report
C5 <CSPA>

Analysis Component			
Storm Event	Design	Discharge	0.9200 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.9200 m³/s	Check Discharge	1.0300 m³/s

Tailwater properties: Trapezoidal Channel

Tailwater conditions for Design Storm.			
Discharge	0.9200 m³/s	Bottom Elevation	253.01 m
Depth	0.66 m	Velocity	0.47 m/s

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-1390 x 970 mm Arch	0.9200 m³/s	253.99 m	1.09 m/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
C5 <CSPA>

Component:Culvert-1

Culvert Summary					
Computed Headwater Elevation	253.99	m	Discharge	0.9200	m³/s
Inlet Control HW Elev.	253.92	m	Tailwater Elevation	253.67	m
Outlet Control HW Elev.	253.99	m	Control Type	Outlet Control	
Headwater Depth/Height	0.73				

Grades					
Upstream Invert	253.29	m	Downstream Invert	253.01	m
Length	39.69	m	Constructed Slope	0.007055	m/m

Hydraulic Profile					
Profile	M1		Depth, Downstream	0.66	m
Slope Type	Mild		Normal Depth	0.48	m
Flow Regime	Subcritical		Critical Depth	0.40	m
Velocity Downstream	1.09	m/s	Critical Slope	0.012858	m/m

Section					
Section Shape	Arch		Mannings Coefficient	0.025	
Section Material	Steel and Aluminum Var CR		Span	1.45	m
Section Size	1390 x 970 mm		Rise	0.97	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	253.99	m	Upstream Velocity Head	0.10	m
Ke	0.90		Entrance Loss	0.09	m

Inlet Control Properties					
Inlet Control HW Elev.	253.92	m	Flow Control	Unsubmerged	
Inlet Type	Thin wall projecting		Area Full	1.1	m²
K	0.03400		HDS 5 Chart	34	
M	1.50000		HDS 5 Scale	3	
C	0.04960		Equation Form	1	
Y	0.57000				

Culvert Analysis Report
C8

Analysis Component					
Storm Event	Design		Discharge	0.1600	m³/s

Peak Discharge Method: User-Specified					
Design Discharge	0.1600	m³/s	Check Discharge	0.1800	m³/s

Tailwater properties: Trapezoidal Channel

Tailwater conditions for Design Storm.					
Discharge	0.1600	m³/s	Bottom Elevation	261.32	m
Depth	0.33	m	Velocity	0.30	m/s

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-825 mm Circular	0.1600 m³/s	262.14 m	0.79 m/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
C8

Component:Culvert-1

Culvert Summary					
Computed Headwater Elevation	262.14	m	Discharge	0.1600	m³/s
Inlet Control HW Elev.	262.12	m	Tailwater Elevation	261.65	m
Outlet Control HW Elev.	262.14	m	Control Type	Entrance Control	
Headwater Depth/Height	0.40				

Grades					
Upstream Invert	261.81	m	Downstream Invert	261.32	m
Length	53.27	m	Constructed Slope	0.009198	m/m

Hydraulic Profile					
Profile	CompositeS1S2		Depth, Downstream	0.33	m
Slope Type	Steep		Normal Depth	0.19	m
Flow Regime	N/A		Critical Depth	0.23	m
Velocity Downstream	0.79	m/s	Critical Slope	0.004012	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	0.84	m
Section Size	825 mm		Rise	0.84	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	262.14	m	Upstream Velocity Head	0.08	m
Ke	0.20		Entrance Loss	0.02	m

Inlet Control Properties					
Inlet Control HW Elev.	262.12	m	Flow Control	Unsubmerged	
Inlet Type	Groove end w/headwall		Area Full	0.6	m²
K	0.00180		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	2	
C	0.02920		Equation Form	1	
Y	0.74000				

Culvert Analysis Report
C9 <CSPA>

Analysis Component			
Storm Event	Design	Discharge	0.5700 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.5700 m³/s	Check Discharge	0.6400 m³/s

Tailwater properties: Trapezoidal Channel

Tailwater conditions for Design Storm.			
Discharge	0.5700 m³/s	Bottom Elevation	263.30 m
Depth	0.58 m	Velocity	0.42 m/s

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-1390 x 970 mm Arch	0.5700 m³/s	264.00 m	0.76 m/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
C9 <CSPA>

Component:Culvert-1

Culvert Summary					
Computed Headwater Elevation	264.00	m	Discharge	0.5700	m³/s
Inlet Control HW Elev.	263.88	m	Tailwater Elevation	263.88	m
Outlet Control HW Elev.	264.00	m	Control Type	Outlet Control	
Headwater Depth/Height	0.69				

Grades					
Upstream Invert	263.34	m	Downstream Invert	263.30	m
Length	45.54	m	Constructed Slope	0.000878	m/m

Hydraulic Profile					
Profile	M2		Depth, Downstream	0.58	m
Slope Type	Mild		Normal Depth	0.77	m
Flow Regime	Subcritical		Critical Depth	0.30	m
Velocity Downstream	0.76	m/s	Critical Slope	0.012219	m/m

Section			
Section Shape	Arch	Mannings Coefficient	0.025
Section Material	Steel and Aluminum Var CR	Span	1.45 m
Section Size	1390 x 970 mm	Rise	0.97 m
Number Sections	1		

Outlet Control Properties					
Outlet Control HW Elev.	264.00	m	Upstream Velocity Head	0.03	m
Ke	0.90		Entrance Loss	0.02	m

Inlet Control Properties					
Inlet Control HW Elev.	263.88	m	Flow Control	Unsubmerged	
Inlet Type	Thin wall projecting		Area Full	1.1	m²
K	0.03400		HDS 5 Chart	34	
M	1.50000		HDS 5 Scale	3	
C	0.04960		Equation Form	1	
Y	0.57000				

PROPOSED CONDITION HYDRAULIC ANALYSIS

100 YEAR AND REGIONAL STORM

Table 5

Proposed Condition - Culvert Design Summary -100 yr Storm									
Crossing / Structure	**Proposed Size**	**u/s Invert**	**d/s Invert**	**Length**	**100yr**	**Design**	**100yr**	**100yr**	**Roadway**
	(Dia.)/(spanxrise)	**Proposed**	**Proposed**	**Proposed**	**Return**	**Flow**	**H.W.**	**F.B.**	**Prop. Elev.**
	(m)				**Period**	**m^3/s**	**(m)**	**(m)**	**(m)**
C2 (Norris Bridge, ID2)	10.9 m span	236.46	236.23	30.00	100 yr	27.52	238.57	2.50	241.07
C3	0.825	248.56	248.26	40.85	100 yr	0.36	249.08	1.02	250.10
C4	1.39x0.970 CSPA	251.56	251.26	43.83	100 yr	1.21	252.42	1.40	253.82
C5	1.39x0.970 CSPA	253.29	253.01	39.69	100 yr	1.03	254.05	1.05	255.10
C6 (Deans Culvert, ID4)	6.5 x 2.2	251.35	251.19	32.32	100 yr	20.95	252.63	2.10	254.73
C7 (Salt Creek, ID5)	7.15 x 2.3	254.11	254.05	34.90	100 yr	18.48	255.74	1.76	257.50
C8	0.825	261.81	261.32	53.27	100 yr	0.18	262.16	1.19	263.35
C9	1.39x0.970 CSPA	263.34	263.30	45.44	100 yr	0.64	264.05	1.11	265.16
C10	1.39x0.970 CSPA	266.91	266.79	37.72	100 yr	1.23	267.81	1.02	268.83
C11	0.825	272.34	272.30	42.16	100 yr	0.21	272.76	1.49	274.25
C12	Removed	-	-	-	-	-	-	-	-
C13	0.825	274.64	274.05	49.40	100 yr	0.34	275.14	1.08	276.22

Notes: All Culverts meet Freeboard Criteria.

Table 6

Proposed Condition - Culvert Design Summary -Regional Storm									
Crossing / Structure	**Proposed Size**	**u/s Invert**	**d/s Invert**	**Length**	**Regional**	**Regional**	**Regional**	**Regional**	**Roadway**
	(Dia.)/(spanxrise)	**Proposed**	**Proposed**	**Proposed**	**Return**	**Flow**	**H.W.**	**F.B.**	**Prop. Elev.**
	(m)				**Period**	**m^3/s**	**(m)**	**(m)**	**(m)**
C2 (Norris Bridge, ID2)	10.9 m span	236.46	236.23	30.00	Regional	88.51	240.12	0.95	241.07
C3	0.825	248.56	248.26	40.85	Regional	0.56	249.22	0.88	250.10
C4	1.39x0.970 CSPA	251.56	251.26	43.83	Regional	2.24	253.36	0.46	253.82
C5	1.39x0.970 CSPA	253.29	253.01	39.69	100 yr	-	254.05	1.05	255.10
C6 (Deans Culvert, ID4)	6.5 x 2.2	251.35	251.19	32.32	Regional	67.39	253.49	1.24	254.73
C7 (Salt Creek, ID5)	7.15 x 2.3	254.11	254.05	34.90	Regional	59.43	256.48	1.02	257.50
C8	0.825	261.81	261.32	53.27	Regional	0.26	262.24	1.11	263.35
C9	1.39x0.970 CSPA	263.34	263.30	45.44	Regional	1.25	264.74	0.42	265.16
C10	1.39x0.970 CSPA	266.91	266.79	37.72	Regional	1.70	268.66	0.17	268.83
C11	0.825	272.34	272.30	42.16	Regional	0.31	272.85	1.40	274.25
C12	Removed	-	-	-	-	-	-	-	-
C13	0.825	274.64	274.05	49.40	Regional	0.44	275.22	1.00	276.22

Notes: None of the Culvert overtops the road during the regional storm.

Culvert Analysis Report
C10 <CSPA>

Analysis Component			
Storm Event	Check	Discharge	1.2300 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	1.0900 m³/s	Check Discharge	1.2300 m³/s

Tailwater properties: Trapezoidal Channel

Tailwater conditions for Check Storm.			
Discharge	1.2300 m³/s	Bottom Elevation	266.79 m
Depth	0.64 m	Velocity	0.50 m/s

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-1390 x 970 mm Arch	1.2300 m³/s	267.81 m	1.50 m/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
C10 <CSPA>

Component:Culvert-1

Culvert Summary					
Computed Headwater Elevation	267.81	m	Discharge	1.2300	m³/s
Inlet Control HW Elev.	267.69	m	Tailwater Elevation	267.43	m
Outlet Control HW Elev.	267.81	m	Control Type	Outlet Control	
Headwater Depth/Height	0.94				

Grades					
Upstream Invert	266.91	m	Downstream Invert	266.79	m
Length	37.72	m	Constructed Slope	0.003181	m/m

Hydraulic Profile					
Profile	M2		Depth, Downstream	0.64	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.47	m
Velocity Downstream	1.50	m/s	Critical Slope	0.013757	m/m

Section			
Section Shape	Arch	Mannings Coefficient	0.025
Section Material	Steel and Aluminum Var CR	Span	1.45 m
Section Size	1390 x 970 mm	Rise	0.97 m
Number Sections	1		

Outlet Control Properties					
Outlet Control HW Elev.	267.81	m	Upstream Velocity Head	0.09	m
Ke	0.90		Entrance Loss	0.08	m

Inlet Control Properties					
Inlet Control HW Elev.	267.69	m	Flow Control	N/A	
Inlet Type	Thin wall projecting		Area Full	1.1	m²
K	0.03400		HDS 5 Chart	34	
M	1.50000		HDS 5 Scale	3	
C	0.04960		Equation Form	1	
Y	0.57000				

Culvert Analysis Report
C10 <Regional>

Overtopping Analysis

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-825 mm Circular	1.7000 m³/s	268.66 m	3.24 m/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
C10 <Regional>

Component:Culvert-1

Culvert Summary					
Computed Headwater Elevation	268.66	m	Discharge	1.7000	m³/s
Inlet Control HW Elev.	268.44	m	Tailwater Elevation	267.54	m
Outlet Control HW Elev.	268.66	m	Control Type	Outlet Control	
Headwater Depth/Height	2.09				

Grades					
Upstream Invert	266.91	m	Downstream Invert	266.79	m
Length	37.72	m	Constructed Slope	0.003181	m/m

Hydraulic Profile					
Profile	CompositeM2PressureProfile		Depth, Downstream	0.76	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.76	m
Velocity Downstream	3.24	m/s	Critical Slope	0.011297	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	0.84	m
Section Size	825 mm		Rise	0.84	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	268.66	m	Upstream Velocity Head	0.48	m
Ke	0.20		Entrance Loss	0.10	m

Inlet Control Properties					
Inlet Control HW Elev.	268.44	m	Flow Control	N/A	
Inlet Type	Groove end w/headwall		Area Full	0.6	m²
K	0.00180		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	2	
C	0.02920		Equation Form	1	
Y	0.74000				

Culvert Analysis Report
C11

Analysis Component					
Storm Event	Check		Discharge	0.2100	m³/s

Peak Discharge Method: User-Specified					
Design Discharge	0.1900	m³/s	Check Discharge	0.2100	m³/s

Tailwater properties: Trapezoidal Channel

Tailwater conditions for Check Storm.					
Discharge	0.2100	m³/s	Bottom Elevation	272.30	m
Depth	0.33	m	Velocity	0.32	m/s

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-825 mm Circular	0.2100 m³/s	272.76 m	1.05 m/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
C11

Component:Culvert-1

Culvert Summary					
Computed Headwater Elevation	272.76	m	Discharge	0.2100	m³/s
Inlet Control HW Elev.	272.71	m	Tailwater Elevation	272.63	m
Outlet Control HW Elev.	272.76	m	Control Type	Outlet Control	
Headwater Depth/Height	0.50				

Grades					
Upstream Invert	272.34	m	Downstream Invert	272.30	m
Length	42.16	m	Constructed Slope	0.000949	m/m

Hydraulic Profile					
Profile	M2		Depth, Downstream	0.33	m
Slope Type	Mild		Normal Depth	0.40	m
Flow Regime	Subcritical		Critical Depth	0.27	m
Velocity Downstream	1.05	m/s	Critical Slope	0.004012	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	0.84	m
Section Size	825 mm		Rise	0.84	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	272.76	m	Upstream Velocity Head	0.04	m
Ke	0.20		Entrance Loss	0.01	m

Inlet Control Properties					
Inlet Control HW Elev.	272.71	m	Flow Control	N/A	
Inlet Type	Groove end projecting		Area Full	0.6	m²
K	0.00450		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	3	
C	0.03170		Equation Form	1	
Y	0.69000				

Culvert Analysis Report
C11 <Regional>

Overtopping Analysis

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-825 mm Circular	0.3100 m³/s	272.85 m	1.20 m/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
C11 <Regional>

Component:Culvert-1

Culvert Summary					
Computed Headwater Elevation	272.85	m	Discharge	0.3100	m³/s
Inlet Control HW Elev.	272.79	m	Tailwater Elevation	272.70	m
Outlet Control HW Elev.	272.85	m	Control Type	Outlet Control	
Headwater Depth/Height	0.61				

Grades					
Upstream Invert	272.34	m	Downstream Invert	272.30	m
Length	42.16	m	Constructed Slope	0.000949	m/m

Hydraulic Profile					
Profile	M2		Depth, Downstream	0.40	m
Slope Type	Mild		Normal Depth	0.50	m
Flow Regime	Subcritical		Critical Depth	0.33	m
Velocity Downstream	1.20	m/s	Critical Slope	0.004090	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	0.84	m
Section Size	825 mm		Rise	0.84	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	272.85	m	Upstream Velocity Head	0.06	m
Ke	0.20		Entrance Loss	0.01	m

Inlet Control Properties					
Inlet Control HW Elev.	272.79	m	Flow Control	N/A	
Inlet Type	Groove end projecting		Area Full	0.6	m²
K	0.00450		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	3	
C	0.03170		Equation Form	1	
Y	0.69000				

Culvert Analysis Report
C13

Analysis Component					
Storm Event	Check		Discharge	0.3400	m³/s

Peak Discharge Method: User-Specified					
Design Discharge	0.3000	m³/s	Check Discharge	0.3400	m³/s

Tailwater properties: Trapezoidal Channel

Tailwater conditions for Check Storm.					
Discharge	0.3400	m³/s	Bottom Elevation	274.05	m
Depth	0.46	m	Velocity	0.37	m/s

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-825 mm Circular	0.3400 m³/s	275.14 m	1.09 m/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
C13

Component:Culvert-1

Culvert Summary					
Computed Headwater Elevation	275.14	m	Discharge	0.3400	m³/s
Inlet Control HW Elev.	275.11	m	Tailwater Elevation	274.51	m
Outlet Control HW Elev.	275.14	m	Control Type	Entrance Control	
Headwater Depth/Height	0.60				

Grades					
Upstream Invert	274.64	m	Downstream Invert	274.05	m
Length	49.40	m	Constructed Slope	0.011943	m/m

Hydraulic Profile					
Profile	CompositeS1S2		Depth, Downstream	0.46	m
Slope Type	Steep		Normal Depth	0.26	m
Flow Regime	N/A		Critical Depth	0.34	m
Velocity Downstream	1.09	m/s	Critical Slope	0.004127	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	0.84	m
Section Size	825 mm		Rise	0.84	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	275.14	m	Upstream Velocity Head	0.13	m
Ke	0.20		Entrance Loss	0.03	m

Inlet Control Properties					
Inlet Control HW Elev.	275.11	m	Flow Control	N/A	
Inlet Type	Groove end w/headwall		Area Full	0.6	m²
K	0.00180		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	2	
C	0.02920		Equation Form	1	
Y	0.74000				

Culvert Analysis Report
C13 <Regional>

Overtopping Analysis

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-825 mm Circular	0.4400 m³/s	275.22 m	1.23 m/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
C13 <Regional>

Component:Culvert-1

Culvert Summary					
Computed Headwater Elevation	275.22	m	Discharge	0.4400	m³/s
Inlet Control HW Elev.	275.18	m	Tailwater Elevation	274.57	m
Outlet Control HW Elev.	275.22	m	Control Type	Entrance Control	
Headwater Depth/Height	0.69				

Grades					
Upstream Invert	274.64	m	Downstream Invert	274.05	m
Length	49.40	m	Constructed Slope	0.011943	m/m

Hydraulic Profile					
Profile	CompositeS1S2		Depth, Downstream	0.52	m
Slope Type	Steep		Normal Depth	0.30	m
Flow Regime	N/A		Critical Depth	0.39	m
Velocity Downstream	1.23	m/s	Critical Slope	0.004279	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	0.84	m
Section Size	825 mm		Rise	0.84	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	275.22	m	Upstream Velocity Head	0.15	m
Ke	0.20		Entrance Loss	0.03	m

Inlet Control Properties					
Inlet Control HW Elev.	275.18	m	Flow Control	N/A	
Inlet Type	Groove end w/headwall		Area Full	0.6	m²
K	0.00180		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	2	
C	0.02920		Equation Form	1	
Y	0.74000				

Culvert Analysis Report
C3

Analysis Component					
Storm Event	Check		Discharge	0.3600	m³/s

Peak Discharge Method: User-Specified					
Design Discharge	0.3200	m³/s	Check Discharge	0.3600	m³/s

Tailwater properties: Trapezoidal Channel

Tailwater conditions for Check Storm.					
Discharge	0.3600	m³/s	Bottom Elevation	248.26	m
Depth	0.43	m	Velocity	0.37	m/s

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-825 mm Circular	0.3600 m³/s	249.08 m	1.28 m/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
C3

Component:Culvert-1

Culvert Summary					
Computed Headwater Elevation	249.08	m	Discharge	0.3600	m³/s
Inlet Control HW Elev.	249.05	m	Tailwater Elevation	248.69	m
Outlet Control HW Elev.	249.08	m	Control Type	Entrance Control	
Headwater Depth/Height	0.61				

Grades					
Upstream Invert	248.56	m	Downstream Invert	248.26	m
Length	40.85	m	Constructed Slope	0.007344	m/m

Hydraulic Profile					
Profile	CompositeS1S2		Depth, Downstream	0.43	m
Slope Type	Steep		Normal Depth	0.30	m
Flow Regime	N/A		Critical Depth	0.35	m
Velocity Downstream	1.28	m/s	Critical Slope	0.004154	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	0.84	m
Section Size	825 mm		Rise	0.84	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	249.08	m	Upstream Velocity Head	0.13	m
Ke	0.20		Entrance Loss	0.03	m

Inlet Control Properties					
Inlet Control HW Elev.	249.05	m	Flow Control	N/A	
Inlet Type	Groove end w/headwall		Area Full	0.6	m²
K	0.00180		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	2	
C	0.02920		Equation Form	1	
Y	0.74000				

Culvert Analysis Report
C3 <Regional>

Overtopping Analysis

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-825 mm Circular	0.5600 m³/s	249.22 m	1.54 m/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
C3 <Regional>

Component:Culvert-1

Culvert Summary					
Computed Headwater Elevation	249.22	m	Discharge	0.5600	m³/s
Inlet Control HW Elev.	249.19	m	Tailwater Elevation	248.78	m
Outlet Control HW Elev.	249.22	m	Control Type	Entrance Control	
Headwater Depth/Height	0.79				

Grades					
Upstream Invert	248.56	m	Downstream Invert	248.26	m
Length	40.85	m	Constructed Slope	0.007344	m/m

Hydraulic Profile					
Profile	CompositeS1S2		Depth, Downstream	0.52	m
Slope Type	Steep		Normal Depth	0.39	m
Flow Regime	N/A		Critical Depth	0.45	m
Velocity Downstream	1.54	m/s	Critical Slope	0.004518	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	0.84	m
Section Size	825 mm		Rise	0.84	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	249.22	m	Upstream Velocity Head	0.18	m
Ke	0.20		Entrance Loss	0.04	m

Inlet Control Properties					
Inlet Control HW Elev.	249.19	m	Flow Control	N/A	
Inlet Type	Groove end w/headwall		Area Full	0.6	m²
K	0.00180		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	2	
C	0.02920		Equation Form	1	
Y	0.74000				

Culvert Analysis Report
C4 <CSPA>

Analysis Component					
Storm Event	Check		Discharge	1.2100	m³/s

Peak Discharge Method: User-Specified					
Design Discharge	1.0800	m³/s	Check Discharge	1.2100	m³/s

Tailwater properties: Trapezoidal Channel

Tailwater conditions for Check Storm.					
Discharge	1.2100	m³/s	Bottom Elevation	251.26	m
Depth	0.80	m	Velocity	0.51	m/s

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-1390 x 970 mm Arch	1.2100 m³/s	252.42 m	1.22 m/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
C4 <CSPA>

Component:Culvert-1

Culvert Summary					
Computed Headwater Elevation	252.42	m	Discharge	1.2100	m³/s
Inlet Control HW Elev.	252.33	m	Tailwater Elevation	252.06	m
Outlet Control HW Elev.	252.42	m	Control Type	Outlet Control	
Headwater Depth/Height	0.89				

Grades					
Upstream Invert	251.56	m	Downstream Invert	251.26	m
Length	43.83	m	Constructed Slope	0.006845	m/m

Hydraulic Profile					
Profile	M1		Depth, Downstream	0.80	m
Slope Type	Mild		Normal Depth	0.59	m
Flow Regime	Subcritical		Critical Depth	0.46	m
Velocity Downstream	1.22	m/s	Critical Slope	0.013690	m/m

Section					
Section Shape	Arch		Mannings Coefficient	0.025	
Section Material	Steel and Aluminum Var CR		Span	1.45	m
Section Size	1390 x 970 mm		Rise	0.97	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	252.42	m	Upstream Velocity Head	0.10	m
Ke	0.90		Entrance Loss	0.09	m

Inlet Control Properties					
Inlet Control HW Elev.	252.33	m	Flow Control	N/A	
Inlet Type	Thin wall projecting		Area Full	1.1	m²
K	0.03400		HDS 5 Chart	34	
M	1.50000		HDS 5 Scale	3	
C	0.04960		Equation Form	1	
Y	0.57000				

Culvert Analysis Report
C4 <CSPA> <Regional>

Overtopping Analysis

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-1390 x 970 mm Arch	2.2400 m³/s	253.36 m	2.08 m/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
C4 <CSPA> <Regional>

Component:Culvert-1

Culvert Summary					
Computed Headwater Elevation	253.36	m	Discharge	2.2400	m³/s
Inlet Control HW Elev.	252.82	m	Tailwater Elevation	252.29	m
Outlet Control HW Elev.	253.36	m	Control Type	Outlet Control	
Headwater Depth/Height	1.86				

Grades					
Upstream Invert	251.56	m	Downstream Invert	251.26	m
Length	43.83	m	Constructed Slope	0.006845	m/m

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	1.03	m
Slope Type	N/A		Normal Depth	N/A	m
Flow Regime	N/A		Critical Depth	0.66	m
Velocity Downstream	2.08	m/s	Critical Slope	0.018402	m/m

Section					
Section Shape	Arch		Mannings Coefficient	0.025	
Section Material	Steel and Aluminum Var CR		Span	1.45	m
Section Size	1390 x 970 mm		Rise	0.97	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	253.36	m	Upstream Velocity Head	0.22	m
Ke	0.90		Entrance Loss	0.20	m

Inlet Control Properties					
Inlet Control HW Elev.	252.82	m	Flow Control	N/A	
Inlet Type	Thin wall projecting		Area Full	1.1	m²
K	0.03400		HDS 5 Chart	34	
M	1.50000		HDS 5 Scale	3	
C	0.04960		Equation Form	1	
Y	0.57000				

Culvert Analysis Report
C5 <CSPA>

Analysis Component			
Storm Event	Check	Discharge	1.0300 m³/s

Peak Discharge Method: User-Specified			
Design Discharge	0.9200 m³/s	Check Discharge	1.0300 m³/s

Tailwater properties: Trapezoidal Channel

Tailwater conditions for Check Storm.			
Discharge	1.0300 m³/s	Bottom Elevation	253.01 m
Depth	0.69 m	Velocity	0.49 m/s

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-1390 x 970 mm Arch	1.0300 m³/s	254.05 m	1.17 m/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
C5 <CSPA>

Component:Culvert-1

Culvert Summary					
Computed Headwater Elevation	254.05	m	Discharge	1.0300	m³/s
Inlet Control HW Elev.	253.97	m	Tailwater Elevation	253.70	m
Outlet Control HW Elev.	254.05	m	Control Type	Outlet Control	
Headwater Depth/Height	0.78				

Grades					
Upstream Invert	253.29	m	Downstream Invert	253.01	m
Length	39.69	m	Constructed Slope	0.007055	m/m

Hydraulic Profile					
Profile	M1		Depth, Downstream	0.69	m
Slope Type	Mild		Normal Depth	0.52	m
Flow Regime	Subcritical		Critical Depth	0.42	m
Velocity Downstream	1.17	m/s	Critical Slope	0.013149	m/m

Section					
Section Shape	Arch		Mannings Coefficient	0.025	
Section Material	Steel and Aluminum Var CR		Span	1.45	m
Section Size	1390 x 970 mm		Rise	0.97	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	254.05	m	Upstream Velocity Head	0.10	m
Ke	0.90		Entrance Loss	0.09	m

Inlet Control Properties					
Inlet Control HW Elev.	253.97	m	Flow Control	N/A	
Inlet Type	Thin wall projecting		Area Full	1.1	m²
K	0.03400		HDS 5 Chart	34	
M	1.50000		HDS 5 Scale	3	
C	0.04960		Equation Form	1	
Y	0.57000				

Culvert Analysis Report
C8

Analysis Component					
Storm Event	Check		Discharge	0.1800	m³/s

Peak Discharge Method: User-Specified					
Design Discharge	0.1600	m³/s	Check Discharge	0.1800	m³/s

Tailwater properties: Trapezoidal Channel

Tailwater conditions for Check Storm.					
Discharge	0.1800	m³/s	Bottom Elevation	261.32	m
Depth	0.35	m	Velocity	0.31	m/s

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-825 mm Circular	0.1800 m³/s	262.16 m	0.83 m/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
C8

Component:Culvert-1

Culvert Summary					
Computed Headwater Elevation	262.16	m	Discharge	0.1800	m³/s
Inlet Control HW Elev.	262.14	m	Tailwater Elevation	261.67	m
Outlet Control HW Elev.	262.16	m	Control Type	Entrance Control	
Headwater Depth/Height	0.42				

Grades					
Upstream Invert	261.81	m	Downstream Invert	261.32	m
Length	53.27	m	Constructed Slope	0.009198	m/m

Hydraulic Profile					
Profile	CompositeS1S2		Depth, Downstream	0.35	m
Slope Type	Steep		Normal Depth	0.20	m
Flow Regime	N/A		Critical Depth	0.25	m
Velocity Downstream	0.83	m/s	Critical Slope	0.004008	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	0.84	m
Section Size	825 mm		Rise	0.84	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	262.16	m	Upstream Velocity Head	0.09	m
Ke	0.20		Entrance Loss	0.02	m

Inlet Control Properties					
Inlet Control HW Elev.	262.14	m	Flow Control	N/A	
Inlet Type	Groove end w/headwall		Area Full	0.6	m²
K	0.00180		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	2	
C	0.02920		Equation Form	1	
Y	0.74000				

Culvert Analysis Report
C8 <Regional>

Overtopping Analysis

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-825 mm Circular	0.2600 m³/s	262.24 m	0.97 m/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
C8 <Regional>

Component:Culvert-1

Culvert Summary					
Computed Headwater Elevation	262.24	m	Discharge	0.2600	m³/s
Inlet Control HW Elev.	262.22	m	Tailwater Elevation	261.73	m
Outlet Control HW Elev.	262.24	m	Control Type	Entrance Control	
Headwater Depth/Height	0.51				

Grades					
Upstream Invert	261.81	m	Downstream Invert	261.32	m
Length	53.27	m	Constructed Slope	0.009198	m/m

Hydraulic Profile					
Profile	CompositeS1S2		Depth, Downstream	0.41	m
Slope Type	Steep		Normal Depth	0.24	m
Flow Regime	N/A		Critical Depth	0.30	m
Velocity Downstream	0.97	m/s	Critical Slope	0.004041	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	0.84	m
Section Size	825 mm		Rise	0.84	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	262.24	m	Upstream Velocity Head	0.11	m
Ke	0.20		Entrance Loss	0.02	m

Inlet Control Properties					
Inlet Control HW Elev.	262.22	m	Flow Control	N/A	
Inlet Type	Groove end w/headwall		Area Full	0.6	m²
K	0.00180		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	2	
C	0.02920		Equation Form	1	
Y	0.74000				

Culvert Analysis Report
C9 <CSPA>

Analysis Component					
Storm Event	Check		Discharge	0.6400	m³/s

Peak Discharge Method: User-Specified					
Design Discharge	0.5700	m³/s	Check Discharge	0.6400	m³/s

Tailwater properties: Trapezoidal Channel

Tailwater conditions for Check Storm.					
Discharge	0.6400	m³/s	Bottom Elevation	263.30	m
Depth	0.61	m	Velocity	0.43	m/s

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-1390 x 970 mm Arch	0.6400 m³/s	264.05 m	0.82 m/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
C9 <CSPA>

Component:Culvert-1

Culvert Summary					
Computed Headwater Elevation	264.05	m	Discharge	0.6400	m³/s
Inlet Control HW Elev.	263.91	m	Tailwater Elevation	263.91	m
Outlet Control HW Elev.	264.05	m	Control Type	Outlet Control	
Headwater Depth/Height	0.73				

Grades					
Upstream Invert	263.34	m	Downstream Invert	263.30	m
Length	45.54	m	Constructed Slope	0.000878	m/m

Hydraulic Profile					
Profile	M2		Depth, Downstream	0.61	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.32	m
Velocity Downstream	0.82	m/s	Critical Slope	0.012264	m/m

Section			
Section Shape	Arch	Mannings Coefficient	0.025
Section Material	Steel and Aluminum Var CR	Span	1.45 m
Section Size	1390 x 970 mm	Rise	0.97 m
Number Sections	1		

Outlet Control Properties					
Outlet Control HW Elev.	264.05	m	Upstream Velocity Head	0.03	m
Ke	0.90		Entrance Loss	0.03	m

Inlet Control Properties					
Inlet Control HW Elev.	263.91	m	Flow Control	N/A	
Inlet Type	Thin wall projecting		Area Full	1.1	m²
K	0.03400		HDS 5 Chart	34	
M	1.50000		HDS 5 Scale	3	
C	0.04960		Equation Form	1	
Y	0.57000				

Culvert Analysis Report
C9 <Regional>

Overtopping Analysis

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-825 mm Circular	1.2500 m³/s	264.74 m	2.29 m/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Analysis Report
C9 <Regional>

Component:Culvert-1

Culvert Summary					
Computed Headwater Elevation	264.74	m	Discharge	1.2500	m³/s
Inlet Control HW Elev.	264.45	m	Tailwater Elevation	264.11	m
Outlet Control HW Elev.	264.74	m	Control Type	Outlet Control	
Headwater Depth/Height	1.67				

Grades					
Upstream Invert	263.34	m	Downstream Invert	263.30	m
Length	45.44	m	Constructed Slope	0.000880	m/m

Hydraulic Profile					
Profile	CompositeM2PressureProfile		Depth, Downstream	0.81	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.67	m
Velocity Downstream	2.29	m/s	Critical Slope	0.007266	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	0.84	m
Section Size	825 mm		Rise	0.84	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	264.74	m	Upstream Velocity Head	0.26	m
Ke	0.20		Entrance Loss	0.05	m

Inlet Control Properties					
Inlet Control HW Elev.	264.45	m	Flow Control	N/A	
Inlet Type	Groove end w/headwall		Area Full	0.6	m²
K	0.00180		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	2	
C	0.02920		Equation Form	1	
Y	0.74000				

APPENDIX C

HEC-RAS MODELING

EXISTING CONDITION

Existing Condition												
HEC-RAS Plan: I River: Salt Creek Reach: Reach 6												
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Reach 6	7035.65	REGIONAL	59.44	255.44	257.38	257.38	257.85	0.011954	3.04	20.03	24.22	0.98
Reach 6	7035.65	100 YEAR	18.48	255.44	256.64	256.64	256.95	0.014787	2.46	7.52	12.41	1.01
Reach 6	7035.65	50 YEAR	16.18	255.44	256.59	256.58	256.87	0.014575	2.36	6.84	11.84	0.99
Reach 6	7035.65	25 YEAR	13.92	255.44	256.6	256.51	256.8	0.010309	2	6.96	11.94	0.84
Reach 6	7035.65	10 YEAR	11.09	255.44	256.59	256.42	256.72	0.006757	1.61	6.88	11.87	0.68
Reach 6	7035.65	5 YEAR	8.92	255.44	256.54	256.34	256.64	0.005398	1.4	6.36	11.41	0.6
Reach 6	7035.65	2 YEAR	5.88	255.44	256.4	256.2	256.48	0.004856	1.22	4.84	9.96	0.56
Reach 6	7035.64	REGIONAL	59.44	254.94	257.31		257.34	0.000556	0.83	81.43	66.72	0.23
Reach 6	7035.64	100 YEAR	18.48	254.94	256.07		256.14	0.003565	1.16	15.93	28.3	0.49
Reach 6	7035.64	50 YEAR	16.18	254.94	255.96		256.04	0.004779	1.25	12.92	25.48	0.56
Reach 6	7035.64	25 YEAR	13.92	254.94	255.84		255.94	0.006856	1.38	10.08	22.51	0.66
Reach 6	7035.64	10 YEAR	11.09	254.94	255.67	255.63	255.81	0.012841	1.65	6.72	18.38	0.87
Reach 6	7035.64	5 YEAR	8.92	254.94	255.57	255.57	255.74	0.018054	1.78	5.02	15.89	1.01
Reach 6	7035.64	2 YEAR	5.88	254.94	255.48	255.48	255.61	0.019169	1.64	3.59	13.44	1.01
Reach 6	7035.63	REGIONAL	59.44	254.1	257.27	256.02	257.3	0.000361	1	154.3	141.06	0.19
Reach 6	7035.63	100 YEAR	18.48	254.1	255.79	254.98	255.91	0.001485	1.53	12.09	43.72	0.38
Reach 6	7035.63	50 YEAR	16.18	254.1	255.7	254.91	255.8	0.001381	1.42	11.41	26.02	0.36
Reach 6	7035.63	25 YEAR	13.92	254.1	255.6	254.83	255.68	0.001271	1.3	10.69	21.84	0.34
Reach 6	7035.63	10 YEAR	11.09	254.1	255.46	254.73	255.52	0.00112	1.14	9.69	15.19	0.31
Reach 6	7035.63	5 YEAR	8.92	254.1	255.34	254.64	255.39	0.000981	1.01	8.85	10.27	0.29
Reach 6	7035.63	2 YEAR	5.88	254.1	255.15	254.51	255.18	0.000746	0.79	7.48	9.42	0.25
Reach 6	7035.625		Culvert									
Reach 6	7035.62	REGIONAL	59.44	254.5	256.57	256.36	256.68	0.002109	1.77	73.24	100.66	0.42
Reach 6	7035.62	100 YEAR	18.48	254.5	255.58	255.4	255.88	0.007147	2.42	7.64	19.99	0.75
Reach 6	7035.62	50 YEAR	16.18	254.5	255.51	255.32	255.77	0.006919	2.27	7.12	17.69	0.73
Reach 6	7035.62	25 YEAR	13.92	254.5	255.43	255.24	255.66	0.006786	2.13	6.54	11.36	0.71
Reach 6	7035.62	10 YEAR	11.09	254.5	255.32	255.14	255.51	0.006658	1.93	5.74	10.18	0.69
Reach 6	7035.62	5 YEAR	8.92	254.5	255.22	255.06	255.38	0.006697	1.77	5.03	9.74	0.68
Reach 6	7035.62	2 YEAR	5.88	254.5	255.05	254.92	255.17	0.007132	1.53	3.84	8.86	0.67

Reach 6	7035.61	REGIONAL	67.4	253.12	255.17	255.17	255.72	0.012709	3.28	20.52	19.03	1.01
Reach 6	7035.61	100 YEAR	20.95	253.12	254.82	254.37	254.93	0.003201	1.46	14.33	15.91	0.49
Reach 6	7035.61	50 YEAR	18.35	253.12	254.72	254.3	254.83	0.003269	1.43	12.87	15.09	0.49
Reach 6	7035.61	25 YEAR	15.78	253.12	254.63	254.23	254.72	0.003295	1.38	11.46	14.24	0.49
Reach 6	7035.61	10 YEAR	12.58	253.12	254.49	254.12	254.58	0.003352	1.31	9.61	13.04	0.49
Reach 6	7035.61	5 YEAR	10.12	253.12	254.38	254.03	254.46	0.003331	1.24	8.18	12.04	0.48
Reach 6	7035.61	2 YEAR	6.67	253.12	254.19	253.87	254.25	0.003251	1.1	6.04	10.36	0.46
Reach 6	7035.6	REGIONAL	67.4	251.8	254.62	254.02	254.62	0.000141	0.64	290.6	205.27	0.13
Reach 6	7035.6	100 YEAR	20.95	251.8	252.82	252.82	253.33	0.011948	3.16	6.62	35.37	1
Reach 6	7035.6	50 YEAR	18.35	251.8	252.73	252.73	253.2	0.012213	3.02	6.08	34.38	1
Reach 6	7035.6	25 YEAR	15.78	251.8	252.64	252.64	253.07	0.012847	2.89	5.47	33.02	1
Reach 6	7035.6	10 YEAR	12.58	251.8	252.53	252.53	252.89	0.01329	2.66	4.72	24.48	1
Reach 6	7035.6	5 YEAR	10.12	251.8	252.43	252.43	252.74	0.014156	2.49	4.07	11.86	1
Reach 6	7035.6	2 YEAR	6.67	251.8	252.27	252.27	252.51	0.015588	2.17	3.08	10.86	1.01
Reach 6	7035.595		Culvert									
Reach 6	7035.59	REGIONAL	67.4	251.5	253.22	253.22	253.42	0.005543	2.62	64.6	111.19	0.7
Reach 6	7035.59	100 YEAR	20.95	251.5	252.57	252.57	253.08	0.013079	3.17	6.62	49.83	1
Reach 6	7035.59	50 YEAR	18.35	251.5	252.48	252.48	252.95	0.013469	3.03	6.06	21.07	1
Reach 6	7035.59	25 YEAR	15.78	251.5	252.39	252.39	252.81	0.013763	2.87	5.5	10.32	1
Reach 6	7035.59	10 YEAR	12.58	251.5	252.27	252.27	252.64	0.01459	2.67	4.72	8.41	1
Reach 6	7035.59	5 YEAR	10.12	251.5	252.2	252.18	252.49	0.01324	2.38	4.26	7.93	0.94
Reach 6	7035.59	2 YEAR	6.67	251.5	252.12	252.02	252.28	0.009188	1.8	3.7	7.31	0.76
Reach 6	7035.58	REGIONAL	67.4	251.12	252.98		253.04	0.00153	1.06	63.37	68.18	0.35
Reach 6	7035.58	100 YEAR	20.95	251.12	252.39		252.41	0.001135	0.71	29.51	46.53	0.28
Reach 6	7035.58	50 YEAR	18.35	251.12	252.34		252.37	0.001051	0.67	27.5	44.91	0.27
Reach 6	7035.58	25 YEAR	15.78	251.12	252.29		252.31	0.001007	0.63	24.96	42.79	0.26
Reach 6	7035.58	10 YEAR	12.58	251.12	252.21		252.22	0.00093	0.58	21.69	39.89	0.25
Reach 6	7035.58	5 YEAR	10.12	251.12	252.13		252.15	0.000877	0.54	18.83	37.17	0.24
Reach 6	7035.58	2 YEAR	6.67	251.12	252		252.02	0.000789	0.47	14.34	32.43	0.22
Reach 6	7035.57	REGIONAL	73.15	251	252.67		252.75	0.003877	2.28	87.19	96.66	0.56
Reach 6	7035.57	100 YEAR	22.74	251	252.11		252.17	0.00389	1.74	37.73	79.67	0.53

Reach 6	7035.57	50 YEAR	19.92	251	252.12		252.16	0.002822	1.49	38.52	79.97	0.45
Reach 6	7035.57	25 YEAR	17.13	251	252.05		252.1	0.003117	1.5	33.17	77.91	0.47
Reach 6	7035.57	10 YEAR	13.65	251	251.97		252.02	0.003185	1.44	27.39	73.72	0.47
Reach 6	7035.57	5 YEAR	10.98	251	251.91		251.95	0.00316	1.37	22.61	66.66	0.46
Reach 6	7035.57	2 YEAR	7.24	251	251.79		251.83	0.003034	1.23	15.62	54.76	0.44
Reach 6	7035.56	REGIONAL	73.15	249.8	251.97		252.09	0.003673	2.5	85.06	95.21	0.54
Reach 6	7035.56	100 YEAR	22.74	249.8	251.15		251.3	0.005673	2.27	25.12	50.35	0.62
Reach 6	7035.56	50 YEAR	19.92	249.8	250.95		251.22	0.01082	2.81	16.04	39.32	0.84
Reach 6	7035.56	25 YEAR	17.13	249.8	250.92	250.92	251.14	0.00909	2.53	15.02	37.88	0.76
Reach 6	7035.56	10 YEAR	13.65	249.8	250.83	250.83	251.05	0.009032	2.39	11.84	32.98	0.75
Reach 6	7035.56	5 YEAR	10.98	249.8	250.74	250.74	250.95	0.009394	2.29	9.07	28.05	0.75
Reach 6	7035.56	2 YEAR	7.24	249.8	250.57	250.57	250.78	0.010818	2.15	5.01	18.54	0.78
Reach 6	7035.553	REGIONAL	73.15	248.9	251.99	251.1	251.99	0.000154	0.71	332.68	231.92	0.13
Reach 6	7035.553	100 YEAR	22.74	248.9	251.2	250.03	251.2	0.000075	0.41	175.24	167.99	0.09
Reach 6	7035.553	50 YEAR	19.92	248.9	250.53	249.95	250.71	0.00284	2	11.54	113.27	0.5
Reach 6	7035.553	25 YEAR	17.13	248.9	250.49	249.86	250.63	0.002286	1.76	11.25	110.05	0.45
Reach 6	7035.553	10 YEAR	13.65	248.9	250.28	249.73	250.41	0.002337	1.63	9.7	93.36	0.44
Reach 6	7035.553	5 YEAR	10.98	248.9	250.13	249.62	250.23	0.00229	1.48	8.53	80.64	0.43
Reach 6	7035.553	2 YEAR	7.24	248.9	249.89	249.47	249.96	0.002061	1.22	6.79	61.8	0.39
Reach 6	7035.552		Bridge									
Reach 6	7035.551	REGIONAL	73.15	248.9	251	251	251.04	0.00128	1.59	143.07	151.65	0.35
Reach 6	7035.551	100 YEAR	22.74	248.9	250.09	250.09	250.67	0.012588	3.41	6.95	77.6	1
Reach 6	7035.551	50 YEAR	19.92	248.9	250.06	249.98	250.53	0.010432	3.06	6.79	75.43	0.91
Reach 6	7035.551	25 YEAR	17.13	248.9	250.03	249.89	250.39	0.008574	2.71	6.57	72.53	0.82
Reach 6	7035.551	10 YEAR	13.65	248.9	249.96	249.75	250.22	0.006657	2.3	6.18	67.25	0.71
Reach 6	7035.551	5 YEAR	10.98	248.9	249.89	249.64	250.09	0.005394	1.98	5.77	61.71	0.64
Reach 6	7035.551	2 YEAR	7.24	248.9	249.76	249.46	249.87	0.003833	1.51	4.97	50.83	0.52
Reach 6	7035.55	REGIONAL	73.15	248.9	250.58		250.69	0.003742	2.34	88.42	118.31	0.58
Reach 6	7035.55	100 YEAR	22.74	248.9	249.98		250.07	0.003647	1.72	31.93	69.78	0.53
Reach 6	7035.55	50 YEAR	19.92	248.9	249.92		250.01	0.003686	1.66	28.08	65.17	0.53
Reach 6	7035.55	25 YEAR	17.13	248.9	249.86		249.94	0.0037	1.6	24.3	60.3	0.52
Reach 6	7035.55	10 YEAR	13.65	248.9	249.77		249.85	0.003765	1.51	19.33	53.22	0.52

Reach 6	7035.55	5 YEAR	10.98	248.9	249.69		249.77	0.003832	1.44	15.42	46.91	0.51
Reach 6	7035.55	2 YEAR	7.24	248.9	249.56		249.63	0.004028	1.3	9.72	35.78	0.51
Reach 6	7035.54	REGIONAL	73.15	248.3	250.21		250.25	0.001842	1.75	138.98	183.89	0.4
Reach 6	7035.54	100 YEAR	22.74	248.3	249.65		249.68	0.001536	1.27	55.17	112.61	0.35
Reach 6	7035.54	50 YEAR	19.92	248.3	249.6		249.63	0.001485	1.21	49.69	106.3	0.34
Reach 6	7035.54	25 YEAR	17.13	248.3	249.54		249.57	0.001454	1.16	43.67	98.91	0.33
Reach 6	7035.54	10 YEAR	13.65	248.3	249.45		249.48	0.001424	1.1	35.6	88.02	0.33
Reach 6	7035.54	5 YEAR	10.98	248.3	249.37		249.4	0.001421	1.04	28.85	77.75	0.32
Reach 6	7035.54	2 YEAR	7.24	248.3	249.22		249.25	0.001407	0.94	18.94	59.55	0.31
Reach 6	7035.53	REGIONAL	73.15	248	249.3	249.3	249.57	0.012163	3.53	57.04	95.8	0.99
Reach 6	7035.53	100 YEAR	22.74	248	248.89	248.89	249.07	0.00974	2.45	23	65.83	0.83
Reach 6	7035.53	50 YEAR	19.92	248	248.84	248.84	249.03	0.009885	2.38	20.1	61.2	0.83
Reach 6	7035.53	25 YEAR	17.13	248	248.8	248.8	248.97	0.009607	2.27	17.57	56.85	0.81
Reach 6	7035.53	10 YEAR	13.65	248	248.75	248.73	248.9	0.00888	2.08	14.53	51.16	0.77
Reach 6	7035.53	5 YEAR	10.98	248	248.7	248.67	248.83	0.007792	1.87	12.41	46.75	0.71
Reach 6	7035.53	2 YEAR	7.24	248	248.62	248.56	248.72	0.006098	1.53	9.02	38.73	0.62
Reach 6	7035.52	REGIONAL	73.15	246.7	248.34		248.37	0.001772	1.52	145.76	178.85	0.38
Reach 6	7035.52	100 YEAR	22.74	246.7	247.75		247.78	0.003096	1.49	49.82	125.96	0.47
Reach 6	7035.52	50 YEAR	19.92	246.7	247.7		247.73	0.003294	1.49	43.41	117.37	0.48
Reach 6	7035.52	25 YEAR	17.13	246.7	247.64	247.49	247.68	0.003534	1.48	37.04	108.16	0.49
Reach 6	7035.52	10 YEAR	13.65	246.7	247.57	247.43	247.61	0.003733	1.45	29.67	96.42	0.5
Reach 6	7035.52	5 YEAR	10.98	246.7	247.5	247.39	247.55	0.003953	1.41	23.8	85.92	0.5
Reach 6	7035.52	2 YEAR	7.24	246.7	247.39	247.31	247.44	0.004455	1.36	15.19	67.66	0.52
Reach 6	7035.51	REGIONAL	73.15	245	247.27		247.58	0.007829	3.87	49.8	46.66	0.82
Reach 6	7035.51	100 YEAR	22.74	245	246.51	246.32	246.69	0.005968	2.57	20.7	29.78	0.67
Reach 6	7035.51	50 YEAR	19.92	245	246.44	246.26	246.61	0.005712	2.44	18.79	28.32	0.65
Reach 6	7035.51	25 YEAR	17.13	245	246.37	246.18	246.53	0.005357	2.29	16.91	26.81	0.62
Reach 6	7035.51	10 YEAR	13.65	245	246.25	246.07	246.4	0.005306	2.14	13.86	24.16	0.61
Reach 6	7035.51	5 YEAR	10.98	245	246.15		246.29	0.005145	2	11.52	21.91	0.59
Reach 6	7035.51	2 YEAR	7.24	245	245.99		246.09	0.004694	1.72	8.16	18.19	0.55
Reach 6	7035.5	REGIONAL	80.47	243.7	245.53	245.46	245.86	0.012778	4.27	47.29	46.96	1.01
Reach 6	7035.5	100 YEAR	25.01	243.7	244.92		245.17	0.011557	3.11	20.62	39.67	0.9

Reach 6	7035.5	50 YEAR	21.91	243.7	244.86		245.1	0.011735	3.03	18.22	37.19	0.9
Reach 6	7035.5	25 YEAR	18.84	243.7	244.79		245.03	0.012158	2.96	15.66	34.36	0.9
Reach 6	7035.5	10 YEAR	15.02	243.7	244.71	244.71	244.93	0.011355	2.72	13.14	31.31	0.86
Reach 6	7035.5	5 YEAR	12.08	243.7	244.64	244.64	244.84	0.010982	2.54	10.89	28.32	0.84
Reach 6	7035.5	2 YEAR	7.96	243.7	244.5	244.5	244.68	0.010898	2.27	7.3	22.73	0.81
Reach 6	7035.49	REGIONAL	80.47	242	244.17	243.89	244.4	0.005864	3.34	64.98	64.2	0.72
Reach 6	7035.49	100 YEAR	25.01	242	243.3	243.22	243.52	0.007459	2.68	21.41	36.29	0.75
Reach 6	7035.49	50 YEAR	21.91	242	243.24	243.15	243.44	0.007358	2.57	19.12	34.2	0.74
Reach 6	7035.49	25 YEAR	18.84	242	243.17	243.08	243.36	0.007112	2.44	16.92	32.06	0.72
Reach 6	7035.49	10 YEAR	15.02	242	243.08	242.98	243.25	0.006731	2.25	14.07	29.06	0.69
Reach 6	7035.49	5 YEAR	12.08	242	243.04	242.89	243.17	0.005196	1.93	12.95	27.79	0.6
Reach 6	7035.49	2 YEAR	7.96	242	242.9		243	0.004443	1.62	9.37	23.27	0.54
Reach 6	7035.48	REGIONAL	80.47	240.7	242.19	242.19	242.46	0.016734	4.26	54.68	79.3	1.12
Reach 6	7035.48	100 YEAR	25.01	240.7	241.88		241.98	0.006689	2.31	31.92	67.29	0.68
Reach 6	7035.48	50 YEAR	21.91	240.7	241.83		241.93	0.006565	2.23	28.75	63.77	0.67
Reach 6	7035.48	25 YEAR	18.84	240.7	241.78		241.87	0.006599	2.16	25.2	59.58	0.66
Reach 6	7035.48	10 YEAR	15.02	240.7	241.69		241.79	0.006715	2.06	20.52	53.55	0.66
Reach 6	7035.48	5 YEAR	12.08	240.7	241.57		241.7	0.009427	2.24	14.47	44.56	0.77
Reach 6	7035.48	2 YEAR	7.96	240.7	241.44	241.44	241.58	0.010729	2.14	9.13	34.76	0.79
Reach 6	7035.47	REGIONAL	80.47	239	240.98		241.03	0.002316	1.97	120.04	125.6	0.45
Reach 6	7035.47	100 YEAR	25.01	239	239.99	239.99	240.17	0.011418	2.76	25.37	66.05	0.89
Reach 6	7035.47	50 YEAR	21.91	239	239.95	239.95	240.13	0.011414	2.68	22.52	62.06	0.88
Reach 6	7035.47	25 YEAR	18.84	239	239.9	239.9	240.07	0.010999	2.55	19.95	58.21	0.86
Reach 6	7035.47	10 YEAR	15.02	239	239.84	239.84	240	0.010286	2.36	16.66	52.88	0.82
Reach 6	7035.47	5 YEAR	12.08	239	239.84		239.94	0.006793	1.91	16.5	52.6	0.67
Reach 6	7035.47	2 YEAR	7.96	239	239.79		239.85	0.00415	1.43	14.01	48.15	0.51
Reach 6	7035.46	REGIONAL	88.51	237.7	240.95		240.96	0.000131	0.67	386.11	214.76	0.12
Reach 6	7035.46	100 YEAR	27.52	237.7	239.07		239.1	0.001784	1.38	58.95	102.65	0.38
Reach 6	7035.46	50 YEAR	24.1	237.7	238.96		239	0.002195	1.45	48.2	92.58	0.41
Reach 6	7035.46	25 YEAR	20.73	237.7	238.84		238.9	0.002773	1.52	38.21	82.11	0.46
Reach 6	7035.46	10 YEAR	16.52	237.7	238.69		238.76	0.003958	1.65	26.59	67.94	0.53
Reach 6	7035.46	5 YEAR	13.29	237.7	238.55		238.65	0.005713	1.8	18.26	55.6	0.62
Reach 6	7035.46	2 YEAR	8.76	237.7	238.36	238.36	238.51	0.009818	1.98	9.06	37.54	0.78

Reach 6	7035.45	REGIONAL	88.51	237	240.92		240.93	0.00012	0.74	332.94	160.56	0.12
Reach 6	7035.45	100 YEAR	27.52	237	238.94		238.96	0.000413	0.86	79.12	85.48	0.2
Reach 6	7035.45	50 YEAR	24.1	237	238.82		238.84	0.000431	0.84	69.22	79.83	0.2
Reach 6	7035.45	25 YEAR	20.73	237	238.7		238.72	0.000448	0.82	59.68	73.97	0.2
Reach 6	7035.45	10 YEAR	16.52	237	238.53		238.55	0.000463	0.78	48.1	66.17	0.2
Reach 6	7035.45	5 YEAR	13.29	237	238.4		238.41	0.000465	0.73	39.49	59.72	0.2
Reach 6	7035.45	2 YEAR	8.76	237	238.18		238.2	0.000435	0.63	27.77	49.59	0.19
Reach 6	7035.443	REGIONAL	88.51	237.4	240.92	239.31	240.93	0.000143	0.79	304.35	160.18	0.13
Reach 6	7035.443	100 YEAR	27.52	237.4	238.65	238.28	238.87	0.003827	2.05	13.4	61.8	0.59
Reach 6	7035.443	50 YEAR	24.1	237.4	238.56	238.21	238.75	0.003769	1.94	12.43	56.96	0.57
Reach 6	7035.443	25 YEAR	20.73	237.4	238.47	238.12	238.64	0.0037	1.82	11.42	51.91	0.56
Reach 6	7035.443	10 YEAR	16.52	237.4	238.34	238.02	238.48	0.00359	1.64	10.06	45.1	0.54
Reach 6	7035.443	5 YEAR	13.29	237.4	238.23	237.94	238.35	0.003471	1.49	8.92	39.39	0.52
Reach 6	7035.443	2 YEAR	8.76	237.4	238.06	237.81	238.14	0.00322	1.23	7.1	30.33	0.48
Reach 6	7035.442		Bridge									
Reach 6	7035.441	REGIONAL	88.51	237.4	239.53	239.3	239.63	0.001748	1.95	112.17	108.47	0.43
Reach 6	7035.441	100 YEAR	27.52	237.4	238.42	238.27	238.74	0.007772	2.51	10.96	49.18	0.8
Reach 6	7035.441	50 YEAR	24.1	237.4	238.33	238.2	238.63	0.007903	2.39	10.07	44.78	0.79
Reach 6	7035.441	25 YEAR	20.73	237.4	238.25	238.12	238.51	0.008125	2.27	9.13	40.09	0.79
Reach 6	7035.441	10 YEAR	16.52	237.4	238.13	238.02	238.35	0.008643	2.11	7.82	33.62	0.79
Reach 6	7035.441	5 YEAR	13.29	237.4	238.02	237.94	238.22	0.009236	1.98	6.73	28.21	0.8
Reach 6	7035.441	2 YEAR	8.76	237.4	237.86	237.81	238.02	0.011147	1.77	4.95	19.43	0.83
Reach 6	7035.44	REGIONAL	88.51	236.5	238.95		239.28	0.003771	3.04	55.66	41.51	0.62
Reach 6	7035.44	100 YEAR	27.52	236.5	237.96		238.11	0.003067	1.94	22.04	26	0.51
Reach 6	7035.44	50 YEAR	24.1	236.5	237.86		238.01	0.003052	1.85	19.68	24.54	0.51
Reach 6	7035.44	25 YEAR	20.73	236.5	237.76		237.9	0.003044	1.75	17.29	22.97	0.5
Reach 6	7035.44	10 YEAR	16.52	236.5	237.62		237.74	0.003019	1.62	14.26	20.82	0.49
Reach 6	7035.44	5 YEAR	13.29	236.5	237.5		237.61	0.002989	1.49	11.89	18.96	0.48
Reach 6	7035.44	2 YEAR	8.76	236.5	237.31		237.39	0.002866	1.27	8.51	15.95	0.45

PROPOSED CONDITION

PROPOSED CONDITION - OPTION 2												
HEC-RAS Plan: Option2 River: Salt Creek Reach: Reach 6												
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Reach 6	7035.64	REGIONAL	59.44	254.94	257.04		257.09	0.001086	1.04	64.26	62.49	0.31
Reach 6	7035.64	100 YEAR	18.48	254.94	255.99		256.08	0.005232	1.34	13.8	26.33	0.59
Reach 6	7035.64	50 YEAR	16.18	254.94	255.9		256	0.006558	1.41	11.47	24.02	0.65
Reach 6	7035.64	25 YEAR	13.92	254.94	255.8		255.91	0.008873	1.52	9.15	21.45	0.74
Reach 6	7035.64	10 YEAR	11.09	254.94	255.64	255.63	255.81	0.016106	1.8	6.17	17.61	0.97
Reach 6	7035.64	5 YEAR	8.92	254.94	255.57	255.57	255.74	0.018099	1.78	5.02	15.88	1.01
Reach 6	7035.64	2 YEAR	5.88	254.94	255.48	255.48	255.61	0.019169	1.64	3.59	13.44	1.01
Reach 6	7035.63	REGIONAL	59.44	254.1	256.48	255.89	256.88	0.004067	2.81	21.87	91.75	0.61
Reach 6	7035.63	100 YEAR	18.48	254.1	255.74	254.96	255.83	0.001599	1.34	13.92	32.96	0.35
Reach 6	7035.63	50 YEAR	16.18	254.1	255.65	254.89	255.73	0.001507	1.24	13	22.65	0.34
Reach 6	7035.63	25 YEAR	13.92	254.1	255.56	254.82	255.62	0.001411	1.15	12.09	21.37	0.33
Reach 6	7035.63	10 YEAR	11.09	254.1	255.43	254.72	255.48	0.001243	1.02	10.91	12.33	0.3
Reach 6	7035.63	5 YEAR	8.92	254.1	255.33	254.64	255.37	0.001095	0.9	9.9	10.2	0.28
Reach 6	7035.63	2 YEAR	5.88	254.1	255.15	254.51	255.18	0.000849	0.71	8.26	9.44	0.24
Reach 6	7035.625		Culvert									
Reach 6	7035.62	REGIONAL	59.44	254.5	256.42	256.22	256.57	0.00321	2.07	59.32	85.79	0.51
Reach 6	7035.62	100 YEAR	18.48	254.5	255.62	255.35	255.81	0.005872	1.96	9.45	21.31	0.63
Reach 6	7035.62	50 YEAR	16.18	254.5	255.54	255.29	255.72	0.005902	1.86	8.7	19.08	0.62
Reach 6	7035.62	25 YEAR	13.92	254.5	255.46	255.23	255.62	0.005984	1.76	7.9	11.76	0.62
Reach 6	7035.62	10 YEAR	11.09	254.5	255.34	255.14	255.48	0.006162	1.63	6.8	10.29	0.61
Reach 6	7035.62	5 YEAR	8.92	254.5	255.24	255.06	255.36	0.006456	1.52	5.87	9.85	0.62
Reach 6	7035.62	2 YEAR	5.88	254.5	255.08	254.92	255.17	0.007387	1.36	4.31	9.13	0.63
Reach 6	7035.61	REGIONAL	67.4	253.12	255.69	255.17	255.9	0.003518	2.1	39.4	65.72	0.56
Reach 6	7035.61	100 YEAR	20.95	253.12	254.74	254.37	254.87	0.004021	1.59	13.15	15.25	0.55
Reach 6	7035.61	50 YEAR	18.35	253.12	254.66	254.3	254.78	0.003976	1.53	11.96	14.54	0.54
Reach 6	7035.61	25 YEAR	15.78	253.12	254.58	254.22	254.69	0.003918	1.47	10.74	13.79	0.53

Reach 6	7035.61	10 YEAR	12.58	253.12	254.46	254.12	254.55	0.003801	1.37	9.16	12.74	0.52
Reach 6	7035.61	5 YEAR	10.12	253.12	254.35	254.03	254.44	0.003702	1.29	7.86	11.81	0.5
Reach 6	7035.61	2 YEAR	6.67	253.12	254.17	253.87	254.24	0.003463	1.13	5.9	10.24	0.48
Reach 6	7035.6	REGIONAL	67.4	251.8	253.49	253.49	254.29	0.010495	3.96	17.01	150.64	1
Reach 6	7035.6	100 YEAR	20.95	251.8	252.63	252.63	253	0.013448	2.67	7.83	32.88	1
Reach 6	7035.6	50 YEAR	18.35	251.8	252.57	252.57	252.9	0.01391	2.56	7.16	31.84	1
Reach 6	7035.6	25 YEAR	15.78	251.8	252.51	252.51	252.81	0.014351	2.43	6.48	20.65	1
Reach 6	7035.6	10 YEAR	12.58	251.8	252.42	252.42	252.68	0.015172	2.26	5.56	11.82	1
Reach 6	7035.6	5 YEAR	10.12	251.8	252.35	252.35	252.57	0.015765	2.1	4.81	11.38	1
Reach 6	7035.6	2 YEAR	6.67	251.8	252.23	252.23	252.41	0.0173	1.87	3.56	10.54	1
Reach 6	7035.595		Culvert									
Reach 6	7035.59	REGIONAL	67.4	251.5	253.35	253.35	253.48	0.003395	2.17	79.4	116.31	0.55
Reach 6	7035.59	100 YEAR	20.95	251.5	252.56	252.56	252.94	0.013711	2.74	7.71	48.99	0.99
Reach 6	7035.59	50 YEAR	18.35	251.5	252.49	252.49	252.84	0.014274	2.64	6.98	21.95	0.99
Reach 6	7035.59	25 YEAR	15.78	251.5	252.41	252.41	252.74	0.014858	2.53	6.23	11.08	1
Reach 6	7035.59	10 YEAR	12.58	251.5	252.3	252.3	252.6	0.015333	2.43	5.18	8.58	1
Reach 6	7035.59	5 YEAR	10.12	251.5	252.22	252.19	252.47	0.014121	2.23	4.55	8.04	0.95
Reach 6	7035.59	2 YEAR	6.67	251.5	252.12	252.02	252.28	0.010296	1.78	3.75	7.3	0.79
Reach 6	7035.58	REGIONAL	67.4	251.12	252.98		253.04	0.00153	1.06	63.37	68.18	0.35
Reach 6	7035.58	100 YEAR	20.95	251.12	252.39		252.41	0.001135	0.71	29.51	46.53	0.28
Reach 6	7035.58	50 YEAR	18.35	251.12	252.34		252.37	0.001051	0.67	27.5	44.91	0.27
Reach 6	7035.58	25 YEAR	15.78	251.12	252.29		252.31	0.001007	0.63	24.96	42.79	0.26
Reach 6	7035.58	10 YEAR	12.58	251.12	252.21		252.22	0.00093	0.58	21.69	39.89	0.25
Reach 6	7035.58	5 YEAR	10.12	251.12	252.13		252.15	0.000877	0.54	18.83	37.17	0.24
Reach 6	7035.58	2 YEAR	6.67	251.12	252		252.02	0.000789	0.47	14.34	32.43	0.22
Reach 6	7035.45	REGIONAL	88.51	237	240.45		240.47	0.000233	0.95	259.89	147.7	0.16
Reach 6	7035.45	100 YEAR	27.52	237	238.73		238.76	0.000714	1.05	62.37	75.67	0.25
Reach 6	7035.45	50 YEAR	24.1	237	238.63		238.66	0.000733	1.02	54.83	70.81	0.26
Reach 6	7035.45	25 YEAR	20.73	237	238.52		238.55	0.000747	0.99	47.57	65.79	0.25

Reach 6	7035.45	10 YEAR	16.52	237	238.38		238.41	0.000749	0.92	38.75	59.12	0.25
Reach 6	7035.45	5 YEAR	13.29	237	238.27		238.29	0.000729	0.86	32.17	53.61	0.24
Reach 6	7035.45	2 YEAR	8.76	237	238.08		238.1	0.000638	0.73	23.21	45.04	0.22
Reach 6	7035.443	REGIONAL	88.51	237.4	240.12	238.96	240.38	0.001624	2.25	39.4	139.49	0.43
Reach 6	7035.443	100 YEAR	27.52	237.4	238.57	238.12	238.7	0.002663	1.63	16.85	69.02	0.48
Reach 6	7035.443	50 YEAR	24.1	237.4	238.48	238.06	238.6	0.002628	1.54	15.63	65.05	0.47
Reach 6	7035.443	25 YEAR	20.73	237.4	238.39	237.99	238.5	0.002584	1.44	14.35	60.91	0.46
Reach 6	7035.443	10 YEAR	16.52	237.4	238.27	237.91	238.36	0.002509	1.31	12.63	55.36	0.45
Reach 6	7035.443	5 YEAR	13.29	237.4	238.17	237.84	238.25	0.002424	1.19	11.2	50.72	0.43
Reach 6	7035.443	2 YEAR	8.76	237.4	238.02	237.74	238.07	0.002226	0.98	8.95	43.43	0.4
Reach 6	7035.442		Bridge									
Reach 6	7035.441	REGIONAL	88.51	237.4	239.34	238.97	239.85	0.005048	3.16	28.04	105.24	0.72
Reach 6	7035.441	100 YEAR	27.52	237.4	238.36	238.12	238.56	0.005056	1.98	13.9	59.48	0.64
Reach 6	7035.441	50 YEAR	24.1	237.4	238.28	238.06	238.46	0.005273	1.9	12.68	55.51	0.65
Reach 6	7035.441	25 YEAR	20.73	237.4	238.19	237.99	238.36	0.005578	1.82	11.39	51.34	0.65
Reach 6	7035.441	10 YEAR	16.52	237.4	238.07	237.91	238.22	0.006161	1.71	9.65	45.69	0.67
Reach 6	7035.441	5 YEAR	13.29	237.4	237.97	237.84	238.1	0.00689	1.62	8.19	40.97	0.69
Reach 6	7035.441	2 YEAR	8.76	237.4	237.81	237.73	237.92	0.009018	1.49	5.88	33.5	0.75
Reach 6	7035.44	REGIONAL	88.51	236.5	238.95		239.28	0.003771	3.04	55.66	41.51	0.62
Reach 6	7035.44	100 YEAR	27.52	236.5	237.96		238.11	0.003067	1.94	22.04	26	0.51
Reach 6	7035.44	50 YEAR	24.1	236.5	237.86		238.01	0.003052	1.85	19.68	24.54	0.51
Reach 6	7035.44	25 YEAR	20.73	236.5	237.76		237.9	0.003044	1.75	17.29	22.97	0.5
Reach 6	7035.44	10 YEAR	16.52	236.5	237.62		237.74	0.003019	1.62	14.26	20.82	0.49
Reach 6	7035.44	5 YEAR	13.29	236.5	237.5		237.61	0.002989	1.49	11.89	18.96	0.48
Reach 6	7035.44	2 YEAR	8.76	236.5	237.31		237.39	0.002866	1.27	8.51	15.95	0.45

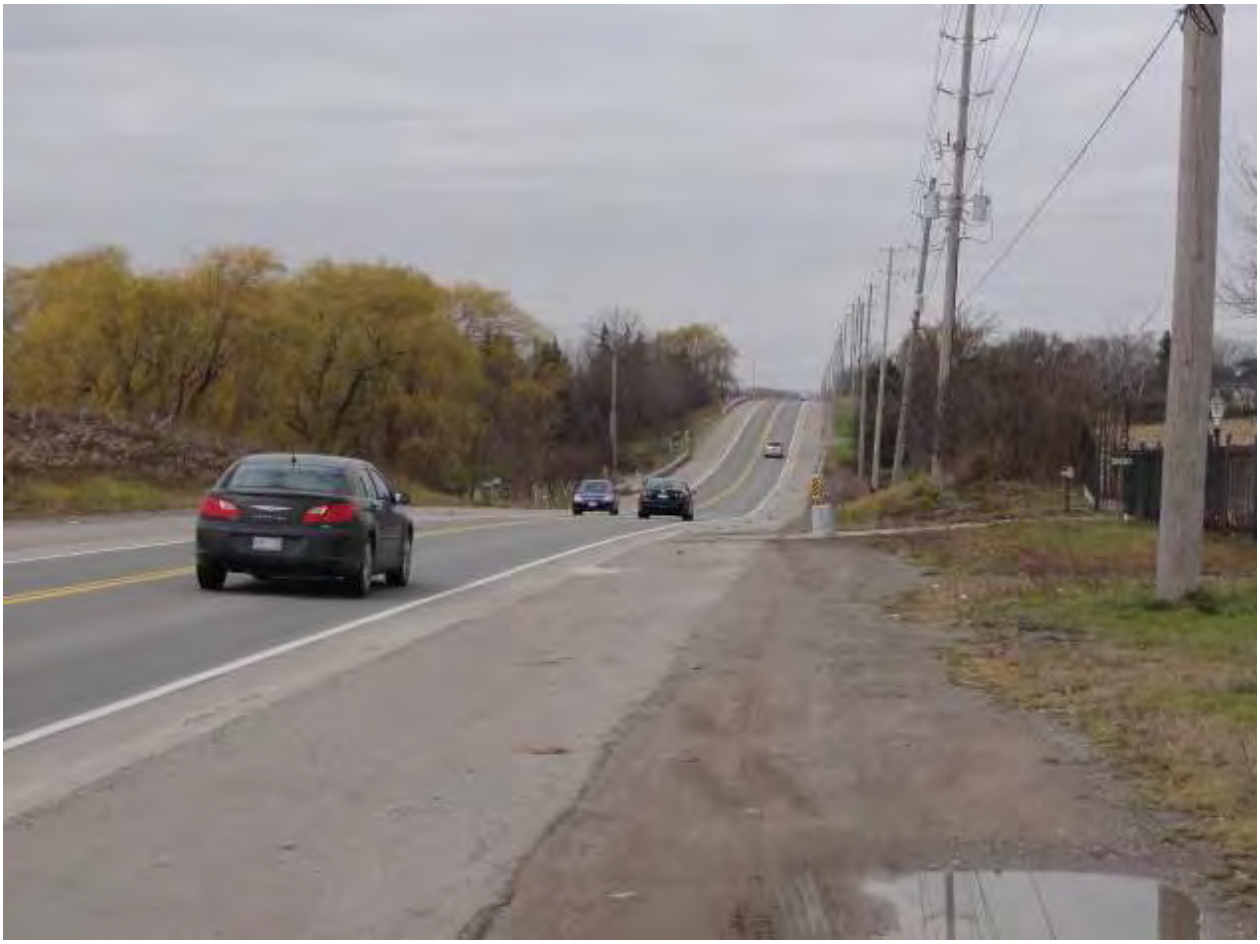
APPENDIX D

CULVERT PHOTOGRAPHS

Crossing 1 recently replaced with ditch pipes (either side of the road) connecting to Airport Road storm sewer
(Approximately 610m North of Mayfield Road)

Salt Creek

Norris Bridge (C2 -TRCA Crossing ID 2) Upstream End



Norris Bridge C-2 Low Point (Salt Creek Crossing Topography)

Culvert 4 (C4 -TRCA Crossing 3) Downstream End

Deans Culvert (C6-TRCA Crossing ID 4) Upstream End

Salt Creek Culvert (C7- TRCA Crossing ID 5)

Culvert 5 (Approximately 250m North of Old School Road) Upstream End

Culvert 8 (TRCA Crossing ID 6) Downstream End

Culvert 10 (TRCA Crossing ID 7) Downstream End

Culvert 11 (TRCA Crossing ID 8) Downstream End

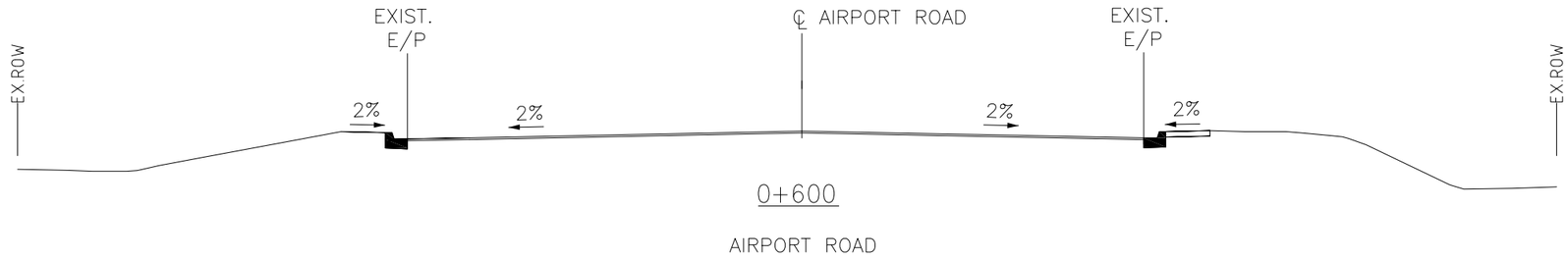
Culvert 12 (Approximately 50m South of King Street) Upstream End

Culvert 13 (TRCA Crossing ID 9 Upstream End)

APPENDIX E

AIRPORT ROAD TYPICAL SECTIONS

EXISTING CONDITION



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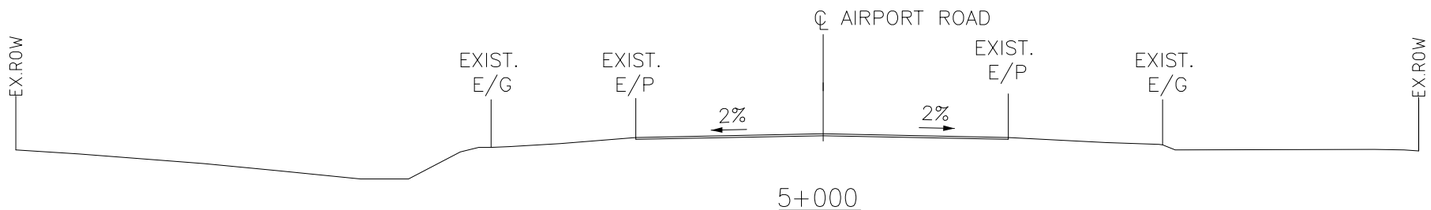
AIRPORT ROAD



5+000

AIRPORT ROAD

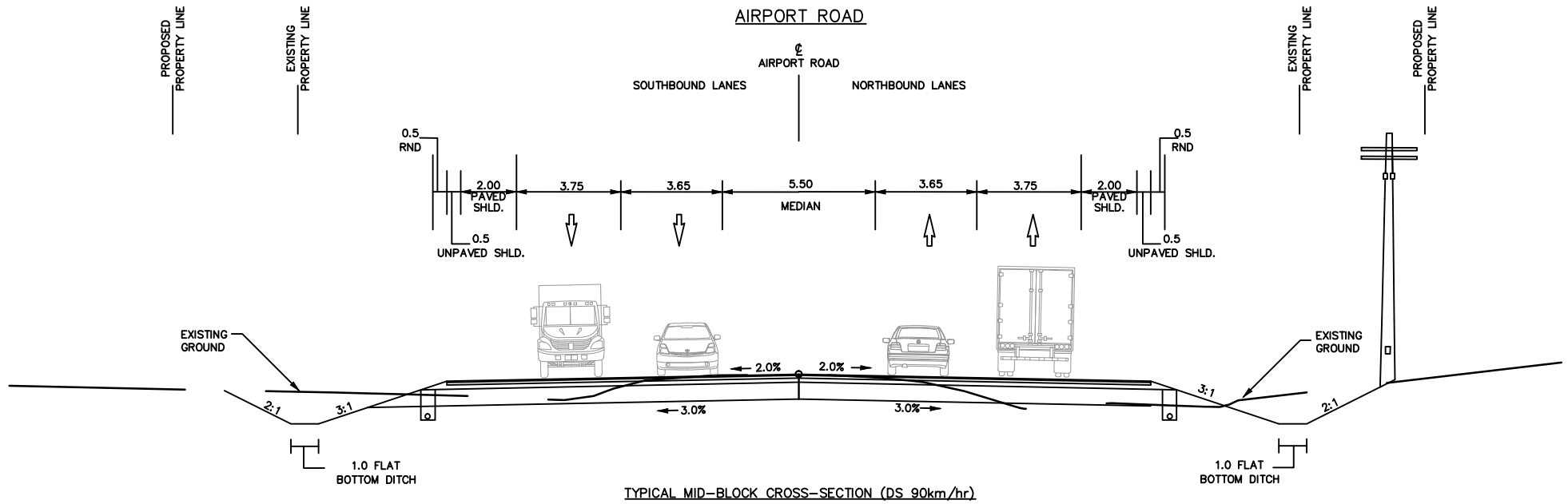
IBI GROUP

TYPICAL ROAD CROSS - SECTION

AIRPORT ROAD IMPROVEMENTS

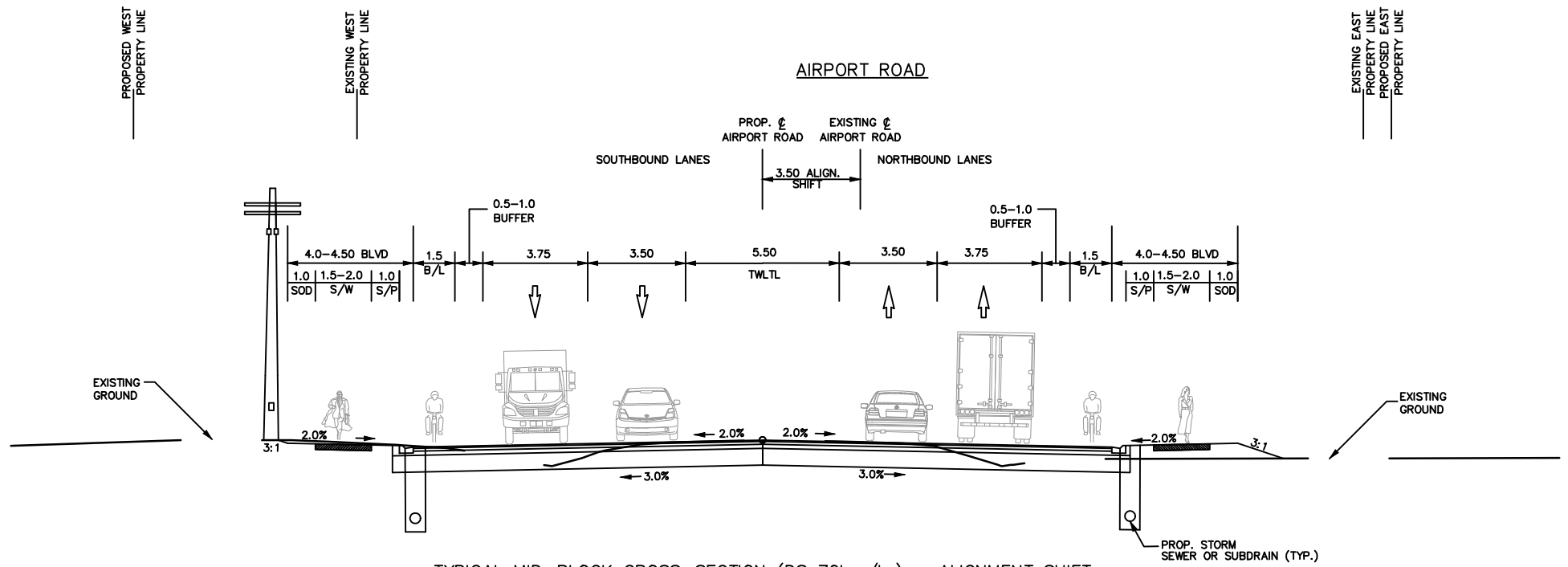
FIGURE 4

PROPOSED CONDITION



TYPICAL MID-BLOCK CROSS-SECTION (DS 90km/hr)

(1.0km NORTH OF MAYFIELD ROAD TO 610m SOUTH OF KING STREET)



TYPICAL MID-BLOCK CROSS-SECTION (DS 70km/hr) – ALIGNMENT SHIFT

(610m SOUTH OF KING STREET TO 600m NORTH OF KING STREET)

IBI GROUP

TYPICAL ROAD CROSS - SECTION

AIRPORT ROAD IMPROVEMENTS

FIGURE 4

APPENDIX F

TRCA MAPPING

TORONTO AND REGION Conservation
for The Living City

January 18, 2012

CFN 46587

BY MAIL AND EMAIL (Solmaz.Zia@peelregion.ca)

Solmaz Zia
Region of Peel
10 Peel Centre Drive, Suite B
Brampton, ON L6T 4B9

Dear Ms. Zia:

Re: Watercourse Crossing Chart and Maps
Airport Road (North of Mayfield Road to North of King Street)
Municipal Class Environmental Assessment (EA) - Schedule C
Humber River Watershed; Town of Caledon; Regional Municipality of Peel

Toronto and Region Conservation Authority (TRCA) staff met on site with Region of Peel staff on December 12, 2011 to identify watercourse crossings within the limits of the future Airport Road Environmental Assessment (EA). Nine (9) watercourse crossings were identified on site and will need to be reviewed as part of the EA.

Enclosed is a copy of the TRCA watercourse crossing chart and associated mapping used to identify each of the locations. Please complete the remaining sections of the chart as part of the EA. Once the Region has determined the proposed works at each of the crossing locations, as a result of the road works (i.e., culvert replacement, extension, do nothing), we will be in a position to provide further input regarding engineering studies and requirements. The Ministry of Natural Resources should also be contacted as soon as possible to identify any concerns under the *Endangered Species Act*.

Should you have any questions please contact me at extension 5717 or by email at slingertat@trca.on.ca.

Yours truly,

Sharon Lingertat

Sharon Lingertat
Acting Senior Planner, Environmental Assessment Planning
Planning and Development

Encl: Summary Sheet for Structure Sizing (Culvert, Bridge) at Watercourse Crossings
Mapping

BY EMAIL
cc: TRCA: Beth Williston, Senior Manager, Environmental Assessment Planning
Quentin Hanchard, Senior Manager, Development, Planning and Regulation
Gary Wilkins, Humber River Watershed Specialist

F:\Letters for Mailing\46587 – Watercourse crossings

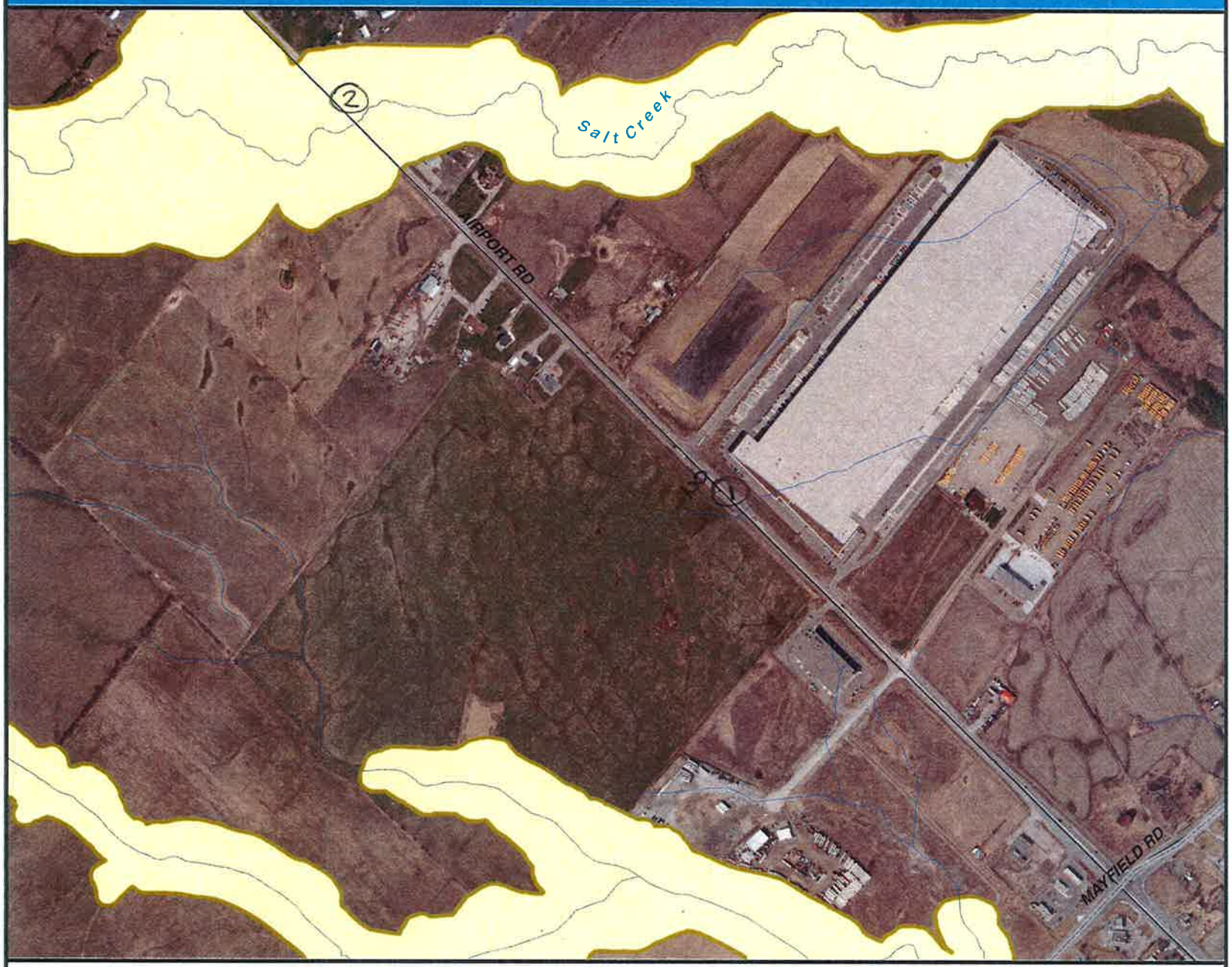
SUMMARY SHEET FOR STRUCTURE SIZING (CULVERT, BRIDGE) AT WATERCOURSE CROSSINGS

Conservation for The Living City

DATE CHART LAST REVISED: Monday, January 16, 2012
DATE OF SITE VISIT(S): Monday, December 12, 2011
PROJECT NAME: Airport Road EA (1 km North of Mayfield Road to King Street)
PROPONENT: Region of Peel
TRCA PROJECT MANAGER: Sharon Lingertat
MUNICIPAL PROJECT MANAGER: Solmaz Zia
TRCA FILE #: 46587

		1	2	3	4	5	6	7	8	9	10
GEOGRAPHIC AREA											
TRCA STAFF TO COMPLETE	Watercourse Crossing Number (to correspond with tables or photos)	1	2	3	4	5	6	7	8	9	10
	Location	North of Purdue Court	Salt Creek - Approx. 1.5 km North of Mayfield Road	Approx. 212 m South of Healey Road	Salt Creek (south bend) - Approx. 450 m North of Healey Road	Salt Creek (north bend) - Approx. 860 m North of Healey Road	Approx. 1.7 km South of King Street	Approx. 940 m South of King Street	Approx. 271 m South of King Street	Approx. 105 m North of King Street	Approx. 729 m North of King Street
	TRCA Property in close proximity to the project area? (Y/N)	No	No	No	No	No	No	No	No	No	No
	If yes, please describe										
Ontario Regulation 166/06 Permit Requirments											
TRCA STAFF TO COMPLETE	Within a Regulated Area	No	Yes	No	Yes	Yes	No	No	No	No	No
	Within a Wetland/Area of Interference ? (Y/N)	No	No	Yes	No	No	No	No	No	No	No
	Within a Watercourse? (Y/N)	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Within a Regional Storm Floodplain** (Y/N) (>50 ha upstream drainage/<50ha* upstream drainage)	No	Yes	TBD	Yes	Yes	TBD	TBD	TBD	TBD	TBD
	*= Regional Storm Floodplain										
HABITAT REVIEW											
TRCA STAFF TO COMPLETE	Fish Habitat	No	Yes	Yes	Yes	Yes	Yes	Yes	TBD	TBD	TBD
	Groundwater Upwellings (Y/N)	No	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
	Fish Passage Within Culvert/Structure? (Y/N)	No	Yes	TBD	Yes	Yes	TBD	TBD	TBD	TBD	TBD
	Managed for Red Side Dace (RSD) Habitat (Y/N)	No	Yes	Yes	Yes	Yes	Yes	Yes	TBD	TBD	TBD
	Is the project a HADD (Y/N)	No	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
	Is the project a MA HADD (Y/N)	No	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
	Timing Window? (Cold = July 1 to September 15) (Warm = July 1 to March 31)	N/A	RSD (July 1 to Sept 15)	RSD (July 1 to Sept 15)	RSD (July 1 to Sept 15)	RSD (July 1 to Sept 15)	RSD (July 1 to Sept 15)	RSD (July 1 to Sept 15)	TBD	TBD	TBD
	In close proximity to a TRCA Habitat Improvement Plan area?	N/A	No	No	No	No	No	No	No	No	No
EXISTING STRUCTURE DETAILS											
CONSULTANT TO COMPLETE	Existing Structure (L x W x H and type)										
	Open or Closed Footed?										
	Photo record of culvert inlet and outlet, date of photos (attached)										
	Structure assessment to determine the life expectancy of the structure										
	Is there is any infrastructure (hydro, phone, etc) which may restrict a larger structure?										
	Hydraulic capacity of existing structure is (adequate/inadequate) to convey Regional Storm?										
PROPOSED STRUCTURE DETAILS AND REQUIREMENTS											
CONSULTANT TO COMPLETE	Proposed Structure (L x W x H and type)										
	Open or Closed Footed?										
	Extension only proposed? (Y/N)										
	Removal, Replacement only proposed?										
	Removal, Replacement and Lengthening Proposed? (Y/N)										
	Estimated cost for design alternative										
	Hydraulic capacity of proposed structure is (adequate/inadequate) to convey Regional Storm?										
	Afflux (rate) and/or rise in the channel										
	Terrestrial Passage? (Y/N)										
	Are there any existing or proposed trails within the valley system? (Y/N)										
	Embedment and substrate for Aquatic Passage Required? (Y/N)										
STUDY REQUIREMENTS											
TRCA STAFF TO COMPLETE	Hydraulic Analysis (Y/N)	No	Yes	Yes - if the drainage area is greater than 50 ha	Yes	Yes	Yes - if the drainage area is greater than 50 ha	Yes - if the drainage area is greater than 50 ha	Yes - if the drainage area is greater than 50 ha	Yes - if the drainage area is greater than 50 ha	Yes - if the drainage area is greater than 50 ha
	Is there an existing HEC RAS model at TRCA? Yes? No?	No	Yes	No	Yes	Yes	No	No	No	No	No
	Meander Belt Analysis (Y/N) (if an extension/replacement only)	No	TBD	No	TBD	TBD	No	No	No	No	No
	100-year Erosion Study (Y/N) (if an extension/replacement only)	No	TBD	No	TBD	TBD	No	No	No	No	No
	Geotechnical Report provided for review (Y/N)	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
SUMMARY OF APPROVALS REQUIRED											
TRCA STAFF TO COMPLETE	Ontario Regulation 166/06 Permit required? (Y/N)	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	DFO HADD - TRCA to coordinate DFO requirements	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CONSULTANT TO COMPLETE	MNR contacted? (Y/N)										
	Transport Canada contacted for navigable waterways? (Y/N)										
ADDITIONAL NOTES											
RSD = Redside dace			Peel must contact MNR directly to confirm requirements under the *Endangered Species Act*	Peel must contact MNR directly to confirm requirements under the *Endangered Species Act*	Peel must contact MNR directly to confirm requirements under the *Endangered Species Act*	Peel must contact MNR directly to confirm requirements under the *Endangered Species Act*	Peel must contact MNR directly to confirm requirements under the *Endangered Species Act*	Peel must contact MNR directly to confirm requirements under the *Endangered Species Act*	Peel must contact MNR directly to confirm requirements under the *Endangered Species Act*	Peel must contact MNR directly to confirm requirements under the *Endangered Species Act*	Peel must contact MNR directly to confirm requirements under the *Endangered Species Act*
			Meander belt and 100 year erosion analysis requirements to be determined once Peel has provided direction regarding culvert/bridge replacement or extension		Meander belt and 100 year erosion analysis requirements to be determined once Peel has provided direction regarding culvert/bridge replacement or extension	Meander belt and 100 year erosion analysis requirements to be determined once Peel has provided direction regarding culvert/bridge replacement or extension					

Airport Road EA



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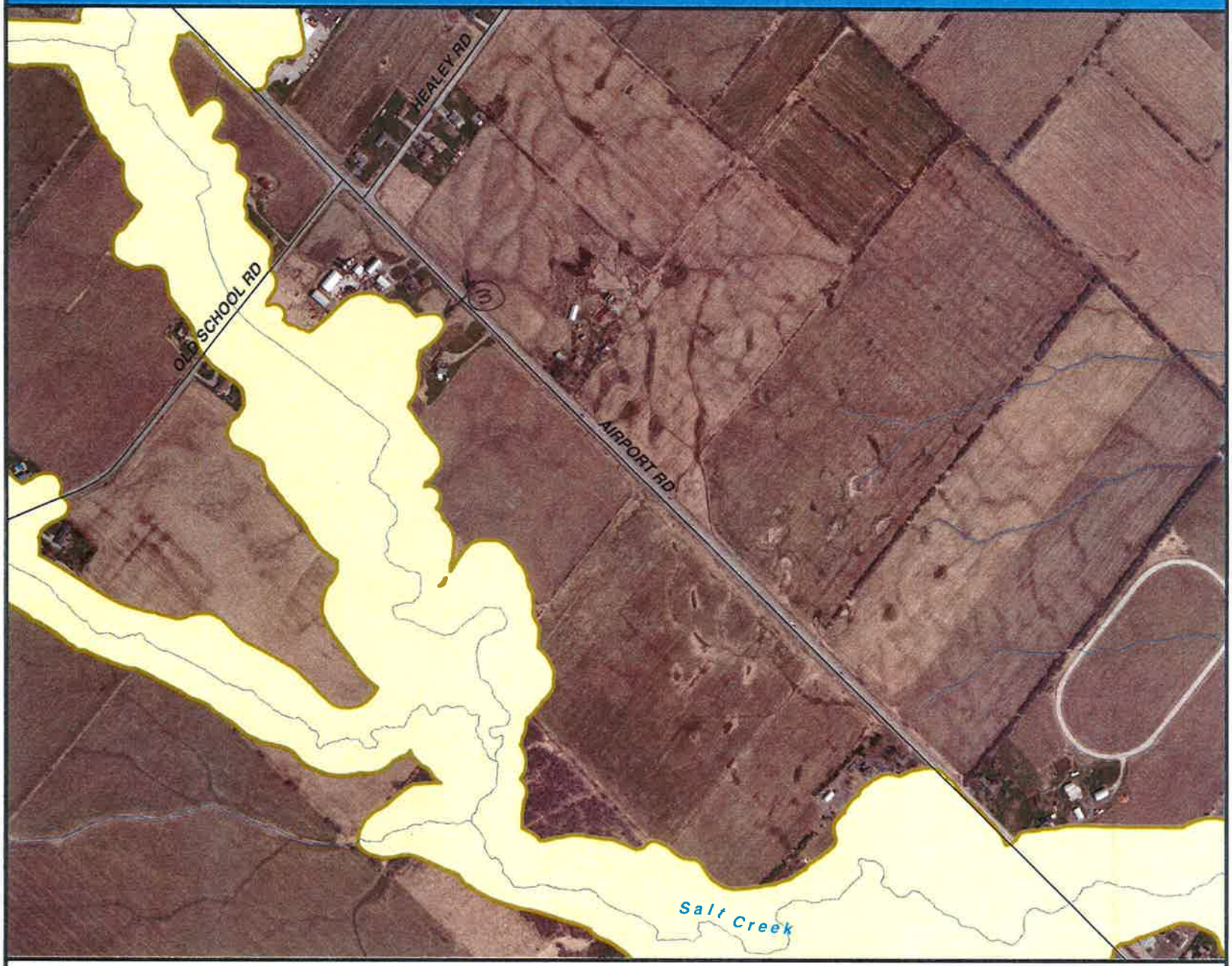
Legend

- Watershed Boundary
- Local Boundary
- Regional Boundary
- Watercourses_TRCA
- Regulation Limit

TORONTO AND REGION Conservation
for The Living City

Airport Road EA



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Legend

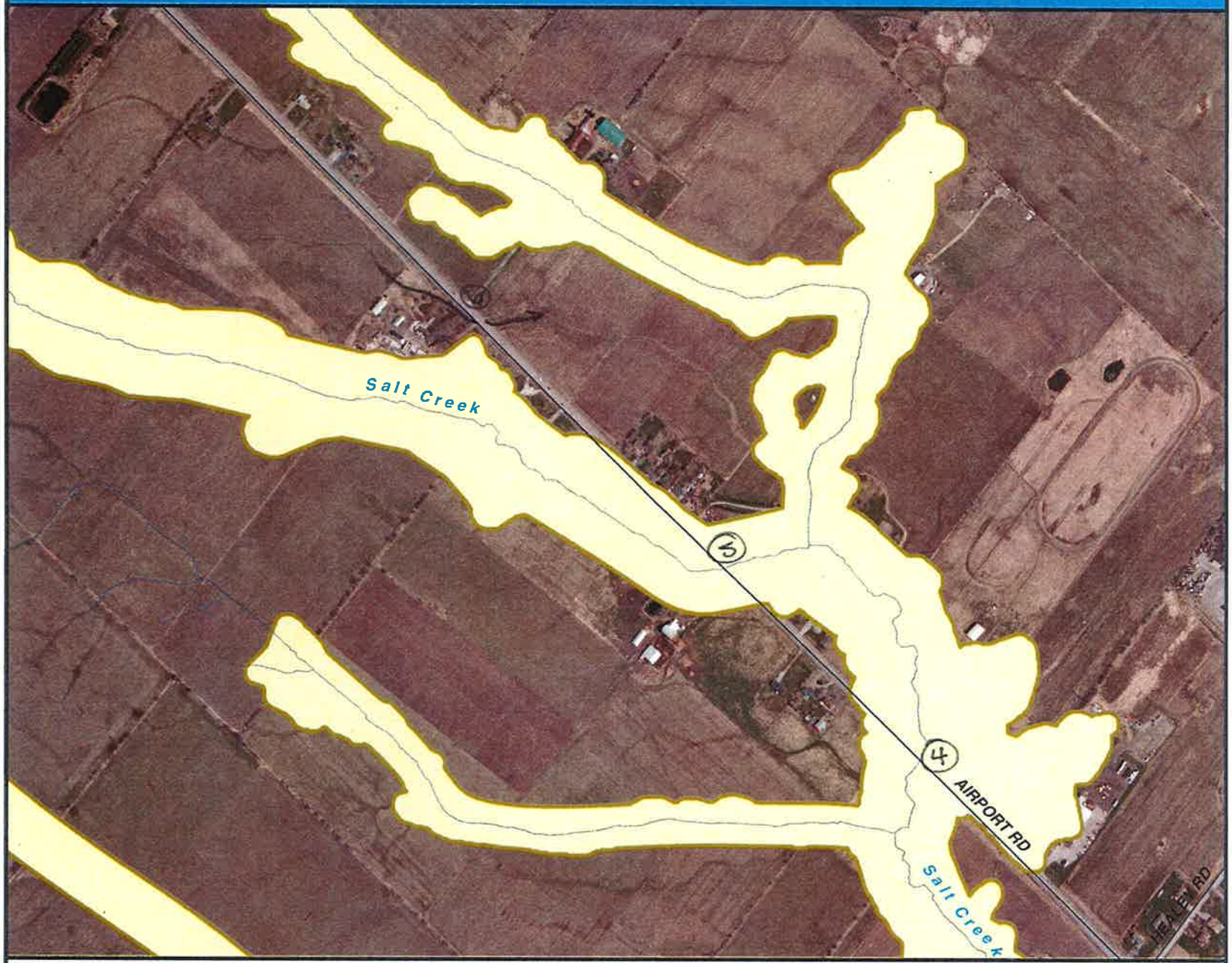
- Watershed Boundary
- Local Boundary
- Regional Boundary
- Watercourses_TRCA
- Regulation Limit

Disclaimer:
The Data used to create this map was compiled from a variety sources & dates. The T.R.C.A. takes no responsibility for errors or omissions in the data and retains the right to make changes & corrections at anytime without notice. For further information about the data on this map, please contact the T.R.C.A. GIS Department. (416) 661-6600

Ortho-photography: First Base Solutions

Toronto and Region Conservation for The Living City

Airport Road EA



1:8,253

Legend

- Watershed Boundary
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- Regional Boundary
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- Regulation Limit

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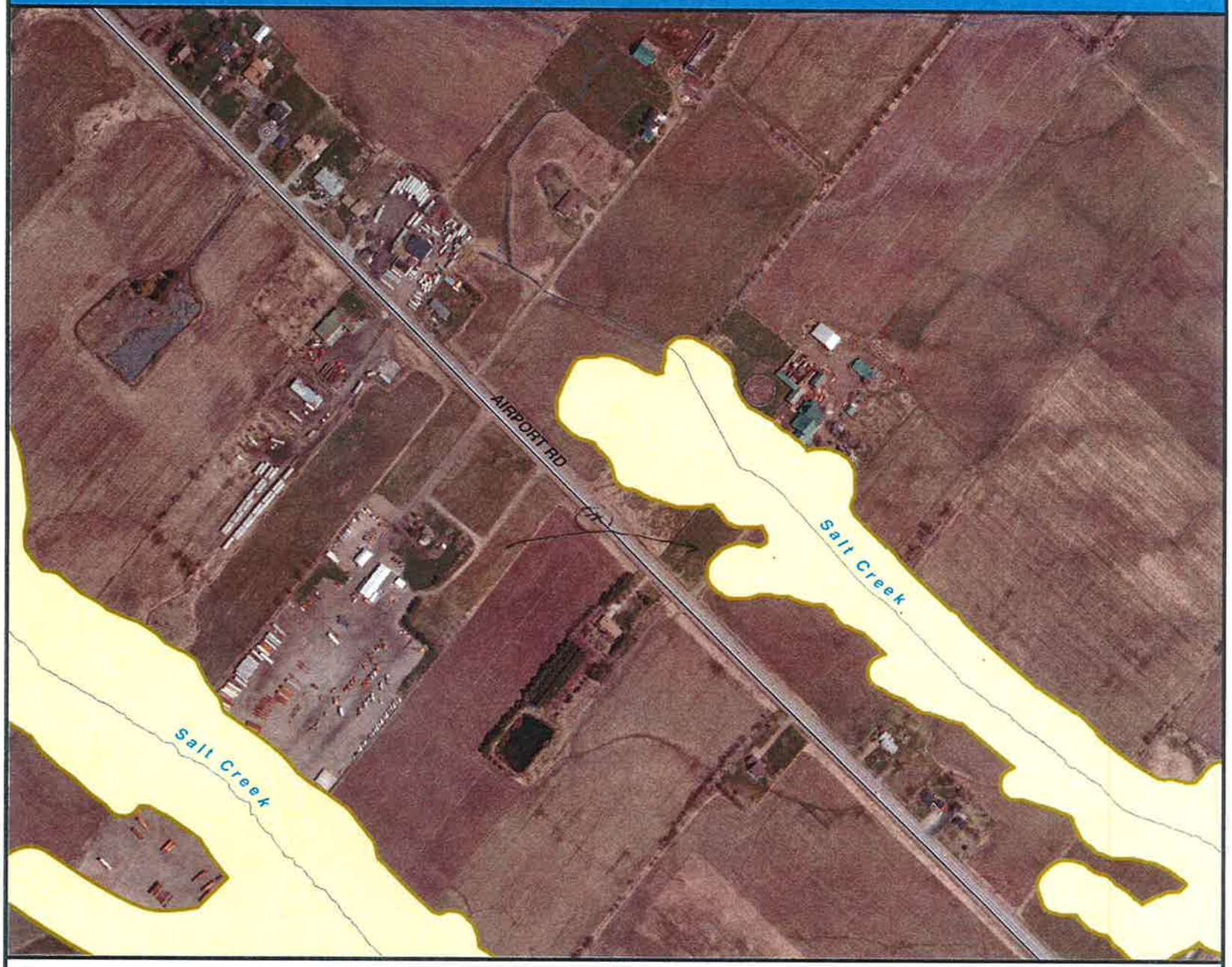
Ortho-photography: First Base Solutions

TORONTO AND REGION Conservation for The Living City

Airport Road EA



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Legend

- Watershed Boundary
- Local Boundary
- Regional Boundary
- Watercourses_TRCA
- Regulation Limit

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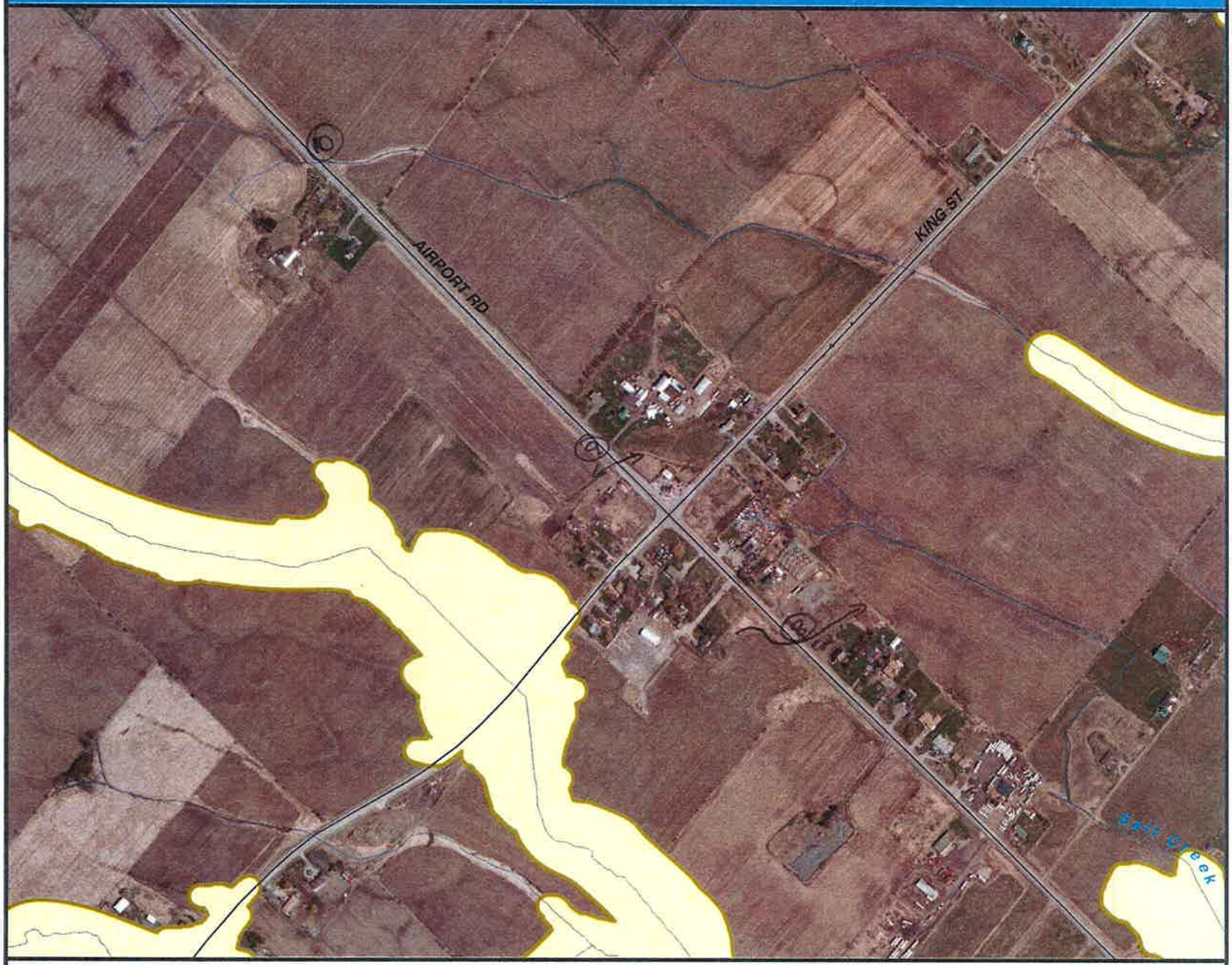
Ortho-photography: First Base Solutions

Toronto and Region Conservation for The Living City

Airport Road EA



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Legend

- Watershed Boundary
- Local Boundary
- Regional Boundary
- Watercourses_TRCA
- Regulation Limit

Toronto and Region Conservation for The Living City

APPENDIX G

MEANDER BELT ASSESSMENT